

©Borgis

\*Katarzyna Wolnicka, Anna Taraszewska, Joanna Jaczewska-Schuetz

## Assessment of dietary habits and dietary intake in underweight children

## Ocena sposobu żywienia dzieci z niedoborem masy ciała

Department of Nutrition and Dietetic with Clinic of Metabolic Diseases and Gastroenterology,  
National Food and Nutrition Institute, Warsaw  
Head of Department: prof. Mirosław Jarosz, MD, PhD

### Summary

**Introduction.** Proper nutrition is one of the determinants of health. Diet disturbances, both lower or higher intake of nutrients, may lead to health impairment. Children and adolescents are exposed to negative effects of dietary mistakes in particular. Prolonged underweight leads to caloric/protein deficiencies which may result, especially at a young age, impairment of physical, mental and social development.

**Aim.** The aim of this study was to evaluate selected dietary habits and dietary intake of underweight students of 3<sup>rd</sup> class in primary schools.

**Material and methods.** From the population 1255 students of 3<sup>rd</sup> class of randomly selected primary schools from 5 regions of Poland, 122 students with underweight was enrolled in this study. Anthropometric data were collected. Food consumption (3-day dietary records) and eating habits questionnaire was completed by the children and their parents.

**Results.** 9.7% students was underweight – 11.5% girls and 7.9% boys. Over 25% of underweight children didn't eat breakfast every day before school and over 34% of them didn't eat second breakfast or school lunch every day. There was high percent of diet with deficiency of energy and nutrients such as fat, potassium, calcium, folate and vitamin D in examined group.

**Conclusions.** Nutritional habits as well as composition of diet of underweight children was unsatisfying and were different from dietary guidelines. Irregularities in nutritional habits and diet may have influenced the occurrence of underweight in this group of children. Underweight in children and adolescents may increase the risk of health impairment and influence negatively mental development and cognitive functions.

Key words: children, nutrition mode, underweight, malnutrition

### Streszczenie

**Wstęp.** Jednym z czynników determinujących zdrowie jest prawidłowe odżywianie. Zarówno niedoborowe, jak i nadmierne odżywianie oraz niewłaściwie zbilansowana dieta zaburzą dobrostan, wywołując bezpośrednio lub pośrednio problemy zdrowotne. Na negatywne skutki zaburzeń w stanie odżywienia są narażone zwłaszcza dzieci i młodzież. Długotrwałe niedożywienie prowadzi do wystąpienia niedoborów energetyczno-białkowych czego skutkiem, szczególnie w młodym wieku, może być zaburzenie rozwoju fizycznego, psychicznego i społecznego.

**Cel pracy.** Celem pracy była ocena sposobu żywienia dzieci z III klas szkół podstawowych z niedoborową masą ciała.

**Materiał i metody.** Badanie ankietowe nawyków żywieniowych oraz ocenę sposobu żywienia metodą 3-dniowego zapisu oraz pomiary masy ciała przeprowadzono w 2010 roku wśród 1255 uczniów III klas z losowo wybranych szkół podstawowych z 5 województw. W pracy przeanalizowano dane od 122 dzieci, u których stwierdzono niedoborową masą ciała, dotyczące wybranych nawyków żywieniowych oraz zawartości energii i składników odżywczych.

**Wyniki.** W badanej grupie dzieci niedowagę stwierdzono u 9,7% uczniów – u 11,5% dziewcząt i 7,9% chłopców. Analiza sposobu żywienia badanych dzieci z niedowagą wykazała, że ponad 25% z nich nie spożywało śniadania codziennie przed wyjściem do szkoły, a ponad 34% – nie spożywało codziennie drugiego śniadania lub obiadu w szkole. Ponadto w badanej grupie dzieci odnotowano znaczny odsetek diet niedoborowych w energii i składniki odżywcze, w tym w szczególności w tłuszcz, potas, wapń, foliany i witaminę D.

**Wnioski.** Nawyki żywieniowe, jak również skład diety badanych dzieci były niezadowolające i odbiegały od zaleceń dotyczących zasad prawidłowego żywienia. Stwierdzone nieprawidłowości mogły mieć wpływ na występowanie niedoborowej masy ciała w tej grupie dzieci. Niedoborowa masa ciała występująca wśród dzieci i młodzieży może zwiększać ryzyko zaburzeń stanu zdrowia i może mieć negatywny wpływ na ich rozwój intelektualny i funkcje poznawcze.

Słowa kluczowe: dzieci, sposób żywienia, niedoborowa masa ciała, niedożywienie

## INTRODUCTION

Proper nutrition is one of the determinants of good health. The term 'proper nutrition' means nutritional habits which optimally meet one's daily energy needs, nutrients, vitamins and minerals. Both lower and higher intake of nutrients, as well as improper diet may lead either directly or indirectly to health impairment. Children and adolescents are exposed to negative effects of dietary mistakes in particular.

Underweight is a state of insufficient flesh on the body usually defined as having a body weight less than skeletal and physical standards. Malnutrition is an imbalanced nutritional status resulted from insufficient intake of nutrients to meet normal physiological requirement. Underweight status and nutrient deficiencies may result, especially at a young age, in impairment of physical, mental and social development, as well as immune disorders. Malnutrition may also cause psychological problems (in connection with poverty it may decrease one's self-esteem) and social problems (bad results at school, and in connection with poverty – a risk of being unaccepted by peers).

