Public Health Nutrition: 23(14), 2557–2562 doi:10.1017/S1368980019004105

Low intake of dietary fibre among Brazilian adolescents and association with nutritional status: cross-sectional analysis of Study of Cardiovascular Risks in Adolescents data

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Submitted 10 January 2019: Final revision received 11 September 2019: Accepted 20 September 2019: First published online 8 May 2020

Abstract

Objective: To evaluate dietary fibre intake in Brazilian adolescents and its association with nutritional status.

Design: This was a cross-sectional study including data from the Brazilian multicentre Study of Cardiovascular Risks in Adolescents (ERICA). Data analysed were geographic region, sex, age, nutritional status, sexual maturation stage, socioeconomic status, school type and level of physical activity. For nutritional status classification, BMI/age was used by sex. Dietary intake was assessed by 24-h recall. Dietary fibre intake was expressed in g/d, and adequacy was determined using dietary reference intake (DRI) values. Complex sample design was considered in statistical analysis, and logistic regression was used to estimate OR for fibre intake and nutritional status.

Setting: Brazilian municipalities with more than 100 000 inhabitants.

Participants: A total of 71 740 adolescents aged 12–17 years were included.

Results: The average total dietary fibre intake was 19·1 g/d (95 % CI 18·5, 19·7), and only 13·1 % (95 % CI 11·6, 14·7) of Brazilian adolescents reached the recommendations. The results of logistic regression analysis adjusted for geographic region, sex and type of school showed that overweight and obese adolescents were 1·6 and 1·8 times more likely, respectively, to have inadequate dietary fibre intake ($P < 0·0001$).

Conclusions: Brazilian adolescents had a significantly inadequate dietary fibre intake. This was particularly notable in adolescents with excess weight. Education policies on nutrition must be implemented, as dietary fibre plays an important role in the prevention and treatment of obesity and other chronic diseases.

Keywords
Dietary fibre
Adolescents
Overweight
Obesity

Dietary fibres are polymers of carbohydrates with ten or more monomeric units, which are not hydrolysed by endogenous enzymes present in the small intestine[1]. Besides, fibre has been used in the prevention and treatment of obesity[2,3] since it regulates body weight, controls blood pressure, reduces chronic inflammation, improves satiety and alters the absorption of carbohydrates and lipids[4]. Furthermore, fibre-rich foods tend to have a lower caloric content and higher content of antioxidant nutrients, which act synergistically with fibre[5–7]. In addition, fibre can also be fermented in the large intestine, making the intestinal microbiota healthier and leading to the production of

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SCFAs, which may affect the secretion of appetite-regulating peptides[2].

Edwards *et al.*[8] identified an inadequate intake of dietary fibre among adolescents in different countries. This may be attributed to the consumption of foods with a high amount of refined carbohydrates and lipids and with low dietary fibre, favouring weight gain[9–11]. An inverse relationship between low fibre intake and overweight has been identified in this age group. Ambrosini *et al.*[12] demonstrated that a dietary pattern characterised by high caloric density and poor fibre content was longitudinally associated with excess adiposity in English children and adolescents. In Iranian adolescents, vegetable and fibre intakes were significantly associated with a reduced probability of being overweight[13].

Brazilian studies on the consumption of dietary fibre by adolescents, despite indicating dietary inadequacy, are scarce, controversial and limited in territorial coverage[14–16]. Our initial hypothesis was that fibre consumption by Brazilian adolescents was low, despite Brazil being a country with a continental dimension and strong food production. The Study of Cardiovascular Risks in Adolescents (ERICA) – the first Brazilian multicentre study with national representativeness from the five macro-regions – was conducted to analyse the different aspects influencing health in this age group, including medium- and large-sized municipalities. Using the information obtained in ERICA, the current study aimed to evaluate dietary fibre intake in a representative sample of Brazilian adolescents and analyse its association with nutritional status, adjusted for possible confounding variables.

Methods

Population

This study was performed using ERICA data between 2013 and 2014 in Brazil. The study comprised adolescents of both sexes, from public and private schools, across municipalities with more than 100 000 inhabitants from the five macro-regions of the country. The study has national, regional, capital and interior strata representation for medium- and large-sized municipalities in the five macro-regions.

