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COMPARISON OF SOME MORPHOLOGICAL PARAMETERS DURING THE ADOLESCENCE STAGE

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Abstract

The fastest changes in a child's growth and development occur during the puberty phase. The purpose of this research is based on this fact. The goal was to determine changes in the dynamics of growth and development of the morphological characteristics of children from age 12 to 15 years in the Municipality of Kamenica, Republic of Kosovo. To achieve this goal in this research are included 360 the masculine gender students of Elementary School "Dëshmorët e Kombit", in Kamenica. The students were divided into 4 group. Each group consisted of 90 children aged 12-15 years, total 360 children. The battery of 12 anthropometric variables (measures) was selected for the present research under the pressumption that there were four hypothetical latent anthropometric dimensions: the longitudinal dimensionality of skeleton, the transversal dimensionality of skeleton, circular dimensionality of skeleton, and the dimension of subcutaneous fat tissue. Basic statistical parameters were applied for all age groups: arithmetic mean and standard deviation. Within comparative statistics, they have been appliedAnalysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD). The results obtained shows that: 1. A more pronounced growth of children happens between years 12-13, 2. A more pronounced increase of the body mass occursbetween years 12-13 and body volume between 13-14years. 3. A more pronounced increase in the transversal dimensions of the body skeleton occurs at the age of 13-14 years. 4. Subcutaneous fat tissue it gradually decreases in all parts of the body by age 12-15 years. During adolescence, growth does not develop evenly, arms and legs grows faster than body and we have a gradual decrease of subcutaneous fat tissue. We can emphasize that the phase of puberty should always be followed by meeting organic energy needs.

Key words: adolescence; anthropometric variables; Analysis of variance; LSD

Introduction

Optimal physical development of children and youth indicates the health level and social and cultural progress of a country. Knowing the laws of physical development, recognizing the conditions of interaction of various factors external and internal environment, studying the dynamics of development of its means to be able to intervene at the right time, in order to create conditions and incentives for optimal physical development of each child at every stage of its development. Within this context, we can define physical development as a complex of morphological characteristics and their interrelation with human biotic and social environmental factors (Vanhelst et al. 2013). The environment in which they live and grow is greatly influenced by the growth and development of anthropological, especially morphological, characteristics of children and youth. Research has shown that habits for exercise need to be developed at the earliest stage of the child, because acquired habits can greatly help develop a healthy and healthy personality (Wais and Ebbec, 1995; Malina et all . 2004). With the exception of genetic factors that can be negatively influenced , there are a number of influential factors such as nutrition, socioeconomic status, and physical activity that may affect children's growth and development (De Privitellio et al., 2007). Each period of life is described by many features and changes that are most pronounced in the puberty phase. Puberty is a period of sexual, physical, and psychological maturity . At puberty, the body grows larger and grows in spite of its rapid growth. Hormones are also affected by other changes in organism. Thus, the appearance of the body differs markedly in boys receiving the characteristics of adult males (Blos, 1962). These changes have a huge personal and social significance because they imply that girls and boys face more and more with their role in reproduction, and that none of them is not gatsh er (Tanner, 1962). Development during adolescence is, as always, uneven. Thus, it is possible for a teenager at different stages of life to reach adulthood to varying degrees. Late adolescents think they have fully entered the adult world morphologically . Often teenagers think they have reached adulthood is often the earliest area of development. As there is no research in Kosovo on the early phase of child development , this research is an attempt to identify this phase of early development in the Kamenica region . The purpose of this study is to determine

changes in the dynamics of growth and development in the field of morphological characteristics of children of primary school from age 12 to 15 years in Municipality of Kamenica, Republic of Kosovo.

