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NUTRITIONAL STATUS *VERSUS* DIET COMPOSITION OF 10–15-YEAR-OLD CHILDREN FROM THE CENTRAL-EAST POLAND

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The study was aimed at determining differences in the content of carbohydrates as well as fat and its constituents in diets of 10-15-year-old children characterised by different nutritional status and originating from small towns of the central-eastern Poland.

The study demonstrated that the diet of overweight and obese children (BMI>90 ptc) compared to that of the thin children (BMI<10 ptc) was characterised by a higher mean content of fats (32.5 cal% *vs*. 30.5 cal%), a lower concentration of carbohydrates (54.8 cal% *vs*. 56.8 cal%), a lower mean ratio of polyunsaturated to saturated fatty acids (0.36 *vs*. 0.45), and a higher mean content of cholesterol (343 mg/24 h *vs*. 298 mg/24 h). The linolic acid:-linolenic acid ratio as well as the vitamin E:linolic acid ratio were alike in all groups examined. From the point of view of the prevention of ischaemic heart disease, it seems that the diet of children with overweight and obesity had more features facilitating atherogenesis than the diet of thin children. The results obtained may also indicate relationships between nutritional status (estimated on the basis of BMI and body adiposity) and diet composition, *i.e*. indirectly, eating patterns of the children analysed.

INTRODUCTION

In the last decades, an increasing incidence of overweight and obesity has been observed among populations of adults and children in Western Europe and North America. In 1998, the World Health Organization (WHO) acknowledged obesity as one of the key health problems of populations originating from highly-developed countries and announced that currently this phenomenon reaches epidemic proportions [WHO, 1998]. In the years 1989–98, in the Great Britain, the incidence of overweight in children increased from 14.7 to 23.6%, and that of obesity – from 5.4% to 9.2% [Bundred *et al*., 2001]. In North America, between the year 1963 and 1991, the incidence of children with overweight increased from 15.0 to 22.5%, and that of children with obesity – from 5.0 to 11.3% [Troiano *et al*., 1995]. The nation-wide assay carried out in Poland in 1997 indicates that overweight occurred in 8.7% and obesity in 3.4% of the children examined [Oblacińska *et al*., 1997].

Obesity is the basis for a number of metabolic diseases social in character. It is estimated that *ca*. 80% of obese children will maintain that trait in the later period of life [Must, 1996]. According to other sources [Rolland-Cachera *et al*., 2002], children and youth characterised by the body mass index (BMI) ranging from 85 to 97 percentille are at high risk of obesity to be developed in adulthood. In the adults, the treatment of obesity is difficult and it seems that the best way of counter-acting it is its prevention in the childhood through adhering to appropriate guidelines of nutrition and increased physical activity. A number of reports have been published recently on the role of excessive energy and cholesterol intake in the etiopathology of metabolic diseases [Nichaman & Hamm, 1987; Lund *et al*., 1992; Mensik, 1993; Przysławski, 1994; Obuchowicz *et al*., 2000]. From the nutritional point of view, a major role in the prevention of those diseases is ascribed to polyunsaturated fatty acids [Simopoulos, 1991, 1996; Connor, 2000; Sanders, 2000]. Whether the particular fat may be considered as an etiological factor of some social diseases is determined, most of all, by its structure, especially by reciprocal proportions between saturated, mono- and polyunsaturated fatty acids. A special role is also ascribed to the concentrations of *n*-3 and *n*-6 unsaturated fatty acids.

The study was aimed at answering the question: are there any differences in the contents of carbohydrates as well as fat and its constituents between diets of 10–15-year-old children with different nutritional status, *i.e.* characterised by low and high BMI values (below 10 and above 90 percentile) and originating from small towns of the central-eastern Poland.

MATERIAL AND METHODS

The study covered 628 children aged 10–15 year, including 302 girls and 326 boys, pupils of town primary schools (Biała Podlaska, Międzyrzec Podlaski). Investigations were carried out in the years 2002–2003.

Body height and body mass were measured exact to

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0.1 cm and 0.1 kg, respectively. Data obtained were used to calculate the body mass index (BMI; kg/m^2). Adiposity was determined based on thickness measurements of arm triceps, subscapular and abdominal skinfolds. The thickness of the skinfolds was measured exact to 1 mm by means of a Harpenden skinfold calliper (Sieber, Hegner Co., Switzerland). The anthropometric measurements were made by a trained person.

On the basis of centile charts elaborated at the Institute of Mother and Child in Warsaw [Palczewska & Niedźwiecka, 2001], the children examined (in respective gender and age categories) were divided into two experimental groups: children below 10 ptc, n=74 (the thin children), and children above 90 ptc, n=57 (the overweight and obese children). The characteristics of the children analysed was presented in Table 1.

