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Original Scientific Paper

REGIONAL AND SOCIODEMOGRAPHIC DETERMINANTS OF THE PREVALENCE OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 7-9 YEARS IN CROATIA

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SUMMARY – The aim of this study was to determine the prevalence and analyze the determinants of overweight and obesity among Croatian schoolchildren aged 7-9 years in relation to sociodemographic factors. This study used data that were gathered as part of the WHO Europe Childhood Obesity Surveillance Initiative in 2015/2016. The sample for the study was nationally representative. Anthropometric measurements of 5591 children, 2811 boys and 2780 girls, were collected during 8 weeks using standardized equipment. Studied variables included child's anthropometric measurements and demographics, maternal education and employment status. The results showed a 35.9% prevalence of overweight and obesity in Croatian 7-9-year-old children. Overweight and obesity were more frequent in boys in comparison to girls, especially among boys from the Adriatic region (42.1%). The risk of overweight and obesity was increased in boys living in the Adriatic region (ORadj=1.33; 95% CI 1.03-1.71) and in girls with high-school educated mothers (ORadj=1.36; 95% CI 1.11-1.66). Girls with unemployed mothers had a lower risk of overweight and obesity (ORadj=0.73; 95% CI 0.58-0.92). The observed prevalence of childhood overweight and obesity warrants national and local time-bound targets for reduction of childhood obesity, accompanied by detailed action plans and monitoring mechanisms.

Key words: *Prevalence; Overweight; Obesity; Children; Croatia*

Introduction

Childhood overweight and obesity represents a serious challenge as a global public health problem. Children with overweight or obesity are more probable to stay obese later in life, and they are at a greater risk of developing noncommunicable diseases[1]. According to the World Health Organization (WHO), in 2016, globally there were over 340 million overweight or obese children aged 5-19[2]. Data from the World Health Organization Regional Office for Europe (WHO/Europe), Childhood Obesity Surveillance Initiative (COSI) showed that the prevalence of overweight or obesity in children aged 6-9 years in 2015-2017 in Europe varied from 18% in Denmark to 43% in Cyprus for boys and from 16% in Albania to 43% in Cyprus for girls[3].

Childhood obesity is greatly influenced by sociodemographic factors. In Europe, a north-south gradient is observed with a higher prevalence of childhood overweight and obesity in southern Europe[4,5]. Studies

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on formal parental education and urbanization seem to have converse findings, which appears to be linked to the level of country development[6,7]. Specifically, maternal education was negatively associated with childhood obesity in several studies showing that overweight and obesity risk was greater among children whose mothers had lower education[8].

In order to better understand the magnitude of this problem, it is crucial to have a well-developed system for childhood obesity surveillance, tracking and prevention[9]. In 2006, WHO/Europe and 13 Member States introduced the COSI survey, targeting children aged 6-9 years[10]. Croatia joined this surveillance initiative in the fourth round in 2015/2016.

The aim of this study was to identify the prevalence of overweight and obesity among Croatian schoolchildren aged 7.0-9.9 years in relation to sociodemographic factors such as age, sex, geographical region of living, level of urbanization, maternal formal education level and employment status.

Methods

Material

In order to organize standard measurements of body weight and height in schoolchildren in Europe, WHO/Europe has established a coordinated surveillance system, COSI. The goal of COSI is to collect Europe-wide comparable data regarding anthropometric measurement of children including body height, weight and waist and hip circumference in order to record and monitor nutritional status in children aged 6.0-9.9 years. This research was planned as semi-longitudinal with repetitions at certain periods in time[10]. The research was implemented in accordance with the COSI Protocol[11].

Methods

Sampling was conducted at the national level. A cluster sample design with elementary school classes as sampling units was used. The sampling frame consisted of 32626 students from 1707 second-grade classes of 878 elementary schools. A simple random sample of second-grade classes was taken using the STATISTICA program. As a result, 182 second-grade classes were included in this research. Third-grade classes were chosen to match second-grade classes from the same schools. Out of 7150 students from 164 chosen schools, a total of 5662 children aged 6 to 11 years took part in the measurement, with a response rate 79.2%. Children who were not measured did not have parental consent, were absent from school or actively declined to undergo measurement. This paper uses data only on children aged 7.0 to 9.9 years (N=5591).