Malnutrition does not always stem from poverty; it may be also the result of improper food intake or developing incorrect dietary habits in children. The problem of child malnutrition may also stem not only from insufficient amounts of food but also from improper dietary habits, a lack of appropriate care as a result of long working hours of parents and not eating anything at school.

Underweight is not only the result of dietary mistakes. Also the mass media, by presenting slim figure as beauty ideal, cause that younger and younger people, especially girls, are making unnecessary attempts to lose weight without doctor's supervision, which very often leads to malnutrition (1-3).

The problem of malnutrition in the world concerns mainly poor and developing countries. It is also observed, to a smaller extent, in developed countries. According to the OLAF research conducted between the years 2007 and 2009 on the representative base sample of children and adolescents (17.5 thousand) aged 6-19, in Poland the problem of underweight concerns 12% of population, including 10% of boys and 13.7% of girls (3-5).

When considering the problem of overweight, one should not forget about malnutrition, whose results may lead to health impairment, as well as to mental and social problems.

## AIM

The aim of this study was to evaluate selected dietary habits and dietary intake of underweight students of 3rd class in primary schools from five regions of Poland.

## MATERIAL AND METHODS

The study was carried out in 2010 among students of the 3<sup>rd</sup> class of 38 randomly selected primary schools

from 5 regions of Poland: pomorski, opolski, wielkopolski, podkarpacki and mazowiecki, as part of the assessment of School Fruit Scheme. Eating habits and food consumption questionnaire (3-day dietary records) was completed by the children and their parents, as well as anthropometric measurements of children were taken. 1255 children were enrolled in the study (628 boys and 627 girls). The occurrence of underweight was assessed according to the criteria of Cole et al. (6). Dietary habits in 122 children with underweight were analysed (50 boys and 72 girls).

A research tool in the study was a questionnaire which included open-ended and closed-ended questions concerning the respondents' eating habits, life-style and their knowledge about proper nutrition. Children filled in the questionnaire after being instructed by the pollster and they did it in his/her presence. Additionally, the assessment of food consumption was carried out with the use of 3-day dietary records. The 3-day dietary record was filled out by the children and their parents. Parents had been instructed by the pollster and additionally they had received written instructions on how to fill out the record.

For the purpose of this paper data concerning eating breakfast before leaving for school, as well as second breakfast or lunch eaten at school was analysed. Moreover, energetic and nutritional value in children's diets was also assessed. The assessment of energetic and nutritional value of diets was carried out with the use of Dieta 4.0 computer program. The collected data was presented as average 3-day food intake (taking into consideration nutrient losses in products) and compared with the EAR (*Estimated Average Requirement*), and in the case of vitamins E and D, as well as calcium, sodium and potassium – it was compared with AI (*Adequate Intake*) (7). When estimating the occurrence of poor diet in the sample group, a principle was applied that poor diet is the diet which meets one's daily energy needs, nutrients, vitamins and minerals in  $\leq 90\%$ .

The study was carried out with the consent of the Bioethical Commission at the National Food and Nutrition Institute.

The statistical analysis of collected data was performed with the use of Statistica 7 software package. Statistical significance of the results was  $p \leq 0.05$ .

## RESULTS

Underweight was observed in 9.7% (N = 122) of all children enrolled in the study (N = 1255). In the group in which dietary habits were analysed underweight was more often observed in girls (11.5%) than in boys (7.9%) ( $p = 0.516$ ). The data on average values of anthropometric features and BMI (*Body Mass Index*) is presented in the table 1.

The qualitative analysis of the collected data on dietary habits showed that most children in the sample group had 5 or more meals during the day. There were no significant differences between boys and girls in this matter (tab. 2).

Table 1. Values of anthropometric measurements and body mass index in examined group of 3<sup>rd</sup> grade primary schools students.

Anthropometric measurements	Total N = 122	Boys N = 50	Girls N = 72
	X ± SD		
Weight (kg)	25.37 ± 3.1	24.96 ± 3.1	25.95 ± 3.1
Height (cm)	136.15 ± 8.1	135.47 ± 8.2	137.13 ± 7.8
BMI (kg/m <sup>2</sup> )	13.63 ± 0.7	13.55 ± 0.7	13.75 ± 0.6

Table 2. Number of meals consumed by students with underweight.

Number of meals	Total N = 122	Boys N = 50	Girls N = 72	p
	N (%)			
2	1 (0.8)	–	1 (1.4)	0.402
3	8 (6.6)	3 (6.0)	5 (6.9)	0.948
4	42 (34.4)	20 (40.0)	22 (30.6)	0.284
5	54 (44.3)	21 (42.0)	33 (45.8)	0.678
> 5	17 (13.9)	6 (12.0)	11 (15.3)	0.605

Over 1/4 of the sample group (26.2%) did not have breakfast every day before leaving for school. The percentage of girls who did not have breakfast at home was lower than the percentage of boys (tab. 3).

