AGE AND SEX-RELATED DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS AND BODY COMPOSITION IN PRIMARY SCHOOL-AGE CHILDREN

STAROSNE I POLNE RAZLIKE U ANTROPOMETRIJSKIM KARAKTERISTIKAMA I TJELESNOJ KOMPOZICIJI OSNOVNOŠKOLSKE DJECE

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ABSTRACT

This study addressed the assessment of anthropometric characteristics and body composition of primary school children. The study aimed to determine age and sex related differences in children aged 7 and 8 years, which could be used to assess the health status of children and to monitor the trend of their growth and development. The study included 1520 students (814 second-grade students and 706 third-grade students; 772 boys and 748 girls). The participants were measured for body height and weight, body mass index, body fat percentage, fat mass, and fat-free mass. The results indicated that there were significant differences between boys and girls in body height and weight, fat percentage, body mass index, and fat-free mass (p <.05), whereas there was no difference in fat mass. Apart from the fat percentage, there are significant differences between seven- and eight-year-old children in all other measured variables. The obtained values of anthropometric characteristics and body composition of children are in accordance with the world trends. The differences between the sexes and the generations of children that have been identified are probably due to genetic predisposition, but also to the conditions in which they grow up.

Key words: health status of children, fat in children

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INTRODUCTION

Obesity among children, adolescents and adults has emerged as one of the most serious public health concerns in the 21st century. According to the World Health Organization (WHO), obesity occurs in one of ten people worldwide (WHO, 2015; van Vliet-Ostaptchouk, Nuotio, Slagter, Doiron, Fischer, Foco, & Joensuu, 2014). Secular trends in increasing body fatness are occurring rapidly and especially sensitive period that can be influenced by this changes are childhood and preadolescents (Ng, Fleming, Robinson, Thomson, Graetz, et al., 2014). Measurement of body composition in childhood, as a key component of individual's health and physical fitness profile, is of considerable importance for creating national health strategies and provide a better environment for healthy growing up. The ability to quantify body composition parameters such as fat mass, pat percentage, free fat mass and body mass index and compare them according age and sex may enable better insight of future health hazards associated with obesity. According to some research sexual dimorphism in body composition is considered to be slight before puberty (Forbes, 1987), but increase of body weight begins at about the age of 8 and this persistence continues until the end of the growing process. (Kędzior, Jakubek-Kipa, Brzuszek, & Mazur, 2017).

Thus, the aim of this study was to compare anthropometrics and body composition parameters in primary school-age children depending on sex and age. In addition, these obtained values of age and sex differences can be used to provide important data on body composition in healthy children from municipality of Banja Luka (region in Bosnia and Herzegovina; ~200,000 inhabitants).

METHODS

The study included second- and third-grade students aged 7 and 8 from Banja Luka (Republic of Srpska, Bosnia and Herzegovina). Stratified random sampling was used in this study. Nine primary schools were identified and randomly selected by the author. Consent to participate in the study was obtained from the parents of the children. A total of 1520 students participated, of which 814 were second-grade students and 706 were third-grade students.

Body weight and height, as the most representative measures of physical growth and development, were measured by standard measurement methods: 1) body height (cm) was measured by a Martin anthropometer; 2) body weight (0.1 kg) was measured by a body composition analyzer (BC-418 "TANITA", Japan). The same apparatus calculated 4 additional parameters: Body Mass Index (BMI), Body Fat Percentage (FatP), Fat Mass (FatM), and Fat-Free Mass (FFM). Bioelectric impedance analyzers can be an accurate device for measuring FatP, FatM and FFM in children (Lim et al. , 2009).

All body parameters were measured by using a multifrequency bioelectrical impedance analyser (TANITA BC-418MA III). Examinees were tested barefoot, in pants and shirts. During the data collection they were standing on the bottom of body analyser and held electrodes in both arms. The surface of the hand electrode was

placed in contact with each of the five fingers. Data input contains body height and age, and for the testing of recreationists' categories were selected. After signal reports the direct current goes throw the body and analysed necessary body parameters: Body Mass Index, Fat Free Mass, Fat Percentage, and Fat Mass. The BIA assessment was performed between 10.00 AM and 4.00 PM. Height was, also, measured barefoot to the nearest 0.1 cm, respectively.

