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EFFECTS OF A LOW GLYCEMIC INDEX DIET ON WEIGHT LOSS IN OBESE CHILDREN AGED 7-12 YEARS

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The purpose of the study was to determine the efficacy of a low glycemic index diet on body weight loss in 30 overweight/obese children aged 7-12 years. Introduction of a low glycemic index diet as well as dietary counseling aimed at correcting the nutritional habits of the overweight/obese children brought about statistically significant body weight reduction (from 55.2±16.5 to 52.8±16.7; p=0.0001). Body mass index values declined from 23.6±3.3 to 21.8±3.3 in children aged 7-9 years and from 26.2±3.9 to 25.0±4.2 in children aged 10-12 years. Nutritional intervention also contributed to changes in the proportions of body composition, expressed by the significant decrease in average fat mass and total fat-free mass as well as to a statistically significant increase in total body water in all the subjects. Nutritional intervention caused a statistically significant decrease in the consumption of energy, fat, protein, and carbohydrates.

INTRODUCTION

The consumption of low-fat diets has been widely advocated for the prevention and treatment of obesity and its complications. However, the effectiveness of low-fat diets in the management of obesity has been questioned in recent years. One potential adverse effect of reduced dietary fat is a compensatory increase in the consumption of high glycaemic index (GI) carbohydrate, principally refined starchy foods and concentrated sugar. Such foods can be rapidly digested or transformed into glucose, causing a large increase in post-prandial blood glucose and insulin. Short-term feeding studies have generally found an inverse association between GI and satiety. Medium-term clinical trials have found less weight loss on high GI or high glycaemic load diets compared to low GI or low glycaemic load diets. Physiologically oriented studies in humans and animal models provide support for a role of GI in disease prevention and treatment.

Dietary factors influencing body weight and body composition include fat, starch, and dietary fiber; these factors impinge on the so-called GI [Wolever *et al*., 1995]. The GI of a meal is determined primarily by the amount of carbohydrate consumed and by other dietary factors affecting food digestibility, gastrointestinal motility, or insulin secretion (including carbohydrate type, food structure, fiber, protein, and fat) [Wolever *et al*., 1995; Jenkins *et al*., 1982; Bjorck *et al*., 1994; Granfeldt *et al*., 1995; Welch *et al*., 1987; Foster-Powell & Miller, 1995; Trout *et al*., 1993]. Most starchy foods commonly consumed in industrialized nations, mainly refined grain products and potatoes, have a high GI, exceeding that of even table sugar by up to 50% [Foster-Powell & Miller, 1995]. By contrast, vegetables, legumes, and fruits generally have a low GI [Foster-Powell & Miller, 1995]. Previously, an inverse relationship between GI and satiety has been shown in several [Holt *et al*., 1992; Van Amelsvoort & Weststrate, 1992; Leathwood & Pollet, 1988; Rodin *et al*., 1988] but not all [Holt *et al*., 1996] single-meal studies. There is scarcity of data regarding the role of low glycemic index diets on body weight reduction and body composition in obese children. Therefore, the aim of the present study was to investigate the effects a low glycemic index diet on body weight loss as well as body composition in obese children aged 7-12 years.

MATERIALS AND METHODS

The study was carried out in 30 overweight/obese children (16 girls and 14 boys) for the period of 6 weeks, between February and May 2006. The inclusion criteria applied in this study was alimentary overweight and/or obesity assessed according to the international BMI cut-off points for overweight and obesity for males and females aged 2 to 18 years [Cole *et al.,* 2000]. During this period, the overweight/obese children and their parents received dietary advice every 2 weeks at the Section of Dietary Counseling, Department of Dietetics, Faculty of Human Nutrition & Consumer Sciences, Warsaw Agricultural University. The purpose of frequent counseling of the obese children and their parents was to ensure adequate monitoring and adherence to the recommended low glycemic index diet. In order to eliminate poor nutritional habits patients were asked to bring with them 3-day food records (2 weekdays and 1 weekend day). After the modification of dietary habits patients were acquainted with the principles of the low glycemic index diet. Further-

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more, the obese children were offered pamphlets with the list of recommended products with low glycemic index as well as the list of foods to avoid due to their high glycemic index. In order to determine changes during the 6-week nutritional intervention, subjects were given diaries for keeping dietary records. The energy content of the low glycemic index diet ranged from 1900 to 2100 kcal. These dietary records were then compared with recommendations of the Commission of Children and Adolescent Nutrition of the Committee of Human Nutrition, Polish Academy of Sciences as well as the Section of Gastroenterology and Nutrition of the Polish Association of Pediatrics.