Over 1/3 of children from the sample group (34.4%) did not have second breakfast or lunch at school. There were no statistical differences between boys and girls in this matter (tab. 3).

Table 3. Percentage of students with underweight who skip first breakfast before school and second breakfast or lunch at school every day.

Meal	Total N = 122	Boys N = 50	Girls N = 72	p
	N (%)			
First breakfast eaten before going to school	32 (26.2)	17 (34.0)	15 (20.8)	0.1
Second breakfast or lunch eaten at school	42 (34.4)	17 (34.0)	25 (34.7)	0.94

The analysis of diets of underweight children showed that the average energy intake in girls, average fat intake, and among minerals and vitamins – calcium, potassium, vitamin D and folate intake was lower than the average intake recommended for this age group. Also a small amount of dietary fiber was noted. The percentage of norm realization for energy, nutrients, minerals and vitamins was lower in girls than in boys. Vitamin D was an exception. Although its intake was insufficient, it was about 13% higher in the diet of girls than in the diet of boys. The data on the average energetic value, as well as on the average content of nutrients, minerals and vitamins was presented in table 4.

In the sample group of underweight children a significant percentage of diets low in energy, fat, folate, calcium and vitamin D was noted (fig. 1), as well as diets low in vitamin E and C, thiamine and niacin.

Almost half of diets did not provide appropriate for this age group amounts of energy, and energy deficiency was more common in girls than in boys (48.6% and

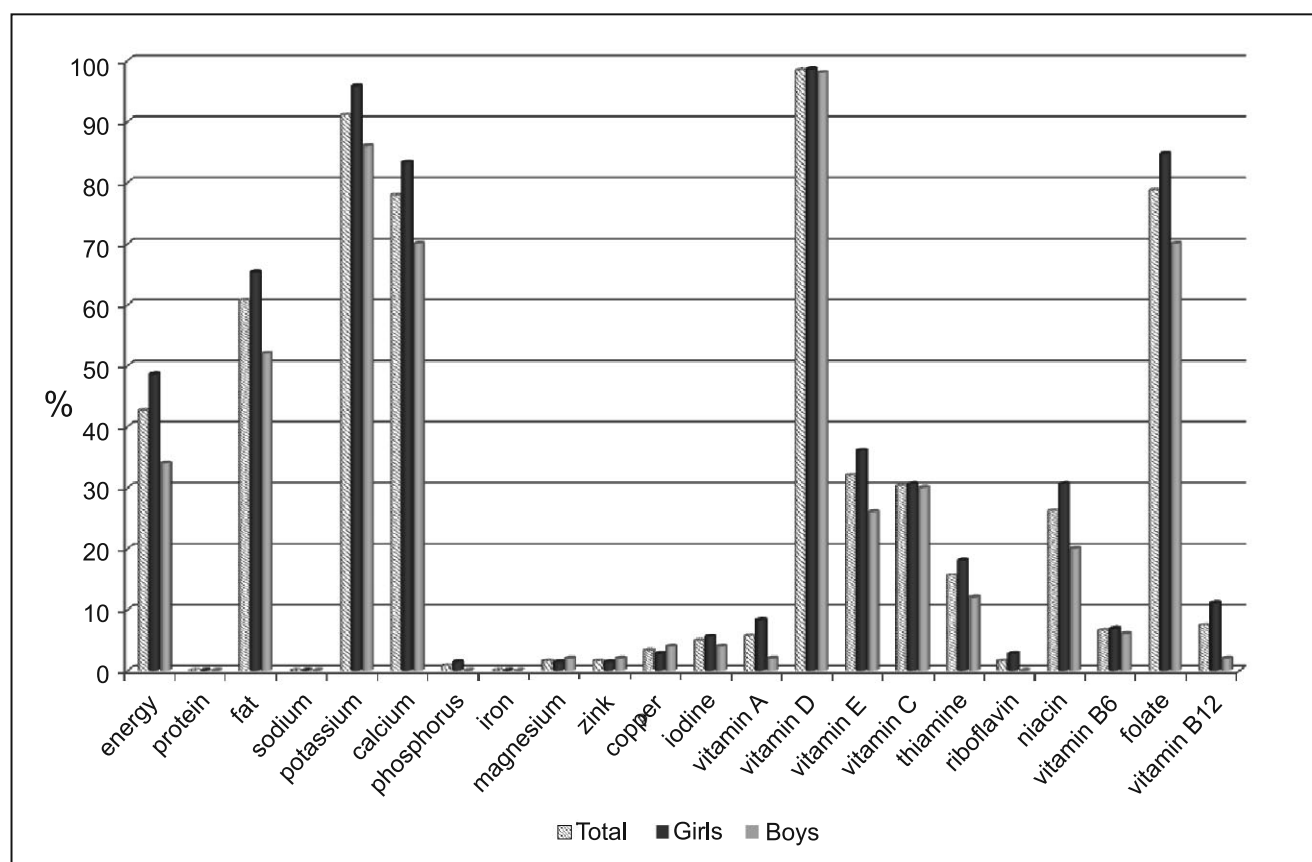


Fig. 1. Percentage of diets insufficient in energy and nutrients, intake under EAR or AI.

Table 4. Energy and nutrients in daily food rations of underweight students.