Data were collected during fieldwork, which lasted from October to December 2015. Children were measured by two-member teams trained in taking standardized measurements according to the protocol[11]. In total, 26 examiners worked on data collection. Children's body weight and height were measured using 22 sets of weight scales (SECA 877, SECA, Hamburg, Germany) and stadiometers (SECA 217, SECA, Hamburg, Germany). Scales were calibrated by the manufacturer. Weight was measured in kilograms and recorded to the nearest 0.1 kg. Height was measured in centimeters and the reading taken to the last completed 0.1 cm. For accuracy, the height was measured twice and the mean value of two measurements was used for analysis. Additional data on sociodemographic characteristics of the children were obtained from a family form the parents were asked to fill in. The original data-collection forms, created by the WHO, were used and translated into Croatian.

Ethics

The research was conducted in accordance with the ethical principles of autonomy, beneficence and non-maleficence, and in accordance with the WHO COSI Protocol[11]. The Ethics Committee of the Croatian Institute of Public Health approved this research in July 2015 (no: 602-01/15-01/0242). A consent form had to be signed by the child's parents or custodians in order to obtain the child's anthropometric measures. However, right before the measurement, the child was asked once again for the active consent to participate in the study.

Variables

Data on children's demographics included child's sex, age, geographical region and level of urbanization. Children's age ranged from 7.0 to 9.9 (mean 8.62) years. Geographical regions were selected according to the NUTS 2 criteria[12]. Additionally, based on a study previously conducted in Croatia[13], the City of Zagreb

Table 1. Selected characteristics

Variable	
Age (years; mean±SD)	8.62±0.6
Height (cm; mean±SD)	135.5±6.8
Weight (kg; mean±SD)	32.6±7.7
Body mass index (kg/m^2; mean±SD)	17.6±3.1
Sex: n (%)	
Girls	2780 (49.7)
Boys	2811 (50.3)
Age group (years): n (%)	
7.0-7.9	960 (17.2)
8.0-8.9	2733 (48.9)
9.0-9.9	1898 (33.9)
Geographical region of living*: n (%)	
Continental	2773 (49.6)
Adriatic	1784 (31.9)
City of Zagreb	1034 (18.5)
Level of urbanization: n (%)	
Urban	3202 (57.3)
Semi-urban	1691 (30.2)
Rural	695 (12.4)
Missing	3 (0.1)
Maternal educational level: n (%)	
Elementary school	328 (5.9)
High school	2790 (49.9)
College degree or higher	1505 (26.9)
Missing	968 (17.3)
Maternal employment status: n (%)	
Unemployed†	1092 (19.5)
Employed	3503 (62.7)
Missing	996 (17.8)

SD = standard deviation; all results were obtained through weighted analysis; *geographical regions based on NUTS 2 classification, classified as continental and Adriatic region. The City of Zagreb was excluded from the continental region and considered as a separate region because of cultural and traditional differences; †the category 'unemployed' includes persons that were unemployed, homemakers, students, retirees and unemployed people unable to work.

was observed as a separate region because as a capital it is also a melting pot in Croatia and is expected to incorporate features of both the continental and Adriatic regions. Level of urbanization of the child's place of living was determined in accordance with the Croatian Bureau of Statistics[14], and was described as urban, semi-urban and rural.

Body mass index (BMI) was calculated as weight in kilograms divided by height in square meters. In this study, overweight and obesity were defined by and presented using the set of cut-off points published by the WHO[15]. Socioeconomic status of the family was analyzed *via* two variables from the family form, i.e. completed level of maternal formal education and maternal employment status. The family form was filled in by the mother of the child in most cases (83.3%). Only those cases in which the mother was the one giving information on herself were included in the analysis.

Statistical analysis

All statistical analyses were performed using the SPSS Statistics 21.0 statistical package (IBM Corporation, Chicago, IL, USA). The level of significance was set at $p<0.05$. Weights to adjust for the sampling design, oversampling and non-response were calculated and used to infer the results from the sample to the population.

