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ORIGINAL ARTICLE

THE NEED FOR MODIFYING ENERGY INTAKE IN PRESCHOOL CHILDREN FROM PIŁA, POLAND[1]

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ABSTRACT

Background. Monitoring energy intake in preschool children is the basis for planning intervention programmes. The published articles in which energy intake in Polish preschool children was reported are still very few.

Objective. The objective was to assess energy intake in preschool children from Piła, including energy intake and intake of energy from macronutrients.

Material and Methods. Energy intake was assessed from weighed food records kept over seven consecutive days by preschool staff and parents of 122 children, 61 girls and 61 boys, aged 4 to 6 years. Energy intake was calculated using Dieta 4.0 and Microsoft Excel computer programmes. Weight and height were measured and BMI was calculated. Statistical analysis was carried out using the IBM SPSS Statistics 21 computer programme.

Results. Energy intake was the lowest in underweight children, 1286 kcal, and the highest in obese children, 1636 kcal. Energy intake (kcal, kJ, kcal/kg body weight, kJ/kg body weight) and intake of energy from sucrose (%) were statistically significantly higher in boys compared to girls, 1546 vs 1428 kcal, 6477 vs 5985 kJ, 77 vs 71 kcal/kg body weight, 322 vs 298 kJ/kg body weight, and 21.2 vs 19.7%, respectively. Intake of energy from starch was statistically significantly higher in girls compared to boys, 24.8 vs 23.4%. It is noteworthy that energy intakes from fat and saturated fatty acids were above the recommendations in 71.3% and 98.4% of the studied preschool children, respectively. Energy intakes from polyunsaturated fatty acids and available carbohydrates were below the recommendations in 98.4% and 57.4% of the studied preschool children, respectively.

Conclusions. Energy intakes from macronutrients in the studied preschool children need urgent modification to prevent the risk of future diet-related diseases. Preschoolers' parents and preschool staff should be educated about nutrition recommendations for children, especially about dietary risks of diseases and impaired neurodevelopment.

Key words: *preschool children, dietary intake, energy, macronutrients, nutrition, gender*

STRESZCZENIE

Wprowadzenie. Monitorowanie spożycia energii przez dzieci w wieku przedszkolnym jest podstawą planowania programów interwencyjnych. Do tej pory opublikowano niewiele prac poświęconych ocenie spożycia energii przez polskie dzieci w wieku przedszkolnym.

Cel. Celem badań była ocena spożycia energii przez dzieci w wieku przedszkolnym z Piły, z uwzględnieniem spożycia energii i spożycia energii z makroskładników.

Materiał i metody. Spożycie energii oceniono na podstawie bieżącego notowania spożywanych produktów, potraw i napojów przez siedem kolejnych dni przez personel przedszkolny i rodziców 122 dzieci, 61 dziewczynek i 61 chłopców, w wieku 4 do 6 lat. Spożycie energii obliczono przy użyciu programów komputerowych Dieta 4.0 oraz Microsoft Excel. Zmierzono masę ciała i wysokość ciała oraz obliczono BMI. Statystyczną analizę wyników przeprowadzono przy pomocy programu komputerowego IBM SPSS Statistics, wersja 21.

Wyniki. Spożycie energii było najniższe u dzieci z niedowagą, 1286 kcal, a najwyższe u dzieci otyłych, 1636 kcal. Spożycie energii (kcal, kJ, kcal/kg masy ciała, kJ/kg masy ciała) oraz spożycie energii z sacharozy (%) były statystycznie istotnie wyższe u chłopców niż u dziewczynek, odpowiednio, 1546 vs 1428 kcal, 6477 vs 5985 kJ, 77 vs 71 kcal/kg masy ciała, 322 vs 298 kJ/kg masy ciała, i 21,2 vs 19,7%. Spożycie energii ze skrobi było statystycznie istotnie wyższe u dziewczynek niż u chłopców, 24,8 vs 23,4%. Warto zwrócić uwagę, że spożycie energii z tłuszczu i nasyconych kwasów tłuszczowych było wyższe niż zalecane u, odpowiednio, 71,3% i 98,4% badanych dzieci. Spożycie energii z wielonienasyconych kwasów tłuszczowych i węglowodanów przyswajalnych było niższe niż zalecane u, odpowiednio, 98,4% i 57,4% badanych dzieci.

