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Original Article

The analysis of the collective diet of preschool children in Niš, Serbia and potential health risks

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Summary. Preschool age is an important period for acquiring the eating habits and evaluation of the children's collective nutrition in kindergartens is especially important for prevention of potential health risks. The aim of the paper was to assess the kindergarten servings in Niš (Serbia), in respect to probable health risks. The study was done in the period from 2011 to 2014. In daily portion, macronutrient shares were determined by using proximate analysis in the accredited laboratory and micronutrient shares were calculated by food composition tables. The mean energy value of the examined servings was (range: 657.7-1,1363 kcal). The share of macronutrients in the total energy intake were in accordance with the national recommendations: protein (13.54%), fat (32.32%) and carbohydrates (54.16%). An average daily serving contained 6.22 mg of Fe, 107 mg of Mg, 2411 mg of Na, and 351.4 mg of Ca. The results of our study indicate that children in kindergartens in Nis, Serbia consumed servings with no risk of developing obesity. The total quality of servings should be improved, because of the observed inadequacies of minerals and vitamins and possible health risks.

Key words: risk management, food quality, preschool children

Introduction

The analysis process of the health risks regarding the food consists of risk assessment of food products, risk management and interactive information exchange regarding the risk. Identifying hazards, i.e. anything that may cause harm is the first step when carrying out health risk assessment (1).

In the preschool period, children learnt about appropriate and balanced diet and acquire good eating habits in later life. It should provide sufficient nutrient and protective substances for proper growth, development and physical activity. During the first year of life, growth and development are extremely rapid, especially in the first six months when a child needs to double its birth weight. At the end of the first year of life, a threefold increase in birth weight is expected, as well as an increase in body length by about 50%. In the early childhood, the stages of intense growth interchange with the stages of a slightly slower growth, and puberty is the next intense growth stage.

Energy needs depend on the age and in infants they are up to 150 kcal/kg of the body weight. The needs of children in their early childhood are about 1000-2000 kcal, in the preschool age of about 1700 kcal and about 2500 kcal in the school age. During adolescence, energy needs differ significantly depending on gender and range from 2500-3600 kcal (2, 3).

Protein intake in children should be significantly higher than in adults. Requirements are greatest in the

youngest children (2-3 g/kg of body weight) and they gradually decrease with the age. Proteins that children intake should be of high quality, in order to satisfy the intake of essential amino acids. Carbohydrates should satisfy 55-60% of a daily intake, where, as in adults, preference is given to complex carbohydrates. Unlike adults, high intake of dietary fibers is not recommended for younger children due to the insufficient development of their digestive tract. Recommended fat intake is slightly higher in children than in adults. By the age of five, the fat intake ranges up to 40% of the total daily intake (due to energy security, the development of the nervous system and the intake of liposoluble vitamins), and after the fifth year of life it should be reduced to 30% (4, 5).

Regarding the protective substances, the requirements for calcium, iron, zinc, vitamin A and vitamin C are increased in children than in adults and deficiencies may be due to inadequate diet. Iron deficiency is common in young children aged 6-36 month, even in Europe (6).

Pre-school nutrition-related behaviours influence diet and development of lifelong eating habits (7). In addition to genetic predisposition and insufficient physical activity, nutrition has the greatest effect on the appearance of obesity in children, which today is one of the biggest problems in the world (8).

The aim of the paper was to assess chemical analysis of the servings in kindergarten in Niš (Serbia), including the different type of food, in respect to a probable health risks.

Method

Study design

The study had been conducted in the period from 2011 - 2014 in 30 kindergartens in Niš, Serbia. The material for analysis (the entire daily serving) was collected seasonally during five random days (20 annually) and the sample of each serving was collected from the serving on the dining table in front of a child. Chemical analysis was carried out after taking samples in sterile packaging by the method of random selection, after serving a meal, directly from the dishes.

Chemical analysis

In daily portion, macronutrient shares and serving weight were determined by using proximate analysis in the accredited laboratory of the Public Health Institute, Niš (9).

Measured serving ingredients were first measured in grams (meat separated from food, husked bananas, etc.), and then the total weight of the daily serving was measured. (10). the homogenization of the shares in servings was done by using mixers for fine homogenization. The weight of the serving was determined via the water share which was determined on the basis of the weight difference in the sample weight before and after drying in a drying oven at a temperature of 103±2°C to a constant weight:

$$\text{Water quantity (\%)} = \frac{\text{weight difference}}{\text{measured amount}} \cdot 100$$

From the obtained percentage of proteins, fats and carbohydrates, by the mathematical proportion from the total mass of the serving sample grams were calculated, and then calculated into kcal (kJ) (11, 12).

