



INDICATORS OF THE DIFFERENCE AND TREND OF CHANGES IN THE PUPIL'S BODY COMPOSITION, DEPENDING ON GENDER

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Abstract

Anthropometric characteristics (height and weight) are used in the assessment of the morphological status of an individual, and on the basis of the results of BMI bring certain estimates and conclusions. BMI, as a statistical measure, is used in many public health campaigns as an approximate measure of the ideal body mass and the degree of nutrition of a population. The research covered the students of high school in Pale, East Sarajevo (Bosnia and Herzegovina). The sample consists of a total of 115 respondents, 55 male (average height 183,07±9,01cm, body weight 68,77±10.11kg, BMI 20,72±2.54g/m²) and 60 female (average height 168,70±7,29; average body weight 56,03±8,66Kg; BMI 19,82±3,03kg/m²) who regularly attended physical education in secondary vocational school, , aged 16±0.5 years. The main goal of the research was to determine and analyze differences in BMI parameters between male and female students, aged 16±0.5 years, and determine the trend of changes. Using the T-test module, the obtained results confirmed that there are statistically significant differences in body height ($t=10,47$; $p<0.001$) and body weight ($t=7,72$; $p<0.001$), while in BMI values there are not statistically significant differences ($t = -0.47$, $p>0.001$).

Key words: Body mass index, obesity, development trend, morphological status.

INTRODUCTION

The primary basis of psychosomatic status is the growth and development of an organism that defines quantitative and qualitative anatomical, physiological and psychological changes, and the development of sensory and motor skills. In their phylogenesis and ontogenesis, a number of complex endogenous (heredity, race, hormonal status, sex) and exogenous factors nutrition, socioeconomic condition, geographically-climatic, birth weight, chronic diseases, seasonal differences, secular increase, physical activity (Dumić, and Mardešić, 2003; Pavlović, 2003; Mišigoj-Duraković, 2008; Šegregur et al., 2010).

Today we live mainly in terms of the accelerated pace, poor quality and unhealthy diet, reduced or lack of movement, in one word - hypokinesian lifestyle. Hypokinesia consequences are many and most are related to diseases of the cardiovascular system, the respiratory system and the emergence of diabetes. In addition, it can be stated that an even growth and development of the individual lead to a negative trend in the development of some anthropometric characteristics and even the physical status of the individual (Pavlović and Pavlović, 2016). Hypokinesia is often more expressed in older than in younger school age. Younger children, unconsciously, mostly

through the game, neutralize this problem, and with age this problem increases (Kohl and Hobbs, 1998). Diagnosis of body weight is often the subject of research aimed to gain an insight into the current status of the defined population trends and potential negative growth and development in a given time period (Pavlović, 2017). Underweight among children and adolescents is associated with higher risk of infectious diseases, and for girls of childbearing age, is associated with adverse lifelong overweight and obesity (Ezzati et al., 2017; Singh et al., 2008). Physical activity, even without reducing calorie intake, is a very effective method for reducing the risk of chronic illnesses, regardless of the degree of obesity (Ross et al., 2000; USDHHS, 1996). In several recent studies (Haskell et al., 2007) it has been established that the risk to the health of an obese person regularly engaged in some physical activity is no greater than the people with an ideal body mass index who are physically inactive.

The findings of the Wickelgren research (Wickelgren, 1998) suggest that the ginoïd type of fat distribution is healthier than the android type, that is, it is less risky to have excess pounds on the hips and thighs than in the area of the abdomen, that is, the accumulation of fat deposits in that part increases the risk from heart disease and diabetes (Zeigler and Filer, 2000). Booth, Chey, Wake, et al. (2003) conducted a study in order to determine changes in the prevalence of overweight and obesity among young Australians (aged 7-15 years), 1969-1985. ended in 1997. year. The results showed that between 1985 and 1997., the prevalence of overweight and obese population has increased by 60-70%, obesity 2-4 times and a combination of body weight and obesity has doubled. The findings were consistent for both sexes. For the period 1969 to 1985 there were no changes in the prevalence of overweight and obesity in girls but among boys the prevalence of overweight increased by 35%, the prevalence of obesity has tripled, and the prevalence of overweight and obesity combined has increased by 60%. The results of the six-year follow-up of 296 patients (aged 10 to 16 years in 2001 and 2007) by Ekblom, et al. (2009) showed that there are no differences in BMI in sixteen year olds and low values of aerobic capacity and high BMI at age 10 years predicts obesity at the age of 16. There was no difference in the prevalence of overweight plus obesity between the sample 2001 and 2007. As a conclusion was stated that normal weight and good aerobic fitness at 10 years old children reduce the risk of elevated BMI in relation to 16-year olds. According to these statistics, it is very possible that the teachers of physical education will more and more meet with obese children in their work. Perception of body weight is a strong determinant of nutri-habit and weight management in adolescents. Adolescents who have normal weight, but think of themselves to be overweight, have a higher risk of eating disorders such as anorexia nervosa (Desmond, 1986). On the other hand, adolescents who are overweight but do not see themselves as such, will probably not participate in weight control such as diet and exercise. The prevalence of obesity in children has been on the rise globally and currently constitutes a public health problem (Sadoh et al., 2016; Wang and Lobstein, 2006).

