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ORIGINAL ARTICLE

DIETARY INTAKE OF VITAMIN D IN CHILDREN AGED 1-3 YEARS WITH SIMPLE OBESITY

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ABSTRACT

Background. Obese children are predisposed to vitamin D deficiency. Most of the findings suggest that requirement for vitamin D is increased in obese children due to this vitamin sequestration in adipose tissue.
Objective. The aim of the study was to evaluate dietary intake of vitamin D in children with simple obesity in relation to nutritional standards.
Materials and Methods. The study included 73 children aged 1-3 years: 38 with simple obesity (group I) and 35 non-obese ones (group II - control). The inclusion criterion for the obese group was BMI z-score > +2.0, for the control group BMI z-score between -1.0 and +1.0.The intake of vitamin D was estimated using the Dieta 5.0 software on the basis of 3-days dietary record. Outcomes were related to nutritional standards. Differences in intake of energy and nutrients between both groups were assessed using the *Mann-Whitney* test (statistical significance was set at $p = 0.05$).
Results. Vitamin D intake in both groups was below the nutritional standards (10 μg/400 IU). Median values / interquartile ranges of results were 2.0 / 1.3-5.9 μg and 4.0 / 1.1-7.6 μg daily, for obese and non-obese children, respectively. The risk of deficient vitamin D intake was observed in 94.7% of obese children and in 82.4% of control group. The main dietary source of vitamin D in both groups was growing-up milk/Junior formula. The median intake of energy, protein, fat and carbohydrates in the obese children were significantly higher than in the control group ($p<0.05$).
Conclusions. In obese children aged 1-3 years adequate dietary intake of vitamin D was not achieved. Similarly, the intake of vitamin D by normal weight children was lower than recommended. Consequently, it is necessary to provide products rich in vitamin D in the diet of toddlers, particularly obese.

Key words*: dietary intake of vitamin D, diet, children, obesity*

STRESZCZENIE

Wstęp. Dzieci z otyłością są szczególnie narażone na niedobór witaminy D. Wiele badań wskazuje, że jednym z czynników mogących niekorzystnie wpływać na biodostępność witaminy D jest jej sekwestracja w tkance tłuszczowej.
Cel badań. Celem badania była ocena podaży witaminy D w dietach dzieci z otyłością prostą w odniesieniu do norm żywienia.
Materiał i metody. Badaniem objęto 73 dzieci w wieku 1-3 lat, w tym 38 dzieci z otyłością prostą (grupa I) i 35 dzieci z prawidłową masą ciała (grupa II/ grupa kontrolna). Kryterium włączenia dzieci do grupy I było BMI z-score > +2,0, do grupy II BMI z-score od -1,0 do +1,0. Spożycie witaminy D oceniono na podstawie 3-dniowego zapisu jadłospisu wykorzystując program żywieniowy Dieta 5.0. Uzyskane wyniki odniesiono do norm żywienia. Do oceny różnic w wartości energetycznej diet i spożyciu składników pokarmowych pomiędzy grupami posłużono się testem *Manna-Whitneya* (za poziom istotności statystycznej przyjęto $p = 0,05$).
Wyniki. Zawartość witaminy D w dietach dzieci z obu grup była zbyt mała w odniesieniu do norm spożycia (10 μg/400 j.m.). Wartości mediany i zakresu 1.-3. kwartyla wynosiły w dietach dzieci otyłych i z prawidłową masą ciała, odpowiednio: 2,0 μg (1,3-5,9 μg) i 4,0 μg (1,1-7,6 μg). Ryzyko niewystarczającego spożycia witaminy D obserwowano u 94,7% dzieci otyłych i u 82,4% dzieci z prawidłową masą ciała. Głównym źródłem witaminy D w dietach z obu grup było mleko modyfikowane typu Junior. Mediany wartości energetycznej diet oraz zawartości białek, tłuszczów i węglowodanów w dietach dzieci otyłych były istotnie większe w porównaniu z grupą dzieci z prawidłową masą ciała ($p<0,05$).
Wnioski. U dzieci otyłych jak i z prawidłową masą ciała w wieku 1-3 lat spożycie witaminy D z całodzienną dietą było mniejsze od zalecanego. Dzieci w wieku 1-3 lat, w tym dzieci otyłe, wymagają modyfikacji diety pod względem doboru produktów bogatych w witaminę D.

