URBAN-RURAL DIFFERENCES IN INDICATORS OF NUTRITIONAL STATUS AND BODY COMPOSITION FOR TEN YEAR OLD CHILDREN

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Abstract
The aim of this study was to determine the nutritional status and body composition as well as the persistence of differences in certain nutritional status indicators with respect to place of residence (urban-rural differences). On the sample of 402 ten year olds (206 students from urban schools and 196 students from rural schools), 7 morphological measures were measured in order to calculate nutritional status and body composition indicators. The results of Man Whitney U test have shown that students from urban areas have significantly higher sum of skin folds (38,25 vs. 35,85; p<0,03), WHR (0,83 vs. 0,82; p<0,01), S/T ratio (80,66 vs. 0,62; p<0,01) and body fat percentage (22,14 vs. 20,90; p<0,01) while students from rural areas have significantly higher hip circumference (78,00 vs. 75,00;p<0,00). The results indicate the existence of differences in the distribution and % of body fat. Participants from urban areas have more central distribution and higher proportion of body fat in total body mass.

Key words: *body fat distribution, body composition, nutritional status, urban-rural difference.*

Introduction

The number of obese people of all age groups is growing bigger each day and this is the reason why overweight and obesity, due to epidemic proportions of this phenomenon and its consequences, represent a global public health problem (Dabo et al., 2009). The growing trend of childhood obesity, which has increased dramatically over the last few decades, especially in developed countries, is particularly concerning (Katzmarzyk et al., 2008). Higher nutritional status in childhood may cause multiple repercussions on human body and health, such as higher incidence of elevated blood pressure and elevated cholesterol as a risk factor for the development of cardiovascular diseases (Freedman et al., 2007), increased risk for impaired glucose tolerance, insulin resistance and type 2 diabetes (Whitlock et al. 2005), breathing disorders such as sleep apnea or asthma (Sutherland, 2008; Han, Lawlor, & Kimm, 2010) and many other. By regular monitoring of nutritional status we get insight into current health condition of an individual. In clinical and epidemiological approach nutritional status is most commonly evaluated by using BMI, however, seeing that BMI is unable to define body fat percentage in relation to body or bone mass, it is advisable to monitor different anthropometric parameters and indices in order to obtain better insight into body composition and body fat distribution as an additional evaluation of obesity. In the case of children it is common to have high variability of body fat in relation to BMI (Wells et al., 2006). Therefore, skinfold thickness is considered to be a better prognostic indicator to determine the quantity of adipose tissue than BMI and it can improve the assessment of obesity in childhood (Bedogni et al., 2003; Freedman et al., 2007).

The quantity of adipose tissue in early childhood may oscillate. The average quantity of adipose tissue in newborn is around 10.8% (Collin et al., 2011). During the first year of infant's life the quantity of adipose tissue grows progressively, while at the end of the first year it makes up about 28.0 % of the body mass (WHO, 2009). During early childhood and preadolescence up until the onset of puberty there is a slow decline in quantity of adipose tissue. The differences between anthropometric parameters in children regarding to place of residence are diminishing every year. Both urban and rural children show negative trend in BMI increase, but also in both groups it is evident an increased number of children in the zone risk of obesity, as shown by the results of numerous studies (Petrić, 2009; Tomac, Šumanović, & Prskalo, 2012). The conclusion arising from the longitudinal study by Aberle et al. (2009) was that the differences between anthropometric parameters of urban and rural children have disappeared in the course of 20 years. This can be attributed to changes in lifestyle in rural areas. Namely, in rural areas children used to spend more time playing outside, in natural environment, while today, just like urban children, they spend most of their time in front of TV and computer screens. Numerous epidemiological studies show that there are significant regional changes in nutritional status. In some countries studies have shown that BMI increase is a nutritional status indicator in rural areas (Finland- Fogelholm et al., 2006; China- McCarthy et al., 2015) but they have also shown the increase in central distribution of body fat (Cesani et al., 2013). Beside physical inactivity, many authors point to imbalanced diet as one of the reasons for disappearing of urban-rural

differences in nutritional status. The aim of this study is to determine nutritional status and body composition of ten year old male and female students as well as the persistence of differences in certain nutritional status indicators with respect to place of residence (urban-rural differences).