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Wnioski. Spożycie energii z makroskładników przez badane dzieci wymaga pilnej modyfikacji, aby zapobiec wystąpieniu chorób dietozależnych w przyszłości. Rodzice badanych dzieci oraz personel przedszkolny powinni być objęci edukacją z zakresu zaleceń żywieniowych dla dzieci, a zwłaszcza z zakresu żywieniowych czynników ryzyka chorób oraz zaburzonego rozwoju układu nerwowego.

Słowa kluczowe: *dzieci przedszkolne, sposób żywienia, energia, makroskładniki, żywienie, płeć*

INTRODUCTION

Nowadays, we are facing the increasing prevalence of diet-related diseases, therefore preventing them in the society becomes of crucial importance. Excessive energy intake is the cause of obesity, while inadequate or excessive intakes of energy from macronutrients may lead to the increased risk of atherosclerosis, diabetes or cancer. The prevention of diet-related diseases should start as early as possible, preferably in women who plan pregnancy. Therefore, preschool age is the time when this prevention should start at the latest.

Monitoring energy intake in preschool children is the basis for planning intervention programmes aimed at improving children's diets and forming healthy food behaviour which would be tracked into prepubertal age, adolescence and adulthood, as well as nutrition education programmes addressed to preschool staff, parents and also the preschoolers. Unfortunately, the published articles in which energy intake in Polish preschool children was reported are still very few. These include: a study on a representative group of Polish preschoolers published by *Szponar* et al. in 2003 [38], a study on randomly selected 4-year-olds from all over Poland published by *Rogalska-Niedźwiedź* et al. in 2008 [31], a study on 6-year-olds from Nowy Sącz and the vicinity published by *Merkiel* in 2014 [22] and a study on 4-6-year-old children from Turek published by Merkiel et al. in 2014 [27]. Also, *Sadowska* et al. [32] published in 2010 a study on 4-6-year-old children from Szczecin in whom total energy intake was reported but not energy from macronutrients which were analysed only as expressed in grams.

The objective of our study was to assess energy intake in preschool children from Piła, including energy intake and intake of energy from macronutrients. These results are the part of a wide-range study described in details in the other article [4].

MATERIAL AND METHODS

General information

The results presented in this article are the part of the results of an intervention study on Polish preschoolers which aim was to modify diet and physical activity in preschool children in order to improve their nutritional status and physical fitness. The outline of this study [23] and the detailed description of the methodology [4] were presented in our previous articles. We present the results of dietary intake assessment from food records collected at the beginning of the study, that is before introducing the intervention. The study was approved by the Bioethics Committee of the Poznan University of Medical Sciences.

Subjects

The target population for this study were 234 children who attended two randomly selected preschools in Piła. Parents of 154 children provided written consent to take part in the study. However, parents withdrew 19 children at the beginning of the study, only five children were 3 years old and therefore were not included in the analysis, food records of two girls were also not included because they had problems with adapting themselves to the new environment and they ate hardly anything at preschool, parents of three children did not provide food records and parents of one child did not keep food records over the weekend. Moreover, we identified two underreporters as described in the section *Underreporting of energy intake*. Thus, we present the results of the assessment of food records collected from 122 children, 61 girls and 61 boys, aged 4 to 6 years.

Energy and macronutrient intakes

Data collection

Energy intake was estimated from weighed food records kept over seven consecutive days as described in details in the previous article [4]. In brief, food records were kept by parents and preschool staff who were instructed how to do it. Although the menu is the same for all children within one preschool, usually some children refuse to eat all the meals served or all the meal components. Moreover, children eat various portion sizes. Therefore, preschool staff weighed all foods, all components of the dishes, as well as beverages and water individually for each child. Supplements, if taken by the children, were also recorded.

Dietary assessment

Energy intake (kcal, kJ) was calculated in Dieta 4.0 computer programme and modified as described in our previous article [23] to receive as accurate data as possible. Intakes of energy from macronutrients (%) were calculated using the Microsoft Excel programme as also described in the previous articles [4, 23].

