THE TREND OF CHANGES OF ANTHROPOMETRIC CHARACTERISTICS PUPILS - OLDER SCHOOL CHILDREN

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Abstract
Morphological space as only one segment of the anthropological area of man is very often the subject of analysis, when one wants to determine the state of somatic status of a particular population. Very often in studies is the student population and is under the scrutiny of monitoring, in terms of growth and development, and possible changes in certain periods of life. In a sample of 209 high school pupils (Gymnasium and Tourist technicians), male, age 15-19±0.5 years from Pale, by applying transversal method of research the diagnosing of basic anthropometric characteristics has been conducted, in the function of determining the changes, the differences of somatic changes, in pupils from grades I to IV. Anthropometric characteristics were presented with the following variables: Body height is expressed in cm, Body weight, expressed in kg, and Body-mass index (BMI), expressed in kg/m². Data were analyzed by basic statistics and module T-test for large independent samples with bi-directional testing. The results showed that pupils differ significantly from I to IV class defining a considerable heterogeneity of the population. In analyzing the data, using the T-test, numerical indicators have been obtained that significantly explain the differences between the pupils I and II; I and grade III and in all three measured parameters ($p<0.05$; $p<0.01$; $p<0.001$), while the differences between pupils of I and the IV grade have been recorded only in Body weight and BMI ($p<0,05$). Based on the obtained results, it can be said with certainty that the process of growth and development of the student population is heterogeneous as expected, and that it is the consequence of a number of endogenously-exogenous factors during maturation of the individual.

***Key words**: growth and development, variability, differences, anthropometric characteristics, pupils*

Introduction

One of the most important health problems in today's society is obesity. In the last few years there have been a significant increase in the prevalence of excessive nutrition and obesity in many countries (WHO, 2000). In the world today there are about 350 million people that are obese and more than 1 billion with excessive weight. The World Health Organization (WHO) considers that overweight and obesity is one of the 10 leading risk factors that lead to coronary heart disease, stroke, diabetes and many forms of cancer (Ivčević-Uhernik, Music & Milanovic, 2009; Pavlica, 2011). According to the Institute for Health Protection of Serbia (2005), more than half of the adult population in Serbia (54%) had a problem with excessive nourishment, where 36.7% are with excessive eating disorders, and 17.3% are obese (Pavlica, 2011). Worst of all is that obesity has a large negative impact on children. Even 13-14% of children in the US are defined as obese, while in England is 10-17%. Realized research on obesity in 2001, which included six countries (Brazil, United Kingdom, Hong Kong, Netherlands, Singapore and the United States) have confirmed that children aged 4-11 have obesity rate of 2-3%. Between 1984 and 1994, the number of obese children has risen to 50% (Jebb, Rennie, & Cole, 2003).

As the best method to prevent and stop this rapid growth of obesity is a combination of regular physical exercise and a balanced diet (Al-Nakeeb, Duncan, Lyons, et al., 2007). Planinšec, & Fošnarič, (2009) conducted a survey with the aim of analyzing the weight and overweight of children in Slovenia based on body mass index (BMI) and triceps skinfold (TSF). Included are 5,613 children aged 6 to 12 years. The results showed that 18.3% of boys and 18.5% of girls are overweight and 6.5% of boys and 6.7% of girls are obese. The correlation between BMI and TSF in boys ($r = 0.785$) and girls ($r = 0.783$), are almost identical. Body weight has a lower correlation with TSF in boys ($r = 0.691$) and girls ($r = 0.631$). It has been shown that there is a significant difference ($p <0.001$) in the TSF according to body weight. Booth, Chey, Wake, et al. (2003) analyzed the determination of changes in the prevalence of overweight and obesity among young Australians (aged 7-15 years), 1969-1985. ended with 1997. Data from 5 independent population surveys were analyzed: Australian Youth Fitness Survey, 1969, Australian Health and Fitness Survey, 1985 South Australian Schools Fitness and Physical Activity Survey, 1997, New South Wales Schools Fitness and Physical Activity Survey, 1997 and Health