Descriptive statistics were calculated for all variables. A T-test for independent samples was used to determine differences between groups. Also, as an effect size statistic, Partial Eta squared (η²) was calculated. Statistical significance was determined at the level .05. All analyses were performed using SPSS version 20.0.(IBM, Armonk, NY).

RESULTS

The collected anthropometric and body composition characteristics of the study are reported in Table 1 stratified by sex, and Table 2 stratified by age.

Table 1. *Sex-related difference in body composition in healthy early age school children*

		N (n=1520)	Mean	Std. Dev.	Std. Error Mean	t	df	*p*	Par. Eta Squared
Height	boys	772	131.20	6.67	.24	5.73	1518	.00	.02
	girls	748	129.27	6.43	.23				
Weight	boys	772	30.09	6.86	.24	3.90	1518	.00	.01
	girls	748	28.74	6.61	.24				
BMI	boys	772	17.33	2.86	.10	2.00	1518	.04	.00
	girls	748	17.04	2.82	.10				
FatP	boys	772	21.95	8.47	.30	-5.17	1518	.00	.00
	girls	748	23.78	4.77	.17				
FatM	boys	772	6.85	3.40	.12	-1.46	1518	.14	.00
	girls	748	7.09	3.13	.11				
FFM	boys	772	23.51	8.26	.29	5.64	1518	.00	.02
	girls	748	21.6428	3.80	.13				

Legend: *FatP-fat mass percentage, FatM-fat mass (kg), BMI-body mass index, FFM-fat free mass (kg), Mean – the value of arithmetic means; StdDev. (Standard Deviation) – Average deviation of the obtained results from their arithmetic mean;p* – coefficient of significance p<.05. *Partial Eta squared-effect size statistics.*

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Table 2. *Age-related differences in Body Composition in healthy Early Age School Children*

		N (n=1520)	Mean	Std. Dev.	Std. Error Mean	t	df	*p*	Par. Eta Squared
Height	seven-year	814	127.378	5.63	.19	-20.55	1518	.00	.21
	eight-year	706	133.57	6.11	.23				
Weight	seven-year	814	27.52	6.02	.21	-12.35	1518	.00	.09
	eight-year	706	31.62	6.92	.26				
BMI	seven-year	814	16.85	2.77	.09	-5.02	1518	.00	.01
	eight-year	706	17.58	2.88	.10				
FatP	seven-year	814	22.74	8.06	.28	-0.65	1518	.51	.00
	eight-year	706	22.97	5.44	.20				
FatM	seven-year	814	6.45	3.02	.10	-6.73	1518	.00	.02
	eight-year	706	7.57	3.45	.12				
FFM	seven-year	813	21.33	7.93	.27	-8.21	1518	.00	.04
	eight-year	706	24.04	3.93	.148				

Legend: FatP-fat mass percentage, FatM-fat mass (kg), BMI-body mass index, FFM-fat free mass (kg), Mean – the value of arithmetic means; StdDev. (Standard Deviation) – Average deviation of the obtained results from their arithmetic mean;p – coefficient of significance p<.05. Partial Eta squared-effect size statistics.

Table 1 shows statistically significant differences in both anthropometric (height p= .00; weight p=.00) and body composition characteristics (BMI p=.04; FatP p=.00; FFM p=.00) between boys and girls. According to Means values, the girls are having a more fat percentage (23.78 vs.21.95), more fat mass (7.09 vs. 6.85) and less body mass index (17.04 vs. 17.33) than boys. The boys are taller approximately 2.93cm (132.20 vs. 129.27) and heavier1.35kg (30.09 vs. 28.74) than girls. Table 2 shows statistically significant differences in anthropometric (height p=.00; weight p=.00) and body composition characteristics (FatM p=.00; BMI p=.00; FFM p=.00) between a seven-year-olds and an eight-year-olds. By observing Mean values it can be noticed that eight year-olds have higher values in fat mass (7.57 vs. 6.45), body mass index (17.58 vs. 16.85) and free fat mass (24.04 vs. 21.33) than seven-year-olds. The eight-year-olds are approximately 6.20cm higher (133.57 vs. 127.37) and 3.75 kg heavier (31.62 vs. 27.52) than seven-year-olds.

