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GLYCEMIC INDEX AND GLYCEMIC LOAD OF DIETS IN CHILDREN AND YOUNG PEOPLE WITH DOWN'S SYNDROME

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ABSTRACT

Introduction. Down's Syndrome (DS) belongs to the most frequent aberrations of autosomal chromosomes of all known chromosome disorders. The most frequent diseases accompanying Down's Syndrome include diabetes and obesity. One of the causes of fatty tissue, including visceral tissue accumulation in body is an ill balanced diet in terms of, among others, the quantity and structure of carbohydrates, as well as values of glycemic index (GI) and glycemic load (GL). As in Down's Syndrome the incidence of both obesity and diabetes is higher than in healthy population, it seems essential to evaluate and correct the diet in terms of not only carbohydrates level, but also of GI and GL. The object of this study was to evaluate the nutritive status and nutritional patterns of children and adolescents (both sexes) with Down's Syndrome (DS) taking into account the GI and GL of their meals.
Material and methods. The state of nutrition was assessed in October and November 2009 in 24 people with clinically-diagnosed trisomy of chromosome 21 including 16 boys (aged 10-22) and 8 girls (aged 13-18) pupils of two school-and-educational centres from the West Pomerania Province. Methods of feeding evaluation that is energy and nutritive value, consumption patterns of groups of food products, GI and GL values were based on analysis of three days menu by currently noting.
Results. Among the young people under research 54% were overweight and obese and among those 41% with visceral obesity. Analysis of menus of the young people with Down's Syndrome has shown low energy value of diet, low realization of the recommended supply of fibre, Ca, Mg, Zn, B_1 vitamin and fluids. The participation of energy coming from fat and saccharose was too high and too low from carbohydrates compared to the recommended values. Resultant GI of meals of the young people under research exceeded average values and the whole day GL exceeded high values.
Conclusions. Everyday food rations of both sexes affected by Trisomy 21 were not balanced in terms of energy and nutritive values, which may predispose them to disorders in carbohydrate body metabolism. Average values of the glycemic index and high values of the glycemic load of diets of the surveyed participants may facilitate the development of obesity and its effects in the form of type 2 diabetes. It is advisable to correct diets of participants with Down's Syndrome being at a high risk of type 2 diabetes development in terms of GI and GL values and it is advisable to conduct health-promoting nutritional education of children and adolescents as well as their parents/guardians and staff of centres they attend to, in the aspect of the prophylaxis of metabolic diseases.

Key words: nutritional status, Glycemic Index, Glycemic Load, Down's Syndrome

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LIST OF ABBREVIATIONS

BMI – Body Mass Index
Ca – Calcium
DS – Down's Syndrome
GI – Glycemic Index
GL – Glycemic Load
RDA – Recommended Daily Allowances
WC – Waist Circumference

INTRODUCTION

Down's Syndrome (DS) belongs to the most frequent aberrations of autosomal chromosomes out of all known chromosome disorders [Korenberg et al. 1994]. The frequency of occurrence of irregularities in the number or structure of a chromosome reaches ca. 6 per 1000 live newborn, and globally it is estimated to occur in one per 600-700 live newborn [Stratford 1993] whereas in Poland the respective number accounts for 1:702 after confirmation of clinical diagnosis with cytogenetic examination and for 1:604 if accounts is taken of children in whom DS was diagnosed clinically but no karyotype was determined owing to technical difficulties [Rogóyski et al. 1996]. The most frequent defects, impairments and diseases accompanying the Down's Syndrome include: mental impairment [Śmigiel and Stembalska 2007], hypoacusis [Szyfter and Łączkowska-Przybylska 1995], vision defects [Koraszewska-Matuszewska et al. 1994], hypothyroidism [Gołębiowski and Trzciąkowska 2007], organic heart diseases [Sadowska et al. 2006], Alzheimer's disease [Barnhart and Connolly 2007], diabetes [Kinik et al. 2006] and obesity [Bell and Bhate 1992, Prasher 1995].

One of the causes of fatty tissue including visceral tissue accumulation in body is an ill-balanced diet in terms of, among others, quantity and structure of carbohydrates, as well as values of glycemic index (GI) and glycemic load (GL). There are available works which describe correlations between BMI, WC and GI and GL indexes in adults, yet only few reports on children and adolescents with diagnosed Trisomy 21. The incidence of both obesity and diabetes occurring is higher in Down's Syndrome than in healthy population, it seems essential to evaluate and correct diet in terms of not only carbohydrates level [Anderson et al. 2002] but also of GI and GL indexes, because products with low values of these parameters have been shown to reduce the risk of the incidence of type 2 diabetes, heart diseases and to confirm the hypothesis that high postprandial glycemia is a universal mechanism in the progression of these diseases [Barclay et al. 2008].

This work aims at evaluation of the state of nutrition and methods of feeding children and youths (both sexes) with Down's Syndrome, GL and taking into consideration GL of meals, because in the accessible literature, both in Polish and foreign language, no work containing such important factors influencing carbohydrates metabolism of human organism which are GI and GL in this disease entity, could have been found.