young Victorians study 1997). The results showed that in the period 1985 to 1997, the prevalence of overweight and obese people has increased by 60-70%, obesity 2-4 times, and the combination of the body weight and obesity was doubled. The findings were consistent for both genders. For the period 1969 to 1985 there were no changes in the prevalence of overweight and obesity in girls, but the boys prevalence of overweight increased by 35% (prevalence of obesity has tripled), and the prevalence of overweight and obesity combined increased by 60%. Studies of some authors in addition to monitoring of physical dimensions also follow the trend of development of motor skills.

The results of the six-year tracking of about 300 Swedish adolescents (between 10 and 16 years in 2001 and 2007) have shown that there are no differences in BMI at sixteen year olds. Low values of aerobic capacity and high BMI at age 10 years predicts obesity at age 16. There was no difference in the prevalence of overweight plus obesity between 2001 and 2007 samples. As a conclusion it is stated that normal weight and good aerobic capacity in 10 year olds reduce the risk of elevated BMI in relation to 16-year olds (Ekblom et al. 2009). Diagnostics of state of the anthropometric characteristics is often the subject of research on the basis of which one gains a real insight into the current state of defined population and the possible negative trends of growth and development over a certain period of time (Sorensen, Smolander, Louhevaara, et al., 2000; Dopsaj, Milosevic, Vuckovic et al., 2005). Certain studies have investigated the problem of athletes and their parameters of anthropological status. In a study conducted in Turkey (Pelin, Kürkçüoglu, Özener, et al. 2009), the 153 men who have varying levels of physical activity, BMI values were as follows: American football players 27,76±5,18kg/m², volleyball players 24,49±2,90kg/m², basketball players 24.70±2,65kg/m², football players 23,37±2,78kg/m², and for students who do not exercise regularly 23,42±3,62kg/m²). It was found that their percentage values of subcutaneous adipose tissue were different with respect to gender and sport they practise. Sınırkavak, Dal, & Cetinkaya, (2004) got the values of subcutaneous adipose tissue in men students of physical education and sport from 11.80±0.55%. In a survey conducted by Akın, Özdere, Drain, et al. 2004 in five different sports, including 100 male athletes, the values of subcutaneous adipose tissue were as follows: 13.06% wrestling, football 15.1%, 18.2% weightlifting, handball 20.8% and 16.8% taekwondo. This is significant, although there are numerous evaluation studies of physical fitness according to the anthropometric characteristics, however, there are not many studies on the bodily proportions for good physical condition. Part of the research with the handball players have confirmed that they have broad shoulders, narrow hips and middle chest circumference, and the football players have long body and narrow hips (Çakıroğlu, Uluca, Cigala, et al., 2002; Cikmazi, Taşkinalp, Uluca, et al, 2005).

In conclusion, in participants of this research was found to have a normal body mass index, RPI, WHR and fat percentage value. Also, in addition to the active athletes the subject of research of some authors is the pupil and the student population, that are also in the stage of growth and development. Kurt, Çatikkaş, & Atalag, (2011) conducted a survey in order to determine the physical proportions of Turkish students of physical education and sport. The study comprised 258 men who exercise on a recreational level, age (22.40 ± 2.75 years), body height (178.67 ± 9,43cm) and body weight (73.44 ± 13,64kg). They are evaluated in BMI, RPI, WHR, body fat percentage, index Cormique, Monourier index, Acromio-iliac index, Martine index, Biacromial index and hip index. Although on the obtained results the subjects showed a normal health in terms of BMI, WHR and percentage of body fat, they also showed a thicker central part of the body, narrow upper body and narrow hips. Vadasova & Balogova (2012) in a study presented the somatic profile and functional fitness of female students of the Faculty of Physical Education and Sports University of Presevo, age 19.5±0.9 years. Basic anthropometric parameters (body height, weight, BMI and percent body fat in the body) were measured. For the assessment of functional capacity, maximal oxygen consumption spiroergometry was applied.