According to Ogden, Carrol, Curtin, Lamb, & Flegel (2010) it is estimated that 15 to 20% of American children aged 6 to 17 years of age have an excessive body mass, which is an alarming result. Even in some studies it is said that this obesity goes to every third inhabitant, which is about 80 million (Sharkey and Gaskill, 2008). The concerning problem of obesity determined the European Union to consider the day of May 22, 2010 the first European Obesity Day (EOD). EOD is a paneuropean independent initiative that unites all the responsible factors for making the public aware regarding the weight excess problems, and recognizing obesity as a chronic illness. Recent studies emphasized the fact that Romania is the third country (in Europe, and in the Balkans) with the highest percentage of obese persons having a body mass index of BMI > 30. (Balint et al., 2010).

Measurement of the morphological characteristics of the human body, processing and studying the obtained data are an integral part of a number of basic applied research, primarily in the field of sports medicine, military and industrial medicine, as well as in the field of physical education and sports (Malina, 1994; Jakonić, 2003). Anthropometric measurements and data processing of larger groups of respondents are performed within scientific researches and allow obtaining the average values of individual anthropometric parameters in observed populations. The so-called longitudinal research method, i.e. monitoring and measuring the same group of people over the years, provides an insight into the dynamics of the development of children and youth in a given area and in certain conditions of life (Hedley et al., 2004) and by transversal method of research, i.e. by a one-time measurement of a larger number of respondents of a particular population, it is provided an insight into the average state of physical development. Health workers and experts in the field of physical culture are able to use anthropometric measurements for practical purposes, in order to assess the individual anthropometric status of the examined individuals.

The analysis of the results of anthropometric measurements enables the setting of norms, using standard methods and index methods. The evaluation of the morphological characteristics of the body's structure through the index has a limited, relative value and gives the examiner only a quick orientation on the body's development of the subjects and is primarily applied in adults (Pavlović, 2015). BMI is used to define the medical standard of obesity in many countries since the mid-1980s, and this method of assessment is also used in statistics of the World Health Organization. At the end of the 1990s, BMI became popular amongst the general public, through various social health programs, which were mainly sponsored by Western governments - as an incentive to spread awareness of healthy lifestyles and healthy eating. BMI as a statistical measure is used in many public health campaigns as an approximate measure of ideal body weight. It is applicable to subjects between 18 and 65 years of age, but it is not suitable for children, pregnant women, athletes with high muscular masses and the elderly. Increased BMI values increase the risk of cardiovascular diseases (hypertension, myocardial infarction, and pulmonary diseases (sleep apnea sindrom). Body composition is an important indicator of the physical fitness and general health of athletes

(Warner et al.; Van der Ploeg et al., 2003) and today, it is often discussed on this topic in scientific literature. According to Claessens, Hlatky, Lefevre, & Holdhaus (1994), the shape of the body and its morphology, in addition to physical abilities, psychological characteristics and energy capacities of the system, is one of the main factors determining sports performance. Therefore, the diagnosis of body condition is often the subject of research, based on which a real insight into the current state of the defined population and possible negative or positive trends of growth and development over a certain period of time (Sorensen et al., 2000; Dopsaj et al., 2005). However, the basic critique of BMI as an indicator of child nutrition is that it does not directly measure the amount of fatty tissue. It would be possible for a teenager with well-developed muscles to describe himself as an overweight person, and a child with normal BMI to have excess fat on certain parts of the body. In children, simply weigh the masses and squares of height, i.e. BMI cannot be applied due to changes in bodybuilding during growth and development. The degree of development differs among different age, gender and ethnic groups. Therefore, the determination of obesity in children is done using special curves of the so-called. BMI percentiles that are adapted to the age and gender of the child. However, a large number of children with high BMI are indeed obese, but in order to be able to talk about obesity, other parameters such as WHR, WSR, etc. should be used. BMI percentiles are a clinical indicator used to compare one child to another child of the same age (Vasić et al., 2011).