Data on the eating patterns were collected based on 3 questionnaire recalls of the last 24 h preceding the test [Thompson & Byers, 1994]. The recalls included school days and weekends (Sundays). The sizes of food rations consumed were evaluated based on the "Album of Food Products and Dishes with a Different Portion Size" [Szczygłowa *et al*., 1991]. By means of "Żywienie" software based on domestic food tables [Kunachowicz *et al*., 1998], the data obtained were used to calculate average daily energy consumption and intakes of major nutrients, the percentage contribution of protein, fats and carbohydrates in providing energy as well as the concentrations of saturated, mono- and polyunsaturated fatty acids (linolic and α-linolenic acids), cholesterol and vitamin. E. Intakes of the nutrients examined were compared with the recommended daily intakes (RDI) taking into account the age and body mass of the pupils examined [Simopoulos *et al*., 1999; Ziemiański, 2001].

The significance of differences between nutritional and anthropometric variables in the selected groups of children was determined with the Student's t-test for independent variables, taking the significance level of p≤0.05 or higher as statistically significant.

RESULTS

Data presented in Table 1 demonstrated that thin children constituted 11.8%, whereas the overweight and obese children – 9.1% of the population examined. The population of the thin children was predominated by boys (66%), whereas that of children with overweight and obesity – by girls (58%). Attention should be paid to nearly 4-fold higher sum of skinfolds in the overweight and obese children, as compared to the thin pupils.

TABLE 1. Characteristics of the children examined (mean ± SD)#.

Group	Thin children (BMI≤10ptc)	Overweight and obese children (BMI≥90ptc)
Girls (n)	25	33
Age (years)	12.8±1.7	12.7±1.7
Body mass (kg)	35.0±8.7	66.6±12.8***
Height (cm)	151.9±10.7	159.3±6.3**
Sum of skinfolds (mm)	24.6±6.1	74.7±16.6***
Boys (n)	49	24
Age (years)	12.7±1.7	11.9±1.8
Body mass (kg)	36.1±7.5	64.0±14.3***
Height (cm)	153.2±11.0	158.1±8.9
Sum of skinfolds (mm)	20.4±5.5	82.7±23.4***

total number of children – 628 (302 girls and 326 boys); ** p≤0.01; *** p≤0.001 significant differences between thin children and those with overweight and obesity

Energy intake by the thin as well as overweight and obese children met the recommended levels in 90–110% of the average demand of the group, except for the group of girls above 90 ptc in which it accounted for 1881±413 kcal/day and was lower from the demand by *ca*. 11% (Table 2). In addition, it was shown that in both experimental groups, *i.e.* thin children

TABLE 2. Contents of energy and macronutrients in diets of the children examined.

Variable	Girls		Boys	
	thin (BMI≤10 ptc) n=25	overweight and obese (BMI≥90 ptc) n=33	thin (BMI≤10 ptc) n=49	Overweight and obese (BMI≥90 ptc) n=24
Energy (kcal)	2072386 (97.9)#	1881413 (88.6)	2550365 (108.5)	2235465** (95.1)
Protein (g)	64.416.6 (127.7)	58.113.6 (117.2)	77.819.6 (151.9)	68.316.4* (138.6)
Fats (g)	70.419.0 (89.7)	65.017.6 (83.8)	86.521.0 (98.9)	84.124.4 (99.0)
Carbohydrates (g)	31362	28373	38565	31975**
including:				
Saccharose (g)	78.030.7	69.936.5	89.334.1	72.736.6
Carbohydrates (cal%)	56.65.8	55.96.5	56.96.3	53.67.0*
including:				
Saccharose (cal%)	21.312.0	20.512.7	14.05.0	13.16.3
Protein (cal%)	12.41.9	12.42.1	12.22.2	12.31.9
Fats (cal%)	30.55.6	31.25.7	30.45.8	33.77.2*

data in brackets mean the percentage of meeting recommended dietary intakes (%) * p≤0.05; ** p≤0.01 significant differences between thin children and those with overweight and obesity

and those with overweight and obesity, protein intake exceeded considerably the RDI, yet its higher intake was observed in boys (151.9% *vs*. 138.6%) than in girls (127.7% *vs*. 117.2%).

The diet of the thin girls, compared to that of overweight and obese girls, was characterised by a higher percentage of meeting RDI for energy originating from carbohydrates (56.6±5.8 *vs*. 55.9±6.5) and saccharose (21.3±12.0 *vs*. 20.5±12.7) and a lower percentage of meeting RDI for fat-derived energy (30.5±5.6 *vs*. 31.2±5.7). A comparative analysis of diets of boys indicated a significantly ($p<0.05$) higher contribution of carbohydrates in providing energy (56.9±6.3 *vs*. 53.6±7.0) and a tendency for high energy intake from saccharose (14.0±5.0 *vs*. 13.1±6.3) in the thin boys. In addition, the diet of those boys was characterised by a significantly ($p<0.05$) lower percentage of energy originating from fats (30.4±5.8 *vs*. 33.7±7.2).

