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## NOURISHMENT STATUS AND ITS ALTERING FACTORS IN CHILDREN AT THE AGE OF 7 AND 9

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### ABSTRACT

Both, under and overnutrition in childhood have long-lasting consequences, but for the first time in history, the number of obese children surpassed the number of malnourished. We aimed to compare nourishment status of children at the age of 7 and 9 years, by using two criteria, and to analyse the role of parental, family and nutrition.

207 children from Eastern Croatia were recruited. Anthropometrics were measured at the age of 7 and 9 years, and the remaining data (birth, parental and family characteristics, and basic nutrition information) were obtained from children's medical records. Nourishment status was assessed by using Croatia's national and International Obesity Task Force criteria.

The share of overweight and obese children increased over time, regardless of the criteria used. However, according to the national criteria, the number of underweight children increased, while according to the International Obesity Task Force criteria dropped over time. Higher Body Mass Index was found in children of parents with lower education. Obese children had more meals during a day and lower meat consumption during a week in comparison to other children. Significant correlation was found between children's Ponderal Index, Cardiometabolic Risk and Body Mass Index.

National criteria provides better assessment of nourishment status, but for the purpose of cross-country or cross-regional comparisons, International Obesity Task Force criteria is more appropriate. Parental education and some nutritional characteristic influence child's risk of overweight/obesity.

**KEYWORDS:** Pediatric Obesity; Child; Body Mass Index; Nutrition Disorders; Nutrition; Parents

### INTRODUCTION

Children, along with women, adolescents and infants are at increased risk of malnutrition. This broad term applies to imbalance of nutrients and/or energy in the body and includes both undernutri-

tion and overnutrition [Dukhi N, 2020]. Undernutrition, although mostly prevalent in middle and low-income countries, has become more recognized in countries such as the US and the United Kingdom [Banjari I, Odobaša R, 2018; Li H et al.,

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2022; Modjadji P, Madiba S, 2019]. Yet, for the first time in history, the number of obese children surpassed the number of underweight children [NCD-RisC, 2021]. Under the influence of COVID-19 pandemic, obesity worsened and we are now facing aggravated obesity rates among children. Some predictions say that by year 2030 we will have 254 million obese children aged 5-19 years [Hauerslev M et al., 2022; Zemrani B et al., 2021].

In Croatia, obesity prevalence is higher among school-aged boys in comparison to girls (8.0-8.9 years), especially among children living in coastal area [Musić Milanović S et al., 2021]. It is of great importance to assess children's nutritional status using growth charts and not to rely solely on Body Mass Index (BMI) given that child's body composition depends on age and sex. When possible, the use of national growth charts is recommended due to regional and country specific differences among children [CDC, 2022]. Croatia has its BMI percentile charts appropriate for children aged 6.5-18.5 years [Jureša V et al., 2018]. International Obesity Task Force (IOTF) criteria is an international nutritional assessment tool commonly used among children aged 2-18 years. Its figures are invented using BMI reference values for age and sex, which are derived from data collected in six different countries [Cole TJ, Lobstein T, 2012].

Numerous health consequences related to both malnutrition and obesity during childhood have long-lasting impact, not only on child's health [Kelsey MM et al., 2014], but their whole quality of life is seriously altered [Nga VT et al., 2019; Smith JD et al., 2020].

The importance of timed recognition of overweight need no special emphasis. Not only that it enables prevention of further weight gain and obesity, but also through continuous follow-up of children's nourishment, we can identify family-related and nutritional risk factors which can further be used to design specific interventions [Smith JD et al., 2020; Thomas-Eapen N, 2021].

The objective of this study was to compare nourishment status over time, and to assess the importance of several parental, family-related and nutritional factors.