The share of the protein in the sample was defined by using the method of determining the share of total nitrogen in food according to the SRPS ISO 1871: 1992 guidelines by assessing the nitrogen share (13). Factor 6.25 was used in the calculation because the short-chain amino acids have higher nitrogen share, and longer-chain amino acids have lower nitrogen share. The process involves the mineralization by sulfuric acid in the presence of a catalyst, the alkalization of the reaction product, distillation of released ammonia and titration with sulfuric acid (14, 15). The result is presented as a percentage of the protein in a whole-day serving sample and it is calculated according to the following formula:

$$\text{Total nitrogen (\%)} = \frac{(b-a) \cdot N \cdot 14 \cdot V \cdot 100}{V_1 \cdot m}$$

a - the volume of the sulfuric acid solution used to titrate the blinded experiment (ml)

b - the volume of the sulfuric acid solution used for the sample titration (ml)

N - concentration of sulfuric acid solution

V - volume of the solution obtained after the mineralization of the sample portion for testing (ml)

V_1 - volume of the stock solution taken for distillation (ml)

m - mass of the sample portion for testing (mg)

The fat share was determined by the Soxhlet total fat determination method which, after the hydrolysis of the hydrochloric acid sample, involves a multiple fat-extraction with an organic solvent in the Soxhlet apparatus. (16) The amount of total fat is expressed in percentages and calculated according to the following formula:

$$\text{Total fat (\%)} = \frac{a}{c} \cdot 100$$

a - mass of extracted fat (g)
c - mass of the sample taken for analysis (g)

The carbohydrate share was calculated by the following formula:

Carbohydrates (%) = 100% - (warer %) + (protein % + fat % + 2.2*)
** 2.2 applies to salt and non-digestible carbohydrates*

Calculation and interpretation

Based on the consumption of food determined by kitchen warehouse lists and the number of presented children in kindergartens, the average daily intake of certain vitamins (vitamin B1, PP and C) and minerals (K, Na, Mg, Ca, P, Cu and Fe) is calculated by using a specially designed software tool, based on the chemical composition of different foods.

The statistics was done by using the Microsoft Excel software.

The obtained results were interpreted in relation to the rulebook on the norm of social nutrition of children in institutions for children. Accordingly to the Serbian Book of Regulations, the kindergarten servings must provide at least 75% of the daily energy requirements and 90% of the daily requirements in animal proteins and vitamins. As children in the "Pčelica" institution are mostly aged 3-5, the results are commented in relation to the Book of regulation Value for that age (17).

Results

Chemical analysis of the pre-school children's servings

The mean weight of daily servings in the investigated period was 1142 g, ranging: 712 g - 1552 g (Fig. 1).

No trend was observed in the average daily weight in the studied period. The energy value of the examined daily servings ranged from 657.7 kcal to 1,1363 kcal and the average energy value of a daily serving was 897.0 kcal. As the daily energy needs of children aged 3-5 years are 1600 kcal per day, the examined servings meet 56.1% of the daily energy needs of this population group.

Table 1 shows the macronutrients shares of servings in the investigated period. The average amount of protein in the energy value of a serving during the investigated four-year period was 34.58 g. The average amount of fat was 36.34g (ranged: 28.50 g - 42.30

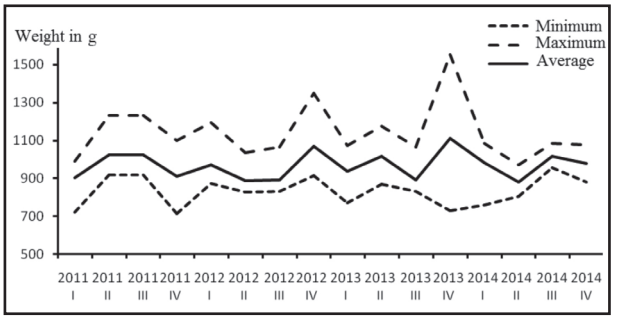

Figure 1. Trends of the mean weight of kindergarten servings in Niš in 2011-2014

Table 1. The macronutrients shares of kindergarten servings in Nis in the 2011-2014 period

Nutrient substances (g)	n	X	Min.	Max.	SD	%	Norm (g)	Norm (%)
Protein	80	34.58	28.30	46.40	4.87	13.54	29	10-15
Fat	80	36.34	28.50	42.30	3.98	32.32	39	25-30
Carbohydrates	80	138.21	118.50	166.20	15.75	54.16	176	55-60

g), whereas the average amount of carbohydrates was 138.21 g. Proteins were present in a full-day serving in the value that was above the normative (29 g), while the fat (32.32%) and carbohydrates share (54.16%) was a little below the normative standards.