Inclusion criteria were as follows: age 12–17 years and participation in research phases. Exclusion criteria were as follows: refusal to participate; physical or mental disability, which would make some evaluations impossible; and pregnancy. A total of 102 327 adolescents were eligible. Sampling losses included cases without information on dietary intake and anthropometric data or those with incomplete responses to the applied questionnaires with regard to the following information: geographic region (North, Northeast, Southeast, South and Central West), sex, age (12–15 years; 16–17 years), sexual maturation stage, socioeconomic status, type of school and level of physical activity.

Regarding sexual maturation, the adolescents were classified according to Tanner's criteria[17] into stages I–V, which were determined by self-evaluation with the support of illustrative boards. Subsequently, participants were categorised as pre-pubescent (stage I), pubescent (stages II–IV) and post-pubescent (stage V). Socioeconomic status was defined based on the sum of certain goods together with the schooling of the householder, creating the categories A, B, C, D and E, with category A denoting greater purchasing power and the subsequent categories denoting purchasing power in descending order[18]. School type was classified according to administrative dependence, as public or private. In Brazil, this variable can also be used as a socioeconomic indicator, considering that students belonging to the upper and upper middle classes normally study in private schools, while public schools comprise a high proportion of adolescents from the less-favoured classes. Physical activity level was assessed through a previously validated questionnaire[19], and adolescents who performed >300 min of physical activity in the last week were classified as active[20].

Anthropometric parameters

Weight and height values were collected by previously trained staff for the calculation of BMI[21,22]. For the classification of adolescent nutritional status, the World Health Organization reference curves were adopted[23], using BMI/age, according to sex.

Dietary assessment

The tool used for dietary assessment was a 24-h recall applied by trained researchers, who used the five-step multiple-pass method[24]. A specific digital programme was developed to record the information and, at the end of the collection, the reported data were sent directly to the central server. This programme generated a database with foods and beverages consumed by adolescents in home measures[25], which were converted to grams[26]. Based on this conversion and the Nutritional Composition Table of Food Consumption in Brazil[27], the consumption pattern of each adolescent was obtained. Total dietary fibre intake was expressed in g/d, and the percentage of adequacy was determined using dietary reference intakes (DRIs)[28]. Total fibre DRIs for females between 9 and 18 years is 26 g/d; for boys between 9 and 13 years, it is 31 g/d; and for male adolescents between 14 and 18 years, it is 38 g/d.

Statistical analyses

To describe the categorical variables, relative frequency values and their respective 95 % CIs were used. Associations between exposures and categorical outcomes

https://doi.org/10.1017/S1368980019004105 Published online by Cambridge University Press

were assessed by Chi-square test. Normally distributed variables were expressed as means and 95 % CI; those with non-normal distribution as median; and the *t*-test, Wilcoxon–Mann–Whitney and Kruskal–Wallis tests were used for comparison between continuous variables. The results were expressed as average, with their respective 95 % CIs. The association between low fibre intake and nutritional status was examined in logistic regression analysis, estimating the OR. Association between exposure (low fibre intake) and nutritional status was investigated using a multivariate model, where the variables that presented statistical significance in the bivariate model were considered. Statistical analyses were performed using the Stata software package, version 14, considering the expansion factors and complexity of the sample design. A significance level of 5 % was adopted in all analyses.

Results

The study evaluated 71 740 Brazilian adolescents with a mean age of 14·4 years; 70·1 % were aged 12–15 years; and 50·2 % were male. Most participants were from the Southeast region (50·8 %), followed by the Northeast (21·3 %), South (11·8 %), North (8·4 %) and Central West (7·7 %) regions. The mean BMI was 21·1 kg/m^2 (95 % CI 21·0, 21·2), with a predominance of adolescents in the normal BMI range, in the pubertal or post-pubertal period and attending public school (Table 1).

