

# Analysis of Macronutrients Intake and Body Mass Index in Preschool Children in the Western Region of the Republic of Srpska

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## SUMMARY

**Introduction** Childhood obesity is currently considered to be one of the most prevailing and challenging public health issues in industrialized countries and some developing countries, including the Republic of Srpska.

**Objective** Our objective was to determine macronutrients intake in collective diet of preschool children and to estimate the rate of obesity in this population.

**Methods** Samples of food intended for preschool children diet were collected in a preschool facility in the western region of the Republic of Srpska. In daily portions, the content of proteins, fats, carbohydrates, water and mineral matter were determined using standard methods. The body mass index was determined on the basis of anthropometric measurements.

**Results** An average daily meal contained 17.5 g of fats, 19.1 g of proteins and 101.5 g of carbohydrates. The energy value was 676 Kcal. The analysis of the data from the menu showed that the number of consumed servings of fruits, vegetables, legumes, milk and dairy products was less than one portion per day. However, the amount of consumed meat and meat products exceeded one portion per day. Out of the total number of children, 10.0% were undernourished, 16.7% were overweight and 13.3% were obese.

**Conclusion** Daily portions in the preschool facility are not in accordance with the recommended dietary allowance for energy and carbohydrates intake, and the composition of meals is inadequate. Parents and caregivers should be encouraged to expose young children to a wide variety of fruit and vegetables, whole grains, low-fat dairy products, and to balance food intake with the requirements.

**Keywords:** nutrition; preschool children; food; body mass index; obesity

## INTRODUCTION

Many diseases are caused by poor or improper diet. Inadequate diet results in occasional improper intake (either excessive or insufficient) of certain foodstuffs, thus causing the imbalance in intake of essential nutrients. The etiology of obesity, as well as the majority of biological functions, is multifactorial and, as commonly believed, is caused by energy imbalance [1]. World Health Organization reported that there were over 1.5 billion overweight adults in the world, while approximately four million of them were classified as clinically obese [2]. It is estimated that in Europe 20–30% of children and adolescents are obese [3, 4], while in the Mediterranean region the prevalence of childhood obesity is as much as 20–40% [3]. Out of the total number of diseases in Europe, 4.6% were associated with poor diet. The percentage of years of life lost due to obesity was 7–8% [5].

The Centers for Disease Control and Prevention in the United States reported tripling of the number of obese people in the last 20 years. Researches in the United States indicate that 16% of children and adolescents between the ages of six and 19 are overweight [6,7, 8] and that among preschool children (between the ages of two and five) the total energy intake in

2009–2010 period is significantly higher than in the period from 1989 to 1991 [9].

There is an assessment that in Northern Africa one in six preschool-aged children is either overweight or obese. This obesity rate is the highest in the world and three times higher than that recorded in 1990. However, numbers vary from country to country: approximately 20% of Egypt's preschoolers in 2008 were overweight or obese, compared to 5% in Sudan. In sub-Saharan Africa, though, overweight and obesity rates among preschoolers can still be expressed at a single-digit level: roughly 9% in Central Africa, 6% in Western Africa, 7% in Eastern Africa, and 8% in Southern Africa [10]. However, for most parts of this region, the rates doubled or tripled, compared to the results of two decades ago; only Southern Africa had a slight rate drop since 1990.

There are only a few research studies on the nutritional status of children and adolescents in the Republic of Srpska. A research on schoolchildren in the city of Banjaluka during 2003 indicated that 21.4% of children had increased body mass, out of which 8.3% were obese. It was deduced that excessive body weight and obesity were more prevalent in boys. Higher obesity rates were observed in both sexes in the group of seven-year-olds. More specifically, obesity

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was observed in cases of 24.4% of boys and 15.2% of girls [11]. The second research was conducted in 2007 in four primary schools in the Banjaluka area, involving 405 participants. It revealed that 19.8% of the total sample were overweight, and 11.6% were obese [12]. The research on nutritional status of children under the age of five during 2006 reported that almost one quarter of children at that age in the Republic of Srpska has increased body mass [13].

## OBJECTIVE

Nutrition and nutritional status follow-up in children and adolescents is especially important since the period of their growth acceleration and development makes children a particularly sensitive category of population, at the same time being a reliable nutritional status indicator in their local communities.