Methods

Sample and variables

The study was conducted on a sample of 402 fourth-graders aged 10 (± 6 months): 206 students from urban schools (111 female and 95 male students) and 196 students from rural schools (97 female and 99 male students). The study was conducted in four urban schools in Zadar city area and in ten rural schools of Zadar County (the differentiation of urban and rural places was made according to the criteria compiled by the Croatian bureau of statistics in 2011). We obtained valid parents/guardian consent forms for every student participating in the study. The study was conducted in accordance with the Ethical code for the research on children compiled by the Council for Children' Affairs, advisory body of the Government of the Republic of Croatia, and with the approval obtained from the Committee for Scientific Research and Ethics of the Faculty of Kinesiology, University of Zagreb. A group of morphologic variables was formed out of seven morphologic measures. Body height, body weight, waist circumference and hip circumference, triceps skinfold, subscapular skinfold and lower leg skinfold were measured. Based on these morphologic measures we calculated the following: body mass index (BMI), waist/hip circumference ratio (WHR), subscapular/triceps skinfold ratio (S/T ratio) and the percentage of body fat using Slaughter equations (Slaughter et al., 1988) (according to Mišigoj-Duraković et al., 2008).

Data analysis

The results were processed using statistical software Statistic 7.0. Descriptive parameters were calculated for all quantitative variables: arithmetic mean (AM), standard deviation (SD), minimum (MIN) and maximum (MAX). The normality of the distribution was tested by using Kolmogorov-Smirnov test. As all the variables deviated significantly from normal distribution, for the purpose of elaborating set aims and hypotheses non-parametric methods were applied for further analysis. In order to determine statistically significant differences in certain indicators of nutritional status and body composition with respect to the place of residence, Man-Whitney U test was applied. Median and quartile range were calculated for this purpose, as well as z-scores and the level of significance (p).

Results

Table 1 shows the results of descriptive parameters of nutritional status and body composition indicators calculated on the subsamples divided according to gender and place of residence.

Table 1: Descriptive parameters of nutritional status and body composition indicators of children from urban and rural areas according to gender

	Female			Male	
	Urban n=111	Rural n=97		Urban n=95	Rural n=99
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD
Body height (cm)	1.47±0.07	1.47±0.07		1.48±0.07	1.48±0.06
Body weight (kg)	39.48±7.93	38.96±9.06		40.75±8.66	42.38±9.16
Waist circumference (cm)	63.38±7.56	62.46±8.01		65.26± 8.25	67.25±9.10
Hip circumference (cm)	76.80±7.45	77.57±8.11		76.20±7.04	79.72±8.66
Skinfold Sum (mm)	44.94±17.85	39.22±16.04		42.10±18.50	40.34±17.95
BMI (kg/m²)	18.10±3.02	17.85±3.40		18.59±3.17	19.16±3.54
WHR	0.83±0.06	0.80±0.05		0.86±0.05	0.84±0.07
S/T ratio	0.69±0.18	0.69±0.21		0.71±0.21	0.64±0.24
% body fat	24.09±7.79	21.19±7.76		24.46±11.07	22.65±9.57

Female students from urban areas have slightly higher average values of waist circumference (63.38±7.56 vs. 62.46±8.01), skinfold sums (44.94±17.85 vs. 39.22±16.04), BMI (18.10±3.02 vs. 17.85±3.40), WHR (0.83±0.06 vs. 0.80±0.05), body fat percentage (24.09±7.79 vs. 21.19±7.76), while female students from rural areas have on average slightly larger hip circumference (77.57±8.11 vs. 76.80±7.45).

Male students from urban areas have slightly higher values of skinfold sums (42.10±18.50 vs. 40.34±17.95), WHR (0.86±0.05 vs. 0.84±0.07), S/T ratio (0.71±0.21 vs. 0.64±0.24) and body fat percentage (24.46±11.07 vs. 22.65±9.57), while male students from rural areas show higher values of body mass (42.38±9.16 vs. 40.75±8.66), waist circumference (67.25±9.10 vs. 65.26± 8.25), hip circumference (79.72±8.66 vs. 76.20±7.04) and BMI (19.16±3.54 vs. 18.59±3.17).

In order to determine the significance of differences between subsamples divided according to place of residence, Man Whitney U test was applied. The test has shown no significant differences in original morphological variables (body height, body mass and waist circumference) and no significant differences in BMI. Among other variables, significant differences were obtained in hip circumference ($z=-2.86$; $p=0.00$), skinfold sum ($z=2.18$; $p<0.03$), WHR ($z=3.12$; $p=0.00$), S/T ratio ($z=2.44$; $p<0.01$) and body fat percentage ($z=2.51$; $p<0.01$) (Table 2), therefore primarily variables which estimate body fat distribution. From the observation of the persistence of differences with respect to place of residence it is evident that male students significantly differ in hip circumference ($z=-3.36$; $p=0.00$) and in S/T ratio ($z=2.89$; $P=0.00$).