MATERIAL AND METHODS

The survey conducted in October and November 2009 covered 24 participants with clinically-diagnosed trisomy of chromosome 21, including 16 boys (aged 10-22) and 8 girls (aged 13-18), pupils of two school and educational centres from the West Pomerania Province.

The nutritional status of the subjects was evaluated with the use (upon consent of parents/legal guardians, directors of centres) of information from files of prophylactic medical examinations of the pupils conducted at the nurse's office (September 2009) that included: measurement of body mass with a medical scale (legalized and standardized exact to 0.1 kg, measurement was done without shoes and in light outfits), measurement of body height in the Frankfurt plane position with a height meter (mounted to the medical scale) exact to 0.5 cm, and measurement of waist circumference at half distance between the inferior margin of costal arch and the upper crest of iliac bone using a non-tensile measuring tape exact to 1 cm at the height of navel under conditions of a short apnoea.

The achieved values of measurement enabled calculating the BMI using the formula: body mass (kg) / body height (m^2), and waist circumference (WC) index. For interpretation of body mass and height values in participants under 18 years old, use was made of centile charts for participants with Down's Syndrome [Cronk et al. 1988]. The BMI values obtained were referred (respectively to sex and age) to centile charts [Palczewska and Szilágyi-Pągowska 2002] and the following BMI intervals were adopted: 85-90 percentile as overweight, and ≥95 percentile as obesity. The WC values in participants aged <18 were referred to centile charts [Nawarycz and Ostrowska-Nawarycz 2007] and values of ≥90 percentile were adopted as a criterion of visceral tissue location, whereas in subjects aged >18 values between 94 and 101.9 cm in men were acknowledged as overweight, and values ≥102 cm were interpreted as obesity [Dalton et al. 2003].

Owing to impaired or completely reduced communication with the pupils of the school-and-educational centres, detailed information on their nutrition was obtained from their parents/guardians and tutors from the centres. Data was collected based on menus from three days of week selected at random (including 1 weekend day), with the method of systematic noting, including type and size of food rations and time of product consumption. The necessary complement were individual interviews with stewards and cooks from the school and educational centres. The size of food rations were determined based on the *Album of Food Rations, Products and Dishes* [Szponar et al. 2000]. The energy and nutritive values of the menus were evaluated using Dietetyk 2009 software, by determining the intake of components each day, and then average intake of three days, with account given to losses of the nutritive value of food products. The values achieved were compared with recommended daily allowances RDA for the age and sex group. The intake of dietary fibre was referred to the recommended level in the prevention of obesity and other non-infectious disease (>25 g) [Jarosz and Bułhak-Jachymczyk 2008]. After considering the quantity of waste in groups of consumed food products, the values obtained were compared with the recommended model food rations [Turlejska et al. 2006].

Values of resultant Glycemic Index (GI) and Glycemic Load (GL) (GI of food product × content of its carbohydrates (g)/100) were computed for particular meals of each menu using tables [Foster-Powell et al. 2002]. The following GI values of food products were adopted: GI ≤55 – low, GI 56-69 – medium, and GI ≥70 – high. The GL value was adopted for standard food ration of food products as: GL ≤10 – low, GL 11-19 – medium, and GL ≥20 – high [Wolever et al. 2006]. The GL of a whole day diet <80 was adopted as low, 80-119 as medium, and ≥120 as high [Monro and Shaw 2008]. Owing to the low number of participants in different age groups and both sexes groups, no statistical calculations were performed and the results achieved were presented as arithmetic means and standard deviation computed in the Microsoft Excel program.

RESULTS

The conducted analysis of body mass values (Table 1) based on centile charts for participants with Down's Syndrome, demonstrated that body mass of both girls and boys in all age groups diverged from the value at 50 percentile of the centile chart. In 4 girls and 13 boys, body mass values were higher (75% of all participants under research) from body mass value at the 50 percentile, whereas in 3 girls and 3 boys (25% of all participants under research) it was lower.

Table 1. Anthropometric attributes values and of the BMI, WC indicators of participants with Down's Syndrome (x ±SD, n = 24)

Parameters and indices	Girls (n = 8)		Boys (n = 16)			
	13-15 years (n = 2)	16-18 years (n = 6)	10-12 years (n = 3)	13-15 years (n = 3)	16-18 years (n = 4)	19-22 years (n = 6)
Body weight, kg	41.7 ±1.1	57.8 ±12.5	33.0 ±3.5	52.6 ±16.6	56.5 ±12.3	70.3 ±14.6
Body height, cm	1.42 ±0.05	1.43 ±0.05	1.27 ±0.06	1.47 ±0.1	1.59 ±0.09	1.55 ±0.07
BMI, kg·m^{-2}	20.8 ± 2.2	28.1 ±7.0	20.2 ±0.5	23.9 ±3.6	22.0 ±3.0	28.9 ±4.6
WC, cm	76.5 ±5.0	78.2 ±8.1	64.2 ±1.6	78.0 ±8.0	73.5 ±8.3	89.3 ±5.8

The carried out analysis of body height (Table 1) based on centile charts for participants with Down's Syndrome showed that in 5 girls and 6 boys (45.8% of all participants) it was higher, whereas in 3 girls and 4 boys (29.2% of all participants) it was lower than the value at 50 percentile of the centile chart.

