

Original empirical article

A COMPARATIVE ANALYSIS OF THE ANTHROPOMETRIC PARAMETERS OF SEVEN-YEAR-OLD CHILDREN

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Abstract. *The aim of this research was to confirm or reject the hypothesis regarding the non-existence of statistically significant differences between young boys and girls from Niš in terms of their anthropometric measures. The sample of subjects consisted of 91 boys and 85 girls, all of whom were first grade elementary students and were, on average, seven years old. Seventeen anthropometric measurements were taken, including the BMI, all of which covered the area of longitudinal, transversal, circular dimensionality and subcutaneous fatty tissue. The differences between the anthropometric measurements of the boys and girls were determined by means of the Student t-test. The results showed that there were no statistically significant differences in the measurements of the anthropometric characteristics. Nevertheless, a numeric difference in many of the parameters can be found between the subsamples, as well as great intra-group differences, which signaled the heterogeneity of the groups in terms of the evaluated characteristics. During any study of the anthropometric characteristics involving a sample of students of this age, it is necessary to pay attention to not only calendar age but biological age as well.*

Key words: *anthropometrics, children, differences, comparison, heterogeneity*

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INTRODUCTION

The anthropometric characteristics of boys and girls aged seven and the relevant differences between them in terms of gender are an important ingredient in the analysis of their effects on the motor behavior of children. Motor behavior is the basis for forming motor characteristics and the acquisition of motor skills, which are important for those children who are actively involved in sports activities. Each sport makes its own demands and has its own basic preconditions which need to be met in order for someone to be successful in it. Some studies have focused on the concrete problems of success in sport on samples of subjects aged seven (Delaš, Miletić, & Miletić, 2008; Miletić, Maleš, & Sekulić, 2000).

Results in terms of the quantitative and qualitative differences in anthropometric characteristics between boys and girls are both theoretically and practically significant. This significance, among other things, is reflected in the organization of work involving school-age children and organized forms of sports activities. The basic problem we face when working with children of this age during physical education classes or sports activities is whether it is necessary to make adaptations and reorganize various movement or sports activities for seven-year-old boys and girls based on any possible differences between them in terms of body build, or whether to use the same activities for all the children in the same way.

Generally speaking, body height is primarily the best and most stable indicator of growth and development, and it is so as a measure of bone marrow tissue, which in turn is considered to be the best indicator of the longitudinal dimensionality of the skeleton. Body weight as an indicator represents a mixture of various kinds of tissue and thus varies during growth and development. On the basis of the knowledge we have of fatty tissue build-up in the body, which is determined by means of measurements at certain points on the body, in addition to longitudinal measurements, transversal measurements and other anthropological measurements, we can obtain an accurate image of the build of a child.

An understanding of body build is necessary for determining the motor characteristics of children of this age, but also some other characteristics as well.

In the research carried out to date, the anthropometric parameters of seven-year-old boys and girls have been found to differ more or less, a fact which is borne out by the summed up values for body height, body mass and the BMI (Table 1).

Secular changes to the basic anthropometric parameters were studied by Malina (1990), Krawczanski, Walkowiak & Krzyzaniak (2003), Hesse et al. (2003), Zellner, Jaeger, & Kromeyer-Hauschild (2004), Marques-Vidal et al. (2008), So et al. (2008). The following table shows the parameters obtained in the research carried out by Zellner et al. (2004) and So et al. (2008) along with the years when the testing took place (Table 2).

Table 1. An overview of the research on some of the anthropometric parameters of children