Analysis of the results showed that according to the percentage of fat, female students occupy the upper zone which is recommended for athletic population, and despite the greater volume of physical activity, their average value of functional indicators are at the level of the standard population. Budakov, Bokan, Rakic, et al. (2012) are using an anonymous questionnaire conducted a survey among 800 students of the University of Novi Sad, aged 20 to 24 years, equally represented gender structure in order to determine the nutritional status and physical activity of students. Older students had average higher BMI (Mean=24.49) than younger (Mean= 23.36), as opposed to female students where younger have a somewhat higher BMI (Mean=20.49) than older (Mean=20,37). Overweight and obese students were 29%, while 15.5% of female students were malnourished. Physically active were 56.4% of students.

Older students were more physically active, 60.1% compared to the younger, 49.9% ($p<.01$). In was determined a sedentary lifestyle, 52.1% of students were spending more than two hours a day with TV and computer. As conclusion is that students are more inclined to obesity, female to malnutrition. Sedentary lifestyle is also present in a high percentage, more in final year students. In a study (Dopsaj, Milosevic, Vuckovic, et al. 2006) have been established also classification criteria for the assessment of body mass index among students. The sample included 311 of female students of Police Academy, aged 19 to 24 years, with the aim of diagnosing BMI as the primary measure for assessing physical and nutritional status.

The results showed that the average value of the BMI tested sample of female students is 21.59±2,29kg/m², and the results range from 16.20 to 29,24kg/m². What is with statistically significance evident, is that already during the study 4.50% of the female students population belongs to the category having a value of BMI in the range of 26.38 to 29,24kg/m², or by all applicable medical standards (or consensus) belongs to the category of obese (mean degree of obesity) females, or category of individuals with inadequate ie. professionally unacceptable physical status. What is surprising is that in the category of undernourished has 11.58% (BMI below 19,1kg/m²), and anorexic category has even 1.61% of tested population of female students (BMI below 17.5 kg/m²). Eisenmann & Malina (2002) in the United States conducted a survey in order to examine the secular changes in maximal oxygen consumption (VO²max) of girls and boys using available data from the 20th century. Data (mean values) were divided by decades into three age groups: 6-12, 13-15, 16-18 years for boys, 6-11, 12-14, and 15 and 18 years for girls. The results showed that the absolute and relative oxygen consumption remained relatively stable among boys and girls. In adolescent girls, particularly those aged 15 and older, VO²max consumption is reduced by about 20% during the last few decades. Available data showed that aerobic endurance is not reduced in young people in the United States, except in female adolescents over the last few decades. Applying transversal research methods, Jankovic, Koropanovski, Vuckovic, et al. 2008 on a sample of 353 students, the Criminal Police Academy (CPA), of both sexes, from Belgrade have made the diagnosis of basic anthropometric characteristics in function of year of study. The results showed that in the students during their studies came to a statistically significant change of trend, the increase of TM as basic measure for assessment of body voluminosity (1.20 kg per year of study) as well as in BMI, ie. nutritional status (0,42kg/m² per year of study). In relation to female students, the results showed that during the study KPA came to a statistically significant trend change, in reduction in BMI, ie. nutritional status (- 0.56kg/m² per year of study). Problem of analysis of anthropological characteristics of students of the Faculty of Sport and Physical Education in Novi Sad have researched Srdić, Dimitrić, & Obradovic, 2009. On the basis of the values of measured anthropometric parameters (body height, body weight, skinfold thickness, body circumferences and diameters) have been estimated level of nutritional status, body composition and somatotype. Average height of boys was 181.46±5.53 cm, while the girls were high on average 166.86±5.93 cm. The average value of body mass index was within normal limits. The largest number of respondents of both sexes had normal weight, 6.06% of girls were underweight, while 9.09% of girls and 28.09% boys had excess body weight. In 4.49% of boys excessive body weight was caused by enlarged lean mass. Overweight body mass with increased fat mass had 19.10% of boys and 6.06% girls. The average fat mass was 18.01±3.57% for 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. In relation to the somatotype, the largest number of respondents of both genders was mesomorphic-endomorph. Similar research was conducted on a sample of 180 students of physical education and sport, with aim to determine the trend of changes of anthropometric characteristics of the four generations of students (Pavlovic, Raković, and Pupiš, 2014). The results showed that in the students during the four year period, there was a statistically significant trend changes that were confirmed by differences and also defined the considerable heterogeneity of the students.

