Research article

TREND CHANGE IN THE MORPHOLOGICAL FEATURES OF BOYS AGED SEVEN TO TEN

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Abstract. *The aim of this research was to determine the trend change in the morphological features of boys aged 7 to 10, of various nutritional status, with particular emphasis on the trend of occurrence of obesity among the same population. The sample consisted of 1164 boys, divided into four sub-groups (based on their age), and then each sub-group was further divided into three groups depending on their nutritional status. Four morphological factors were measured: the longitudinal, transversal and circular dimensionality of the skeleton, body mass and subcutaneous fat tissue. They were used to determine the morphological characteristics of the participants. The data were processed using the SPSS 20.0 statistics program. To determine the dynamics of change in the increasing or decreasing continuum, a trend analysis was used. By analyzing and evaluating the results obtained during the course of this study, differences in morphological characteristics were determined between children with normal body mass, overweight children and obese children of various ages. The dynamic of the change in the aforementioned characteristics in most morphological spaces of the boys indicated a continued increase that accompanies the age of the participants. Among the participants with normal body mass and overweight participants, a discontinued form of development among the morphological characteristics was noted. The discontinued form of development is visible among obese participants in the space which refers to measuring subcutaneous fat tissue. A significantly greater annual increase in body fat, compared to the average, was also noted.*

Key words: *Body Build, Young School Age Children, Obesity, Growth, Development*

INTRODUCTION

The morphological characteristics of human anthropological status usually include growth processes and human ontogenetic development. Morphological space is in essence four-dimensional: the longitudinal dimensionality of the skeleton; transversal dimensionality of the skeleton; body volume and mass; and subcutaneous fat tissue (Malacko & Rađo, 2004; Živković, 2019).

The existing literature indicates that morphological characteristics, viewed as a factor of anthropological status, represent the biological and physiological basis through which anthropometric measurements are manifested (Popović & Radanović, 2010; Đošić et al., 2019).

Humans go through several phases of growth and development including the following: The first phase of rapid growth lasts from birth to the age of three. The next phase is one of deaccelerated growth and consists of two cycles of development: the preschool age (from the age of four to seven) and the younger school age (from the age of seven to eleven). The prepubescent and pubescent phase are known for their intense growth and development, otherwise known as the middle school age (from the age of 11 to 15 of one's extrauterine life). Older school age is a phase of development where sexual maturation takes place, which lasts up until the age of 20, and belongs to the second cycle of deaccelerated growth. The growth process and ossification end at the age of 25 (Đurašković, 2009).

Information which is of significant relevance for the aforementioned factors can be obtained from morphological characteristics, that is, the anthropometric measurements of children (Madić, Popović, & Kaličanin, 2009). The aforementioned method is used to establish the nutritional status of children and adolescents, which represents one of the most important indicators of health, psychophysical abilities and the potential for normal growth and development (Stamenkovič, Bratić, Berić, & Pantelić, 2017). Thus, it can function as a prognostic factor of their state of health (Marković, Igrutinović, Kostić, & Vuletić, 2008; Pavlica, Rakić, & Sironjić, 2017). Any greater deviations from optimal body mass values are indicators of symptoms of a health disorder, or indicators of a preexisting condition (Vlaški & Katanić, 2010).

Physical inactivity and the increase in energy intake lead to changes in the morphological status of children and young people. According to the World Health Organization, in 2016 there were 41 million obese children in the world under the age of 5, and over 340 million obese children and adolescents aged between 5 and 19. The prevalence of overweight and obesity increased from 4% in 1975 to over 18% in 2016 (WHO, 2017 according to Živković, 2019). According to Spruijt-Metz (2011) several factors can be singled out as a consequence of the increase in obesity: Genetic (Robiou-du-Pont et al., 2017); biological and psychological (Tripicchio et al., 2017); socio-cultural (Hasson et al., 2005); and environmental factors (Rath et al., 2016). Various studies have shown that the rate of obesity in industrialized countries is on the rise, as it is in developing countries (Apovian & Riffenburg, 2017; Ghanemi & St-Amand, 2018).

Although Serbia is not at the top of the list of countries with a sharp rise in obesity, among children and adolescents obesity has taken on epidemic proportions (Wang & Lobstein, 2006). The official documents of the Ministry of Health of the Republic of Serbia confirm that one-fifth of children and the young aged 7 to 19 (18%) is overweight and obese (the Ministry of Health of the Republic of Serbia, 2007 according to Đošić et al., 2019).

The aim of this research was to determine the trend change in the morphological features of boys aged 7 to 10, of various nutritional status, with particular emphasis on the trend of occurrence of obesity among the same population.

METHODS

The sample of participants included younger school aged boys, aged 7 to 10. The overall sample consisted of 1164 boys, divided into four subsamples in relation to their age (SS1, SS2, SS3, and SS4). Each subsample in turn was divided into three groups, depending on their nutritional status (participants with normal body mass, participants who are overweight, and obese participants). SS1 included 254 children aged 7 of whom 168 had a normal nutritional status (66%), 47 were overweight (19%) and 39 were obese (15%). SS2 included 288 children aged 8 of whom 196 had a normal nutritional status (68%), 49 were overweight (17%) and 43 were obese (15%). SS3 included 278 children aged 9 of whom 166 had a normal nutritional status (60%), 70 were overweight (25%) and 42 were obese (15%). SS4 included 344 children aged 10 of whom 199 had a normal nutritional status (58%), 93 were overweight (27%) and 52 were obese (15%).

The results were obtained using the body mass index (BMI, in kg/m^2), which was adapted to the age of the children, and in accordance with the tables provided by the Cole, Bellizzi, Flegal, & Dietz (2000).

For the participants included in the study, approval was obtained from the school principal, the teachers and parents. At the same time they were acquainted with the rules and means of the measurement.

Measuring instruments for the evaluation of morphological characteristics

By measuring four morphological factors (longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, circular dimensionality and body mass, subcutaneous fat tissue) the morphological characteristics of the participants were determined: 1) The longitudinal dimensionality of the skeleton (*Body height in cm; Leg length in cm*; *Arm length in cm)*; 2) The transversal dimensionality of the skeleton (*Shoulder width in cm; Pelvic width in cm; Hip width in cm)*; 3) Body mass and circular dimensionality (*Body mass in kg; Average thoracic volume in cm; Volume of the extended upper arm in cm; Thigh volume in cm)*; 4) Subcutaneous fat tissue (*Upper arm skinfolds in mm; Back skinfolds in mm; Abdominal skinfolds in mm).*

The measurements were carried out following the standard procedures based outlined in the International Biological Program (Weiner & Lourie, 1969).

Data processing was carried out using the statistical program SPSS 20.0. To determine the dynamics of change along the increasing or decreasing continuum, a trend analysis was used.