Słowa kluczowe: *spożycie witaminy D, dieta, dzieci, otyłość*

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INTRODUCTION

Obesity is a growing health problem, also in the children population. According to the 2007–2008 National Health and Nutrition Examination Survey (NHANES), from 1980 to 2008 the percentage of obese children doubled (5.0% to 10.4%) among children aged 2-5 years, tripled (6.5% to 19.6%) in group aged 6-11 years, and almost quadrupled (5.0% to 18.1%) in adolescents aged 12-19 years [29]. Polish epidemiological data indicate that 20% of toddlers and 9-18% of preschool children are overweight or obese [20]. One of the basic causes obesity is a long-term imbalance between the amount of energy supplied with food and those expended.

This leads to abnormal or excessive fat accumulation exceeding its physiological needs and possibilities of adaptation, that may impair health [41*]*. Despite of the energy oversupply, diets of obese children may be deficient in various components including minerals, eg. calcium and iron [13,14] and vitamins (eg. vitamin D) [9]. Children are especially vulnerable for vitamin deficiencies. Insufficient vitamins supply affects them more seriously than adults [38].

Vitamin D plays a pivotal role in the organism, affecting the calcium and phosphorus homeostasis, thus providing a proper bone development and mineralization. Besides these well-known effects, vitamin D has much border range of actions (pleiotropic effects) in the human body. It is essential for the proper functioning of the immune, endocrine, neurological, muscular and cardiovascular systems [19, 26, 28, 45].

Vitamin D refers to the group of fat-soluble vitamins. Vitamin D is a steroid hormone with a broken B – ring known as secosteroid, involved in enhancement of calcium, iron, magnesium, phosphorus and zinc absorption [24]. The term "vitamin D" refers to several different forms of this vitamin. Two forms are essential in humans: vitamin D_2 (ergocalciferol) derived from products of plant origin including fungi, and vitamin D_3 (cholecalciferol) occurring in products of animal origin, especially fatty marine fish species, eggs and liver [19, 22, 46]. For infants and toddlers the food sources of vitamin D_3 are also milk formulas and cereals fortified with this vitamin [28].

It must be stressed, that the most important source of vitamin D_3 is skin exposure to solar UV irradiation with wavelengths of 290-315 nm. The effectiveness of this process is affected by numerous factors, such as the amount of sunlight (depending on latitude, season and time of day), the surface of the exposed parts of the body, skin pigmentation, age and body weight [27].

Vitamin D deficiencies are found in populations worldwide and due to pandemic nature, they are a serious public health problem [17, 21]. Among the factors responsible for the increased incidence of deficiency of this vitamin in children there are: limited time spent outdoors, the use of sunscreens and inadequate intake of food that are sources of vitamin D, fortified foods and especially marine fish [28]. It has been documented in numerous studies that overweight/obesity is an important risk factor for vitamin D deficiency in children [2, 34, 36]. Moreover, it has been observed that the increased amount of subcutaneous adipose tissue in overweight children sequestrates vitamin D, thus preventing its transport to the blood stream. It results in the reduction of vitamin D concentrations in serum [2, 34, 39, 44]. Recent research has shown that 25 (OH)D blood concentration are lower among obese children. The prevalence of the vitamin D hypovitaminosis increased with degree of adiposity: in healthy weight at 21%, in overweight at 29%, in obese at 34%, and in severely obese at 49% [25].

The aim of the study was to evaluate dietary intake of vitamin D in obese children with reference to nutritional standards.

MATERIAL AND METHODS

The examined group consisted of 38 children (Group I), aged 1-3 years diagnosed simple obesity, recruited from the Gastroenterology Outpatient Clinic at the Warsaw Institute of Mother and Child. The inclusion criterion for the group I was BMI z-score > +2.0. The reference group (Group II) were 35 age-matched healthy subjects with normal body mass (BMI z-score between -1.0 and +1.0). Nutritional status was assessed using Body Mass Index (BMI) which was standardised according to the WHO growth charts for children [42, 43] to obtain BMI z-scores independent of gender and age.

Vitamin D intake and daily food rations (DFR) of children were estimated on the basis of 3 days record, randomly chosen from the dietary records, using the "Album of Photographs of Food Products and Dishes" [5, 15, 32]. The average energy value and nutrients intake from DFR was calculated using Dieta 5.0 nutritional software [37].

