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ASSESSING THE HEALTH CONDITION OF STUDENTS WITH SPORTS PROGRAM BY ANTHROPOMETRIC NUTRITION

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ABSTRACT. The anthropometric measurements are non-invasive methods which determine the condition of growth and development, as well as the prediction of the health of the organism. The research has been done on 200 students aged between 11-16 years old. It studied the level of high development, nutrition level and the proportion between different segments of the body. One group of students is represented by sportsmen and the other is represented by students who do not practice any sports (un-sportsmen). The results lead to the following conclusions: all the studied indicators increased in the age span 11-16 years old; the somatic development is influenced according to age, sex and sport activities.

Keywords: students, sports program, anthropometric measurements, nutrition

INTRODUCTION

Pre-puberty begins around 10-11 years, and it lasts about 2 years until 12-13 years, when talking about girls, but it lasts until 14-15 years old, when referring to boys. When studying the growth and the development of the body, the research of the soma usually precedes the research of the organs, the exterior aspects are more accessible to direct information and objective determination and the changes occurred in time can be more easily recorded, followed and compared one to another, than the internal ones.

In the puberty period, the somatic development is influenced by internal and external factors, which bring about quantitative and qualitative changes, which are faster and more obvious in the somatic field. The great number of studies carried so far in this field has focused on these changes, supplying a great number of data referring to the morphological and functional modifications of the soma.

The paper investigates the dynamic of the scholarly population in the growing period, when the individual anthropometric values are being modified in close relation to age, sex and sport activities.

MATERIALS AND METHODS

The study has been carried out on a number of 200 students between 11-16 years old, divided into two grups, one made up of sportsmen, and the second one of students who do not have any sport activities. Each group is made up of 100 subjects. Interpretations of each group have been made separately, regarding the sex. A number of 20 subjects for each age group 10 girls and 10 boys. When selecting the students, their health has also been taken into consideration.

The recommended procedures for the anthropometric measurements are the subjects in orthostatic posture, wearing light clothes. The measurements have been made on healthy subjects. The variables studied were: height (Iv-sol) using the stadiometre; weight using a calibrated balance and the biachromial and bitrohanterian diameters. The biachromial diameter was measured in the middle of distance between the edge of the last rib and the anterior-superior spine, and the circumference of the hips at trochanters levels. In both cases compasses have been used and the results are in centimeters.

Appreciation of the harmonious trunk development has been made by calculating the proportion of height using the following formula:

Biachromial index = (biachromial diameter/height) x 100

Bitrochanterian index = (bitrohanterian diameter/height) x 100

Fat percentage has the following formula (Deurenberg et al., 1991):

Child body fat % = (1.51 x BMI) - (0.70 x Age) - (3.6 x gender) + 1.4

Where: BMI = body mass index; male gender = 1; female = 0

Measurement of the cutaneous ply has been done using Holtain calipers.

In appreciation the nutrition state, the index of corporal mass was used. Body mass index represents the report between weight expressed in kg and the squared height in cm. Body mass index is used as a test screening in appreciating the overweight and obesity (Dietz and Bellizzi, 1999).

Water quantity is calculated regarding sex using the following formulas:

Total water (masculine) = 0.184 x G + 0.345 x T – 35.270

Total water (feminine) = 0.295 x G + 0.195 x T – 14.013

Where: G = weight, T = subject`s height (Nicolescu et al., 2006).

Muscle mass is obtained using the formula (Niculescu et al., 2006):

Muscle mass = (total water/73) x 100

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Another studied index was the ponderal index. This represents the report between real weight and ideal weight of a child.

Different mathematical methods have been used when working with the data, calculating frequencies and other data have been statistically processed with the help of Student *t* test. Aberrant values were eliminated using the Chauvenet criterion (Snedecor and Cochram 1978; Weber, 1980). The statistic interpretation of the data was done on the two sex groups separately. Correlation was made using the Pearson coefficient (Badea and Georgescu, 2003; Jaba and Grama, 2004).

RESULTS AND DISCUSSIONS

Somatic indexes (height and weight) increase during pre-puberty and puberty (Heger et al., 2008; Vasilov et al., 2001). Average values and standard deviations regarding the body mass index, weight and height are included in Table 1.

