

Evaluation of diet in preschool-age children with Down syndrome – preliminary examination

Ocena sposobu żywienia u dzieci z zespołem Downa w wieku przedszkolnym – badanie wstępne

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Słowa kluczowe: nadwaga, wskaźnik masy ciała, zespół Downa, błędy żywieniowe.

Abstract

Introduction: Down syndrome (DS) is the most common genetic pathology in the population. The risk factors of overweight and obesity in children with DS have not been comprehensively examined, and research in this area, conducted in Poland, is scarce.

Aim of the research: To evaluate the diets of children with Down syndrome in preschool age, depending on their nutritional status.

Material and methods: The survey was conducted in children with DS between the ages of three and six years. The analysis included 50 questionnaires correctly completed by parents or legal guardians. The children were divided into three groups according to the body mass index (BMI) index: overweight children, children with a normal BMI, and underweight children. To determine the relationship between BMI and diet, the χ^2 test was used, and the significance level was $p < 0.05$.

Results: Overweight children consume significantly more meals in kindergarten than other children ($p = 0.04$), including two lunches (in kindergarten and at home) ($p = 0.02$), and more often eat between meals ($p = 0.007$). In addition, hypothyroidism was significantly more frequent among children with overweight and obesity ($p = 0.005$). In the study group we also found frequent, unjustified applications of elimination diets, resulting from parents' conviction about their beneficial effects on the health of children with DS.

Conclusions: In preschool-age children with Down syndrome, numerous nutritional errors are made resulting in disturbances in their nutritional status. It seems necessary to introduce nutritional education that mainly covers kindergarten employees responsible for nutrition, as well as parents and guardians of children with Down syndrome.

Streszczenie

Wprowadzenie: Zespół Downa (ZD) to najczęściej występująca patologia genetyczna w populacji. Czynniki ryzyka wystąpienia nadwagi i otyłości u dzieci z ZD nie zostały dotąd wyczerpująco opisane, a badania w tym zakresie prowadzone w Polsce są nieliczne.

Cel pracy: Ocena sposobu żywienia dzieci z ZD w wieku przedszkolnym w zależności od stanu ich odżywienia.

Materiał i metody: Badanie ankietowe przeprowadzono u dzieci z ZD w wieku od 3 do 6 lat. Analizie poddano 50 kwestionariuszy prawidłowo wypełnionych przez rodziców lub opiekunów dzieci. Na podstawie wskaźnika masy ciała (BMI) podzielono dzieci na trzy grupy: dzieci z nadwagą, z prawidłowym BMI oraz z niedowagą. Do określenia zależności między BMI a sposobem żywienia zastosowano test χ^2 , przyjęto poziom istotności $p < 0,05$.

Wyniki: Dzieci z nadwagą spożywały w przedszkolu istotnie więcej posiłków niż pozostałe dzieci ($p = 0,04$), jadły dwa obiady (w przedszkolu i w domu) ($p = 0,02$), a także częściej podjadały między posiłkami ($p = 0,007$). Dodatkowo wśród dzieci z nadwagą i otyłością istotnie częściej występowała niedoczynność tarczycy ($p = 0,005$). W badanej grupie stwierdzono też częste, nieuzasadnione stosowanie diet eliminacyjnych, wynikające z przekonania rodziców o ich korzystnym wpływie na zdrowie dziecka z ZD.

Wnioski: U dzieci z ZD w wieku przedszkolnym popełniane są liczne błędy żywieniowe skutkujące zaburzeniami w stanie odżywienia. Konieczne wydaje się wprowadzenie edukacji żywieniowej obejmującej przede wszystkim pracowników przedszkoli odpowiedzialnych za żywienie oraz rodziców i opiekunów dzieci z ZD.

Introduction

Down syndrome (DS) is a well-recognised and researched chromosomal mutation associated with the tripling of genetic material on the 21st chromosome. This is the most common genetic pathology in the population. It is estimated that it occurs in 6.1 to 13.1 out of 10,000 people [1, 2]. This overexpression of genetic material is associated with the occurrence of dysmorphic features (including narrow and slanting eyes, small and flat nose, and poor growth), multi-level body disorders, mental retardation, physical and psychomotor delay, and many diet-related illnesses [3].