Author	Age	Number of subjects	Body height (cm)	Body mass (kg)	BMI (kg/m ²)	Skin fold (mm)
Ruxton et al. (1999)	7	M-133 F-124	125.0±5.4 124.0±5.2	25.1±4.1 24.2±4.2	16.0±1.8 15.8±2.0	
Hurbo (2008)	7	M-102 F-114	123.23±5.50 123.50±5.35	24.32±3.22 24.05±3.53	15.97±1.39 15.71±1.63	
Yi-ling, Bei-jun (1982)	7	M-305 F-327	120.79±5.01 120.12±4.67	20.87±2.43 20.20±2.47		
Al-Hazzaa (1990)	7	M-180	117.4±4.6	21.4±3.2		7.3±1.9 Triceps
Aldegheiri, Agostini (1993)	7	M F	122.0 120.0			
Graf et al. (2004)	6.70±0.42	M-341 F-327	123.51±5.49 121.93±5.12	25.14±5.04 23.80±3.99	16.39±2.49 15.94±2.00	
Holm et al. (2008)	M-7.6±0.3 F- 7.5±0.3	M-40 F-19	128.2±4.3 128.4±6.2	26.8±2.6 27.8±4.2	16.3±1.2 16.7±1.4	
Katić et al. (2005)	7	M-566	128.82±6.36	27.94±5.24		10.30±3.92 Triceps
Kumar et al. (2004)	M-7-8	M-185	119.2±6.0	19.46±2.79	13.64±1.26	
Bharati et al. (2005)	M-7	M-40 F-40	M-118.70 city M-113.55 country F-114.50 city F-113.33 country	19.38 city 16.15 country 16.80 city 16.32 country		
Moreno et al. (2002)	M-7-9 F-7-9	M-97 F-67	M-131.0±0.06 F-130.0±0.07	30.5±6.1 30.3±6.0	17.7±2.6 17.8±2.6	10.4 Triceps 12.4
Villoria (2008)	M-7.2 F-7.1	M-297 F-302	M-121.9±5.72 F-121.1±5.82	M-22.28±5.45 F-22.6±5.88	M-15.2±2.39 F-15.2±2.56	
Reilly et al. (1999)	M-7 F-7	M-132 F-123	M-124±5.4 F-123.9±5.2	M-25.1±4.1 F-24.3±4.2	M-16.1±1.8 F-15.8±2.0	
Padez et al. (2004)	M-7 F-7	M-311 F-310	M-12.06±4.9 F-124.9±5.2	M-27.1±4.9 F-27.3±5.2	M-17±2.5 F-17.4±2.9	Triceps M-11.2±4.4 F-13.6±5.2 Subscapular M-7.4±3.9 F-9.6±5.3
Nikolić et al. (2006)	M-7 F-7	M-408 F-375	M-124.56±6.5 F-123.77±6.58	M-25.18±5.52 F-24.13±6.58		

Legend: M-male, F-female

Table 2.

Author	Age	Number of subjects	Body height (cm)	Body mass (kg)	BMI (kg/m ²)
Zellner et al. (2004)	M-7 F-7	1985. god M-74 F-83	M-126.0±5.5 F-125.1±5.0	M-24.8±3.5 F-24.1±3.3	M-15.6±1.4 F-15.4±1.6
	M-7 F-7	1995. god M-79 F-71	M-125.9±5.4 F-126.7±5.7	M-25.6±4.1 F-25.9±3.8	M-16.1±2.0 F-16.1±1.7
	M-7 F-7	2001. god M-67 F-81	M-126.6±4.6 F-124.5±4.8	M-25.7±4.0 F-25.1±4.6	M-16.1±2.0 F-16.1±2.2
So et al. (2008)	M-7 F-7	1963. god M-742 F-742	M-115.5±5.3 F-114.7±5.1	M-19.0±2.2 F-18.3±2.3	M-14.1±1.0 F-13.9±1.0
	M-7 F-7	1993. god M-643 F-553	M-120.6±5.6 F-119.8±5.1	M-22.9±4.5 F-22.1±4.3	M-15.7±2.3 F-15.3±2.3
	M-7 F-7	2005/6. god M-483 F-488	M-122.9±5.8 F-120.8±5.3	M-24.9±5.7 F-23.0±4.7	M-16.4±2.7 F-15.7±2.4

On the basis of the available research, we can conclude that the parameters for body height, body mass and the BMI for the samples of boys and girls, aged 7 on average, numerically speaking differ only slightly. We can assume that some of the numerical differences are statistically significant.

Our research was carried out with the aim of confirming and/or refuting the hypothesis that states that there are no statistically significant differences between the anthropometric characteristics of boys and girls, first grade elementary school students. The aim of our research was to determine the statistically significant difference in the anthropometric characteristics of seven-year-old boys and girls from the city of Niš.