## MATERIAL AND METHODS

### Participants

Study encompassed 207 children at the age of 7 and 9 years. The recruitment was conducted during physical examinations in one county in Eastern Croatia. Their parents/guardians were informed about the aims, utility and anonymity of the data collected. Informed written consent was provided by parents/ guardians. The study was approved by the Ethics Committee of the Teaching Institute of Public Health Osijek-Baranya County (date of approval July 7, 2022, No: 381-05-22-8, Class No: 501-01/22-01/1).

### Data

Anthropometric data included height and weight measurement. For all measurements, children wore minimal clothes and were barefoot. Seca scale with integrated stadiometer was used, with child's head in the Frankfurt plane ( $\pm 1$  cm). Children's waist circumference was measured with a non-elastic tape. Anthropometric measurements were taken at the age of 7 (in the 1<sup>st</sup> grade of elementary school), and 9 years (in the 3<sup>rd</sup> grade of primary school). All measurements were done by the same nurse and with the same equipment.

These measurements were used to calculate children's BMI, and to classify their nourishment status based on the Croatia's national criteria [Jureša V et al., 2018] and IOTF [Cole TJ, Lobstein T, 2012] criteria. Cardiometabolic Risk (CMR) was calculated as waist in cm/ height in cm, where values  $<0.5$  represents low risk,  $0.5 - 0.6$  increased risk and  $>0.6$  high risk [Chung ST et al., 2018].

Additionally, birth weight and length were collected from children's medical charts. Based on this information, Ponderal Index (PI) was calculated as  $PI = (BW \text{ in g} / BL^3 \text{ in cm}) \times 100$ , where BW represent birth weight and BL birth length. PI is used as a measure of disproportional fetal growth *in utero* ( $PI < 2.32$  or  $PI > 2.85$ ) [Šegregur J, 2009].

Parental education and marital status, number of children in the family and basic nutrition information were also collected from children's medical charts and were assessed as potential nourishment-altering factors.

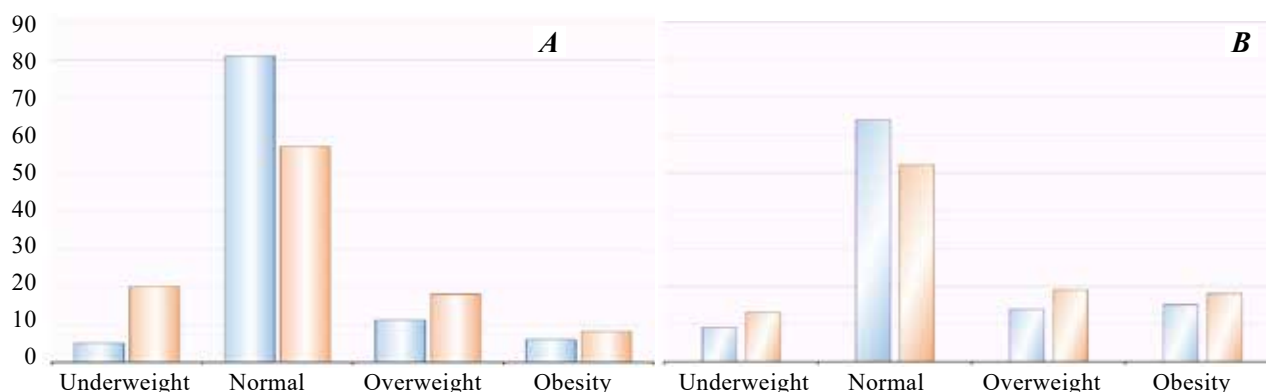


Figure 1 State of nourishment of girls at the age of 7 (A) and 9 (B) years, according to the national (blue columns) and the International Obesity Task Force criteria (Brown columns)

**Statistical analysis**

Software package Statistica 14.0 was used for statistical analysis, with selected level of significance at 0.05. Graphic analysis was conducted with MS Office Excel 2016 package.

The normality of data distribution was tested using the non-parametric Kolmogorov-Smirnov test, along with the comparison of medians, the comparison of the arithmetic means and by creating histograms.

