

## Journal of Pediatric Gastroenterology & Nutrition:

February 1999 - Volume 28 - Issue 2 - pp 169-174

Original Articles

# Diet and Chronic Constipation in Children: The Role of Fiber

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Received March 26, 1997; revised November 12, 1997 and May 5, 1998; accepted September 8, 1998.



### Abstract

**Background:** Chronic constipation is one of the most common disorders in Western countries and despite numerous clinical, pathophysiologic, and epidemiologic studies its cause is still unclear. Several hypotheses have been proposed and according to experimental studies and clinical observation, fiber intake could play a role in its pathogenesis. The purpose of this case-control study was to examine the possible correlation of idiopathic chronic constipation in children and dietary intake, particularly fiber intake.

**Methods:** A randomized sample of children (291 children with constipation and 1602 controls) aged 2 to 14 years was taken from three of the 52 counties of Greece. Stratification was performed on the basis of urban, rural, or suburban location and socioeconomic status. The nutritional data were obtained from a 3-day dietary record and a dietary history. Statistical analysis was performed with multivariate tests, multivariate analysis of variance, discriminant analysis, and chi-square analysis according to the characteristics of the correlated variables.

**Results:** Constipated children had a lower caloric and nutrient intake ( $p < 0.001$ ), lower body weight/height ( $p < 0.001$ ), and higher prevalence of reported anorexia ( $p < 0.001$ ). Discriminant analysis indicated that dietary fiber alone was independently negatively correlated with chronic constipation, despite the age and the age of onset of constipation. Relative risk also had a negative correlation with fiber intake ( $p < 0.001$ ). Of the main fiber fractions only cellulose and pentose were independently correlated with chronic constipation.

**Conclusions:** Lack of fiber may play an important role in the etiology of chronic idiopathic constipation in children.

Chronic constipation is one of the most common disorders in Western countries. Field surveys have shown that up to 10% of children suffer from chronic constipation [\(1-3\)](#), but only 3% of parents seek medical advice [\(4\)](#).

Several hypotheses have been proposed for the cause of chronic constipation. Hippocrates observed that certain food items of plant origin (fruit, vegetable, bran) resulted in soft stools [\(5\)](#). Several studies have indicated that a diet high in fiber may prevent constipation, but others have failed to support this suggestion [\(5-8\)](#). In 1969 Burkitt proposed the "fiber hypothesis." He suggested that many disorders common in western countries, including chronic constipation, were caused by a low-fiber diet [\(9\)](#). Dietary fiber may be defined as that part of plant material in food that is resistant to digestion [\(10\)](#).

Despite numerous clinical, pathophysiologic, and epidemiologic studies the cause of chronic constipation in childhood is still unclear. The fiber hypothesis for the pathogenesis of chronic constipation has been investigated in experimental studies showing a negative correlation between daily fiber intake and large bowel transit time and a positive correlation with the volume and the water content of stools [\(11\)](#). In addition, epidemiologic studies have reported a negative correlation between the incidence of chronic constipation and the per capita fiber intake in various countries [\(9,11\)](#), and clinical studies have reported successful management of chronic constipation with fiber supplementation [\(12,13\)](#).

The purpose of this case-control study was to examine the possible correlation of idiopathic chronic constipation in children and the dietary intake-particularly, fiber intake.

### SUBJECTS AND METHODS

A randomized sample of children aged 2 to 14 years [\(14\)](#) was taken from 3 of the 52 counties of Greece. Stratification was performed on the basis of urban, rural, or suburban location and socioeconomic status. All children aged 2 to 14 years living in selected villages and urban blocks were asked to participate in the study [\(15\)](#). A researcher visited every house in the block or village selected on two occasions. Two thousand six hundred ten children were identified, of whom 674 (25.9%) did not agree to participate. Forty-three children were excluded because of chronic disease.

Two hundred ninety-one children were considered to be chronically constipated, who had three or fewer bowel movements per week or hand stools with painful defecation (even with more than three bowel movements per week) at least during the past 2 months (16). The remaining 1602 children served as control subjects.