DISCUSSION

In this study, we aimed to make comparisons between anthropometric and body composition parameters in primary school-age children depending on sex and age. We also assumed that there were no significant differences in anthropometric parameters and body composition between the measured boys and girls and that there were no significant differences in

anthropometric parameters and body composition between the two generations of children. The results showed that, except in Fat mass (p = .14), there are significant differences between boys and girls in Height, Weight, Fat Percentage, Body Mass Index, and Fat-Free Mass (p < .05). For all variables Partial Eta Squared was η² ~ .01 (*small,*accordingto Pierce, Block, & Aguinis, 2004). Furthermore, except in Fat percentage (p = .51), there are significant differences between seven-year and eight-

year girls and boys (p < .01). Partial Eta Squared for the Height variable was η² = .21 (*large*), and for the variable Weight was η² = .09 (*medium*). All remaining values Partial Eta Squared was η² ~ .01 (*small*).

If we compare the values obtained with Fomon's "reference child" (Fomon et al., 1982) and the values obtained by Ruxton et al. (1999) a clear trend of increasing all measured characteristics in children is evident. Mean values are presented in the table 3.

Table 3. *The trend of changing anthropological characteristics and body composition of children aged 7 and 8*

	Age 7			Age 8		
Variables boys↓	Fomon et al., 1982	Ruxton et al., 1999	Vučković et al., 2019	Fomon et al., 1982	Ruxton et al., 1999	Vučković et al., 2019
Height (cm)	121.7	125.0	128.13	127.0	130.2	134.67
Weight (kg)	22.9	25.1	28.05	25.3	28.2	32.40
FatP (%)	12.8	16.5	21.89	13.0	16.9	22.01
FatM (kg)	2.9	4.4	6.31	3.3	4.7	7.45
BMI	15.5	16.0	16.97	15.7	16.5	17.74
FFM (kg)	19.9	20.7	22.26	22.0	23.5	24.93
Variables girls↓						
Height (cm)	120.6	124.0	126.60	126.4	130.0	132.41
Weight (kg)	21.8	24.2	26.98	24.8	27.8	30.80
FatP (%)	16.8	19.0	23.60	17.4	20.0	23.99
FatM (kg)	3.7	4.6	6.58	4.3	5.8	7.69
BMI	15.0	15.8	16.72	15.5	16.5	17.41
FFM (kg)	18.1	19.6	20.40	20.5	22.0	23.09

Hence, due to the large increase in measured characteristics of children over the last 37 years, comparing our results with others only makes sense if we consider recent research. In our study, children from 7 to 8 years grow ~ 6.2 cm and gain ~ 4.1kg. As expected, boys are taller and heavier than girls, which is in concordance with the results of significant studies on a large population of children (Lobstein & Frelut, 2003; Binkin et al., 2010; Özkan et al., 2014; Wijnhoven et al., 2014; Datar &

Chung, 2015; Đorđić et al., 2016). According to WHO standard norms (WHO, 2019), the average BMI values of 17.33 kg/m² in boys and 17.04 kg/m² in girls in our study indicated average-normal nutritional status. The boys in our study have a higher BMI than the girls and this is not the rule. In some studies, boys have a higher BMI (Đorđić et al., 2016; Chwałczyńska et al., 2018;), yet in other studies girls do (Halasi et al., 2018; Taylor et al., 1997, Basterfield et al., 2011) and in some cases they are

