ANALYSIS OF THE MORPHOLOGICAL STATUS STUDENTS BY APPLYING OF DIFFERENT METHODS OF THE INDEX

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Original scientific paper

Abstract
Nowadays it is generally lived in conditions of rapid pace, poor quality and unhealthy nutrition, reduced or insufficient movement, in a word hypokinetic lifestyle. Consequences of hypokinesia are many, and refer mainly to diseases of the cardiovascular system, the respiratory system, and the occurrence of diabetes. In addition, it can also be stated and the uneven growth and development of the individual leading to the negative trend of the development of some anthropometric characteristics and also to the morphological status of the individual. This research is dealing with the analysis of students of Physical Education and Sports. For the estimation of the morphological space was applied: Lorentz constitutional index (LKI), Muscle index (MI%), Body Mass Index (BMI kg/m²). The results showed that it is to low but positive a tendency of the stronger development of bone and muscle tissues of students, where the mean value of LKI is (Mean=1,50), muscle index MI (Mean=10,64%), that is they are in the upper limit of the middle development musculature. The average BMI values of students (Mean=23,60kg/m²) is also an indicator that this population increases the value defined by BMI, whose value is in the upper limit of normal body weight. These values BMI fully correspond to the values that were realized in the LKI and MI.

Key words: *morphological status, the index method, evaluation, students*

Introduction

According to data (WHO, 2015) Worldwide obesity has more than doubled since 1980. In 2014, more than 1.9 billion adults, 18 years and older, were overweight. Of these over 600 million were obese. 39% of adults aged 18 years and over were overweight in 2014, and 13% were obese. Most of the world's population live in countries where overweight and obesity kills more people than underweight, 42 million children under the age of 5 were overweight or obese in 2013. One of the most important health issues of modern society is obesity, and worst of all, it seems to have a large negative impact on children. Even 13-14% of children in the U.S. are defined as obese, while in England is 10-17%. In 2001, researches about obesity, which included six countries (Brazil, United Kingdom, Hong Kong, Netherlands, Singapore and the United States) found that children aged 4-11 have overweight rate of 2-3%. Between 1984. and 1994. the number of obese children has increased to 50% (Jebb et al., 2003). As the best method to prevent and stop this rapid growth in obesity is a combination of regular physical exercise and a balanced nutrition (Al Nakeeb et al., 2007). Proper and systematic physical exercise and sports activities have a positive impact on the health, physical development and functional abilities (Morris & Froelicher, 1991; Pate, Pratt, Blair, et al., 1995; First, Khomyakova, Purundzhan, et al., 2007; Vadasova & Balogha, 2012; Sharma, Subramanian, & Arunachalam, 2013), both in younger and in older age (Trudeau, Laurencelle, Tremblay, et al., 1999). However, it was also pointed to the possibility of damage to health, as well as some diseases in which these activities would have the opposite effect, ie the deterioration of health conditions (Koplan, Siscovick, & Goldbaum, 1985; Ghilarducci, Holly, & Amsterdam, 1989; Malina & Bouchard, 1991). It is therefore necessary to ensure that in these activities are involved only healthy, or those to whom these activities will be useful, and so that can be continuously monitored their physical development during systemic exercise and sporting activities (Wilmore, 1983; Telam, Leskinen, & Yang, 1996; Stewart, Dennison, Kohl, & Doyle, 2004). This is achieved through regular and systematic mandatory health examinations by competent medical professionals. In addition to a medical examination in order to preserve of the health of individuals, athletes is needed to monitor and supervise the physical development (Sallis, McKenzie, Conway, Elder, et al., 2003). To estimate the physical development of one or more persons usually are used two anthropological methods: anthroposkopy (method of observation) and anthropometry (measurement method). Measurement of morphological characteristics of the human body, treatment and study of the data obtained are an integral part of a series of basic applied research, primarily in the field of sports medicine, military and industrial medicine and also in the field of physical education and sport (Malina, 1994; Jakonić, 2003).

Anthropometric measurements and data processing in larger groups of respondents are performed as part of research and hey enable obtaining the average values of some anthropometric parameters in the surveyed populations (Shepard, 1991). In so doing, by the so-called. longitudinal method of research, ie. monitoring and measuring the same group of people over the years, gains an insight into the dynamics of development of children and young people in a given area and under certain conditions of life (Hedley, Ogden, Johnson, et al., 2004), by so-called. transversal method of research, ie. one-time measurement of a large number of respondents of a particular population, obtains an insight into average condition of physical development. Health care professionals and experts in the field of physical education, have the opportunity to use anthropometric measurements for practical purposes, in order to assess the individual anthropometric status of tested individuals. Analysis of the results of anthropometric measurements enable the development of standards, using standard methods (comparison of results obtained by anthropometric measurements of a particular population of subjects with previously established standards for a particular population, for example determining the optimum and the relative body mass per Demole, Brocov index, an optimal body mass per Brugsch, non-fat body mass per Willmoreu, the relative content of fat, Quetelet body mass index, Rorher index, index Pignet, Lorentz constitutional index, muscle index,...) and the index method (looking at the relationship between certain anthropometric parameters, ie. perceive the bodily proportions). Evaluation of morphological characteristics of the body by the index has limited, relative value and gives to the interviewer only a quick orientation on the physical development of the participants and are used above all in adults. Body mass index is applicable to cases between the ages of 18 and 65, but is not suitable for children, pregnant women, athletes with high muscle mass and the elderly persons. Quetelet index is used in the American insurance companies to determine the risk of cardiovascular disease in patients older than 65 years. Increased values of Body Mass Index increase the risk of cardiovascular disease (hypertension, myocardial infarction, and pulmonary disorders (sleep apnea syndrome). Body composition (BC) is an important indicator of physical fitness and general health of athletes (Warner, Fornetti, Jallo, & Pivarnik, 2004; van der Ploeg, Gunn, Withers, et al. 2003) and nowadays it also is a frequently discussed topic in scientific literature. According to, Claessens, Hlatky, Lefevre, & Holdhaus, 1994) the shape of the body and its morphology is, in addition to physical abilities, psychological characteristics and energetic system capacity, one of the major factors determining sporting performance. Diagnostics of body weight is often the subject of research by which to gain a real insight into current status of a defined population and the possible negative trends of growth and development over a certain period of time (Sorensen et al. 2000a; Dopsaj, et al. 2005).