The total average consumption of dietary fibre was 19·1 g/d (95 % CI 18·5, 19·7), with those in the South presenting lower consumption ($P < 0·0001$) (Table 2). Male adolescents had an average intake of 21·2 g/d, which was significantly higher than among female adolescents ($P < 0·0001$). Participants aged 12–15 years presented an average intake of total dietary fibre of 18·6 g/d, which was significantly lower than the consumption among adolescents aged 16–17 years ($P < 0·0001$). Considering nutritional status, obese individuals reported the lowest intake ($P < 0·0001$). No significant difference was observed in total dietary fibre intake when adolescents were stratified by sexual maturation stage. Participants with a higher socioeconomic status (categories A and B) presented lower consumption ($P = 0·0309$), and this result was confirmed by the fact that private school students had a significantly lower fibre intake than those from public schools ($P < 0·0001$). Students considered inactive presented a lower intake of total dietary fibre than did those who were active ($P < 0·0001$).

Only 13·1 % (95 % CI 11·6, 14·7) of the adolescents reached the recommended total dietary fibre intake value, and those in the South presented a lower adequacy level, at only 7·7 % ($P = 0·0038$). Among female adolescents, 15·2 % reached the recommendation for fibre intake, but only 11·0 % of the boys achieved the DRIs ($P < 0·0001$). No significant difference was observed when participants were stratified by age, sexual maturation stage, socioeconomic status and physical activity level. According to nutritional status, obese adolescents presented a lower adequacy of total dietary fibre intake ($P < 0·0001$). Among public school students, 13·8 % reached the recommendation, which was significantly higher than among private school participants ($P < 0·0001$) (Table 2).

Results of bivariate logistic regression are presented in Table 3. In terms of geographic region, those from the South were 2·2 times likelier to present an inadequate consumption compared to those from other regions ($P < 0·0001$). Male adolescents had 1·4 times more chance of having an insufficient intake compared to the girls ($P < 0·0001$). The variables age, sexual maturation stage, socioeconomic status and physical activity level were not associated with total dietary fibre intake. Overweight and obese participants were 1·6 and 1·9 times as likely, respectively, to have an inadequate intake compared to those with a normal BMI ($P < 0·0001$). This difference was not observed among those with a low weight. Private school adolescents had 1·5 times the chance of presenting an insufficient intake of total dietary fibre compared to those studying in public schools ($P < 0·0001$).

Table 4 shows the association between low fibre intake among Brazilian adolescents and nutritional status, adjusted for geographic region, sex and type of school. The multivariate analysis showed that those with overweight and obesity had 1·6 and 1·8 times, respectively, the chance of presenting an insufficient consumption of total dietary fibre, compared to those with a normal BMI ($P < 0·0001$). Low weight did not present an association with fibre consumption.

Table 1 General characteristics of Brazilian adolescents according to nutritional status, sexual maturation stage, socioeconomic status, type of school and physical activity level

	%	95 % CI
Nutritional status		
Low weight	2·8	2·6, 3·1
Normal	71·8	70·6, 72·9
Overweight	17·1	16·2, 17·9
Obese	8·4	7·9, 8·9
Sexual maturation		
Pre-pubescent	0·6	0·5, 0·8
Pubescent	64·7	63·9, 65·4
Post-pubescent	34·7	34·0, 35·4
Socioeconomic status		
A	11·2	9·7, 12·9
B	53·8	52·6, 55·0
C	33·4	31·5, 35·3
D and E	1·6	1·4, 19
Type of school		
Public	82·6	78·0, 86·3
Private	17·5	13·7, 22·0
Physical activity		
Inactive	48·3	47·4, 49·2
Active	51·7	50·8, 52·6

https://doi.org/10.1017/S1368980019004105 Published online by Cambridge University Press