Methods

This research involved 360 male students of the Elementary School "Dëshmorët e Kombit”in Kamenica. The students were divided into 4 groups. The first group consisted of 90 students aged 12 years, The second group consisted of 90 students aged 13 years, the third group comprised 90 students aged 14 and the fourth group comprised 90 students aged 15. All students regularly attended the educational process, completed the tasks foreseen in the physical education classes program, and all have been willing to undergo physical development measurements for the purpose of this paper. The measurements were carried out in April and May 2018 at the Elementary School "Dëshmorët e Kombit”, in Kamenica at the hours and mornings. First, to conduct research were asked the permission from the director of the Elementary School "Dëshmorët e Kombit" in Kamenica. After obtaining permission, the questionnaire was distributed to children surveyed, or their parents, in accordance with ethical principles (Helsinki Declaration was satisfied), and their parents approved their children's participation in the research project. The battery of 12 anthropometric variables (measures) was selected for the present research under the pressumption that there were four hypothetical latent anthropometric dimensions: the longitudinal dimensionality of skeleton, the transversal dimensionality of skeleton, circular dimensionality of skeleton, and the dimension of subcutaneous fat tissue. To assess longitudinal dimensionality of skeleton three measures were used: body height (ABOHE), width of arm (AWIAR) and leg length (ALELE). Three measures were selected to assess body mass and body volume (the circular dimensionality of skeleton): body weight (ABOWE), circumference of the chest (ACICH) and upper arm circumference (AUACI). The transversal dimensionality of skeleton was determined by means of thre measures: left wrist diameter (ALWDI), elbow diameter (AELDI) and knee diameter (AKNDI). Subcutaneous fat tissue was assessed by 3 measures: subscapular skinfold (ASUSK), upper arm skinfold (AUASK) and abdominal skinfold (AABSK). The measurements were conducted in the morning.

All subjects were barefoot and wore only shorts. Before the actual measure taking, every measurer marked the relevant, selected anthropometric points. Pair body segments were measured on the left side of the body. Anthropometric measurements were made based on techniques suggested by International Biological Program (IBP) (Harvey, 1974) and "International Society for the Advancement of Kinanthropometry (ISAK) (Weiner & Lourie, 1969). Basic statistical parameters were applied for all age groups: arithmetic mean and standard deviation. Within comparative statistics, they have been applied Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD).

Results

This chapter will present the research results that give us an overview of the sample involved in the research regarding their anthropometric characteristics. Also, the research results obtained by comparing the examined groups will be presented. Table 1 presents the descriptive (mean and standard deviation) parameters of anthropometric variables in children (students) aged 12 years, 13 years, 14 years, 15 years as well as analysis of variance (ANOVA) and post hoc multiple comparisons, at least significant difference (LSD). This table shows that for each group 90 children aged 12 Years, 13 Years, 14 Years and 15 Years were measured.

The arithmetic mean of the variable body height (ABOHE) in children 12 years of age is X = 153.20; SD = 7.58, in children 13 years of age is X = 162.00; SD = 4.53, in children 14 years of age is X = 167.17; SD = 7.58, in children 15 years of age is X = 171.27; SD = 5.91. Analysis of variance (ANOVA) and Post Hoc multiple comparisons, least significant difference (LSD) indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

The arithmetic mean of the variable width of arm (AWIAR) in children 12 years of age is X=151.93; SD=10.64, in children 13 years of age is X=166.73; SD=7.56, in children 14 years of age is X=169.73; SD=8.25, in children 15 years of age is X=174.47; SD=6.95. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

The arithmetic mean of the variable leg length (ALELE) in children 12 years of age is X=89.37; SD=6.29, in children 13 years of age is X=95.83; SD=3.58, in children 14 years of age is X=98.47; SD=5.01, in children 15 years of age is X=102.60; SD=4.96. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD), indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

The arithmetic mean of the variable body weight (ABOWE) in children 12 years of age is X=48.33; SD=15.31, in children 13 years of age is X=55.93; SD=4.49, in children 14 years of age is X=62.00; SD=13.36, in children 15 years of age is X=66.20; SD=7.35. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

Tabela 1. Basic statistical parameters, Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD).