First, prevalence rates and descriptive statistics for investigated variables were calculated. Differences in the prevalence of overweight and obesity between the groups based on sex and geographical region were tested with Pearson $\chi 2$.

Adjusted odds ratios (ORs) of being overweight or obese were estimated by carrying out a binary logistic regression analysis: a logistic model including the above-mentioned variables as covariates was estimated for boys and girls separately and for all children together.

Results

The study sample consisted of 5591 children aged 7.0 to 9.9 years, 2811 boys and 2780 girls (Table 1). Data on children's nutritional status according to the WHO criteria are presented in Table 2. These data show that there was 1% of thin children. More than one-third of children (35.9%) were overweight or obese. There was a significant difference in nutritional status between boys and girls ($\chi^2=74.236$, $p<0.001$). Obesity, including severe obesity, was more prevalent among boys in comparison to girls (18.4% *vs*. 10.8%); the more so, 5.3% of boys could be classified as severely obese.

When looking at different geographical regions (Table 3), there was a statistically significant difference

Table 2. Nutritional status of children according to WHO criteria

WHO criteria	Thinness	Recommended weight	Overweight	Obesity	Severe obesity
	%	%	%	%	%
Boys	0.6	60.0	21.1	13.1	5.3
Girls	1.3	66.4	21.5	9.2	1.6
Total	1.0	63.1	21.3	11.1	3.5

Prevalence estimates were based on 2007 WHO recommended criteria[15].

Table 3. Prevalence of overweight and obesity in 3 geographical regions of Croatia

Adriatic region	Overweight (%)	Obesity (%)
Boys	23.2	18.9
Girls	22.7	9.4
Total	22.9	14.1
	χ^2=18.296*, p<0.001	
Continental region	Overweight (%)	Obesity (%)
Boys	19.9	20.1
Girls	20.3	13.1
Total	20.1	16.6
	χ^2=11.853*, p=0.001	
City of Zagreb	Overweight (%)	Obesity (%)
Boys	20.6	14.1
Girls	22.4	7.3
Total	21.5	10.8
	χ^2=2.454*, p=0.117	

*Continuity correction for 2x2 table.

in the prevalence of overweight and obesity (χ^2=7.313, p=0.026). The highest prevalence of overweight and obesity was found in the Adriatic region (37%), followed by the continental region (36.7%), and the lowest prevalence was observed in the City of Zagreb (32.3%). In the Adriatic region, boys had a significantly higher prevalence of overweight and obesity than girls (42.1% *vs.* 32.1%). The same could be observed in the continental region, where 40% of boys and 33.4% of girls were overweight or obese. In the City of Zagreb, there was no statistically significant difference in the prevalence of overweight and obesity between boys and girls.

The predictive value of geographical region, level of urbanization, maternal education level and maternal employment status was tested using binomial logistic regression and the results are shown in Table 4. When adjusted for other investigated variables, geographical region, maternal education level and maternal employment status were significant predictors of childhood overweight and obesity. Children living outside the City of Zagreb had a greater chance of overweight and obesity (OR=1.21; 95% CI 1.00-1.45) than children living in Zagreb. Children of high school educated mothers had a greater chance for overweight and obesity (OR=1.24; 95% CI 1.08-1.42) than those of mothers with higher education level. In addition, children of unemployed mothers had a 20% lower chance for overweight and obesity (OR=0.80; 95% CI 0.69-0.93) than those with employed mothers. When stratified by sex, living in the Adriatic region was the only statistically significant predictor for overweight and obesity in boys after adjusting for confounders. Boys from the Adriatic region had a greater chance for being overweight and obese (OR=1.33; 95% CI 1.03-1.71) than boys from Zagreb. Statistically significant predictors of overweight and obesity for girls, after adjusting for confounders, were maternal education level and maternal employment status. Girls with high school educated mothers had higher odds for being overweight or obese (OR=1.36; 95% CI 1.11-1.66) than girls with college or higher educated mothers. In addition, girls with unemployed mothers had lower odds for being overweight or obese (OR=0.73; 95% CI 0.58-0.92) than girls with employed mothers. After adjustment, urbanization itself was not a statistically significant predictor of overweight and obesity in children.