METHOD

Participants

The sample numbered a total of 176 subjects, 91 of whom were boys and 85 of whom were girls. All of the subjects were first grade elementary school students from the city of Niš. The elementary schools were chosen at random, and only the students whose parents gave written consent for their child to participate in the study via the school board were included in the sample. Children who attend the following schools were measured: "Sveti Sava", "Car Konstantin" and "Ratko Vukićević". On the days that the measuring took place, all of the children were of sound health. The measurements were carried out in the school facilities which met the necessary requirements, by a team of doctors who are specialists in the field of sports medicine.

Instruments

The following parameters were used to evaluate longitudinal dimensionality: body height, leg length, and arm length.

The following parameters were used to evaluate transversal dimensionality: shoulder width, pelvic width, and hip width.

The following parameters were used to evaluate circular dimensionality and body mass: body mass, thorax volume, upper arm volume, thigh volume and calf volume.

The following parameters were used to evaluate subcutaneous fatty tissue: triceps skin folds, subscapular skin folds, abdominal skin folds, thigh skin folds and medial calf skin folds.

The measures for longitudinal dimensionality and transversal dimensionality were determined with the help of the Martin metal anthropometer (GPM Swiss Made). The measures for circular dimensionality were determined with the help of centrimetric tape (GPM Swiss Made). Body mass was measured with the help of the Body Composition Monitor (TANITA UM-72 - Made in Japan). The parameters of skin fold thickness were determined with the help of calipers (GPM Swiss Made).

The measurements were carried out during the morning hours. In the measuring rooms, there were no more than five subjects of the same sex at the same time. The measuring technique was in accordance with the methodology recommended by the International Biological Program (Weiner & Lourie, 1981).

Procedure

The data were entered into the Statistica 6.0 program for Windows. The basic descriptive parameters were calculated for all of the results: arithmetic means, standard deviation, minimum value, maximum value, and range. The differences between the boys and girls were examined using the t-test for independent samples. The level of significance was defined as $p \leq 0.05$.

RESULTS

The results for the basic descriptive parameters for the boys show that the average body height was 129.3 ± 5.35 cm. The difference between the shortest and tallest student was 26 cm, which we can consider to be a great difference. The differences between the minimum and maximum values for the anthropometric measures were in accordance with the displayed differences in body height (Table 3). The means for average thorax volume was 63.28 ± 6.07 , which is in accordance with the average body height, with the note that there is a great difference between the lowest and highest value for this parameter (35.70 cm). The greatest deviation between the lowest and highest value for body mass was 49.30 kg.

Table 3. The descriptive parameters for the anthropometric characteristics of the boys

	N	Mean	Min	Max	Range	Std.Dev.
Age	91	7.11	6.09	8.03	1.94	0.41
Body height	91	129.03	116.80	142.80	26.00	5.35
BMI	91	18.05	12.58	39.29	26.71	3.72
Leg length	91	70.17	61.20	78.20	17.00	3.78
Arm length	91	53.73	47.30	59.30	12.00	2.44
Shoulder width	91	28.39	25.30	33.00	7.70	1.52
Pelvic width	91	20.37	17.50	27.00	9.50	1.75
Hip width	91	21.83	18.20	26.80	8.60	1.67
Body mass	91	30.26	20.00	69.30	49.30	7.51
Thorax volume	91	63.28	54.80	90.50	35.70	6.07
Upper arm volume	91	19.18	15.00	29.50	14.50	2.72
Thigh volume	91	38.93	30.60	52.60	22.00	4.87
Calf volume	91	27.20	22.20	36.30	14.10	2.80
Triceps skin folds	91	12.56	5.00	45.00	40.00	5.95
Subscapular skin folds	91	9.85	3.00	44.80	41.80	6.93
Abdominal skin folds	91	10.82	2.60	31.40	28.80	7.30
Thigh skin folds	91	17.41	4.20	40.00	35.80	6.70
Medial calf skin folds	91	15.92	6.00	40.20	34.20	5.94

The values for the measures for the transversal dimensionality of the skeleton for the boys, aged 7, indicate normal growth and development, with the note that there is a great numerical difference between the lowest and highest measured value for all the measured parameters. This indicates that there is a great difference in the anthropometric measures of transversal dimensionality of the body of students at this age, that is, that the group is heterogeneous.

