IZVORNI ZNANSTVENI RAD / ORIGINAL SCIENTIFIC PAPER

BREAKFAST SKIPPING, SOFT DRINK INTAKE, AND LOW FRUIT AND CEREAL CONSUMPTION ARE LINKED TO OBESITY IN CROATIAN SCHOOLCHILDREN: THE CROCOSI STUDY

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Summary

Childhood obesity is frequently linked to poor dietary habits, however, there are conflicting results regarding status of specific food groups consumption and dietary habits like (un)regular breakfast consumption. The aim of this study was to explore food and beverages intakes associated with obesity among children enrolled in the CroCOSI study as part of the WHO European Childhood Obesity Surveillance Initiative. This cross-sectional study investigated dietary habits of school-aged children on a nationally representative sample (n=5608; 7-10 years). Parents or caregivers completed a questionnaire with indicators of dietary habits, and children's body weight and height were measured. The 2007 WHO recommended growth reference for school-age children was used to compute BMI-for-age Z-scores. Descriptive statistics and logistic regression analyses were performed. The prevalence of obesity among Croatian children was 15.6%. Children who consume breakfast (OR 0.72, 95% CI 0.60–0.87), fruits (OR 0.82, 95% CI 0.68–0.97) and cereals (OR 0.72, 95% CI 0.52–0.97) every day were less likely to have obesity. Further, children who had ≥4 servings of soft drinks weekly were 1.17 (95% CI 1.07–1.36) times more likely to have obesity. Other food groups showed no significant associations with obesity. Daily consumption of fruits and cereals was associated with a lower risk of obesity in children. Skipping breakfast and the intake ≥4 servings of soft drinks per week was associated with a higher likelihood of obesity in this population of school-age children. Interventions with the aim to reduce prevalence of obesity in school-age children in Croatia can be based on the obtained results.

***Keywords**: childhood obesity, COSI, dietary habits, breakfast, food groups*

Introduction

Childhood obesity negatively affects almost every organ system, including the cardiovascular, metabolic, pulmonary, gastrointestinal, and skeletal systems (Daniels, 2009). Since inadequate dietary habits during childhood are associated not only with the occurrence of childhood obesity but also with the subsequent risk of developing diseases both in childhood and adulthood, understanding the relationship between dietary habits and obesity is of utmost importance. This is because dietary habits established in childhood often persist into adulthood (Rauber et al., 2014).

Although studies on the association between the frequency of consuming specific foods and beverages and obesity show contradictory results, dietary habits that have been positively associated with overweight and obesity in children, according to meta-analyses and review papers, include skipping breakfast (Wang et al., 2023; Poorolajal et al., 2020), consuming soft drinks (Malik et al., 2013) and fast-food consumption (Jakobsen et al., 2023). According to the latest available data, the prevalence of overweight and obesity among children aged 6 to 9 years has stabilized (Buoncristiano et al., 2021). Although most European countries have seen a stabilization in the high prevalence of childhood overweight, Mediterranean countries show a concerning trend of increasing childhood overweight (Garrido-Miguel et al., 2019). This trend has also been observed in Croatia, where, according to the latest data from the CroCOSI in 2021/2022 school year, 36.1% of eight-year-olds were classified as overweight or obese. The total percentage of children with obesity in this round of the CroCOSI study was 15.4% (Musić Milanović et al., 2024).

Given the high prevalence of overweight and obesity among children in Croatia, it is crucial to identify the factors contributing to childhood obesity. Currently, there is limited data on the dietary habits of school-aged children in Croatia, highlighting the need to investigate these habits further. The main objectives of this study are to examine children's dietary habits and determine the associations between specific dietary habits and childhood obesity in school-aged children.

Materials and Methods

This cross-sectional study was conducted on a nationally representative, regionally stratified random cluster sample comprising 5,608 children, 51% of whom were boys and 49% were girls, from the CroCOSI study. A standard protocol was used to ensure the data quality. Data collection and measurements were conducted in Croatia for 8 weeks, involving children aged 7–10 years and their parents.

Ethics approval was obtained from the University of Zagreb School of Medicine Ethics Committee and the Croatian Institute of Public Health Ethics Committee. The parents provided a signed informed consent for their children to participate in the study, and each child provided verbal consent before commencing the measurement. The study methodology has been described in more detail elsewhere (Breda et al., 2021).