Components	Total N = 122			Girls N = 72			Boys N = 50		
	X ± SD	Median	% of norm realization	X ± SD	Median	% of norm realization	X ± SD	Median	% of norm realization
Energy [kcal]	1720.99 ± 376.87	1673.79	95.61	1654.83 ± 320.09	1626.67	91.94	1816.25 ± 425.20	1786.41	100.90
Protein [g]	58.71 ± 14.58	58.42	255.28	56.55 ± 12.94	57.53	245.86	61.83 ± 16.03	59.64	268.85
Fat [g]	62.57 ± 18.96	59.17	89.39	60.93 ± 18.70	57.13	87.04	64.94 ± 18.89	61.96	92.77
Cholesterol [mg]	214.30 ± 105.6	196.58	–	211.76 ± 125.55	192.09	–	217.96 ± 65.34	201.95	–
Carbohydrates [g]	243.45 ± 54.91	234.18	–	232.02 ± 42.10	222.16	–	259.90 ± 65.47	249.95	–
Fiber [g]	14.39 ± 4.05	13.9	–	13.56 ± 3.40	13.32	–	15.64 ± 4.53	15.13	–
Sodium [mg]	3127.43 ± 845.87	3012.53	260.62	2945.40 ± 736.30	2831.86	245.45	3389.55 ± 913.46	3230.74	282.46
Potassium [mg]	2404.65 ± 681.46	2425.02	64.99	2272.25 ± 564.85	2268.64	61.41	2595.31 ± 776.40	2652.22	70.14
Calcium [mg]	568.46 ± 219.23	539.63	71.06	544.24 ± 210.00	523.57	68.03	603.33 ± 225.26	552.24	75.42
Phosphorus [mg]	916.84 ± 232.3	920.15	183.37	877.87 ± 207.79	880.25	175.57	972.96 ± 251.16	965.53	194.59
Magnesium [mg]	210.39 ± 55.3	211.01	191.26	199.50 ± 46.82	198.86	181.36	226.07 ± 61.85	238.83	205.52
Iron [mg]	7.78 ± 2.31	7.42	194.48	7.54 ± 2.30	7.22	188.51	8.12 ± 2.26	7.97	203.07
Zinc [mg]	7.06 ± 1.89	7.0	176.53	6.76 ± 1.74	6.37	169.10	7.49 ± 2.01	7.77	187.24
Copper [mg]	0.84 ± 0.24	0.84	167.38	0.79 ± 0.20	0.76	157.50	0.91 ± 0.27	0.93	181.60
Vitamin A [µg]	834.95 ± 616.54	724.98	238.56	801.96 ± 623.09	724.98	229.13	882.47 ± 597.51	710.49	252.13
Vitamin E [mg]	7.77 ± 2.82	7.45	111.01	7.61 ± 2.68	7.02	108.74	8.00 ± 2.97	8.01	114.28
Thiamine [mg]	0.95 ± 0.33	0.91	135.85	0.91 ± 0.31	0.86	129.78	1.01 ± 0.33	1.06	144.60
Riboflavin [mg]	1.32 ± 0.4	1.28	165.2	1.27 ± 0.40	1.23	159.08	1.39 ± 0.39	1.36	174.02
Niacin [mg]	11.18 ± 3.98	10.87	124.26	10.91 ± 4.04	9.74	121.18	11.58 ± 3.83	11.59	128.70
Vitamin B6 [mg]	1.38 ± 0.45	1.39	172.75	1.32 ± 0.43	1.28	165.23	1.47 ± 0.45	1.52	183.59
Vitamin C [mg]	66.6 ± 47.68	47.76	166.49	62.61 ± 44.72	44.47	156.53	72.33 ± 50.65	61.27	180.83
Folate [µg]	183.0 ± 51.02	175.12	73.2	176.93 ± 48.31	170.15	70.77	191.75 ± 53.00	193.68	76.70
Vitamin B12 [µg]	2.76 ± 2.03	2.36	183.91	2.73 ± 2.39	2.36	181.71	2.81 ± 1.32	2.36	187.09
Vitamin D [µg]	1.91 ± 1.06	1.74	38.24	2.02 ± 1.14	1.78	40.38	1.76 ± 0.90	1.65	35.16
Iodine [µg]	122.53 ± 41.43	121.47	175.05	115.56 ± 34.98	114.48	165.09	132.57 ± 47.12	127.09	189.39



34.0%, respectively). Serious deficiencies concerned also fat – in girls 65.3% of diets were low in this component, and in boys – 52.0%. Folate and calcium were components whose deficiencies were noted in 70.0% of diets of boys and in 84.7% and 83.3% of diets of girls, respectively. Over 95% of diets of girls and 85.0% of diets of boys were low in potassium. All diets (98.8% of diets of girls and 98.0% of diets of boys) were low in vitamin D. In the case of other vitamins (apart from riboflavin) and minerals (apart from phosphorus and sodium) the percentage of diets low in those components fluctuated between 1.4% and 30.6% in girls and between 2.0% and 30.0% in boys, depending on the component. The only components whose deficiencies were not observed were: in girls – protein, iron and sodium, and in boys – protein, iron, phosphorus, sodium and riboflavin.