Variable		2		3		4		5		ANOVA
	N	X	S.D	X	S.D	X	S.D	X	S.D	LSD
ABOHE	90	153.20	7.58	162.00	4.53	167.17	7.58	171.27	5.91	$2^{345};3^{245};4^{235};5^{234}$
AWIAR	90	151.93	10.64	166.73	7.56	169.73	8.25	174.47	6.95	$2^{345};3^{245};4^{235};5^{234}$
ALELE	90	89.37	6.29	95.83	3.58	98.47	5.01	102.60	4.96	$2^{345};3^{245};4^{235};5^{234}$
ABOWE	90	48.33	15.31	55.93	9.49	62.00	13.36	66.20	7.35	$2^{345};3^{245};4^{235};5^{234}$
ACICH	90	76.93	12.88	77.57	9.40	83.87	8.88	87.28	9.87	$2^{45};3^{45};4^{235};5^{234}$
AUACI	90	23.00	4.81	25.80	2.22	30.73	16.98	33.68	2.31	$2^{345};3^{245};4^{235};5^{234}$
ALWDI	90	4.93	0.33	5.09	0.57	5.27	0.39	5.44	0.45	$2^{345};3^{245};4^{235};5^{234}$
AELDI	90	6.13	0.60	6.26	0.62	6.42	0.47	6.54	0.57	$2^{45};3^{5};4^{2};5^{23}$
AKNDI	90	7.13	0.71	7.64	0.51	7.88	0.43	8.05	0.90	$2^{345};3^{245};4^{23};5^{23}$
ASUSK	90	13.20	10.33	11.87	3.92	10.60	5.40	10.20	1.94	$2^{45};3,4^{2};5^{2}$
AUASK	90	15.43	9.69	13.13	4.58	12.30	6.42	10.53	2.50	$2^{345};3^{25};4^{2};5^{23}$
AABSK	90	16.50	12.33	15.07	7.53	11.86	7.00	11.40	2.72	$2^{45};3^{45};4^{23};5^{23}$

Legend: X – Arithmetic mean, S.D. – Standard deviation, ANOVA – ANalysis Of Variance $p<0.05$, LSD – Post Hoc multiple Comparisons, 2 - 12 Years, 3- 13 Years, 4 - 14 Years, 5 - 15 Years.

The arithmetic mean of the variable circumference of the chest (ACICH) in children 12 years of age is X=76.93; SD=12.88, in children 13 years of age is X=77.57; SD=9.40, in children 14 years of age is X=83.87; SD=8.88, in children 15 years of age is X=87.28; SD=9.87. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

The arithmetic mean of the variable upper arm circumference (AUACI) in children 12 years of age is X=23.00; SD=4.81, in children 13 years of age is X=25.80; SD=2.22, in children 14 years of age is X=30.73; SD=16.98, in children 15 years of age is X=33.68; SD=2.31. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

The arithmetic mean of the variable left wrist diameter (ALWDI) in children 12 years është X=4.93; SD=0.33, in children 13 years of age is X=5.09; SD=0.57 in children 14 years of age is X=5.27; SD=0.39, in children 15 years of age is X=5.44; SD=0.45. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) indicate that there are statistically significant differences between the arithmetic averages of the age groups included in the research $p<0.05$.

The arithmetic mean of the variable elbow diameter (AELDI in children 12 years of age is X=6.13; SD=0.60, in children 13 years of age is X=6.26; SD=0.62 in children 14 years of age is X=6.42; SD=0.47, in children 15 years of age is X=6.54; SD=0.57. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) tregon se në mes mesatareve aritmetikore të grupmoshave 12 years: 14 years, 12 years: 15 years; 13 years: 15 years; 14 years: 12 years; 15 years: 12 years, 15 years: 13 years ekzistojnë dallime të rëndësishme statistikore $p<0.05$.

The arithmetic mean of the variable knee diameter (AKNDI) in children 12 years of age is X=7.13; SD=0.71, in children 13 years of age is X=7.64; SD=0.51 in children 14 years of age is X=7.88; SD=0.43, in children 15 years of age is X=8.05; SD=0.90. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD shows that between arithmetic averages of age groups 12 years: 13 years, 12 years:

14 years, 12 years: 15 years; 13 years: 12 years, 13 years: 14 years, 13 years: 15 years; 14 years: 12 years, 14 years: 13 years; 15 years: 12 years, 15 years: 13 years there are statistically significant differences $p<0.05$.

The arithmetic mean of the variable subscapular skinfold (ASUSK) in children 12 years of age is X=13.20; SD=10.33, in children 13 years of age is X=11.87; SD=2.92 in children 14 years of age is X=10.60; SD=5.44, in children 15 years of age is X=10.20; SD=1.94. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) shows that between arithmetic averages of age groups 12 years: 14 years and 12 years: 15 years; 14 years: 12 years; 15 years: 12 years there are statistically significant differences $p<0.05$.