In connection to the above mentioned, this research was carried out with the aim of diagnosing somatic status of pupils of school age 16 years and possible differences in quantitative indicators of somatic status, depending on sex, using BMI.

MATERIAL AND METHODS

The research covered the students of high school in Pale, East Sarajevo (Bosnia and Herzegovina). The sample consists of a total of 115 respondents, aged 16 ± 0.5 years, divided into two sub-classes: 55 male students (average height $183,07 \pm 9,01$ cm, body weight $68,77 \pm 10,11$ kg, BMI $20,72 \pm 2,54$ g/m²) and 60 female students (average height $168,70 \pm 7,29$; average body weight $56,03 \pm 8,66$ Kg; BMI $19,82 \pm 3,03$ kg/m²) who regularly attended physical education in secondary vocational school. The measurements were done in the physical education room of the secondary vocational school in Pale (East Sarajevo) according to the IBP protocol. All students participated in measurement voluntarily.

Variables taken for the analysis of somatic status are:

1. Body height (cm),
2. Body weight (kg),
3. Body Mass Index (BMI-kg/m²).

The body height was measured by an Anthropometer, while the body weight was measured by a digital scale. The data obtained in the research were processed in the statistical package SPSS Statistic 20.0. The results were obtained by descriptive statistics and the T-test for independent samples. For the assessment of students nutrition status, the BMI=kg/m² and percentile range standard was applied. (NCHS, USA, 2000 and WHO).

Table 1. Values of the of BMI and Percentile range pupils (National Center for Health Statistics CDS Growth Charts: United States 2000)

BMI kg/m ²	Percentile range	Status
<18.5	<5 th	Malnutrition
18.6-24.9	5 th to 85 th	Normal nutrition
25-29.9	85 to <95 th	Excessive nutrition
30-34.9	>95 th	Obesity I degree

RESULTS AND DISCUSSION

Obesity represents new world epidemics and is among the most serious health issues in Europe. In order to have a real chance to fight this phenomenon and keep it under control, all factors involved in this equation must get involved pragmatically for implementing an integrated management (Balint et al., 2010).

The research was carried out with the aim of diagnosing the somatic status of students 16 ± 0.5 years old and the difference in quantitative indicators of somatic status depending on gender. Although the population of the student was defined with 115 subjects, final results determined this population and determined the trend of changes in the psychosomatic status of the body with the emphasis on changes in physical status. It is known that excessive nutrition in children and adolescents is a complex disorder whose incidence has increased significantly in recent years, which is a major health problem in the developed world (Al-Nakeeb et al., 2007). It mostly occurs as a result of insufficient physical activity and sedentary lifestyle from the earliest age. Previous researches have suggested that regularity in physical activity, before any genetic factor, is associated with health. Development is now moving towards the advancement of technology, however, the performance and inclusion of children and adults in activities of a physical character are minimized. The assumption is that reduced physical activity has a major negative impact on the school populations psychomotor and psychosomatic effects. Studies have shown that the incidence of obesity is increasing in all age groups in both sexes. The more the index exceeds the scope of normal value, the greater the risk of the development of various diseases of the heart, diabetes and high blood pressure. BMI should be understood as a framework method because the actual state of health of a person should be assessed in a wider medical context (Pavlović, 2017).

Maintaining a normal body weight is one of the most important ways of keeping yourself healthy, and avoiding the risk of getting ill. Body weight and health state are in a interdependence relation. The health state can influence, in a positive or negative manner, the body weight, and vice-versa, any drop or increase in weight can influence, in a positive or negative manner, the health. An increase in body weight raises the risk for different health issues to appear, such as: cardio-vascular diseases, heart failure, arterial hypertension, myocardial infarction (heart attack), cerebrovascular accident (stroke), joint disorders, some types of diabetes, some types of cancer (Balint et al., 2010).