The problem of analysis of anthropological characteristics of students of the Faculty of Sport and Physical Education in Novi Sad researched Srdić, et al. in 2009. The sample included 122 students of both sexes, and based on the measurements of anthropometric parameters (body height, body weight, skinfold thickness, body circumferences and diameters) the degree of nutritional status, body composition and somatotype were assessed. The average body height of young men was 181.46±5.53cm, while the girls were on average 166.86±5.93cm tall. The average value of the body mass index was within normal limits. Most of the respondents of both sexes was well nourished, 6.06% of girls were underweight, while 9.09% of girls and 28.09% boys had excessive body weight. At 4.49% of boys excess body weight was due to increased fat-free mass. Overweight body mass with increased fat mass had 19.10% of boys and 6.06% girls, while the multiple increased fat mass was determined in four boys and one girl. Average fat mass was 18.01±3.57% in males and 26.68±6.03% in girls. Muscle mass accounted for an average of 42.77±7.57% of total body weight in boys and 36.76±2.99% of body weight in girls. Compared to somatotype, the majority of respondents of both sexes had a mesomorphic-endomorph type of material. In the study Dopsaj, et al. 2006 were identified classification criteria for the assessment of body mass index of students. The sample consisted of 311 female students of the Police Academy, aged 19 to 24 years with the aim of diagnosing BMI as key measure to assess the physical status and nutritional status. The results showed that the average BMI of the sample female students is 21.59±2.29kg/m², and the range of scores from 16.20 to 29.24kg/m². What is with the statistically significance established, is that already during the study 4.50% of the population of the female respondents belong to the category with a BMI value ranging from 26.38 to 29.24kg/m², and according to the current medical standards (or consensus) belong to the category of overweight (obesity medium) females, or category of individuals with inadequate that is professionally unacceptable physical status. What is surprising is that in the category of underweight there are 11.58% (BMI below 19.1kg/m²) and in the category of anorexic are even 1.61% of female respondents from the tested female student population (BMI below 17.5 kg/m²). Aim the study (Sharma, Subramanian, Arunachalam, 2013**)** was conceived to assess and find the association between morphological parameters in the students in the age group of 12-17 years. Body composition was assessed using anthropometric measures (Height, weight, BMI, waist circumference, hip circumference and skin fold thickness) and cardio respiratory fitness (CRF) was assessed using estimated VO²max from Rockport Walk Fitness Test. We observed that the anthropometric measures were normal for the respective age groups and VO2max (mL/kg/min) in all the age groups in both the genders were in superior category according to Heywood classification.

We observed higher body fat percentage (BF%) in girls of all the age groups compared to the boys and higher fat free mass (FFM) and VO2max in the boys of all age groups when compared to girls. VO²max showed a strong correlation with FFM ($r=0.891, p<0.001$) and a weak correlation with BF% ($r=-0.322$, $p<0.0001$). Optimal body composition and CRF can be attributed to the regular structured physical activity of one hour duration daily and the provision of adequate nutrition. FFM can be put forth as a stronger determinant of CRF than BF% in the adolescents. Applying transversal research methods, Janković, et al. 2007 on a sample of 267 male and 88 female students of the Police Academy (KPA) from Belgrade made a diagnosis of basic anthropometric characteristics in function of the study year. Basic anthropometric characteristics of respondents were presented by body mass, body height, body-mass index (BMI). The results showed that in the KPA students during their studies came to statistically significant trend change in increase of BM as key measure to assess the volume of the body (1.20kg per year of study) and with BMI, ie. nutritional status (0,42kg/m² per year of study). Compared to female students, the results showed that during the study KPA came to a statistically significant trend change in reductions in BMI, ie. nutritional status (-0.56kg/m² per year of study). The aims of the research Romanov, et al. (2014) were to determine the body mass index (BMI), percentage of body fat, maximum oxygen consumption and level of habitual physical activities, and the differences in the student population of both sexes regarding data on health, exercise and nutrition. The sample of participants was composed of 160 students (94 male and 66 female), age 221 years. The overall sample of participants is divided into two subsamples, 95 of them were students of physical education that were informed through the study program about health, exercise and nutrition, while the second subsample consisted of 65 students of other study programs that did not receive the afore mentioned information. Body height, body weight and percentage of body fat were established, the body mass index was calculated, maximum oxygen consumption was estimated (by a direct method) and the (weekly) level of habitual physical activities. The results show (complete sample) that almost 2/3 of male students are not physically active, and that the female students have significantly better indicators of body composition than their colleagues. The results for maximum oxygen consumption (complete sample) show that the statistically highest average was obtained in the subsample of students from the physical education study program (49.54 ml/kg/min), while the lowest was identified for a group of female students of other study programs (36.92 ml/kg/min). Students of physical education and sports, it can be said, belong to a separate population of physically active people, given the nature of the faculty and physical activities practiced during the study. It is because of the nature of faculty that evaluation of morphological dimensions is of great importance in this population of students.

Also, this way of defining the development of bone and muscle tissue provides a good perception of the morphological space of the tested population. Taking into account previous studies that treated similar issues on the same or other populations, the main objective of this study was to determine the level of development of morphological space one and muscle tissues of students applying Lorentz constitutional index, index of muscle and Body mass index (BMI).

Also, this way of defining different treatment of the index provides a good perception of morphological space study population. Taking into account previous studies that treated similar issues at the same or different populations, the main objective of the research was to determine the level of development of the morphological status of third year of the Faculty of Physical Education and Sport, using different methods for the index.