The arithmetic mean of the variable upper arm skinfold (AUASK) in children 12 years of age is X=15.43; SD=9.69, in children 13 years of age is X=13.13; SD=4.58 in children 14 years of age is X=12.30; SD=6.42, in children 15 years of age is X=10.53; SD=2.50. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) shows that between arithmetic averages of age groups 12 years: 13 years, 12 years: 14 years and 12 year: 15 years; 13 years: 12 years and 13 years: 15 years; 14 years: 12 years; 15 years: 12 years and 15 years: 13 years there are statistically significant differences $p<0.05$.

The arithmetic mean of the variable upper arm skinfold (AUASK) in children 12 years of age is X=15.43; SD=9.69, in children 13 years of age is X=13.13; SD=4.58 in children 14 years of age is X=12.30; SD=6.42, in children 15 years of age is X=10.53; SD=2.50. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) shows that between arithmetic averages of age groups 12 years: 13 years, 12 years: 14 years and 12 years: 15 years; 13 years: 12 years and 13 years: 15 years; 14 years: 12 years; 15 years: 12 years and 15 years: 13 years there are statistically significant differences $p<0.05$.

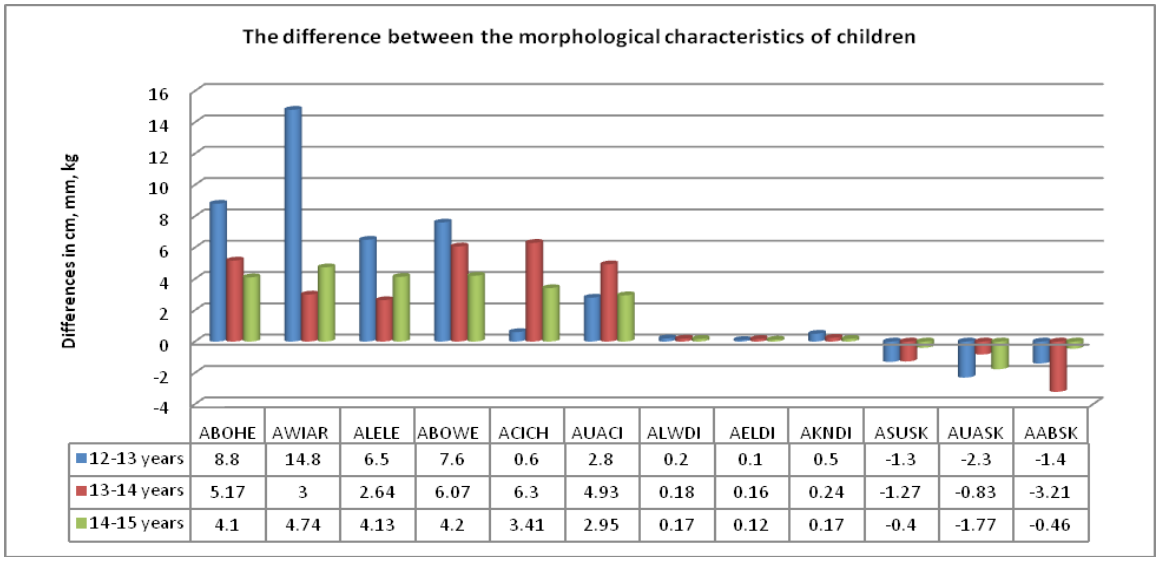
The arithmetic mean of the variable abdominal skinfold (AABSK) in children 12 years është X=16.50; SD=12.33, in children 13 years of age is X=15.07; SD=7.53 in children 14 years of age is X=11.86; SD=7.00, in children 15 years of age is X=11.40; SD=2.72. Analysis of variance (ANOVA) and Post Hoc multiple Comparisons, least significant difference (LSD) shows that between arithmetic averages of age groups 12 years: 14

years, 12 years: 15 years; 13 years: 14 years and 13 years: 15 years; 14 years: 12 years and 14 years: 13 years; 15 years: 12 years and 15 years: 13 years there are statistically significant differences $p<0.05$.

Discussion

Morphological parameters of children are constantly changing as they grow and develop. In particular, the increase in body height and weight is most pronounced in the pubertal phase, and these changes are conditioned by a number of internal and external factors (Mader, 2001). Longitudinal research related to tracking morphological development during the stages of child rearing is scarce because of the time required for their realization, and therefore, most research is of a transgender nature. This research of transference character was conducted with the aim of comparing some anthropometric characteristics of children aged 12, 13, 14 and 15 years, and establishing differences between groups in all variables considered in our research. The results of our research indicate that there was a high level $p < 0.01$ difference between the four groups of children in some characteristics of morphological development. Differences between groups of children in some morphological development characteristics are shown in Graph1.