Discussion

Our study, aiming to determine the prevalence of overweight and obesity in 7-9-year-old children showed an overall high prevalence of overweight and obesity in Croatian children, positioning Croatia among the Mediterranean countries like Malta, Cy-

Table 4. Association of geographical region, level of urbanization and maternal socioeconomic status with overweight and obesity among 7-9-year-old Croatian children†*

	Boys		Girls		Total	
	OR (95% CI)	OR_{adj} (95% CI)	OR (95% CI)	OR_{adj} (95% CI)	OR (95% CI)	OR_{adj} (95% CI)
Geographical region‡§						
City of Zagreb	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Continental	1.25 (1.02-1.54) **p=0.033**	1.21 (0.94-1.55) p=0.129	1.18 (0.95-1.48) p=0.138	1.19 (0.91-1.56) p=0.202	1.21 (1.04-1.41) **p=0.012**	1.21 (1.00 – 1.45) **p=0.044**
Adriatic	1.37 (1.10-1.71) **p=0.006**	1.33 (1.03-1.71) **p=0.028**	1.11 (0.88-1.41) p=0.375	1.08 (0.82-1.42) p=0.583	1.23 (1.05-1.45) **p=0.012**	1.21 (1.00 – 1.46) **p=0.045**
Level of urbanizationII						
Rural	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Urban	1.00 (0.79-1.27) p=0.993	1.01 (0.76-1.34) p=0.935	0.76 (0.59-0.97) **p=0.028**	0.79 (0.60-1.06) p=0.116	0.88 (0.74-1.04) p=0.127	0.89 (0.73-1.09) p=0.259
Semi-urban	1.19 (0.92-1.53) p=0.185	1.12 (0.84-1.49) p=0.434	0.78 (0.60-1.01) p=0.060	0.81 (0.61-1.09) p=0.163	0.96 (0.80-1.16) p=0.686	0.95 (0.77-1.16) p=0.616
Maternal education level¶						
College degree or higher	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
High school	1.13 (0.94-1.36) p=0.186	1.13 (0.93-1.37) p=0.202	1.32 (1.09-1.60) **p=0.004**	1.36 (1.11-1.66) **p=0.003**	1.22 (1.07-1.39) **p=0.004**	1.24 (1.08-1.42) **p=0.003**
Elementary school	0.84 (0.60-1.18) p=0.328	0.84 (0.58-1.23) p=0.383	1.01 (0.69-1.50) p=0.941	1.08 (0.71-1.66) p=0.710	0.93 (0.72-1.20) p=0.595	0.94 (0.71-1.25) p=0.685
Maternal employment status**						
Employed	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Unemployed††	0.86 (0.71-1.05) p=0.146	0.87 (0.70-1.07) p=0.195	0.80 (0.65-0.99) **p=0.037**	0.73 (0.58-0.92) **p=0.007**	0.84 (0.72-0.96) **p=0.014**	0.80 (0.69-0.93) **p=0.005**

CI = confidence interval; OR = odds ratio; OR_{adj} = adjusted odds ratio; *prevalence estimates were based on 2007 WHO recommended criteria[15]; †overweight and obese children were compared to all other children; ‡geographical regions based on NUTS 2 classification, classified as continental and Adriatic region. The City of Zagreb was excluded from the continental region and considered as a separate region because of cultural and traditional differences; §adjusted for age, (sex), level of urbanization, maternal education and maternal employment; IIadjusted for age, (sex), geographical region, maternal education and maternal employment; ¶adjusted for age, (sex), geographical region, level of urbanization and maternal employment; **adjusted for age, (sex), geographical region, level of urbanization and maternal education; ††the category 'unemployed' includes persons that are unemployed, homemakers, students, retirees and unemployed people unable to work.

prus and Greece that have the highest prevalence of childhood overweight and obesity in Europe[3]. The prevalence of childhood overweight and obesity in Europe varies greatly, but one of the most important recent findings is the very high prevalence in south European countries positioned in the Mediterranean region[3,4,16,17]. While at first, this finding seems unexpected because the traditional Mediterranean diet has long been lauded as one of the healthiest and most balanced ones, there are some explanations for this

phenomenon. Some authors explain that a big dietary change from the Mediterranean to the Western type of diet has occurred in this area[18], and it has been observed that children living in the Mediterranean are less physically active in comparison to children in other European regions[19]. The results of this study have confirmed that Croatia, like other Mediterranean countries, has a great public health challenge ahead and that coordinated regional action is required.