## DISCUSSION

According to academic literature, the problem of malnutrition in children in developed countries is a problem to which still less attention is paid than child overweight and obesity, in spite of the fact that both underweight and overweight/obesity in children and adolescents increase the risk of health impairment and developmental disabilities. Thus, it would be justified to pay more attention to the problem of underweight in children and adolescents.

In this study underweight children made 9.7% of the whole sample group (N = 1225). It was noticed that underweight was more frequent in girls than in boys. The collected data is close to nationwide, representative data collected in the OLAF research, in which the percentage of underweight children and adolescents was 12% and in girls the percentage was a few percentage points higher than in boys (5). In the study of other authors, the percentage of underweight children, depending on sex and applied criteria of assessing nutritional status, fluctuated between 6.4% and 14.3%, and in girls it was usually higher than in boys (2, 8). In the study carried out in podlaski and podkarpacki region the percentage of underweight children was higher and reached 24.2% and 28%, respectively (9, 10). A few authors of the study, which was, however, carried out on a subset of subjects that was not representative of the entire Polish population, noticed that underweight occurred more often in boys than in girl (11-13).

Among many causes of underweight in children and adolescents researchers most often point to two main causes: improper dietary habits and social and economic problems in the family (14).

The results presented in this paper concern selected dietary habits and nutrition. They confirm unfavourable tendencies in child nutrition observed also by other authors.

According to the principles of rational nutrition, the most favourable for the child is to have five meals a day: three main meals (breakfast, lunch and dinner)

and two supplementary meals (second breakfast, afternoon snack) (15, 16). As the research carried out on school children shows, irregular meals or avoiding some meals are a common phenomenon. Students most often do not have breakfast and second breakfast, as well as dinner. Avoiding breakfast seems to be the most worrying phenomenon, because it causes that students do not feel well and their predisposition to study decreases (worse concentration of the mind, irritation, drowsiness) and make peers contacts worse (1, 15, 17).

In the sample group of underweight children most students had 5 or more meals during the day. In research carried out in Szczecin among 13-year-old underweight children (BMI  $\leq$  5 percentile) 74% of children had 5 meals per day, in boys the percentage was 55% (12). On the other hand, research carried out among underweight children aged 1-14 from Podlasie region showed that only 23.2% of children had 4 or more meals per day (9).

Almost 21% of underweight girls and 34% of underweight boys did not have breakfast every day before leaving for school. In the study carried out among students aged 11-15 from primary school and junior high school in Ustrzyki Dolne it was noted that 42% of children did not have breakfast at home every day (10). What is more, the study of Wolnicka and Jaczewska-Schuetz, carried out among Warsaw students from the 5<sup>th</sup> and 6<sup>th</sup> class, showed that 30% of girls did not have breakfast every day before leaving for school, in boys the percentage was 22% (18). The data, concerning both underweight children and children with diverse body weight, indicates irregularities in frequency of having breakfast before leaving for school. Breakfast eaten before leaving for school is one of the most important meals, because it provides the child's body with energy and nutrients, as well as vitamins and minerals, which indirectly influences the child's well-being, as well as muscle tension or neurohormone biosynthesis, playing an important role in improving the child's mental processes (19, 20).

**According to this study, about 34% of underweight children, both boys and girls, did not have any meal at school (second breakfast or lunch).**

The study of Marcysiak et al., carried out among students of primary school and junior high school in Ustrzyki Dolne, showed a big percentage of children who did not have second breakfast at school (10). The results of other study carried out among school children indicate that the percentage of children who do not have second breakfast at school fluctuates between 9% and 21% (12, 17, 18, 21, 22). The study of Wolnicka and Jaczewska-Schuetz shows that there is also a big percentage of children who do not have lunch at school, in boys it is 60% and in girls – 49% (18). In the research of Wajszczyk et al. the percentage of boys and girls who did not have lunch at school was estimated 75% and 81%, relatively (21). The results of own study concerning having breakfast at home and

second breakfast and lunch at school in the light of presented data are not satisfactory, especially as far as underweight children are considered. The analysis which confirms the unsatisfactory assessment of nutritional habits among underweight children was carried out in the study of Marcysiak et al. The authors assessed nutritional habits in children aged 11-15 on the basis of 25 questions concerning irregularities in dietary habits, applying principles of rational nutrition and physical activity. Almost half of underweight children (44%) showed irregularities in nutrition (including 6% of unsatisfactory nutritional habits), whereas in the group of children with right body mass, as well as overweight/obese children the percentage of irregularities in nutrition was much lower and amounted to 28% and 15%, respectively (10).

In our study the attention was also paid to energetic and nutritional value of whole day food rations consumed by children.

The average energetic value of the diets of girls and in the case of both sexes the average calcium, potassium, vitamin D and folate content in the diet was lower than it is recommended for this age group. However, taking into consideration that the average value hides values of both insufficient and excessive intake, the paper describes diets low in energy and those components whose severe deficiencies were observed (fat, folate, potassium, calcium, vitamin D). Moreover, among children examined a smaller percentage of diets low in vitamins E and C, thiamine and niacin was observed.