Table 1

Average values of height and weight (body mass) and body mass index

Sex repartition	Groups	Weight (kg)	Height (cm)	Body mass index (kg/m^2)
		X ± Es	X ± Es	X ± Es
Boys	Unsports	56.08 ± 2.37	164.20 ± 0.02	23.05 ± 0.97
	Sports	54.57 ± 1.82	163.30 ± 0.02	19.69 ± 0.47
Girls	Unsports	53.98 ± 1.01	162.10 ± 0.08	20.53 ± 0.31
	Sports	45.93 ± 1.42	157.20 ± 0.01	18.43 ± 0.41

Note: The table includes the average + the standard error (X + Es)

Body mass is a very labile index, which depends less on the genetic factors and more on the influences of the external (nutrition) and internal (metabolism) environment. Body mass is a sensible and significant index for the metabolic function and for the capacity of the organism to gain or lose nutrients.

Average values regarding body mass of the boys who lead a sporty life were 54.57 ± 1.82 kg while the other group had 56.08 ± 2.37 kg. Talking about girls, the average values of body mass were 45.93 ± 1.42 kg while the other group had 53.98 ± 1.01 kg. The body mass of the students who practice sports is 1.51 kg less for boys and 8.05 kg for girls.

Both sexes puberty is characterized by a rapid height growth and a slow body mass growth. Generally, height characterizes the individual development well enough and all the other anthropometric measurements are being reported to it.

The data confirm some differences between boys' and girls' body mass from 10 to 11 years old when the girls' body mass is higher than that of the boys (the puberty period). In this case the first crossing of the weight curves appears. But between 14-15 years old, boys' body mass is bigger than that of the girls, therefore, the second crossing of the weight curves appear.

The Pearson correlation coefficient between weight and height for boys was 0.74 (unsports) and 0.75 (sports), for girls it was 0.52 (unsports) and 0.74 (sports). The coefficient indicates the existence of a positive correlation between weight and height.

Body height has always been and still is one of the main factors of somatic growth. Height is influenced more by heredity and less by environment. This is why it is a more stable index which varies between narrow limits (it only goes down in very few cases). The boys` height has an average of 164.20 + 0.02 cm (unsports) and 163.30 + 0.02 cm (sports). The differences between these values were between 0.9 cm in favor of unsports students. After Rainer`s stair the boy have the middle height. The girls' height was between 157.20 + 0.01 cm (the sports group) and 162.10 + 0.08 cm (unsports group). After Rainer`s stair the girls have the little height.

Evaluation of a harmonious body is done by calculating the biachromial and bitrohanterian index. In Table 2 there are the average values of these indexes presented for the boys. The biachromial diameter for the sports had values between 32 cm and 45 cm with an average of 37.10 cm (r = 0.87) and for unsports it was between 28 cm and 42 cm with an average of 35.15 cm (r = 0.88). The biachromial diameter was used in order to calculate the biachromial index. The average values of this index for unsports were between 21.54% (11 years old) and 23.80% (16 years old), for sports they were between 22.77% and 22.69%. The average values of the biachromial index at unsport was 21.74% of the height and at sports 22.59%. Normally, these values are between 18-23% of the height for men. In the case of those who have sport activities, the higher the index is the better.

The bitrochanterian diameter is lower than the biachromial one with a value of 4-5 cm. This diameter for sports is between 24.50 cm and 34 cm with an average of 29.73 cm (r = 0.81) for unsports the values are between 22 cm and 31 cm with an average of 27.94 cm (r = 0.84).

In order to evaluate the harmonious development of the trunk we calculated the bitrochanterian index. In the case of the students who do not do sport the average values of the index was between 16.92% (11 years old) and 17.98% (16 years old). In case of the student who practices high performance sport the bitrochanterian index was between 17.13% and 17.89%. To make a comparison between the bitrochanterian indexes we made an arithmetical mean at sports and unsports. This was 17.76% (unsports) and 17.44% (sports). The bitrochanterian index has the

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values between 18-19% in the height for men. In the case of those who do not practice any sports, it is recommended that this index to be low.