Graph 1. Differences between groups of children in some morphological development characteristics



	ABOHE	AWIAR	ALELE	ABOWE	ACICH	AUACI	ALWDI	AELDI	AKNDI	ASUSK	AUASK	AABSK
12-13 years	8.8	14.8	6.5	7.6	0.6	2.8	0.2	0.1	0.5	-1.3	-2.3	-1.4
13-14 years	5.17	3	2.64	6.07	6.3	4.93	0.18	0.16	0.24	-1.27	-0.83	-3.21
14-15 years	4.1	4.74	4.13	4.2	3.41	2.95	0.17	0.12	0.17	-0.4	-1.77	-0.46

The difference in body height variable (ABOHE) between children 12 years and 13 years old is 8.8cm, the difference between children 13 years old and 14 years old is 5.17cm and between children 14 years old and 15 years old the difference is 4.1cm. It is clear that the fastest increase in body height is between the ages of 12-13 years.

A more pronounced difference in the width of arm variable (AWIAR) was obtained between children aged 12 and 14.8 cm, between children 13 - 14 years old the difference is 3.00 cm and between children 14 - 15 year difference is 4.74cm. It is clearly seen that the fastest increase in width of arm is between 12-13 years of age. Even in the anthropometric variable, walking length (ALELE) between children 12 years and 13 years old shows a difference of 6.5cm, between children 13-14 years old the difference is 2.64cm and among children 14-15 years old the difference is 4.20cm. It is evident that the fastest increase in leg length is between 12-13 years of age. During the adolescent phase the anthropometric variables belonging to the longitudinal dimension did not have an equal increase during the puberty phase. The most rapid and uneven phase occurs during the age of 12-13 years and a stabilization of growth during the age of 14-15 years equally.

Between the children of 12 year olds and 13 year olds in body weight (ABOWE), the difference is 7.6kg, between 13-14 year olds the difference is 6.07kg and between 14-14 year olds the difference is 4.1 kg. It is clearly seen that the fastest increase in body height is between the ages of 12-13 years. A more pronounced difference in the circumference of the chest (ACICH) variable was obtained between children 12 years of age and children 13 years of age is 0.6cm, between children 13-14 years of age the difference is 6.30cm and between children ages 14 - 15 years old the difference is 3.41cm. It is clearly observed that the fastest increase in the circumference of the chest variable is observed between the ages of 13-14 years. Even in the anthropometric upper arm circumference (AUACI) variable between children 12 years and 13 years old there is a difference of 2.8cm, between children 13-14 years old the difference is 4.93cm and between children 14-15 years old the difference is 2.95cm. It is clearly seen that the fastest increase in upper arm circumference is observed between the ages of 13-14 years. During the adolescence phase the anthropometric variables belonging to the body mass and body

volume dimension did not increase evenly during the puberty phase. The fastest phase of variable body mass occurs during the age of 12-13 years, while the variables of body volume occur during the age of 13-14 years and a stabilization of growth over the age of 14-15 years. Anthropometric indicators of physical development of 14-year-old male children of Kosovo (Kamenica) in relation to growth and development standards from some European countries have satisfactory values are shown in Table 2 (Radulović and Krivokapić, 2016).

Table 2. Values of anthropometric characteristics of fourteen year old boys in Kosovo and some European countries

	Kos (Kamenica)	Monte Negro	Serb	Span	Slovak	Litvan	Eston	Alban	Belg
ABOHE	167,17	167,16	173,46	165,5	170,2	168,3	166,9	157,8	162,9
ABOWE	62,0	57,09	65,08	58,0	57,3	53,8	53,5	49,6	54,6

Legenda: ABOHE – body height, ABOWE – body weight

It can be concluded that health-related quality of life is a very complex phenomenon that depends on many different factors, internal and external genetic, including climatic, geographical, nutritional, macro and micro-social factors, physical activity and others, largely determined by subjective perception and subjective experience.