The results of this study showed that there were differences in the prevalence of overweight and obesity according to gender and geographical region. According to our findings, the problem of overweight and obesity was more frequent in boys in comparison to girls (39.5% and 32.3%, respectively). Especially concerning is the prevalence of severe obesity in boys, as the highest ends of obesity impose the highest risk for both immediate and long-term health[20-22]. The finding that Croatian boys had higher prevalence rates of overweight and obesity than girls, according to the WHO criteria, is in line with previous research conducted in European and non-European countries[16,17,23,24] and once again confirms that special attention should be paid to health promotion activities for boys.

When observing Croatia as a country composed of three distinct geographical regions, continental, Adriatic and the City of Zagreb, we found that the highest prevalence of overweight and obesity was in the Adriatic region and lowest in the City of Zagreb. In both the Adriatic and continental regions, boys were significantly more frequently overweight or obese than girls. Especially of note is the staggering result of overweight and obesity among boys in the Adriatic region, followed by boys in the continental region and the City of Zagreb. Even when placed in the context of the recently reported high prevalence rates in other Mediterranean countries, this is still an alarmingly high number, only surpassed by the prevalence in boys in Cyprus[3]. This finding might be explained by the fact that the Adriatic region is culturally very similar to other Mediterranean countries, especially in regards to dietary habits, implying that boys living in the coastal areas are becoming less likely to consume the Mediterranean diet[25-27]. What this finding also shows is that the north-south gradient of childhood obesity observed in Europe, where the south has a higher prevalence than the north[28], can also be observed at the level of a single country with diverse regions, such as Croatia.

Moreover, we explored the possible predictors of childhood overweight and obesity and identified geographical region, maternal education level and maternal employment status as statistically significant predictors. Children living outside the City of Zagreb, both in the continental and Adriatic regions, had higher odds for being overweight or obese than those living in Zagreb. This could be explained by the social gradient of childhood obesity, by which the occurrence of obesity is negatively associated with higher socioeconomic position[29-31]. It is therefore expected for the City of Zagreb, as the Croatian capital and the most inhabited city with the highest level of employment and highest proportion of residents with the highest levels of education[32,33] to have the smallest proportion of overweight and obese children. When we stratified them by sex, we observed that, specifically, boys living in the Adriatic region had higher odds for overweight and obesity than boys living in Zagreb, which once again confirms the previously discussed findings about the Mediterranean being a risk factor for childhood overweight and obesity, especially in boys.

Parental education seems to be of particular importance regarding childhood overweight and obesity[34]. Specifically, studies suggest that overweight and obesity is more common in children of less educated mothers[8,35]. Our study found that being a child of a mother with high school education bore significantly higher odds for overweight and obesity in comparison to being a child of a mother with a college degree or higher, yet being a child of an elementary school educated mother did not. This could be explained with the argument that high school educated mothers are usually in a position to be full-time employed, but have less paid jobs in comparison to mothers with higher educational degrees and therefore neither have the funds nor time to prepare nutritious meals, afford high quality childcare or ensure participation in free-time sports clubs for their children[36,37]. This is supported by the finding that children of employed mothers had a higher risk of overweight and obesity than children of unemployed mothers. Interestingly, when stratified by sex, these predictors remained significant only for girls. The traditional role of women in Croatian society implies that female household members take care of family nutrition. In line with this, it could be argued that

female children are expected to be more independent in relation to food intake, and could therefore receive less support from their time- and resource-constrained mothers than male children[38].