There is no published data on nutritional status in preschool children between the ages of five and six in the Republic of Srpska. Due to the facts stated above, the objective of our study was to assess the quality of nutrition in preschool children in kindergartens, i.e. to estimate macronutrients intake and the rate of obesity increase in this population.

## METHODS

This research investigated the diet of preschool children between the ages of five and six who were included in a collective diet program. Samples of food intended for children's diet were collected in the Radost kindergarten in Prijedor.

Children stay up to 10 hours per day in the preschool facility and their diet is composed of the following three meals: breakfast, snack and lunch.

A collection of 20 samples was taken over the period of 20 working days. The sampling was made by taking meal portions served for the consumer (by spot check method). The portions collected during the day were combined and homogenized to make a unique working sample (hereinafter: a daily meal, which comprises breakfast, lunch and snack). The samples were delivered to an accredited laboratory for foodstuffs, where the collected daily meals were homogenized. This was followed by a chemical analysis of freshly homogenized samples of daily portions, in order to evaluate the fat, proteins, ash and moisture content, whereas the content of carbohydrates and the total energy level of daily portions were mathematically calculated from the results obtained. All evaluations were made in duplicate in the accredited laboratory. All reagents applied were of analytical purity grade.

Considering that the sampled daily meal was composed of only 75% of dietary intake in this population, the results obtained were modified by multiplying them by factor 1/0.75.

To evaluate the nutritional status, we used anthropometric measurements of 60 children (28 girls and 32 boys), which included body height and weight measurements.

The height and weight were measured with height rod and digital scales. Based on the anthropometric measurements, body mass index (BMI) was calculated in accordance with the following formula:  $BMI = \text{body weight (kg)} / \text{body height (m}^2\text{)}$ .

The calculation of BMI was followed by the calculation of BMI percentile and comparison of BMI with typical values for other children of the same age. The BMI percentile was used to identify the children's weight status either as underweight (<5%), normal (5–85%), at risk of being overweight (85–95%), or overweight (>95%) [14].

In the statistical analysis we used the Pearson's common linear correlation coefficient and Student's t-test for comparison of calculated average values for various nutrients intake and their recommended daily allowance [15]. Statistical hypotheses were tested with 95% certainty. The data was statistically processed using statistical software package SPSS 15.

## RESULTS

Analysis of the data from the menu showed the prevalence of certain foods (Table 1). The number of fruit portions was extremely inadequate (only 0.45 portions per day). The number of portions of milk and dairy products was also inadequate (0.9 portions per day). The number of portions of leguminous and green vegetables was extremely small. Only the number of meat and meat products portions was above one portion per day.

The results of calculation of the contents of fat, proteins and carbohydrates and energy in daily meals are shown in Table 2. The minimum and maximum values of daily meals amounted to 520 and 844 Kcal and the average energy intake was 676 Kcal. Considering that the sampled daily portions comprised of only 75% of dietary intake for this population, for the purpose of calculation of daily intake, we multiplied mean levels of macronutrients by the coefficient 1/0.75.

The proportion of proteins, fats and carbohydrates in the total energy intake was approximately 12% from proteins, 63% from carbohydrates and 25% from fats, which is shown in Table 3. The participation of protein and carbohydrates in energy intake was in accordance with the recommendations, whereas the percentage of fat was slightly smaller than recommended.

**Table 1.** Proportion of different foodstuffs in the daily diet of preschool children during 20 consecutive days

Foodstuffs and food groups	Number of portions
Milk and dairy products	18
Legumes	5
Meat and meat products	21
Fish	0
Eggs	4
Green leafy vegetables	5
Fruit	8
Grains	2
Potato	6

**Table 2.** The contents of fat, proteins, carbohydrates and energy in a daily meal (n=20)

Parameters	Fats (g/daily meal)	Proteins (g/daily meal)	Carbohydrates (g/daily meal)	Energy (kcal/daily meal)
Minimum value	8.2	13.4	69.9	520
Maximum value	23.0	26.2	139.6	844
Average level	17.5	19.1	101.5	676
Estimated level*	23.3	25.4	135.3	901
RDA	-	19	130	1,632**
Standard deviation	4.6	4.2	19.5	381.8