The studied variables for circular dimensionality for the boys indicate an extensive range, and a significant difference can be noted for the average thorax volume, which is consistent with the analyzed body areas, that is, a great intra-group difference.

The differences between the minimum and maximum values for skin folds indicate great ranges for the measured points, which can be a result of the influence of outside factors, but also of great intra-group differences.

By analyzing the results for the anthropometric characteristics of the girls from the city of Niš (Table 4), aged 7, we can conclude that their average height was 127.68 ± 5.97 cm. The girls on average have numerically lower values for body height, a total of 1.3 cm compared to the boys. The difference between the lowest and highest measured body height for the girls was 27 cm, which was 1 cm higher than for the boys. This indicates a more pronounced heterogeneity for body height among the girls in relation to the boys. The great difference between the minimum and maximum value can be noted for body mass as well. This difference is 27 kg, which also indicates a great heterogeneity in the group. The average value for body mass is 29.66 ± 6.8 kg. A great difference can also be noted for the average thorax volume. The remaining anthropometric measurements are consistent with body height, with the note that the differences can be found between the minimum and maximum values for circular dimensionality and subcutaneous fatty tissue, which confirms the extensive heterogeneity of the group.

Table 4. The descriptive parameters for the anthropometric measurements of the girls

	N	Mean	Min	Max	Range	Std.Dev.
Age	85	7.08	5.09	8.04	2.95	0.528
Body height	85	127.68	115.10	142.10	27.00	5.972
BMI	85	18.09	13.62	29.84	16.22	3.08
Leg length	85	70.23	60.50	80.00	19.50	4.197
Arm length	85	53.50	46.50	60.00	13.50	2.684
Shoulder width	85	28.33	25.20	31.50	6.30	1.548
Pelvic width	85	20.32	17.00	28.50	11.50	1.684
Hip width	85	21.91	17.60	26.20	8.60	1.621
Body mass	85	29.66	19.40	47.00	27.60	6.282
Thorax volume	85	63.61	53.00	80.50	27.50	5.920
Upper arm volume	85	19.49	15.20	25.20	10.00	2.452
Thigh volume	85	39.30	21.50	53.30	31.80	5.032
Calf volume	85	27.62	22.50	35.80	13.30	2.792
Triceps skin folds	85	12.86	4.00	25.00	21.00	4.280
Subscapular skin folds	85	10.27	3.20	34.00	30.80	5.688
Abdominal skin folds	85	12.80	3.20	34.00	30.80	6.965
Thigh skin folds	85	19.26	5.60	38.00	32.40	7.023
Medial calf skin folds	85	14.68	4.60	46.40	41.80	7.052

The process of determining the differences between the anthropometric characteristics of the boys and girls was realized with the help of the t-test (Table 5). The results indicate that no statistically significant difference was noted for any of the anthropometric measurements, and that a pronounced numeric difference can be found for body height, but one which is not statistically significant (Figure 1).

Table 5. The t-test for the anthropometric parameters of the boys and girls

	Boys	Girls	t-value	p
Body height	129.03	127.68	1.58	0.116
BMI	18.05	18.09	-0.06	0.950
Leg length	70.17	70.23	-0.09	0.925
Arm length	53.73	53.61	0.22	0.826
Shoulder width	28.29	28.75	-0.81	0.419
Pelvic width	20.37	20.32	0.18	0.856
Hip width	21.83	21.91	-0.33	0.745
Body mass	30.26	29.66	0.57	0.572
Thorax volume	63.28	63.61	-0.37	0.714
Upper arm volume	19.18	19.49	-0.80	0.427
Thigh volume	38.93	39.30	-0.49	0.622
Calf volume	27.20	27.62	-1.00	0.320
Triceps skin folds	12.56	12.86	-0.39	0.701
Subscapular skin folds	9.85	10.27	-0.44	0.660
Abdominal skin folds	10.82	12.80	-1.84	0.067
Thigh skin folds	17.41	19.26	-1.79	0.075
Medial calf skin folds	15.92	14.68	1.27	0.207

The results indicate that for individual parameters, numerically higher values were noted for the boys in comparison to the girls, and vice versa.

