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Factors associated with risk of low folate intake among adolescents

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Abstract

Objective: To evaluate factors associated with the risk of low folate intake among adolescents.

Methods: We employed cluster sampling, using a random selection of 40 representative census sectors and households within those sectors, including all individuals between 10 and 19 years of age. The weight, height and skin folds of subjects were measured and socioeconomic data on their families were collected. A 24-hour dietary recall and frequency questionnaire were used to estimate the quantity and frequency of folate intake. Folate consumption was quantified using Nutwin software. Risk of low folate intake was defined as Folate consumption below the estimated average requirement. The statistical analysis employed hierarchical logistic regression.

Results: A total of 722 adolescents were investigated and their mean folate intake was 145±117 µg. The frequency of subjects at risk of having a lower than recommended folate intake was 89%. Adolescents had a greater risk of inadequate folate intake if their body mass index was at or above the 85th percentile, their waist circumference was at or above the 80th percentile or they had a family history of cardiovascular disease. Adolescents who ate beans and dark green vegetables less than four times a week also exhibited an increased chance of having folate intake below recommended levels.

Conclusions: These adolescents present a high risk of low folate intake and this risk is linked with increasing age, waist circumference above the 80th percentile and low frequency of beans and dark green vegetables consumption.

J Pediatr (Rio J). 2006;82(2):121-6: Adolescent, folic acid, food habits, obesity.

Introduction

The Institute of Medicine,[1] which was set up by the United States federal government to be an adviser on scientific and technological matters, has established that the prevention of cardiovascular diseases (CVD) and neural tube defects (NTD) should be prioritized when defining dietary recommendations for folate intake, including for adolescents. Folate intake is dependent on dietary habits that provide adequate quantities of dark green vegetables, beans, fruit, cow's liver and enriched or fortified foods.[1]

Adolescence is being focused on as a period of high risk for diets that are deficient in micronutrients and rich in energy and saturated fats,[2,3] compromising health in adulthood and driving up chronic disease rates. Analysis of certain international studies of adolescents indicates that the average level of folate intake is below the estimated average requirement (EAR) in the most recent recommendations[1] and that the most recent comparative studies show that the prevalence of adolescents with such habits has increased, suggesting that the risk for low folate intake begins at this stage of the lifecycle. Studies that investigated factors that determine low folate consumption found links with socioeconomic status and sex.[3-7]

In the context of these considerations the fact that no studies exist that have investigated folate intake among adolescents in Brazil, the objective of this study was to evaluate factors linked with the risk for folate deficiency during this phase of life.

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Methods

This was a cross-sectional study of a representative sample of adolescents from the town of São Leopoldo (Rio Grande do Sul state, Brazil). The sample size was calculated based on a prevalence of overweight of 18%,[8-10] a confidence level of 95% and statistical power of 80%, adding 10% for possible losses, and 15% for the multivariate analysis, which resulted in a sample size of 807 adolescents. The following were excluded: pregnant adolescents, nursing mothers or adolescent mothers and adolescents with mental deficiencies, physical disabilities or chronic diseases.

The town on São Leopoldo is located in the Vale do Rio dos Sinos, 30 km from Porto Alegre, in the state of Rio Grande do Sul. It has approximately 193,547 inhabitants, including 36,607 individuals aged 10 to 19 years and a literacy rate of 95.6%.[1]

Sampling was made by clusters in three stages: first census regions were chosen by systematic lots from the total of 40, next the blocks and street corners where sampling would start were chosen at random and finally residences were sampled systematically with one in three being selected. All individuals aged 10 to 19 years resident at the addresses selected in the manner described were identified and invited to take part in the project.

A pre-coded questionnaire was developed that covered information on socioeconomic and biological factors, family details, anthropometric data and nutritional intake. Data were collected by undergraduate students from the Nutrition course at the Universidade do Vale do Rio dos Sinos (UNISINOS) who had been specifically trained to perform interviews and take measurements and who were given a manual. A pilot study was performed involving 60 adolescents from sectors that had not been chosen for the main study.

Food habits were investigated by means of 24-hour dietary recall with the aid of an album that had been specially produced for the research project containing color photos of foods and utensils to improve the level of precision of the quantities consumed. Dietary folate levels and lipid content were calculated using Programa de Apoio à Nutrição – Nutwin (nutrition support software). The resultant intake levels were then compared with the Institute of Medicine recommended levels,[1] which define the minimum EAR levels according to age group and sex. Adolescents whose diets do not meet their EAR are considered at risk for inadequate folate intake. For children of both sexes aged 9-13 the EAR is 250 µg and from 14 to 18, for both sexes, it is 330 µg. Frequency of consumption of each food or food group was investigated using objective questions, previously selected to identify folate sources. If an adolescent reported eating a particular food or food group four or more times a week, this was defined as habitual and considered a part of their food habits. Consumption was defined as not being habitual if less frequent than four times a week.