The analysis of BMI values (Table 2) demonstrated that over a half of the surveyed girls and boys were characterised by overweight or obesity. In addition, the WC values pointed to the occurrence of visceral obesity in 4 girls and 6 boys (41.6% of all participants under research).

The qualitative analysis of eating habits of participants with DS (72 menus) showed that the optimum number of 5 meals a day (Table 3) was consumed by only every second person. However, eating between meals (6 and more meals) was noted in 15% of the surveyed. The most frequently consumed meals were: breakfast, dinner and supper which were prepared at the centres, whereas the less often consumed meals included lunch and afternoon snack (Table 4) prepared by parents/guardians, which for the 2/3 of the participants included mainly sweets and confectionery.

Table 2. Percentage of participants with Down's Syndrome depending of BMI index value, n = 24

Range of BMI	Girls 13-18 years (n = 8)		Boys 10-22 years (n = 16)		Total (n = 24)
	n	%	n	%	%
> 95 percentile (obesity)	4	50	7	43.8	8.3
85-95 percentile (overweight)	1	12.5	1	6.3	45.8
5-75 percentile (norm)	3	37.5	8	50	45.9
<5 percentile (underweight)	0	0	0	0	0

Table 3. Number of males consumed daily by participants with Down's Syndrome in the term of interview, n = 24

Number of meals	Percentage
1-2	0
3	2.8
4	20.8
5	61.1
6 and more	15.3

Table 4. Percentage of participants with Down's Syndrome eating basic meals in the term of interview, n = 24

Meal	Percentage
Breakfast	100
Lunch	86
Dinner	100
Afternoon snack	69
Supper	100

The quantitative analysis of menus (Table 5) of girls with DS aged 13-18 demonstrated low energy value of their diets, low coverage of recommended intakes of dietary fibre, as well as Ca, Mg, Zn (in younger participants), vitamin B_1 (in younger participants), and fluids. The qualitative analysis of menus (Table 5) of boys with DS aged 11-22 showed a low energy value of their diets, low coverage of recommended intakes of dietary fibre, as well as Ca, Mg, Zn (in boys aged 13-15), vitamin B_1 and fluids. The contribution of energy originating from some basic nutrients in both girls and boys diverged from the recommended values and was too high for fats and saccharose and too low for carbohydrates.

The identified irregularities in the intake of nutrients resulted from a low intake of cereal products, potatoes, vegetables and fruits, legumes and nuts, milk and dairy products, fish, and the excessive intake of cured meat products, eggs, animal fats, sugar and sweets by the surveyed (Table 6).

The analysis of values of the resultant Glycemic Index (GI) of particular meals in diets of girls and boys (Table 7) demonstrated that it exceeded the medium values (GI >55). The highest GI was assayed in suppers and dinners (GI 62-64), whereas the lowest one in afternoon snacks (GI 47-48). The reported GI

Table 5. Energy value and some basic nutrients levels in daily rations consumed by participants with Down's Syndrome during the period of interview, n = 24