RESULTS AND DISCUSSION

In 7 years old boys and in relation to BMI values are given as follows: normal-15.59; overweight-19.19; obese-23.16. In 8 years old boys those were: normal-16.00; overweight-19.70; obese-24.35. In 9 years old boys those were: normal-16.27; overweight-20.75; obese-24.41. In 10 years old boys those were: normal-17.02; overweight-21.80; obese-26.35.

An overview of morphological features of boys aged 7 to 10 of various nutritional status is presented in Table 1.

Table 1 Mean values of morphological features of boys aged 7 to 10 of various nutritional status

Anthropometric measures	Mean			
	7 years old	8 years old	9 years old	10 years old
BMI (kg/m^2)	normal-15.59 overweight-19.19 obese-23.16	normal-16.00 overweight-19.70 obese-24.35	normal-16.27 overweight-20.75 obese-24.41	normal-17.02 overweight-21.80 obese-26.35
Body height (cm)	normal-127.54 overweight-130.92 obese-132.71	normal-134.16 overweight-137.66 obese-138.48	normal-139.45 overweight-143.21 obese-145.28	normal-145.22 overweight-147.85 obese-150.63
Leg length (cm)	normal-69.48 overweight-71.97 obese-72.22	normal-74.28 overweight-77.67 obese-76.70	normal-77.85 overweight-80.95 obese-81.01	normal-82.01 overweight-83.38 obese-85.31
Arm length (cm)	normal-54.10 overweight-55.17 obese-55.75	normal-56.64 overweight-58.73 obese-58.47	normal-58.94 overweight-61.33 obese-61.60	normal-62.12 overweight-63.16 obese-64.89
Shoulder width (cm)	normal-28.58 overweight-29.99 obese-30.58	normal-29.84 overweight-31.47 obese-32.55	normal-30.71 overweight-32.37 obese-33.61	normal-32.10 overweight-33.98 obese-35.40
Pelvic width (cm)	normal-20.23 overweight-21.77 obese-22.77	normal-21.21 overweight-22.90 obese-24.57	normal-21.62 overweight-23.52 obese-25.44	normal-22.79 overweight-24.73 obese-27.07
Hip width (cm)	normal-21.36 overweight-23.33 obese-24.62	normal-22.51 overweight-24.63 obese-26.26	normal-23.20 overweight-25.41 obese-27.14	normal-24.75 overweight-26.85 obese-29.04
Body mass (kg)	normal-25.42 overweight-32.99 obese-40.99	normal-28.89 overweight-37.43 obese-46.79	normal-31.71 overweight-42.73 obese-51.64	normal-36.03 overweight-47.79 obese-60.04
Thoracic volume (cm)	normal-58.89 overweight-64.83 obese-71.23	normal-60.99 overweight-68.28 obese-74.91	normal-63.59 overweight-70.93 obese-78.22	normal-66.39 overweight-74.95 obese-81.88
Upper arm volume (cm)	normal-17.09 overweight-20.36 obese-23.00	normal-17.88 overweight-21.22 obese-24.18	normal-18.58 overweight-22.34 obese-24.82	normal-19.71 overweight-23.67 obese-26.70
Thigh volume (cm)	normal-33.97 overweight-39.43 obese-44.75	normal-35.80 overweight-41.47 obese-45.74	normal-37.46 overweight-44.68 obese-48.65	normal-40.11 overweight-45.79 obese-50.14
Upper arm skinfold (mm)	normal-9.32 overweight-14.95 obese-20.31	normal-10.05 overweight-15.44 obese-19.95	normal-10.25 overweight-16.97 obese-23.03	normal-11.11 overweight-18.18 obese-24.51
Back skinfold (mm)	normal-5.93 overweight-10.60 obese-18.67	normal-6.25 overweight-10.75 obese-18.81	normal-6.48 overweight-13.63 obese-21.16	normal-7.02 overweight-13.99 obese-20.39
Abdominal skinfold (mm)	normal-6.23 overweight-14.32 obese-21.89	normal-7.20 overweight-15.93 obese-24.30	normal-7.55 overweight-19.09 obese-26.10	normal-8.94 overweight-20.33 obese-26.45

Table 2 Trend analysis of the morphological characteristics of participants with normal
nutritional status

	F	Sig
Body height (cm)	236.39	.000[**]
Leg length (cm)	243.03	.000[**]
Arm length (cm)	242.72	.000[**]
Shoulder width (cm)	156.59	.000[**]
Pelvic width (cm)	118.62	.000[**]
Hip width (cm)	181.26	.000[**]
Body mass (kg)	216.85	.000[**]
Thoracic volume (cm)	130.23	.000[**]
Upper arm volume (cm)	83.77	.000[**]
Thigh volume (cm)	91.01	.000[**]
Upper arm skinfold (mm)	10.22	.000[**]
Back skinfold (mm)	7.11	.000[**]
Abdominal skinfold (mm)	14.69	.000[**]

Legend: *F* – Rao's F approximation; *sig* – level of significance

Table 2 shows the results of the trend analysis of the morphological characteristics of individuals with normal nutritional status, aged seven, eight, nine and ten. A statistically significant trend was determined for all the measured variables at the .01 level of statistical significance.

Table 3 Trend analysis of the morphological characteristics of overweight participants

	F	Sig
Body height (cm)	66.69	.000[**]
Leg length (cm)	57.76	.000[**]
Arm length (cm)	67.90	.000[**]
Shoulder width (cm)	63.95	.000[**]
Pelvic width (cm)	48.12	.000[**]
Hip width (cm)	68.22	.000[**]
Body mass (kg)	106.37	.000[**]
Thoracic volume (cm)	65.57	.000[**]
Upper arm volume (cm)	60.25	.000[**]
Thigh volume (cm)	43.43	.000[**]
Upper arm skinfold (mm)	8.71	.000[**]
Back skinfold (mm)	9.83	.000[**]
Abdominal skinfold (mm)	14.39	.000[**]

Legend: *F* – Rao's F approximation; *sig* – level of significance

Based on the results presented in Table 3, which shows the trend analysis of the morphological characteristics of overweight participants aged seven, eight, nine and ten, it can be concluded that there is a statistically significant trend for the applied measures at the .01 level of statistical significance.