In people with DS, the following defects and illnesses occur more often than in the general population: congenital heart defects, digestive tract, urogenital, muscular, and osteoarticular defects as well as haematopoietic system disorders, impaired immune responses, visual defects, hypoacusia, epilepsy [3], endocrine disorders of the thyroid [4], and oral and dental diseases [5]. In patients with DS intolerance of food, malabsorption, metabolic disorders, as well as deficiencies of vitamins and minerals appear more frequently than in people without DS [6, 7].

The somatic development of children with DS is delayed and discordant from birth. In children with DS there is often a lower birth weight than in children without DS. According to the available data, it can be stated that in the first stage of life, a deficiency of body mass is observed in young children with DS, whereas overweight and obesity is observed in adolescence [8, 9]. Among the reasons for this occurrence are metabolic disorders, abnormal blood leptin levels, and comorbidities, such as hypothyroidism [4, 10, 11]. However, it is worth paying attention not only to genetic conditions, but also to environmental factors, bad eating habits, and too little physical activity of children with DS [4]. Available data show that children with DS prefer eating food rich in simple carbohydrates that are easy to chew and swallow. Their diet is low in fresh vegetables and fruit, which leads to many nutritional deficiencies – vitamins, minerals, and fibre [6, 12]. The nutritional behaviour of parents also contributes to the development of overweight and obesity in children with DS. Parents' nutritional behaviours are negatively influenced by factors such as the child's diagnosis, family income, age of the parent, and anxiety associated with the incorrect weight of the child. As a form of reward or consolation, parents often give children high-calorie and highly processed snacks abounding, among others, in sugar. Nutritional mistakes may also be caused by numerous dysfunctions related to disturbances of sucking, swallowing,

hunger, and the functioning of many organs as well as intolerances and deficiencies accompanying people with DS, while these people and/or their relatives lack knowledge about optimal nutrition [13, 14].

The low level of physical activity may contribute to the development of overweight and obesity, which in children with DS may be associated with their poor physical fitness resulting from the associated defects of the musculoskeletal system and dysfunction of the muscular and osteoarticular system. In children with DS, hypotonia and laxity of the ligament-joint system often occur, which leads to dysfunctions and postural defects, abnormal curvatures of the spine, and chest deformities [15, 16]. There is also social stigmatisation and a reluctance to undertake physical activity [17].

The risk factors of overweight and obesity in children with DS have not been comprehensively examined, and research in this area, conducted in Poland, is scarce.

Aim of the research

The aim of the study was to assess the diets of children with Down syndrome at preschool age, depending on their nutritional status.

Material and methods

A questionnaire was used, which involved preschool-age children with DS from 3 to 6 years old. There were 61 questionnaires, of which 11 were rejected due to the lack of complete data or because the age of the children was not in accordance with the guidelines of the study. In further analysis, 50 questionnaires were used. Questionnaires were completed by parents or legal guardians of the children. Before starting the tests, the parents or guardians of each child agreed to participation in the study. The approval of the Bioethics Committee of the Faculty of Medicine and Health Sciences of Jan Kochanowski University in Kielce No. 47/2018 was also obtained for the test.

The research used the authors' original questionnaire, consisting of 29 questions. The questionnaire contained questions on the child's diet up to 6 months of age and from 6 to 12 months of age, as well as the type of elimination diet used, concomitant birth defects and diseases, regularity of meals, snacking, meals in kindergarten, the frequency of consumption of selected groups of food products, liquids drunk, and information about which sources they use to learn about proper nutrition. The questionnaire also included questions about the child's basic anthropometric data (height and body mass). Parents were

Table 1. Characteristics of the study group

Characteristics of the study group	X ± SD; N (%)
Age [years]	4.52 ±1.1
Body mass [kg]	16.74 ±4.06
Height [m]	1.02 ±0.09
BMI [kg/m ²]	16.03 ±2.23
Congenital defect of the heart	21 (51.2)
Congenital defects of the gastrointestinal tract	5 (12.2)
Hypothyroidism	27 (65.9)
Other birth defects and/or diseases	10 (24.4)

asked to obtain these data from the children's health books. In the absence of current data, parents had to measure and weigh the child.