Table 2: Differences with respect to place of residence (urban-rural differences) obtained by using Man-Whitney U test:

Total	Urban (n=206)	Rural (n=196)		
	MED (QR)	MED (QR)	Z	p-level
Body height (cm)	1.47 (0.09)	1.48 (0.08)	-0.71	0.47
Body weight (kg)	38.15 (10.70)	38.90 (10.80)	-0.67	0.50
Waist circumference (cm)	62.00 (10.00)	63.00 (9.25)	-0.49	0.62
Hip circumference (cm)	75.00 (10.50)	78.00 (10.00)	-2.86	0.00*
Skinfold Sum (mm)	38.25 (24.70)	35.85 (23.00)	2.18	0.03*
BMI (kg/m²)	17.55 (4.41)	17.63 (4.23)	-0.12	0.90
WHR	0.83 (0.07)	0.82 (0.06)	3.12	0.00*
S/T ratio	0.66 (0.30)	0.62 (0.31)	2.44	0.01*
% body fat	22.14 (12.35)	20.90 (12.08)	2.51	0.01*
Boys				
Body height (cm)	1.47 (0,09)	1.48 (0.07)	-0.75	0.45
Body weight (kg)	38.00 (12,60)	39.70 (12.70)	-1.47	0.14
Waist circumference (cm)	63.00 (10,00)	64.00 (10.00)	-1.68	0.09
Hip circumference (cm)	75.00 (10,50)	80.00 (10.00)	-3.36	0.00*
Skinfold Sum (mm)	37.00 (23,70)	36.40 (25.30)	0.61	0.54
BMI (kg/m²)	17.80 (4,50)	18.27 (4.65)	4.65	0.31
WHR	0.84 (0,06)	0.83 (0.07)	25.30	0.05
S/T ratio	0.67 (0,35)	0.57 (0.29)	2.89	0.00*
% body fat	21.56 (12,95)	21.65 (15.63)	0.85	0.39
Girls				
Body height (cm)	1.46 (0.09)	1.47 (0.09)	-0.14	0.89
Body weight (kg)	38.30 (9.90)	38.00 (9.00)	0.73	0.47
Waist circumference (cm)	61.00 (10.00)	60.50 (8.00)	1.07	0.28
Hip circumference (cm)	76.00 (10.50)	77.00 (10.00)	-0.61	0.54
Skinfold Sum (mm)	41.60 (24.00)	35.30 (18.10)	2.47	0.01*
BMI (kg/m²)	17.43 (4.23)	16.98 (3.54)	1.02	0.31
WHR	0.82 (0.08)	0.81 (0.06)	2.64	0.01*
S/T ratio	0.66 (0.24)	0.67 (0.33)	0.45	0.65
% body fat	23.09 (11.28)	19.14 (9.41)	2.73	0.01*

MED- QR- median-quartile range; Z-z score; p-statistical significance

Male students from urban areas have significantly higher values of S/T ratio, which points to specific accumulation of adipose tissue in abdominal area and to central body fat distribution. In future this may become one of the risk factors for developing various health conditions.

Additionally, male students from rural areas have significantly higher hip circumference, which points to excessive accumulation of body fat in hip area. By observing female students significant differences were obtained as well, namely in body fat distribution and body fat percentage in total body mass. Female students from urban areas have significantly higher skinfold sum ($z=2.47$; $p<0.01$), WHR ($z=2.64$; $p<0.01$) and body fat percentage ($z=2.73$; $p<0.01$). From median and quartile range values it can be observed that female students from urban area have more central distribution of body fat and higher percentage of body fat in total body mass, although they do not differ in body mass index as nutritional status indicator.

Discussion

Arithmetic means of anthropometric variables (body height and body mass) correspond to reference values with respect to age and gender (Jureša, Musil, & Kujundžić Tiljak, 2012). The average body mass index (ITM) measured on the overall sample is 18.42 ± 3.31 and it falls within criteria for normal body mass (according to Cole et al., 2000), while there are no visible differences on subsamples divided according to place of residence.

The results of this study have shown significant differences in body mass percentage and distribution with respect to place of residence of the participants. Girls from urban area have significantly higher WHR, which points to more central distribution of body mass. By comparing obtained values with reference values of Fredriks et al. (2005), which were obtained on the population of German children, it can be concluded that female participants are on the borderline for developing the risk type of obesity. High values of WHR, as in the case of this study, point to the type of obesity with predominant fat accumulation in upper segment of the body, namely in trunk.