Measurement of Body Weight and Height

Anthropometric measurements of study participants were conducted at school. Weight was measured to the nearest 100 grams and height to the nearest 1 millimeter. Height was measured twice, and the average of the two measurements was used for analysis. A SECA 877 weight scale was used to measure body weight, while a SECA 217 stadiometer was used for height measurement. During the measurement of children's height and weight, additional data on the type of clothing worn by the child were recorded. The measured body weight was adjusted during data processing based on the recorded clothing.

Determination of Weight Status

To determine the weight status of children in this study, WHO SPSS Syntax (who2007.sps) was used, containing data on children's growth from ages 5 to 19 (WHO, 2006). During the analysis, z-score values of the body mass index (BMI)-for-age were used to determine the weight status of children. The children were divided into two categories: those without obesity (including children who were underweight-BMI-for-age z-score <–2; normal weight- BMI-for-age z-score ≥–2 and ≤+1; or overweight- BMI-for-age z-score >+1 and ≤+2) and those with obesity (children with a BMI-for-age z-score >2).

Assessment of Dietary Habits

During the children's measurements at school, they were additionally asked whether they had breakfast that day. Regarding dietary habits, parents completed a food frequency questionnaire (FFQ) at home, indicating the frequency of their children's breakfast consumption, as well as food and beverage intake, by selecting one of the following five responses: 1) never; 2) less than once a week; 3) 1–3 times a week; 4) 4–6 times a week; and 5) every day. Some parents did not answer all questions related to dietary habits, resulting in differences in the final number of responses.

For statistical analyses foods such as fruits, vegetables, cereals, bread, meat, potatoes, milk, flavoured milk, cheese, and dairy products (yogurt, milk pudding, cream cheese/quark, or other), as well as 100% fruit juice, were categorized into daily and non-daily consumption. Unlike these foods, items such as soft drinks, diet or "light" drinks, eggs, sweet snacks, savoury snacks, bakery products, and fast food were classified into higher frequency consumption (≥4x times per week) and lower frequency consumption (<4x times per week). Since Croatian dietary recommendations suggest consuming fish at least once a week, children were divided into those who consume fish at least once a week (≥1× per week) and those who do not. The outcome variables were recorded based on recommendations (daily consumption of fruit, vegetables, cereals, milk, and dairy products) and previous research (higher frequency consumption of other foods and beverages), in order to examine the association between these variables and childhood obesity (Wijnhoven et al., 2015; WHO 2003).

Statistical Analysis

Chi-square tests were used to examine dietary differences between children without obesity and children with obesity. Firstly, the strength of the association between childhood obesity and each dietary habit was assessed using logistic regression analysis. Predictors that were found to be statistically significant in univariate logistic regression were included in multivariate logistic regression adjusted for gender. Multivariate logistic regression analyses were performed to identify independent risk factors of dietary habits associated with obesity in children. Odds ratios (OR) and 95% confidence intervals (95% CI) were determined from these analyses. An OR greater than one indicates a higher risk of childhood obesity, while an OR lower than one signifies a protective effect. A p-value of 0.05 or lower is considered statistically significant. Descriptive analyses and logistic regression were conducted in IBM SPSS Statistics for Windows version 23 (IBM Corp., Armonk, NY, USA).

The generalized variance inflation factors (GVIF) were examined to determine the collinearity between the dietary habits. The results were between 1.01 and 1.33, showing that the indicators were not collinear.

Results and discussion

The average body weight of the children was 33.94±8.32 kg and the average body height was 137.57±7.01 cm. According to the results, the proportion of children with obesity is 15.7%. As shown in **Table 1**, 82.5% of children without obesity reported having breakfast on the day of measurement, while a slightly lower percentage (67.8%) had breakfast daily on a weekly basis. On the day of measurement, 17.5% of children without obesity and 22.4% of children with obesity did not consume breakfast.

Table 2 presents the percentages of frequency of consumption of specific foods and beverages among children with and without obesity. A statistically significant difference between children with and without obesity was found for fruit, vegetables, cereals, milk, soft drinks, savoury snacks, and fish.

Table 1. Consumption of breakfast according to children's weight status.