A preliminary examination will allow us to complete and refine this tool for further research. The author's original questionnaire was used for the study, because currently there is no validated Polish tool intended for this age group.

The values of anthropometric measurements – height and body mass – were used to assess the nutritional status of the subjects of the study. On their basis, the body mass index (BMI) was calculated, which was compared to the developmental norms of children and adolescents aged 0–18 years [18].

Statistical analysis

The obtained results were statistically analysed in the Statistica 13.1 program by StatSoft. Nutrition was evaluated in three groups: overweight children (BMI > 90th centile), children with a normal BMI (10th–90th centile), and underweight children (BMI < 10th centile). To determine the relationship between BMI and diet, the χ^2 test was used, and the significance level was < 0.05.

Results

The study covered a group of 50 children – 30% girls and 70% boys – aged 4.52 ±1.1 years (Table 1). The mean BMI value of the study group, calculated on the basis of anthropometric data (body mass and height) given in the survey, was 16.03 ±2.23 kg/m². More than half of the subjects (52%) had a normal body weight, 24% of the them had excessively low BMI, and the same amount (24%) had overweight and obesity.

Birth defects and/or diseases occurred in 82% of children with DS. In 65.9% hypothyroidism was diagnosed. 51.2% of parents declared a congenital defect of the heart. Congenital defects of the gastrointestinal tract were found in 12.2% of the children, among them Hirschsprung's disease was most frequently mentioned. Hypothyroidism was significantly more common ($\chi^2 = 10.73, p = 0.005$) in overweight children (in 50%) than in underweight ones (8.3%).

Up to 6 months of age, 40% of the examined children were exclusively breastfed (Table 2). Every third child was mixed fed (breast and formula), 22% were breastfed from 6 to 12 months of age, and the same number of children were mixed fed. No significant relationship was found between the way the baby was fed in the first year of life and his/her BMI in pre-school age.

An elimination diet was used in 34% of children. The parents most often declared a dairy-free, lactose-free, or gluten-free diet, and a diet with the restriction of easily digestible carbohydrates, which in the questionnaire was referred to as "diabetic" (Table 3). The subjects also eliminated single food products such as vegetables, fruit, or goat's milk. No relationship between the elimination diet and the BMI of the children was observed ($\chi^2 = 0.67, p = 0.72$).

As a reason for the elimination diet, more than half of the parents reported available information about the benefits of using it (Table 4). Almost every third child had lactose intolerance, and every fourth had a cow's milk protein allergy. One child was suffering from celiac disease. None of the parents of the children indicated that they suffered from diabetes.

Table 2. Feeding practices in the first year of the child's life

Feeding practices	Feeding period															
	Up to 6 months								From 6 to 12 months of age							
	Underweight		Normal BMI		Overweight		Total		Underweight		Normal BMI		Overweight		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Breastfed	5	41.7	9	34.6	5	41.7	20	40	4	33.3	4	15.4	3	25	11	22
Mixed fed	5	41.7	7	26.9	6	50	17	34	1	8.3	6	23.1	4	33.3	11	22
Formula	2	16.6	10	38.5	1	8.3	13	26	7	58.4	16	61.5	5	41.7	28	56
χ^2, p					4.91, 0.297								3.59, 0.464			

Table 3. Types of elimination diets used

Types of elimination diets	Underweight		Normal BMI		Overweight		Total	
	N	%	N	%	N	%	N	%
Dairy-free diet	3	75	6	60	2	66.7	11	64.7
Lactose-free diet	1	25	6	60	3	100	10	58.8
Gluten-free diet	1	25	6	60	2	66.7	9	52.9
Diet with the restriction of easily digestible carbohydrates	1	25	5	50	1	33.3	7	41.2
Other diets	0	0	1	10	0	0	1	5.9