According to the research methodology, energetic value of diets and the content of particular components was compared with the EAR norm. However, if such a comparison was made according to the RDA norm (*Recommended Daily Intake*), nutrients deficiencies would be noted in a bigger percentage of children than it was observed in the study.

Almost half of diets did not provide enough energy for this age group, and the problem was more common in girls. Also other authors point to low energetic value of diets of school children. In the study from Szczecin, which was carried out among 13-year-old underweight children, the energetic value of their diets was observed to be much lower than recommended for this age group (12). Similar observations were made among children in Łódź, Poznań and Białystok (23-25). By contrast, higher energetic value of diets was observed in adolescents from Oleśnica (26). Prolonged low energy intake may lead to metabolic disorders, among others, the use in the process of gluconeogenesis muscle proteins in order to cover energetic deficit. Long-term low calorie intake may not only result in the child's lowered physical and mental fitness, but it may also hamper the child's general body growth.

**Fat was a component whose intake in underweight children was insufficient (in 65.3% of girls and in 52% of boys).** Similar results achieved Kiliańska et al. assessing nutritional value of whole day food rations

among children aged 9-14. According to the study of these authors, there was insufficient fat intake in 36.3% of diets of boys and in almost 43% of diets of girls (24). Many authors, however, observed excessive fat intake in school children, especially in boys (27-30). Fats, apart from providing body with energy, play many various roles in the development of young bodies, among others, they are building blocks of cell membrane and white matter in brain, they provide necessary unsaturated fatty acids, they act as a carrier for the fat soluble vitamins A, D, E and K, enabling their absorption from other products. It was also noted that poly-unsaturated fatty acids n-3 have influence on concentration of the mind and on the process of memorizing in children, as well as on their sight, including their visual acuity. Fat deficiencies, especially deficiency in unsaturated fatty acids, in children may result in serious health impairments, such as hampered weight gain and growth, susceptibility to infections or tissue and organs disorders connected with limiting the biosynthesis of eicosanoids (7, 31, 32).

Vitamin D was a component whose deficiency was most frequent in the diets of children examined. **Almost all diets were low in vitamin D in comparison with the daily dose recommended for this age group.** Also in the study of other authors, among others, of Charzewska and Weker, Bączyk et al., serious deficiencies of vitamin D were observed (23, 33). Vitamin D deficiency leads to impaired metabolism of calcium and phosphorus, causing demineralization of bones manifested in rickets in children.

**Folate are another component whose deficiency in children's diets was examined – folate deficiencies were observed in 85% of diets of girls and in 70% of diets of boys.** Similar folate deficiencies noted Charzewska et al. in their study carried out among Warsaw primary school children aged 11-15 (1). Also, a study conducted among urban children aged 10-12 from wielkopolski region showed a serious percentage (reaching almost 80%) of diets low in folic acid (23). Folate, playing a role of coenzymes in many metabolic processes, are essential for development and normal functioning of all body cells, as well as for a balanced work of the circulatory and nervous system (7). The research carried out among Swedish 15-year-olds also showed a positive correlation between folic acid intake and achieving better results in studies (34). Folic acid deficiencies resulting from its insufficient intake may lead to megaloblastic anemia (31, 32).

Among underweight children enrolled in the study there was also a big percentage of potassium deficiencies, which amounted to 96% in girls and 86% in boys. Low potassium intake was also observed by other authors in their research carried out among school children with various body mass (12, 35, 36). Bączyk et al. noted much lower than in our study percentage of diets low in potassium, which did not exceed 20% (23). Potassium is, among others, the main ion of intercellular fluid, it helps to maintain body's normal water balance,

it influences acid-base balance, as well as it regulates work of nerves and muscles. Prolonged hypokalemia may lead to impairment of cell functions, especially functions of muscle and nerve cells (7).

**Calcium was a component whose intake was insufficient in diets of the examined girls and boys – the percentage of diets low in calcium amounted to 84% and 70%, respectively.** Unfortunately, the study of other authors confirmed this unfavourable situation (12, 19, 23, 37, 38). Calcium is a major building-block of our bone tissue, and its deficiencies in the period of childhood and adolescence may lead to the decrease in bone mass, rickets and in adulthood they may increase the risk of osteoporosis (7, 31, 32).

In the diets of the examined children the ratio of calcium to phosphorus, influencing absorption of calcium from the alimentary canal, was also bad and it amounted to 0.62. Similar results were noted by Błaszczuk et al. and Goluch-Koniuszy (12, 37). The excess of phosphorus in diet may increase bone demineralization and may lead to impaired absorption of calcium in the small intestine through negative influence on the synthesis of active vitamin D in kidneys (39, 40).

A negative calcium balance in children's diets could be also connected with excessive sodium intake (average daily intake of this chemical element amounted to 3127 mg), which caused increased urinary calcium excretion (7).

Also iron is worth mentioning here. Being a major component of dyes which transport and store oxygen or being a part of enzymes regulating many metabolic processes, iron plays the main role in child and adolescent development. Prolonged iron deficiency leads

to anemia, which causes worse mental and physical child development. It is assumed that iron deficiency accompanied by zinc deficiency may hamper the development of the nervous system (41).

