

Applied nutritional investigation

# Fiber intake, constipation, and overweight among adolescents living in Sao Paulo city

Érica Bloes de Carvalho, M.S.<sup>a</sup>, Márcia Regina Vitolo, Ph.D.<sup>b</sup>, Cíntia Mendes Gama, Ph.D.<sup>b</sup>,  
Fabio Ancona Lopez, M.D., Ph.D.<sup>c</sup>, José Augusto C. Taddei, M.D., Ph.D.<sup>c</sup>, and  
Mauro Batista de Moraes, M.D., Ph.D.<sup>d,\*</sup>

<sup>a</sup> Postgraduate Course of Nutrition, Federal University of Sao Paulo, Sao Paulo, Brazil

<sup>b</sup> Public Health Department, Federal Foundation Faculty of Medical Sciences, Porto Alegre, Brazil

<sup>c</sup> Nutrition and Metabolism Division, Federal University of Sao Paulo, Sao Paulo, Brazil

<sup>d</sup> Pediatric Gastroenterology Division, Federal University of Sao Paulo, Sao Paulo, Brazil

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## Abstract

**Objective:** This study evaluated the dietary fiber intake of adolescents in the metropolitan area of Sao Paulo city and any association between low dietary fiber intake with constipation and overweight.

**Methods:** In total, 716 adolescents were included within the study, of whom 314 attended private school and 402 attended public school. Evaluation of fiber intake was based on a 24-h daily intake record and a frequency questionnaire. Data concerning bowel movements and height and weight measurements were also taken.

**Results:** Fiber consumption, below that recommended (“age + 5”), was found in 61.8% and 41.4% ( $P = 0.000$ ) of girls attending private and public schools, respectively, and in 44.1% and 25.6% of boys ( $P = 0.001$ ). Adolescents who did not eat beans on more than 4 d/wk presented a higher risk of fiber intake below that recommended (age + 5;  $P < 0.05$ ), with odds ratios ranging from 10.4 to 14.2 according gender and private or public schooling. Dietary fiber intake below that recommended was associated with a greater risk ( $P < 0.05$ ) toward overweight in students attending public schooling (odds ratios 2.84 and 2.95 for males and females, respectively). Low dietary fiber intake was not associated with constipation.

**Conclusion:** Intake of beans more than four times per week is associated with the appropriate level of fiber intake. Dietary fiber intake below the recommendation was not associated with constipation but was associated with being overweight among those students attending public schooling. © 2006 Elsevier Inc. All rights reserved.

## Keywords:

Dietary fiber; Teen health; Constipation; Overweight

## Introduction

Dietary fiber has been considered an important nutrient that can provide a beneficial effect to health [1,2]. Dietary fiber may be used in the treatment and prevention of many diseases such as obesity, cardiovascular disease, type 2 diabetes, colonic diverticulosis, and constipation [2].

Adolescence is considered a risky period in which to adopt feeding habits that constitute a diet with high energy

density and an insufficient intake of specific nutrients, including dietary fiber [3–5]. According to studies conducted concerning the eating habits within a typical Brazilian family, fiber intake was neither included [6] nor studied [7,8] among teenagers. In general Brazilian studies analyzed themselves towards analyzing the relation between dietary fiber intake and intestinal chronic constipation [9–11]. Dietary fiber intake by adolescents has been assessed in some countries [12–14], but in Brazil this subject has not previously been studied.

Taking into consideration that obesity has been described for Brazilian adolescents [15,16] and the possible existence

\* Corresponding author. Tel./fax: +55-11-5579-5834.

E-mail address: mbmoraes@osite.com.br (M.B. de Moraes).

of a relation between low dietary fiber intake and constipation [11,17] and overweight [18], this study evaluates low dietary fiber intake by adolescents within private and public schools in Sao Paulo and its association with constipation and overweight.