Table 2. Descriptive statistics of students

Variables	Gender	Mean	Min.	Max.	Rang	Std. Dev.	CV%
Body Height (cm)	M	183.07	168.00	200.00	32	9.01	4.92
	F	168.70	165.00	178.00	13	7.29	4.32
Body Weight (kg)	M	68.77	55.00	87.00	32	10.11	14.70
	F	56.03	49.00	79.00	30	9.66	17.24
BMI (kg/m ²)	M	20.72	17.45	24.11	6.66	2.54	12.25
	F	19.82	16.74	24.35	7.61	3.03	15.36

Table 3. Gender differences (T-test for independent samples, 2-tailed)

Variables	Gender	Mean± Std. Dev	t-value	p<0,001 Sig.(2-tailed)	95% Confidence Interval of the Difference	
					Lower	Upper
Body Height (cm)	M	183.07±9.01	10.47	0.000*	10.39	19.33
	F	168.70±7.29				
Body Weight (kg)	M	68.77±10.11	7.72	0.000*	4.98	16.14
	F	56.03±9.66				
BMI (kg/m ²)	M	20.72±2.54	-0.47	0.884	-2.13	3.96
	F	19.82±3.03				

Legend: Mean (mean value); Std.Dev.(standard deviation); t-value (t test); p (level of significance p<0.001)

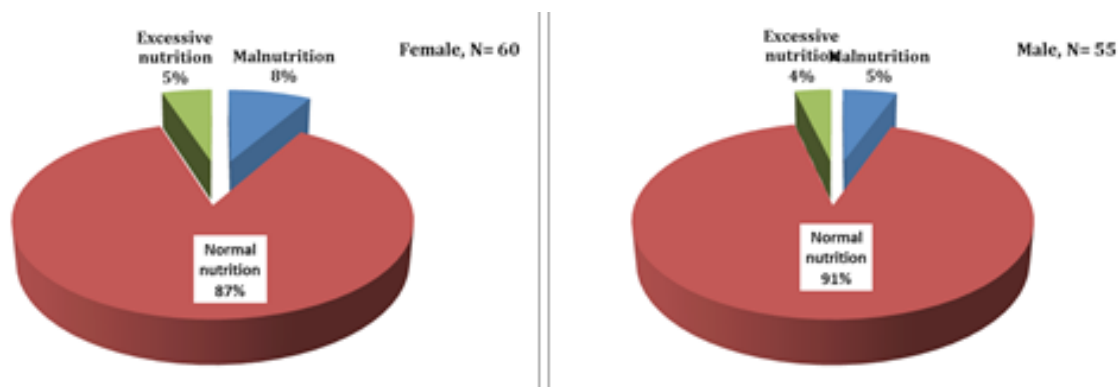


Figure 1. Trend of change nutrition

Table 2 represents the numerical quantitative indicators of the physical status of the analyzed sample of students who provide the necessary information on their physical status. The average body height of the male students (183.07cm) is considerably more than the female students (168.70cm), which means 10 cm more in male than female. It is evident that the values of CV% show a higher homogeneity of body height in female (4.32%) compared to male students (4.92%). Almost identical conclusions can be made in the values of the body weight of the analyzed sample. The average male students weight is about 69kg, which is 10kg more than the female student's weight. Also, female students showed less homogeneity of results (CV% 17.24) than male students (CV% 14.70).

Generally, in this variable, both sub-samples are defined with a significant low homogeneity, which is confirmed by the values of the range of results (Rang). Body Mass Index (BMI) as an indicator of the physical status of both sub-samples showed quantitatively quiet equal values (BMI male pupils 20.72kg/m², BMI female pupil 19.82kg/m², which is a significant homogeneity in relation to the average values of body height and body weight. However, by inspecting the minimum and maximum BMI values of both sexes, their range as well as coefficients of variation, it can be concluded that the sample is extremely heterogeneous. This is an indicator of the unequal trend of growth and development, or even physical status of students.

To determine statistically significant differences between sexes, depending on numerical parameters for the assessment of body status, the T-test for the significance level $p < 0.001$ was applied (Table 3). By inspecting the table, it is evident that there are significant differences in anthropometric measurements of body height ($t = 10.47$; $p < 0.001$) and body weight ($t = 7.72$; $p < 0.001$), unlike BMI where statistically significant difference between sexes is not evident ($t = 0.884$; $p > 0.001$). This is, however, an indicator of a period of where there are no major statistically significant morphological changes that characterize male and female population of the students, although it is evident that they exist.