The medians and interquartile ranges of dietary intake of vitamin D, energy, macronutrients, other vitamins and minerals in obese and non-obese children were related to the current nutritional standards [19] and the model food ration for children aged 13-36 months [40]. Odds of children with dietary intake below the Estimated Average Requirement (EAR) and Adequate Intake (AI) were evaluated in both groups using Dieta 5.0 software.

The differences in energy and nutritional value of an average daily food ration between studied groups of children as well as in amounts of food from each of 6

groups of products consumed by children were evaluated by *Mann-Whitney* test.

The variables measuring the nutritional status of children and their diets were not normally distributed and statistical analyses were performed with non-parametric methods with p value below 0.05 adopted as being significant. The testing was conducted with the Statistica 10 PL package.

RESULTS

The characteristics of the studied groups are presented in Table 1.

Table 1. Characteristics of studied children

Parameter	Obese children (n=38)		Control group (n=35)		*Mann-Whitney* test p value
	Median	Interquartile range	Median	Interquartile range	
Age (years)	2.5	2.2-3.1	2.5	1.9-3.1	0.5
Body weight (kg)	20.0	16.6-24.8	12.9	11.6-14.4	<0.001*
Height (cm)	97.0	91.0-105.0	92.0	86.5-95.5	0.005*
BMI (kg/m^2)	20.9	19.6-23.1	15.5	14.8-16.1	<0.001*
BMI z-score	3.2	2.5-4.6	-0.1	-0.8-0.4	<0.001*

* – statistically significant differences
BMI – Body Mass Index

The median age for children of the both group were 2.5 years, the difference in age was not statistically significant (p>0.05). There were significant differences between children from Group I and II with regard to anthropometric parameters and indices (p<0.05).

Table 2 provides results of dietary intake of energy and nutrients in children's diet.

The median and interquartile ranges of vitamin D daily intake were as follows: in the obese children 2.0 μg (1.3-5.9 μg), in the control group 4.0 μg (1.1-7.6 μg). No statistically significant difference was found (p>0.05). The risk of deficient vitamin D intake was observed in 94.7% of obese children and in 82.4% of control group.

The median intake of energy, protein, fat and carbohydrates in the obese children were significantly higher than in control group (p<0.05).

Table 3 provides comparison of medians of daily food consumption in two groups of studied children in relation to the model food ration for children aged 1-3 years.

The main dietary source of vitamin D in both groups was junior formula. The percentage of children consuming growing-up milk was 42.1% of obese (n=16/38) *vs* 55.9% of non-obese ones (n=19/35). The interquartile range of junior formulas daily intake in obese children was 0-238 ml (median 0.0), while in non-obese group 0-317 ml (median 96.5). This milk provided respectively 49.8% and 66.7% of vitamin D supplied with food in the obese and healthy weight children.

Cow's milk was consumed by 92% of children from Group I (n=35/38) and 94% from Group II (n=33/35). The median values and interquartile ranges of amounts of cow's milk consumed daily were respectively: 101.9 ml (43.7-210), and 54.5 ml (11.6-113.6). These amounts of milk provided 0.02 μg (0.8 IU) vitamin D for children from Group I and 0.01 μg (0.4 IU) of this vitamin for children from Group II.

The percentage of obese and non-obese children eating fish was 34% (n=13/38) of obese and 28% (n=10/35) non-obese ones. The medians and the interquartile ranges of the portion of fish daily consumption by children from Group I and II were respectively: 19.1 g (8.0-29.1) *vs* 29.6 g (19.1-46.7).

DISCUSSION

Given that the problem of obesity in Poland affects about 20% of children aged 1-3 [20, 23], and that Polish geographic location impedes the effective process of photosynthesis of vitamin D [26], exogenous supplies of this vitamin such as diet sources and supplementation seem to be important to ensure its adequate provision. Insufficient dietary intake of vitamin D in children was confirmed by various studies [4, 9, 11, 12, 28-31, 33].

In the present study, the average content of vitamin D in the diets of obese and healthy weight children was lower, as compared to the Polish nutritional standards [19] as well as to Polish Expert Group statement [7].

In our study, most of the children did not reach EAR standard (94.7% in Group I *vs* 82.4% in Group II) [19]. Also the results of the National Health and Nutrition Examination Survey showed that over 75% of older children (9-13 years of age) did not achieve the EAR for vitamin D through dietary intake [11]. Similarly, 85% of boys and 93% of girls (aged 9-13 years of age) from a nationally representative sample of Canadian children did not achieve the EAR from food sources alone [16].

