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Effect of Low-Carbohydrate, Unlimited Calorie Diet on the Treatment of Childhood Obesity: A Prospective Controlled Study

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ABSTRACT

Background: Childhood obesity has been recognized as the new epidemic in developed countries. Caloric restriction with physical activity is the main therapeutic treatment available for these children. We compared two different dietary protocols to assess treatment efficacy.

Methods: Obese children from the Pediatric Endocrinology clinic were prospectively recruited for the study. Children and their parents were allowed to choose one of two dietary protocols: (1) carbohydrate restricted diet (<30 g/day), with unlimited calories, protein, and fat (High protein, Low CHO Diet), and (2) calorie restricted diet (Low Cal Diet). Anthropometric data were measured at baseline and at the 2 month follow up appointment.

Results: Thirty-seven children completed the study of whom 27 chose High Protein, Low CHO Diet and 10 chose Low Cal diet. No differences in gender ratio, age, or BMI were observed at baseline. At 2 months, children in the High Protein, Low CHO Diet lost an average of 5.21 ± 3.44 kg ($p < 0.001$) and decreased their BMI by 2.42 ± 1.3 points ($p < 0.001$), compared to the children in the Low Cal Diet who gained an average of 2.36 ± 2.54 kg and 1.00 point on the BMI value ($p < 0.001$).

Conclusions: A high protein, low carbohydrate, unlimited calorie diet was superior to a restricted calorie protocol for weight loss in obese school age children; moreover, compliance was better.

INTRODUCTION

The prevalence of childhood obesity has increased dramatically over the last decade.[1–4] In a recent UN sponsored workshop on children's health, obesity was recognized as an increasing problem, especially in developed countries.[5] Obesity has been associated with increased morbidity and mortality in adults and children.[6,7] Obese children are at greater risk for developing cardiovascular disease, type 2 diabetes mellitus, lipid abnormalities, metabolic abnormalities (syndrome X), obstructive apnea, orthopedic problems, and variety of other health disorders.[7–11]

Modern treatment for childhood obesity includes decreasing total caloric intake, reducing dietary fat, and increasing physical activity.

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Following the U.S. Surgeon General's recommendation in 1988, a decrease in fat consumption was observed in the diets of adults and children.[12–14] Despite this response, the incidence of obesity has continued to increase in the U.S. population. Several studies have suggested that the reduction in fat consumption was offset by a higher carbohydrate consumption, which resulted in higher caloric intake.[15,16]

Previous attempts to curb the obesity epidemic by long term dietary interventions in children have been unsuccessful. Although low fat diets were safe and successful in reducing serum lipid levels, no effect on anthropometric variables was noted.[17–19] In a previous open-labeled study, we failed to effectively reduce weight in children with a low fat, restricted calorie protocol, mostly due to lack of patient compliance (Bailes et al., unpublished data). We hypothesize that the lack of patient compliance was attributable to several factors including: discouraging results (lack of weight loss), unpalatable diet, and patient hunger. In order to improve compliance, in the present study, we altered the dietary protocol to include an option of low carbohydrate intake with no restrictions on calories, fat or protein.

MATERIALS AND METHODS

Patient population

Obese children who attended the Endocrinology Clinic, Department of Pediatrics, Marshall University School of Medicine, were prospectively recruited. The study was conducted between April 2000 and February 2001. Body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters. Obesity was defined as a BMI value above the 95th percentile for age as determined by the CDC BMI nomogram (www.CDC.gov). Obese children, aged 5–18, were considered for this study. Exclusion criteria included patients with metabolic disorders and children who failed to return for a 2-month follow-up appointment. All children had an initial weight, height, and BP with a complete physical examination and appropriate labs to confirm the absence of any metabolic disease.

Study protocol

Children were recruited in a non-randomized, prospective, controlled study. The study was explained to the participants and their parents, and a consent form was signed. The study was approved by the IRB committee at Marshall University School of Medicine. The participants and their parents were then asked to choose between two dietary interventions: (1) high protein, carbohydrate-restricted diet (High protein, Low CHO Diet) or (2) calorie-restricted diet (Low Cal Diet). The subjects who chose a low cal diet were referred to a dietitian who calculated ideal body weight from standard growth curves using actual height. Their energy needs were calculated based on ideal weight and decreased by 20% to stimulate weight loss. The subjects and their parents were then instructed to consume less than 30% of total calories from fat, 15–20% of calories from protein and 50–55% of total calories from carbohydrates. (See Table 1). They were encouraged to consume "healthy" carbohydrates, including fruits and vegetables, and were discouraged from consuming "sugary" foods. There were no limitations placed on carbohydrate drinks, including juices, milk, and pop.

The subjects who chose a high protein, carbohydrate restricted diet were instructed on how to count carbohydrates and were told to limit carbohydrate intake to <30 g per day (See Table 1). They had no limitations on protein or fat. They had no limitations on total calories. They were encouraged to eat when hungry. They were allowed to eat any carbohydrates. There was no distinction between "healthy" carbohydrates (i.e., fruits/vegetables) or "sugary" foods. They were instructed to avoid drinking any drinks that contained carbohydrates.

The decision to follow a certain dietary approach was made jointly by the subject and their parents with no bias or preference shown by the dietitian or study recruiter. They were instructed to choose the dietary regimen that they thought would be easier to follow and more successful based on their own food preferences and lifestyle. Required follow-up did not differ between the two groups. All subjects were seen approximately 2 months after initiation of the diet. A complete physical exam was performed, including height, weight, BP and BMI

TABLE 1. DIETARY PROTOCOLS

	Low CHO diet	*Low calorie diet*
CHO	<30 g/day	55% total calories
Protein	Unlimited	15–20% total calories
Fat	Unlimited	<30% total calories
Calories	Unlimited	Limited: energy needs based on ideal weight for height and decreased by 20%
Supplement	Multivitamin and calcium	Multivitamin and calcium

determination. Because of the possibility that errors in height measurement could significantly change BMI values, BMI was calculated based on height measurements before the diets were started.