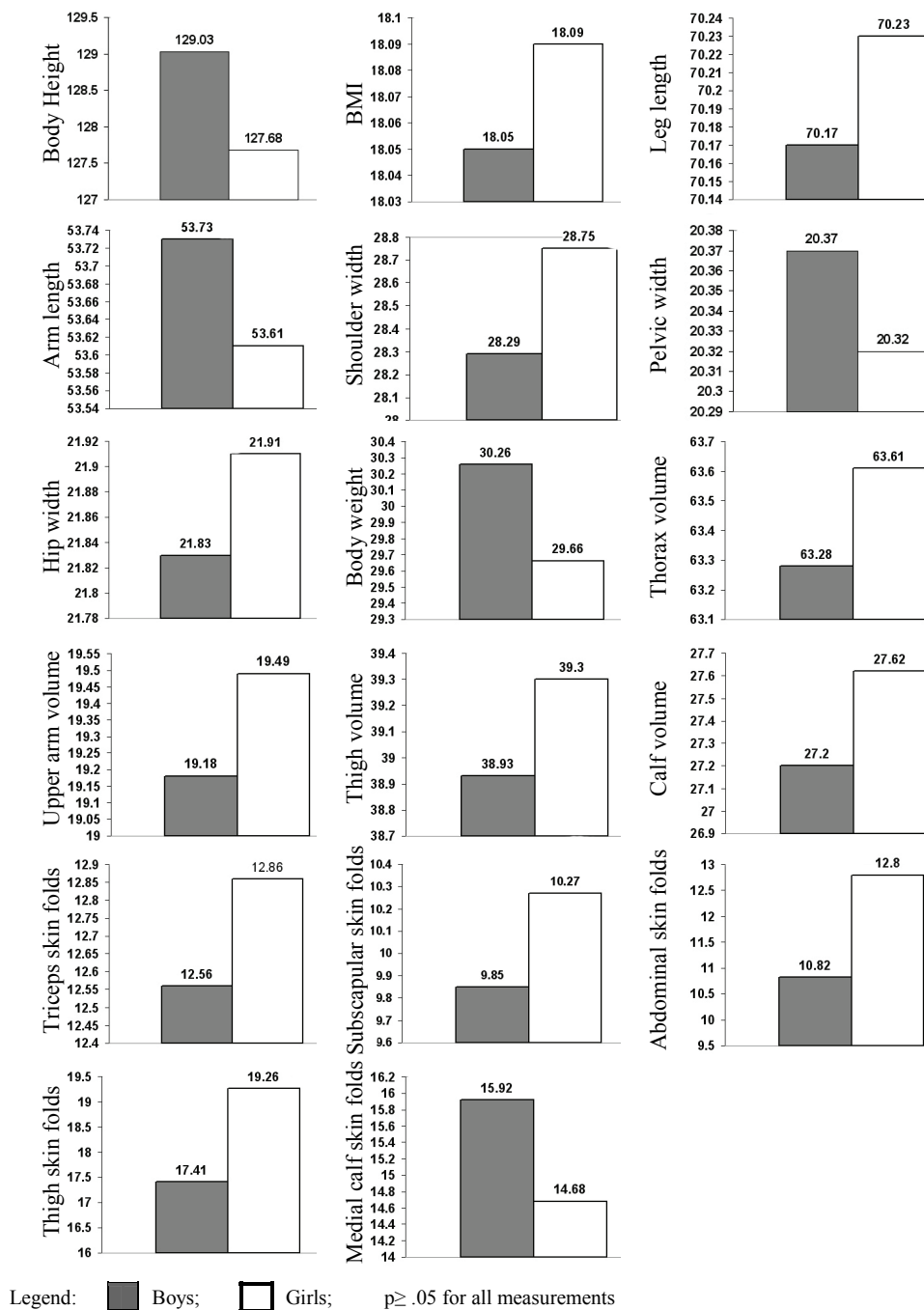


Fig. 1. The numerical difference between the anthropometric characteristics between the boys and the girls

DISCUSSION

The results for the body height of the boys have indicated that the average height of the subjects included in the research had numerically higher values compared to the results obtained by other authors (Ruxton et al., 1999; Hurbo, 2008; Yi-Ling & Bei-Jun, 1982; Al-Hazzaa, 1990; Kumar et al., 2004).