\* Estimated daily intake was calculated by multiplying mean level by 1/0.75; \*\* The average value for both sexes, FAO/WHO recommendations in Prentice et al., 2004; British Nutrition Foundation, Available from: <http://www.nutrition.org.uk/>  
RDA – recommended daily allowance

**Table 3.** Distribution of energy from macronutrients in a diet

Proportion in energy intake (%)	Macronutrient		
	Fat	Proteins	Carbohydrates
Average±SD	24.6±6.7	12.0±1.7	63.3±6.0
Minimum limit	9.9	9.5	52.8
Maximum limit	33.7	15.6	72.4
Recommendation [16]	25–35	10–30	45–65

**Table 4.** The results obtained in this research and the results calculated using tables of the chemical composition of foods

Macronutrient (g)	USDA [21]	Finelli [22]	The experimental results
Carbohydrates	113.2	96.8	101.5
Proteins	34.8	29.1	19.1
Fat	30.7	34.5	17.5

**Table 5.** Age and sex structure of study participants

Age (years)	Female		Male		Total	
	N	%	N	%	N	%
5.0–5.24	6	21.4	6	18.7	12	20.0
5.25–5.49	8	28.6	14	43.8	22	36.7
5.5–5.74	7	25.0	6	18.7	13	21.6
5.75–6.0	7	25.0	6	18.8	13	21.7
Total	28	100.0	32	100.0	60	100.0

**Table 6.** Height, weight and BMI percentile

Parameter		Sex	
		Female	Male
Height (cm)	Min	114	109
	Max	128	124
	Average	119.7	118.8
Weight (kg)	Min	18	17
	Max	36.3	27.8
	Average	24.2	23.7
BMI (percentile)	<5 <sup>th</sup>	4	2
	5 <sup>th</sup> –85 <sup>th</sup>	16	20
	85 <sup>th</sup> –95 <sup>th</sup>	4	6
	>95 <sup>th</sup>	4	4

BMI – body mass index; Min – minimum value; Max – maximum value

**Table 7.** SD score of height for chronological age

Age (years)	SSD			
	<-3	-3 to -2	-2 to 2	>3
5–5.24	0	0	14	2
5.25–5.49	0	0	12	2
5.50–5.74	0	0	14	0
5.75–6.0	0	0	16	0
Total	0	0	56	4

SD – standard deviation; SSD – score standard deviation

The comparison of results obtained in this research for macronutrients content, together with data obtained in the calculation using different food composition tables (source) is reported in Table 4. Our results for the content of carbohydrates mainly coincide with the calculated results, whereas for proteins and fats content significant deviations were observed.

Data about age and sex structure of children which were included in this research are shown in Table 5. The average age of children was 66.0 months, 66.1 months for girls and 65.9 months for boys.

Results of anthropologic measurements of the study participants are reported in Tables 6 and 7. What is interesting is that girls had a higher maximum value, as well as weight and height. It is shown that there are no children who lag in growth.

In terms of BMI, out of the total number of children, 10.0% were undernourished, 16.7% were overweight and 13.3% were obese (BMI > 95 percentiles); 14.3% of girls and 18.7% of boys were overweight, and obesity was detected in 14.3% of girls and in 12.5% of boys. The rate of undernourished girls (14.3%) was significantly higher than that of boys (6.3%). Minimal BMI for girls and for boys was one percentile, and maximum BMI for both sexes was 99 percentile.

Table 8 shows the value of BMI percentile for chronological age. It is noted that the number of obese children is constant throughout the age groups.

## DISCUSSION

In this study, data on the composition of meals shows that consumed meat was mostly chicken and beef. It was noticed that veal, pork and fish were not present in meals during the test period. This data may suggest a possible deficiency of micronutrients in the diet. The research results

**Table 8.** BMI percentiles for chronological age

Age (years)	BMI percentiles			
	<5 <sup>th</sup>	5 <sup>th</sup> –85 <sup>th</sup>	85 <sup>th</sup> –95 <sup>th</sup>	>95 <sup>th</sup>
5–5.24	0	8	2	2
5.25–5.49	2	8	4	2
5.50–5.74	2	12	0	2
5.75–6.0	2	8	4	2
Total	6	36	10	8

BMI – body mass index

confirm non-compliance of the diet with the principles of rational nutrition.