Table 2. The energy and nutrients intake in relation to Polish nutritional standards 2012 [19] in obese and non-obese children

Energy value Nutrients	Units	Obese children (n=38)		Control group (n=35)		*Mann-Whitney* test p value	Nutritional standards EAR/AI+
		Median	Interquartile range	Median	Interquartile range		
Energy	Kcal	1497.1	944.0-1686.5	1113.2	993.7-1361.6	0.011*	1000 (EER)
Total protein	g	50.4	34.2-59.9	41.4	32.0-48.9	0.049*	12
Total fat	g	51.3	32.4-64.3	35.7	28.7-45.8	0.01*	33-44
· saturated fatty acids	g	19.5	11.9-24.7	14.2	10.9-19.2	0.044*	-
· monounsaturated fatty acids	g	19.5	13.4-27.6	13.4	11.0-17.5	0.006*	-
· total polyunsaturated fatty acids	g	6.7	4.4-8.2	4.5	3.1-5.7	0.001*	-
- LC-PUFA	g	0.0	0.0-0.1	0.0	0.0-0.1	0.9	0.25+
Cholesterol	mg	147.5	108.5-231.4	123.8	96.1-233.6	0.5	-
Total carbohydrates	g	199.1	139.5-242.1	159.7	125.9-202.7	0.046*	-
Digestive carbohydrates	g	186.2	129.7-225.9	150.8	121.9-196.2	0.06	100
Starch	g	65.4	46.0-103.1	58.7	29.4-74.5	0.036*	-
Sucrose	g	55.6	32.0-79.7	34.0	25.5-50.8	0.006*	-
Lactose	g	13.5	9.0-24.0	12.0	4.8-24.1	0.8	-
Fibre	g	11.7	8.2-15.2	7.8	5.5-12.0	0.01*	10+
Percent of energy · from protein	%	14.1	12.2-15.5	14.5	12.9-16.6	0.2	5-20
· from fat	%	30.9	27.3-35.6	30.5	24.8-35.2	0.4	20-35
· from carbohydrates	%	54.0	49.2-58.7	53.4	50.8-60.0	0.9	50-70
Vitamin A	µg	799.4	576.8-1038.6	767.8	557.5-944.1	0.4	280
Vitamin E	mg	7.0	5.2-9.1	5.2	3.6-7.5	0.042*	6+
Vitamin D	µg/IU	2.0/80	1.3-5.9/52-236	4.0/160	1.1-7.6/44-304	0.3/12	10/400
Vitamin B_1	mg	0.8	0.6-1.0	0.8	0.5-1.0	0.7	0.4
Vitamin B_2	mg	1.3	1.0-1.7	1.3	0.8-1.4	0.1	0.4
Folate	µg	166.8	123.4-208.1	174.8	122.8-200.1	0.9	120
Vitamin B_{12}	µg	2.2	1.7-2.9	1.9	1.5-2.4	0.08	0.7
Vitamin C	mg	66.8	38.7-88.2	72.6	44.3-98.5	0.6	30
Vitamin PP	mg	10.9	7.5-13.3	9.1	6.5-11.6	0.02*	5
Vitamin B_6	mg	1.3	1.1-1.6	1.2	0.8-1.4	0.053	0.4
Calcium	mg	480.5	413.4-675.4	540.6	329.6-637.3	0.9	500
Phosphorus	mg	831.7	558.4-1019.4	700.7	564.6-804.1	0.053	380
Magnesium	mg	185.9	125.9-215.2	127.5	108.7-179.7	0.005*	65
Iron	mg	7.4	6.1-10.0	7.2	5.2-9.7	0.5	3
Zinc	mg	5.9	4.6-8.4	6.1	4.4-7.4	0.5	2.5
Copper	mg	0.8	0.5-0.9	0.5	0.4-0.8	0.004*	0.25
Iodine	µg	95.8	59.1-123.2	87.1	55.8-124.8	0.9	65
Potassium	mg	2159.7	1492.1-2532.5	1580.6	1277.0-1878.6	0.003*	2400+
Sodium	mg	1913.2	1392.1-2614.4	1399.7	1243.2-1794.1	0.002*	750+

LC-PUFA – long-chain polyunsaturated fatty acids
EAR – Estimated Average Requirement
EAR intake of vitamin D for children aged 1-3 years was adopted in accordance with the statement of Polish Expert Group (2012) [7].
EER – Estimated Energy Requirement
AI+ – Adequate Intake
* – statistically significant differences