similar (Maynard et al., 2001; Planinšec & Fošnarič, 2009). For children measured in our study, BMI increases by ~ 0.7 in one year. In Hungarian 6-year longitudinal study (Kovacs et al., 2018) followed the height, weight , and BMI of seven-year-old boys and girls. After 6 years, a new generation of seven-year-olds was measured. New generation of boys and girls are taller, heavier and have a higher BMI. This increase is not statistically significant but is an indication. In this study, boys have a lower percentage of adipose tissue than girls. This is consistent with the results of available research (McCarthy et al., 2006, Halasi et al., 2018;Taylor et al., 1997; Chwałczyńska et al., 2018). Zhang et al. (2015) analysed fatness in Tibetan children. They found that there were no differences between age groups until 11 years, but all fat indices were higher in girls than in boys (p < 0.05). Finnish girls of the same age as in our study, have a higher body fat percentage than boys (23.2% vs.18.2, p < 0.001, Soininen et al., 2018). When processing the data, we also calculated the relationship between BMI and FatP. Spearman's rank correlations suggesting a significant positive correlation (r = 0.667, p < 0.01), which is consistent with the studies of Taylor et al. (1997) and Eisenmann et al. (2004). The girls in our study had significantly higher adipose tissue mass than boys. In similar studies (Taylor et al., 1997; Dencker et al., 2007; Chwałczyńska et al., 2018) girls also have higher adipose tissue mass than boys. The study by Dencker et al. (2006) on the 8 to 11-year-olds suggests that girls have a significantly higher fat mass (FatM) (.007 and .0008) and a significantly higher percentage of fat (FatP p<.001). Consequently, girls in the prepubertal phase of life seem to have a higher fat mass and a higher percentage of fat than boys. Regarding Fat Free Mass (FFM) in our study, there is more in boys. This is also the case in the studies of Chwałczyńska et al. (2018) and Sen & Mondal (2013). Also, Dencker et al. (2007) found more Fat Free Mass (FFM) in boys (p <0.001). However, Wells et al. (2002) found no significant differences between eight-year-old boys and girls in Fat Free Mass. From the age of 3 to 11 FFM significantly increased (~ 10 kg, p < .001) in children (Nakao & Komiya, 2003). This is logical as children grow and develop. The Japanese children in that study, aged 7 and 8, recorded an FFM value of 19.10 kg, which is less than the children in our study (22.59kg).

The composition of the human body changes with ontogenetic development. The intensity of changes is determined by genetic factors and it is well influenced by environmental factors (Chwałczyńska et al., 2018). Economic power and social inequalities strongly influence the anthropological characteristics and physical composition of children. According to Dubois et al. (2012), genetics seems to play an increasingly important role in explaining differences in height, weight, and BMI from early childhood to late adolescence, especially in boys. Furthermore, common environmental factors have the strongest impact, especially in the pre-adolescent years, more significantly in girls. These findings underscore the need to target health-related-family and social impacts on children in early childhood, especially in girls.

CONCLUSION

Age and sex-related differences in anthropological characteristics and body composition of urban children aged 7 and 8 in the Republic of Srpska seem to be comparable to those of other European regions. But, to the best of the author's knowledge, there are very few studies that analyse in details the body composition of children aged 7 and 8. The gender differences we identified probably develop from genetic predispositions as well as current environmental conditions. The increase in the value of anthropometric characteristics and body composition of the children we identified in this study is in line with global trends. There are two limitations to this study that should be considered. The participants of the study were children from one region of Bosnia and Herzegovina. It is quite possible to get slightly different results if children from other regions were measured. Secondly, if we had followed multiple generations of children, we would probably have analysed the trend of growth and development of children, or their anthropometric characteristics and body composition we could make more reliable conclusions.

REFERENCES

Basterfield, L., Adamson, A., Frary, J., Parkinson, K. , Pearce, M., Reilly, J. (2011). Longitudinal Study of Physical Activity and Sedentary Behavior in Children. Pediatrics. 127:24-31.
https://doi.org/10.1542/peds.2010-1935
PMid:21173005

Binkin, N., Fontana, G., Lamberti, A., Cattaneo, C., Baglio, G., i sar. (2010). A national survey of the prevalence of childhood overweight and obesity in Italy. Obesity Reviews. 11:2-10.
https://doi.org/10.1111/j.1467-789X.2009.00650.x
PMid:19761508

Bixby, H., & 1156 more authors (2019). Rising rural body-mass index is the main driver of the global obesity epidemic in adults. Nature, 569(7755):260.
https://doi.org/10.1038/s41586-019-1171-x
PMid:31068725 PMCid:PMC6784868

Brown, L., Campbell-Jack, D., Gray, L., Hovald, P., Kirkpatrick, G., Knudsen, L., Leyland, A.H., Montagu, I., & Rose, J. (2016). The Scottish Health Survey. In: Scotland ANSPf, editor.
http://www.gov.scot/Publications/2016/09/2764/0.

Chwałczyńska A, Rutkowski T, Jędrzejewski G, Wójtowicz D, Sobiech KA. (2018). The comparison of the body composition of children at the early school age from urban and rural area in southwestern Poland. BioMed Research International.
https://doi.org/10.1155/2018/9694615
PMid:30255102 PMCid:PMC6142738

Conolly, A. (2016). Health Survey for England 2015 Children's body mass index, overweight and obesity. In: Centre HaSCI, editor. London: Health and Social Care Information Centre.