## Materials and methods

### Subjects

This study analyzed the information obtained from a project that evaluated the prevalence of obesity in adolescent students enrolled at three different schools (one private and two public schools) in the district of Vila Mariana, in the southeast area of Sao Paulo city [19]. The sample included 716 adolescents. In the private school, 314 were included in the study from among 2581 adolescents (56.6% females and 43.4% males). The adolescent sample from the public schools consisted of 402 of 2062 adolescents (58.2% females and 41.8% males). The students were randomly selected using a computer program that considered the number within each grade. The sample was adequate for an expectation of 40% of adolescents to have a dietary fiber intake lower than that recommended (“age + 5”). According to the Stacalc module of Epi-info 6.4, considering a power of 80.0% and an  $\alpha$  value of 5.0%, from the total population of the public and private schools (4643 adolescents), and using an oscillation of 4% in the proportion of adolescents with fiber intake lower than that recommended, the number of students should be 513. Consequently, the number of adolescents ( $n = 713$ ) included in this study was larger than necessary for this project’s aim.

The study was approved by the ethics committee of the Federal University of Sao Paulo (UNIFESP)/Paulista School of Medicine. Signed consent forms were obtained from parents, guardians, and/or adolescents.

### Methods

#### Food intake evaluation

The 24-h daily record intake [20] was used as a food-intake quantitative method. The technique consisted of asking for the amounts and types of foods consumed during the 24 h of the previous day, starting at breakfast. The types of foods or preparations regularly consumed more than four times a week were also requested. This qualitative analysis of food consumption or specific food groups was determined by means of a frequency questionnaire [21]. This strategy enabled the classification of adolescents into those with or without low dietary fiber intake according to their food frequency consumption of different types of foods or food groups. The denomination “non-daily consumption” was used when the food was consumed fewer than four times a week.

#### Fiber intake evaluation

Total dietary fiber intake was defined by using a table based on the Association of Official Analytical Chemists (AOAC) [22], a method used to determine dietary fiber (soluble + insoluble) content in foods.

Dietary fiber intake was considered low when consumption was lower than the minimum recommended by the American Health Foundation for age (age in years + 5) [23]. Results were also expressed according to fiber amount per 1000 cal [24] in the diet (fiber density). Dietary fiber density was calculated by dividing fiber intake (grams) by total energy intake (kilocalories) multiplied by 1000. The energy value of the diet was obtained with Sistema de Apoio à Nutrição 2.5 (Nutrition Support System 2.5) from the Health Informatics Center of the UNIFESP/Paulista School of Medicine.

#### Evaluation of intestinal habit

Evaluation of intestinal habit was based on answers to questions regarding defecation frequency, consistency and shape of feces, and pain during defecation. The occurrence of fewer than three bowel movements per week or evacuation of hard, scybalous, pebble-like, or cylindrically cracked form associated with pain during evacuation was considered indicative of intestinal constipation [25,26].

#### Definition of overweight

Weight and height measurements were taken as recommended previously [27]. Weight was determined by means of a digital balance with the adolescents wearing light clothes and being barefoot. The height measurement was taken using a stadiometer with millimeter accuracy (Microtoise-Stanley-Mabo Ltd., Poissy, France) and a 2-m extension with a plastic sight glass for readouts and a cross-staff attached to both ends.

Classification of nutritional status was based on body mass index (BMI; weight in kilograms divided by height in meters squared) as recommended by the World Health Organization [27]. The table prepared by Must et al. [28] was used as a reference in accordance with gender and age. The BMI of each adolescent was rated according to the following classification: underweight, BMI <5%; normal weight, BMI between 5% and 85%; overweight, and BMI  $\geq$ 85%.

#### Statistic analysis

The database was created with Epi-info 6.4 and statistical analysis was done with Jandel Sigma Stat for Windows (Systat Software Inc., Richmond, CA, USA). Odds ratios were calculated to evaluate the relation between “insufficient fiber consumption” with “excessive body weight” and “constipation” and were determined with Epi-info. A multiple logistic regression model (MULTLR program) was used to evaluate gender, type of schooling, and low dietary fiber intake as associated factors related to the consequences (constipation and overweight).

Table 1

Mean  $\pm$  standard deviation of daily dietary fiber intake and fiber density (grams per 1000 kcal of diet) by adolescents in private and public schools, according to gender

	Private school		Public school		P*
	n	Mean $\pm$ SD	n	Mean $\pm$ SD	
Daily fiber intake (g/d)					
Females	178	19.1 $\pm$ 12.9	234	24.5 $\pm$ 14.3	0.000
Males	136	22.9 $\pm$ 13.7	168	32.5 $\pm$ 19.0	0.000
Fiber density (g/1000 cal)					
Females	178	8.3 $\pm$ 4.4	234	10.1 $\pm$ 5.1	0.004
Males	136	9.0 $\pm$ 4.8	168	10.7 $\pm$ 5.2	0.000

Females versus males,  $P < 0.05$  for all comparisons except for fiber density in group attending public school (Student's  $t$  test).