Components	Girls (n = 8)				Boys (n = 16)							
	(x ±SD)		percentage of daily allowance		(x ±SD)				percentage of daily allowance			
	13-15 years (n = 2)	16-18 years (n = 6)	13-15 years (n = 2)	16-18 years (n = 6)	10-12 years (n = 3)	13-15 years (n = 3)	16-18 years (n = 4)	19-22 years (n = 6)	10-12 years (n = 3)	13-15 years (n = 3)	16-18 years (n = 4)	19-22 years (n = 6)
Energy, kcal	1 745.5 ±23.8	2 133.2 ±516.9	71.2	85.3	2 075.8 ±99.7	1 975.1 ±265.9	2 494.8 ±434.3	2 123.2 ±358.4	86.5	65.8	73.3	74.5
Assimilable carbohydrates, g	277.2 ±9.6	295.6 ±86.2	213.2	227.6	330.1 ±10.1	305.8 ±52.1	353.3 ±53.4	306.5 ±53.8	253.9	235.2	271.8	235.8
Dietary fibre, g	17.1 ±1.6	21.0 ±7.1	68.4	84.0	18.3 ±1.6	19.1 ±4.7	22.8 ±4.3	19.3 ±5.5	73.2	76.4	91.2	77.2
Calcium, mg	457.2 ±312.2	638.4 ±185.4	42.1	49.1	695.9 ±113.5	557.8 ±232.4	686.7 ±316.2	660.7 ±264.2	53.5	42.9	52.8	50.8
Magnesium, mg	215.8 ±71.5	263.6 ±44.7	59.9	73.2	225.6 ±27.4	275.7 ±66.5	286.9 ±55.1	251.4 ±41.2	94.0	67.2	68.3	62.9
Zinc, mg	7.5 ±0.2	10.7 ±2.6	83.3	118.8	9.2 ±0.6	9.4 ±1.9	11.5 ±2.6	9.6 ±2.8	115.0	85.4	104.5	87.3
Vitamin B_1, mg	1.0 ±0.1	1.1 ±0.4	90.9	100	0.9 ±0.1	0.9 ±0.2	1.2 ±0.3	1,0 ±0.3	81.8	75.0	100	76.9
Water, g	1 422.3 ±193.8	1 677.9 ±146.1	64.7	73.0	1 567.5 ±70.6	1 446.4 ±153.5	1 779.5 ±305.5	1 320.9 ±199.0	65.3	48.2	59.3	35.7
Protein, % of energy	12.7 ±0.9	14.4 ±2.2	90.7	102.9	13.8 ±0.8	13.0 ±0.6	13.9 ±1.5	14.0 ±1.0	98.6	92.9	99.3	100
Fat, % of energy	33.0 ±1.8	34.4 ±2.2	110.0	114.7	34.9 ±1.2	31.4 ±3.4	33.5 ±2.9	35.8 ±3.2	116.3	104.7	111.7	119.3
Carbohydrates, % of energy	54.3 ±0.9	51.2 ±4.9	97.0	91.4	51.3 ±1.9	55.6 ±3.3	52.6 ±3.9	50.2 ±3.0	91.6	99.3	93.9	89.6
Sucrose, % of energy	12.0 ±5.2	11.1 ±1.5	120.0	111.0	12.1 ±1.4	16.0 ±3.5	12.3 ±2.2	11.0 ±3.2	121.0	160.0	123.0	110.0

Table 6. Chosen groups of products in daily food rations consumed by participants with Down's Syndrome during the period of interview, n = 24

Components	Percentage of daily allowance					
	girls (n = 8)		boys (n = 16)			
	13-15 years (n = 2)	16-18 years (n = 6)	10-12 years (n = 3)	13-15 years (n = 3)	16-18 years (n = 4)	19-22 years (n = 6)
Wheat and rye bread	86	64	63	47	48	53
Flour, pasta	16	81	65	56	54	33
Groats, rice, breakfast cerals	31	109	65	38	52	8
Potatoes	57	44	30	33	41	31
Vegetables	23	34	33	26	39	29
Pulses seeds and nuts	15	25	13	0	17	5
Fruits	34	34	36	32	42	40
Milk and milk fermented beverages	15	35	42	30	33	30
Fresh cheeses	23	47	13	45	29	21
Ripening cheeses	75	52	116	61	75	97
Meat, poultry	47	102	145	54	92	88
Sausages	163	135	187	127	167	135
Fish	50	43	100	30	67	42
Eggs	51	115	211	294	218	103
Animal fats	216	154	143	68	135	132
Vegetable fats	32	57	48	55	29	79
Mixed fats	110	100	140	0	20	22
Sugar and sweets	147	123	157	250	233	191

values were similar in boys and girls. The analysis of values of the Glycemic Load (GL) of particular meals (Table 7) demonstrated that it was high (GL >20). The highest GL was determined in dinners and breakfasts of girls, as well as in dinners and suppers of boys. The 24-h GL of participants' diets was high (GL >120), and higher in diets of boys than in those of girls.

DISCUSSION

Compared to the healthy population, participants affected by Down's Syndrome are retarded in physical development and are characterised by greater abnormalities in both body mass and height. The common stunted growth or growth retardation in DS belongs to one of its clinical symptoms. In the conducted survey, in case of girls and boys with clinically diagnosed Trisomy 21, body height values often diverged from the value at the 50 percentile of the centile chart. Likewise, Schmid [1987] demonstrated that in boys with DS, body height values were below normal values up to the age of 10, however after reaching this age some of the participants achieved values from the range of standard values for a normal population. In turn,

Table 7. Glycemic Index (GI) and Glycemic Load (GL) in daily food rations of participants with Down's Syndrome (x ±SD, n = 24)