Underreporting of energy intake

Underreporters were identified using the same methods as in our previous article [22]. In brief, the ratio of energy intake to predicted basal metabolic rate (EI:BMR) was calculated [35]. Basal metabolic rate

was calculated using gender- and age-dependent Oxford predictive equations [12]. Records with EI:BMR ratios up to 0.97 for children aged 4 to 5 years, up to 1.01 for 6-year-old girls and up to 1.04 for 6-year-old boys were considered as not plausible measurements of the actual energy intake [35]. In the studied population, one 4-year-old girl and one 6-year-old boy with EI:BMR ratio below the abovementioned cut-off values were identified and were excluded from further analysis.

Comparison with nutritional guidelines

To assess if energy intake was adequate, body mass index (BMI) was calculated and assessed as described in the section *Anthropometric measures* and energy intake was presented according to the percentile categories for BMI. Intakes of energy from macronutrients were compared to those recommended in the prevention of diet-related diseases [39], similarly to the previous articles [22, 27].

Anthropometric measures

To calculate BMI, weight and height were measured. Similarly to our previous articles [22, 25], BMI was classified to the percentile ranges using the tables provided by *Kuczmarski* et al. [17]. The percentile ranges were called using the terminology recommended by the International Obesity Task Force (IOTF) [2]: below the 5th percentile – underweight; from the 5th to the 84th percentile – healthy weight; from the 85th to the 94th percentile – overweight; the 95th percentile or above – obesity.

There were two reasons for using the IOTF classification and terminology. The first reason is that presenting results according to this classification makes it possible to compare the results with the results of children from various countries. The second reason was that there are only four percentile ranges according to the IOTF classification and as many as seven according to the Polish percentile ranges for BMI. When we classified the results according to the Polish percentiles, as many as three percentile ranges were represented by only one child or two children which is not good for statistical analysis.

Statistical analysis

Statistical analysis was carried out using the IBM SPSS Statistics computer programme, version 21.0 (Armonk, NY: IBM Corp.). Energy intake (kcal, kJ) and intakes of energy from macronutrients (%) were analysed according to gender. Energy intake (kcal) was also analysed according to the percentile categories for BMI. Means, standard deviations (SD), medians and standard errors (SE) were calculated. The percentages of children with energy intakes from macronutrients below or above the recommendations were calculated.

Statistical analysis was performed as previously [22]. Qualitative variables were presented in contingency tables. Statistical significance was determined using Pearson's chi-square test with the level of significance at $P \leq 0.05$. The normality of quantitative variables was tested using the *Shapiro-Wilk* statistisc. The level of significance was set at $P \leq 0.05$. To investigate statistically significant differences, the unpaired *Student's t* test for normally distributed variables and the non-parametric *Mann-Whitney U* test for skewed variables were used. The level of significance was also set at $P \leq 0.05$.

RESULTS

Table 1 shows energy intake in the studied children according to the percentile categories for BMI. Energy intake was the lowest in underweight children, 1286 kcal, and the highest in obese children, 1636 kcal.

Table 2 presents energy intake in the studied children according to gender. Energy intake (kcal, kJ, kcal/kg body weight, kJ/kg body weight) and intake of energy from sucrose (%) were statistically significantly higher in boys compared to girls, 1546 vs 1428 kcal, 6477 vs 5985 kJ, 77 vs 71 kcal/kg body weight, 322 vs 298 kJ/kg body weight, and 21.2 vs 19.7%, respectively. Intake of energy from starch was statistically significantly higher in girls compared to boys, 24.8 vs 23.4%.

Table 3 shows the percentages of the studied children in the reference ranges for energy intake from macronutrients according to gender. No statistically significant differences were observed. It is noteworthy that energy intakes from fat and saturated fatty acids were above the recommendations in 71.3% and 98.4% of the studied preschool children, respectively. Energy intakes from polyunsaturated fatty acids and available carbohydrates were below the recommendations in 98.4% and 57.4% of the studied preschool children, respectively.