Statistics

Mann-Whitney Rank Sum Test (Microsoft Excel, Office 2000 edition) and Chi-Square (Fisher exact) (EP Info 2000) analyses were performed to assess differences between groups.

RESULTS

A total of 52 children entered the study of whom 36 chose High protein, Low CHO Diet and 16 chose Low Cal Diet. Fifteen subjects (nine from Low CHO Diet and six from Low Cal Diet) were subsequently excluded from the study for the following reasons: 13 subjects failed to come to the 2-month follow-up appointment (seven patients from Low CHO Diet and six from Low Cal Diet), and two patients were excluded for the diagnosis of type 2 diabetes mellitus (both from High Protein, Low CHO Diet). The reasons for failure to attend the follow-up appointment are summarized in Table 2.

A total of 37 patients completed the study protocol (27 from High Protein, Low CHO Diet, 10 from Low Cal Diet). Overall, at recruitment, no significant differences in age or anthropometric data were observed between the diet protocol groups (Table 3). At the 2-month follow-up visit, subjects who followed the High protein, Low CHO Diet lost an average of 5.21 ± 3.44 kg, while subjects in Low Cal Diet gained an average of 2.36 ± 2.54 kg ($p = 0.001$). Subjects in the High protein, Low CHO Diet had a mean decrease of 2.42 ± 1.3 in their BMI, while those children in the Low Cal Diet had increased their BMI value by a mean of 1.0 ± 1.2 ($p = 0.001$) (Table 3). No significant differences in weight or BMI values were observed between genders in the same group.

TABLE 2. REASONS GIVEN FOR NO FOLLOW-UP

	High protein low CHO diet	*Low cal diet*
Moved from area	3	1
Poor compliance	1	2
Lack of positive results	0	3
Expense	1	0
Difficulty complying with diet while in school	2	0
Total	7	6

DISCUSSION

Our data show that over a short-term period, a high protein, low carbohydrate, unrestricted calorie diet is superior to a low fat, low calorie

TABLE 3. DEMOGRAPHICS AND RESULTS

	High protein low CHO diet	*Low cal diet*	*p-value*[a]
Number	27	10	
Age (years ± SD)	12 ± 3	11 ± 2	0.9
Males	17	6	
Females	10	4	
Baseline data			
Weight (kg)	90 ± 10.9	89.1 ± 13.6	0.69
BMI (± SD)	36.68 ± 4.0	36.0 ± 3.1	0.72
2 months			
Weight (±SD)	84.79 ± 3.63	91.36 ± 2.72	
Delta-weight	−5.21 ± 3.44	2.36 ± 2.54	0.001
BMI (±SD)	34.26 ± 2.0	37 ± 1	
Delta-BMI	−2.42 ± 1.3	1.0 ± 1.2	0.001

[a]Mann-Whitney rank sum test.

diet in reducing weight and BMI values in obese school-aged children. Previous studies have shown that protein is the most satiating of all macronutrients on a calorie for calorie basis.[20,21] Moreover, compared to the high carbohydrate diet, a high protein diet has been shown to increase thermogenesis and energy expenditure.[22] We hypothesize that subjects on the low carbohydrate, high protein diet, experienced an increased in satiety, and an increase in thermogenesis, resulting in weight loss.

Sothern et al.[23] also showed good short-term results utilizing a low carbohydrate diet protocol. However, in their study the diet was also very restricted in calories. Moreover, the researchers used a team approach that included weekly visits for a two-hour weight reduction clinic, structured exercise program, and a behavioral modification program. We chose a less restrictive diet with unlimited fat, protein and calorie intake. In addition, our diet was designed to be implemented without large time and financial commitments by the practitioner or the patient.

We acknowledge that there are many shortcomings with the design of our study. Our study was not randomized. Most of the obese children in this study have previously tried a variety of diets without success. Many of these children and their families had strong preconceived opinions based on their own experiences that made randomization difficult. In the hope of improving compliance, we allowed children and their families to select the dietary regimen they wanted to attempt. It is possible that this self-selection introduced a bias.

We also acknowledge that we did not control for exercise. It is possible that, with such small numbers, children who chose a high protein, low carbohydrate approach also increased their exercise and daily energy expenditure. However, this is not likely as there was no emphasis placed on doing so by the researchers or the dietitian.

We also acknowledge that we did not control for compliance. The object of this study was not to compare two dietary regimens if all patients were 100% compliant but to find a dietary approach that was easy to understand, successful, and practical to implement in a primary care setting. Certainly critics may argue that with such small numbers it is possible that none of the patients who chose a low calorie diet were compliant with the regimen. Nonetheless, this is the kind of information we were hoping to acquire. A dietary approach will not be successful if compliance is very low.

In summary, despite our limited numbers and short follow-up period we are encouraged by the results. We presented a dietary protocol that was successful in reducing weight and BMI measurement in obese children. The diet was limited in carbohydrate content with an unlimited consumption of protein, fat, and calories. The high compliance rate (as evidenced by weight loss) achieved by the children is very encouraging as compliance is a major obstacle in many previous dietary protocols. Although promising results were seen in our short-term study, a long-term follow-up study with a larger group of children will be needed to assess potential health risks associated with a low carbohydrate, high protein diet.

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