In the examined group of children no deficiencies (below the Estimated Average Requirement) of iron were reported. However, the analysis of the children's diets to check if they meet Recommended Dietary Allowances for iron showed a big percentage of diets low in iron, amounting in the case of girls to 82%, and in the case of boys – to 64%.

## CONCLUSIONS

1. The percentage of students with underweight amounting to almost 10% is so high, that paying attention to the problem of underweight in children and adolescents seems justified.
2. Nutritional habits of the examined group of children concerning having breakfast before leaving for school, as well as having second breakfast and lunch at school were unsatisfactory and they were not in line with nutritional recommendations.
3. Improper diet of the underweight children examined in the study caused mainly energy deficiency (in girls), as well as deficiencies of fat, vitamin D, folate, potassium and calcium.
4. Improper nutrition reported in the examined children could affect the occurrence of underweight in this group.
5. Underweight in children and adolescents may increase the risk of health impairment and have a negative influence on their mental development and cognitive functions.

## BIBLIOGRAPHY

1. Niedożywienie a zdrowie publiczne. Januszewicz P, Mazur A, Socha J (red.), Rzeszów, Wyd. UR 2011.
2. Chabros E, Charzewska J, Wajszczyk B et al.: Częstość występowania niedoborowej masy ciała u młodzieży warszawskiej w wieku pokwitania w ostatnich 3 dekadach. *Probl Hig Epidemiol* 2011; 92(1): 99-102.
3. Marek A, Marek K: Niedożywienie białkowo-kaloryczne u dzieci – nowe elementy patofizjologii. *Pediatr Współ Gastroenterol Hepatol Żyw Dziecka* 2002; 4, 2: 193-197.
4. de Onis M, Frongillo EA, Blössner M: Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. *Bulletin of WHO* 2000; 78: 1222-1233.
5. Grajda A, Kułaga Z, Gurzkowska B et al.: Regional differences in the prevalence of overweight, obesity and underweight among Polish children and adolescents. *Med Wieku Rozwoj* 2011; 15(3): 258-265.
6. Cole TJ, Flegal KM, Nicholls D et al.: Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2007; 335: 194-202.
7. Normy żywienia człowieka. Podstawy prewencji otyłości i chorób niezakaźnych. M Jarosz, B Bułhak-Jahymczyk (red.). Warszawa PZWL 2008.
8. Szponar L, Ołtarzewski M: Epidemiologia niedożywienia dzieci i młodzieży w Polsce. *Pediatr Współ Gastroenterol Hepatol Żyw Dziecka* 2007; 6(1): 13-17.
9. Roszko-Kirpsza I, Olejnik BJ, Zalewska M et al.: Wybrane nawyki żywieniowe a stan odżywienia dzieci i młodzieży regionu Podlasia. *Probl Hig Epidemiol* 2011; 92(4): 799-805.
10. Marcysiak M, Ciosek A, Żywica M et al.: Zachowania żywieniowe i aktywność fizyczna uczniów klas sportowych i ogólnych w Ustrzykach Dolnych. *Probl Pielęgniarstwa* 2009; 17(3): 216-222.
11. Oblacińska A, Tabak I, Jodkowska M: Demograficzne i regionalne uwarunkowania niedoboru masy ciała u polskich nastolatków. *Przeegl Epidemiol* 2007; 61: 785-793.
12. Goluch-Koniuszy Z: Ocena sposobu żywienia dzieci w okresie skoku pokwitaniowego z BMI ≤ 5 percentyla z terenu miasta Szczecin. *Roczn PZH* 2010; 61(3): 307-315.
13. Wolanicka A, Albrecht P, Kotowska M: Analiza stanu odżywienia młodzieży na przykładzie uczniów gimnazjów w Radomsku. *Pediatr Współ Gastroenterol Hepatol Żyw Dziecka* 2008; 10, 1: 37-42.
14. Giza-Oleszczuk A: Problem niedożywienia dzieci w Polsce. [W:] *Niedożywienie dzieci w Polsce – na drodze do rozwiązania problemu*. Danone 2007.
15. Dyjak A: Żywność a zdrowie i rozwój dzieci wiejskich. *Zarys problematyki*. *Zdr Publ* 2005; 115: 92-95.
16. Gawęcki J, Mossor-Pietraszewska T: *Kompendium wiedzy o żywności, żywieniu i zdrowiu* (red.). Warszawa PWN 2007.
17. Stefańska E, Falkowska A, Ostrowska L et al.: Wartość odżywcza całodziennych posiłków 10-letnich dzieci o zróżnicowanej masie ciała. *Roczn PZH* 2011; 62, 4: 419-425.