Methods

The study included 20 student Faculty of Physical Education and Sport in Eastern Sarajevo, male, age 21±0.5 years, mean height of 182.30±6,57cm, weight 78.55±7,29kg. The measurements were made in 2014/15. year. All subjects gave their consent and voluntarily participated in the study. To estimate the morphological status of the index method, and within it, the development of bone and muscle tissue of students as well as a weight-height relations were applied: Lorentz constitutional index (LKI), Muscular index (MI%) and Body Mass Index (BMI), (Jakonić, 2003; WHO, 2014). 1) The formula for calculating the LKI = OG-OT-14 (LKI - Lorentz constitutional index; OG – mean volume of chest (cm); OT - abdomen volume (cm)xc). *Results were scored as follows: /* < 0 the excess of body mass (obesity); > 0 stronger development of bone and muscle tissue/. If the body mass of adults is greater than its optimum mass, by calculating the index can be roughly estimated that the increase in body mass is conditioned by a stronger level of development of bone and muscle (active) or adipose tissue (ballast) tissue.

The positive values (greater than 0) indicate the stronger development of bone and muscle tissue. Negative values indicate the excess of body weight conditioned by the excess of adipose tissue (obesity, adipose-constitution). 2) The formula for calculating the muscle index MI = $\frac{ONs - ONo \times 100}{Ono}$ = % (MI - muscle index - %; ONs - the volume of the upper arm bent – cm; ONo- the volume of upper arm extended - cm). *Results were scored as follows:*(< 5% Poorly developed musculature; 5-12% Average developed musculature; > 12% Stronger developed musculature). 3) The formula for calculating the Body Mass Indexa (BMI) = $\frac{\text{Body Weight (kg)}}{\text{Body Height (m)}^2}$. *Results were scored as follows:* (Below 18,5 Underweight; 18,5-24,9 Normal weight; 25,0-29,9 Pre-obesity; 30,0-34,9 Obesity class I; 35,0-39,9 Obesity class II; Above 40 Obesity class III).

Results and discussion

Table 1 Descriptive statistic Lorentz constitution index

	Mean	Min	Max	Range	SD.	Skew	Kurt
OG	100,61	90,00	109,00	19	5,28	-,54	-,26
OT	85,11	76,00	96,00	20	5,45	,33	,04
LKI	1,50	-6,00	8,00	14	4,05	,14	-,78

Mean (average value); Min (minimal result); Max (maximal result); Rang (range result); SD (standard deviation); Skew. (skewness), Kurt. (kurtosis)

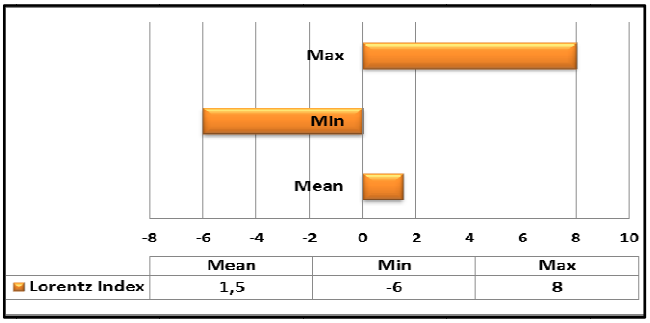

Figure 1 Numerical indicators of Lorentz index

Table 1 gives the basic statistical parameters of circular skeleton dimensionality, ie. medium volume of chest (OG), the volume of the abdomen (OT) and Lorentz constitutional index (LKI) students. The average value of the volume of the chest of the respondents is about 100cm (Mean=100,61cm) with a minimum score of 90cm and a maximum of 109cm. The mean volume of the stomach (OT) is (Mean=85,11cm) with a minimum score of 76cm and a maximum of 96cm. On the basis of these results the mean value of Lorentz constitutional index was obtained, which showed a positive value, different from zero (LKI=1,50). This result suggests that it is about the tendency the stronger development of bone and muscle tissues of students. Minimum value (LKI= -6) is an indication that among the respondents were those who have excess body weight which is the assumption of more adipose constitution, or un proportional relationship of body height and body weight. On the other hand, the maximum value of (+8) is an indicator of the good condition and a stronger development of skeletal muscle system of one respondent (Chart 1).

Table 2 Descriptive statistics muscle index

	Mean	Min	Max	Range	SD	Skew	Kurt
ONs	35,89	33,00	41,00	8,00	2,27	1,03	,22
Ono	32,39	30,00	36,00	6,00	1,91	,56	-,62
MI%	10,64	5,88	14,70	8,82	2,97	-,47	-1,19

Mean (average value); Min (minimal result); Max (maximal result); Rang (range result); SD (standard deviation); Skew. (skewness), Kurt. (kurtosis)

Table 2 also presents the basic statistical parameters of circular dimensionality of the cranial extremities, ie. upper arm. Volumes were measured in two variants, the upper arm bent-flexion (ONs) and the upper arm outstretched-extension (ONo). Based on these indicators was calculated muscle index (MI%) of students.

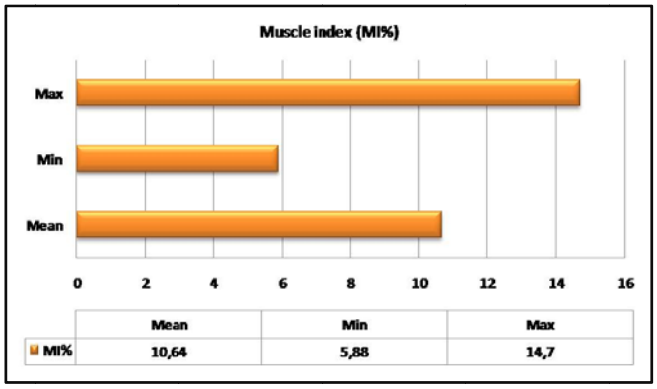

Figure 2 Numerical indicators of Muscle Index

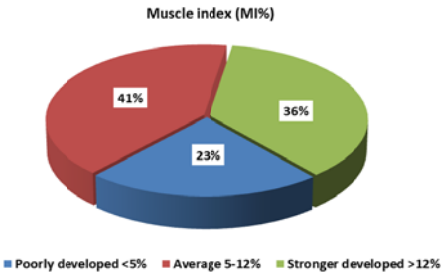

Figure 3 Development of the musculature of students (MI%)