Numerous studies link fat accumulation in upper segment of the body with the risk for developing a whole range of diseases in adult age, such as coronary diseases, hypertension, diabetes etc. (Kissebah, 1996). Research on obese children with predominant abdominal fat accumulation did not show the risk for developing the above mentioned diseases in childhood (Iwatta et al., 1995; Goran & Gower, 1999). However, it was established that abdominal obesity in childhood can be linked to abdominal obesity and its health risks in adult age (Gillum, 1999; Daniels et al., 1999). By comparing the WHR values obtained through this study with the values from other studies it can be observed that the measured sample in this study has lower WHR from measured samples of some previous studies (Mushtag et al., 2011; Pruenglampoo, Taejaroenkul, & Sirisanthana, 2012). The average value of the total sample S/T ratio, often used to estimate the type of body fat distribution, is 0,68, which is slightly lower value in comparison with the results of some previous studies (Daniels, Khoury, & Morrison, 2000; Moreno et al., 2007).

Numerous studies have registered a secular increase in waist circumference in children (McCarthy et al., 2003; Dollman & Olds, 2006), which can be a prognostic indicator of cardiovascular risk. An increase in waist circumference is linked to increased adipose tissue in comparison with lean body mass, which is a prominent additional risk factor for developing chronic illnesses in future (Machado et al., 2016). Significant differences in body fat percentage were also obtained. Female students from urban areas have significantly higher values of body fat percentage than female students from rural areas. By comparing the average body fat percentage of female students from urban areas, which is 24.09 %, with percentile values of body fat percentage for children and youth (aged 3 to 18) according to McCarthy et al. (2006); Schwandt et al. (2012), it can be concluded that female students from urban areas are on the borderline for overweight body fat percentage category for the measured age group.

Numerous studies have shown the persistence of gender differences in body composition that are visible even before the onset of puberty (Taylor et al., 1997; Garnett et al., 2004) and girls usually have more total body fat and higher percentage of adiposity with lower lean body mass (Kirchengast & Marosi, 2008), which contradicts the results of the present study. The scientific contribution of this study lies in information gathered for this purpose which increases the fund of knowledge on nutritional status, body composition and body fat distribution of ten year olds who are at the threshold of entering the adolescence and who are about to experience a series of morphological changes. We examined the existence of differences with respect to place of residence, which gave us new insight into differences in nutritional status, body composition and body fat distribution of children from urban and rural areas. The disadvantage of this study is certainly a lack of information on dietary habits of participants, their level of physical activity, lifestyle and socio-economic status since all the aforementioned factors can have a great impact on nutritional status in this age group and gathering information on these factors would surely contribute to better understanding of changes in nutritional status and body composition.

Conclusion

On a sample of 402 ten year olds from urban and rural areas in Zadar county significant differences were measured for some nutritional status and body composition indicators. Students from urban areas have significantly higher skinfold sum, waist/hip circumference ratio, S/T ratio and body fat percentage while students from rural areas have significantly higher hip circumference. The results obtained from this study lead to the conclusion that the measured sample shows significant differences in body fat distribution and body fat percentage. Students from urban areas have more central body fat distribution; for them is specific accumulation of fat in the abdominal area, while students from rural areas show body fat accumulation predominantly in the hip area.

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URBANO-RURALNE RAZLIKE U POKAZATELJIMA NUTRITIVNOG STATUSA I SASTAV TIJELA KOD DESETOGODIŠNJE DJECE

Sažetak

Cilj ovog istraživanja bio je odrediti nutritivni status i sastav tijela, kao i postojanost razlika u određenim pokazateljima prehrambenog stanja obzirom na mjesto stanovanja (urbano-ruralne razlike). Na uzorku od 402 desetogodišnjaka (206 učenika iz urbanih škola i 196 učenika ruralnih škola) izmjereno je sedam morfoloških mjera kako bi se izračunali pokazatelji prehrambenog stanja i sastav tijela. Rezultati Man Whitney U testa pokazali su da učenici iz urbanih područja imaju znatno veću količinu duplikature kože (38,25 prema 35,85, p <0,03), WHR (0,83 prema 0,82; <0,01), S/T odnos (80,66 u odnosu na 0,62, p <0,01) i postotak tjelesne masti (22,14 prema 20,90, p <0,01) dok učenici iz ruralnih.pPodručja imaju znatno veći opseg kukova (78,00 prema 75,00, p <0,00). Rezultati ukazuju na postojanje razlika u distribuciji i % tjelesne masti. Sudionici iz urbanih sredina imaju više središnje raspodjele i veći udio tjelesne masti u ukupnoj tjelesnoj masi.

Ključne riječi*: distribucija tjelesne masti, sastav tijela, nutritivni status, urbano-ruralne razlike.*

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