Results statistically significantly explain the differences on the level of significance ($p<0.01$) for body height, body mass and body mass index. Taking into account previous studies that treated similar issues of anthropological status, in other populations, the main objective of this research is to determine the trend of possible changes and differences of anthropometric characteristics of secondary school pupils.

Methods

The sample

The sample population consisted of students from secondary schools (Gymnasium and Tourist technicians) from Pale, male, age 15-19 ± 0.5 years. The survey includes pupils from first to fourth grade (grade I, n = 57), (II grade, n = 58), (III grade, n = 47), (IV grade, n = 47) for a total of 209 pupils.

The sample of variables

To estimate the morphological status were measured three variables: body height (height), body mass, (weight) Body Mass Index (BMI) according to Heyward & Stolarczyk, 1996). To obtain relevant results, by which can be determined the trend of changes of the morphological status of pupils on the basis of which the responses were obtained, Basic statistical procedures were applied, a in terms of determining the differences an analysis was performed using the t-test for large independent samples. Measurements were carried out in March-April 2014. All pupils voluntarily participated in the study.

Results and discussion

Table 1 presents the basic statistical parameters of anthropometric measures of studied sample of pupils. For each variable were calculated relevant central and dispersion parameters. After examining the value of the arithmetic means and standard deviations in all measures there is considerable heterogeneity of anthropometric measures. Differences do exist and are mainly related to all three measures of morphological status.

When it comes to body height, it is evident that the pupils of the third grade are at least homogeneous (SD=10.35cm) in body mass pupils of class IV (SD=10,77kg) and in values of BMI pupils of grade II (SD=2,58kg/m²). As most homogenous generation of pupils by body height is the generation of the first grade (SD=8,11cm), then grade two (SD=8,69cm), and fourth-grade pupils (SD = 9,07 cm). Per body weight, the highest homogeneity of results is manifested in pupils of second grade (SD=9,62kg), slightly lower in first-grade pupils (SD=10,10kg), and the lowest among pupils of third grade (SD=10,64kg). When it comes to BMI as the most homogenous group were pupils of grade III (SD=1,83kg/m²), then first grade (SD=2,10kg /m²), slightly less homogeneous pupils in fourth grade (SD= 2,52kg/m²) and the least homogeneous second grades (SD=2,58kg/m²).

Table 1 Basic statistical parameters of pupils

	Body height (cm)			Body weight (kg)			BMI (kg/m²)		
	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max
I class (n=57)	171,51± 8,11	153,00	193,00	58,54±10,10	39,00	87,00	19,77±2,10	16,66	26,26
II class (n=58)	176,52± 8,69	160,00	200,00	65,17± 9,62	45,00	87,00	20,87±2,58	14,86	27,99
III class (n=47)	175,94±10,35	158,00	199,00	64,19±10,64	50,00	93,00	20,62±1,83	17,63	26,03
IV class (n=47)	174,23± 9,07	160,00	195,00	63,43±10,77	46,00	93,00	20,86±2,52	16,14	28,67
Total pupils	174,55± 9,05	157,75	196,75	62,83±10,28	45,00	90,00	20,53±2,25	16,32	27,23

Mean (average value); SD (standard deviation); Min (minimal result); Max (maximal result)