Table 4. Reasons for the elimination diet

Reasons for the elimination diet	Underweight		Normal BMI		Overweight		Total	
	N	%	N	%	N	%	N	%
Available information about the benefits of using it	2	50	5	50	2	66.7	9	52.9
Lactose intolerance	1	25	3	30	1	33.3	5	29.5
Cow's milk protein allergy	1	25	2	20	1	33.3	4	23.5
Celiac disease	0	0	1	10	0	0	1	5.9
Diabetes	0	0	0	0	0	0	0	0.0
Other reasons	1	25	3	30	0	0	4	23.6

Among other reasons, the respondents mentioned the child's reluctance to eat certain groups of products, intestinal problems, excessive growth of *Candida albicans* fungus, and an attempt to maintain the child's slim figure.

The examined children with DS consumed an average of 4.86 ± 0.45 meals a day. Most of them, as many as 78% of the children, consumed five meals a day, 18% of children four meals a day, and 4% of children six or more meals a day. Body mass index was not associated with the number of meals consumed ($\chi^2 = 3.44$, $p = 0.49$).

The vast majority of the children (92%) attended kindergarten. Parents declared that 10.9% of children consumed one meal a day in the kindergarten, 43.5% of children consumed two meals a day, 30.4% children three meals a day, and 15.2% children four meals. Of the children attending kindergarten, 71.7% consumed breakfast before going to kindergarten, and 60.9% ate lunch with their family members, after returning home, despite eating lunch in kindergarten. There were statistically significant differences in the nutritional status of the subjects of the study, depending on the number of meals consumed in kindergarten ($\chi^2 = 13.31$, $p = 0.04$). As many as 60% of overweight children attending kindergarten ate three or four meals in kindergarten. For comparison, in a group excluding overweight children, 38.9% of children consumed this number of meals. It was also found that 80% of overweight children attending kin-

dergarten ate two lunches a day: one in kindergarten, the other at home. Among other children, the intake of two lunches was 55.6% ($\chi^2 = 7.79$, $p = 0.02$). However, no significant relationship was found between breakfast consumption before going to kindergarten and the BMI of the children.

There were statistically significant relationships between the nutritional status of the subjects (BMI) and snacking ($\chi^2 = 21.05$, $p = 0.007$) (Table 5). Every day, as many as 25% of overweight children were found to snack, while 41.7% of underweight children never or almost never snacked.

The children most often snacked on fruit including juices, yoghurts and/or flavoured cheeses (Table 6). Slightly less frequent were salty snacks, sweets, junk food, and vegetables.

Most of the subjects consumed fruit and vegetables 1–2 times a day (Table 7).

Of the other product groups, children with DS consumed most often cereal products as well as meat and meat products (Table 8). There were no significant correlations between the frequency of consumption of any of the included product groups and the BMI of the children.

The beverages most frequently drunk by the children were water (44%) and fruit juices (36%).

Almost half of the parents or guardians completing the questionnaires (44%) declared that they gained information about nutrition from the Internet, and only every fourth parent or guardian (24%) in-

Table 5. The frequency of snacking between meals

Frequency of snacking	Underweight		Normal BMI		Overweight		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Never or almost never	5	41.7	4	15.4	0	0	9	18
Once a month or less frequently	3	25	1	3.9	0	0	4	8
Several times a month	1	8.3	5	19.2	5	41.7	11	22
Several times a week	3	25	5	19.2	4	33.3	12	24
Every day	0	0	11	42.3	3	25	14	28
Several times a day	0	0	0	0	0	0	0	0
χ^2, p	21.05, 0.007							