If we look at the individual contribution to this cumulative redistribution of the trend of physical changes (Fig. 1), we would come to the conclusion that normal nutrition predominates in both sub-classes (91% male and 87% female students), malnutrition (5% of male students and 8% of female students) and excessive nutrition (4 of male students and 5% of female students). These indicators are another confirmation that this 16-year-old age was not morphologically shaped and homogenized, since there are extremely small female (BMI 16.74kg/m²) and the increased values female (BMI 24.35g/m²) that are still in the phase of turbulent changes, and the possible consequence of extremely low or high values of defined anthropometric parameters, as a consequence of genetic modifications and the environment of an individual (Koziel and Gomula, 2017). From the aspect of health diagnosis, BMI values and the degree of nutrition of our 6% male students and 9% of female students are in the category of increased nutrition, which is not alarming. However, if it is taken

the students status, physical activity, body composition, bones, muscles then this is not a reliable conclusion. Perhaps one of these students is active in some sports such as athletics, martial sports where there is no ballast tissue, but an increase in BMI is an indicator of the active body mass, bones, muscles, extracellular fluid, etc. Also, these BMI values may have been predetermined much earlier, when they were about 10 years old. This is confirmed by the results of a six-year follow-up study of about 300 subjects aged 10-16 years, (Ekblom et al. 2009) who have shown that high BMI at age 10 predicts obesity at the age of 16, followed by decreased aerobic capacity. At every age, the average body height of girls is closer to the body height that they reach at maturity which is not the case with boys. Girls reach approximately half of the total body height (that they will reach in life) in their second year of life, and boys reach that when they are two and a half years old (Abernethy et al., 2012). On average, girls with burning acceleration, reach peak body mass at 10.7 years of age. Boys, on the other hand, achieve this at 12.6 years. The girls who matured at the average (expected) speed were 12.1 years old and boys 14.0 years at the time of reaching the peak of the body mass (Abernethy et al., 2012, Hagg and Taranger, 1991). All these are reference indicators that sex differences are evident and have a corresponding growth trend, as confirmed by the research (Koziel and Gomula, 2017). The results of our research are in accordance with the research of (Šegregur et al., 2010) which showed significant differences in terms of body height and body mass between male and female students. Here too, an imperative is imposed, without distinction in sex, that in addition to the medical examination of the individual, it is necessary to monitor and control the physical development in order to prevent the preservation of his health (Sallis et al., 2003). Another indicator which has not been taken into account in this study is waist circumference which can be a useful indicator of nutritional status in children and in adults (Katmarzyk et al., 2004). Health risks of people with BMI over 25 are slightly smaller if their waist circumference is less than 101.6 cm, a condition common for athletes exposed to considerable exercise load (Sharkey and Gaskill, 2008). In all BMI categories, people with the highest waist circumference have an increased tendency of hypertension, diabetes, increased blood fat and metabolic syndrome, compared to those with normal waist circumference (Janssen et al., 2002). The question arises as to whether there would be significant differences in our sample in this parameter or not, as in the case of BMI, and would a different picture of this population be obtained? It is known that heredity plays an important, if not a key role, in the growth and development of the organism. In research on monozygotic and dizygotic twins (Stunkard et al., 1986), researchers have found a major influence of hereditary factors in the expression of body weight and BMI. They concluded that body weight and obesity were under strong genetic control, and that the environment in which a person grows has relatively little influence, which is contrary to the results of the study by (Koziel and Gomula, 2017). Discovery of genes that are partially responsible for developing obesity supports this conclusion.

Nevertheless, numerous studies (Cho and Kim, 2017) confirmed the importance of physical activity as a means of preventing excessive obesity. In any case, whatever the results of some research are, physical activity, and especially sport, which is our personal choice, should be an integral part of our everyday life and an important factor in maintaining health, working capacity and balance in today's modern society, which unfortunately, high school students are increasingly avoiding.

CONCLUSION

The results of the current study on a sample of 108 students of both sexes, age 16 ± 0.5 years, confirmed the differences between male and female respondents in anthropometric parameters (height, $p < 0.001$, weight, $p < 0.001$), while in BMI values did not make a significant difference ($p > 0.001$). This may be expected if the trend of growth and development of individual features and their acceleration and deceleration is known. What is encouraging, however, is the fact that in average 89% male and female students of both sexes are in the normal nutrition category where BMI is male students 20.72; female students 19.82; malnutrition 5% of male students and 8% of female students and excessive nutrition 4% of male students and 5% of female students. The results are not too alarming, but it is important to monitor and record their trend of changes, especially these 4% (males) and 5% (females) obese, taking care to prevent their growth trend.

As the main factor contributing to these indicators is today's way of life of children and young people, because today's development is moving towards the advancement of technology, however, the performance and inclusion of children and adults in physical activity is minimized. A lot of research is needed to understand the negative impact of obesity and express physical activity as an imperative that builds a healthy environment and population.

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