In Table 3 there are presented the average values of the biachromial indexes for the girls too. The biachromial index for girls was between 29 cm and 38 cm with an average of 34.78 cm (r = 0.79) and in the case of those who practice high performance sport the values were between 31 cm and 40 cm with an average of 35.59 cm (r = 0.58). The biachromial index for girls who do not practice any sports was 20.12% (11 years old) and 23.14% (16 years old) of height, whereas 22.04% (11 years old) and 22.47% (16 years old) of height for those who practice sport. The data found in the literature show that the values of the biachromial index are between 18-20% of height for women. The average values of the biachromial index for unsports girls was 21.84% in height and for sports girls it was 22.17%.

The bitrochanterian diameter for girls who practice sport has the values between 25 cm and 33 cm with an average value of 27.72 cm (r = 0.74) whereas in the case of those who do not practice high performance sports the values are between 26 cm and 36 cm with an average of 30.08 cm (r = 0.62). The bitrochanterian index has the values between 16.46% (11 years old) and 19.39% (16 years old) for the girls who do not practice any sport activities 17.42% (11 years old) and 18.23% (16 years old) in height. The bitrochanterian index has values between 19-20% in height. The values which in the case of the sports batch is lower (17.52% in height for sports girls and 18.07% in height for unsports girls).

Table 2

Average values of the biachromial and bitrohanterian indexes for the studied boys

Years old	Unsports Boys		Sports Boys	
	Biachromial index	Bitrochanterian index	Biachromial index	Bitrochanterian index
11	21.54%	16.92%	22.77%	17.13%
12	21.47%	17.12%	22.51%	17.38%
13	22.22%	18.75%	22.67%	17.09%
14	20.09%	18.26%	22.30%	17.66%
15	23.38%	17.56%	22.61%	17.47%
16	23.80%	17.98%	22.69%	17.89%

Table 3

Average values of the biacromial and bitrohanterian indexes for the studied girls

Years old	Unsports Girls		Sports Girls	
	Biachromial index	Bitrochanterian index	Biachromial index	Bitrochanterian index
11	20.12	16.46	22.04	17.42
12	21.98	17.45	22.30	16.99
13	21.80	17.80	21.87	17.71
14	21.89	18.40	22.13	16.67
15	22.08	18.92	22.24	18.08
16	23.14	19.39	22.47	18.23

Table 4

Mass index of the subjects study

Sex repartition	Groups	Paratrophic children (%)	Eutrophic children (%)	Protein - caloric first degree malnutrition (%)	Protein - caloric second degree malnutrition (%)
Boys	Unsports	16.22	35.13	32.43	16.22
	Sporty	11.29	38.71	33.87	16.13
Girls	Unsports	10.61	51.51	34.85	3.03
	Sporty	4.54	27.28	45.45	22.73

In Table 4 there are the results of mass index. Mass index is used in order to underline the degree of dystrophy and weight shortage. Referring to weight index, children are divided into: paratrophic, eutrophic, protein-caloric first degree malnutrition and protein-caloric second degree malnutrition. When the mass index is higher than 1.10, we talk about paratrophic children. As we expected, the percentage of paratrophic children is higher among those who do not practice any sports.

Boys who have very good sport results show the following characteristics: 11.29% paratrophic, 38.71% eutrophic, 33.87% protein-caloric first degree malnutrition and 16.13% protein-caloric second degree

malnutrition. Protein-caloric malnutrition was emphasized in a percentage of 48.65% for unsports boys and 50% for the sports boys. Girls who have very good sport results present 45.45% and 22.73% protein-caloric first and second degree malnutrition. Unsports girls presented a percentage of 37.88% of protein-caloric malnutrition and those who practice sports presented a percentage of 68.18%. We could draw the conclusion that there is a growth of the percentage of protein-caloric malnutrition in the case of the children who practice sports.

Nutrition quantitative and qualitative errors are responsible for protein-caloric malnutrition.

Referring to body mass index means, they are presented as follows for boys between 19.69 ± 0.47 kg/m2 (sports) and 23.05 ± 0.97 kg/m2 (unsports) and for girls between 18.43 ± 0.41 kg/m2 (sports) and 20.53 ± 0.31 kg/m2 (unsports). Because the average values of the body mass and of the height are lower in the case of those who practice sports and the index of the body mass is lower. Numerous studies (Nelson et al., 2004; Parson et al., 2006; Tiruneh, 2009) have underlined the fact that the physical activity is responsible for the decrease of the body mass index.