The average value of the volume of the upper arm bent (ONs) of students was slightly more than 36cm (Mean=35,89cm) with a minimum score of 33cm and a maximum of 41cm. The average value of the measured volume of the upper arms outstretched (ONo) is about 32cm (Mean=32,39cm) with a minimum volume of the upper arm of 30cm and a maximum of 36cm. Based on these results, was calculated and obtained the mean value of muscle index of students (Mean=10,64%). Based on these results of MI% over 10% it can be concluded that students are in the upper limit of the mean development of musculature. This result suggests that it is about tendency for the stronger development of muscle tissues of students, as demonstrated Lorentz constitutional index (LKI) only in the domain of both bone and muscle tissue. Recorded minimum value of muscle index (MI=5,88%) is an indication that among the students were those who have less developed musculature. On the other hand, the maximum value of (MI=14,70%) is an indicator of good condition and a stronger development of the muscular system of one respondent. A range of results (over 8%) between the min. and max. value is an indication of considerable heterogeneity of students in terms of development of the musculature, or the value of the muscle index (MI%). After examining the individual results of subjects (Figure 4) there were obtained numerical values that 23% of students had poorly developed musculature (<5%), and 41% were with average-developed musculature (Chart 3). With more developed musculature were 36% of the students. This result of 36% enabled that in the overall result of muscle index students are in the "upper limit" (MI=10.64%) of average development of musculature (range 5-12%).

Table 3 Descriptive statistics Body Mass Index (BMI-kg/m²)

	Mean	Min	Max	Range	SD	Skew	Kurt
AVIS-cm	182,30	170,00	192,00	22,00	6,57	,13	-,69
AMAS-kg	78,55	66,00	92,00	26,00	7,29	,06	-,65
BMI-kg/m²	23,60	20,53	26,40	5,87	1,76	-,08	-1,09

Mean (average value); Min (minimal result); Max (maximal result); Rang (range result); SD (standard deviation); Skew. (skewness), Kurt. (kurtosis)

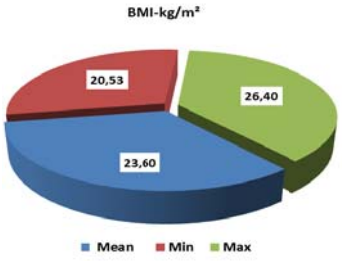

Figure 4 Development of the musculature of students (MI%)

The parameters in Table 3, which relate to the basic central and dispersion statistics provide us with information that enables statistically significant conclusion. On the basis of body height and body mass were obtained results that indicate a normal Gaussian distribution, a lthough in the measures of dispersion can be felt the heterogeneity in terms of height and body mass, and thus in the final values of BMI. However, these data speak of the individual extreme results of subjects who disturb the total state of affairs. The average height of the sample of 182,30cm is an indication of significant longitudinallity, with a body mass of 78,55kg and value of BMI 23,60kg / ², that is giving the state of the body mass index of the studied measured sample, which is located in the upper limits of normal weight (18.5-24.9). Bearing in mind the fact that it is about the students of physical education and sport, then this value can be defined as a population of normal weight and that these values are more directed to lean mass or muscle mass, skeleton and internal organs. However, the increased normal BMI values are an indication that it is about the respondents in which dominates body weight in relation to height of the body. Globally, the value of BMI index over 25 units of a certain number of students is the only data that indicates the treatment and definition of body weight and its indexes, which can sometimes give the wrong information so they should still be checked, as this is a physically active population, where often the body mass is constituted from lean mass, ie the mass is constituted from the mass of muscles and skeleton, and yet, in general they contribute to a ascertainment of excessive weight. Obesity, as a chronic non-contagious disease, represents a primary health problem for people all over the world. The overall prevalence of youth pre-obesity and obesity in the USA amounts to as much as 54.3% (Hedley et al., 2004; Ogden et al., 2006). In comparison with the USA, the frequency of overweight children and adolescents in the northern European countries is significantly lower, ranging from 10 to 20%. Still, the results that refer to the south of Europe indicate that the frequency of these disorders is greater (20–35%) than in the north of Europe, but still almost half of that in the USA (Lobstein, Baur & Uauy, 2004). According to the latest research published by the Serbian Institute for Health Protection, 54% of the adult population has (Institute of Public Health of Serbia, 2008) problems with being overweight (pre-obese and obese), with 36.7% pre-obese and 17.3% obese. Obesity is defined as a growth of body mass beyond the defined values, taking into account the gender, chronological age and bodily height of a person and characterized by excessive body fat in one's organism. In medical nomenclature it is regarded as an illness, and obesitology indicates that this problem goes beyond the medical aspects and takes on global social characteristics. The BMI parameter was suggested, by the World Health Organisation as the best one for the evaluation of the degree of nutrition and for defining and classifying obesity (Vlašić & Katanić, 2010). A study on the health and behavior of children and adolescents which includes independent research that was conducted in as many as 41 countries (Richter, Hurrelmann, Klocke, Melzer & Ravens-Sieberer, 2008) along with a broad range of behavioral patterns of the school population related to dietary habits and a lifestyle characterized by physical inactivity and pronounced sedentary activities of the youth , which all indicate a trend of increase of health risks (Brettschneider & Naul, 2007; Owen, Healy, Matthews & Dunstan, 2010; Tremblay et al., 2011). Growth in height and weight is an indicator of nutritional status, resulting in a variety of endogenous and exogenous factors. The prevalence of obesity, particularly infantile obesity has risen rapidly in the last two decades, both in industrialized and in developing countries. This phenomenon is determined by the World Health Organization (WHO, 2006), starting from 1998, considering that obesity is a major health problem of the world. In order to observe this aspect, WHO recommends for assessing the somatic and phenotype, the use of anthropometric data. It is believed that anthropometry is valid for a universal technique that allows the evaluation of physical development, the state of nutrition and health. Evaluation of somatic phenotypes to physical development in vulnerable populations is imposed by the World Health Organization. Based on experience, (Lacob, Dragoi & Melinte, 2011) have been developed the study of algorithms that can be used during developing public health strategy. Body composition provides us with a detailed physiological profile of an athlete (Heyward & Wagner, 2004). The amount of active mass determines the value of individual parameters of physical fitness. Optimal BC for a specific sport discipline is, however, difficult to determine. A determiner of physical activity is active muscle mass while fat mass is to be rather eliminated by athletes. Excessive adipose tissue acts as a dead weight in activities where the body mass must be repeatedly lifted against gravity during locomotion and jumping (Reilly, 1996).