Table 2 Total dietary fibre intake among Brazilian adolescents and adequacy percentage according to dietary reference intake (DRI)[28]

	g/d	95 % CI	*P*	Adequacy %	95 % CI	*P**
Geographic region†			**<0·0001**			**0·0038**
North	19·5	18·9, 20·0		15·6	14·2, 17·1	
Northeast	19·3	18·8, 19·9		13·2	12·0, 14·4	
Southeast	19·5	18·3, 20·7		14·0	11·3, 17·1	
South	16·4	15·7, 17·2		7·7	6·1, 9·7	
Central West	19·1	18·6, 19·5		12·6	11·1, 14·3	
Sex‡			**<0·0001**			**<0·0001**
Female	17·0	16·4, 17·5		15·2	13·7, 16·7	
Male	21·2	20·4, 21·9		11·0	9·4, 12·9	
Age‡			**<0·0001**			0·7727
12–15 years	18·6	17·8, 19·4		13·0	11·1, 15·1	
16–17 years	20·2	19·7, 20·6		13·3	12·2, 14·5	
Nutritional status†			**<0·0001**			**<0·0001**
Low weight	19·8	18·9, 20·6		12·4	10·2, 14·9	
Normal	19·8	19·2, 20·4		14·6	12·9, 16·4	
Overweight	17·0	16·6, 17·5		9·4	8·3, 10·5	
Obese	16·8	15·0, 18·6		8·2	5·8, 11·4	
Sexual maturation†			0·9791			0·7810
Pre-pubescent	18·9	16·5, 21·4		11·7	6·9, 19·2	
Pubescent	19·1	18·2, 19·9		13·3	11·1, 15·7	
Post-pubescent	19·1	18·7, 19·5		12·8	11·8, 13·9	
Socioeconomic status†			**0·0309**			0·1528
A	18·8	17·9, 19·6		11·8	9·9, 13·9	
B	18·8	18·4, 19·3		12·5	11·4, 13·7	
C	19·4	18·9, 19·9		13·9	12·5, 15·3	
D and E	20·5	19·3, 21·7		13·7	10·2, 18·1	
Type of school‡			**<0·0001**			**<0·0001**
Public	19·4	18·7, 20·2		13·8	12·2, 15·7	
Private	17·4	16·8, 17·9		9·5	8·6, 10·6	
Physical activity‡			**<0·0001**			0·1635
Inactive	17·9	17·3, 18·5		12·6	11·1, 14·2	
Active	20·1	19·3, 20·9		13·4	11·5, 15·6	

Bold values refers significance level $P < 0·05$.
*Chi-square test.
†Kruskal–Wallis test.
‡*t*-test.

Discussion

This study identified a high prevalence of low dietary fibre intake among Brazilian adolescents, especially those with excess weight, after adjusting for possible confounding variables.

The inadequacy of total dietary fibre intake among Brazilian adolescents, as confirmed in the current study, has also been observed in other countries[8]. A study performed in eight European cities with 1804 adolescents aged 12·5–17·5 years demonstrated an average consumption of 20·0 g/d of dietary fibre, which was slightly higher than that observed in the present study[29]. However, considering the recommendations of the Institute of Medicine[28], only 2·1 and 11·4 % of European male and female participants, respectively, had a sufficient dietary fibre intake; these values are lower than those observed in this study. On the other hand, an Australian study conducted among 856 adolescents aged 12 years showed an approximate consumption of 28 g/d[30], which is higher than that observed among Brazilian adolescents.

The low adequacy of total dietary fibre intake among adolescents may be justified by the dietary preferences of this age group, which tends to be characterised by a reduced consumption of fruits and vegetables and an excessive intake of fats and sweets. This habit contributes to the consumption of foods with a high amount of refined carbohydrates and lipids and with low dietary fibre, favouring weight gain[9–11]. According to Edwards *et al.*[8], a high intake of total dietary fibre among adolescents may be associated with a lower risk of obesity, intestinal constipation, metabolic syndrome, insulin resistance and elevated blood pressure, which could represent a better quality of life in the long term.

As in the present study, Lin *et al.*[29], when evaluating European adolescents, observed a significantly higher intake of total dietary fibre among male and older participants, as well as a greater inadequate intake when adolescents were classified as being overweight or obese. Storey and Anderson[31], in a study among American children and adolescents, demonstrated that male participants consumed higher levels of dietary fibre than their female counterparts; this is similar to the present study's findings. A study conducted with Australian adolescents did not identify a significant difference between the sexes[30].