Table 1. Energy intake in the studied children according to the percentile categories for BMI

Percentile categories for BMI	Energy intake (kcal)				Population	
	Mean	SD	Median	SE	%	N
Below the 5th percentile (underweight)	1286	202	1298	90	4.1	5
5th – 84th percentile (healthy weight)	1481	231	1462	25	73.0	89
85th – 94th percentile (overweight)	1521	330	1458	69	18.8	23
95th percentile and above (obesity)	1636	299	1689	134	4.1	5

Table 2. Energy intake in the studied children according to gender

Energy	Reference values	Girls (*N* = 61)		Boys (*N*= 61)		All children (*N*= 122)		*P*	Girls (*N* = 61)		Boys (*N* = 61)		All children (*N* = 122)	
		Mean	SD	Mean	SD	Mean	SD		Median	SE	Median	SE	Median	SE
Energy (kcal)	body weight dependent	1428	243	1546	258	1487	256	0.011	1425	31	1519	33	1459	23
Energy (kJ)		5985	1019	6477	1078	6231	1073	0.011	5970	130	6374	138	6116	97
Energy (kcal/kg body weight)	NA	71	13	77	14	74	14	0.017	72	2	77	2	75	1
Energy (kJ/kg body weight)	NA	298	54	322	57	310	57	0.017	302	7	324	7	313	5
Energy from protein (%)	10-15%	12.0	1.5	12.1	1.8	12.0	1.6	NS	11.8	0.2	12.1	0.2	11.9	0.1
Energy from fat (%)	20-30%	33.7	4.9	33.2	4.1	33.4	4.5	NS	32.9	0.6	33.7	0.5	33.2	0.4
Energy from saturated fatty acids (%)	<10%	14.2	2.4	14.5	2.1	14.3	2.3	NS	14.2	0.3	14.4	0.3	14.3	0.2
Energy from polyunsaturated fatty acids (%)	6-10%	3.9	1.0	3.7	0.8	3.8	0.9	NS	3.7	0.1	3.5	0.1	3.6	0.1
Energy from monounsaturated fatty acids (%)	>10%[1]	13.3	2.4	12.8	2.0	13.0	2.2	NS	12.8	0.3	12.8	0.3	12.8	0.2
Energy from available carbohydrates (%)	55-70%[2]	54.0	5.0	54.3	4.9	54.1	4.9	NS	53.9	0.6	53.7	0.6	53.8	0.4
Energy from lactose (%)	NA	3.9	2.3	4.1	1.9	4.0	2.1	NS	3.3	0.3	3.7	0.2	3.5	0.2
Energy from sucrose (%)	NA	19.7	3.7	21.2	4.6	20.5	4.2	0.047	19.2	0.5	20.9	0.6	20.4	0.4
Energy from starch (%)	NA	24.8	4.4	23.4	4.2	24.1	4.3	0.010	24.9	0.6	22.9	0.5	23.8	0.4

P – significance; NA – not available; NS – not significant ($P>0.05$).

[1]Calculated by difference as: energy from fat – (energy from saturated fatty acids + energy from polyunsaturated fatty acids).

[2]Calculated by difference as: the percentage of total energy – energy from protein – energy from fat.

Table 3. The percentages of the studied children in the reference ranges for energy intake from macronutrients

Nutrient	Girls (N = 61)	Boys (N = 61)	All children (N = 122)	P
	%	%	%	
Energy from protein (%)				
below the recommendations	3.3	6.6	4.9	
within the recommendations	95.1	86.9	91.0	NS
above the recommendations	1.6	6.6	4.1	
Energy from fat (%)				
within the recommendations	26.2	31.1	28.7	NS
above the recommendations	73.8	68.9	71.3	
Energy from saturated fatty acids (%)				
within the recommendations	3.3	0.0	1.6	NS
above the recommendations	96.7	100.0	98.4	
Energy from polyunsaturated fatty acids (%)				
below the recommendations	96.7	100.0	98.4	NS
within the recommendations	3.3	0.0	1.6	
Energy from monounsaturated fatty acids (%)				
below the recommendations	9.8	13.1	11.5	NS
within the recommendations	90.2	86.9	88.5	
Energy from available carbohydrates (%)				
below the recommendations	57.4	57.4	57.4	NS
within the recommendations	42.6	42.6	42.6	

P – significance; NS – not significant (P>0.05).