Data on family history of CVD, such as heart attack, heart surgery or heart failure, were obtained from the adolescents' parents or guardians.

Adolescents were weighed barefoot wearing shorts and T-shirt on portable electronic scales by Techline®. Height was measured with stadiometer with a built-in rule by Secca® Ltda. Body mass index (BMI) was calculated using the National Center for Health and Statistics reference curves and, in accordance with World Health Organization criteria,[11] adolescents were defined as overweight if their BMI $\geq$ 85th percentile and obese if it is at the 95th percentile or above.

Tricipital and subscapular skin folds (both right-side) were measured using calipers by Lange®. Body fat percentage was calculated using the Slaughter formula.[12] Male adolescents were defined as having excess body fat above 25%, while for female adolescents the cutoff was 30%. We adopted the proposal that Taylor et al.[13] made of adopting waist circumference percentiles over the eightieth as indicative of localized excess abdominal fat.

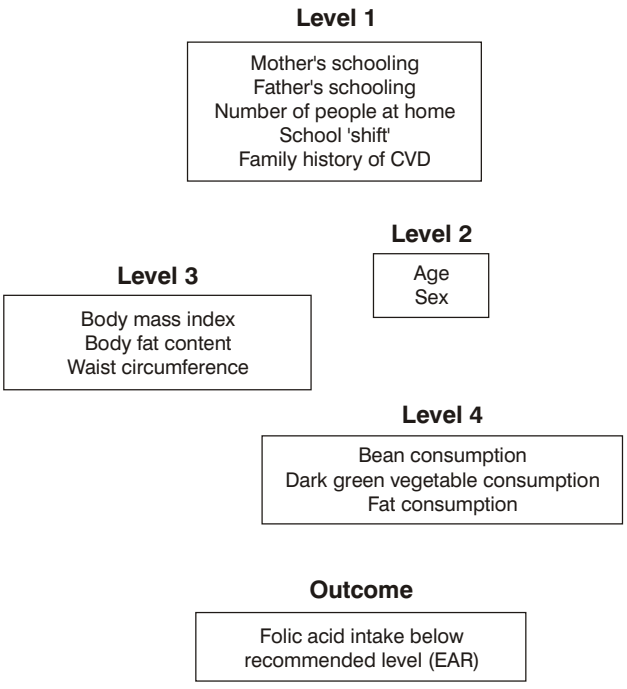
Data were compiled on Epi-Info version 6.0 with double entry and validation. Analysis was performed with SPSS version 11.0. The Mann-Whitney test was used to compare mean folate intake across age groups and sexes. Bivariate analysis results were expressed as odds ratios (OR), and a hierarchical logistic regression model was developed for the multivariate analysis (Figure 1). Odds ratios were used as the measure of effect, in the knowledge that this is mildly superior to prevalence ratios for risk factor, and mildly inferior for protective factor. Variables that achieved a 20% significance level were included in the model and associations were considered significant at 5% or less.

This project was approved by the Committee for Ethics in Research at the Universidade Federal do Rio Grande do Sul.

Results

A total of 810 eligible adolescents were identified at the selected residences, of whom 8.6% (n = 70) did not consent to participate or were not allowed to do so by their parents. A further 1.8% (n = 15) could not be located at home after three interview attempts and 0.3% (n = 3) had changed address. Males predominated among the losses (n = 60). Losses ran at 24.5% in sectors with less than 5% illiteracy, while in sectors with more than 5% illiteracy there were 17.5% losses.

A total of 722 adolescents were therefore studied, 40.6% (n = 293) were male and 59.4% (n = 429) were female. Mean age was 14.4 (±2.7) years, with 50% of the



CVD = cardiovascular diseases; EAR = estimated average requirement.

Figure 1 - Hierarchical model

adolescents in the 10-13 age group. Caucasians predominated (80.8%), and the monthly income of 47.6% of the families was less than or equal to three times the minimum wage (MW). The majority of fathers (59%) and mothers (65.6%) had spent less than 9 years at school. Ninety percent of the adolescents were in education, with 88.6% of them attending public schools.