In Table 5 the body mass indexes are grouped into 4 categories: underweight, normal, overweight and obesity. Overweight is indicated by a body mass index equal or higher than 25 kg/m2 and lower than 30 kg/m2. It has a percentage of 9.38% for sporty boys and 13.51% for those who do not practice any sports. Talking about the girls, the results also underline the increase of overweight percentage for those who do not practice any sports, being of 7.81% whereas those who practice sports are 4.35%.

Numerous studies (Dietz et al. 1999; Jelea and Jelea, 2009 a, b; Torrance et al., 2007; Williams et al., 2005) are concerned about the presence of obesity among students. Overweight appeared at an early age (teenager) is associated with obesity at an adult life. Obesity corresponds to a body mass index equal to or higher than 30 kg/m2.

Epidemiologically speaking, there are proves that this is independently associated to a high cardiovascular risk (Dubbert et al., 2002; Gang et al., 2004; Hu et al. 2004), the increase of waist/hips report (which is a marker abdominal obesity) being independently co-related to the increase of cardiovascular risk.

Table 5

Body mass index of the subjects study

Sex repartition	Groups	Subnutrition (%)	Normal (%)	Overweight (%)	Obesity first degree (%)	Obesity second degree (%)
Boys	Unsports	13.51	59.46	13.51	8.11	5.41
	Sports	42.18	46.88	9.38	1.56	-
Girls	Unsports	20.31	71.88	7.81	-	-
	Sports	52.17	43.48	4.35	-	-

If the body mass index is lower than 18.5 kg/m2, we talk about subnutrition. Regarding subnutrition, this has been demonstrated for those who have physical activities, as follows a percentage of 42.18% boys and 52.17% girls.

Obesity can be referred to as a symptom of an imbalance between caloric intake as food and calories expended through physical activity. Persistent obesity may increase the risk of developing many chronic diseases in adulthood (cardiovascular diseases, diabetes mellitus, osteoarthritis and colon cancer).

Physical activity plays an important role in controlling stature. Increased stature to students with sporting performance is not followed to the increase corporals mass. The changes which came up in the dynamic of the development of different somatic indexes have an effect on the general appearance of the teenagers` bodies. Therefore application of the formula for body mass index leads to increasing the percentage of subnutrition students.

In Table 6 there are presented the average values regarding the body fat at different ages. Body mass index has been shown as being in correlation with body fat (Jackson et al., 2002; Omondi et al., 2010). Body fat percentage in boy's unsports was between 2.70% (11 years) and 35.24% (14 years). The boys with sports performance have values between 9.52% (14 years) and 25.40% (15 years). For teenagers aged 10-15 years the percentage of fat is between 25-30% and 20-25% when subjects up to the age 18 years (Rodriguez et al., 2004).

In the case of unsports girls, the average values of the fat tissue was between 1.54% (11 years) and 52.31% (15 years), whereas in the case of those who practice sports the values were situated between 34.78% (11 years) and 34.78% (15 years). The results indicate a constant accumulation of fat on both sexes in the case of the students who do not practice any sports. The important increasing of the fat deposit is seen on the boys of 14 years old and on the girls of 15 years old.

In Table 7 there are presented the average values of the abdominal skinfold. Skinfold reflects the subcutaneous fat deposits and the extracell water content. Studying the average values of the abdominal skinfold, we have drawn the conclusion that there is a growing tendency for the students who do not practice any sports. The abdominal skinfold had a growth for boys with 1.28 cm and for girls with 2.00 cm. Many studies support the body fat are normally higher in girls (Vizmanos et al., 2000).

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Talking about the average values of the abdominal skinfold at students from a sports school, we saw the decrease of the abdominal skinfold for boys from 1.94 cm to 1.31 cm and for girls from 1.76 cm to 1.50 cm.

In Tables 8 and 9 there are presented the average values of total water and the average values regarding the muscle mass. Between 10-16 years old, the water is accumulated in the organism different quantities, depending on the sex. The females accumulate approximately 12 L, whereas the males 16 L (Nicolescu et al., 2006). The data presented in Table 8 indicate the increasing in the total water quantity in the studied groups, according to age. Studying the average results and comparing them between the groups, you can observe the increase of these values in the case of boys who practice sports.

