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ASSESSMENT OF DIETARY INTAKE AND SELECTED PARAMETERS OF NUTRITIONAL STATUS IN SCHOOL CHILDREN

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Healthy diet is one of the most important factors determining somatic and mental development of children. The reported study aimed at assessing food intake and nutritional status of 600 children aged 11–14, pupils of primary schools in the city of Poznań. The 24-h recall was taken to evaluate the total intake of basic nutrients, *i.e*. proteins, fats and carbohydrates. The nutritional status of children was evaluated based on the measurements of basic anthropometric parameters, *i.e*. body weight and height, and body mass index (BMI). It has been found out that the daily food rations did not cover the daily demand for basic nutrients according to the recommended norms. Daily food rations (DFR) oversupplied calories (112–125% of the recommended norms) and fats (120–130%), with concomitant insufficient supply of proteins (95% of the recommended intake). Cholesterol and saccharose intakes were higher from recommendations and amounted to 124–150% and 174–194%, respectively. Even more pronounced insufficient protein intake was reported in older children. The analysis of basic anthropometric parameters has, however, confirmed adequate physical development of most of the children from the studied population, *i.e*. 70–80%. Nevertheless, prolonged dietary deficiencies may predispose to various developmental abnormalities and diet-dependent disorders.

INTRODUCTION

Human organism requires various nutrients as the source of energy, for the synthesis of cellular and tissue components and for the regulation of metabolic processes. Somatic development of children is determined by genetic, hormonal and environmental factors [Charzewska *et al.*, 1984; Rogalska-Niedźwiedź *et al.*, 1984]. Adequate nutrition is one of the key environmental factors determining physical development of children and developmental dynamics. Prolonged malnutrition is one of the factors most negatively charged with regard to its effect on growth and development, as it may disrupt bone mineralization, delay puberty, impair growth and mental development. Overfeeding, usually with sweets, fats and other high-calorie food products, is an equally important problem, as it leads to overweight and obesity [Obuchowicz *et al.*, 1996 a, b; Przysławski *et al.*, 1997]. Nutritional regimens of school children should be based on the nutritional guidelines specified for children of this age and on appropriate daily meal schedule [Stopnicka *et al.*, 1998].

Our study aimed at evaluating the diet and nutritional status of 600 children aged 11–14, pupils of primary schools in the city of Poznań. The study analysed the total daily intake of basic nutrients, *i.e*. proteins, fats and carbohydrates, and assessed the degree of meeting the recommended dietary intake of those nutrients and potential dietary deficiency or overfeeding. The nutritional status of children was evaluated on the basis of the measurements of basic anthropometric parameters, *i.e*. body weight and height, as well as of body mass index (BMI) and the age and sex adjusted centile charts [Goryński *et al.*, 1980; Rymkiewicz-Kluczyńska *et al.*, 1999].

MATERIALS AND METHODS

The study evaluated the diet and nutritional status of 600 children aged 11–14, pupils of primary schools in the city of Poznań, and was carried out during winter-spring period of 1999. Because nutritional norms are age-dependent, the total population of 600 children (300 boys and 300 girls) was divided into two subgroups, *i.e*. group I (11–12-year olds) and group II (13–14-year olds). Nutritional evaluation involved history taking which spanned 24 hours preceding the examination [Charzewska & Chwojnowska, 1998]. Specially designed food album charts, *i.e*. „Album fotografii produktów i potraw o zróżnicowanej wielkości porcji" [Szponar *et al.*, 2000], were used to determine the qualitative and quantitative composition of the intaken food rations. Questionnaire-derived data on nutrients and calorie intake were subsequently processed with Microsoft Access-based application (an extended version of Tables of Nutritional Value of Food Products) [Kunachowicz *et al.*, 1998]. The analysis focused on the daily intake of basic nutrients, *i.e*. proteins, fats and carbohydrates taking into account the 10% loss for proteins, fats and carbohydrates. Mean values and standard deviations were calculated, compared with the recommended norms for children of moderate physical activity and referenced against the average body-mass values for the given age-group [Ziemlański *et al.*, 1998]. The

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intake of cholesterol and fibre was compared with the recommendations for feeding prophylaxis, assuming values of 300 mg and 30 g for cholesterol and fibre, respectively. When determining the degree to which the recommended intakes were met it was not assumed the safe level of intake but the recommended intakes, as optimal values that not only protect against nutritional deficiencies, but are also important for preventing some civilization diseases [Ziemlański *et al.*, 1998]. Daily intake of basic nutrients was analysed for each age group, separately for boys and girls, and compared between the age groups.