Figures 2-4 present the trend of the share of proteins, fats and carbohydrates in a daily serving. Proteins are increased, and fats and carbohydrates are below the recommended values.

Micronutrient shares in the daily servings of pre-school children

Table 2 presents the share of minerals in daily servings in the investigated period.

The share of calcium in the examined servings was lower than the recommended value (720 mg) and amounted to 351.41 mg. The phosphorus share in the servings ranged from 451.80 mg to 828.00 mg and is also lower than the value prescribed by the norm. The average potassium share (1697.87 mg) is optimal, and copper share (0.50 mg) is lower. An average daily serving contained 1528.50 mg of sodium. The average magnesium share was 107.95 mg (60.08%), which was lower than the recommended value. The average iron share was 6.22 mg (69.14%), which was also below the value prescribed by the norm (9 mg) (Figures 5-11) present the trend of mineral shares in daily servings.

The vitamins share in servings is presented in Table 3.

In the average children's serving, the share of vitamin B1 (34.25%) ranged from 0.44 mg to 0.90 mg, which was insufficient compared to the values prescribed by the norm. The share of vitamin PP (67.07%) ranged from 5.06 mg to 8.80 mg, which was also insufficient compared to the norm. The share of vitamin C (173.65%) was above the recommendation. Vitamins

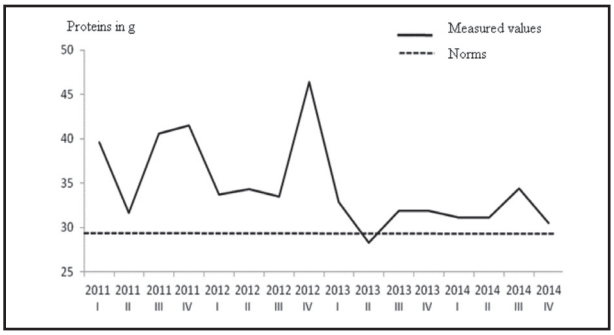

Figure 2. Trends of protein share in the energy value of a serving compared to the norm

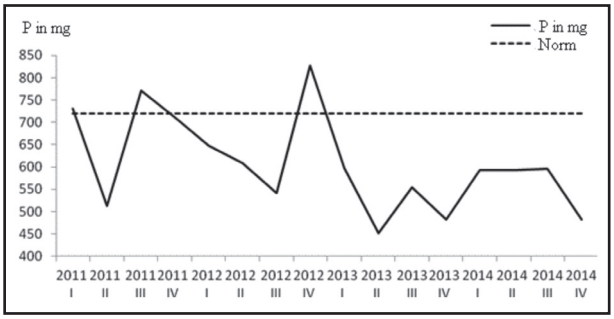

Figure 3. Trends of fat share in the energy value of a serving compared to the norm

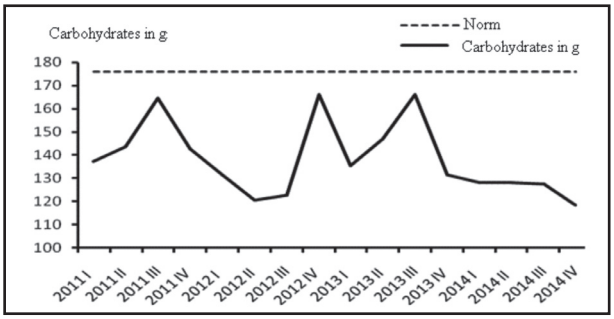

Figure 4. Presents trends of carbohydrate share in the energy value of a serving compared to the norm

Table 2. Minerals share in daily servings

Minerals (mg)	N	Min.	Max.	X	SD	%	Norm (mg)
Ca	80	165.00	512.70	351.41	104.59	48.78	720
P	80	451.80	828.00	606.36	108.19	85.51	720
Mg	80	75.20	158.60	107.95	26.88	60.08	180
Fe	80	4.60	9.00	6.22	1.27	69.14	9
Cu	80	0.36	0.63	0.50	0.09	lower	0.7-1.8
Na	80	1103.00	2411.20	1528.50	360.39	higher	405-215
K	80	1033.60	2191.40	1697.87	314.82	prescribed	697-2092