Table 4 Trend analysis of the morphological characteristics of obese participants

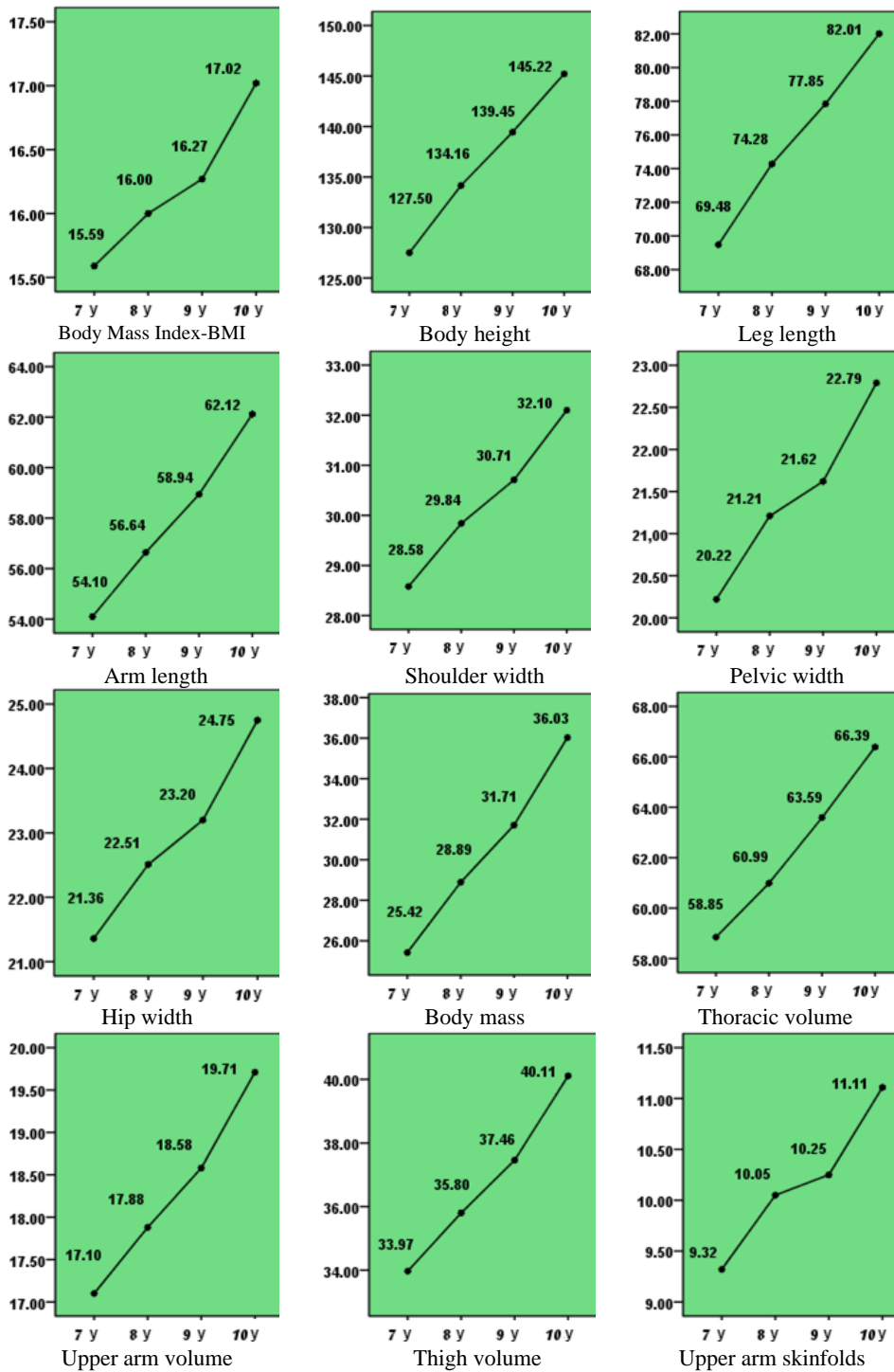|	F	Sig
Body height (cm)	82.18	.000[**]
Leg length (cm)	81.77	.000[**]
Arm length (cm)	82.96	.000[**]
Shoulder width (cm)	47.19	.000[**]
Pelvic width (cm)	52.53	.000[**]
Hip width (cm)	66.40	.000[**]
Body mass (kg)	66.02	.000[**]
Thoracic volume (cm)	30.29	.000[**]
Upper arm volume (cm)	20.36	.000[**]
Thigh volume (cm)	14.04	.000[**]
Upper arm skinfold (mm)	4.57	.004[**]
Back skinfold (mm)	1.44	.234
Abdominal skinfold (mm)	3.32	.021[*]

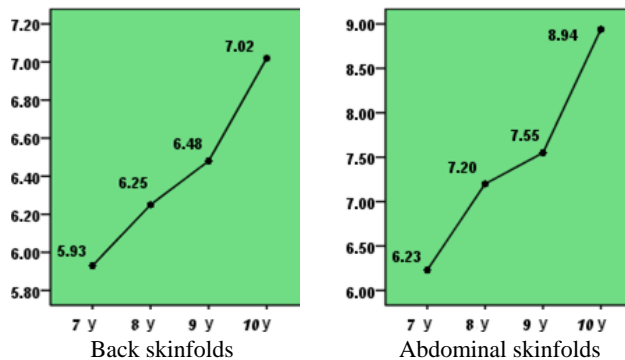*Legend: F* – Rao's F approximation; *sig* – level of significance

Table 4 shows the results of the trend analysis of the morphological features of obese participants aged seven, eight, nine and ten. A statistically significant trend in the variables of longitudinal, transversal and circular dimensionality, along with body mass, were determined and at the .01 level of statistical significance. When it comes to subcutaneous fat tissue, a statistically significant trend was noted for upper arm and abdomen skinfolds, while none was recorded for the back skinfolds.

The dynamics of change in the morphological characteristics of participants with various nutritional status is shown in Graphs 1, 2, and 3.

The growth and development of children is to the greatest extent genetically conditioned, where the aforementioned determinance mostly refers to the space of longitudinal dimensionality of the skeleton (Malina, Boushard. & Bar-or, 2004; Stupar, 2016). Previous research has indicated that a continued form of linear growth was noted during the first ten years of life (Rogol, Roemmich, & Clark, 2002; Wells, 2007). At that time, the differences between boys and girls in terms of most anthropometric measurements are more or less insignificant, until they enter puberty when sudden changes and differences occur (Malina & Bouchard, 1991). However, a trend of increase was noted for the parameters which indicate overweight and obesity among children, compared to past measurements. In this research we can see from the results that over the years, the percentage of overweight and obese participants has increased, among participants aged 7 - 34%, aged 8 - 32%, aged 9 - 40% and aged 10 - 42%, from the ages of 7 to 10 the percentage of obesity did not change and had a value of 15%, while excessive overweight increased over time. Compared to previous research (Đokić & Stojanović, 2010; Ostojić, Stojanović, Stojanović, Marić, & Njaradi, 2011) in which the percentage of obesity among boys of a younger school age ranged from 4.6% - 8.2%, data of 15% - obese indicate a significant increase in the obesity of boys of the same age category.

The dynamics of change in the morphological characteristics of participants with normal nutritional status are shown in Graph 1, while the results shown in Table 3 have indicated a statistically significant trend for all measurements used to evaluate the morphological characteristics of the participants with normal body mass, at the .01 level of statistical significance.