Table 2 The differences between pupils using the T-test

	Body height Mean±SD	T-test	p-level	Body weight (kg) Mean±SD	T-test	p-level	BMI (kg/cm²) Mean±SD	T-test	p-level
1.	171,51± 8,11	-2,14	0,0018**	58,54±10,10	-3,18	0,0005***	19,77±2,10	-1,92	0,0137*
2.	176,52± 8,69			65,17± 9,62			20,87±2,58		
1.	171,51± 8,11	-1,35	0,0161*	58,54±10,10	-2,92	0,0066**	19,77±2,10	-1,42	0,0319*
3.	175,94±10,35			64,19±10,64			20,62±1,83		
1.	171,51± 8,11	-1,11	0,1097	58,54±10,10	-2,61	0,0189*	19,77±2,10	-1,81	0,0179*
4.	174,23± 9,07			63,43±10,77			20,86±2,52		
2.	176,52± 8,69	-1,23	0,7556	65,17± 9,62	,878	0,6217	20,87±2,58	,665	0,5769
3.	175,94±10,35			64,19±10,64			20,62±1,83		
2.	176,52± 8,69	,234	0,1909	65,17± 9,62	,912	0,3844	20,87±2,58	,767	0,9841
4.	174,23± 9,07			63,43±10,77			20,86±2,52		
3.	175,94±10,35	,341	0,3965	64,19±10,64	,734	0,7315	20,62±1,83	-,226	0,5986
4.	174,23± 9,07			63,43±10,77			20,86±2,52		

Mean (average value); SD (standard deviation); Min (minimal result); Max (maximal result); T-test;
p- level significance (p<0.05*; p<0.01**; p<0.001***)

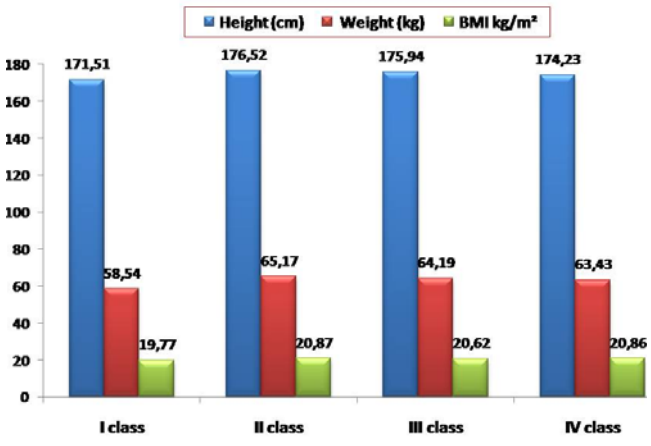

Figure 1 Mean values of anthropometric measures for school years

To display any quantitative differences in the morphological status of pupils, presented arithmetic means were analyzed by t-test module for large independent samples, and tested on the level (p<0.01). By using T-test, a total of four generations of pupils who have represented the high school population, were recorded statistically significant differences (Table 2).

By analyzing the differences of body weight, a statistically significant difference was obtained between the first and second grade (T=-3.18***), the first and third grades (T=-2.92**) and the first and fourth grades (T=-2.61*).

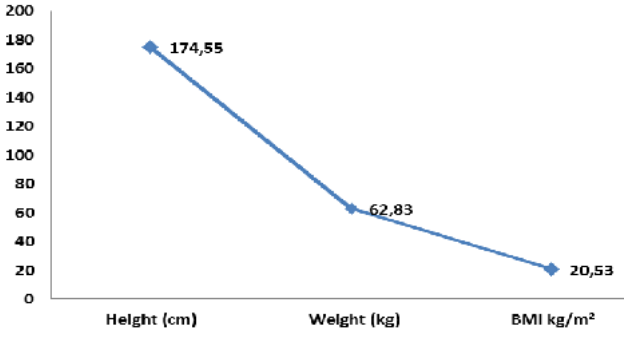

Figure 2 Mean morphologic measures (I-IV class)

The greatest weight had generation of pupils of second grade (Mean = 65.17 ± 9,62kg) in the range between minimum and maximum result of 42kg. Slightly lower average body mass defined the generation of third grade pupils (Mean=64.19±10,64kg) ranging from 43kg, generation of fourth grade (Mean=63.43±10,77kg).