Table 6. Products eaten between meals

Products eaten between meals	Underweight		Normal BMI		Overweight		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Fruit (including juices)	4	33.2	11	42.3	3	25	18	36
Yoghurt or flavoured cheese for snacking	2	16.7	4	15.4	5	41.7	11	22
Salty snacks	2	16.7	3	11.5	2	16.7	7	14
Sweets	2	16.7	2	7.7	1	8.3	5	10
Junk food	0	0	1	3.9	0	0	1	2
Vegetables	0	0	0	0	1	8.3	1	2
Other products	2	16.7	5	19.2	0	0	7	14

Table 7. The frequency of vegetable and fruit consumption

Products	Frequency of consumption	Underweight		Normal BMI		Overweight		Total	
		<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Vegetables	Never or almost never	2	16.7	2	7.7	0	0	4	8
	Several times a month	0	0	0	0	1	8.3	1	2
	Several times a week	2	16.7	5	19.2	2	16.7	9	18
	1–2 times a day	7	58.3	17	65.3	7	58.3	31	62
	3–4 times a day	1	8.3	1	3.9	2	16.7	4	8
	5 or more times a day	0	0	1	3.9	0	0	1	2
χ^2, p		8.01, 0.628							
Fruit	Never or almost never	1	8.3	1	3.9	0	0	2	4
	Several times a month	0	0	1	3.9	1	8.3	2	4
	Several times a week	4	33.4	4	15.4	2	16.7	10	20
	1–2 times a day	7	58.3	19	72.9	7	58.3	33	66
	3–4 times a day	0	0	1	3.9	2	16.7	3	6
	5 or more times a day	0	0	0	0	0	0	0	0
χ^2, p		7.11, 0.525							

Table 8. The frequency of consumption of selected groups of food products

Products	Frequency of consumption	Underweight		Normal BMI		Overweight		Total	
		N	%	N	%	N	%	N	%
Meat and meat products	Never or almost never	0	0	0	0	0	0	0	0
	Once a month or less frequently	0	0	2	7.7	0	0	2	4
	Several times a month	0	0	0	0	1	8.3	1	2
	Several times a week	7	58.3	15	57.7	8	66.7	30	60
	Every day	5	41.7	9	34.6	3	25	17	34
	Several times a day	0	0	0	0	0	0	0	0
	χ^2, p	5.63, 0.466							
Fish	Never or almost never	1	8.3	3	11.5	0	0	4	8
	Once a month or less frequently	1	8.3	4	15.4	1	8.3	6	12
	Several times a month	7	58.4	13	50	11	91.7	31	62
	Several times a week	3	25	6	23.1	0	0	9	18
	Every day	0	0	0	0	0	0	0	0
	Several times a day	0	0	0	0	0	0	0	0
	χ^2, p	7.08, 0.629							
Milk and dairy products	Never or almost never	3	25	9	34.6	3	25	15	30
	Once a month or less frequently	1	8.3	1	3.9	0	0	2	4
	Several times a month	1	8.3	2	7.7	1	8.3	4	8
	Several times a week	2	16.7	7	26.8	3	25	12	24
	Every day	5	41.7	6	23.1	5	41.7	16	32
	Several times a day	0	0	1	3.9	0	0	1	2
	χ^2, p	4.07, 0.944							
Eggs	Never or almost never	2	16.7	3	11.5	0	0	5	10
	Once a month or less frequently	1	8.3	2	7.7	1	8.3	4	8
	Several times a month	5	41.7	11	42.3	6	50	22	44
	Several times a week	4	33.3	8	30.8	5	41.7	17	34
	Every day	0	0	2	7.7	0	0	2	4
	Several times a day	0	0	0	0	0	0	0	0
	χ^2, p	4.07, 0.851							
Animal fats	Never or almost never	3	25	6	23.1	3	25	12	24
	Once a month or less frequently	3	25	2	7.7	1	8.3	6	12
	Several times a month	0	0	4	15.4	2	16.7	6	12
	Several times a week	4	33.3	6	23.1	2	16.7	12	24
	Every day	2	16.7	8	30.7	4	33.3	14	28
	Several times a day	0	0	0	0	0	0	0	0
	χ^2, p	5.61, 0.691							

Table 8. Cont.