Body Mass Index-BMI

Body height

Leg length

Arm length

Shoulder width

Pelvic width

Hip width

Body mass

Thoracic volume

Upper arm volume

Thigh volume

Upper arm skinfolds

Graph 1 The dynamics of change in the morphological characteristics of participants with
normal nutritional status, ages seven to ten

For the body mass index, a continued increase in the results in accordance with the
increase in the age of the participants is noticeable, while the greatest increase was noted for
children aged nine to ten. The obtained results are in agreement with the research results of
Schaefer, Georgi, Wühl, & Schärer (1998) where it was confirmed that the BMI and
percentage of fat tissue increased during growth, so that the value was greater with the
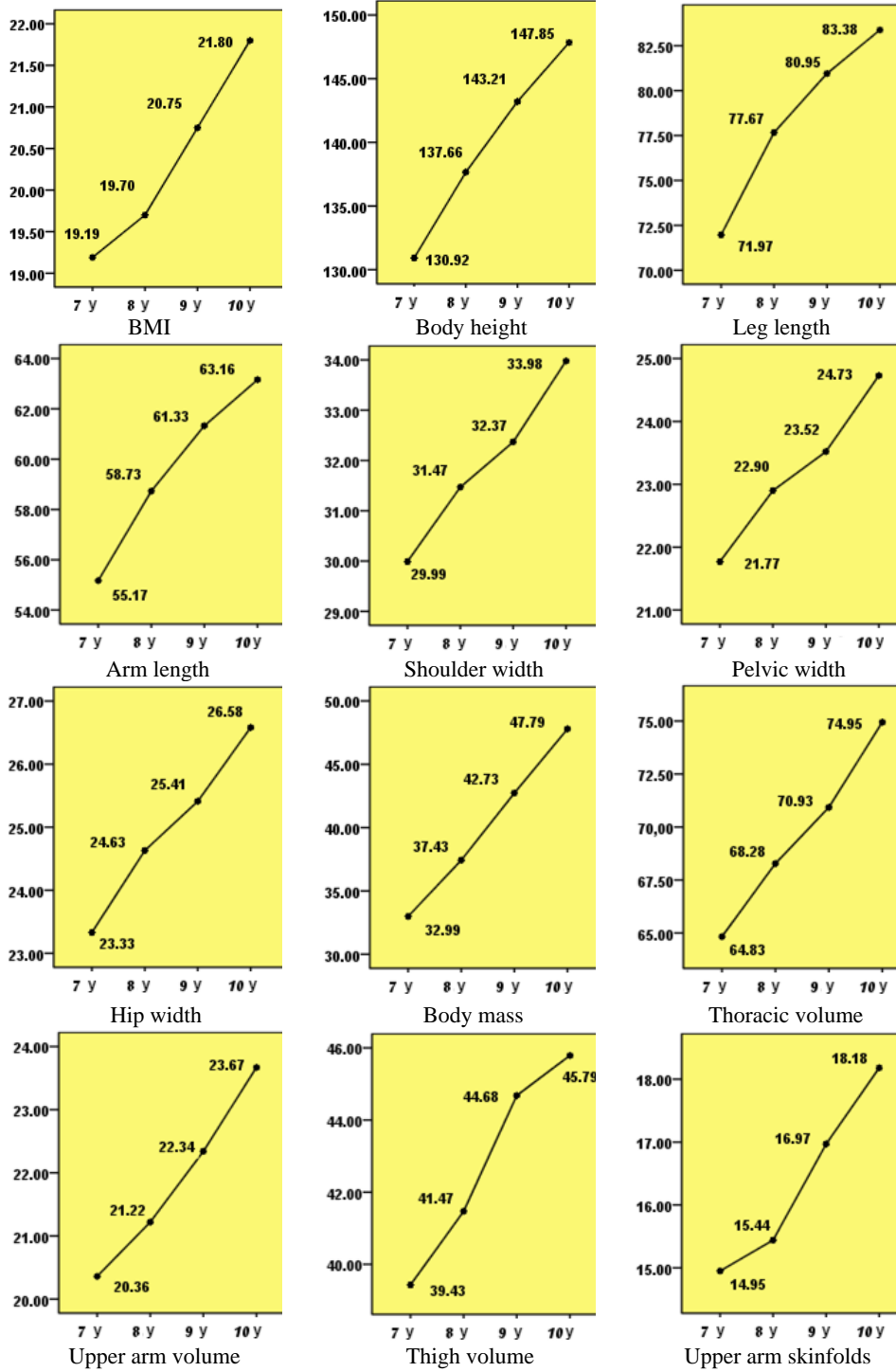increase in the age of the participants.

A relatively equal continued form of growth which accompanies the increase in the age
of the participants can be seen in all three variables of the longitudinal dimensionality of the
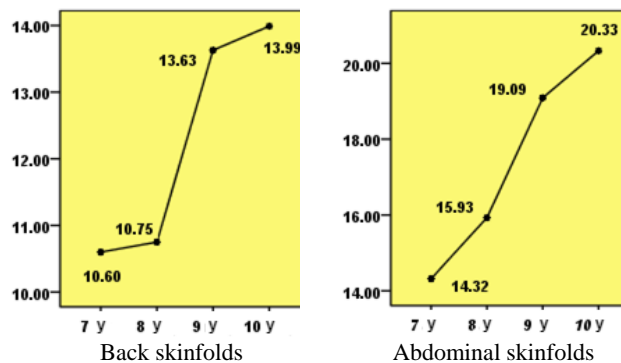skeleton (body height, arm length and leg length).

In the space of transversal dimensionality of the skeleton (shoulder width, pelvic width
and hip width), based on the linear graph, we can note a continued increase in the results
which accompanies the increase in the age of the participants, where the greatest increase
was noted between the ages of nine and ten. These results are compatible with previous
research (Popović, 2008; Đorđević, 2015).

Without any significant oscillations, the dynamics of change in body volume and mass
(body mass, thoracic volume, upper arm volume, and thigh volume) have indicated a
continued growth from the ages of seven to ten, which is analogous with the study of Popović
(2008).

The graphs which indicate the dynamics of change of subcutaneous fat tissue (upper
arm skinfold, abdominal skinfold, and back skinfold) of participants with normal body
mass showed a continued increase in the values which accompanied the increase in the
age of participants aged seven, eight, nine and ten. Between the ages of eight and nine, in
all three morphological measurements (upper arm skinfolds, abdominal skinfolds and
back skinfolds), the smallest increase in the values was noted. The obtained results are in
agreement of those of Schaefer et al. (1998). Still, in some studies a discontinued form of
development in subcutaneous fat tissue was noted (Popović, 2008; Đorđević, Živković,
Ranđelović, Pantelić, & Mitrović, 2017).