Measurements of body weight and height (for the assessment of BMI) and body composition by bioimpedance method were carried out at baseline and 6 weeks after nutritional interventions. Analysis of body composition (fat mass and fat-free mass) was carried out by bioelectric impedance technique with the aid of BIA 101S, AKERN – RJL bioanalyzer, Italy. Measurements were conducted in the mornings in a supine position after an overnight fast.

Statistical analysis. Anthropometric and body composition data in kilograms were analyzed by Statgraphics version 4.1 by Student's t-test for paired samples. Because BMI and percentage values were highly skewed, differences between baseline and end-of-study were assessed using the non-parametric Wilcoxon rank sum test. An alpha of .05 was set at the level of significance.

RESULTS AND DISCUSSION

Before nutritional interventions, body weight and BMI in both girls and boys exceeded recommended values. The introduction of the low glycemic index diet resulted in a statistically significant fall in body weight in all patients (p=0.0001).

TABLE 1. Mean BMI values (kg/m²) in overweight/obese children aged 7-12 years with alimentary obesity before the introduction of the low glycemic index diet.

	7-9-year old children	10-12-year old children
Recommended values	16.25-16.79	17.08-18.68
Mean	23.6	26.20
Range	19.4-32.3	20.4-35.6
SD	3.27	3.97

TABLE 2. Mean BMI values (kg/m²) in overweight/obese children aged 7-12 years with alimentary obesity after the introduction of the low glycemic index diet.

	7-9-year old children	10-12-year old children
Recommended values	16.25-16.79	17.08-18.68
Mean	21.8	25.0
Range	17.06-30.7	18.6-34.1
SD	3.27	4.2

Tables 1 and 2 show BMI values in the obese children before and after the introduction of low glycemic diet.

There are few studies that examined the role of low glycemic index diet in reducing BMI in children. In a retrospective, non-randomized study of the effects of a low-GI diet (n=64) compared with a conventional reduced-fat diet (n=43) in the management of pediatric obesity, greater decreases in body mass index (BMI) and body weight were seen in the low-GI group, even after adjustment for age, sex, ethnicity, baseline BMI, and baseline weight [Spieth *et al*., 2000]. Significantly more patients in the low-GI group

TABLE 3. The intakes of energy and macronutrients by overweight and obese children before and after the introduction of the low glycemic index diet.

Parameter	7-9-year old children	10-12-year old girls	10-12-year old boys
Energy intake (kcal):			
Before	2552.9 ± 538.6	2421.0 ± 340.7	2978.1 ± 775.7
After	1112.6 ± 235.2	1078.6 ± 170.4	1189 ± 372.7
	p = 0.0001	p = 0.0001	p = 0.002
Protein intake (g):			
Before	94.20 ± 27.1	84.2 ± 18.2	103.43 ± 29.8
After	57.2 ± 14.4	59.1 ± 12.9	61.7 ± 19.3
	p = 0.0001	p = 0.0002	p = 0.001
Fat intake (g):			
Before	101.6 ± 28,10	100.6 ± 20.20	119.7 ± 33.20
After	33.8 ± 9.8	30.7 ± 8.2	35.3 ± 18.9
	p = 0.0001	p = 0.0001	p = 0.002
Carbohydrate intake (g):			
Before	333.8 ± 77.8	311.3 ± 40.8	393.5 ± 107.4
After	161.3 ± 36.70	157.4 ± 29.3	172.4 ± 38.0
	p = 0.0001	p = 0.0001	p = 0.005

TABLE 4. Body composition in overweight/obese children before and after nutritional intervention.

Parameter	Before intervention	After intervention
Body weight (kg)*:	55.15 ± 16.5	52.8 ± 16.7
Fat mass:		
(kg)**	20.0 ± 7.7	18.7 ± 8.3
(%)	35.5 ± 4.2	34.1 ± 4.8
Fat-free mass:		
(kg)***	35.15 ± 9.0	34.3 ± 8,6
(%)	64.5 ± 4.2	65.8 ± 4.9
Total body water:		
Liters	27.9 ± 5.5	27.4 ± 5.20
(%)****	51.8 ± 6.4	53.7 ± 7.5
Muscle mass:		
(kg)*****	22.10 ± 5.7	21.8 ± 5.3
(%)	40.7 ± 3.4	42.1± 4.0

*p = 0.0001, **p = 0.0001, ***p = 0.001, ****p = 0.003, *****p = NS

achieved a decrease in BMI of at least 3 units (17% *vs*. 2%, p=0.001). BMI dropped by 2 units in the present study in 7-9-year old obese children, but was significant in all patients (p=0.0001). However, the findings by Spieth *et al.* [2000] must be considered preliminary as the children were not randomly assigned to treatment groups.