We found a twofold lower intake of vitamin D in diets of obese children (2.0 µg/80 IU *vs* 4.0 µg/160 IU), however this difference was not statistically significant. Similarly, *Dyląg* et al. [9] reported lower vitamin D intake among obese children aged 1-5 years compared to healthy weight children (3.2 µg/128 IU *vs* 4.7 µg/188 IU). The same tendency was observed by *Barry* [1] in a cohort of older children aged 6 – 14.9 years. The vitamin D intake was significantly lower in obese children compared to the normal weight children (4.5 µg/181.9 IU *vs* 6.6 µg/259.5 IU). In addition to the insufficient vitamin D intake by obese children found in our study, it is worth noting that calcium intake, which was adequate according to current Polish nutri-

Table 3. Comparison of medians of daily foods consumption in two groups of studied children with reference to model food ration for children aged 1-3 years [40]

Groups of food products	Obese children (n=38)		Control group (n=35)		*Mann-Whitney* test p value	Model food ration	Percentage of vitamin D from food products	
	Median	Interquartile range	Median	Interquartile range			Obese children	Control group
Cereal products (based on flour)	92.6	68.6-121.8	88.0	68.8-118.8	0.6	-	-	-
Flour, pasta	24.4	14.6-38.4	24.9	14.8-42.7	0.7	25	0.5	0.3
Groats, rice	7.7	0.0-30.0	15.9	1.3-37.0	0.1	30	1.6	0.3
Breakfast cereals	5.2	0.0-9.1	1.3	0.0-7.0	0.2		0.0	0.0
Bread	47.5	24.0-86.0	36.3	19.0-54.9	0.1	20	0.6	0.5
Potatoes	95.2	28.9-160.3	45.0	27.8-103.8	0.03*	80-100	0.0	0.0
Vegetables and fruits	311.7	218.2-365.5	237.7	113.1-403.0	0.2	450	0.0	0.0
Vegetables	142.9	68.9-177.0	92.0	62.6-138.5	0.1	200	2.3	0.1
Fruits	156.8	123.3-212.5	106.1	45.0-260.4	0.4	250	0.0	0.0
Juices, beverages	83.3	0.0-200.0	15.9	0.0-110.0	0.1	-	0.0	0.0
Nuts, seeds	0.0	0.0-1.3	0.0	0.0-0.0	0.2	-	0.0	0.0
Milk and dairy products (based on milk)	502.5	318.3-706.0	435.5	261.1-627.6	0.5	-	-	-
Milk and junior formula	203.4	92.9-404.6	210.3	91.3-440.0	0.96	450	-	-
Milk	91.7	33.0-195.1	49.3	8.3-113.6	0.06	450	0.9	0.5
Junior formula	0.0	0.0-238.0	96.5	0.0-317.0	0.2		49.8	66.7
Fermented milk beverages	16.5	0.0-50.0	23.5	0.0-60.8	0.96	100	0.2	0.2
Rennet cheese	0.0	0.0-0.0	0.0	0.0-5.0	0.6	2	0.2	0.2
Cottage cheese	24.3	6.7-67.0	8.0	0.0-33.3	0.07	10-15	1.1	0.9
Meat and poultry, cold meats, fish, eggs	98.9	74.5-155.7	88.5	57.3-147.6	0.3	-	-	-
Meat and poultry	48.4	30.7-65.8	38.2	18.9-53.2	0.1	20	9.2	7.0
Cold meats	32.7	13.8-50.4	20.0	6.7-30.0	0.04*		5.3	3.1
Fish	0.0	0.0-8.0	0.0	0.0-17.0	0.95	10	8.0	4.3
Eggs	10.4	3.6-24.7	19.0	4.5-47.9	0.2	25	7.3	10.7
Fats	22.9	13.2-41.0	12.2	6.0-22.6	0.002*	16	-	-
Oils	5.0	2.0-9.0	1.5	0.0-6.0	0.04*	10	0,0	0.0
Margarines	3.3	0.0-9.2	1.7	0.0-4.8	0.2	6	10.3	3.8
Butter	6.3	1.0-14.0	5.0	2.0-10.0	0.6		2.1	1.3
Cream	2.1	0.4-5.0	0.0	0.0-1.0	0.0009*		0.5	0.2
Sugar and sweets	28.7	18.0-56.3	24.5	12.7-37.7	0.09	20	0.0	0.0

* – statistically significant differences

tional standards [19] could be regarded as insufficient taking into the account previous recommendations [8]. Simultaneous deficiency of these nutrients in toddlers may have an adverse effect on the rapidly growing bone mineralization.