It is necessary to point out that the average height of the boys from the city of Niš has, numerically speaking, significantly greater values compared to the values noted by the cited authors. The average body mass of the subjects included in our research was 30.26 kg and has, numerically speaking, greater values compared to the subjects cited in the other research (Ruxton et al., 1999; Hurbo, 2008; Yi-Ling & Bei-Jun, 1982; Al-Hazzaa, 1990; Kumar et al., 2004; Bharat, et al., 2005; Reilly et al., 1999). The explanation for these great numeric values for body mass can be found in the difference between the average values for body height, which is accompanied by the appropriate body mass. Confirmation for the greater body mass and greater height of the boys included in our research can be found in the values of the BMI. Greater average values for this index are consistent with body height and mass, and they have greater values compared to those found in the research of other authors (Padez, et al., 2004; Villoria, 2008; Reilly et al., 1999; Kumar et al., 2004).

The circular dimensions of the boys included in our research indicate that the measured values are greater than the same ones measured in the research of other authors (Hurbo, 2008; Bharati et al., 2005; Padez et al., 2004). The explanation for this lies in the fact that the average values for mass and body height of the subjects included in our research are higher than those found in the research of the aforementioned authors.

The average values for the skin folds of the measured points are greater than those found in the research of certain authors. Padez et al. (2004) cited in their study that the average value for the skin folds of boys in the triceps area was 11.2 mm, while the value for the subscapular skin folds was 7.4 mm. Al-Hazzaa (1990) cites that the triceps skin folds among seven-year-old boys was 7.3 ± 1.9 mm, which is a lower value than the one noted for the boys included in our research. Đurašković et al. (2006) cited that the noted values for skin folds in the measured points among seven-year-old boys from Leskovac (Serbia) were lower than the ones noted for the subjects in this research.

The results for the basic parameters of descriptive statistics for seven-year-old girls are shown in Table 2. The average value for body height was 127.68 cm and is somewhat lower than the average value noted for the boys. In the research carried out by a great number of authors, the body height of seven-year-old boys has a greater average value than that of the girls, but is not statistically significant (Bharati et al., 2005; Padez et al., 2004; Zellner et al., 2004; Aldegheri & Agostini, 1993). Nevertheless, in a certain number of studies, the values for the body height of the girls are greater than those noted for the boys (Hurbo et al., 2008). In the research carried out by Zellner et al. (2004), greater body height was measured for seven-year-old boys in 1985 and 2001, while in 1995, higher body height was noted for the girls. The average height of the boys is somewhat greater, and the height of the girls somewhat smaller than the values noted by Katic et al. (2005) and Holm et al. (2008). This can be explained by the size of the selected sample or possibly the measurements that were carried out in different years.

The value for the body mass of the girls was 29.66 ± 6.28 kg and is greater than the values recorded by other authors (So et al., 2008; Hurbo, 2008; Đurašković et al., 2006;

Nikolić, et al. 2006). The body mass of the girls has a lower value in comparison to the value of the body mass of the boys in our research, as is the case in the studies of the aforementioned authors. These results are consistent with the differences in body height between the boys and girls included in this research, or in other words, we can claim that the body mass is consistent with body height, which is borne out by the values of the BMI. The average value for the BMI for the girls is higher than the value for the boys, and similar results have been noted by other authors (Moreno et al., 2002; Padez et al., 2004). This can be explained by the lower values for body height for the girls and higher levels for skin folds in certain points. In some studies, the values for the BMI are greater for the boys than the girls (Villoria, 2008; Hurbo, 2008; Ruxton et al. 1999; So et al., 2008), and this can probably be explained by the difference in body height and mass.