In Belgium, Flemish preschoolers have the intake of fruit of 109.9 g/day, their intake of milk is 439.9 g/day and the intake of meat and meat products is 90.3 g/day, which is significantly higher than what the results of our research show [16]. Fox et al. [17] state that, in the case of US children at the ages of two and three, the level of fruit and vegetables consumption represents roughly one third and one half of recommended intakes of vegetables and fruit, respectively.

The Donald Study shows increased intake of bread and grain products in two- to 18-year-olds in Germany, which corresponds to our findings. Further research could examine the use of different types of grain. Traditionally, in the Dortmund region, wheat is used more often than other grains [18].

Research in the Republic of Serbia indicated insufficient energy value of daily meals of preschool children in 1990 and 1993 (938 Kcal and 876 Kcal) [19]. Moreover, data obtained in this study showed inadequacy of dietary energy intake. The average energy value of a daily meal in the kindergarten in the Republic of Srpska comprised only two thirds of the recommended value [20]. The meal schedule prescribes the following eating times: breakfast at 8:00 a.m., lunch at 12:00 noon and snack at 2:00 p.m. This meal schedule and the lack of energy and nutritional value of meals are probably the reason why children meet most of their nutritional needs at home. Diet at home was beyond our control, therefore we had no information about it. However, the results of anthropological measurements indicate that the amount and/or composition of the food were inadequate. The most popular and cheapest types of food are high in calories, fat, carbohydrates and salt and are low in micronutrients. These facts, combined with the present global trend of reduced physical activity resulted in the rapid increase of obesity rate.

The results obtained in this research concerning fat and protein content differ significantly from the results derived using tables of the chemical composition of foods (Fineli and USDA), which suggests that it is necessary to create tables of nutritional composition of foods that will represent the Republic of Srpska region [21, 22].

In our study, the proportions of proteins, fats and carbohydrates in energy intake were 12%, 25% and 63%, respectively, which does not differ significantly from the recommendations. The research conducted in Serbia reported that the proportion of proteins, fats and carbohydrates in energy intake is 15.7%, 35.6% and 48.6%, respectively [17]. In their study of preschool children diet in Bahrain, Gharib et al. [23] reported that the proportions of proteins and fats in energy value are slightly higher, whereas the percentage of carbohydrates is lower, compared to the results obtained in this study. Other authors showed that fats and proteins have higher proportions in energy value and that the proportion of carbohydrates is lower, compared to our study [16, 18].

In our study, 13.3% of children were obese, and 16.7% of children were overweight.

The obtained results are comparable with the data on children in Poland and the Tuscany region in Italy [24, 25].

Also, the research conducted in the Republic of Srpska by the Ministry of Health and Social Welfare in collaboration with UNICEF showed a similar number of overweight children under five years of age and lower prevalence of childhood obesity [26]. In a study conducted in Bosnia and Herzegovina, 20.2% of children were obese and 1.9% were underweight [13]. Research data outside the European continent was somewhat different. The research of Mushtaq et al. [27] in Pakistan showed a higher number of underweight children (19%) and less children who were overweight and obese (8%).

Data about correlation of energy intake and obesity in children is inconsistent. Several cross-sectional studies have shown positive correlation between fat intake and a degree of obesity in children [28, 29, 30], while others have not [30]. There are only a small number of published studies which have been dealing specifically with intake of fats, proteins and carbohydrates in relation to BMI in children [31]. These studies provide an obvious proof that the role of dietary composition in the development of childhood obesity is yet to be clarified. Researchers are now investigating the correlation between diet composition and obesity in children [28]. Several studies have investigated the correlation between BMI and energy intake and it is assumed that dietary composition with respect to macronutrients (proteins, carbohydrates, fat) can play an important role in the development of childhood obesity as is the case with adults [15, 32]. The research shown in this paper, which aimed to investigate the possible correlation between BMI and macronutrients intake, did not find statistically significant difference in relation to the recommendations. When considering the proportion of certain macronutrients in the total energy intake, with 95% certainty, i.e. within the certainty interval (Student's t-test), the situation is quite clear in case of proteins, which do not exceed the recommended range, while in the case of fats and sugar we obtained cut points. The obtained results also show that, statistically, the intake of fats and carbohydrates was not significantly different compared to recommended daily allowance, while the protein intake was above the recommendations.