DISCUSSION

Gender as a factor influencing energy intake

Higher intake of energy in boys compared to girls is natural and results from mean higher body weight of males compared to their female peers. Moreover, boys are usually more physically active than girls irrespective of age [15], however, not always as was observed among preschool children from Poznań [7]. In the previously studied Polish preschoolers, energy intake was also higher in boys compared to girls: in 4-6-year-old girls and boys from all over Poland [38], in 4-6-year-old girls and boys from Turek [27], as well as in 4.6-year-old girls and boys from both urban and rural regions [31]. The same tendency may be found in preschool children from other countries, for example in 4-6-year-old girls and boys from Great Britain [11] or in 4-6.5-year-old girls and boys from Belgium [13].

Moreover, as in the studied preschool girls and boys from Piła, statistically significant differences in energy intake between girls and boys were also found in children of the same or similar age from Poland or other countries. Gender was reported to be statistically significant factor of energy intake among 4.6-year-old girls and boys from rural regions [31], among girls and boys aged 49-60 months from Greece [21], among 4-6.5-year-old girls and boys from Belgium [13], among 6-year-old girls and boys from Nowy Sącz and the vicinity [22], among 7-year-old girls and boys from Great Britain [10], among 5-11-year-old girls and boys from France [20] and among 7-9-year-old girls and boys from Portugal [28]. Only among 4-6-year-old girls and boys from Turek [27] and 4.6-year-old girls and boys from urban regions [31], energy intake was not statistically significantly different.

We expected to find more statistically significant differences in energy intake from macronutrients in the studied preschoolers from Piła. Among 6-year-old girls and boys from Nowy Sącz and the vicinity [22] and among 7-year-old girls and boys from Great Britain [10], statistically significant differences were found in energy intake from four macronutrients, while among 4-6.5-year-old girls and boys from Belgium [13] – from as many as six macronutrients. However, among 7-9-year-old girls and boys from Portugal [28], statistically significant difference was found in energy intake from only one macronutrient and among 4-6-year-old girls and boys from Turek [27] no statistically significant differences were observed.

Assessment of energy intake

Energy intake in the studied preschool children from Piła increased through the percentile categories for BMI. Although such result is logical and should be expected, it is not usually observed due to underreporting of energy intake by overweight and obese subjects. However, underreporting has been little explored in preschool children. Energy underreporting in children with the highest body weight and/or the highest BMI was found in 4-11-year-old children from the United States [9], 2-18-year-old children and adolescents from Germany [1] and 3-17-year-old

children from France [19]. It is worth noting that in the latter study, the rate of underreporters was very low in younger children, aged 3 to 10 years, and much higher in older children, aged 11 to 17 years [19]. In the studied group of preschool children from Piła, only two underrporters were identified. The probability of underreporting among the children included in the analysis is very low because preschool staff was strongly motivated, actively involved in keeping the food records and assisted by the authors while parents were willing to cooperate and filled in the food records reliably. This is reflected in the increase of energy intake across the percentile categories for BMI. In our previous studies, we observed the increase of energy intake through all of the percentile categories except for the highest categories: obesity in 6-year-old children from Nowy Sącz and the vicinity [22], and tendency to overweight and overweight in preschool children from Turek [27].

Although most of the studied children had adequate body weight, a substantial percentage of them was characterised by excessive body weight. It is interesting that energy intake in the studied children was lower than in their peers from all over Poland [38] and from Szczecin [32], and even younger Polish children, aged 4.6 years, from both urban and rural regions [31]. However, 4-6-year-old children from Turek were characterised by lower energy intake [27] than the studied preschoolers from Piła. The explanation may probably be found when taking the date of publication into account. The results in 4-6-year-old children from all over Poland [38] were published in 2003, those in 4,6-year-old children in 2008 [31] and those in 4-6-year-old children from Szczecin in 2010 [32]. Thus, lower energy intake in 4-6-year-old children from Turek published in 2014 [27] and in the studied 4-6-year-old children from Piła may result from the decreasing physical activity observed among preschool children since 2005 [5] which may have caused the decrease in energy intake. Another explanation may be the differences in body weight. In 4-6-year-old children from Turek, whose energy intake was lower than in the studied children, as many as 12% were underweight, only 4% were overweight and nobody was obese [27]. However, among 4-6-year-old children from all over Poland [38] and 4-6-year-old children from Szczecin [32], whose energy intake was higher than in the studied children, the percentages of children with underweight and considerable underweight were higher than in the studied children, nevertheless, the percentages of obese children were also higher.