Prevalence rates of overweight according to BMI percentiles were 19% for boys and 17% for girls and prevalence rates for obesity were 8.9 and 7.5%. The waist circumferences of 19.2% of the boys and 18.5% of the girls were above the eightieth percentile and prevalence rates for excess body fat were 17.5% for males and 20.8% for females.

Table 1 shows a comparison of the mean folic acid intake across sexes and age groups together with the percentage of below-recommended intake. Mean folic acid intake for the whole sample was 145±117 µg, breaking down to 162±137 µg for girls and 133±100 µg for boys (p = 0.006). The frequency of adolescents at risk of inadequate folate intake (< EAR) was 89%.

Table 2 contains the initial and the adjusted analyses of variables investigated as possible predictors of folate intake below the EAR. Low intake was more prevalent among adolescents whose mother and father had spent more than eight years in school, although without statistical significance. Monthly family income, number of people living at the same address and whether adolescents studied during the morning or afternoon did not exhibit any association with the dependent variable (the Brazilian school system allows students to choose between different 'shifts', morning or afternoon). Adolescents with family history of CVD tended towards lower than recommended folic acid consumption. The adjusted analysis demonstrated that 14 to 19-year-old adolescents had a greater chance of consuming less than the recommended quantity of folic acid and also that there was no difference between sexes.

With respect to anthropometric data, neither body fat percentage nor BMI were associated with a risk for inadequate folate consumption. Waist circumference was at or above the eightieth percentile was positively associated with a greater chance of risk for insufficient intake once adjustments had been made for variables at the same level and the previous one.

Fat intake lost its association with outcome after multivariate analysis. Analysis of the frequency with which different foods were eaten revealed that adolescents who consumed beans and dark green vegetables less than four times a week had a greater chance of below-EAR folate intake. Adolescents whose families had incomes of less than three times the minimum wage were 1.7 times more likely to eat beans four times or more per week (data not shown in table).

Table 1 - Folic acid intake by age and sex

	Mean±SD	p	< EAR (%)
Boys	162.4±137		87.3
10 to 13 years	151.6±120	0.006 †	85.3
14 to 19 years	173.0±153	0.331 ‡	89.4
Girls	133.0±100		90.2
10 to 13 years	144.5±106	0.038 ‡	84.1
14 to 19 years	123.0±92		95.9

EAR = estimated average requirement; SD = standard deviation.[1]
† Mann-Whitney test: between sexes;
‡ Mann-Whitney test: between same-sex age groups.

Discussion

This is the first study to analyze the folate intake of adolescents in Brazil. It is important to point out that this research was conducted before the National Agency for Sanitary Vigilance (Agência Nacional de Vigilância Sanitária - ANVISA) Resolution number 344 of December 13, 2002, which obliges flour to be fortified with folic acid. An investigation of the intake of this nutrient by adolescents prior to this public heath policy's implementation makes it

possible to establish a basis for comparison with future studies and investigate its repercussions. The incidence of Adolescents at risk of inadequate intake was elevated (89%). Comparisons with studies undertaken in other countries are limited by the fact that different recommendations and criteria for adequate intake were used. Nevertheless, it can be clearly observed that the level of consumption is very much lower than what has

Table 2 - Prevalence rates of below EAR folic acid intake, simple and adjusted analyses of outcome against predictive variables