The skin folds in the measured points have greater values compared to the values noted for the boys. The obtained results are consistent with the results obtained by other authors (Padez et al., 2004; Đurašković et al., 2006). This can be explained by a difference in gender, a claim which was confirmed in the research done by Turek (1999).

The values of the circular dimensions of the body for the girls included in our research are greater than those for the boys. These values are consistent with former research carried out by certain authors (Padez et al., 2004; Đurašković et al., 2006). Nevertheless, certain authors have noted higher values for the differences in the circular dimensions for the boys in relation to the girls, which can be explained by greater body height and mass, and also by greater muscle strength (Kukulj et al., 2006).

The process of determining the inter-group differences in terms of anthropometric measures was realized with the help of a t-test (Table 3). The results we obtained indicate that none of the differences noted for any of the parameters used to evaluate anthropometric characteristics are statistically significant. The studies carried out by certain authors have shown that there are no statistically significant differences for body height, body mass and the BMI. Nikolić, Milutinović, Stojanović, Gligorijević & Cvetković (2006) did not note any statistically significant differences for body height and body weight between boys and girls aged 7, who live in and around the city of Niš, while other authors have cited similar results (Ruxton et al., 1999; Reilly et al., 1999; Nikolić et al., 2006; Đurašković et al., 2006).

Nevertheless, a certain number of authors have noted results which indicate that there are statistically significant differences between boys and girls at this age in terms of certain anthropometric characteristics.

Sabo (2006) has found a difference in the anthropometric measurements of boys and girls about to start school. Graf et al. (2004) used a sample of 341 boys and 327 girls and determined statistically significant inter-group differences for body height, body mass and the BMI. A possible explanation for these results can be found in the fact that various authors have carried their research out on more homogenous or heterogeneous groups, which showed greater or lesser differences in biological as compared to calendar age.

The lack of any statistically significant differences in the circular dimensions of the body and skin folds can be explained by the fact that these segments develop more intensely during the prepubescent and pubescent phase of growth and development. A statistically significant difference between the boys and girls can be expected during this particular period of growth and development (Kukulj et al., 2006; Đurašković, 2002).

CONCLUSION

On the basis of the results that we have obtained we can draw the conclusion that there are no statistically significant differences in the studied anthropometric measurements between boys and girls aged 7. The results have confirmed the initial hypothesis. The differences in the average numeric values of the studied measures do exist and the girls have shown higher values for parameters of circular dimensionality of the body and subcutaneous fatty tissue, which can be explained by gender characteristics. For the measures of longitudinal and transversal dimensionality of the skeleton, there is no homogeneity for gender.

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KOMPARATIVNA ANALIZA ANTROPOMETRIJSKIH PARAMETARA SEDMOGODIŠNJE DECE

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Svrha istraživanja je da se potvrdi ili negira hipoteza o nepostojanju statistički značajnih razlika između dečaka i devojčica grada Niša u antropometrijskim merama. Uzorak ispitanika činio je 91 dečak i 85 devojčica koji pohađaju prvi razred osnovnih škola i imaju u proseku sedam godina. Izmereno je 17 antropometrijskih mera uključujući BMI, koje su pokrivalo prostor longitudinalne, transferzalne, cirkularne dimenzionalnosti i potkožnog masnog tkiva. Razlike u antropometrijskim merama između dečaka i devojčica utvrđene su izračunavanjem Studentovog t-testa. Rezultati su pokazali da ne postoji statistički značajna razlika u merama antropometrijskih karakteristika. Međutim, postoji numerička razlika u mnogim parametrima između subuzoraka, kao i velika razlika unutar grupa što je ukazalo na izraženu heterogenost grupa u pogledu procenjenih karakteristika. Pri istraživanjima antropometrijskih karakteristika na ovom uzrastu ispitanika potrebno je obratiti pažnju ne samo na kalendarsku, već i na biološku starost.

Ključne reči: antropometrija, deca, razlike, komparacija, heterogenost