It is highly favourable that energy intakes from protein and monounsaturated fatty acids in the studied preschool children from Piła were within the recommended. Energy intake from protein in the studied girls from Piła was exactly the same as in 4-6-year-old girls from all over Poland [38], while in the studied boys it was lower than in 4-6-year-old boys from all over Poland [38] but still within the recommendations. Higher energy intake from protein, compared to the studied children from Piła, was observed in their peers from Szczecin [32], Great Britain [11] and 4-6.5-year-old children from Belgium [13], but also in children of similar age, that is 6-year-old children from Nowy Sącz and the vicinity [22], 4-10-year-old children from the United Kingdom [3], 7-year-old children from Great Britain [10], 5-11-year-old children from France [20] and children aged 5.7-7.6 years from Crete [37]. Much higher energy intake from protein than in the studied children, but also higher than the recommended, was reported in 4-6-year-old children from Turek [27], children aged 49-60 months from Greece [21], 6-7-year-old children from Spain [30], 2-5-year-old and 6-9-year-old children from Spain [34] and 7-9-year-old children from Portugal [28].

Similar energy intake from monounsaturated fatty acids as in the studied children from Piła was observed in 4-6-year-old children from all over Poland [38]. Lower energy intake from this macronutrient, but not lower than the recommended, was observed in 4-6-year-olds from Turek [27], 6-year-olds from Nowy Sącz and the vicinity [22], 4-6.5-year-olds from Belgium [13], 4-10-year-olds from the United Kingdom [3], 7-year-olds from Great Britain [10], 2-5-year-olds and 6-9-year-olds from Spain [34] and 7-9-year-olds from Portugal [28], but the highest energy intake from monounsaturated fatty acids, above 17% of energy, was observed in Cretan 5.7-7.6-year-olds [37] and Spanish 6-7-year-olds [30].

Unfortunately, the studied children's diets were characterised by excessive energy intake from fat and saturated fatty acids along with inadequate energy intake from polyunsaturated fatty acids. The same observations were reported in 4-6-year-old children from all over Poland [38] and 6-year-old children from Nowy Sącz and the vicinity [22]. Also, 4-6-year-old children from Szczecin were characterised by excessive energy intake from fat [32]. In 4-6-year-old children from Turek [27] energy intake from fat was within the recommended but energy intake from saturated fatty acids was too high and energy intake from polyunsaturated fatty acids was too low, that is the same as in studied children. The same tendencies were found in children from other countries of the same age or similar. Except for 4-6.5-year-old children from Belgium [13], energy intake from fat exceeding 30% was reported in all the previously studied groups of children: British 4-6-year-olds [11] and 7-year-olds [10], Greek children aged 49-60 months [21], 4-10-year-olds from the United Kingdom [3], Spanish 2-5-year-olds and 6-9-year-olds [34], French

5-11-year-olds [20] and Portuguese 7-9-year-olds [28]. The highest energy intake from fat, above 40%, was observed in Cretan 5.7-7.6-year-olds [37] and Spanish 6-7-year-olds [30]. In all of the mentioned groups of children from various countries [3, 10, 11, 13, 21, 30, 34, 37] energy intake from saturated fatty acids exceeded the recommendations, with the highest values reaching 16% in Spanish 6-7-year-olds [30], and in all these groups of children energy intake from polyunsaturated fatty acids was lower than the recommended except for Spanish 6-7-year-olds [30].

Taking into account the high prevalence of obesity and the studies which link obesity with excessive fat intake [18], as well as the high prevalence of obesity in the studied children's families [24], it is of great importance to limit energy intake from this macronutrient in the studied children. Moreover, a long time ago many studies showed that lower content of energy from fat in children's diets results in higher micronutrient intake [36], higher intake of fruit, vegetables and low-fat foods within such food groups as meats and dairy [8, 36], and higher nutrient density of most vitamins and minerals [29].