The nutritional status of children was evaluated on the basis of the measurements of basic anthropometric parameters, *i.e*. body weight and height, as well as body mass index (BMI). In addition to the body weight and body height centile charts, BMI values were used to find potential abnormalities in body weight.

RESULTS AND DISCUSSION

The share of the basic nutrients in the daily diet was used for determining the daily calorie intake and the ratio of calorie supply provided by each nutrient (Tables 1 and 2). Group I exceeded by 25% and group II by 12% the recommended calorie intake, with no significant differences between the sexes (Table 1). Our earlier studies on the same age groups revealed slightly lower calorie intake surplus, *i.e*. 95%, 98%, 95,4% for the years 1987, 1990 and 1994, respectively [Duda *et al.*, 1992; Duda *et al.*, 1997; Szajkowski *et al.*, 1992]. Similar calorie intake (92–95% of the recommended value) was reported by other authors who analysed the nutritional status of girls from Warsaw primary schools [Chwojnowska *et al.*, 1990]. The results of our studies indicate that over the years 1994–1999 there has been a rise of about 20% in mean daily calorie intake which exceeded the recommended calorie intake by 12–25% [Duda *et al.*, 1997].

TABLE 2. Share of total energy for basic dietary components.

Component	Age			
	11–12 years		13–14 years	
	Girls	Boys	Girls	Boys
Proteins [%]	11.0	10.8	10.7	11.5
Fat [%]	31.5	31.0	30.7	32.3
Carbohydrates [%]	57.6	58.5	58.6	56.3

The analysis revealed insufficient daily protein intake among girls in both age groups (Table 1), *i.e*. 95.1% and 81.4% of the recommended daily protein intake for group I and group II, respectively. The recommended daily protein intake was met among group I boys in 101.3%, yet was found insufficient in group II boys (90.2%). The analysis revealed also a negative trend of age-dependent decrease in the recommended daily protein intake, *i.e*. lower intake among older children as compared to the younger ones. Proteins were found to constitute a higher caloric share of food rations among younger children.

The ratio of animal protein daily intake to plant protein intake was also analysed. Both among girls and among boys daily animal protein intake was higher than the plant protein intake and constituted 60% of the total daily protein intake. On the basis of our earlier studies of 1990 and 1994, it can be observed that there has been a moderate increase in the plant protein intake and an increase in the share of plant protein against the total daily protein intake. Similar results were also obtained by other authors in their studies on school children [Charzewska *et al.*, 1992; Czeczelewski *et al.*, 1995; Rogalska-Niedźwiedź *et al.*, 1984].

Low daily total protein intake among school children was often associated with unsatisfactory consumption of dairy products and leguminous plants in the daily diet [Stopnicka *et al.*, 1998], yet this hypothesis needs to be confirmed in the analysis of the share of specific dietary products in an average daily diet.

TABLE 1. Intake of selected dietary components and their recommended dietary intake in school children.

Component	Age							
	11–12 years				13–14 years			
	Girls		Boys		Girls		Boys	
	$X_m \pm SD$	% of recommended intake	$X_m \pm SD$	% of recommended intake	$X_m \pm SD$	% of recommended intake	$X_m \pm SD$	% of recommended intake
Energy [kcal]	2 589±637	124.8	2 804±566	125.3	2 587±626	111.9	2 988±607	111.9
[kJ]	(10 832±2 665)		(11 731±2 368)		(10 824±2 619)		(12 501±2 540)	
Total protein [g]	71.3±22.4	95.1	76.0±20.2	101.3	69.2±22.0	81.4	85.7±23.6	90.2
Animal protein [g]	41.6±17	-	44.0±16.5	-	41.1±18.3	-	52.5±20.3	-
Plant protein [g]	29.6±10.8	-	31.9±9.5	-	27.9±8.6	-	33.1±9.6	-
Fat [g]	90.5±29.1	131.1	95.9±26.4	131.4	88.3±27.7	117.7	107.2±29.3	120.4
Saturated fatty acids [g]	36.9±13.2	-	39.0±12.6	-	36.1±12.8	-	43.3±15.2	-
Monounsaturated fatty acids [g]	33.1±11.9	-	34.9±11.0	-	31.6±11.1	-	39.1±11.9	-
Polyunsaturated fatty acids [g]	13.5±6.8	-	14.7±7.8	-	14.1±7.9	-	16.5±7.3	-
Cholesterol [mg]	373.5±214.5	124.5	408.2±230.6	136.1	399.0±229.5	133.0	450.3±255.0	150.1
Total carbohydrates [g]	373.1±101.4	97.5	409.9±90.0	82.4	379.6±105.0	99.2	420.9±102.8	84.6
Glucose [g]	13.6±9.7	-	12.2±8.4	-	13.3±8.6	-	13.0±9.9	-
Saccharose [g]	124.8±54.3	193.0	136.0±54.4	194.0	125.4±61.7	194.0	130.3±58.6	174.0
Starch [g]	188.0±66.4	-	218.2±58.9	-	194.3±71.4		229.6±68.3	-
Fibre [g]	21.3±7.7	71.0	22.3±7.6	74.3	21.4±7.9	71.3	23.6±8.1	78.7