Components	Girls (n = 8)			Boys (n = 16)				
	13-15 years (n = 2)	16-18 years (n = 6)	average (n = 8)	10-12 years (n = 3)	13-15 years (n = 3)	16-18 years (n = 4)	19-22 years (n = 6)	average (n = 16)
				Glycemic Index				
Breakfast	58.0 ±14.7	57.9 ±12.9	59.0 ±11.6	63.2 ±4.0	61.0 ±9.7	63.2 ±4.9	63.3 ±7.0	62.8 ±6.5
Lunch	50.1 ±21.7	55.1 ±13.7	55.4 ±17.6	58.8 ±4.6	56.7 ±21.6	59.2 ±6.4	53.8 ±24.1	56.6 ±17.6
Dinner	59.4 ±15.3	2.9 ±5.2	62.8 ±4.7	62.7 ±7.0	62.0 ±6.0	64.2 ±3.8	64.7 ±4.2	63.7 ±5.1
Afternoon snack	46.9 ±20.0	53.4 ±21.7	48.5 ±22.7	44.7 ±34.1	48.6 ±30.4	53,3 ±26.9	45.2 ±27.4	47.7 ±28.5
Supper	62.5 ±19.9	64.0 ±18.2	63.8 ±15.9	61.4 ±9.3	65.9 ±5.5	66.9 ±2.4	64.2 ±8.6	64.8 ±7.2
Average daily	**55.7 ±18.8**	**58.7 ±15.6**	**57.9 ±16.4**	**58.3 ±17.1**	**58.8 ±18.0**	**61.3 ±13.2**	**58.2 ±18.5**	**58.2 ±18.5**
				Glycemic Load				
Breakfast	32.2 ±24.8	34.4 ±25.7	33.3 ±22.8	32.2 ±12.1	34.6 ±14.9	37.2 ±18.1	36.7 ±14.9	35.6 ±15.0
Lunch	24.9 ±21.2	29.4 ±17.8	27.2 ±19.2	36.8 ±12.6	43.1 ±29.4	50.3 ±21.0	30.8 ±25.6	39.2 ±24.0
Dinner	40.9 ±16.9	48.5 ±24.9	44.7 ±22.1	44.5 ±19.1	48.8 ±30.9	55.9 ±6.2	50.8 ±17.1	50.5 ±16.0
Afternoon snack	29.6 ±18.8	36.9 ±35.0	33.2 ±33.2	20.5 ±17.4	18.9 ±17.6	23.7 ±19.6	16.5 ±13.9	24.0 ±19.5
Supper	26.8 ±11.0	24.5 ±15.5	25.7 ±14.2	34.8 ±13.7	34.4 ±10.9	49.5 ±12.4	43.6 ±16.1	41.7 ±14.8
Average daily	**154.4 ±27.6**	**173.7 ±27.0**	**164.1 ±2.3**	**192.8 ±19.8**	**79.8 ±19.6**	**216.6 ±12.9**	**178.4 ±28.2**	**191.0 ±17.9**

GI ≤55 low, GI 56-69 medium, GI ≥70 high.
GL ≤10 low, GL 11-19 medium, GL ≥20 high.
GL of an everyday diet ≤80 low, GL 80-119 medium, GL ≥120 high.

in the case of girls – irrespective of age, body height values were lower than respective values of healthy girls of the same age. Whereas the research conducted by Prasher [1995] amongst adults with DS, showed lower body height values compared to the normal population.

In the conducted survey body mass of 75% of the surveyed (more often in the case of boys) was higher than the standard values. Likewise Schmid [1987] demonstrated that body mass of boys with DS was increasing since they exceeded the age of 11 and was higher than in normal peers, whereas in case of girls – it was lower, higher or correct compared to body mass values of girls not affected by the disease. In the case of participants with DS, excessive body mass may be due to the frequently occurring hypothyroidism that induces retardation or disorders of metabolism [Gołębiowski and Trzciąkowska 2007].

The BMI value should correspond to standard values irrespective of body height at the correct body mass. According to the WHO [2000] the BMI is a useful measure of overweight and obesity in population. Overweight and obesity are common in participants with DS as was demonstrated by Melville et al. [2005] based on BMI values analysis in adults, and by Witt-Glover et al. [2006] based on respective analysis in children. In the groups of participants with DS analysed in our study, BMI exceeding normal values was reported in over a half the surveyed (more frequently in girls), yet it ought to be emphasized that a higher percentage was noted in older participants of the study. Research conducted by Bell and Bhate [1992] and by Rubin et al. [1998], demonstrated the fact of a higher incidence of overweight and obesity in participants affected by Down's Syndrome, compared to normal population, as well as a higher percentage of women with incorrect nutritional status. Slightly different results were reported by Prasher [1995], who noted overweight and obesity in 69% of adult women and 79% of adult men with DS.

The BMI determines total content of fatty tissue in the body, however of great significance is also identification of its localization around the waist [Hirsler et al. 2005]. In our study, the location of visceral fatty tissue was estimated using the waist circumference (WC) parameter as it has been shown [Savva et al. 2000], to be a better indicator of the risk of cardiovascular disease and type 2 diabetes than the BMI [Virtanen et al. 2005]. In nearly half of the surveyed participants with DS, WC values demonstrated visceral obesity. Accumulation of this fatty tissue is accompanied by insulin resistance and hyperinsulinemia, which leads to the impairment of glucose tolerance and, consequently, to the development of type 2 diabetes as a result of, among other things, a successive decrease in the number of peripheral insulin receptors.