Products	Frequency of consumption	Underweight		Normal BMI		Overweight		Total	
		N	%	N	%	N	%	N	%
Vegetable fats	Never or almost never	1	8.3	3	11.5	2	16.7	6	12
	Once a month or less frequently	0	0	3	11.5	0	0	3	6
	Several times a month	4	33.4	3	11.5	3	25	10	20
	Several times a week	6	50	8	30.8	6	50	20	40
	Every day	1	8.3	9	34.7	1	8.3	11	22
	Several times a day	0	0	0	0	0	0	0	0
	χ^2, p	10.35, 0.241							
Cereal products	Never or almost never	0	0	0	0	0	0	0	0
	Once a month or less frequently	0	0	1	3.9	0	0	1	2
	Several times a month	2	16.7	2	7.7	1	8.3	5	10
	Several times a week	4	33.3	9	34.5	6	50	19	38
	Every day	6	50	13	50	5	41.7	24	48
	Several times a day	0	0	1	3.9	0	0	1	2
	χ^2, p	3.29, 0.915							
Sweets	Never or almost never	4	33.4	8	30.8	2	16.7	14	28
	Once a month or less frequently	1	8.3	4	15.3	1	8.3	6	12
	Several times a month	3	25	8	30.8	4	33.3	15	30
	Several times a week	3	25	5	19.2	5	41.7	13	26
	Every day	1	8.3	1	3.9	0	0	2	4
	Several times a day	0	0	0	0	0	0	0	0
	χ^2, p	4.05, 0.853							

licated a medical doctor or dietitian as the source of their knowledge about nutrition. Ten per cent learned about nutrition from books, 4% from friends, and 2% from TV. The other parents of the children gained information about nutrition from their own experience, from observation of the child, or were guided by intuition.

Discussion

Analysis of the nutritional status of children with DS showed that only 52% of them had a normal body mass. Overweight and obesity was noted in 24% of respondents. The prevalence of overweight and obesity among preschool children in European countries ranges from 10.0% to 20.6% [19]. In the work of Roszko-Kirpsza *et al.*, 63.3% of respondents were characterised by a normal nutritional status, whereas 24% of children with DS and 12.5% of children without DS were overweight and obese [20]. Higher rates of

overweight and obesity among children and adolescents with DS have also been observed by many other authors [4, 21].

Dietary inclinations that contribute to the shaping of eating patterns and habits are influenced by the way the child is fed in the first period of life. Koziół-Kozakowska *et al.* observed more beneficial nutritional behaviour among breast-fed children [22]. Kowal *et al.*, however, noticed that an overly long breastfeeding period may cause the appearance of overweight and obesity among preschool children [23]. Among the examined children with DS, 40% were breastfed until 6 months of age and 22% in the period from 6 to 12 months. However, there was no relationship between the way of feeding children with DS in the first year of life and their BMI in preschool age.

Over 80% of the children with DS had congenital malformations and diseases. Some parents also declared cow's milk protein allergy, lactose intolerance, or celiac disease. In the examined children, a re-

lationship was observed between the occurrence of overweight and obesity and hypothyroidism. In the literature review, Bertapelli *et al.* suggested that hypothyroidism may be related to the BMI of children with DS [4].

Fat accumulation leads to dysfunction of the hypothalamic-pituitary-thyroid axis and to changes in thyroid function. In obese people, a higher level of thyroid-stimulating hormone (TSH) is often observed at normal concentrations of thyroid hormones. The reason for the abnormalities of these results, however, is not clear. Hypothyroidism is associated with reduced thermogenesis and metabolic rate. It is suggested that a high level of leptin may play an important role in this case [24–26].

In another study, however, overweight and obesity appeared more often in children who did not have co-existing disorders [21].