Based on the analysis of the results shown in Graph 1 (the dynamics of change in the
morphological characteristics of individuals with normal nutritional status aged seven,
eight, nine and ten), it could be concluded that in all the measurements for the evaluation
of morphological characteristics, a continued form of growth with an increase in the age
of the participants was noted. The obtained results were mostly in agreement with the
results of previous studies (Popović, 2008; Runhaar et al., 2010; Đorđević, 2015).

BMI

Body height

Leg length

Arm length

Shoulder width

Pelvic width

Hip width

Body mass

Thoracic volume

Upper arm volume

Thigh volume

Upper arm skinfolds

Graph 2 The dynamics of change of the morphological characteristics of overweight participants aged seven to ten

The dynamics of change in the morphological characteristics of overweight participants are shown in Graph 2. The existence of a statistically significant trend on the tests for the evaluation of all of the measured morphological characteristics was determined at the .01 level of statistical significance.

The dynamics of change in the BMI showed continued growth with an increase in age of the overweight participants. The smallest increase was noted for the ages of seven to eight, after which there was a period of more intense growth from the age of nine to ten. Similar results were obtained by the researchers Schaefer et al. (1998).
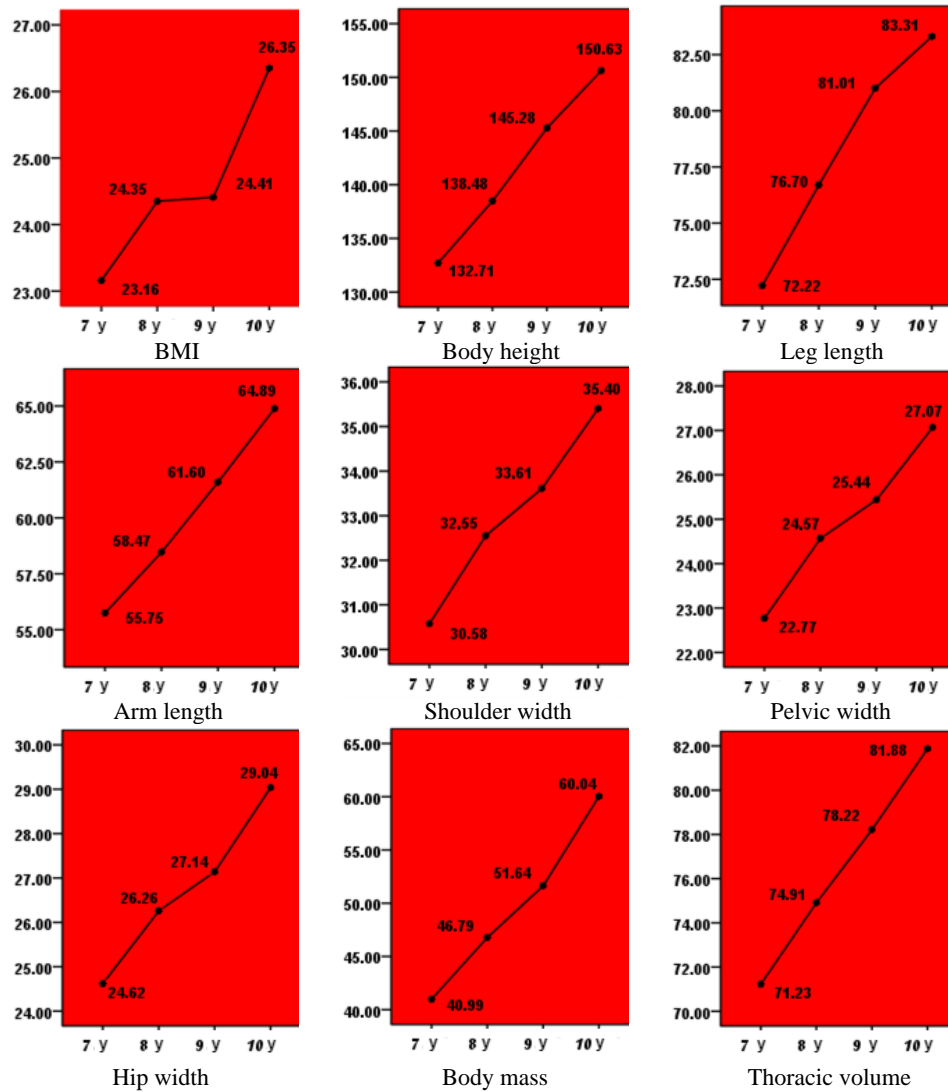
In the case of the measures for the evaluation of the longitudinal dimensionality of the skeleton (body height, leg length and arm length), a continued form of growth accompanying the increase in the age of the participants can be noted for all the variables of the aforementioned dimension (body height, leg length, and arm length). The greatest growth was noted from the ages of seven to eight, which is to a great extent in agreement with previous studies (Popović, 2008; Đorđević, 2015).
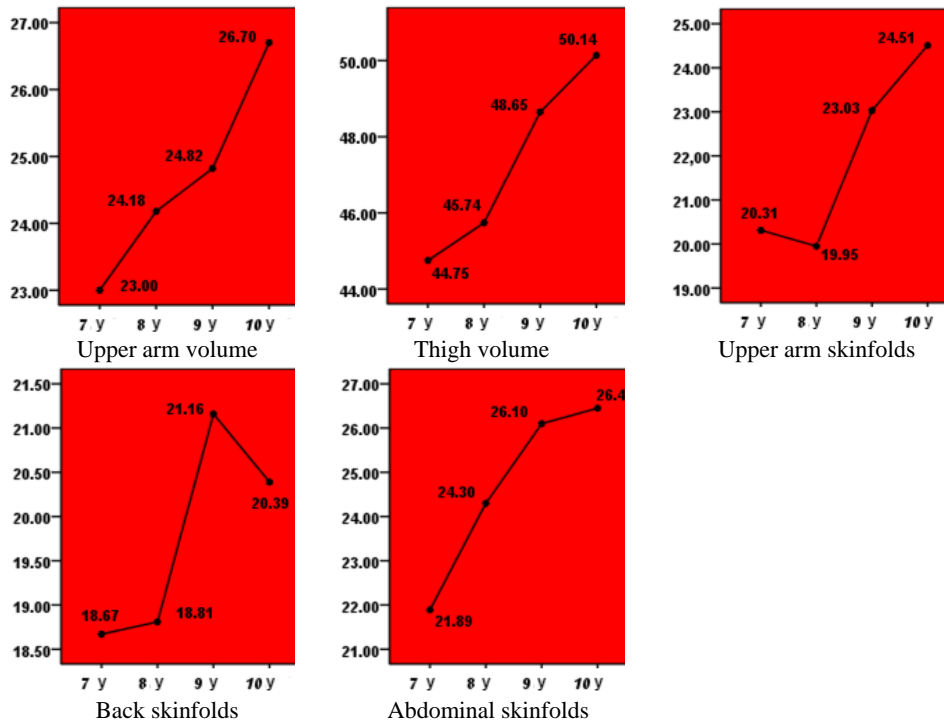
By analyzing the curve of the transversal dimensionality of the skeleton (shoulder width, pelvic width and hip width) we can see a trend of increase with the increase in the age of the participants. The smallest increase was noted for all three parameters of the aforementioned space from the ages of eight to nine, while the trend of increase between the ages of seven and eight, as well as nine and ten, is slightly more intense (Đorđević, 2015).