### Dietary Survey Methods

The nutritional data were obtained from a 3-day dietary record and also a dietary history (17,18). Each parent was provided a 3-day diet diary (17,19-22) and a standard volumetric measure for food quantities. To avoid bias due to the day of the week, the season, and the year, the sample was equally divided into days, seasons, and years. Parents were instructed to measure each component of the meal separately before it was served and to measure the quantities of food remaining after the meal. Small quantities were recorded in teaspoons or tablespoons, and the amounts of commercially manufactured food were obtained from the label. Parents were asked to provide a detailed description of the food (e.g., peeled or unpeeled fruits, specific kind of bread, specific portion of meat). Parents and, when appropriate, the child were interviewed and asked about various aspects of the child's usual diet including food frequency and quantity of simple food items and food groups. Three-day records were obtained from 1522 control subjects and 255 constipated children and a dietary history from 1602 control subjects and 291 constipated children. Parents were also asked about their usual diet, and a dietary history was obtained from them. The investigator also noted child's and family's medical history, body weight and height, and socioeconomic data. All constipated children were physically examined, and only those with a suspected organic cause of constipation were investigated by laboratory analysis (3). Nine with an organic cause were excluded from the study.

### Nutrient Intake

To calculate the daily nutrient intake of each subject, the food tables of the Federal Republic of Germany (23) were used. The composition of commercially manufactured food was obtained by the manufacturers. Nutrient losses resulting from cooking were estimated (24,25).

### Statistics

Statistical analysis was performed with multivariate tests, multivariate analysis of variance, discriminant analysis, and chi-square analysis (26), according to the characteristics of the correlated variables (qualitative or quantitative, continuous or interval, dependent or independent). Age, sex, social class, place of residence, day of the week, season, and year of observation were entered as covariates. Canonical distribution of each variable was examined using the criterion of goodness of fit. Variables without a canonical distribution were mathematically transformed using, where necessary, the square root, the logarithm, or the square root of the logarithm. The homogeneity of variability for all continuous variables was examined (26,27).

## RESULTS

All continuous variables (nutrients) fulfilled the criteria of homogeneity of variability to enter multivariate analysis: Cochran-C, Box-F, Box-M ( $p > 0.01$ ). Children with constipation, compared with control subjects, had a significantly lower caloric intake with both dietary survey methods ( $p < 0.001$ ; Table 1). Anorexia was reported by parents in 27.5% of constipated children and in 5.2% of control subjects (chi-square value = 159.54;  $p < 0.00001$ ). In 60% anorexia was reported to have begun with the onset of constipation. Body weight and height were lower in constipated children than in control subjects (0.20 kg/cm vs. 0.22 kg/cm;  $r = 0.55$ ;  $p < 0.05$ ).

Nutrient	Constipated (n=291)	Control (n=1602)
Energy (kcal)	1150 ± 250	1350 ± 300
Protein (g)	45 ± 10	55 ± 15
Fat (g)	60 ± 15	70 ± 20
Carbohydrate (g)	180 ± 40	210 ± 50
Fiber (g)	10 ± 5	15 ± 10
Calcium (mg)	400 ± 100	500 ± 150
Phosphorus (mg)	350 ± 100	450 ± 150
Iron (mg)	5 ± 2	6 ± 3
Potassium (mg)	1500 ± 400	1800 ± 500
Vitamin A (μg)	1000 ± 300	1200 ± 400
Thiamine (mg)	0.5 ± 0.1	0.6 ± 0.2
Riboflavin (mg)	0.4 ± 0.1	0.5 ± 0.2
Ascorbic acid (mg)	20 ± 10	30 ± 15

Table 1

Constipated children, compared with control subjects, had lower mean daily intake of all nutrients examined with the 3-day record and the dietary history ( $p < 0.001$ ) but there was no difference in the percentage of energy derived from protein, fat, and carbohydrates (Table 1). Mean food density in fiber, calcium, phosphorus, iron, potassium, vitamin A, thiamine, riboflavin, and ascorbic acid was lower in constipated children ( $p < 0.001$ ) according to the dietary history, and in fiber, thiamine, and niacin on the basis of the 3-day record ( $p < 0.001$ ; Table 1). Both history and record measurements showed that mean daily fiber intake and food density in fiber were lower in constipated children in all age groups ( $p < 0.001$ ; Figs. 1, 2).

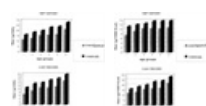


Fig. 1

Fig. 2

Discriminant analysis found that only fiber intake, expressed as mean daily intake or as mean food density and measured by dietary history or record, was independently correlated to constipation. Using fiber intake as the discriminating criterion, children were correctly classified in the constipated or control groups in 70% of cases.