X_m = mean value ; (-) no norm; S – saturated fatty acids, M – monounsaturated fatty acids, P – polyunsaturated fatty acids

High intake of fats among school children has been observed for many years [Charzewska *et al.*, 1992; Duda *et al.*, 1992; Szajkowski *et al.*, 1992] and has been also confirmed by the authors of this study (Table 1). In both the analysed groups, the level of the consumption of fats in DFR exceeded the recommended intake in about 21–30% (Table 1). Although the recommended daily intake of fats was only moderately in excess, the persistence of such tendency may lead to formation of unhealthy dietary habits, predisposing to the development of obesity, hypertension and atherosclerosis.

The proportions of fatty acids in the analysed dietary rations were also proved unfavourable (Table 1), with saturated fatty acids constituting about 13% of the total calorie intake. Monounsaturated acids delivered about 11% and polyunsaturated ones about 5% of the total calorie intake. These data seem worrying, once it is noted that saturated fatty acids should provide less than 9% of the total calorie intake, monounsaturated – 13% and polyunsaturated acids--about 8% of the total calorie intake, what was also found out by other researchers [Przysławski *et al.*, 1997]. This unfavourable trend is even more exacerbated by high intake of cholesterol which exceeds the recommended 300 mg/day (Table 1). Daily intake of cholesterol among boys ranged from 408.2 mg to 450.3 mg, group I and II, respectively, whereas the corresponding values for girls were 373.5 mg and 399.0 mg. High cholesterol intake is related to increased risk of metabolic abnormalities and cardiovascular diseases. High intake of cholesterol among boys aged 13–14 was also reported by other authors [Hamułka *et al.*, 1998] who attributed the pattern to high consumption of eggs, baked sweets and desserts.

The daily intake of carbohydrates in our study was within the low-recommended range (Table 1). Carbohydrates provided about 57% of the total calorie intake in 11–12--year-old boys and girls, and 56–59% in the older age group. These values may be considered rather low as the recommended carbohydrate intake should supply 65% to 70% of the total daily calorie intake, with complex carbohydrates being the dominant fraction [Ziemlański *et al.*, 1998]. Saccharose was the dominant source of carbohydrate calories (20% of total calorie intake) in our study, and its intake was almost twice higher than the recommended dietary intake. High consumption of simple sugars could have been related to low intake of complex carbohydrates, *e.g.* starch, which was observed in our study.

The recommended daily intake of fibre equals 20–40 g/day [Ziemlański *et al.*, 1998] and is related to the intake of carbohydrates. Similarly to carbohydrates, the daily intake of fibre among children in our study was within the low-normal range of values (Table 1). The risk related to low intake of fibre is further aggravated by high cholesterol intake, as it is known that fibre accelerates elimination of sterol compounds and cholesterol from the body, thus reducing plasma cholesterol concentration. Moreover, sustained low intake of fibre may predispose to metabolic abnormalities, atherosclerosis, obesity, constipation and the neoplasms of the large intestine. Clinical and epidemiological studies have indicated that atherosclerosis and obesity may occur during adolescence period [Gunnell *et al.*, 1998; Stopnicka *et al.*, 1998]. Increased cholesterol and triglyceride level, known to be atherosclerosis risk factors, were observed even in 8–9--year-old boys [Pardo & Słowiński, 1989].

Compared to our earlier studies [Duda *et al.*, 1992; Duda *et al.*, 1997], the ratio of daily fat-derived calorie intake against total calorie intake decreased by 10% against 1990 results and by 8% against 1994 results. Decreased proportion of fats in the daily calorie intake was accompanied by the rise in carbohydrate calorie intake by 10% and by fibre intake by 5%. However, the intake of saccharose did not decreased against the baseline value of 15–19% reported in our earlier studies.