Energy and macronutrient intakes by the obese children exceeded the Polish RDA for this group of population. The introduction of the low glycemic index diet caused a significant decrease in the consumption of all macronutrients (Table 3). It is worth stating that the recommended diet was characterized by normal energy content, that is, 1900-2100 kcal.

The decrease in the intakes of energy and macronutrients might have been brought about by the satiating effect of foods with a low glycemic index. Even when appearance and nutrient content are matched, low-GI foods typically induce higher satiety than their high-GI counterparts, and are followed by less energy intake at subsequent meals [Ludwig, 2002]. Overall, at least 16 of 17 studies have confirmed that low-GI meals increase fullness to a greater extent than comparable high-GI meals [Ludwig, 2002].

Currently, there is much interest in the potential of low glycemic index (GI) foods in the management of obesity [Ludwig, 2002; Pawlak *et al*., 2002; Pi-Sunyer, 2002; Raben, 2002]. It has been hypothesized that low-GI foods may benefit weight regulation in 2 ways: by promoting satiety and promoting fat oxidation at the expense of carbohydrate oxidation [Brand-Miller *et al*., 2002]. Although no long-term clinical trials have examined the effects of dietary GI on body weight regulation, single-day studies have shown lower satiety, increased hunger, or higher voluntary food intake after consumption of high-GI compared with low-GI meals [Ludwig, 2002]. Two medium-term studies of 5 and 12 weeks also showed improved weight or fat loss on low-GI diets [Bouche *et al*., 2002; Slabber *et al*., 1994]. A pioneering study by Ludwig *et al*. [1999] showed that obese children who were given high-, medium-, or low-GI breakfasts and lunches of equal-energy content had a voluntary food intake for the rest of the day that was 53% higher after the high-GI breakfast. A recent study suggested the prolongation of satiety after low-GI meals in obese adolescents [Ball *et al*., 2003].

Table 4 shows changes in body composition as a result of the introduction of the low glycemic index diet in the obese children. It was a surprise that the low glycemic index diet brought about a fall, not only in fat mass, but also in fat-free mass in absolute values. The intervention diet did not significantly affect muscle mass. It could be speculated that the decline in fat-free mass might have been brought about by the continuous maintenance of low physical activity. Data are lacking on the effects of low glycemic index diet on body composition in overweight/obese children. Bouche *et al.* [2002] showed that in slightly overweight men, a low-GI diet for 5 weeks, in comparison with a high-GI diet of equal energy and macronutrient content, decreased total fat mass by 500 g (p=0.05), as measured by dual x-ray absorptiometry, despite no differences in body weight. The decrease in fat mass was mostly abdominal and was associated with a decrease in *ob* gene expression in the subcutaneous fat tissue.

CONCLUSIONS

1. The low glycemic index diet induced a significant decrease in body weight and fat-free mass.
2. The intervention, weight-reducing diet did not affect muscle mass.
3. Six-week nutritional intervention with the low glycemic index diet brought about considerable fall in the intakes of energy and macronutrients.
4. In order to elucidate exact mechanisms whereby a low glycemic index diet brings about a decline in body weight further studies need to be performed in a large number of obese subjects.

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WPŁYW DIETY Z NISKIM INDEKSEM GLIKEMICZNYM NA REDUKCJĘ MASY CIAŁA U DZIECI Z NADWAGĄ I OTYŁOŚCIĄ PROSTĄ W WIEKU 7-12 LAT

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Celem pracy była ocena skuteczności diety z niskim indeksem glikemicznym na redukcję masy ciała u 30 dzieci z nadwagą i otyłością prostą w wieku 7-12 lat. Wprowadzenie diety z niskim indeksem glikemicznym oraz korekta dotychczasowego sposobu żywienia u badanych dzieci przyczyniły się do istotnego statystycznie spadku masy ciała (od 55,2±16,5 do 52,8±16,7; p=0,0001). Wskaźnik BMI zmalał z 23,6±3,3 do 21,8±3,3 u dzieci w wieku 7-9 lat i od 26,2±3,9 do 25,0±4,2 u dzieci w wieku 10-12 lat. Interwencja żywieniowa doprowadziła do zmian w proporcjach składników ciała, wyrażonych istotnym statystycznie ($p<0,05$) spadkiem średniej tłuszczowej masy ciała, średniej beztłuszczowej masy ciała ogółem, istotnemu statystycznie wzrostowi średniej całkowitej zawartości wody w organizmie ogółem.