The nutritional status displayed by the surveyed participants with DS could be affected not only by genetic factors but also by incorrect eating habits. The obtained results of the qualitative evaluation of menus enabled stating that some irregularities occurred in the nutritional patterns of the surveyed with DS that were linked not to meals distribution within a day but rather to their qualitative formulation. The number of meals in the analysed group of participants was, in most cases, consistent with the recommended number of 4-5 meals a day. Because the surveyed were using canteens at the centres, hence the regularity of meals did not arouse reservations and intervals between them were fitting with generally recommended range of 3-3.5 hours [Turlejska et al. 2006]. This is essential in the prevention of diabetes in participants with DS, as it facilitates the improvement of cells susceptibility to insulin at the concomitant reduction of glucose concentration in blood [Farshchi et al. 2005]. Nevertheless, distribution of everyday meals into 5 meals a day would be advisable because frequent meals reduce the rate of carbohydrates absorption in the gastrointestinal tract with equal efficiency as dietary fibre or some inhibitors, being efficient factors in type 2 diabetes prevention [Jenkins et al. 1992].

The quantitative evaluation of the nutritional patterns of the surveyed with DS demonstrated that they were ill balanced in terms of energy value, which in the case of participants being in the period of growth and development may enhance the loss of systemic proteins, thus suppressing their synthesis and thereby contributing to growth inhibition and debilitation of immune functions of the body. Analyses of menus of the surveyed with DS demonstrated additionally incorrect intakes of most of nutrients, though owing to the character of the study attention was paid only to few ones being important in carbohydrate metabolism of the body. It is common knowledge that the quality of carbohydrates is a very significant risk factor of the incidence of type 2 diabetes [Willet et al. 2002], especially in participants with Down's Syndrome predisposed to this disease. Unfortunately the contribution of energy originating from carbohydrates in the analysed menus was too low compared to the recommended values at simultaneously too high contribution of energy originating from sucrose. Both sweets and confectionery were provided to children/pupils at breakfast, lunch and afternoon snack mainly by their parents/guardians.

Being the main source of energy in diet carbohydrates affect brain functions including regulation of food intake [Anderson et al. 2002]. In dietary prophylaxis of both obesity and type 2 diabetes as well as in diet therapy of these diseases, attention is paid to postprandial glycemia, which is affected by the quantity and common ratios of carbohydrates (ratio of amylose to amylopectin), technological processes (size of particles, form and structure of a product, degree of starch gelatinization), contents of other components in the product (fat, protein, dietary fibre, anti-nutrients or organic acids), and their availability, as well as glycemic index and load [Brand-Miller and Marsh 2008, Pi-Sunyer 2002, Willet et al. 2002].

Low intake of dietary fibre by the surveyed participants with DS, resulting from insufficient consumption of cereal products, vegetables, legumes, nuts and fruits was also unfavourable. Especially gums, pectin and plant mucilage present in the above mentioned products, by increasing viscosity of digesta and elongating its passage from stomach to intestines, decrease the rate of glucose absorption, reduce postprandial glycemic response [Jenkins et al. 2002] and affect positively the lipid profile [Weickert and Pfeiffer 2008]. The presence of dietary fibre in food products reduces the GI value [Jenkins et al. 2002].

Low intakes of Ca, Mg and Zn determined in the analysed diets of the surveyed with DS (owing to a low intake of dairy and cereals products, vegetables, fruits, and legumes) could enhance the accumulation of fatty tissue and disorders of carbohydrate metabolism. It has been demonstrated [Kao et al. 1999] that the low magnesium intake is accompanied by reduced consumption of glucose in cells, which increases the risk of the development of insulin resistance in peripheral tissues as a post-receptor defect. The lower the concentration of magnesium ions in blood serum, the higher quantities of insulin are needed to metabolize the same quantity of glucose, which suggests reduced insulin resistance. The reported low calcium intake by the surveyed participants may also contribute to body mass increase. It has been demonstrated that sufficient supply of calcium affects metabolism of adipocytes by stimulating lipolysis and inhibiting lipogenesis [Zemel et al. 2000], which has a normalizing effect on body mass. The reported low content of zinc in diets of the surveyed subjects is also unfavourable, because this element takes part, among other things, in biosynthesis and storage of insulin in pancreas, and its release to blood. In states of zinc deficiency, impairment of glucose tolerance is observed, that leads to the development of type 2 diabetes [Chausmer 1998].

It is common knowledge that vitamin B_1 participates in carbohydrate metabolism and that body demand for it is increasing along with an increasing intake of carbohydrates. However, analyses of menus demonstrated a low intake of this vitamin that resulted from significant consumption of white bread and confectionery, and low consumption of whole wheat bread, groats, rice, legumes and vegetables. In turn lack of thiamine in body may lead to disorders in transketolation proceeding during oxygenic metabolism of glucose [Babaei-Jadidi et al. 2003].