The contribution of individual fatty acids in providing energy with a daily food ration was found inappropriate in both groups of children (Table 3). The content of saturated fatty acids appeared to be too high (>10%) and that of polyunsaturated fatty acids – too low (<6%). In thin children's diet, the content of α-linolenic acid constituted 0.9% of total energy and approximated the recommended level (1%). The content of linolic acid reached 3.4% of daily energy value of a diet, on average, in both groups analysed and was higher from the RDI (~3%). The ratio of *n*–6 to *n*–3 fatty acids, calculated based on concentrations of linolic and α-linolenic acids in the diet and found optimal when ranging from 4:1 to 6:1, was observed in daily food rations of 34% of slim children and in those of 23% of overweight and obese children, on average. The ratio of vitamin E content to linolic acid content of the diet exceeded over two times the recommended level (minimum 0.5 mg of tocopherol equivalent per 1 g of linolic acid) in both groups examined.

The concentration of vitamin E in diets of girls from both experimental groups accounted for 94–107%, which corresponded to the absolute intake of 8.5±3.2 and 8.1±3.6 mg/day/person. In the case of thin as well as overweight and obese boys, vitamin E contents of diet reached 9.1±3.3 and 9.0±3.5 mg/day/person, respectively, which constituted *ca*. 95% of RDI.

The diet of the thin children demonstrated a tendency for a lower cholesterol content, as compared to the diet of the overweight and obese children (girls – 271±175 mg *vs*. 288±188 mg; boys – 324±169 mg *vs*. 398±217 mg).

DISCUSSION

Despite a low and age-depended correlation between BMI values and fatty tissue content of children [Burton *et al*., 1985], the European Childhood Obesity Group (ECOG) recommends the application of that indicator in diagnosis of overweight and obesity [Poskitt, 1995]. Due to ethnical and socio-economic differences, a number of countries have elaborated their own centile charts for children. In the study reported, the classification of underweight, normal weight as well as overweight and obesity was based on centile BMI charts worked out at the Institute of Mother and Child in Warsaw [Palczewska & Niedźwiecka, 2001]. The results obtained indicate that the percentage of overweight and obese children (9.1%) was very similar to nation-wide data [Oblacińska *et al*., 1997], whereas the percentage of thin children (11.8%) was over twofold lower compared to assays carried out in other area of the country [Olszańska-Glinkiewicz *et al*., 2004]. In analysing diet composition, especially contents of carbohydrates as well as fat and its constituents in daily food rations of children from the experimental groups, it was demonstrated that the diet of the children

TABLE 3. Contents of fatty acids and cholesterol in diets of the children examined.

Variable	Girls		Boys		Nutritional recommendations
	thin (BMI≤10 ptc) n=25	overweight and obese (BMI≥90 ptc) n=33	thin (BMI≤10 ptc) n=49	overweight and obese (BMI≥90 ptc) n=24	
Saturated fatty acids (g) (S)	25.7±8.7 (11.1)*	25.6±8.3 (12.3)	33.3±12.0 (11.7)	33.1±13.1 (13.1)	~ 10% [Ziemlański, 2001]
Monounsaturated fatty acids (g) (M)	27.8±8.4 (12.6)	25.1±6.9 (12.0)	34.9±9.2 (14.3)	33.0±9.6 (13.4)	~ 13% [Ziemlański, 2001]
Polyunsaturated fatty acids (g) (P)	11.0±5.1 (4.5)	8.7±4.4 (4.1)	12.2±4.4 (4.8)	10.8±3.4 (4.2)	not less than 67% [Ziemlański, 2001]
including:					
Linolic acid (g) (n-6)	7.8±3.2 (3.4)	7.1±4.5 (3.3)	9.8±4.8 (3.5)	8.0±3.7 (3.3)	~ 3% [Simopoulos *et al*., 1999]
α-Linolenic acid (g) (n-3)	2.1±0.8 (0.9)	1.7±1.0 (0.8)	2.6±1.2 (0.9)	2.0±1.1 (0.8)	~ 1% [Simopoulos *et al*., 1999]
P:S Ratio	0.49	0.37	0.41	0.35	1.0 [Przysławski, 1994]
Cholesterol (mg)	271±175	288±188	324±169	398±217	300 [Ziemlański, 2001]
Linolic acid: α-linolenic acid (g):(g)	4.0(±1.2):1	4.4(±1.7):1	4.1(±1.8):1	4.6(±2.5):1	4:1 – 6:1 [Ziemlański, 2001]
Vitamin E:linolic acid (mg):(g)	1.24±0.63	1.35±0.75	1.23±0.56	1.34±0.65	at least 0.5 [Ziemlański, 2001]