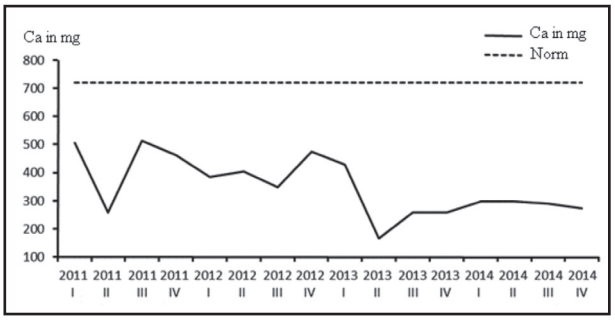

Figure 5. Calcium share trends in daily servings compared to the norm

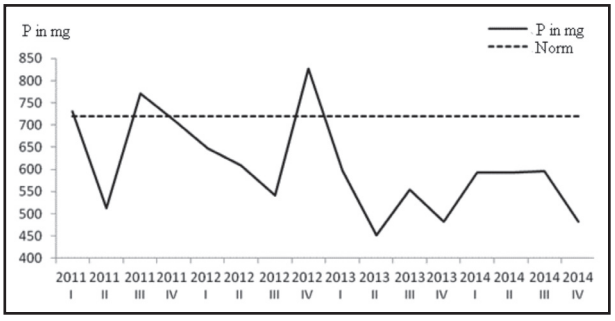

Figure 6. Trends in phosphorus share in daily servings compared to the norm

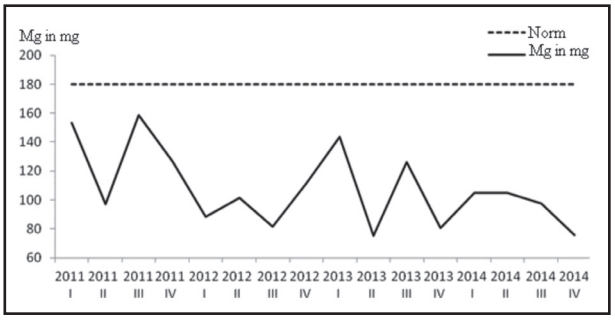

Figure 7. Trends of magnesium share in daily servings compared to the norm

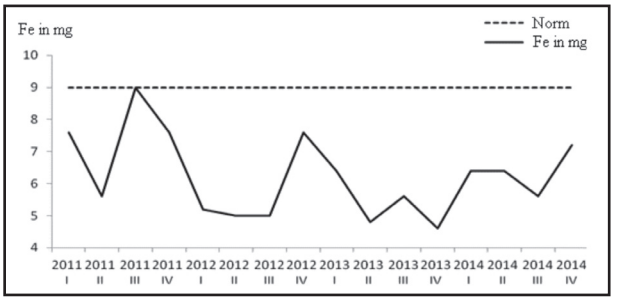

Figure 8. Trends of iron share in daily servings compared to the norm

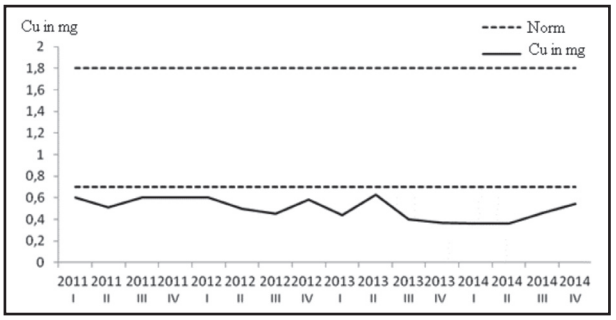

Figure 9. Trends of copper share in the daily servings compared to the norm

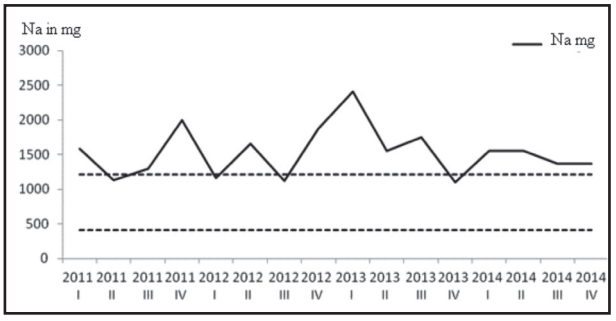

Figure 10. Trends in sodium share in daily servings compared to the norm

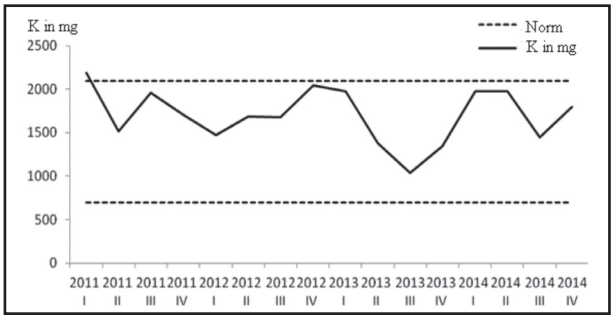

Figure 11. Trends of potassium share in daily servings compared to the norm

share in the examined period in relation to the normative is presented in Figures 12-14.

Discussion

Pre-school servings make significant contributions to a healthy dietary behaviour, at a time when eating habits and food preferences are being formed. Prevention of the unhealthy dietary habits in preschool

Table 3. Vitamins share in daily servings

Vitamin (mg)	N	Min.	Max.	X	SD	%	Norm (mg)