Current positive family history for constipation (parents or siblings) was found in 62.5% of constipated children and in 30.3% of control subjects (chi-square value = 73.32;  $p < 0.000001$ ). The prevalence of chronic constipation in children was 3.4% if neither of the parents was constipated, 10.3% if one was constipated, and 48.5% if both were ( $p < 0.0001$ ). Mean fiber intake in parents of constipated children estimated by a dietary history (23.4 g/24 hours), was lower than in parents of control subjects (27.1 g/24 hours;  $p$

< 0.001). With discrimination relying only on the current family history of constipation, children were correctly classified in the constipated and control groups in 68.5% of cases, in 70.8% of cases when relying on family history and parents' fiber intake, and in 78.2% of cases when relying on family history and children's fiber intake. Constipated children had lower fiber intake than control subjects regardless of positive (11.9 g/24 hours vs. 14.1 g/24 hours) or negative current family history for constipation (10.1 g/24 hours vs. 13.0 g/24 hours; values estimated by 3-day record;  $p < 0.001$ )

Mean daily fiber intake was statistically lower in constipated children than in control subjects, regardless of accompanying symptoms namely painful defecation, abdominal pain, and soiling (Table 2). The whole sample (control subjects and cases) was subdivided into three groups according to the consistency of stool: hard, semihard, and soft. Fiber intake in these groups was 10.9, 12.0, and 13.5 g/24 hours, respectively; ( $p < 0.001$ ).

Symptoms	n	g/24h	g/1000 kcal
Abdominal pain +	97	11.40*	7.34*
Abdominal pain -	158	10.52*	7.05*
Encopresis +	58	11.93*	7.97 n.s.
Encopresis -	197	10.15*	7.01*
Painful defecation +	200	11.00*	7.41*
Painful defecation -	155	9.97*	6.48*
Controls	1522	13.89	8.29

n.s., not significant.  
Dietary survey method: 3-day record Statistics: Analysis of variance  
\*  $p < 0.001$  compared with controls.  
\*  $p < 0.05$  compared with controls.

Table 2

No statistical correlation was found between fiber intake and age of onset of constipation. A progressive increase of the relative risk of constipation with decreased fiber intake was found (Table 3). The relation of fiber components to chronic constipation was studied. It was found that constipated children had lower cellulose, uronic acid, pentose, and exose intake ( $p < 0.01$ ; Table 4). Discriminant analysis proved that only cellulose and pentose were independently correlated with constipation.

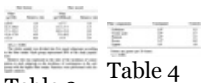


Table 3

Table 4

DISCUSSION

Chronic constipation is one of the most common causes of morbidity in childhood (1-3). Numerous hypotheses for its pathogenesis have been proposed. Several of them support the protective effect of fiber (5-8). The purpose of the present study was to investigate the role of nutrition and especially fiber, in the cause of idiopathic chronic constipation in children.

Studies on the links between diet and chronic constipation have been mainly based on comparisons of per capita fiber consumption and the frequency of chronic constipation in various countries (9). Until now, case-control studies have failed to prove a statistically significant correlation between fiber intake and chronic constipation (13). In contrast, numerous investigators have found that the treatment of constipation with fiber supplements was successful (4,28,29).

Selection of the appropriate methods to measure dietary intake is of great importance to the reliability of the results in nutritional surveys (19,30). There is no completely satisfactory method for the estimation of nutrient intake that provides both maximum validity and reliability (30,31). Most researchers agree that diet recorded in the household is an appropriate method for large field surveys, representing the person's current and usual diet (30-32). It is a method of good validity, especially if information is derived from both the child and the parents (17,20,22,33). When the diet record is used for surveys in children, there is no Hawthorne effect (33,34). This means there is no change in an individual diet, as may happen in nutrition surveys in adults. Parents of constipated children were possibly more concerned about their children's diet, and consequently, they kept diet records more carefully than did parents of control subjects. Therefore, underestimation of food quantities was more likely to occur in the control group. Conversely, most children with constipation (especially in the more severe cases) had already visited physicians who probably gave them nutritional advice to consume fibers. These two reasons could minimize the difference in reported fiber intake between cases and control subjects rather than increase it, leading to bias. Dietary history is a suitable method for dietary surveys in children, especially when investigators are interested in the usual diet and that of the recent past (35). It is of good validity and reliability when it combines information from both parents and children (35). The combination of the two methods increases validity and reliability of the results, especially in surveys of children (19).

The advantages of the present study are that a standard volumetric measure was used for the quantity estimation of the food consumed, and two dietary survey methods were used. In addition to fiber, other main nutrients and their interactions were correlated to constipation. For the first time in the literature, the dose-response association between fiber intake and chronic constipation was proved in a case-control study. The role of separate fiber components was studied.