Table 6

The percentage of the deposit of body fat of the subjects study

Sex repartition	Groups	11 years	12 years	13 years	14 years	15 years	16 years
Boys	Unsports	2.70%	21.62%	16.22%	35.24%	18.92%	5.30
	Sports	12.70%	17.46%	22.22%	9.52%	25.40%	12.70%
Girls	Unsports	1.54%	10.76%	7.69%	24.62%	52.31%	3.08%
	Sports	34.78%	13.04%	10.87%	2.17%	34.78%	4.34%

Table 7

Mean skinfold of the subjects study

Years old	Sports boys (cm)	Unsports boys (cm)	Sports girls (cm)	Unsports girls (cm)
11	1.94	0.50	1.76	1.00
12	1.86	1.07	1.58	1.07
13	1.82	1.60	1.79	1.80
14	1.30	2.16	1.60	2.36
15	1.31	1.78	1.79	2.84
16	1.31	1.78	1.50	3.00

Table 8

The muscle mass and the total water of the investigated boys

Years old	Boys sporty		Boys unsporty	
	The muscle mass (kg)	Total water (l)	The muscle mass (kg)	Total water (l)
11	30.23	22.07	19.42	14.18
12	35.45	25.88	36.59	26.71
13	41.61	30.37	29.82	21.77
14	45.07	20.34	43.28	31.59
15	51.64	37.57	48.84	35.65
16	49.58	36.19	48.98	35.79

Table 9

The muscle mass and the total water of the investigated girls

Years old	Girls sporty		Girls non-sporty	
	The muscle mass (kg)	Total water (l)	The muscle mass (kg)	Total water (l)
11	42.93	31.24	36.67	26.77
12	43.33	31.63	38.57	28.15
13	43.78	31.88	41.22	30.09
14	44.70	32.71	53.95	39.38
15	47.18	34.34	45.73	33.38
16	49.60	36.21	41.46	30.26

The evolution of the muscle mass is extremely dynamic. In adolescence an active growth of muscle mass takes place. This is connected to the body growing and developing processes and also to practicing physical activities. For example, the muscle mass at the age of 11 years old was 30.23 kg at boys who practice sports and 19.42 kg at those who do not practice sports. At the age of 13 years old, the values were: 41.61 kg at boys who practice sports and 29.82 kg at those who do not practice sports.

The sports between the age of 11 years old and 15 years old, the muscle mass increased with 21.41 kg and

total water with 15.5 L, unlike the unsports whose muscle mass increased with 29.42 kg and the content of water with 21.47 L.

Similar results have been registered for girls (Table 9). In the period between 13-14 years old, the growing of muscle mass takes place, because the biological development implies the growing of the muscle mass (Prejbeanu et al., 2008). The muscle mass and the water content increased with 0.32 kg and 4.97 L for sports. In the case of girls who do not practice any sports, the muscle mass increased with 4.79 kg and total water with 3.49 L. Increasing the muscle mass can be realized with isometric exercises.

The changes which came up in the dynamic of the development of different somatic indexes have an effect on the general appearance of the teenagers' bodies.

CONCLUSIONS

Throughout the studied period of time all the somatic indexes have raised. The somatic development depends on the age, sex and physical activity. The results of the study allowed us to draw the following conclusions: the somatic indexes (weight and height) have lower values at sportsman; the physical activity is responsible for reducing of the body mass index and the muscle mass and the total water content depends on the age, sex and physical activity.

In the case of the sportsmen there is a weight shortage combined with an active body mass as well as protein caloric malnutrition. Protein caloric malnutrition seen at the sports group allows us to recommend a hypercaloric and hyperproteic diet and in the same time an effort orientated to the raising the muscle mass should be done.

In order to evaluate the harmonious body development we calculated the biachromial and bitrohanterian indexes. In the case of the students who practice sports, we observed the raising of the biachromial index and a reducing of the bitrochanterian index.

We also observed an accumulation of the fat tissue in both the boys and girls who do not practice any sports. A significant accumulation of the fat tissue occurs at the age of 14 for boy and at the age of 15, when talking about girls. The abdominal skinfold grows with the age in the case of the students who do not do any sport activities. The girl presents a greater value. In the case of the students who practice sports, we observed a reducing of the abdominal skinfold.

In adolescence the body composition is changes. Increase of total body mass and its relative distribution are mainly related to gender, pubertal development and physical activity.

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