Datar, A., & Chung, P.J. (2015). Changes in socioeconomic, racial/ethnic, and sex disparities in childhood obesity at school entry in the United States. JAMA Pediatrics;169:696-7.
https://doi.org/10.1001/jamapediatrics.2015.0172
PMid:25984706

Dencker, M., Thorsson, O., Karlsson, M.K., Linden, C., Eiberg, S., Wollmer, P., Andersen, L.B. (2006). Daily physical activity related to body fat in children aged 8-11 years. Journal of Pediatrics. 149(1), 38-42.

Dencker, M., Thorsson, O., Karlsson, M.K., Linden, C., Eiberg, S., Wollmer, P., Andersen, L.B. (2007). Gender differences and determinants of aerobic fi tness in children aged 8-11 years. European Journal of Applied Physiology. 99(1), 19-26.
https://doi.org/10.1016/j.jpeds.2006.02.002
PMid:16860124

Vučković, I., Ljubojević, A., Vukić, Ž., & Pašić, G. (2019). Age and sex related differences in anthropometric characteristics and body composition in primary school-age children. *Sportlogia 15*(1), 60-72. doi: 10.5550/sgia.191501.en.vlvp

Djordjic, V., Radisavljevic, S., Milanovic, I., Božic, P., Grbic, M., Jorga, J., & Ostojic, S. M. (2016). WHO European Childhood Obesity Surveillance Initiative in Serbia: a prevalence of overweight and obesity among 6-9-year-old school children. Journal of Pediatric Endocrinology and Metabolism, 29(9), 1025-1030.
https://doi.org/10.1515/jpem-2016-0138
PMid:27544722

Dubois, L., Ohm Kyvik, K., Girard, M., Tatone-Tokuda, F., Pérusse. D., Hjelmborg, J., i sar. (2012). Genetic and Environmental Contributions to Weight, Height, and BMI from Birth to 19 Years of Age: An International Study of Over 12,000 Twin Pairs. PLoS ONE 7(2): e30153.
https://doi.org/10.1371/journal.pone.0030153
PMid:22347368 PMCid:PMC3275599

Eisenmann, J.C., Heelan, K.A., Welk, G.J. (2004). Assessing body composition among 3- to 8- year-old children: anthropometry, BIA, and DXA. Obesity Research. 12(10),1633-1640.
https://doi.org/10.1038/oby.2004.203
PMid:15536227

Fomon, S., Haschke F., Ziegler, E., & Nelson, S. (1982). Body composition of reference children from birth to age 10 years. American Journal of Clinical Nutrition. 35: 1169.
https://doi.org/10.1093/ajcn/35.5.1169
PMid:7081099

Forbes, G. (1987). Human body composition. Growth, aging, nutrition and activity. Springer-Verlag: New York.
https://doi.org/10.1007/978-1-4612-4654-1

Halasi, SZ., Lepeš, J., Đorđić, V., Stevanović, D., Ihász, F., Jakšić, D., Živković-Vuković, A., Cvetković, M., Milić, Z., Stajer, A., Zrnzević, N. & Marinković, D. (2018). Relationship between obesity and healthrelated quality of life in children aged 7-8 years. Health and Quality of Life Outcomes 16:149
https://doi.org/10.1186/s12955-018-0974-z
PMid:30055623 PMCid:PMC6064135

Kędzior, A., Jakubek-Kipa, K., Brzuszek, M. & A. Mazur (2017). Trends in prevalence of childhood overweight and obesity on the World, in Europe and in Poland. Pediatric Endocrinology reviews, 16(1) 58-41.
https://doi.org/10.18544/EP-01.16.01.1662

Kovacs, V. A., Bakacs, M., Kaposvari, CS., Illes, E., Erdei, G., Martos, E., & Breda, J. (2018). Weight Status of 7-Year-Old Hungarian Children between 2010 and 2016 Using Different Classifications (COSI Hungary). Obesity Facts. 11:195-205
https://doi.org/10.1159/000487327

Vučković, I., Ljubojević, A., Vukić, Ž., & Pašić, G. (2019). Age and sex related differences in anthropometric characteristics and body composition in primary school-age children. *Sportlogia 15*(1), 60-72. doi: 10.5550/sgia.191501.en.vlvp