\* Student's  $t$  test.

## Results

### Dietary fiber intake by gender and type of schooling

Mean dietary fiber intake by adolescents in public school was higher than that in private school for females (24.5 versus 19.1 g/d) and males (32.5 and 22.9 g/d; Table 1). In addition, fiber density within the diet (grams of dietary fiber/1000 cal) confirmed this finding according to the statistical study. However, mean fiber intake by females represented 83.4% (19.1 of 22.9) and 75.3% (24.5 of 32.5) of the mean male fiber intake in private and public schools, respectively. These differences were statistically significant. Mean fiber density for females in relation to males was 92.2% (8.3 of 9.0) and 94.4% (10.1 of 10.7) in public and private schools, respectively (Table 1). Therefore, lower fiber consumption by females is a consequence of not only a smaller quantity of energy intake but also differences in dietary quality, at least in private school.

Proportions of adolescents with fiber intake lower than the minimum recommended (age + 5) were higher in private school (61.8% and 44.1% with intake lower than that recommended for females and males, respectively) for both genders and the differences were statistically significant in relation to public school (41.4% and 25.6%, respectively; Table 2). Statistical analysis showed that the percentage of adolescents with insufficient fiber intake occurred in females in private and public schools. In males and females, insufficient fiber intake was more prevalent in private school.

Table 2

Proportion of adolescents in private or public school with fiber intake lower than the minimum recommended (age + 5) according to gender

	Adolescents in private school	Adolescents in public school	P*
Female	110/178 (61.8%)	97/234 (41.4%)	0.000
Male	60/136 (44.1%)	43/168 (25.6%)	0.001

Private school: female (110/178) versus male (60/136),  $P = 0.003$ .

Public school: female (97/234) versus male (43/168),  $P = 0.001$ .

\* Chi-square test.

Percentages that each food or group of foods represented in the total fiber intake (Fig. 1) by adolescents in public and private schools showed that in both groups beans (48% in public and 28% in private school) and fruit (27% in private and 16% in public school) were the major sources of dietary fiber. In public school, bean consumption (48%) was a more important source of fiber than fruit, which represented only 16%. In private school, fruit and beans represented almost the same contribution to fiber intake. Potatoes, vegetables, bread, and rice presented similar percentages in relation to total daily dietary fiber intake in teenage diets for both types of school.

### Non-daily consumption of fruit, vegetables, and beans as a risk factor for insufficient fiber intake

The role of the non-daily consumption of fruit, vegetables, and beans as possible risk factors for a fiber intake level lower than that recommended was assessed using the odds ratio (Table 3). Non-daily consumption of beans was associated with a higher probability of dietary fiber intake lower than that recommended in both genders in private and public schools and the odds ratio varied from 10.43 to 14.17 ( $P < 0.000$  for all). In public school, non-daily consumption of fruit was associated with a higher probability toward dietary fiber intake being lower than that recommended for

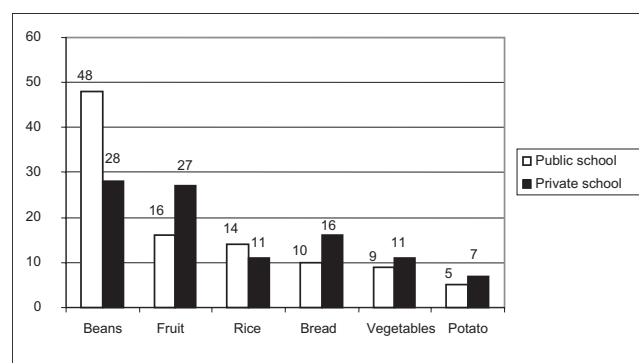


Fig. 1. Mean percentage that each food or food group represents of the total dietary fiber intake according to private and public schools.