Finally, the level of urbanization of the child's residence was not found to be a significant predictor of overweight and obesity in this study. There are studies that confirm this finding, which also did not find any difference in obesity between urban and rural children, but these are not very frequent[39,40]. Other studies from Europe and North America show that living in rural areas brings higher odds for being obese in comparison to living in urban areas[41,42]. However, this finding needs to be more thoroughly examined in the future, as our study had a rather small share of rural children due to the fact that it included only children from schools that are mostly located in urban or semi-urban areas, and not children from peripheral schools.

This study had several limitations. First, the sample was nationally, but not regionally representative. However, the large size of the sample gives us authority to make inferences based on acquired results. In addition, weights were calculated to post-stratify the sample by the 3 geographical regions. Second, in order to get a clearer picture of the origins of childhood obesity, it would be beneficial to have information on the parental weight status. Previous studies suggest that a child's weight status is positively associated with the weight status of parents[43]. Third, the response rate was 79.2%, suggesting there might be a non-response bias at play. Yet, it is important to state that the response rate was similar to those from other European countries participating in this study and is, unfortunately, expected in a national study using anthropometric measurements[28]. Fourth, we used BMI to assess the nutritional status of children, which is not the most accurate method of assessing body structure (muscle, bones, fat). Some of the differences in overweight and obesity prevalence observed in this study may therefore be the result of differing body structures.

In conclusion, the results of this study, using COSI methodology for the first time in Croatia, show that Croatia has one of the highest prevalence of childhood overweight and obesity among European countries and that this problem is more frequent among boys. Especially concerning is the high rate of overweight and obesity in boys living in the Adriatic region and the increased risk in girls with high-school educated and employed mothers. This information warrants urgent implementation of specifically directed health promotion measures. In addition, the results of this study show that it is essential to implement continuous, standardized surveillance of childhood obesity, such as the COSI study. Considering the very high prevalence established in this study, it is of utmost importance to set national and local time-bound targets for reduction in childhood overweight and obesity, as well as monitoring mechanisms. The national targets would have to be accompanied by a detailed action plan, which will require coordinated efforts from multiple governmental sectors and institutions contributing to policy development, implementation and workforce capacity strengthening.

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Sažetak

REGIONALNE I SOCIODEMOGRAFSKE ODREDNICE UČESTALOSTI PREKOMJERNE TJELESNE MASE I DEBLJINE U DJECE U DOBI OD 7-9 GODINA U HRVATSKOJ

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Cilj ovoga istraživanja bio je utvrditi učestalost i analizirati odrednice prekomjerne tjelesne mase i debljine kod školske djece u dobi od 7-9 godina u Hrvatskoj u odnosu na sociodemografske čimbenike. U istraživanju su korišteni podaci prikupljeni u sklopu istraživanja SZO Europa "Europska inicijativa praćenja debljine u djece, Hrvatska 2015./2016.". Uzorak u ovom istraživanju bio je nacionalno reprezentativan. Antropometrijska mjerenja 5591 djeteta, 2811 dječaka i 2780 djevojčica, provedena su standardiziranom opremom kroz 8 tjedana. Proučavane varijable bili su antropometrijski i demografski podaci djece, obrazovanje i zaposlenost majki. Prema rezultatima, učestalost prekomjerne tjelesne mase i debljine u hrvatske djece u dobi od 7-9 godina iznosi 35,9%. Učestalost prekomjerne tjelesne mase i debljine veća je kod dječaka nego kod djevojčica, a izrazito je velika kod dječaka iz jadranske regije (42,1%). Rizik za prekomjernu tjelesnu masu i debljinu veći je za dječake koji žive u jadranskoj regiji (ORadj=1,33; 95% CI 1,03-1,71) i djevojčice čije majke imaju srednjoškolsko obrazovanje (ORadj=1,36; 95% CI 1,11-1,66). Djevojčice čije su majke nezaposlene imaju manji rizik od prekomjerne tjelesne mase i debljine (ORadj=0,73; 95% CI 0,58-0,92). Uočena učestalost prekomjerne tjelesne mase i debljine zahtijeva vremenski ograničene, nacionalne i lokalne, ciljeve za smanjenje debljine kod djece, praćene detaljnim akcijskim planovima i mehanizmima praćenja.

Ključne riječi: *Učestalost; Prekomjerna tjelesna masa; Debljina; Djeca; Hrvatska*