In this study, in logistic regression adjusted for geographic region, sex and school type, overweight and obese adolescents were 1·6 and 1·8 times more likely,

https://doi.org/10.1017/S1368980019004105 Published online by Cambridge University Press

Table 3 Association between low fibre intake and nutritional status with variables of interest among Brazilian adolescents by logistic regression bivariate model

	OR	95 % CI	P*
Geographic region			
North	1·0	–	–
Northeast	1·2	1·0, 1·4	**0·018**
Southeast	1·1	0·9, 1·5	0·402
South	2·2	1·7, 2·9	**<0·0001**
Central West	1·3	1·1, 1·6	**0·010**
Sex			
Female	1·0	–	–
Male	1·4	1·3, 1·6	**<0·0001**
Age			
12–15 years	1·0	–	–
16–17 years	1·0	0·8, 1·2	0·773
Nutritional status			
Low weight	1·3	1·0, 1·6	0·052
Normal	1·0	–	–
Overweight	1·6	1·3, 2·0	**<0·0001**
Obese	1·9	1·4, 2·4	**<0·0001**
Sexual maturation			
Pre-pubescent	1·0	–	–
Pubescent	0·9	0·5, 1·6	0·619
Post-pubescent	0·9	0·5, 1·6	0·713
Socioeconomic status			
A	1·0	–	–
B	0·9	0·8, 1·2	0·548
C	0·8	0·7, 1·0	0·107
D and E	0·9	0·6, 1·3	0·442
Type of school			
Public	1·0	–	–
Private	1·5	1·2, 1·8	**<0·0001**
Physical activity			
Inactive	1·0	–	–
Active	0·9	0·8, 1·0	0·164

Bold values refers significance level $P < 0·05$.
*Bivariate logistic regression – model without adjust.

Table 4 Association between low fibre intake and nutritional status, adjusted for geographic region, sex and type of school by multivariate regression

	OR	95 % CI	P*
Low weight	1·2	0·9, 1·5	0·180
Normal	1·0	–, –	–
Overweight	1·6	1·3, 2·0	**<0·0001**
Obese	1·8	1·4, 2·4	**<0·0001**

Bold values refers significance level $P < 0·05$.
*Multivariate logistic regression.

respectively, to have inadequate dietary fibre intake. Other studies have also identified an inverse relationship between low fibre intake and overweight in this age group. Ambrosini *et al.*[12] demonstrated that a dietary pattern characterised by a high caloric density and poor fibre content was longitudinally associated with excess adiposity in English children and adolescents. In Iranian adolescents, vegetable and fibre intakes were significantly associated with a reduced probability of being overweight[13].

Despite the relevance of our results, this study has some limitations. Owing to the cross-sectional design, it was not possible to determine causal or temporal associations. In addition, dietary consumption data were based on a 24-h recall, which is a method dependent on interviewee memory. Despite the recommendation to apply more than one 24-h recall, the large sample size and the care taken with the use of the five-step multiple-pass method can minimise this limitation[24,32]. The dietary intake analysis was hampered because the national food composition tables are incomplete. However, the methodological rigor of ERICA in data collection and analysis allowed for the determination of total dietary fibre intake and its association with nutritional status. This is the first national study in Brazil that focuses on dietary fibre consumption in a representative sample of individuals belonging to this age group.

In conclusion, Brazilian adolescents presented a significant inadequacy of total dietary fibre intake, especially among those who were obese or overweight. Considering these findings, measures to increase fibre intake in Brazilian adolescents should be implemented individually or collectively to improve the quality of life of this population in the long term.

Acknowledgements

Acknowledgements: The authors would like to acknowledge the help provided by the adolescents who participated in this study. *Financial support:* ERICA was supported by the Funding Authority for Studies and Projects (grant number 01090421); and Brazilian National Counsel of Technological and Scientific Development (grant numbers 565037/2010-2, 405009/2012-7, 457050/2013-6). *Conflict of interest:* None. *Authorship:* C.L.O., D.T.G. and M.C.C.K. were involved in design of research, coordination of data collection and writing of the article. C.F.F.M. and C.d.S.C.-R. were involved in data analysis and writing of the article. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving humans were approved by the Research Ethics Committee (REC) of the Institute of Collective Health Studies, Federal University of Rio de Janeiro (process number 45/2008), and the REC of each participating institution. Written informed consent was obtained from all students.

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