Table 3  
Risk of fiber intake lower than recommended (age + 5) as a consequence of non-daily consumption of fruit, vegetables, and beans

Type of school/gender	Non-daily consumption	Odds ratio (95% confidence interval)	P*
Private school			
Female	Fruit	0.50 (0.19–1.31)	0.183
	Vegetables	0.76 (0.36–1.60)	0.547
	Beans	10.43 (4.69–23.6)	0.000
Male	Fruit	1.42 (0.50–4.04)	0.634
	Vegetables	1.05 (0.40–2.24)	0.971
	Beans	11.7 (4.7–29.7)	0.000
Public school			
Female	Fruit	2.44 (1.26–4.76)	0.0067
	Vegetables	1.41 (0.77–2.58)	0.287
	Beans	14.17 (6.85–29.72)	0.000
Male	Fruit	4.55 (1.99–10.93)	0.000
	Vegetables	1.64 (0.74–3.59)	0.252
	Beans	13.41 (4.83–38.38)	0.000

\* Chi-square test.

female (odds ratio 2.4,  $P = 0.0067$ ) and male (odds ratio 4.55,  $P < 0.000$ ) adolescents. In private school, such an association was not observed. Irregular intake of vegetables was not identified as a factor related to insufficient fiber intake ( $P > 0.05$ ).

#### Low dietary fiber intake as a risk factor for constipation and overweight

In private school, intestinal habit compatible with constipation was observed in 25.2% (45 of 178) of the female teenagers and in 16.9% (23 of 136) of the male teenagers (chi-square test,  $P = 0.100$ ). In students from public school, those values were 31.6% (74 of 234) for females and 19.6% (33 of 168) for males, with a tendency toward a higher prevalence in females (chi-square test,  $P = 0.051$ ).

In private school, the ratios for underweight, normal weight, and overweight were 3.4%, 83.1%, and 13.5%, respectively, in 178 female adolescents and 2.2%, 78.7%, and 19.1%, respectively, in 136 male adolescents. In public school, these values were 3.8%, 79.1%, and 17.1% for the female adolescents ( $n = 234$ ) and 8.9%, 76.2% and 14.9% for the male adolescents ( $n = 168$ ).

There was no statistically significant association between insufficient consumption of dietary fiber and constipation according to the odds ratio (Table 4). In contrast, in public school, there was an association between insufficient dietary fiber intake and overweight for both genders (2.95,  $P = 0.003$  in females and 2.84,  $P = 0.033$  in males). This tendency (odds ratio 2.59,  $P = 0.052$ ) was also observed for male adolescents in private school.

Multiple logistic regression (Table 5) including gender, type of schooling (private versus public), and low dietary fiber intake, as associated factors involved with constipation and overweight as a consequence, showed a relation between females and constipation (odds ratio 1.78). For this population, multiple logistic regression also showed low dietary fiber intake as a risk factor toward overweight because the odds ratio was 2.06 (95% confidence limits 1.32, 3.08;  $P = 0.0010$ ).

## Discussion

During 2002, a dietary reference intake standard for total dietary fiber was published [29]. This recommendation sug-

Table 4  
Dietary fiber intake lower than that recommended as possible risk factors for constipation and overweight

Type of school	Gender	Odds ratio (95% confidence interval)	P*
Constipation			
Private school	Female	1.33 (0.62–2.87)	0.548
	Male	0.84 (0.30–2.28)	0.886
Public school	Female	1.00 (0.55–1.81)	0.895
	Male	1.16 (0.45–2.95)	0.911
Overweight			
Private school	Female	0.69 (0.27–1.80)	0.547
	Male	2.59 (0.99–6.84)	0.052
Public school	Female	2.95 (1.39–6.34)	0.003
	Male	2.84 (1.07–7.49)	0.033

\* Chi-square test.

Table 5  
Multiple logistic regression evaluating gender, type of schooling, and low dietary fiber as factors associated with constipation and overweight as outcomes

Outcomes	Variable	Odds ratio (95% CI)	P
Constipation	Gender: female × male	1.78 (1.23–2.56)	0.0020
	Private × public school	0.76 (0.53–1.53)	0.1285
	Overweight: yes × no	0.72 (0.53–1.53)	0.1847
	Low dietary fiber intake: yes × no	1.06 (0.74–1.53)	0.7350
Overweight	Gender: female × male	0.83 (0.55–1.26)	0.3850
	Private × public schooling	0.84 (0.56–1.27)	0.4119
	Constipation: yes × no	0.74 (0.45–1.22)	0.2317
	Low dietary fiber intake: yes × no	2.06 (1.32–3.08)	0.0010