Lean body mass contributes to the production of power during high-intensity activities and provides greater absolute strength for resistance to high dynamic and static loads. Regular physical activity and aerobic fitness are associated with lower risk of coronary heart disease, and reduced influence of psychological stress (Lorenz, Van Cdoornen, & Eco De Geus, 1993). Also research of some authors (Gutin, Barbeau, Owens, et al., 2002; Ara, Vicente-Rodriguez, Jimenez-Ramirez, Dorado, et al., 2004) has been proven many times and confirmed in practice that regularly participation in sports activities is closely related to the increase of physical condition and reducing body fat in boys, both pre adolescence and in older age (Schwartz, Shuman, Larson, et al., 1991).

It is very important not to forget that training with high load can lead to negative influence on the arterial disease (Ghilarducci, Holly, & Amsterdam, 1989). Well-planned and implemented training can have positive effects on the body constitution, regardless of where the age (Khomyakova, Purundzhan, et al., 2007). In our case, the student population is representative of a wider population, which is characterized by numerous psychosomatic changes, the population involved in sports activities as professionals or amateurs. It can be rightly said that the mere teaching at the university is one aspect of the training process, so-called olympic cycle. This is a significant period of time when it can be positively act on the transformation of subjects. As a result of that teaching process occur transformations of their morphological status, or the condition of the muscular and skeletal systems. This is the period in which it can be performed various analyzes in terms of monitoring and diagnostics of all anthropological characteristics, as well as bone and muscle index. In our sample of students obtained are the results that are in most cases characterized by precisely this population of students of physical education and sport, to whom physical activity is a primary, and as such, differentiates them from other populations of the same age. To confirm this done numerous studies have been conducted.

Ganciu, 2013 was on a sample of 40 students from the University of Bucharest, explored the development of respiratory parameters: respiratory frequency, vital capacity and Lorentz index. The sample was divided into experimental and control group. The control group worked with classical, traditional means, while the experimental group used the cardio program. The final results were better than the initial, recorded at the beginning of the experiment, but in the experimental group there was a significant increase in all investigated parameters between the initial and final testing, as compared to the control group, where the growth rate was lower. Certain studies have investigated the problem of athletes and their parameters of anthropological status. In a study conducted in Turkey, on 153 men who have different levels of physical activity, BMI values were as follows: American footballers 27.76±5.18kg/m², volleyball players 24.49±2.90kg/m², basketball players 24.70±2.65kg/m², footballers 23.37±2.78 kg/m², and for students who do not exercise regularly 23.42±3.62kg/m (Pelin, Kürkçüoglu, Özener, et al. 2009) and percentages of body fat values were different with respect to gender and sport they do. Sınırkavak et al. in 2004 Values obtained values of subcutaneous fat tissue in men students of physical education and sport from 11.80±0.55%. In a survey conducted by Akın et al. in 2004 in five different sports, including 100 male athletes, subcutaneous body fat values were as follows: 13.06% wrestling, football 15.1%, 18.2% weightlifting, handball 20.8% and 16.8% of taekwondo. This is significant, although there are a number of studies to estimate physical fitness of anthropometric characteristics, there are not many studies on the physical proportions for a good physical condition. Part of the research with the handball players have confirmed that they have wide shoulders, narrow hips and middle chest latitude, and football players have a long body and narrow hips (Cakiroglu et al. 2002; Çıkmaz et al, 2005).

In conclusion, the participants in this study were found to have a normal body mass index, RPI, WHR and fat percentage value. According to the physical structure they have medium body structure, with broad shoulders, narrow upper body and hips. Also, in addition of active athletes the subject of research of some authors is the student population that is also at the stage of growth and development. Kurt, et al. in 2011 conducted a survey in order to determine the physical proportions of Turkish students of physical education and sport. This study involved 258 men of physical education and sport who practice on a recreational level, age 22.40±2.75 years, body height: 178.67±9.43cm, weight: 73.44±13.64kg. They were evaluated in terms of BMI, RPI, WHR, percentage of body fat, index Cormique, Monourier index, Acromio-iliac index, Martin index, Biacromial index and hip index. The results were as follows: BMI: 22.86±2.66kg/m², RPI: 42.89±1.77cm/kg, WHR: 0.79±0.05%, percentage of body fat 14.43±4.41%, Cormique index of 51.51±1.58%, Monourier index 94.31±6.10%, Acromio-iliac index of 63.88±6.61%, Martine index of 6.11±0.48%, Biacromial index 22.32±1.86% and hip index 13.89±0.97%. Although the respondents showed normal-healthy in terms of BMI, WHR, and percentage of body fat, they also showed a thicker middle section of the body, a narrow upper body and narrow hips. Budakov, et al. (2012) are, using an anonymous questionnaire survey conducted research among 800 students from the University of Novi Sad, aged 20 to 24 years, of equal representation of gender structure in order to determine the nutritional status and physical activity of students. Older students had higher average BMI (Mean=24.49) than younger (Mean=23.36), as opposed to female students where younger have a slightly higher BMI (Mean=20.49) than older (Mean=20.37).

There were 116 (29%) obese students, while 62 (15.5%) female students were underweight. Physically active were 451 (56.4%) students. Older students were physically more active, 481 (60.1%), compared to the younger, 399 (49.9%) ($p<.01$). On a sample of 180 students, from the Faculty of Physical Education and Sports in Eastern Sarajevo (Pavlovic, Simeonov, Radic et al. 2014) using longitudinal research method, performed diagnostics of basic anthropometric characteristics in function of monitoring of differences of somatic changes in order to determine the differences in basic anthropometric characteristics. The results showed that in students of FFVS during the four-year period, there was a statistically significant trend of differences that defined the considerable heterogeneity of the population. All the above studies that were conducted on the student population speak mainly about heterogeneity, the increased values of the measured parameters (BMI, respiratory frequency, vital capacity, Lorentz index) and other parameters of morphological space, as in the case of our sample. Mainly it is about numerical indicators from the extremely negative to the extremely positive results.