	Children without obesity	Children with obesity	Total	p-value
	N (%)	N (%)		
Breakfast on the morning of measurement	4731 (84.4%)	876 (15.6%)	5607	<0.001*
Yes	3905 (82.5%)	680 (77.6%)	4585	
No	826 (17.5%)	196 (22.4%)	1022	
Breakfast consumption frequency	4678 (84.4%)	867 (15.6%)	5545	0.08
Daily	3171 (67.8%)	561 (64.7%)	3732	
Non-daily	1507 (32.2%)	306 (35.3%)	1813	

p *- significance comparing children without obesity and children with obesity (Chi-square test).

Table 2. Consumption of different food groups according to children's weight status.

	Children without obesity N (%)	Children with obesity N (%)	Total	p-value
Fruit	4689 (84.3%)	874 (15.7%)	5572	
Daily	1542 (32.8%)	230 (26.3%)	1772	<0.001*
Non-daily	3156 (67.2%)	644 (73.7%)	3800	
Vegetables	4597 (84.4%)	871 (15.6%)	5568	
Daily	984 (20.9%)	144 (16.5%)	1128	<0.001*
Non-daily	3713 (79.1%)	727 (83.5%)	4440	
Cereals	4666 (84.3%)	866 (15.7%)	5532	
Daily	417 (8.9%)	53 (6.1%)	470	0.01*
Non-daily	4249 (91.1%)	813 (93.9%)	5062	
Bread	4639 (84.3%)	861 (15.7%)	5500	
Daily	2570 (55.4%)	477 (55.4%)	3047	1.00
Non-daily	2069 (44.6%)	384 (44.6%)	2453	
Meat	4686 (84.4%)	867 (15.6%)	5553	
Daily	814 (17.4%)	164 (18.9%)	978	0.27
Non-daily	3872 (82.6%)	703 (81.1%)	4575	
Potatoes	4675 (84.4%)	863 (15.6%)	5538	
Daily	184 (3.9%)	44 (5.1%)	228	0.12
Non-daily	4491 (96.1%)	819 (94.9%)	5310	
Milk	4668 (84.4%)	861 (15.6%)	5529	
Daily	2459 (52.7%)	417 (48.4%)	2876	0.02*
Non-daily	2209 (47.3%)	444 (51.6%)	2653	
Flavoured milk	4602 (84.3%)	855 (15.7%)	5457	
Daily	374 (8.1%)	54 (6.3%)	428	0.07
Non-daily	4228 (91.9%)	801 (93.7%)	5029	
Cheese	4608 (84.4%)	852 (15.6%)	5460	
Daily	212 (4.6%)	42 (4.9%)	254	0.68
Non-daily	4396 (95.4%)	810 (95.1%)	5206	
Dairy products	4676 (84.5%)	860 (15.5%)	5536	
Daily	835 (17.9%)	151 (17.6%)	986	0.83
Non-daily	3841 (82.1%)	709 (82.4%)	4550	
100% fruit juice	4514 (84.4%)	835 (15.6%)	5349	
Daily	328 (7.3%)	47 (5.6%)	375	0.09
Non-daily	4186 (92.7%)	788 (94.4%)	4974	
Soft drinks	4707 (84.4%)	869 (15.6%)	5576	
<4× per week	2943 (62.5%)	502 (57.8%)	3445	0.01*
≥4× per week	1764 (37.5%)	367 (42.2%)	2131	
Diet or "light" soft drinks	4707 (84.4%)	869 (15.6%)	5576	
<4× per week	2943 (62.5%)	502 (57.8%)	3445	0.90
≥4× per week	1764 (37.5%)	367 (42.2%)	2131	
Egg dishes	4686 (84.4%)	864 (15.6%)	5550	
<4× per week	4179 (89.2%)	760 (88%)	4939	0.83
≥4× per week	507 (10.8%)	104 (12%)	611	

Table 2 Continues. Consumption of different food groups according to children's weight status.