Lim, J.S., Hwang, J.S., Lee, J.A., Kim, D.H., Park, K.D., Jeong, J.S., & Cheon, G.J. (2009). Crosscalibration of multi-frequency bioelectrical impedance analysis with eightpoint tactile electrodes and dual-energy X-ray absorptiometry for assessment of body composition in healthy children aged 6-18 years. Pediatrics International. 51(2):263-268.
https://doi.org/10.1111/j.1442-200X.2008.02698.x
PMid:19405930

Lobstein, T., & Frelut, M.L. (2003). Prevalence of overweight among children in Europe. Obesity Reviews. 4:195-200.
https://doi.org/10.1046/j.1467-789X.2003.00116.x
PMid:14649370

McCarthy, D.H., Cole, T.J., Fry, T., Jebb, S.A. & Prentice, A.M. (2006). Body fat reference curves for children. International Journal of Obesity. 30, 598-602
https://doi.org/10.1038/sj.ijo.0803232

Maynard, L.M., Wisemandle, W., Roche, A., Cameron Chumlea, W., Guo, S. & Siervogel, R. (2001). Childhood Body Composition in Relation to Body Mass Index. Pediatrics. 107;344-350.
https://doi.org/10.1542/peds.107.2.344
PMid:11158468

Nakao, T. & Komiya, S. (2003). Reference Norms for a Fat-free Mass Index and Fat Mass Index in the Japanese Child Population. Journal of physiological anthropology and applied human science. 22: 293-298.
https://doi.org/10.2114/jpa.22.293
PMid:14646264

NCD Risk Factor Collaboration (NCD-RisC) (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128•9 million children, adolescents, and adults. Lancet, 390, 2627-2642.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., et al. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. The lancet, 384(9945), 766-781.

Özkan, S., Özcebe, H., Yardim, N., & Tülay, A. (2014). Turkey Childhood (Ages 7-8) Obesity Surveillance Initiative (COSI-TUR) 2013. Ankara: Republic of Turkey Ministry of Health.

Pierce, C.A., Block, C.A. & Aguinis, H. (2004). Cautionary note on reporting eta-squared values from multifactor anova designs. Educational and Psychological Measurement, 64(6).
https://doi.org/10.1177/0013164404264848

Planinšec, J. & Fošnarič, S. (2009). Body Mass Index and Triceps Skinfold Thickness in Children. Collegium Antropologicum. 33(2)341-345.

Vučković, I., Ljubojević, A., Vukić, Ž., & Pašić, G. (2019). Age and sex related differences in anthropometric characteristics and body composition in primary school-age children. *Sportlogia 15*(1), 60-72. doi: 10.5550/sgia.191501.en.vlvp

Popkin, B. M. (2006). Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. American Journal of Clinical Nutrition. 84, 289-298. https://doi.org/10.1093/ajcn/84.2.289

Wagner, K. H. & Brath, H. (2012). A global view on the development of non communicable diseases. Preventive Medicine. 54, S38-S41. https://doi.org/10.1016/j.ypmed.2011.11.012

Ruxton, C., Reilly, J. & Kirk, T. (1999). Body composition of healthy 7-and 8-year-old children and a comparison with the 'reference child'. International Journal of Obesity. 23, 1276-1281. https://doi.org/10.1038/sj.ijo.0801067
PMid:10643684

Sen, J., & Mondal, N. (2013). Fat mass and fat-free mass as indicators of body composition among Bengalee Muslim children. Annals of Human Biology, 40(3), 286-293. https://doi.org/10.3109/03014460.2013.764014
PMid:23398370

Soininen, S., Sidoroff, V., Lindi, V., Mahonen, A., Kröger, L., Kröger, H., Jääskeläinen, J., Atalay, M., Laaksonen, D.E., Laitinen, T. i sar. (2018). Body fat mass, lean body mass and associated biomarkers as determinants of bone mineral density in children 6-8 years of age-The Physical Activity and Nutrition in Children (PANIC) study. Bone. 108, 106-114. https://doi.org/10.1016/j.bone.2018.01.003
PMid:29307776

Taylor, R.W., Gold, E., Manning, P., & Goulding, A. (1997). Gender differences in body fat content are present well before puberty. International Journal of Obesity. 21, 1082-1084. https://doi.org/10.1038/sj.ijo.0800522
PMid:9368835