Namely, today lifestyle is in terms of the fast pace, poor and unhealthy diet, decreased or lack of movement, in one word hypokinetic lifestyle. The effects of hypokinesia are numerous, and mostly refers to diseases of the cardiovascular system, the respiratory system and the occurrence of diabetes. In addition, it can be stated also uneven growth and development of the individual leading to the negative trend of the development of individual and anthropometric characteristics and the physical status of the individual (body height, weight and BMI). The close relationship between health status and body mass has been known for a long time. Somatic type of man can be determined by genetic factors, diet, socio-economic conditions, age, gender, etc., what may have the ability and give valuable information for researchers of modern societies (Muñoz- Cachón, et al. 2007). Increased BMI, WHR and RPI are just some of the indicators of disease, such as heart diseases or diabetes mellitus. Although it has become customary to present high value of these criteria in modern societies, it is surprising to see an increase of these values in athletes. Although this is about, we can say, physically active population, the negative consequences are obvious and they are reflected in the morphological status of the respondents, which may further lead to many medical disorders. In our case, although it was not about some invasive methods, however, there have been determined certain changes in the status of the student population, which may be a good initial indication of the physical status and as the initial recommendation about future physically active lifestyle.

Conclusion

The study comprised of a group of students of third year, from the Faculty of Physical Education and Sports in East Sarajevo, male, age 21 ± 0.5 years. A total of 20 students were included, with an average height of 182,30±6,57cm, body mass 78,55±7,29kg. The study was aimed to determine the level of development morphological status of students applying Lorentz constitutional index, Muscle index, Body mass index (Jakonić, 2003; WHO, 2015). The results showed that it is about the tendency for the stronger development of bone and muscle tissue of students, where the mean value is LKI=1,50 in the range of from Min.=-6. to Max.=+8. This is an indicator that among the respondents were those who have excess body weight which is the assumption of adipose constitution, that is the disproportionate ratio of body height and body weight (Max value BMI=26,40). On the other hand, the maximum value of (+8) is an indicator of the good condition and a stronger development of the muscle skeletal system of one respondent (Min.value BMI=20,53). Based on the results of MI% of over 10% it can be concluded that the students are in the upper limit of the medium development of musculature. Recorded minimum value of muscle index (MI=5,88%) is an indication that among the students were those who have less developed musculature. On the other hand, the maximum value of (MI=14,70%) is an indicator of good condition and a stronger development of the muscular system of one respondent. A range of results (over 8%) between the min. and max. value is an indication of heterogeneity of students in terms of development of the musculature, that is the value of the muscle index (MI%). The results showed that 23% of students had poorly developed musculature (<5%), and 41% were with medium-developed musculature. With more developed musculature were 36% of the students. This result of 36% enabled that in the overall result of muscle index students are in the "upper limit" (MI=10.64%) of medium development of musculature. The average BMI of students amounted 23,60kg/m² and is an indicator of normal weight, with a large number of results that are in the upper limit of normal weight (24,9 kg/m²). The minimum value of the BMI of students from 20,53kg/m² to the maximum value of 26,40 kg/m² is an indication of significant heterogeneity**.** The analysis of different methods of index obtained results with the results, significant correlations and good global indicator of overall morphological status of students Physical Education and Sport. This research can be a guideline for further research of this type on the same population from other faculties and with a larger number of subjects, in order to determine the development trend of morphological parameters.

References

Akin, G., Özder, A., Özet, B.K., & Gültekin, T. (2004). Body composition values in elite male athletes. *Ankara University Journal of the faculty of letters*, *44*(1), 125-134.

Ara, I., Vicente-Rodriguez, G., Jimenez-Ramirez, J., Dorado, C., Serrano-Sanchez, J.A., & Calbet, J.A. (2004). Regular participation in sports is associated with enhanced physical fitness and lower fat mass in prepubertal boys. *Int J Obes Relat Metab Disord, 28*, 1585–1593.

Budakov, N., Bokan, D., Rakić, D., & Bokan, D. (2012). Body mass index and physical activity of students of University of Novi Sad. *South Eastern Europe Health Sciences Journal, 2*(1), 8-14.

Brettschneider, W.D., & Naul, R. (2007). *Obesity in Europe: young people's physical activity and sedentary lifestyles.* Switzerland: Peter Lang.

Claessens, A.L., Hlatky, S., Lefevre, J., & Holdhaus, H. (1994). The role of anthropometric characteristics in modern pentathlon performance in female athletes. *Journal of Sports Sciences, 12*(4), 391-401.

Çakiroglu, M., Uluçam, E., Cigali, B.S., & Yilmaz, A. (2002). Body propositions measured in handball players. *Medical Journal of Trakya University, 19*(1), 35-38.

Çikmaz, S., Taşkinalp, O., Uluçam, E., Yilmaz, A., & Çakiroglu, M. (2005). Anthropometric measurements and proportions of body constitution in football players. *Medical Journal of Trakya University, 22*(1), 32-36.

Cech, P., Maly, T., Mala, L., & Zahalka, F. (2013). Body composition of elite youth pentathletes and its gender differences. *Sport Science, 6*(2), 29-35.

Dopsaj, M., Milošević, M., Vučković, G., Blagojević, M., & Mudrić, R. (2005). Dijagnostika stanja indeksa telesne mase studenata Policijske akademije [Diagnostics of the body mass index of students of the Police Academy. In Serbian]. *Sportska Medicina, 5*(4), 180-191.

Dopsaj, M., Milošević, M., Vučković, G., Blagojević, M., & Mudrić, R. (2006). Klasifikacioni kriterijumi za procenu indeksa mase tela kod studentkinja Kriminalističko-policijske akademije [Classification criteria for the assessment of body mass index of student Police Academy. In Serbian]. *Sp Medicina, 6*(4), 100-110.