	Children without obesity N (%)	Children with obesity N (%)	Total	p-value
Savoury snacks	4666 (84.4%)	864 (15.6%)	5530	
<4× per week	3929 (84.2%)	714 (82.6%)	4643	0.25*
≥4× per week	737 (15.8%)	150 (17.4%)	887	
Sweet snacks	4686 (84.4%)	864 (15.6%)	5550	
<4× per week	3048 (65%)	574 (66.4%)	3622	0.43
≥4× per week	1638 (35%)	290 (33.6%)	1928	
Bakery products	4677 (84.5%)	861 (15.5%)	5538	
<4× per week	3185 (68.1%)	581 (67.5%)	3766	0.72
≥4× per week	1492 (31.9%)	280 (32.5%)	1772	
Fast food	4686 (84.4%)	865 (15.6%)	5551	
<4× per week	4551 (97.1%)	835 (96.5%)	5386	0.35
≥4× per week	135 (2.9%)	30 (3.5%)	165	
Fish	4679 (84.4%)	865 (15.6%)	5544	
<1× per week	2505 (53.5%)	505 (58.4%)	3010	0.01*
≥1× per week	2174 (46.5%)	360 (41.6%)	2534	

p *—significance comparing children without obesity and children with obesity (Chi-square test).

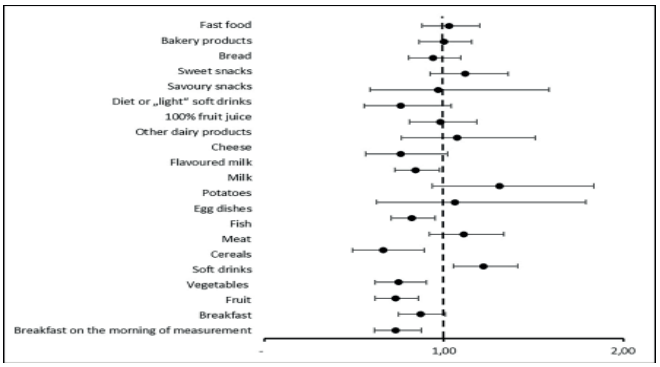

Figure 1. *Determinants of the prevalence of obesity according to dietary habits derived from univariate regression analysis, CroCOSI 2019.*

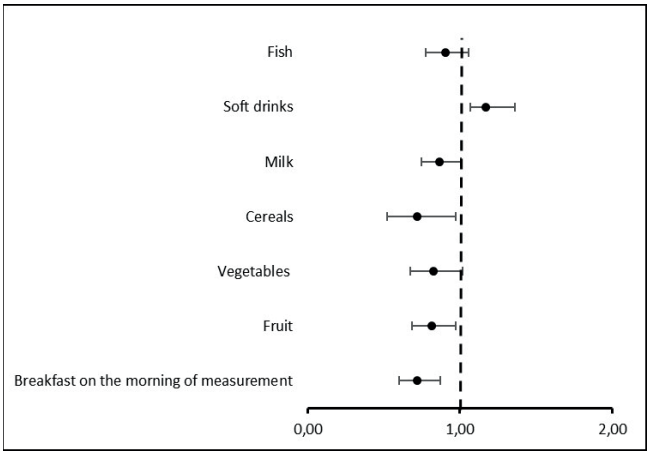

Figure 2. *Determinants of the prevalence of obesity according to dietary habits derived from multivariate regression analysis, CroCOSI 2019.*

The results of the univariate regression analysis (**Figure 1**) indicate that childhood obesity in Croatia is negatively associated with consumption of fruit, vegetables, cereals, milk, and fish; and positively associated with higher consumption of soft drinks. Additionally, children who reported having breakfast on the day of measurement had a lower risk of obesity compared to those who reported only drinking a beverage or skipping breakfast entirely.

When all statistically significant predictor variables were included in the multivariate regression analysis (**Figure 2**), it was found that daily consumption of fruit and cereals, as well as having breakfast, had a protective effect against obesity in children. In contrast, children who consumed soft drinks four or more times per week had a higher risk of obesity. This study, based on a nationally representative sample of second- and third-grade children in Croatia, shows that many children do not follow dietary guidelines.

According to parental responses (breakfast consumption frequency), it was determined that over 60% of children, both with and without obesity, have breakfast daily. However, based on children's self-reports, a higher percentage of children stated that they had breakfast on the day of measurement. This is consistent with findings from a recent systematic review, which showed considerable variability in breakfast skipping, ranging from 0.7% to 74.7%, depending on the definition used (Monzani et al., 2019).