In the space of body mass and volume, a continued increase in all the measures for its evaluation (body mass, thoracic volume, upper arm volume and thigh volume) can be noted. Based on the results we can see that in the case of body mass, thoracic volume and upper arm volume it is approximately equal to the increase in the age of the participants, where in the case of thigh volume the greatest increase in value is between the ages of eight and nine, and the smallest from the age of nine to ten.

In the space of subcutaneous fat tissue, the curve of the upper arm skinfold shows the least increase from the age of seven to eight. After that the values are greater with the increase in the age of the participants, until the age of ten. For the back skinfolds we can note that the greatest increase is between the age of eight and nine among overweight participants. Similar dynamics can be seen for the abdominal skinfolds, which is similar to the results of previous studies (Popović, 2008).

By analyzing the results in Graph 2, a continued form of increase was identified with an increase in the age of the participants for all the morphological measurements, which is in agreement with the study of Schaefer et al. (1998). They determined that the values of the body mass index and the percentage of fat tissue increased with the increase in the age of the participants.

BMI

Body height

Leg length

Arm length

Shoulder width

Pelvic width

Hip width

Body mass

Thoracic volume

Graph 3 The dynamics of change in the morphological characteristics of obese participants aged seven to ten

Graph 3 indicates the trend of mean values of the morphological characteristics of the participants aged seven, eight, nine and ten, who based on their body mass index belong to the group of overweight participants. A statistically significant trend was determined for all the measures used to evaluate longitudinal dimensionality of the skeleton (body height, leg length and arm length), the transversal dimensionality of the skeleton (shoulder width, pelvic width and hip width), and body mass and volume (body mass, thoracic volume, upper arm volume and thigh volume) at the .01 level of statistical significance, while in the space of subcutaneous fat tissue a statistically significant intergroup difference was visible for the upper arm skinfolds and abdominal skinfolds.

The curve of the body mass index indicates a continued form of increase with an increase in the age of the participants, where the smallest changes can be noted between the ages of eight and nine, and then a sudden growth and the highest values at the age of ten. Similar results were obtained by Ogden, Flegal, Carroll, & Johnson (2002) who point out that the body mass index increased with the age of the participants.

In the space of the longitudinal dimensionality of the skeleton (body height, leg length and arm length), we can see a continued form of growth with the increase in the age of the participants. The greatest values recorded for the obese participants were noted at age ten, which is in agreement with the results of other researchers (Malina et al., 2004).

In the space of transversal dimensionality of the skeleton (shoulder width, pelvic width and hip width), by studying the curve of the aforementioned space we can see a

continued form of growth which accompanies the increase in the age of the obese participants, where from the ages of eight to nine the increase is the smallest. After that there is a more intense increase in all the measures of transversal dimensionality of the skeleton when the participants reach the age of ten.

The dynamics of the change in the measures for the evaluation of body volume and mass (body mass, thoracic volume, upper arm volume and thigh volume) have a continued form of growth from the age of seven to the age of ten. For upper arm volume we can note that the smallest increase occurs from the ages of eight to nine, and the greatest from the age of nine to the age of ten. For thigh volume the results indicate the smallest increase between the ages of seven and eight, and after that the greatest until the age of nine, while the greatest values were noted at the age of ten for the obese group of participants, in all the parameters for the evaluation of volume and body mass. These results are in part in accordance with the results of the study carried out by Đorđević (2015).

In the case of subcutaneous fat tissue, in two of the three variables (upper arm skinfold and back skinfold) a discontinued form of development was noted with the increase in the age of the participants. To be precise, for the upper arm skinfolds, there is a clear decrease in the values between the ages of seven and eight, followed by their continued growth until the age of ten, when the greatest values of the aforementioned measure were noted. The curve of the back skinfold indicates a slight increase in the results from the ages of seven to eight, which is followed by the greatest increase until the age of nine, which at the same time represents the greatest result for the aforementioned measure. After that there is a decrease in the value until the age of ten among the obese participants. The only variable in the space of subcutaneous fat tissue where the curve indicates continued growth with the increase in the age of the participants, and the greatest values at age ten, is abdominal skinfold. The obtained results are to the greatest part analogous to the results of the research of Popović (2008).

Generally speaking, the dynamics of change in the morphological dimensions of obese participants aged seven, eight, nine and ten for most of the morphological measures have indicated a continued form of growth with an increase in the age of the participants, while for two of the parameters from the space of subcutaneous fat tissue (upper arm skinfold and back skinfold) a discontinued form of development with the increase in the age of the participants was noted. The obtained results are for the most part compatible with the results of the study carried out by Popović (2008) where the author indicates a continued form of growth with the increase in the age of obese participants in terms of body height, mass and the measures for the evaluation of body voluminosity, while a discontinued form of development with the increase in the age of the participants was noted in the space of subcutaneous fat tissue among children of a younger school age. Similar results were noted in the study of Živković, Đorđević, Ranđelović, & Bjelaković (2018), where in the space of subcutaneous fat tissue, a discontinued form of development was determined.

The speed of growth and nutritional level of children after the age of three and all the way to the beginning of puberty is mostly similar, and has a value of 5-7.5 cm, while the increase in body mass has a value of 2-3 kg on an annual level (Zdravković, Banićević, & Petrović, 2009). After analyzing the set norms and standards for growth and development, we come to the conclusion that there are certain deviations among the obese participants. In the group of obese boys, an increase in body mass ranging from 5 to 10 kg a year can be noted. Similar results were found by Živković et al. (2018), who indicated an annual increase in body mass of 4 to 10kg.