As a generation that, on average, had the lowest body mass is generation of first grades with values of 58.54±10,10kg and range of 48kg. Based on the presented values of body mass it can be concluded that the generation of second grade pupils, was the most homogenous in terms of body mass (SD=9,62kg). In terms of height were also achieved statistically significant differences between pupils but only between the first and second grades (T=-2.14**) and the first and third grades (T=-1.35*). Pupils of first grades showed the highest homogeneity with the smallest mean value (Mean=171.51±8,11cm) and range from 40cm. Other three generations (II, III, IV grades) are characterized by heterogeneity of height with a range of results from 40-45cm. As the highest by growth were pupils of second grades (Mean=176,52cm). The same observation can be made for the mean BMI that is representative of the body-mass index kg/m² in which are also observed statistically significant differences ($p<0.05$) between the pupils of first and second grades (T=-1.92*), the first and third grades (T= -1.42*), the first and fourth grades (T= -1.81*). The best homogeneity defined the third grade pupils with a mean BMI (Mean=20.62 ± 1,83kg/m²) ranged from below the limit 17.63 to 26.03kg/m². The greatest value of BMI was recorded in the generation of second grades (Mean=20.87 ± 2,58kg/m²), which also represents the highest BMI of all generations, where the minimum score is (BMI=14,86kg/m²) and maximum (BMI=27,99kg/m²). Almost identical mean BMI had fourth-grades pupils (Mean = 20,86kg/m²).

Observing the morphological profile of pupils by grades (Figure 1) it can be concluded that pupils in second grades were on average of the highest by height 176,52cm, the highest body mass 65,17kg and maximum BMI=20.87kg/m². Based on cumulative analysis of mean values of four generations of pupils from grades I-IV it can be concluded that the mean body height amounted to (Height=174,55cm), body mass (Weight=62,83kg) and Body Mass Index (BMI=20,53kg/m²) (Figure 2). Existing differences in the morphological status between pupils are expected and they are the result of turbulent psychosomatic changes of pupils. Very often the increase of parameters (AMAS, BMI) leads to disruption of the health of the population. That these findings are justified tells us the data from VHO in 2006 when they conducted a broad research of the International Health Organization (WHO), which included 22 countries, including 18,152 students (male: 8,115, female: 10,037). The following values of BMI were obtained: Belgium 22,1kg/m², England 22,7kg/m², France 21,9kg/m², Germany 22,8kg/m², the US 24,3kg/m², Bulgaria 23,1kg/m², Greece 23,1kg/m², Italy 22,1kg/m² (Wardle et al. 2006). If we compare the results of this study with the results of previous studies it can be concluded that the pupils are below the average of European countries. Comparing with the research of Dopsaj et al. (2006); Peline et al. (2009), Budakova et al. (2012), Vadasova & Balogova (2012) Pavlovic et al. (2013) the students from Pale had lower values of BMI, as expected, and it is a good indicator that they are still in some middle average of the same or similar populations. The average should be less because here is about the pupils who are still in the stage of growth and development, when as a negative phenomenon, comes to an abrupt increment of certain morphological characteristics. However, when looking at the differences between generations within four years, then we may also indicate at the negative factors related to the accelerated trend of growth and development of the student population. Here came to the expression of an abrupt trend towards the growth and development of the pupils of second grades that were shown to be as the highest and the heaviest. The question is why is this so?