The proportion of children with obesity who eat fruit daily is 26.3%, while 16.5% of children with obesity consume vegetables daily. This is a lower proportion of children who consume fruit and vegetables daily compared to the COSI study in Serbia (Božić et al., 2020). Furthermore, since fruit and vegetables are the foundation of the Mediterranean diet, these results confirm the findings of the study by Matana et al., 2022, which indicate a low percentage of children and adolescents in Croatia who adhere to the principles of the Mediterranean diet. The proportion of children with obesity who drink soft drinks ≥4× per week is 42.2%, which is a higher percentage compared to children in other countries. The proportion of children who consume fish at least once a week is over

40%, which is consistent with the study by Castaño et al. (2014).
The results show that children who reported having breakfast on the day of measurement had a lower risk of obesity (OR 0.72, 95% CI 0.60–0.87, p>0.001). These results are consistent with studies among children and adolescents aged 6 to 19 years, showing that those who skip breakfast are more likely to have overweight (OR 0.2, 95% CI 0.05–0.84) and obesity (OR 0.07, 95% CI 0.01–0.30) (Nasreddine et al., 2014). A positive association between irregular breakfast consumption and overweight/obesity in children has also been established by other COSI studies in various countries (Božić et al., 2020; Nilsen et al., 2017; Wijnhoven et al., 2015).
Multivariate regression analysis found that children who consume fruit daily are more often children without obesity (OR 0.82, 95% CI 0.68–0.97), which is consistent with a study among boys aged 6–12 years in Spain, where it was established that consuming ≥2 servings of fruit per day has a protective effect against the development of overweight, including obesity (Santiago et al., 2013). Thus, the same results regarding breakfast consumption, fruit consumption, and sweet snacks intake were found as in the study by Wijnhoven et al. (2015), except for fast-food consumption such as pizza, fries, hamburgers, or sausages, which may be explained by the fact that children of this age in Croatia do not have a habit of consuming these foods.
In the study by Nasreddine et al. (2014), no association was found between the consumption of bread and cereals with overweight or obesity. However, this study found a correlation between daily cereal consumption and childhood obesity (OR 0.72, 95% CI 0.52–0.97, p=0.04), whereas no such association was found for bread.
In the meta-analysis by Poorolajal et al. (2020), based on the results of 20 studies, it was determined that consuming soft drinks ≥4x times per week may increase the risk of childhood obesity by 24% (P=0.003, CI 1.24; 1.07–1.43). The results of this meta-analysis align with the findings of this study, as it was found that children in Croatia who consume soft drinks≥4 times per week have a higher risk of obesity (OR 1.17, 95% CI 1.07–1.36, p=0.03). Additionally, a large study in China on children aged 7 to 12 years found that consuming one glass of soft drinks per day is significantly associated with overweight (p<0.05, OR 1.37, 95% CI 1.03–1.83) and obesity (p<0.05, OR 1.39, 95% CI 1.05–1.85). Therefore, future preventive actions should focus on reducing the consumption of soft drinks among children (Zhang et al., 2016).
Although univariate analysis showed an association between daily milk consumption and obesity in children, multivariate analysis did not confirm this link. This finding is in line with a recent meta-analysis that did not establish a reduced risk of overweight/obesity in children aged 5-11 years who consume milk and dairy products daily (p=0.06) (Jakobsen et al., 2023).
The advantage of this study is that it examined the association between childhood obesity and a wide range of foods and beverages on a nationally representative sample of second- and third-grade children in the Republic of Croatia, following a strictly defined protocol. Although the frequency of consumption of certain foods and beverages was determined based on parental responses, which may have introduced bias, children's body weight and height were measured by trained personnel. Additionally, only the frequency of consumption was assessed, not the quantity. Since this is a cross-sectional study, a causal relationship cannot be established. One of the limitations is that the regression analyses are adjusted for gender but do not appear to account for other potential confounders.

Conclusion

The results of this study indicate that a small number of children in the Republic of Croatia follow dietary recommendations, regardless of their weight status. Only 32.8% of children without obesity and 26.3% of children with obesity consume fruits daily. The results for vegetable consumption are more unfavourable; only 20.9% of children without obesity and 16.5% of children with obesity consume vegetables daily. It was also found that children who reported having breakfast on the day of measurement were more often children without obesity. Children who consume both fruits and cereals daily have a lower risk of obesity. However, children who drink soft drinks ≥4× per week are more often children with obesity. Studies like this, which focus on identifying dietary habits associated with obesity, can help develop guidelines for effective prevention and intervention strategies for reducing childhood obesity in the Republic of Croatia.

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