Between the children of 12 years and the children of 13 years in the left wrist diameter (ALWDI), the difference is 0.2cm, the difference between the children of 13-14 years is 0.18cm and the difference between the children of 14 - 15 years is 0.17 cm. It is clearly seen that the fastest growth on the left wrist diameter is between the ages of 13-14 years. A less pronounced difference in the elbow diameter (AELDI) variable was obtained between children at the age of 12 years and 13 years old is 0.1cm, between children 13-14 years old the difference is 0.18 cm and between children 14 - 15 years old the difference is 0.12cm. It is clearly seen that the fastest increase in the elbow diameter variable is observed between the ages of 13-14 years. Even in the anthropometric variable knee diameter (AKNDI) between children 12 years and 13 years old there is a difference of 0.5cm, between children 13-14 years old the difference is 0.24cm and between children 14-15 years old the difference is 0.17cm. It is clearly seen that the fastest

increase in knee diameter is observed between the ages of 13-14 years. During the adolescent phase the anthropometric variables belonging to The transversal dimensionality did not increase evenly during the puberty phase. The fastest phase of the variables The transversal dimensionality occurs during the age of 13-14 years.

Among children between the ages 12 and 13 years old in the subscapular skinfold variable (ASUSK), the difference is -1.3mm, the difference between children at the 13 – 14 years old is -1.27mm and the difference between children 14 – 15 years old is -0.4mm. It is clearly noted that the fastest decrease in the subscapular skinfold variable is between the ages of 12-13 years. A more pronounced difference in upper arm skinfold variable (AUASK) was obtained between children 12 and 13 years old, it is - 2.3mm, between children 13 - 14 years old the difference is -0.83mm and between children 14 - 15 years old difference is -1.77mm. It is clearly seen that the fastest decrease in the upper arm skinfold variable is observed between the ages of 12-13 years old. Even in the anthropometric abdominal skinfold variable (AABSK) there is a difference of -1.4mm between children 12 and 13 years old, difference between children 13-14 years old is -3.21mm and difference between children 14-15 years old is -0.46mm. It is clearly seen that the fastest decrease in abdominal skinfold is observed between the ages of 13-14 years old. During the adolescent stage the anthropometric variables belonging to the subcutaneous fat tissue did not decrease evenly during the puberty phase. The fastest phase of subcutaneous fat tissue reduction, subscapular skinfold, and upper arm skinfold occurs during the age of 12-13 years, while the abdominal skinfold variable occurs during the age of 13-14. Obesity is caused by an imbalance between consumption (calories from food) and energy consumption (calories needed for basic metabolism and physical activity). Obesity at this age is probably the result of the interplay of genetic, biological, psychological, socio-cultural and environmental factors (Miller et al., 2004).

For the child in adolescence the health-related quality of life depends on real life compliance with wishes, family life and relationships with friends, standard of living, health, fulfilling biological needs, specific social, cultural and spiritual factors (Brajša and Kaliterna, 2006). This research may serve as another basis for further scientific work that will address this issue in order to obtain relevant information, and thus advance science.

Conclusion

The results obtained indicate a statistically significant difference in anthropometric characteristics in children during the early and middle adolescence phase. By analyzing the results obtained from anthropometric measurement and proper processing, we can establish the following principles of morphological structure and physical development during the developmental stage of adolescence:

- The longitudinal dimensions of the body skeleton continuously increase from the age 12-15 years old with a more pronounced increase in 12-13 years old.
- Body mass and body volume steadily increase from 12-15 years old with a more pronounced increase in body mass at 12-13 years old and 13-14 years old of body volume.
- The transversal dimensions of the body skeleton continuously increase from 12-15 years old with a more pronounced increase in 13-14 years old.
- Subcutaneous fat tissue continuously decreases in all parts of the body from the age of 12-15 years.

The results also indicate that some anthropometric characteristics may be affected, meaning that they may be altered (such as anthropometric variables pertaining to subcutaneous fat tissue, body mass and body volume) while in others they may not be affected because they are largely determined by genetic factors.

In the human body, some functional systems show some relatively regular periodic changes in the intensity of functioning, that is, certain biorhythms. Although autonomous biorhythms predominate in the child's early developmental stage (adolescence), particularly related to the function of the neuroendocrine system, they nonetheless, to some extent, respond and may adapt to environmental rhythms, largely conditioned by environmental conditions nutritional, sports factors. Thus, all of these characteristics condition the interplay of hereditary and environmental factors in the growth and development of the child.

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