United Nations Department of Economic and Social Affairs, Population Division (2015). World Urbanization Prospects: the 2014 Revision.https://esa.un.org/unpd/wup/publications/files/wup2014-report.pdf (United Nations). Accessed 22 sep 2019

van Vliet-Ostaptchouk, J.V., Nuotio, M.L., Slagter, S.N., Doiron, D., Fischer, K., Foco, L., Joensuu, A. (2014). The prevalence of metabolic syndrome and metabolically healthy obesity in Europe - a collaborative analysis of ten large cohort studies. BMC Endocrine Disorders.14(1):9. https://doi.org/10.1186/1472-6823-14-9
PMid:24484869 PMCid:PMC3923238

Wells, J.C.K., Cole, T.J. & ALSPAC study team (2002). Adjustment of fat-free mass and fat mass for height in children aged 8 years. International Journal of Obesity. (26)947-952. https://doi.org/10.1038/sj.ijo.0802027

Vučković, I., Ljubojević, A., Vukić, Ž., & Pašić, G. (2019). Age and sex related differences in anthropometric characteristics and body composition in primary school-age children. *Sportlogia 15*(1), 60-72. doi: 10.5550/sgia.191501.en.vlvp

WHO (2016). Global Report on Urban Health: Equitable Healthier Cities for Sustainable Development. Report No. 9241565276. https://apps.who.int/iris/handle/10665/204715 (World Health Organization). Accessed 01 okt 2019

WHO (2000). Obesity: preventing and managing the global epidemic. Report of a WHO Consultation (WHO Technical Report Series 894). https://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/. Accessed 06 okt 2019

World Health Organization (2015) .Waist circumference and waist-hip ratio:report of a WHO expert consultation.Geneva: WHO. http://apps.who.int/iris/bitstream/10665/44583/1/9789241501491_eng.pdf.

Wijnhoven, T.M., van Raaij, J.M., Spinelli, A., Starc, G., Hassapidou, M., i sar. (2014). WHO European Childhood Obesity Surveillance Initiative: body mass index and level of overweight among 6-9-year-old children from school year 2007/2008 to school year 2009/2010. BMC Public Health;14:806. https://doi.org/10.1186/1471-2458-14-806 PMid:25099430 PMCid:PMC4289284

Yusuf, S., Reddy, S., Ôunpuu, S. & Anand, S. (2001). Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. Circulation. 104, 2746-2753. https://doi.org/10.1161/hc4601.099487 PMid:11723030

Zhang, H.L., Fu, Q., Li, W.H., Liu, S.W., Zhong, H., Duoji, B.M., i sar. (2015). Gender differences and age-related changes in body fat mass in Tibetan children and teenagers: an analysis by the bioelectrical impedance method. Journal of Pediatric Endocrinology and Metabolism. 28(1-2)87-92. https://doi.org/10.1515/jpem-2013-0503

SAŽETAK

Ova studija se bavila procjenom antropometrijskih karakteristika i tjelesne kompozicije osnovnoškolske djece. Cilj istraživanja bio je da se utvrde starosne i polne razlike kod djece starosti 7 i 8 godina, što bi poslužilo procjeni zdravstvenog statusa djece i praćenja trenda njihovog rasta i razvoja. Studija je obuhvatila 1520 učenika (814 učenika drugih razreda i 706 učenika trećih razreda; 772 dječaka i 748 djevojčica). Ispitanicima su izmjereni tjelesna visina i težina, indeks tjelesne mase, procenat tjelesne masti, masa masnoće i masa bez masnoće. Rezultati su pokazali da postoje značajne razlike između dječaka i djevojčica u tjelesnoj visini i težini, procentu masnoće, indeksu tjelesne mase i masi bez masnoće (p<.05), dok razlike nije bilo u masi masnoće. Sem u procentu masnoće, postoje značajne razlike između sedmogodišnje i osmogodišnje djece u svim ostalim mjerenim varijablama. Vrijednosti antropometrijskih karakteristika i tjelesne kompozicije djece koje su dobijene mjerenjem i razlike među djecom u skladu su sa svjetskim trendovima. Za razlike između polova i generacija djece koje su utvrđene vjerovatno su zaslužne genetske predispozicije, ali i uslovi u kojima odrastaju.

Ključne riječi: *zdravstveni status djece, masnoće kod djece*

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