B1	80	0.44	0.90	0.62	0.14	34.25	1,81
PP	80	5.06	8.80	6.62	1.16	67.07	9,90
C	80	21.20	108.40	70.14	26.71	173.65	40,50

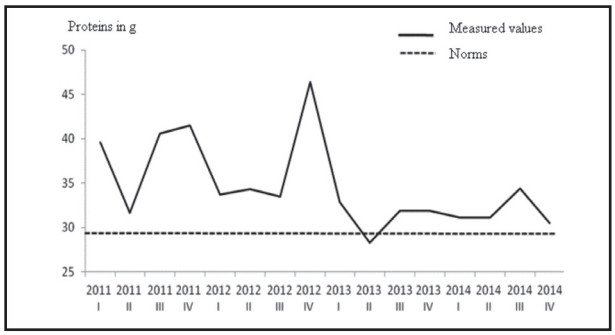

Figure 12. Trends of B1 vitamin share in daily servings compared to the nor

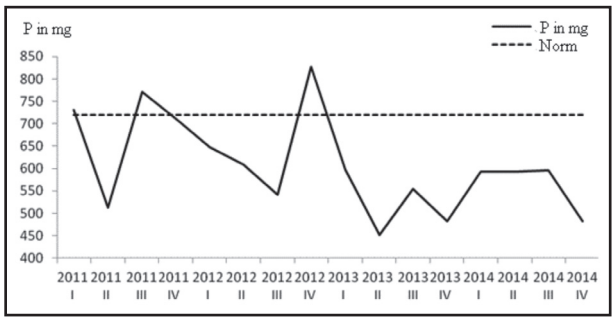

Figure 13. Trends of PP vitamin share in daily servings compared to the norm

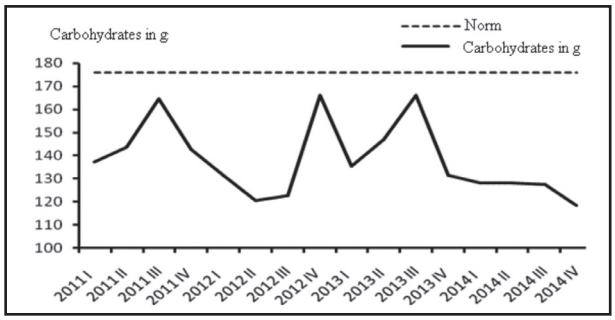

Figure 14. Trends of vitamin C share in daily servings compared to the norm

children is very important for their future health and permanent concern about children's food intake in kindergarten is serious social task (18, 19).

The results of our study indicate that the energy values of preschool servings consumed in kindergarten in Nis did not pose a risk of developing obesity. The energy value of servings did not exceed the level recommended by the national regulative and were adequate to the time spent by children in kindergartens, usually shorter than 10 hours. Compared to our results, kindergarten children in Brazil consumed servings of lower energy value than required (13). On the other hand, on average, the children consumed 1.280 kcal per day, in Hong Kong or 92% of the Chinese Nutrition Society's energy recommendation (20).