Spearman’s correlation test and Levene’s homogeneity of variance test were used to calculate correlations between numerical data, while the average value and standard deviation were used to compare categorical data. Student’s t-test was used for independent and dependent measurements.

**RESULTS**

A total of 207 children were analyzed. The mean BMI for girls and boys at the age of 7 years was  $16.3 \pm 2.8$  and  $16.3 \pm 2.5$ , while the mean BMI for girls and boys at the age of 9 years was  $18.7 \pm 4.3$  and  $19.1 \pm 4.2$ , respectively. No significant difference was found regarding the mean value of anthropometric indicators and CMR among children of same age. CMR increased from  $0.2 \pm 0.04$  to  $0.3 \pm 0.07$  between the ages 7 and 9 among all children, while still remaining in the acceptable range (Table 1).

By comparing the selected criteria, it was found that the IOTF criteria classified more children as underweight, overweight and obese regardless of the sex and age, with the excep-

**TABLE 1**

Anthropometric indicators and Cardiometabolic Risk of children at the age of 7 and 9 years

	7 years old				9 years old			
	Girls		Boys		Girls		Boys	
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
Body height	104	124 ± 5.4	103	125 ± 5.5	102	144 ± 6.8	99	143 ± 7.1
Body weight	104	25 ± 5.7	103	26 ± 5.3	102	39 ± 11.2	99	40 ± 11.1
BMI	104	16.3 ± 2.8	103	16.3 ± 2.5	102	18.7 ± 4.3	99	19.1 ± 4.2
CMR	104	0.2 ± 0.04	103	0.2 ± 0.04	102	0.3 ± 0.07	99	0.3 ± 0.07

NOTES: n – number of children; SD – standard deviation; BMI – Body Mass Index; CMR – Cardiometabolic Risk

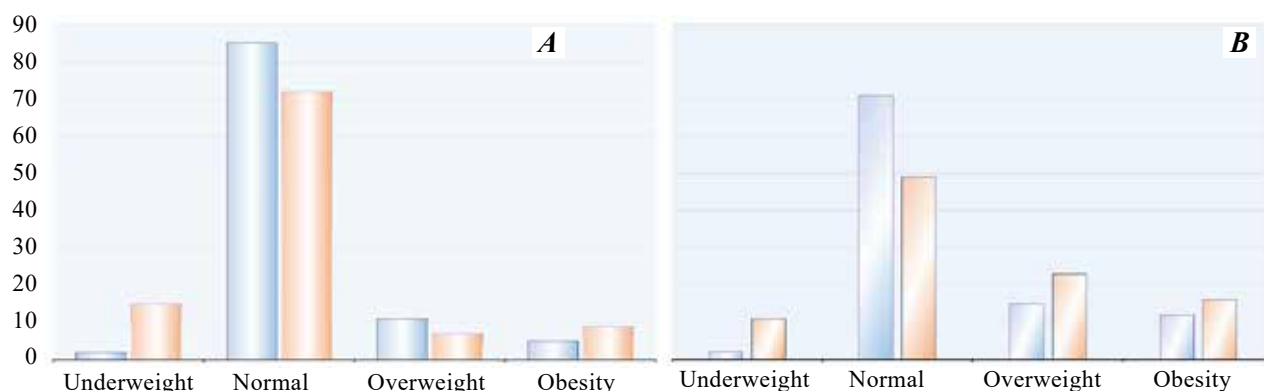


Figure 2 State of nourishment of boys at the age of 7(A) and 9 (B) years, according to the national (blue columns) and the International Obesity Task Force criteria (Brown columns)

tion of overweight boys at the age of 7 years. On the other hand, more children were considered to have a normal BMI according to the national criteria (Figures 1 and 2).

A decrease in the proportion of children with normal weight and an increase in the proportion of overweight and obese children during two years (from the age of 7 to 9 years) was found regardless of the criteria used. The only difference was found in the proportion of underweight children, which increased according to the national criteria and decreased according to the IOTF criteria (Figure 1 and 2).