18. Wolnicka K, Jaczewska-Schuetz J: Zachowania żywieniowe dziewcząt i chłopców klas V-VI szkół podstawowych z losowo wybranych szkół warszawskich. *Żyw Człow Metabol* 2010; 37(4): 255-267.
19. Friedrich M: Wpływ żywienia na psychofizyczne uwarunkowania dobrego samopoczucia. *Biuletyn AR w Szczecinie* 2005; 7/8, 137/138: 10-11.
20. Ganong WF: *Fizjologia*. Warszawa PZWL 2007.
21. Wajszczyk B, Charzewska J, Chabros E et al.: Jakościowa ocena sposobu żywienia młodzieży w wieku pokwitania. *Probl Hig Epidemiol* 2008; 89(1): 85-89.
22. Zimna-Walendzik E, Kolmaga A, Tafalska E: Styl życia – aktywność fizyczna, preferencje żywieniowe dzieci kończących szkołę podstawową. *Żyw N Technol Jakość* 2009; 4: 195-203.
23. Bączyk I, Sawicka N, Gutaj P et al.: Analiza nawyków żywieniowych dzieci miejskich w wieku 10-12 lat z województwa wielkopolskiego. *Pediatr Współ Gastroenterol Hepatol Żyw Dziecka* 2010; 12, 3: 113-116.
24. Kiliańska A, Chlebna-Sokół D, Kulińska-Szukalska K: Ocena wartości odżywczej całodziennych racji pokarmowych dzieci łódzkich w wieku szkolnym – składniki podstawowe. *Przegl Pediatr* 2008; 38(1): 20-24.
25. Falkowska A, Stefańska E, Ostrowska L et al.: Ocena wartości energetycznej i zawartości podstawowych składników odżywczych w racjach pokarmowych dzieci ze szkół podstawowych i gimnazjalnych. *Bromat Chem Toksykol* 2011; 3: 385-388.
26. Iłow R, Regulska-Iłow B, Płonka B et al.: Ocena sposobu żywienia gimnazjalistów z Oleśnicy. *Roczn PZH* 2008; 59(3): 335-341.
27. Chwojnowska Z, Charzewska J, Chabros E: Sposób żywienia i stan odżywienia warszawskiej młodzieży w wieku pokwitania. *Żyw Człow Metab* 2002; 29 (Supl. 1): 123-127.
28. Augustyniak U, Wegner S, Brzozowska A: Ocena sposobu żywienia chłopców w wieku 14-17 lat z Warszawy. *Materiały Sympozjum „Bezpieczna żywność i prawidłowe odżywianie podstawą profilaktyki zdrowotnej”*. Wrocław 2002; 178-179.
29. Ostrowska A, Szewczyński J: Charakterystyka kwasów tłuszczowych i cholesterolu w racjach pokarmowych młodzieży szkolnej z woj. mazowieckiego. *Bromat Chem Toksykol* 2002; 35: 323-327.
30. Szponar L, Sekuła W, Rychlik E et al.: Badania indywidualnego spożycia żywności i stanu odżywienia w gospodarstwach domowych. *IŻŻ* 2003; 752-762.
31. *Żywnie człowieka*. J. Gawęcki, L. Hryniewiecki (red.). Warszawa PWN 2000.
32. *Praktyczny podręcznik dietetyki*. M Jarosz (red.), IŻŻ 2010.
33. Charzewska J, Weker H: Ogólnopolskie badanie nad zawartością wapnia i witaminy D w dietach dzieci w wieku 4 lat. *Żywność dla Zdrowia* 2006; 3: 6-7.
34. Nilsson TK, Yngve A, Böttiger AK et al.: High folate intake is related to better academic achievement in Swedish adolescents. *Pediatrics* 2011; 128(2): 358-365.
35. Oblacińska A, Jodkowska M: Otyłość u polskich nastolatków: epidemiologia, styl życia, samopoczucie: raport z badań uczniów gimnazjów w Polsce. *Instytut Matki i Dziecka. Zakład Medycyny Szkolnej* 2007; 2-7.
36. Suliga E: Ocena sposobu żywienia niskich dziewcząt i chłopców. *Endokrynol Diabetol Chor Przem Wiek Rozw* 2006; 12, 2: 43-47.
37. Błaszczak A, Chlebna-Sokół D, Frasunkiewicz J: Ocena spożycia wybranych witamin i składników mineralnych w grupie dzieci łódzkich w wieku 10-13 lat. *Pediatr Współ Gastroenterol Hepatol i Żyw Dziecka* 2005; 7, 4: 275-279.
38. Cieślak E, Filipiak-Florkiewicz A, Topolska K: Częstotliwość spożycia wybranych grup produktów spożywczych oraz stan odżywienia młodzieży gimnazjalnej. *Żyw Człow Metab* 2007; 34, 3/4: 846-851.
39. Lorenc R, Karczarewicz E: Znaczenie wapnia i witaminy D w optymalizacji masy kostnej oraz zapobieganiu i leczeniu osteoporozy u dzieci. *Pediatr Współ* 2001; 3, 2: 105-109.
40. Rajendra J, Adachi J: Wapń i witamina D w prewencji złamań osteoporotycznych. *Pol Arch Med Wew* 2007; 117(10): 13-14.
41. Sanstead HH: Causes of iron and zinc deficiencies and their effects on brain. *J Nutr* 2000; 347S-349S.

received/otrzymano: 26.09.2012

accepted/zaakceptowano: 31.10.2012

Address/adres:

\*Katarzyna Wolnicka

Department of Nutrition and Dietetic with Clinic  
of Metabolic Diseases and Gastroenterology

National Food and Nutrition Institute

ul. Powsińska 61/63, 02-903 Warszawa

tel.: +48 (22) 550-96-38

e-mail: kwolnick@izz.waw.pl