By analyzing and evaluating the results obtained in this research, the differences in the morphological characteristics of children with normal nutritional status, and those of obese children of various ages were determined. The dynamics of change of the aforementioned characteristics in most of the morphological spaces of boys indicates a continued form of development with the increase in the age of the participants. Among normal and overweight participants, no discontinued form of development of morphological characteristics was noted. A discontinued form of development is visible among obese participants in a smaller number of variables, in particular in the space which refers to the measuring of subcutaneous fat tissue. Furthermore, a significantly greater increase in body mass on an annual level can be noted in comparison to the average can be noted. The percentages indicate a much greater number of obese children compared to previous studies with a similar focus (Živković et al., 2018; Zdravković et al., 2009; Đokić & Stojanović, 2010; Ostojić et al., 2011). Knowing, on the basis of a greater number of studies, that obesity among children and adults leads to metabolic disorders, increased blood pressure, type 2 diabetes, coronary conditions, liver disease and the onset of cancer (Corey & Kaplan, 2014; Ogden et al. 2016; Ghanemi & St-Amand, 2018), the proper manner and solution for the prevention of a further increase in the prevalence of overweigh and obesity should be found. Attempts should also be made to decrease the percentage of obesity primarily among children but also among adults, with a change in the approach to this health problem. The results of certain studies have indicated that in southern European countries, approximately 40% of children under the age of 10 are overweight or obese, while in the northern countries of Europe, that number is less than 10% (Prentice, 2005; Cattaneo et al., 2010). In a national representative study in Sweden, carried out on a population of 4538 participants aged 7-9, only 3% were obese (Sjöberg et al., 2011). Based on these data, and knowing that the nutritional level of children is one of the more important indicators of their health, psycho-physical abilities as well as potential for normal growth and development, the solution should be found in a different approach and attitude towards this health problem, modelled perhaps on the system and life habits of the nations of northern European countries, which would be implemented in our environment.

CONCLUSION

The study has shown the dynamic through which the morphological characteristics change, and at the same time indicated the differences in the morphological characteristics of boys aged seven to ten, depending on their nutritional status. Insight into the results of their morphology and its evaluation indicated significant differences in almost all the measured parameters of the participants.

REFERENCES

Apovian, C.M., & Riffenburg, K.M. (2017). Perspectives on the global obesity epidemic. Current opinion in endocrinology. *Diabetes and Obesity, 24*(5), 307-309.

Cattaneo, A., Monasta, L., Stamatakis, E., Lioret, S., Castetbon, K., Frenken, F., et al. (2010). Overweight and obesity in infants and pre-school children in the European Union: a review of existing data. *Obesity Reviews*, *11*(5), 389-398.

Corey, K.E., & Kaplan, L.M. (2014). Obesity and liver disease: the epidemic of the twenty-first century. *Clinical Liver Disease*, *18*(1), 1-18.

Cole, T.J., Bellizzi, M.C., Flegal, K.M., & Dietz, W.H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ, 320*(7244), 1240-1243.

Đurašković, R. (2009). *Sportska Medicina (Sports medicine)*. Niš: S.I.I.C. In Serbian

Đokić, Z., & Stojanović, M. (2010). Morfološke karakteristike i posturalni status dece od 9 do 12 godina na području Sremske Mitrovice (The morphological characteristics and postural status of children aged 9 to 12 on the territory of Sremska Mitrovica). *Opšta medicina, 16*(1-2), 41-49. In Serbian

Đošić, A., Bratić, M., Jezdimirović, M., Purenović-Ivanović, T., Živković, D., & Bratić, M. (2019). Fitness parameters and morphological characteristics of overweight and obese children aged seven**.** *Facta Universitatis Series Physical Education and Sport, 17*(3), 549-558.

Đorđević, M. (2015). *Trend promena morfo-motoričkog statusa devojčica različitog stepena uhranjenosti (The trend of change in the morpho-motor status of young girls of various levels of nutritional status)*. Unpublished doctoral dissertation. Niš: Faculty of sport and Physical Education, University of Niš. In Serbian

Đorđević, M., Živković, D**.**, Randjelović, N., Pantelić, S., & Mitrović, B. (2017). Trend of changes in morpho-motoric status of normal weight girls. In S. Pantelić (Ed.). *Proceedings of the 20 Scientific Conference „FIS Communications 2017" in Physical Education, Sport and Recreation*, October 19. - 21, 2017, (pp.172-179). Niš: Faculty of sport and Physical Education, University of Niš.

Ghanemi, A., & St-Amand, J. (2018). Redefining obesity toward classifying as a disease. *European Journal of Internal Medicine, 55*(1), 20-22.

Hasson, R.E., Adam, T.C., Pearson, J., Davis, J.N., Spruijt-Metz, D., & Goran, M.I. (2005). A review of family and social determinants of children's eating patterns and diet quality. *Journal of the American College of Nutrition, 24*(2), 83-92.

Madić, D., Popović, B., & Kaličanin, N. (2009). Antropometrijske karakteristike devojčica uključenih u program razvojne gimnastike (The anthropometric characteristics of young girls taking part in a developmental gymnastics program). *Glasnik Antropološkog društva Srbije, 44,* 79-86. In Serbian

Malina, R.M., Bouchard, C. (1991). *Growth, Maturation, and Physical Activity*. Human Kinetics Books.

Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. Human Kinetics.

Malacko, J., & Rađo, I. (2004). *Tehnologija sporta i sportskog treninga* (The technology of sport and sports training). Sarajevo: Faculty of Sport and Physical Education.

Marković, S., Igrutinović, Z., Kostić, G., &, Vuletić, B. (2008). Stanje uhranjenosti i mogući činioci etiopatogeneze gojaznosti kod školske dece (Nutritional status and possible factors in the ethiopathogenesis of obesity among school aged children). *Medicinski časopis 1*, 7-14. In Serbian

Ogden, C., Flegal, K., Carroll, M., & Johnson, C. (2002). Prevalence and trends in overweight among U.S. children and adolescents, 1999-2002. *Journal of the American Medical Association,* 288, 1728-1732.

Ogden, C.L., Carroll, M.D., Lawman, H.G., Fryar, C.D., Kruszon-Moran, D., Kit, B.K., et al. (2016). Trends in obesity prevalence among children and adolescents in the United States, 1988-1994 through 2013-2014. *JAMA, 315*(21), 2292-2299.

Ostojić, S.M., Stojanović, M.D., Stojanović, V., Marić, J., & Njaradi, N. (2011). Correlation between fitness and fatness in 6-14-year old Serbian school children. *Journal of Health Population Nutrition, 29*(1), 53-60.

Pavlica, T., Rakić, R, & Sironjić, T. (2017). Changes in morphological characteristics during the period 2005-2014 in a sample of Serbian 7 - year-old children. *International Journal of Morpholology, 35*(2), 691-697.

Popović, B., & Radanović, D. (2010). Relacije morfoloških karakteristika i koordinacije kod devojčica koje se bave gimnastičkim aktivnostima (The relations between morphological characteristics and coordination among young girls involved in gymnastics activities). *Glasnik Antropološkog društva Srbije, 45*, 243-252. In Serbian

Popović, B. (2008). Trend razvoja antropometrijskih karakterisika dece uzrasta 4-11 godina (The trend of development of the anthropometric characteristics of children aged 4 to 11). *Glasnik Antropološkog društva Srbije, 43*, 455-465. In Serbian

Prentice, A.M. (2005). The emerging epidemic of obesity in developing countries. *International Journal of Epidemiology, 35*(1), 93-99.