The nutritional data obtained in our study revealed relatively low intake of proteins and carbohydrates with concurrent high intake of fats and saccharose in the analysed population of school children. Similar observations were also made by other authors [Charzewska *et al.*, 1992; Stopnicka *et al.*, 1998].

The observed abnormality in the intake of basic nutrients may be related to inappropriate selection of food products, namely insufficient consumption of milk, dairy products, cereals, fruit and vegetables, with concurrent high intake of fats, red meat, sugar and sweets [Hamułka *et al.*, 1998; Rogalska-Niedźwiedź *et al.*, 1984; Stopnicka *et al.*, 1998].

Low intake of proteins and carbohydrates with concurrent high intake of fats, and unfavourable ratios of fatty acids, *i.e.* high intake of saturated and low intake of polyunsaturated fats, was observed even in pre-school children [Daniewski *et al.*, 1998; Drabowicz *et al.*, 1992]. A similar pattern was also observed among adolescents [Karmelita--Katulska & Swulińska-Katulska, 1997] and may be related to insufficient knowledge of nutritional recommendations and unfavourable dietary habits [Chalcarz *et al.*, 1991; Międzobrodzka *et al.*, 1996; Narojek *et al.*, 1984].

Recent years have witnessed increased incidence of obesity, hypertension and hypercholesterolemia in children and adolescents [Obuchowicz *et al.*, 1996 a, b; Pardo & Słowiński, 1989; Przysławski *et al.*, 1997]. These observations seem of particular interest with regard to high correlation between obesity in children and increased incidence of cardiovascular mortality among adults [Gunnel *et al.*, 1998].

Our study also involved evaluation of the nutritional status through basic anthropometric parameters, *i.e.* body weight and height, as well as body mass index (BMI). Centile charts seem particularly helpful in evaluating somatic development of children, though some authors also use BMI values [Charzewska *et al.*, 1984; Dietz & Bellizzi, 1999]. It must be remembered that specific, age-adjusted values of the BMI index must be used which, according to the Institute of Mother and Child, equal 17.8–19.4 for boys, and 17.6-19.8 for girls aged 11-14 [Rymkiewicz-Kluczyńska *et al.*, 1999]. The mean BMI values for boys and girls obtained in our study fall within the pre-specified normal range and equal 19.2 and 18.7, respectively (Table 3).

The studies carried out 20 years ago on Warsaw school children aged 11–14 [Charzewska *et al.*, 1984] revealed lower body weight and height compared to our studies. The BMI value of 18.6 for girls was similar to that of our study, *i.e.* 19.2, yet the BMI value of 18.3 for boys was significantly lower compared to our result. Body weight and height data from this study and earlier studies confirm the phenomenon of acceleration of development of children and adolescents of school age [Krawczyński *et al.*, 1997 a, b].

The data from our study have also been referenced against the centile charts of body weight and height, with the

TABLE 3. Basic anthropometric parameters of girls and boys aged 11–14.

Sex		Parameter				
		Number of subjects	Age [years] $X_m \pm SD$	Height [cm] $X_m \pm SD$	Body weight [kg] $X_m \pm SD$	BMI $X_m \pm SD$
Girls	11–12	144	11.6±0.48	148.8±9.47	40.7±8.06	18.2±2.35
	13–14	156	13.5±0.49	159.5±7.02	48.9±8.09	19.2±2.36
Boys	11–12	154	11.6±0.50	148.6±8.98	40.7±7.12	18.3±2.21
	13–14	146	13.5±0.50	164.4±9.13	54.6±10.51	20.1±2.48

normal range of values between the 10th and 90th centile for a specified age. In the studied population, 80% of children were within the normal range for body weight, with 10% of girls and 20% of boys being overweight, and 7% of girls and 4% of boys being underweight. As regards height, 70% of the studied population were within the normal range, with 10% of girls and 18% of boys being over the upper limit and 19% of girls and 8% of boys under the lower limit (Table 4).

TABLE 4. Percentage of school children failing to meet the centile chart norms (% of population).

	Below normal range	Within normal range	Above normal range
		Body weight	
Girls	7.3	82.3	10.3
Boys	4	76.0	20.0
		Height	
Girls	19.3	70.3	10.3
Boys	8.0	74.3	17.7

normal range: x±2SD

When analysing the results of the study it should be noted that overweight, co-occurring with excessive body height, has been observed in 10% of girls and in 20% of boys (Table 4) and such proportions of boys and girls may be considered to display accelerated physical development, as compared to their peers.