Children with DS often suffer from diseases and intolerances, which require individual nutritional recommendations and modification of the menu. Parents of these children should, therefore, especially take care of the development of their knowledge and find appropriate sources of information. Almost half of the parents surveyed declared that their nutritional knowledge comes mainly from the Internet, and only every fourth parent gained knowledge during their visits to a doctor or dietitian. The elimination diet was administered for children with DS by every third parent (34%). These were dairy-free, lactose-free, and gluten-free diets and diets with the restriction of easily digestible carbohydrates. Unfortunately, only in the case of some of the children did the use of elimination diets have any grounds. Every second child had gluten excluded from the diet, while only 5.9% of people had celiac disease. Almost 60% of people excluded lactose from the diet, and only half of them indicated lactose intolerance. Over 40% of parents indicated in the survey a diet with the restriction of easily digestible carbohydrates, and none of the children had diabetes. The most frequently indicated reason for the use of the elimination diet was the common knowledge about the benefits of using it. Such an attitude and unwarranted use of the elimination diet may be associated with the improper content of nutrients in the diets of the subjects. In the study by Magnesis *et al.*, regarding diets of children with DS, numerous nutritional errors were observed, such as an increased intake of carbohydrates and calories as well as sodium, accompanied by insufficient intake of calcium, certain B vitamins, and water [27]. In other studies, a high-carbohydrate diet rich in simple carbohydrates and with a deficiency of vitamins and minerals was also observed [7, 28].

Preschool children (3–6 years) should consume 4–5 meals a day. Regularity of eating meals allows one to avoid eating between meals and can also reduce the reluctance of children to eat the main meals resulting from snacking. As many as 78% of parents

of children with DS declared that their children consumed five meals a day. None of the participants of the study indicated consumption of less than four meals a day. Twenty-eight percent of the examined children snacked between meals. Most of the children snacked several times a week and several times a month. The children most often chose fruit as well as yoghurts or flavoured cheese for snacking. A small percentage of children (10%) snacked on sweets. Sosnowska-Bielicz and Wrotniak observed snacking in 78% of children and as much as 65% declared eating sweets [29]. In other studies, the authors also showed that a large proportion of children snacked between meals, and children most often chose sweets and confectionery [22, 30].

Nutrition and the habits of preschool children are influenced not only by parents and the home environment, but also by the preschool institution – the quality and quantity of meals the child eats in kindergarten, and whether and how the parent adjusts feeding at home to preschool meals. Eating at home should complement the preschool meals. To properly plan a child's menu, it is necessary for parents to have information about meals in the kindergarten. However, as Sadowska and Krzymuska emphasise, knowledge about the preschool menu of children is often not used by parents when preparing meals at home. As many as half of parents declared that they did not use this information [31].

Our research showed that the majority of children with DS attending kindergarten consumed two (43.5%) or three (30.4%) meals per day in the kindergarten. Breakfast before going to kindergarten was consumed by over 70% of children, and over 60% declared consumption of two lunches (in kindergarten and at home). Studies by other authors have shown that the largest number of children consumed four meals a day in kindergarten [32]. Breakfast before going to kindergarten was consumed by only about 30–45% of children, which, as the authors suggest, may result from the belief that the child receives this meal in kindergarten.

According to the current pyramid of nutrition and physical activity, the basis of nutrition should be vegetables and fruits. In children with DS, the intake of vegetables and fruits was observed to be too low. Over 60% of the children consumed both fruit and vegetables 1–2 times a day. Almost 20% declared consumption of these products only a few times a week. It is worrying that there were responses that showed fruit and vegetable intake several times a month and never or almost never.

Insufficient intake of vegetables and fruit by preschool children without DS with higher intake of fruit has been noted by other authors as well [32–34].

Roszko-Kirpsza *et al.* also analysed the impact of the amount of fruit and vegetables consumed on the nutritional status of children. As in this study, there was no significant relationship between vegetable

and fruit intake and nutritional status (BMI) of children [20].

Children with DS usually consumed meat and meat products several times a week (60%) or daily (34%). Other authors showed a much higher intake of these products by children without DS. In the work of Newerli-Guz and Kulwikowska, none of the children consumed meat and meat products less often than once a day, and 40% consumed these products two or more times a day [34]. Similar results were also obtained by Roszko-Kirpsza *et al.* [20].