Rath, S.R., Marsh, J.A., Newnham, J.P., Zhu, K., Atkinson, H.C., Mountain, J., et al. (2016). Parental pre-pregnancy BMI is a dominant early-life risk factor influencing BMI of offspring in adulthood. *Obesity Science & Practice, 2*(1), 48-57.

Robiou-du-Pont, S., Anand, S.S., Morrison, K.M., McDonald, S.D., Atkinson, S.A., Teo, K.K., et al. (2017). Parental and offspring contribution of genetic markers of adult blood pressure in early life*: The family study. PLoS ONE, 12*(10). doi.org:10.1371/journal.pone.0186218.

Rogol, A.D., Roemmich, J.N., & Clark, P.A. (2002). Growth at puberty. *Journal of Adolescent Health, 31*(6), 192-200.

Runhaar, J., Collard, D.C.M., Singh, A.S., Kemper, H.C.G., van Mechelen, W., & Chinapaw, M. (2010). Motor fitness in Dutch youth: Differences over a 26-year period (1980-2006). *Journal of Science and Medicine in Sport, 13*(2), 323-328.

Schaefer, F., Georgi, M., Wühl, E., & Schärer, K. (1998). Body mass index and percentage fat mass in healthy German schoolchildren and adolescents. *International Journal of Obesity, 22*(5), 461-469.

Sjöberg, A., Moraeus, L., Yngve, A., Poortvliet, E., Al-Ansari, U., & Lissner, L. (2011). Overweight and obesity in a representative sample of schoolchildren–exploring the urban-rural gradient in Sweden. *Obesity Reviews*, *12*(5), 305-314.

Spruijt-Metz D. (2011). Etiology, treatment, and prevention of obesity in childhood and adolescence: a decade in review. *Journal of Research on Adolescence*, *21*(1), 129-152.

Stupar, D. (2016). *Evaluacija efekata primene specifičnog programa vežbanja kod različitih generacija dece, uzrasta 4-5 godina, u desetogodišnjem periodu (The evaluation of the implementation of a specific exercise program on children of various generations, aged 4 to 5, over a ten-year period)*. Unpublished doctoral dissertation. Novi Sad: Faculty of sport and Physical Education, University of Novi Sad. In Serbian

Tripicchio, G.L., Borner, K.B., Odar Stough, C., Poppert Cordts, K., Dreyer Gillette, M., & Davis, A.M. (2017). Confirmatory Factor Analysis of Sizing Me Up: Validation of an obesity-specific health-related quality of life measure in Latino youth. *Journal of Pediatric Psychology*, *42*(4), 457-465.

Vlaški, J., & Katanić, D. (2010). Zdravstveni i socijalni značaj epidemije gojaznosti kod adolescenata u Srbiji (The health and social significance of the epidemic of obesity in adolescents in Serbia). *Specijalna bolnica za bolesti štitaste žlezde. 15*(34), 43-46. In Serbian

Wang, Y., & Lobstein, T.I.M. (2006). Worldwide trends in childhood overweight and obesity. *International Journal of Pediatric Obesity,* 1(1), 11-25.

Weiner, J.S., & Lourie, J.A. (1969). *Human Biology*. Oxford and Edinburgh: Published for the International Biological Programme by Blackwell Scientific Publications.

Wells, J.C. (2007). Sexual dimorphism of body composition. *Best practice & research Clinical endocrinology & Metabolism*, *21*(3), 415-430.

World Health Organization-WHO (2017). Obesity and overweight. Retrieved February 20, 2018 from the World Wide Web: http://www.who.int/mediacentre/factsheets/fs311/en/

Zdravković, D., Banićević, M., & Petrović, O. (2009). *Novi standardi rasta i uhranjenosti dece i adolescenata (New standards of growth and nutritional levels of children and adolescents)*. Belgrade: Paediatric Association of Serbia. In Serbian

Živković, D., Đorđević, M., Ranđelović, N., & Bjelaković, Lj. (2018). Trend promena morfoloških karakteristika gojazne dece (Trend of changes in morphological characteristics of obese children). In S. Mandarić, L. Moskovljević, M. Marković, & M. Ćosić (Eds.). Proceedings of the International Scientific Conference Effects of Applying Physical Activity on Anthropological Status of Children, Adolescents and Adults, (pp. 181-187). Belgrade: Faculty of Sport and Physical Education Belgrade, University of Belgrade. In Serbian

Živković, D. (2019). *Fitnes parametri i morfološke karakteristike gojazne dece (The fitness parameters and morphological characteristics of obese children)*. Unpublished doctoral dissertation. Niš: Faculty of Sport and Physical Education, University of Niš. In Serbian

TREND PROMENE MORFOLOŠKIH KARAKTERISTIKA DEČAKA STAROSTI 7-10 GODINA

Cilj ovog istraživanja bio je da se odredi trend promena morfoliških karakteristika dečaka starosnog doba od 7 do 10 godina različitog stepena uhranjenosti sa akcentom na trned pojave gojaznosti kod dečaka starosti od 7 do 10 godina. Ukupan uzorak sačinjavalo je 1164 dečaka, raspoređenih u četiri subuzorka u odnosu na godine starosti SU1, SU2, SU3, i SU4), a potom je svaki subuzorak podeljen na tri grupe u zavisnosti od stepena uhranjenosti. Utvrđivana su četiri morfološka faktora: longitudinalna, transverzalna i cirkularna dimenzionalnost skeleta, i masa tela i potkožno masno tkivo, i pomoću njih su se utvrđivale morfološke karakteristike ispitanika. Obrada podataka izvršena je statističkim programom SPSS 20.0. Za utvrđivanje dinamike promena u rastućem ili opadajućem kontinuumu korištena je trend analiza. Inspekcijom i evaluacijom rezultata dobijenih u ovom istraživanju utvrđene su razlike u morfološkim karakteristikama kod normalno uhranjene, prekomerno uhranjene i gojazne dece različite starosti. Dinamika promena gorepomenutih karakteristika u većini prostora morfologije dečaka pokazuje kontinuiranu formu rasta sa uzrastom ispitanika. Kod ispitanika sa normalnom i prekomernom telesnom masom nije uočena diskontinuirana forma rasta morfoloških karakteristika. Diskontinuirana forma rasta je vidljiva kod gojaznih ispitanika u prostoru koji se odnosi na merenje potkožnog masnog tkiva. Vidljiv je i znatno veći porast telesne mase na godišnjem nivou u odnosu na prosek.

Ključne reči: *građa tela, mlađi školski uzrast, gojaznost, rast, razvoj*