Parental education level, with the emphasis on mother, was found to have a statistically significant impact on child’s nutritional status. Mother’s education had a strong correlation to child’s BMI and CMR continuously, while father’s education level was found to have a significant influence on child’s BMI later in life (Table 2). Children of lower educated parents were more prone to devel-

oping obesity by having higher BMI. Parental marital status and the number of children in the family had no influence on children’s nourishment status.

PI significantly correlates to child’s BMI and CMR at the age of 7 indicating the connection between child’s birth weight/length and state of nourishment later in life (Table 2). Boys and girls did not differ in PI value.

We also analyzed the daily consumption of milk, cooked and cold meals and weekly consumption of meat. Cooked meals refer to every meal that has been cooked, while cold meals refer to meals without any cooking method applied, with the exception of milk (e.g. salad, yogurt, fruit, sandwich, etc.). Underweight children (M=3.1; SD=0.5) and overweight children (M=3.4; SD=0.5) had more cold meals during a day compared to overweight children and children with normal weight. Although not statistically significant, the difference was also found in the weekly consumption of meat with obese children having lower meat consumption. On the other hand, obese children had a higher daily milk and cooked meals con-

TABLE 2

The influence of parental education level and Ponderal Index on child’s Body Mass Index and Cardiometabolic Risk at the age of 7 and 9 years

	7 years old		9 years old	
	BMI	CMR	BMI	CMR
<b>Mother’s education</b>	0.011*	0.025*	0.02*	0.017*
<b>Father’s education</b>	0.092	0.132	0.046*	0.071
<b>Ponderal Index</b>	0.182*	0.162**	0.109	0.101

NOTES: BMI – Body Mass Index; CMR – Cardio-metabolic Risk \*significant at p=0.05; \*\*significant at p=0.01

TABLE 4

Correlation coefficients between observed meal types

Type and frequency of consumed meals	Milk/day	Meat/week	Cooked meals/day	Cold meals/day
<b>Milk/day</b>	1	-0.05	0.063	-0.058
<b>Meat/week</b>	-0.05	1	0.178**	0.137**
<b>Cooked meals/day</b>	0.063	0.178*	1	0.215*
<b>Cold meals/day</b>	-0.058	0.137**	0.215**	1

Notes: \*significant at p=0.05; \*\*significant at p=0.01

TABLE 3

Consumption frequency of observed meals depending on child's nourishment status								
Meal consumption	Underweight		Normal		Overweight		Obesity	
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
<b>Milk/ day</b>	35	2.7 ± 1.4	128	2.7 ± 1.6	26	2.7 ± 1.6	18	2.9 ± 1.5
<b>Meat/ week</b>	35	5.1 ± 1.3	128	5.5 ± 1.5	26	5.4 ± 1.4	18	4.8 ± 1.7
<b>Cooked meals /day</b>	35	1.5 ± 0.5	128	1.5 ± 0.5	26	1.4 ± 0.6	18	1.7 ± 0.5
<b>Cold meals/ day</b>	35	3.1 ± 0.5*	128	3.2 ± 0.6	26	3.0 ± 0.4	18	3.4 ± 0.5*

**Notes:** n – number of children; SD – standard deviation; \*statistically significant at p=0.05

sumption as compared to others, even though the difference was not statistically significant (Table 4). Children who consume more cold meals per day also consume more cooked meals. The number of consumed meat per week is associated with a greater number of consumed cold and cooked meals per day (Table 3). In other words, obese children ate more meals during the day, regardless of their type.

### DISCUSSION

Croatia is a country where obesity is considered to be a public health concern; every third child struggles with overweight or obesity [Musić Milanović S et al., 2021]. Study from 2018 conducted among school-aged children in Croatia examined their nutritional status using WHO criteria and IOTF criteria. It was observed that according to the IOTF criteria more children were classified as underweight, while the WHO criteria classified more children as overweight and obese [Sila P et al., 2018]. Our results also show differences in classification of children according to their nourishment status between the two criteria used.