The analysed menus were additionally characterized by improper intake of fluids mostly in terms of volume but also their quality. In all the surveyed, the volume of fluids was far below the recommended values and they usually included teas, juices and compotes and least frequently pure mineral water or cooked water.

Moreover, the study demonstrated that the value of resultant GI of three-day menus of participants with DS was medium (GI 57-58) irrespective of sex. The highest GI value was reported for dinners and suppers, whilst the lowest one – for afternoon snacks. Alike GI values in 13-year-old healthy children with visceral obesity were assayed by Goluch-Koniuszy and Bonczek [2011], and slightly higher ones (GI 64-80) in adult women – by Liu et al. [2000] and Pi-Sunyer [2002]. It has already been demonstrated that the consumption of meals with even medium GI causes rapid absorption of carbohydrates from the gastrointestinal tract, which leads to an increasing level of insulin in blood [Willet et al. 2002], thus generating a strong, anabolic stimulus that initiates enhanced accumulation of energy compounds (glucose and triacylglycerols) by tissues susceptible to insulin, as well as stimulates glycogenesis and lipogenesis, and inhibits gluconeogenesis and lipolysis. In addition, as early as around two hours after such a meal, the absorption of nutrients from the gastrointestinal tract and concentration of glucose in blood are decreasing, whereas effects of the biologically high level of insulin and a low level of glucagon are still remaining, which leads to reactive hypoglycemia. As a consequence, the reduced level of glucose stimulates the secretion of glucagon, adrenalin and cortisol as well as growth hormone, thereby stimulating degradation of glycogen and gluconeogenesis (which normalises glycemia), but additionally enhances insulin resistance [Goldfine et al. 2003] and protein proteolysis. This is perceived as a state of hunger, which leads to consumption of another meal and in consequence to a significantly greater increase of glycemia. Also meals with medium and high GI intensify the postprandial glycemia [Brand-Miller and Marsh 2008].

Some food products with medium or high GI in usually consumed food ration contain a small quantity of available carbohydrates, hence significant is their glycemic load (GL) that determines the quantity and quality of the contained carbohydrates [Sheard at al. 2004]. The higher the GL value, the greater the increase of glucose concentration in blood and the stronger the insulin response, which in turn predisposes the occurrence of insulin resistance [Brand-Miller and Marsh

2008]. The GL has been shown to be an effective measure and risk indicator of the occurrence of type 2 diabetes or cardiovascular diseases [Asp 1995]. In our study, although the medium sum of GL from three day menus of the surveyed girls with DS was lower than in boys, still it exceeded the permissible GL <120 by 37%, and that of boys – by as many as 59%. In the case of girls, the highest GL values of a meal (>20) were reported for dinners, breakfasts and afternoon snacks, whilst in the case of boys for dinners, suppers and lunches. All these meals had a low content of vegetables and fruits. Goluch-Koniuszy and Bonczek [2011] who were surveying 13-year-old healthy children with visceral obesity, also reported high GL of their diets, with the GL values being higher (GL 123) in girls than in boys (GL 109). Liu et al. [2000] demonstrated GL values between 117 and 177 in diets of women. The high diet GL enforces insulin secretion from pancreas, thus leading to hyperinsulinemia that is a permanent trait accompanying obesity, irrespective of its causes, as well as age and sex of the obese person. After some time, persons with obesity develop also insulin resistance which may be defined as a suppressed biological response to the physiological quantity of insulin. In addition, hyperinsulinemia occurring naturally in the pubescence (most of the surveyed were aged 11-18) and 30% reduction of insulin resistance of peripheral tissues [Nader et al. 2006], excessive body mass and too high intake of available carbohydrates with a high GL may – by increasing insulin resistance – increase glucose intolerance and resultantly lead to development of type 2 diabetes [Chen et al. 2005]. Nearly half of the surveyed were characterised by visceral accumulation of fatty tissue. Significant quantities of fatty acids released from this tissue are circulating in blood and penetrate into cells, which diminishes glucose capture by cells, which stimulates pancreas for insulin secretion. Simultaneously, fatty acids supplied in excess to liver inhibit insulin degradation in this organ [Ginsberg et al. 2005].

In order to improve the carbohydrate-lipid metabolism, many researchers [Bouché et al. 2002, Ebbeling et al. 2005] have undertaken attempts of diet correction that consisted in not only reduction of the total content of carbohydrates but also in reduction of GI and GL values. This correction involved the introduction of higher quantities of vegetables and fruits – sources of not only vitamins but also minerals (Ca, Mg, Zn, Cr) and dietary fibre; substitution of white bread with whole wheat bread, introduction of coarse-grained groats, and reduction in the intake of simple carbohydrates both from confectionery, as well as sweetened beverages. In this study the decreased content of fatty tissue in the body and in waist circumference and the increased free-fat body mass enabled extending the time of satiety sensation and delaying the appearance of hunger sensation, reducing postprandial glycemia, improving susceptibility to insulin, and reducing concentrations of free fatty acids, triacylglycerols, total cholesterol and its LDL fraction in blood.