It is known that on the nutritional status and BMI also has influence the age (Kuczmarski, Carroll, Flegal, et al., 1997; Nysom, et al., 2001; Jakovljevic, et al. 2005), but this is a relatively young population. The answer can be explained as follows. In fact, today it is mainly lived in conditions of accelerated pace, poor quality and unhealthy diet, reduced or lack of movement, in one word hipokinetic lifestyle. The consequences of hypokinesia are numerous, and most related to various diseases of the cardiovascular system, the respiratory system, and the occurrence of diabetes. In addition, it can be mentioned also the uneven growth and development of the individual who leads to the negative trend of development of individual anthropometric characteristics including the physical status of the individual (body height, weight and BMI). Somatic type of man can be determined by genetic factors, nutrition, socio-economic conditions, age, sex, etc., that can have the possibility and provide valuable information about modern societies for researchers (Huntsmann, 2005; Muñoz-Cachón, et al. 2007). Increased BMI, WHR and RPI are just some of the indicators of the disease, so it became the custom that high values of stated criteria in modern societies are present, so it is surprising to see an increase in these values in athletes or pupils.

The study of Joyce & Hecth (2005) has found that ¼ of US football players ¼ are with the second degree of obesity. When it comes to body height of our pupils it has been noticed the trend of small oscillations, with a smaller decline in height in the generation of third and fourth grades in relation to the first and second grades (Table 1). Some studies have confirmed that the body height can be potentially independent risk factor for the development of over-nutrition and obesity (Pavlica, 2011). Kimura, 2005 conducted a research on the secular trend of faster growth of the Japanese. The obtained results show that the height of the entire population in this century has increased (except in time of war) and to a lesser extent body mass. Results Ekblom, et al. (2009) showed a connection of physical inactivity (low values of aerobic capacity) with prediction of obesity in old age.

Negative correlation of insufficient activity with functional skills in study confirmed Dyrstad, et al. (2005). Butler, et al. (2004) conducted a survey among 54 female freshmen students to examine the efficacy of diet, physical activity and weight changes associated with commuting from home to college lasting for 5 months. The results showed that, even though the calorie intake is significantly reduced, the increase of parameters of body weight can be attributed to a significant reduction in the overall physical activity. Comparing our results with the results of Kurt et al. (2011) it can be concluded that students are on average of less body height, body weight and BMI value in relation to the Turkish students. However, there are individual cases that are above the permitted limits in all generations of students, where BMI values exceed the limit of 25kg/m². Increased percentage value of body fat students obtained Sınırkavak, et al. 2004, which is an indicator of increased BMI values and reduced physical activity, although it is a relatively young and '' healthy '' population. The research of Sorensen et al. 2005 explored the trend of morphological changes of the police female population where they have found an increasing trend of individual measures of the morphological status. Similar results to this study obtained Jankovic, et al. (2008). Changes in trend growth, body weight and BMI in pupils were evident but it was not possible to determine with certainty the cause of such changes, particularly in men who have had an increase in weight and nutritional status in general, as opposed to girls who have shown considerable malnutrition. The research of Dopsaj, et al. (2006) with the aim of diagnosing BMI as the primary measure for assessing physical status and nutritional status showed that the average BMI of the tested sample of female student was 21.59±2.29kg/m², and the results range from 16.20 to 29,24kg /m². What is with the statistical significance evidented, is that already during the study 4.50% of the female population belongs to the category of respondents having a value of BMI in the range of 26.38 to 29.24kg/m², or by all applicable medical standards (or consensus) belongs to the category of obese (mean degree of obesity) females, or category of individuals with inadequate ie. professionally unacceptable physical status. What is surprising is that in the category of undernourished has 11.58% (BMI below 19,1kg/m²), and in the category of anorexic 1.61% of tested population of female students (BMI below 17,5kg/m²). If we take into account that it is a well-selected population for this occupational profile then these data are unexpected and alarming, and it is necessary to look for the cause of this situation. Something different results compared to the current research were obtained in studies Krsmanovic, et al. (1997) and Srdić, et al. (2009). On somewhat older population was identified only increase in average body weight, and BMI in relation to our sample, while the body height is almost even. Earlier stated studies have shown that the pupil and the student population are in the turbulent phase of psychosomatic changes that are usually manifested in heterogeneity of anthropometric characteristics (in this case Body Height = 174,55cm; Body Weight = 62,83kg; BMI =2 0,53kg/m²). The heterogeneity is primarily reflected in the values of body weight, or BMI, where in isolated cases was reported increased malnutrition or obesity. The results generally showed relatively good anthropometric profile of pupils with individual variations when it comes to BMI. This increased value should be a warning that this is a disruption of normal growth and development. Based on the research results it can not be said with certainty what the consequence of the established trend of increasing voluminosity and body (mal) nutrition status of pupils, which should be determined in future studies. However, the premise and the key to everything is just a physical activity with a balanced diet.