Adequate supply of vitamin D from food products is generally not achievable. Important food sources of vitamin D in the diets of young children include: milk formulas and baby cereals fortified with this vitamin, and oily marine fish. The other relevant vitamin D sources are eggs, meat and full-fat dairy products [19]. The main food source of vitamin D in this study for both groups of children was growing-up milk fortified with this vitamin. Its level in milk formulas intended for children aged 12 months and older available in Poland is about 1.75-2.0 μg (70-80 IU) per 100 mL [26]. According to nutritional recommendations, children aged 1-3 years should consume 450 ml of milk every day (the model food ration) [40]. Such amount of junior formula provides 7.9-9.0 μg (315-360 IU) of vitamin D, while cow's milk (2.0-3.2% of fat) provides 0.09-0.14 μg (3.6-5.6 IU) of the vitamin.

In this study, the daily amount of milk (cow's/modified) consumed in both groups of children was roughly the same and was about half of the recommended in the model food ration (median and interquartile ranges for obese and normal weight children: 203.4 ml and 92.9-404.6; 210.3 ml and 91.3 – 440.0, respectively). Less than recommended milk consumption among children aged 13-36 months (average 310 ml per day) was shown also in another recent Polish study [12]. In our study 42.1% children from Group I and 55.9% children from Group II consumed junior formulas. Cow's milk was consumed by the most of children from both groups (Group I – 92.0%, Group II – 94%), however due to the low content of vitamin D it was not a significant source of this vitamin in children's diets.

The other dietary sources of vitamin D were meat and meat products, fats, especially margarines fortified with this vitamin, and fish. According to the nutritional

requirements toddlers should eat fish 1-2 times per week [8]. Model food ration includes an average fish consumption of 10 g per day (ie. 70 g weekly) [40].

In the United States FDA [35] suggests an amount of 3-5 ounces (85-142 g) of fish per week for children under the age of six. According to EFSA scientific opinion weekly consumption of oily fish in the general population should amount to 1-2 portions (130 g) [10].

Although fish are an important natural source of vitamin D, their consumption in both observed groups of children were relatively small, that was confirmed by the interquartile ranges of fish intake (0.0-8.0 g in obese children *vs* 0.0-17.0 g in healthy group). Fish was consumed only by 34.2% of obese and 28.6% of healthy weight children. Opposite to the recommendations children consumed primarily lean fish species, not oily marine ones which are better source of vitamin D and valuable fatty acids of n-3 family [6, 7, 18, 19]. It should also be noted that obese children consumed significantly smaller quantities of fish as compared to healthy weight children (19.1 *vs* 29.6 g per day). The results of a nationwide survey [12] confirmed low fish intake by children aged 1-3 years (obese children 19.6 ± 9.4 g, non-obese children 16.9 ± 8.3 g). Fish consumption rates among children aged 2 and 3 years found in the above cited study was 58% and 41% respectively. Inadequate consumption of fish by toddlers was shown in results of other authors [6, 31].

Considering the phenomenon of vitamin D sequestration by adipose tissue, which reduces its bioavailability, Polish Expert Group issued recommendations for prevention of vitamin D deficiency among obese children. They urge to consider supplementation with twofold higher dose of vitamin D in a group of obese children (20-25 µg/800-1000 IU daily) as compared to children with normal weight (10 µg/400 IU daily) [3]. According to the Practical Guidelines for the supplementation of vitamin D [26] an intake of vitamin D 15-25 µg/600-1000 IU/day (depending on the body weight) for children aged 1–18 is recommended and for obese ones an intake of 30-50 µg/1200-2000 IU/day (depending of severity of obesity). The supplementation is recommended from September to April or throughout the whole year if sufficient skin synthesis of vitamin D is not ensured in summer.

Adequate supply of children with vitamin D is particularly important not only because of the effects of vitamin D on bone mineralization, but also due to its beneficial pleiotropic action. Results of many studies suggest that proper supply of this vitamin may play a role in prevention of certain chronic diseases [26].

CONCLUSIONS

In obese children aged 1-3 years adequate dietary intake of vitamin D was not achieved. Similarly, the intake of vitamin D by normal weight children was lower than recommended. Consequently, it is necessary to provide products rich in vitamin D in the diet of toddlers, particularly obese.

Conflict of interest

The authors declare no conflict of interest.

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