Thus the occurrence of a certain number of obese study participants could be explained by means of consumption of meals outside the kindergarten. In the same manner, the study on correlation of BMI and the food intake outside the home, conducted on approximately 14,000 adolescents in America, showed that BMI increases with the increase of the number of meals outside the home, which is associated with a higher intake of total energy, fizzy drinks, trans-fatty acids and low intake of low-fat foods, fruit and vegetables [33]. The proportions of nutrients are extremely important for normal metabolism and prevention of certain conditions and diseases caused by imbalance of nutrients intake in the body [34].

Efforts to foster healthy eating habits need to begin early in life. In a longitudinal analysis of food preferences among young children, Skinner et al. [35] showed that the number of preferred foods did not change significantly between the ages of two or three, and eight.

The general prevalence of obesity in the child population in the Šumadija region of Serbia is 10.7%, which is lower than the number of obese children in our population (13.3%) [36]. The average height of the study participants was between 114 cm and 128 cm for girls and between 109 cm and 124 cm for boys [36]. Our findings are opposite to those obtained in the study conducted by Pokos et al. [37], whose results show that the average height for boys was between 116 cm and 117.6 cm, whereas the girls were somewhat shorter (113.9–115.9 cm). The research conducted by Pavlović et al. [19] on anthropometric indicators and the quality of collective and family nutrition in children, suggests the necessity to adapt an adequate nutrition practice and thus prevent nutrition and health disorders in preschooler population. This conclusion was also supported by the results of our research.

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## CONCLUSION

The results of this research indicate an alarming situation related to children nutrition in preschool facilities in the Republic of Srpska and suggest the need for its regular monitoring. Daily portions in the preschool facility are not in accordance with the recommended dietary allowance for energy and carbohydrates intake and the composition of meals is inadequate. Data showing that 10% of preschool children were undernourished, and that 16.7% of them were overweight, as well as that 13.3% of them were obese, suggest that parents and caregivers should be encouraged to expose young children to a wide variety of fruit and vegetables, whole grains, low-fat dairy products, and to balance the food intake with the requirements.

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## Анализа уноса макронутријената и индекса телесне масе код деце предшколског узраста у регији западне Републике Српске

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### КРАТАК САДРЖАЈ

**Увод** Гојазност у дечјој доби је данас један од важнијих проблема здравства, како у индустријским, тако и у земљама у развоју, укључујући и Републику Српску.

**Циљ рада** Циљ истраживања је био да се одреди унос макронутријената у колективној исхрани деце предшколског узраста и процени учесталост гојазности у овој популацији.

**Методе рада** Узорци хране намењени исхрани деце прикупљани су у предшколској установи у западном делу Републике Српске. У дневним оброцима садржаји масти, беланчевина, угљених хидрата, воде и минералних материја одређени су стандардним методама. Индекс телесне масе (BMI) је утврђен на основу антропометријских мерења.

**Резултати** Просечан садржај масти у дневном оброку био је 17,5 g, беланчевина 19,1 g, а угљених хидрата 101,5 g, док

је енергетска вредност била 676 Kcal. Анализа података из јеловника показала је да је број порција воћа, поврћа, млека и млечних производа мањи од једне порције на дан. Само је број порција меса и месних производа био већи од једне порције дневно. Од укупног броја деце потхрањено је било 10,0%, с прекомерном телесном тежином 16,7%, док је 13,3% деце било гојазно.

**Закључак** Дневни оброци у предшколској установи нису у складу с препорученим уносом за енергију и угљене хидрате, а састав оброка је неодговарајући. Родитељи и васпитачи би требало да подстакну децу да једу различите врсте воћа и поврћа, житарица од целог зрна и немасних млечних производа, те да се избалансира унос хране с препорукама.

**Кључне речи:** исхрана; деца предшколског узраста; храна; индекс телесне масе; гојазност

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