Energy intake from saturated fatty acids in the studied children needs urgent reduction, while energy intake from polyunsaturated fatty acids should be increased because of the substantial cardioprotective benefit. It is of crucial importance since ischaemic heart disease and stroke are the two most common causes of death all over Europe [14]. To reverse their increasing prevalence, the prevention should start in childhood. It is even more important when taking into account the high prevalence of myocardial infarction in the studied children's families [24]. Moreover, modifying energy intake from saturated and polyunsaturated fatty acids is also vital to the studied children's neurodevelopment. Studies showed that polyunsaturated fatty acids are involved in numerous neuronal processes, have significant effects on brain function and their deficiencies and imbalances may cause neurocognitive disorders [33]. Another study indicates that children whose diets are high in saturated fatty acids exhibit compromised ability to flexibly modulate their cognitive operations, particularly when faced with greater cognitive challenge [16].

To solve the problem of excessive energy intake from fat and saturated fatty acids along with inadequate energy intake from polyunsaturated fatty acids, high-fat foods in the studied children's diets should be replaced with their low-fat equivalents. The result would be not only reduced energy intake from fat but also increased intake of essential vitamins and minerals [36]. To improve energy intake from fatty acids, animal fat should be exchanged for rapeseed oil which in Poland is of high quality and available at relatively low price. This oil should be used not only for cooking but also for spreading on bread or pouring on salads and cooked vegetables. To make the taste of rapeseed oil better when spreading on bread or adding to vegetables, the good idea is to mix it with herbs, red pepper, garlic or ginger. Such mixture may be kept in the fridge for several days, so that it may be prepared in larger amount to use over a couple of days. Adding nuts to the studied children's daily diets would additionally increase their energy intake from polyunsaturated fatty acids.

Another concern is that energy intake from available carbohydrates in the studied preschool children from Piła was lower than the recommended and that energy intake from sucrose was very high. Although there are no reference values of energy intake from sucrose, it is recommended to consume less than 10% of energy from monosaccharides and disaccharides, including sucrose, which are added to foods by manufacturer, cook or consumer, as well as sugars which naturally occur in honey, syrups and fruit juices [39]. This means that if the energy intake from sucrose in the studied children was twice higher than the cited recommendation, energy intake from all added mono- and disaccharides and sugars contained in honey, syrups and fruit juices must have been much higher.

Among the previously studied Polish children, only in 4-6-year-old children from all over Poland [38] energy intake from available carbohydrates was within the recommendations. In 4-6-year-old children from Turek [27] and Szczecin [32], and in 6-year-old children from Nowy Sącz and the vicinity [22], energy intake from this macronutrient was too low, while energy intake from sucrose was too high, similarly to the studied children. Among the previously studied children from other countries, energy intake from available carbohydrates was also too low [3, 10, 11, 13, 20, 21, 30, 34, 37] with the lowest values, below 40%, in Spanish 6-7-year-olds [30]. Energy intake from sucrose was not analysed in children from other countries. However, energy intake from non-milk extrinsic sugars in 4-10-year-olds from the United Kingdom [3] was almost 15% and energy intake from simple carbohydrates exceeded 20% in Spanish 6-7-year-olds [30], Portuguese 7-9-year-olds [28] and British 7-year-olds [10], while in 4-6.5-year-old children from Belgium [13] it exceeded 30%.

High energy intake from sucrose in the studied children from Piła shows that parents either did not realise that the amount of sweets and sweetened beverages in their children's diets was too high or they were not able to refuse their children sweets. For sure, parents realised that high intake of sucrose is not good for the children's health because previous studies on nutritional knowledge of preschoolers' parents showed that they were aware of its adverse effects on teeth [6] and of the lack of any essential micronutrients in sugar [26].

To increase energy intake from available carbohydrates, more cereal products should be introduced to the studied children's diets. Eating meat or cheese without bread, pasta, rice or any other cereal product was quite a frequent habit among the studied children. To reduce energy intake from sucrose, it is necessary to eliminate sugar added to tea, to give up consuming sweetened beverages and to limit sweets which were eaten by the children even several times a day.

CONCLUSIONS

1. Energy intakes from macronutrients in the studied preschool children need urgent modification to prevent the risk of future diet-related diseases.
2. Preschoolers' parents and preschool staff should be educated about nutrition recommendations for children, especially about dietary risks of diseases and impaired neurodevelopment.

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Conflict of interest

The authors declare no conflict of interest.

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