Overweight was observed in 12.6% of girls and in 7% of boys (total of columns B and C in Table 5), which indicates that being overweight is almost twice higher among girls and seems to be related to earlier onset of prepubertal age in girls, as compared to boys. In significant proportion of the analysed population the observed overweight may be also related to excessive consumption of fats and sugars in the daily diet.

Our study revealed the presence of unhealthy dietary patterns among school children which include consumption of surplus fats, cholesterol and saccharose, and insufficient intake of complex carbohydrates, fibre and proteins. Such inadequate diet may predispose to metabolic abnormalities and civilization diseases, *e.g.* obesity, hypercholesterolemia, cardiovascular diseases and neoplasms which contribute to mortality among even younger populations in developed countries. When searching for civilization diseases morbidity and mortality causes it is often forgotten that the underlying causes are related to unhealthy dietary habits which develop in the childhood and adolescence to become permanent in the adulthood.

CONCLUSIONS

1. Daily food rations of the school children are not fully compatible with the nutritional recommendations particularly for insufficient intake of complex carbohydrates and fibre and excessive intake of fats, cholesterol and saccharose.
2. Most of the analysed population exhibit normal somatic development as confirmed by body weight, height and body mass index.
3. Dietary faults occur twice more often among girls than boys and seem to be related to higher incidence of overweight or obesity among girls.
4. Sustained dietary faults during the childhood or adolescence may predispose to various metabolism-related diseases during the adulthood.

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TABLE 5. Percentage of school children with significant body weight-height abnormalities.

	Column A*		Column B*		Column C*		Column D*	
	Excessive height against body weight		Too low height against body weight		Excessive body weight against height		Too low body weight against height	
	% of total	% N	% of total	% N	% of total	% N	% of total	% N
Girls	3.3	19.2	7.3	42.3	5.3	30.8	1.3	7.7
Boys	2.0	20.0	2.7	26.7	4.3	43.3	1.0	10.0

N = number of children who exceeded the normal range by ± 2SD; girls N=52; boys N=30; * Column A, B, C, D – children classification according to body-height abnormalities.

wybranych metod oceny spożycia żywności ze szczególnym uwzględnieniem metody wywiadu. Żyw. Człow. Metab., 1998, 15, 1, 65–73 (English abstract).
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OCENA SPOSOBU ŻYWIENIA I WYBRANYCH PARAMETRÓW STANU ODŻYWIENIA DZIECI W WIEKU SZKOLNYM

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O właściwym rozwoju dziecka decyduje wiele czynników, jednym z najważniejszych jest prawidłowe odżywianie, które ma wyraźny wpływ na dynamikę rozwoju. Celem niniejszej pracy była ocena sposobu żywienia i stanu odżywienia 600 dzieci w wieku 11–14 lat, uczniów szkół podstawowych miasta Poznania. Poziom spożycia określono posługując się metodą wywiadu 24-godzinnego, pozwalającego m.in. określić wielkość spożycia białek, tłuszczów i węglowodanów. Stan odżywienia dzieci oceniono w oparciu o pomiar podstawowych parametrów antropometrycznych tj. masy ciała i wzrostu oraz obliczonego wskaźnika masy ciała (BMI). Stwierdzono, że całodzienne racje pokarmowe spożywane przez dzieci nie są wystarczającym źródłem omawianych składników odżywczych. Wykazano, że racje te charakteryzują się w odniesieniu do norm zalecanych, nadmierną podażą energii ogółem (124,8%) tłuszczu (131,1% normy), przy równoczesnej niskiej podaży białek (95% normy). Przekroczono jednocześnie zalecenia żywieniowe dotyczące cholesterolu (124–150% wartości zalecanej) i sacharozy (174–194%). Podaż błonnika pokarmowego w racjach pokarmowych wahała się od 71–79% wartości zalecanych (tab. 1). Wykazano malejącą wraz z wiekiem zawartość białka w całodziennych racjach pokarmowych dzieci starszej grupy wiekowej w stosunku do dzieci młodszych. Analiza podstawowych parametrów antropometrycznych wskazuje na właściwy rozwój fizyczny zdecydowanej większości (70–80%) badanej populacji (tab. 4, 5). Długotrwałe utrzymywanie się stwierdzonych nieprawidłowości w sposobie odżywiania się badanej grupy dzieci może być w przyszłości przyczyną powstawania odchyleń w ich stanie zdrowia i powstawania szeregu schorzeń dietozależnych.