There was too little fish intake in children with DS. The largest group (62%) consumed fish several times a month. There were also answers indicating a lack of fish consumption (8%) and fish consumption only once a month or less frequently (12%). Fish consumption by preschool children without DS was at a similar, excessively low level [20, 34].

Consumption of milk and dairy products in children with DS was found to be too low. Only 32% of children consumed products from this group every day, and 24% several times a week. As many as 30% of children did not consume dairy products, which could have been related to the intolerances described above or the conviction of beneficial effects of dairy-free, lactose-free diets. In the studies that describe diets of children without DS, the consumption of milk and milk products was higher [34]. A small percentage of the examined children did not consume these products or consumed them less frequently than once a day [20, 30, 32, 34, 35].

The examined children with DS consumed few eggs. Most children consumed them several times a month (44%) or several times a week (34%). Some parents even declared that their children did not eat eggs at all. Insufficient egg consumption was also reported by other authors analysing preschool food rations [31, 36].

Almost every fourth child (24%) did not consume animal fats. The same number of children consumed these products several times a week, and a similar number every day. The largest number of children with DS consumed vegetable fats several times a week (40%) and daily (22%). It is worrying that up to 12% of children never or almost never consumed vegetable fats. According to Myszkowska-Ryciak and Harton, there were too few animal and vegetable fats in preschool meals [36]. Sadowska and Krzymuska, however, in their work described excessive consumption of animal and vegetable fats [31].

Only nearly every second child consumed cereal products on a daily basis (48%). Almost all other respondents indicated a smaller intake of cereal products, which could be related to the gluten-free diet. Too small portions of bread, flour, groats, pasta, cereals, and other cereal products in comparison with model food rations were also described by other authors [31, 36].

The parents of children with DS declared that their children ate sweets only a few times a week (26%) or several times a month (30%). Forty per cent of children consumed sweets less often, of which 28% indicated the answer never or almost never. Such behaviour may have resulted from preventive actions of parents who are aware of the risk of developing overweight and obesity and the health consequences associated with them. Other authors who conducted studies of children without DS, showed that the results for the consumption of sweets were much less favourable. Children ate sweets several times a week, every day, or even several times a day [29, 30, 32, 34]. Magenis *et al.*, however, showed high carbohydrate intake among children with DS [27].

Proper diet is supplemented with proper fluid intake. Children aged 4–6 years should drink 1600 ml of water per day [37].

Children with DS most often drank water (44%) and fruit juices (36%), and a small percentage of them drank tea. Among children without DS, a similar distribution of consumption of fruit juices (40%) and water (40%) was observed [29]. Harton *et al.*, however, observed the highest consumption of tea (37%) and water (34%). Juices were consumed by fewer children (20%) [30].

The results of this study show that the nutrition status of children with DS could be affected by hypothyroidism, a high number of meals consumed by children in kindergarten, eating two lunches (in kindergarten and at home), and eating between meals. The lack of dependence between the frequency of consumption of certain product groups and the BMI of the examined children may be due to the fact that the size of the portions consumed and the intake of calories [38], which were not analysed in the present study, had a greater impact on their body weight. The limitation of the work is also the lack of data on the physical activity of the examined children, which could have a significant impact on the formation of their BMI.

Conclusions

In children with Down syndrome at preschool age, a number of nutritional errors are made resulting in disorders in their nutritional status. The high incidence of excess body mass in children with DS may be associated with eating more meals in the kindergarten in comparison with other children, including eating two lunches (in kindergarten and at home) and eating between meals. In addition, hypothyroidism was significantly more common among children with overweight and obesity, which is also a factor that increases the risk of excess body weight. We found in the study group frequent, unjustified use of elimination diets, resulting from parents' conviction about their beneficial effects on the health of a child with

DS. The results obtained indicate the necessity of introducing nutritional education that mainly includes kindergarten employees responsible for nutrition as well as parents and legal guardians of children with Down syndrome.

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Conflict of interest

The authors declare no conflict of interest.

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