The result of the study indicated that the share of macronutrients in the total energy intake were in accordance with the national recommendations: protein (13.54%), fat (32.32%) and carbohydrates (54.16%). On the other hand, shares of fat were higher than suggested in the children servings in kindergartens of six cities in China had the higher energy value higher due to fat (21).

The share of calcium, magnesium, iron, cooper and phosphorus in the analyzed servings were inadequate. The obtained results indicate a significant deficiency in mineral share in the collective diet of the preschool population in Nis. According to the chemical analysis, Djermanovic M. et al. reported similar data for the intakes of calcium and iron through the collective diet of the preschool children aged up to 7 in Republika Srpska (22).

Minerals have significant roles in the human organism and are very important in the process of children's growth and development. According to the WHO, there are approximately 2 billion people worldwide with a mineral deficiency and children belong to the particularly sensitive to the lack of minerals (23).

Determined low calcium intake in our study may predispose the studied preschoolers to osteoporosis in later life (24). According to Ekbote V. et al., the mean calcium intake was 57% of the RDA in 2–16-year-old

Urban Western Indian children. The modifications of servings in kindergarten, with the choice of calcium-rich foods, the estimated calcium share of the diet may be increased. Preschool children are consuming more nutrient-dense foods and a more servings of fruit and vegetables at childcare during lunch than at home during dinner. Childcare and parents should work together to provide early and consistent exposure to nutrient-rich foods to ensure optimal nutrition for developing children (25).

This study also indicates inadequate magnesium intake through the servings in kindergartens. Magnesium deficiency is not usual in this period of life, but a comparison between the whole wheat bread versus the refined wheat bread in Serbian Food composition database reveals higher amounts of magnesium (86 vs 15 mg/100 g) and one of the basic change could be using more of whole grains in children's servings.

Iron deficiency is considered to be one of the most widespread micronutrient deficiencies in the world. Due to the increased need for iron during the period of accelerated growth and development, children belong to the group that is exposed to the highest risk of this deficiency. Several studies indicated the connection between sideropenic anemia in infants and their slower cognitive development.

Copper deficiency manifests as hypochromic anemia, and neutropenia, and in children has been associated with bone abnormalities, including osteoporosis, fractures of the long bones and ribs, and stunting. This metal is an essential nutrient, also very important for iron metabolism.

This study demonstrated a too excessive intake of sodium in the preschool servings in Nis, which is one of the factors for hypertension development. Investigations have brought evidence that salt intake is positively related to systolic blood pressure and that children with higher blood pressure are more susceptible to hypertension in adulthood. Much further effort is required to reduce salt share of consumed food. Our findings of a high sodium intake in children are similar to data from recent research studies in Serbia and other countries.

Our examination of vitamin shares in an average children's serving showed that vitamin B1 was lower in relation to the norm, as well as the share of vitamin PP. Vitamin C was just above the prescribed values. As well as in our study, investigators from Poland found many inadequacies for vitamin intakes (26).

If the nutritional share of preschool menus was not balanced, it is not surprising that the result is preschoolers' inadequate intake. To prevent health effects resulting from inadequate and excessive intakes of nutrients, it is necessary to plan balanced preschool menus and for this purpose, a dietician has been employed in the kindergarten of the city of Nis.

In modern science, both in our country and in the world, the quality of products and its safety are closely linked and they represent a good basis for further research. Nutrition is a significant factor in the prevention of various diseases and the improvement of the health of the pre-school children. It is necessary for growth, development and body function, and nutrition planning is based on the physiological needs of each and every individual.

The issues of management of the risk of preschool children's nutrition as well as the methods of the quality control and safety standards are increasing in their importance in the modern world because the consumers are the most sensitive population – children. Risk management is significant in terms of comprehensively addressing problems that include the safety of technological systems, types of risks and risk assessment methods, with a special emphasis on the health risk caused by food. Our analyses show that compliance with norms is of great importance for the quality of the final product.

Conclusion

To conclude, preschool diets in kindergarten need continuous improvement to prevent diet-related diseases in the preschoolers. Even though the mean energy value of servings did not exceed the recommendation and the share of proteins, fats and carbohydrates was optimal, the total quality of investigated servings should be improved by introducing food with high-nutrient density. Better planning of the children's nutrition in kindergartens with constant laboratory control of servings may be the future strategy, any deviation from the prescribed intake of nutrients negatively af-

fects the growth, development and health of children. Multidisciplinary consideration of nutrition issues is significant because of its complexity and actuality.

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