CI, confidence interval.

gested daily intakes of 26 g/d for female adolescents and 31–38 g/d for male adolescents. However, according to this recommendation, total dietary fiber should include not only soluble and insoluble fiber but also functional fiber [29]. In a previous study, our group had advised that there were considerable variations in dietary fiber intake according to the food fiber table used for the evaluation of dietary fiber consumption [30]. Taking into account that, to our knowledge, there is no reference table for functional fiber in food, the table of dietary fiber in food according to the AOAC method was adopted for this study. Subsequently, the classic American Health Institute recommendation for dietary fiber intake (age in years + 5) was used as a reference value [23]. Based on these criteria, our present study found dietary fiber intake lower than that recommended for 25.6% to 61.8% of adolescents, varying according to gender and private or public school. The largest proportion of low intake of dietary fiber was found within the female group who had studied at private school. This result may be explained in part by the lower energy requirements and food intake observed for the female gender. This suggestion is in line with our result showing no difference when a comparison between dietary fiber density in males and females (Table 1) at private and public schools is done. Mean fiber intake in our study was similar to that found for adolescents living in European countries, where a lower consumption by female adolescents was also observed [12–14,31].

Beans were the most important dietary fiber source in public and private schools (Fig. 1). In private school, consumption of fruit as a source of dietary fiber was more important than at public school. Processed rice and bread were also important sources of dietary fiber, despite their lower fiber density, because these foods are in general consumed in significant quantities by the Brazilian population. The higher consumption of fruit as a fiber source in the private school may reflect the higher cost of fruit in Brazil in relation to other types of food. In Table 3, non-daily consumption of beans was identified as a risk factor for insufficient dietary fiber intake. The odds ratio varied between 10.4 and 14.2, showing that this association is very strong. At public school, irregular consumption of fruit constituted a risk factor for insufficient fiber consumption,

with odds ratios of 4.55 and 2.44 in males and females, respectively (Table 3). Consequently, for Brazilian adolescents to attain adequate dietary fiber intake, the recommendation of daily consumption of beans and fruit might be a possible strategy.

Our study also evaluated a possible association between low dietary fiber intake and both constipation and overweight. The bivariate statistical analysis (Table 4) and multiple logistic regression (Table 5) showed no relation between low dietary fiber intake and constipation. Despite the belief associating low consumption of fiber with constipation, there have been few pediatric studies addressing this question. A study that evaluated children with severe chronic constipation identified a relation between chronic constipation and low dietary fiber intake [11]. In contrast, studies performed at the community level have presented controversial results [9,10,17]. Although a Greek study [17] found a relation between constipation and low dietary fiber intake, two studies performed in Brazil [9,10] failed to demonstrate this association. It should be emphasized that the lack of any association found in these studies does not prove that higher fiber consumption might not play a favorable role in the treatment of intestinal constipation.

Our results also demonstrated that, in adolescents attending public school, dietary fiber intake lower than that recommended was associated with overweight. The odds ratios were 3.0 for females and 2.8 for males. For the total population studied, multiple logistic regression indicated that low dietary fiber intake was a risk factor toward overweight (odds ratio 2.06; Table 5). Epidemiologic data has shown that low dietary fiber intake is associated with overweight in studies involving adults living in the United States of America [32–35], Canada [36], the United Kingdom [37], and Europe [38]. Any comparison of the different results involving low dietary fiber and excess weight is not possible due to differences in statistical methodology. Our data are the first demonstration of such an association in adolescents. Possible mechanisms toward explaining the effect of dietary fiber on body weight include: 1) fiber may displace available energy and other nutrients from the diet; 2) fiber increases chewing and limits intake of food by promoting the secretion of saliva and gastric juice, resulting in precocious

satiety; and 3) fiber may decrease the absorption efficiency of the small intestine. These effects related to dietary fiber that have an influence on body weight were recently reviewed in *Nutrition* [18].

It is important to emphasize the eating habit of a large sector of the Brazilian population who consume beans more than four times per week, which brings about a lower risk of insufficient consumption of dietary fiber. Dietary fiber intake in adolescents lower than that recommended was not associated with constipation, but it was associated with a higher risk toward overweight.

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