Ghilarducci, L.E.C., Holly, R.G., & Amsterdam, E.A. (1989). Effects of high resistance training in coronary artery disease. *Am J Cardiol,* 64, 866-870.

Gutin, B., Barbeau, P., Owens, S., Lemmon, C.R., Bauman, M., Allison, J., Kang, H.S., & Litaker M.S. (2002). Effects of exercise intensity on cardiovascular fitness, total body composition, and visceral adiposity of obese adolescents. *Am J Clin Nutr,* 75, 818–826.

Godina, E., Khomyakova, I., Purundzhan, A., Tretyak, A., & Zadorozhnaya, L. (2007). Effect of physical training on body composition in Moscow Adolescents. *J of Physiological Anthropology, 26*(2), 229-234.

Ganciu, M. (2013). The improvement of the functional respiratory status of students from the University of Bucharest using the means of aerobic gymnastics. *Palestrica of the Third Millennium Civilization & Sport. 14*(4), 283-287.

Hedley, A.A., Ogden, C.L., Johnson, C.L., Carroll, M.D., Curtin, L.R., & Flegal, K.M. (2004) Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. *JAMA, 291*, 2847–2850.

Heyward, V.H., & Stolarczyk, L.M. (1996) Applied body composition assessment. *Human Kinetics*, 147-154.

Heyward, V., & Wagner, D. (2004). *Applied Body Composition Assessment*-2nd Edition. Human Kinetics.

Iacob, C.M., Dragoi, G., & Melinte, R.P. (2011). Considerations on an algorithm for evaluation of somatic phenotype transformations determined by the nutritional status of vulnerable populations. *Rom J Leg Med, 19*, 133-134.

Jakonić, D. (2003). *Osnove sportske medicine* [Basic of sports medicine. In Serbian] Novi Sad: Fakultet fizičke kulture.

Jebb, S.A., Rennie, K.L., Cole, T.J. (2003). Prevalence of overweight and obesity among young people in Great Britain. *Public Health Nutrition, 7*(3), 461-465.

Janković, R., Koropanovski, N., Vučković, G., Dimitrijević, R., Atanasov, D., Miljuš, D., Marinković, B., Ivanović, J., Blagojević, M., & Dopsaj, M. (2008). Trend promene osnovnih antropometrijskih karakteristika studenata kriminalističko-policijske akademije u toku studija [The trend in basic anthropometric characteristics of students of Police Academy during the study. In Serbian]. *Nauka, bezbednost, policija, 13*(2), 137-152.

Koplan, J.P., Siscovick, D.S., & Goldbaum, G.M. (1985). The risks of exercise: a public health view of injuries and hazards. *Public Health Rep, 100*, 189-195.

Kurt, C., Çatikkaş, F., & Atalag, O. (2011). Body proportions of Turkish physical education and sports students. *6th Fiep Euro Congress PE in the 21.Cen. pupils compentencies* (pp. 287-291). Poreč. Hrvatska.

Lorenz, J.P., Van Cdoornen & Eco J.C.De Geusa (1993). Stress, physical activity and coronary heart disease. *Work & Stress: An International Journal of Work, Health & Organisations, 7*(2), 121-139.

Lobstein, T., Baur, L., & Uauy, R. (2004). Obesity in children and young people: a crisis in public health. *Obesity Reviews, 5*(1), 4-85.

Malina, R., & Bouchard, C. (1991). *Growth, maturation and physical activity*. Champagn, IL: Human Kinetics.

Malina, R.M. (1994). Physical activity and training: effects on stature and the adolescent growth spurt. *Med Sci Sports Exercise, 26*(6), 759-766.

Morris, C.K., & Froelicher, V.F. (1991). Cardiovascular benefits of physical activity. *Herz, 16*, 222-236.

Muñoz-Cachon, M.J., Salces, I., Arroyo,M., Ansotegui, L., Rocandio, A.M., & Rebato, E. (2007). Body Shape in Relation to Socio-Economic Status in Young Adults from the Basque Country. *Coll. Antropol, 31*(4), 963-968.

Al-Nakeeb, Y., Duncan, M.J., Lyons, M., & Woodfield, L. (2007). Body fatness and physical activity levels of young children. *Annals of human Biology, 34*(1), 1-12.

Ogden, C.L., Carroll, M.D., Curtin, L.R., McDowell, M.A., Tabak, C.J., & Flegal, K.M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *Journal of the American Medical Association, 295*(13), 1549-1555.

Owen, N., Healy, G.N., Matthews, C.E., & Dunstan, D.W. (2010). Too Much Sitting: The Population Health Science of Sedentary Behavior. *Exercise & Sport Sciences Reviews, 38*(3), 105-113.

Pate, R.R., Pratt, M., Blair, S.N., Haskell, W.L., Macera, C.A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G.W., King, A.C., et al.(1995). Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA, 273*, 402-407.

van der Ploeg G.E., Gunn, S.M., Withers, R.T., & Modra, A.C. (2003). Use of anthropometric variables to predict relative body fat determined by a four-compartment body composition model. *Eur J Clin Nutr. 57*(8), 1009-1016.

Pelin, C., Kürkçüoglu, A., Özener, B., & Yazici, C.A. (2009) Anthropometric characteristics of young Turkish male athletes. *Coll. Antropol, 33*(4), 1057-1063.

Richter, M., Hurrelmann, K., Klocke, A., Melzer, W., & Ravens-Sieberer, U. (2008). Gesundheit, Ungleichheit und jugendliche Lebenswelten: Ergebnisse der zweiten internationalen Vergleichsstudie im Auftrag der Weltgesundheitsorganisation WHO. Weinheim: Juventa.

Romanov, R., Perić, D., Ahmetović, Z., & Međedović, B. (2014). Obesity and the physical work capability of students in Novi Sad. *Facta Universitatis Series: Physical Education and Sport, 12*(3), 315-325.