Obese children usually have a high CMR, which makes them more prone to developing cardiovascular diseases and diabetes [Chung ST et al., 2018]. Study conducted in Montenegro, contrary to our findings, showed that higher CMR is more prevalent among overweight/obese boys compared to girls [Martinović M et al., 2021].

Firstly, this can be explained by the exclusion of underweight children in study conducted in Montenegro. Our study focused on the whole sample including children of different nutritional status. Secondly, most of the children examined in our study had normal weight. Still, we noticed an increase in CMR from the age of 7 to the age of 9 following an increase in overweight/obese children. However, it should be noted that a study comparing school-aged children from Croatia and Montenegro found that obesity was more prevalent in Montenegro, while more children were underweight in Croatia [Banjari I et al., 2020].

Our study confirmed previous findings that parental marital status had no correlation to children's nutritional status [Bilić-Kirin V et al., 2014; Hsu PC et al., 2022]. On the other hand, several studies found significant correlation between the number of children in a family and children's BMI [Ahmed FB, Ahmed EB, 2016; Degarege D et al., 2015]. On contrary to our results, study from 2015 reported that children from households with more than five children were more likely to be malnourished [Degarege D et al., 2015]. Children included in our research mostly came from households with one, two or three children, with only one child having six siblings and two children having five siblings. The connection between the number of children and child's body weight is mainly noticed in households with more children [Degarege D et al., 2015].

Similar to our results, several studies empha-

sized the link between parental education level and children's nourishment status [Hsu PC et al., 2022; Musić Milanović S et al., 2020; Scheffler C et al., 2021]. Study in Taiwan among children aged 2-9 years found that children of lower educated mothers were more likely to develop obesity or be overweight and thus have a higher BMI [Hsu PC et al., 2022].

It was noticed in some studies, including ours, that child's early state of nourishment can affect its BMI later in life [Evensen E et al., 2017; Rahman MS et al., 2016]. Study from 2017 conducted in Norway observed that Ponderal Index and child's weight during childhood are significantly connected to child's nourishment status during adolescence [Evensen E et al., 2017].

A study from 2017 [Shin SM, 2017], which included 16,261 school children found that 1,875 of them do not consume meat or consume it only once a day. From that group, 386 were obese or overweight, 80 were underweight and the rest had a normal BMI. The proportion of obese and underweight children was higher among those who do not consume meat/week (58.0%) as compared to those who consume it once a day (48.0%) [Shin SM, 2017]. Another study conducted in Korea observed that the consumption of meat less than one serving a week is mostly found in obese children. This study also found a positive relationship between reduced meat consumption (<1 serving/week) and increased blood pressure. In other

words, children who consumed less than one serving of meat on a weekly basis had a higher prevalence of increased blood pressure [Kim GH et al., 2017]. Study from 2020 among 22,315 children aged 8-16 years found a correlation between milk consumption and nutritional status and anemia. The results indicated that the prevalence of anemia is lower in children who consumed milk frequently (4-6 times a week). Also, the greater the consumption of milk was, higher body height and weight were found. Thus, children who consumed more milk had higher body mass in comparison to others [Zhang X et al., 2020]. We also discovered similar findings in this present study.

### CONCLUSION

Our results show discrepancies in children's nourishment status categorization according to the national and IOTF criteria. National criteria seem more appropriate, especially from the aspect of assessing potential health risks. However, we feel that the use of IOTF criteria should be encouraged to enable better cross-country comparisons.

Besides confirming the importance of pregnancy on child's nourishment status later in life, we found unfavorable dietary habits related to overweight and obesity.

The results confirm the importance of close monitoring and education of children, teachers and parents about the importance of a healthy nourishment and dietary practices.

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