* data in brackets mean the per cent of total energy derived from fats

with overweight and obesity contained less carbohydrates and more fats as compared to the diet of the thin children. Those differences were more distinct in diets of boys than in those of girls (Table 2). It should be emphasized that in the case of girls saccharose was the major source of energy in the diet. According to the binding dietary guidelines, in children's diet fats should not provide more than 30% and saturated fatty acids more than 10% of total energy of the diet [Ziemlański, 2001]. The study indicates, however, that the diet of overweight and obese children considerably exceeded both these values (Tables 2 and 3). Current recommendations for reduced intakes of fats by children may, however, be taken with great caution. As demonstrated in the study of Lifshitz and Terim [cit. after Ziemlański, 1997], too drastic reduction in fat intake, including that of saturated fatty acids, may induce negative health effects manifested, among others, by energy deficiency, and consequently growth inhibition. On the other hand, investigations of Hegsted *et al*. [cit. after Gertig & Przysławski, 1994] indicated that a decreased intake of those acids (by 1% of the total energy of diet) lowered cholesterol content of blood by *ca*. 2.2 mg/dL on average, which may be of significance to the inhibition of the development of atherosclerosis and some tumor diseases [McPherson & Spiller, 1996].

The assay reported demonstrated also that the diet of overweight and obese children was characterised by lower concentrations of mono- and polyunsaturated fatty acids, compared to the diet of thin children (Table 3). The content of monounsaturated fatty acids in that diet oscillated around the dietary allowances, whereas that of polyunsaturated fatty acids was lower by 26–37% on average than the recommended dietary intakes. The results obtained indicate, however, that the diet of thin children provided slightly higher concentrations of mono- and polyunsaturated fatty acids, as compared to the diet of children with overweight and obesity. The diet of the thin children was also observed to provide a higher ratio of polyunsaturated to saturated fatty acids (P:S) in comparison to the diet of overweight and obese children. The diet with a higher P:S ratio (that should account for 1.0) has been proved to lower cholesterol level in blood, thus reducing the risk of developing ischaemic heart disease in the future [McPherson & Spiller, 1996].

Due to the necessity of keeping the balance between antioxidative and prooxidative processes in the body, it is crucial to provide appropriate ratios between polyunsaturated fatty acids of *n*-3 and *n*-6 family with the diet. Excessive dietary concentrations of n-6 acid may intensify the oxidative process and lead to the excessive production of lipid peroxides as well as disturb metabolism of *n*-3 acids and their products [Newton, 1996; Simopoulos, 1991]. In a human body, acids belonging to the *n*-6 family may be replaced by the acids of the *n*-3 family only partially, and *vice versa* [Bartinkowska & Obiedziński, 1997]. Taking those facts into account as well as the function served by vitamin E in this process, the ratio of that vitamin to linolic acid in the diet is also of key importance [Ziemlański, 2001]. Both ratios calculated in the study appeared to be appropriate in the groups examined, which seems beneficial in respect of the prophylaxis of civilization diseases.

From the point of view of the development of diseases of atherosclerotic origin, the content of cholesterol in diets of both adults and children should not exceed the threshold of 300 mg/day. A high intake of cholesterol may considerably affect its level in blood plasma. In the reported study, the diet of overweight and obese boys was characterised by a substantially higher content of that component (398 mg/day), as compared to the diet of thin boys (324 mg/day). In the case of girls, daily intake of cholesterol did not exceed the upper limit of RDI.

The described differences in the contents of carbohydrates as well as total fat and its constituents in diets of thin as well as overweight and obese children are likely to indicate diverse nutritional preferences. The assay points also to potential relationships between nutritional status (estimated on the basis of BMI and body adiposity) and diet composition, *i.e.* indirectly – eating patterns of the children examined. The correlation between fat content of diet and fatty tissue content was also demonstrated by, among others, Miller *et al*. [1990] and z Miller [1991] in adults and by Bandini *et al*. [1990] in youth.

Bearing in mind the increasing incidence of obesity in children and youth, the results obtained point to the necessity of popularizing proper nutritional guidelines in that age group of our population.

CONCLUSIONS

1. In respect of the prophylaxis of ischaemic heart disease, it seems that the diet of children with overweight and obesity had more traits facilitating atherogenesis, compared to the diet of thin children.

2. The study indicates relationships between nutritional status (estimated on the basis of BMI and body adiposity) and diet composition, *i.e.* indirectly – eating patterns of the children examined.

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