Therefore, bearing in mind DS participants predisposition for obesity and its metabolic effects, including disorders in the carbohydrate metabolism, it is advisable to consider GI and GL values in their diets as an effective measure to improve glycemia and prevent the development of type 2 diabetes. Once the study has been completed, all the surveyed participants with DS were subjected to health-promoting nutritional education in the form of "live" workshops with food products where they were familiarized with principles of rational nutrition adjusted to their developmental age and sex in the aspect of their future physical and intellectual development and prevention of the development of civilization diseases. The health-promoting education encompassed also the staff of both school and educational centres, as well as parents/guardians of the study participants.

CONCLUSIONS

The analysis of achieved results enabled concluding that:

1. Everyday food rations of both girls and boys affected by Trisomy 21 were not balanced in terms of energy and nutritive values, which may predispose them to disorders in the carbohydrate metabolism of the body.

2. Medium values of the GI and high values of the GL of diets of the surveyed participants with Down's Syndrome may facilitate the development of obesity and its effects in the form of type 2 diabetes.

3. It is advisable to correct diets of participants with Down's Syndrome, being at high risk of type 2 diabetes development, in terms of GI and GL values.

4. It is advisable to conduct health-promoting nutritional education of children and adolescents with Down's Syndrome, as well as their parents/guardians and staff of the centres they attend to, in the aspect of the prophylaxis of metabolic diseases.

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INDEKS GLIKEMICZNY I ŁADUNEK GLIKEMICZNY DIET DZIECI I MŁODZIEŻY Z ZESPOŁEM DOWNA

STRESZCZENIE

Wstęp. Zespół Downa należy do najczęstszych aberracji chromosomów autosomalnych spośród wszystkich znanych zaburzeń chromosomowych. Najczęstszymi chorobami towarzyszącymi zespołowi Downa są cukrzyca oraz otyłość. Jedną z przyczyn gromadzenia tkanki tłuszczowej w organizmie, w tym wisceralnej, jest niezbilansowana dieta, m.in. pod względem ilości i struktury węglowodanów oraz wartości indeksu glikemicznego i ładunku glikemicznego. Ponieważ u osób z zespołem Downa częstość występowania zarówno otyłości, jak i cukrzycy jest większa niż u zdrowej populacji, ważna wydaje się ocena i korekta diety pod kątem nie tylko ilości węglowodanów, ale i indeksu glikemicznego (GI) oraz ładunku glikemicznego (GL). Celem pracy była ocena stanu odżywienia oraz sposobu żywienia dzieci i młodzieży (obojga płci) z zespołem Downa (DS), uwzględniająca GI i GL posiłków.

Materiał i metody. Oceniono stan odżywienia, w okresie X-XI 2009 r., 24 osób z klinicznie potwierdzoną trisomią chromosomu 21, w tym 16 chłopców (w wieku 10-22 lata) oraz 8 dziewcząt (w wieku 13-18 lat), wychowanków dwóch ośrodków szkolno-wychowawczych z województwa zachodniopomorskiego. W ocenie sposobu żywienia uwzględniano: wartość energetyczną i odżywczą jadłospisów, struktury spożycia grup produktów spożywczych, wartości GI i GL na podstawie analizy trzydniowych jadłospisów sporządzonych metodą bieżącego notowania.

Wyniki. Spośród badanych osób 54% charakteryzowało się nadwagą lub otyłością, w tym 41% otyłością wisceralną. Analiza jadłospisów wykazała małą wartość energetyczną diety i niewielką realizację zalecanej podaży: błonnika, Ca, Mg, Zn, witaminy B_1 oraz płynów. Udział energii pochodzącej z tłuszczów oraz z sacharozy był za wysoki, a z węglowodanów za niski w stosunku do zalecanych wartości. Wypadkowy GI posiłków badanych osób przekraczał wartości średnie, a całodobowy GL przekraczał wartości wysokie.

Wnioski. Całodzienne racje pokarmowe osób obojga płci dotkniętych trisomią 21 nie były zbilansowane pod względem wartości energetycznej i odżywczej, co może predestynować do zaburzeń w gospodarce węglowodanowej organizmu. Średnie wartości indeksu glikemicznego i duże wartości ładunku glikemicznego diet badanych osób mogą sprzyjać powstaniu otyłości i jej skutków w postaci cukrzycy typu 2. Zasadne jest korygowanie diet osób z zespołem Downa, szczególnie narażonych na rozwój cukrzycy typu 2, pod kątem wartości GI i GL oraz celowe jest prowadzenie prozdrowotnej edukacji żywieniowej dzieci i młodzieży i ich rodziców/opiekunów oraz pracowników palcówek, w których przebywają, w aspekcie profilaktyki chorób metabolicznych.

Słowa kluczowe: stan odżywienia, indeks glikemiczny, ładunek glikemiczny, zespół Downa

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