Children with chronic constipation had lower energy intake than did control subjects. This finding is in agreement with the fact that in the constipated group the percentage of anorectic children was five times higher than in control subjects, and the body weight and height were lower. Anorexia and low energy intake could be caused by early satiety secondary to constipation, or it could exist previously and predispose to constipation.

The findings of the present study strongly support the low-fiber hypothesis for the pathogenesis of chronic constipation for the following reasons: constipated children had significantly lower dietary fiber intake and lower food fiber density based on the 3-day record and the dietary history; discriminant analysis proved that dietary fiber intake correlated with constipation independently of other nutrients; this correlation was found in all age groups, and in the various manifestations of constipation (painful defecation, abdominal pain, soiling), regardless of their proposed different pathogenesis; the increase of the relative risk up to eight times as fiber intake decreases proved the dose-response effect of fiber on constipation; and fiber intake was statistically correlated to the consistency of stools.

The finding that the prevalence of chronic constipation in children was 3.4% when neither of the parents was constipated, 10.3% with one constipated parent, and 48.5% with both agrees with data in another study (3.2%, 26%, and 46%, respectively) (1). The above finding could be caused by inherited predisposing factors, psychological factors common in the same family, and similar food habits in parents and children, which was proved in the present study. The correlation of low fiber intake to constipation remained statistically significant regardless of the presence of positive family history, which weakens the possibility of different pathogenic mechanisms of constipation in children with negative family history from those in children with a positive one. That the correlation of low fiber intake with constipation was statistically significant even in children whose constipation began in early months of life (when fiber intake is universally low), suggests that although low fiber intake may not be a causative factor for the onset of constipation in all cases, it is an important factor for the maintenance of constipation.

Discriminant analysis showed that fiber intake classified our sample correctly into constipated and nonconstipated groups in 70% of children. This means that low fiber intake is the main but not the only causative factor in chronic constipation. Another factor could be a positive family history, which alone classified 68.5% correctly and with fiber, classified 78.2% of the sample correctly. All of these data mean that, in a small percentage, inheritance played an autonomous role in the cause of constipation unrelated to common family food habits. However, these two factors cannot explain the cause of idiopathic constipation in all cases. Other factors are probably involved (12,28,36). The protective role of fiber against constipation is supposedly related to its ability to induce osmotic and mechanical stimulation of colonic motility (4,37). Osmotic stimulation is caused by the short chain fatty acids after the decomposition of fiber by colonic flora fermentation (1,4,37). Mechanical stimulation is the result of the water-holding capacity of undigested components of fiber, the increase of colonic flora that is particularly rich in water, and the gas production during colonic fermentation of fiber (4,37). That only pentose (derived mainly from hemicellulose) and cellulose (two fiber components that are fermented in large bowel) have independent correlation to constipation, indicates that the laxative effect of fibers is most likely caused by fermented components in the large bowel that produce short chain fatty acids, gas, and an increase of colonic flora.

In conclusion, the statistically significant lower fiber intake in constipated children, regardless of age, accompanied symptoms, age of onset, and the dose-response effect of fiber to strongly support the fiber hypothesis for the cause of idiopathic chronic constipation.

**Acknowledgments:** The authors thank Prof. A. Trichopoulou and her colleagues for their valuable advice; the local authorities of the survey regions for their help in collecting data; teachers of elementary and high schools and staff of kindergartens for their collaboration; the following contributions in specific parts of the survey: Assist. Prof. C. Bakoula, E. Kleitsa, P. Karamolegou, A. Legaki, A. Koliopanou, V. Drosou, C. Manta, M. Samartzi, M. Michalaki, A. Zerbou, P. Antoniou, S. Papavergis, J. Fitsialos, M. Tserkezou, J. Kapolis, M. Tsiava, D. Asvestopoulou, M. Kokkinaki, E. Serafidou, G. Moulatziko, S. Rafail, G. Georganas, A. Orfanou, D. Mpokis, D. Dafliou, E. Kollia, A. Kasimatis, C. Mpelou, V. Katsikerou, V. Koukousia, D. Ampatzis, Z. Antonarou, S. Zois, J. Sigalas, E. Farmaki, M. Giannakouli, S. Fakriadou, G. Mitsopoulos, and Th. Konstantinidis; and all children and their parents who participated in this survey.

Funded in part by the Greek Ministry of Health, Athens.

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**Keywords:**



Children; Constipation; Fiber; Nutrition

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