Shwartz, R.S., Shuman, W.P., Larson, V., Cain, K.C., Fellingham, G.W., Beard, J.C., Kahn, S.E., Stratton, J.R., Cerqueira, M.D., & Abrass, I.B. (1991). The effect of intensive endurance exercise training on body fat distribution in young and older men. *Metabolism, 4*i, 545-551.

Shepard, R.J. (1991). Measurements of fitness. The Can. experience. *J Sp Med Phys Fitness, 3*, 470-480.

Sorensen, L., Smolander, J., Louhevaara, V., Korhonene, O., & Oja, P. (2000) Physical activity, fitness and body composition of Finnish police officers: A 15-year follow-up study. *Occup. Medicine, 50*(1), 3-10.

Sallis, J.F., McKenzie, T.L., Conway, T.L., Elder, J.P., Prochaska, J.J., Brown, M., Zive, M.M., Marshall, S.J., & Alcarez, J.E. (2003). Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools. *Am J Prev Med, 24*, 209–217.

Sinirkavak, G., Dal, U., & Çetinkaya, Ö. (2004). The relation between the body composition and maximal oxygen capacity in elite sportsmen. *Cumhuriyet medical Journal, 26*(4), 171-176.

Stewart, J.A., Dennison, D.A., Kohl, H.W., & Doyle, J.A. (2004). Exercise level and energy expenditure in the Take 10! in-class physical activity program. *J Sch Health, 74*, 397–400.

Srdić, B., Dimitrić, G., & Obradović, B. (2009). Antropološke karakteristike studenata Fakulteta sporta i fizičkog vaspitanja [Anthropological characteristics of the students of the Faculty of Sport and Physical Education]. *Glasnik Antropološkog društva Srbije*, *44*, 463-470.

Sharma.V.K., Subramanian, S.K., & Arunachalam, V. (2013). Evaluation of body composition and its association with cardio respiratory fitness in south Indian adolescents. *Indian J Physiol Pharmacol, 57*(4), 399–405.

Telama, R., Leskinen, E., & Yang, X. (1996). Stability of habitual physical activity and sport participation: a longitudinal tracking study. *Scandinavian Journal of Medicine And Science in Sports, 6*, 371-378.

Trudeau, F., Laurencelle, L., Tremblay, J., Rajic, M., & Shephard, R.J. (1999). Daily primary school physical education: effects on physical activity during adult life. *Med Sci Sports Exerc, 31*, 111–117.

Tremblay, M.S., LeBlanc, A.G., Kho, M.E., Saunders, T.J., Larouche, R., Colley, R.C., Goldfield, G., & Gorber, S.C. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity, 8*(98), 3-22.

Vlaški, J., & Katanić, D. (2010). Zdravstveni i socijalni značaj epidemije gojaznosti kod adolescenata u Srbiji (Health and social significance of epidemic of obesity in adolescents in Serbian). *Medicinski glasnik, 15*(34), 43-46.

Vadasova, B., & Baloga, S. (2012). Somatic and functional parameters of physical education female students at faculty of sports in University of Prešov. In Slovakian. *Proceedings J.Brodan, Sport and recreation* (pp. 108-112). Constantine the Philosopher University in Nitra, Faculty of Education Department of Physical Education and Sports, Nitra.

Warner, E.R.., Fornetti, W.C., Jallo, J.J., & Pivarnik, J.M. (2004). A Skinfold Model to Predict Fat-Free Mass in Female Athletes. *Journal Athletic Training, 39*(3), 259-262.

Wilmore, J.H. (1983). Body composition in sport and exercise: directions for future research. *Med Sci Sports*, *15*, 21-31.

* * * (2006). /WHO/ - Multicentre Growth Reference study group. WHO Child Growth standards based on length / height, weight and age. *Acta pediatrica, 450*(Suppl.), 76–85.

* * * (2008). *Zdravlje stanovnika Srbije - analitička studija 1997-2007* [Health of population of Serbia - Analytical Study 1997-2007. In Serbian]. Institut za javno zdravlje Srbije. Accessed 04.07.2014, www: http://www.batut.org.rs/download/publikacije/Zdravlje%20stanovnika%201997-2007.pdf.

* * * (2015). /WHO/ - Obesity and overweight, Fact sheet N°311. Retrieved at http://www.who. int/mediacentre/factsheets/fs311/en/

* * * (2015). /WHIO/ - Body mass index–BMI. Retrieved, http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi.

ANALIZA MORFOLOŠKOG STATUSA STUDENATA PRIMJENOM RAZLIČITIH METODA INDEKSA

Sažetak

Danas je općenito živi u uvjetima brzog ritma, loše kvalitete i nezdrave prehrane, smanjenog ili nedovoljnog kretanja, jednom riječju hipokinetički lifestyle. Posljedice hipokinezije su mnogi, a odnose se uglavnom na bolesti kardiovaskularnog sustava, dišnog sustava i nastanka dijabetesa. Osim toga, ona također može biti uzrok neujednačnog rasta i razvoja pojedinca što dovodi do negativnog trenda razvoja nekih antropometrijskih karakteristika i na morfološkom statusu pojedinca. Ovo istraživanje se bavi analizom studenata tjelesnog odgoja i športa. Za procjenu morfološkog prostora primjenjuju se: Lorentz konstitutivni ustavna indeks (LKI), indeks mišića (MI%) i indeks tjelesne mase (BMI kg / m²). Rezultati su pokazali da postoji niska ali pozitivna tendencija jačeg razvoja kostiju i mišićnog tkiva studenata, gdje je srednja vrijednost LKI je 1,50, mišićni indeks MI (Mean = 10,64%) i da se oni nalaze u gornjoj granici srednjeg razvoja mišića. Prosječne vrijednosti BMI studenata (srednja = 23,60kg / m²) je također pokazatelj da ova populacija povećava vrijednost BMI, čija je vrijednost u gornjoj granici normalne tjelesne težine. Te vrijednosti BMI potpunosti odgovaraju vrijednostima koje su ostvarene u LKI i MI.

Ključne riječi: *morfološki status, metode indeksa, evaluacija, studenti*

Received: October 27, 2014
Accepted: June 10, 2015
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