Conclusion

The survey was conducted on a sample of 209 high school pupils, male gender, chronological age 15-19±0.5years, with a view to determining the trend of changes and anthropometric characteristics, four generations of pupils from grades I to IV. The results showed that in pupils came to a statistically significant trend of changes that were confirmed by differences and also defined the considerable heterogeneity of the student population. Results statistically significantly explain the differences between the pupils of grades I and II in the measures, Body height (T=-2.14**), Body weight (T=-3.18***) and BMI (T=-1.92*); between pupils grades I and III in measures, Body height (T= -1.35*), body weight (T=-2.92**) and BMI (T=-1.42*); between pupils of the first and the fourth grade in measures of Body weight (T=-2.61*) and BMI (T=-1.81*), while in other relations between the pupils showed no statistically significant differences. Based on the results of research it can be confirmed with certainty that the process of growth and development of the population of secondary school pupils is heterogeneous, variable, and in the process of changes and that is the result of numerous endogenous (heritage) and exogenous factors (living conditions, nutrition, exercise, etc.) Such phenomena are evident in the earlier studies mentioned in this paper and are mainly a result of reduced physical activity, unbalanced diet and conditions of 'modern' way of life.

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TREND PROMJENA ANTROPOMETRIJSKIH KARAKTERISTIKA UČENIKA - STARIJA ŠKOLSKA DJECA

Sažetak

Morfološka prostor kao samo jedan segment antropološkog prostora čovjeka vrlo često predmet analize, kada se želi utvrditi stanje somatske statusa određene populacije. Vrlo često u studijama je studentska populacija te je pod povećalom praćenja, u smislu rasta i razvoja, te mogućim promjenama u određenim razdobljima života. U uzorku od 209 učenika srednjih škola (gimnazija i turistički tehničari), muški, dobne 15-19 ± 0,5 godina od Palama, primjenom poprečnog metodu istraživanja je provedeno dijagnosticiranje osnovnih antropometrijskih karakteristika, u funkciji utvrđivanja promjene , razlike u somatskim promjenama, u učenicima iz razreda I. do IV. Antropometrijska obilježja su predstavljene sa sljedećim varijablama: visina tijela izražena u cm, tjelesne mase, izraženo u kg, a indeks tjelesne mase (BMI), izražena u kg / m². Podaci su analizirani osnovne statistike i modula T-testom za velike nezavisne uzorke s dvosmjerno testiranje. Rezultati su pokazali da učenici znatno razlikuju od I. do IV klase definira znatan heterogenost populacije. U analizi podataka, primjenom t-test, brojčani pokazatelji dobiveni su koji značajno objašnjavaju razlike između učenika I i II; I i stupanj III i sva tri mjerene parametre (p <0,05; p <0,01; p <0,001), dok su razlike između učenika I. i IV razred su zabilježene samo u tjelesne težine i BMI (p <0,05). Na temelju dobivenih rezultata može se reći sa sigurnošću da je proces rasta i razvoja studentske populacije je heterogena očekivano, a to je posljedica niza endogeno-egzogenih čimbenika tijekom sazrijevanja pojedinca.

***Ključne riječi**: rast i razvoj, varijabinost, razlike, morfološke značajke, učenici*

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