	Prevalence intake < EAR	Simple OR (95%CI)	Adjusted OR * (95%CI)	p †
Monthly family income				
< 3 times MW	87.1	1	1	
3 to 5 times MW	91.7	1.64 (0.86-3.15)	1.60 (0.82-3.16)	0.173
> 5 times MW	89.0	1.21 (0.64-2.28)	1.04 (0.48-2.21)	0.921
Mother's schooling				
≤ 4 years	87.2	1	1	
5 to 8 years	87.9	1.06 (0.59-1.93)	1.04 (0.54-1.98)	0.911
> 8 years	90.9	1.47 (0.77-2.81)	1.44 (0.59-3.53)	0.421
Father's schooling				
≤ 4 years	86.7	1	1	
5 to 8 years	87.8	1.10 (0.58-2.10)	1.23 (0.62-2.44)	0.544
> 8 years	90.2	1.41 (0.73-2.73)	1.14 (0.50-2.63)	0.751
Number of people at home				
> 4 people	86.4	1	1	
≤ 4 people	91.1	1.60 (1.00-2.57)	1.52 (0.88-2.61)	0.134
School 'shift'				
Morning	88.1	1	1	
Afternoon	88.5	1.04 (0.61-1.77)	1.12 (0.65-1.92)	0.690
Family history of CVD?				
No	86.7	1	1	
Yes	91.5	1.66 (1.02-2.70)	1.63 (0.97-2.74)	0.065
Age (years)				
10-13	84.6	1	1	
14-15	93.4	2.55 (1.50-4.35)	2.44 (1.42-4.19)	0.001
Sex				
Male	87.3	1	1	
Female	90.2	1.34 (0.82-2.20)	1.51 (0.84-2.31)	0.191
BMI				
< 85th percentile	88.6	1	1	
≥ 85th percentile	90.6	1.22 (0.64-2.33)	2.76 (0.86-8.85)	0.088
Body fat				
Acceptable	92.5	1	1	
Excessive	94.0	1.18 (0.63-2.20)	1.79 (0.64-5.01)	0.267
Waist circumference				
< percentile 80	87.2	1	1	
≥ percentile 80	89.6	1.26 (0.68-2.30)	3.87 (1.41-10.6)	0.009
Bean consumption				
≥ 4 times per week	86.3	1	1	
< 4 times per week	95.0	3.02 (1.56-5.83)	2.98 (1.40-6.32)	0.005
Dark green vegetable consumption				
≥ 4 times per week	74.4	1	1	
< 4 times per week	89.0	2.50 (1.19-5.27)	2.62 (1.16-5.94)	0.021
Fat consumption ‡				
≤ 35%	87.3	1	1	
> 35%	93.3	2.04 (1.08-3.91)	1.52 (0.79-2.91)	0.213

BMI = body mass index; CI = confidence interval; CVD = cardiovascular disease; EAR = estimated average requirement;[1] MW = minimum wage; OR = odds ratio.

Family income and father's schooling accounted for 7.5% of unanswered questions compared with 2.5% for all other variables.

* Odds ratio adjusted for same-level and previous-level variables, according to the hierarchical model.

† Wald test; ‡ Percentage of total energy value.

been observed in studies of North-American adolescents.[3,6] In the present study 11% of adolescents exhibited intake above the EAR, whereas, in a study of 15-year old North-American children, 30% were consuming more than the recommended dietary allowance (RDA), which is the EAR plus two standard deviations.[7]

There is already evidence of the significance of obesity prevalence among adolescents in our country,[8-10] but there are no other studies of folate intake in this age group. The dietary tendency among adults observed in the last two national surveys was towards an increased intake of saturated fat and reduced consumption of complex carbohydrates, vegetables and greens.[8] In this study, a lower frequency of consumption of beans and dark green vegetables was associated with the risk of below-EAR intake. The concomitant presence of obesity, abdominal adiposity and family history of CVD, associated with inadequate folate intake suggests a strong risk to the health of the adolescents in the population s studied.

The association between elevated plasma levels of homocysteine and inadequate folate intake has been demonstrated by several different studies,[1,14,15] because of the need for folate for converting homocysteine to methionine. Data from the NHANES III study (a longitudinal population study developed by the US Health Department) shows that plasma homocysteine concentrations in North-American adolescents and adults tends to increase with age in both sexes, increasing more quickly in males than females.[16] Their results can be extrapolated to this research since a greater proportion of male adolescents aged 14-19 years exhibit below-EAR folate intake. This is a reflection of changing food habits as the basic foods of some years ago, predominantly based on a combination of rice and beans, are being replaced by other preparations that do not contain significant folate sources. Family income and parents' schooling did not affect the pattern of folate consumption among the adolescents, contradicting the results of studies undertaken in other countries, which have shown that adolescents and adults living in better socioeconomic conditions exhibit lower risk of inadequate ingestion.[5,17] Nevertheless, in this study it was demonstrated that adolescents from families with incomes below three times the MW still eat more beans, which are an important source of folate. This practice is protecting them from insufficient folate intake, considering the economic difficulties involved in access to more expensive sources, including fortified foods.

It is important to point out that RDA, but not EAR, is applied differently depending on sex. The level of RDA is the same (400 µg) for both sexes at 14-18 years, but there is an extra warning for females which states that this figure should be achieved by means of enriched or fortified foods in addition to what is provided by a healthy diet (250 to 300 µg). This part of the recommendation is aimed at the priority objective of NTD prevention, which can affect all women of fertile age.[1] It was girls aged 14 to 18 years who had the lowest intake of all study groups (123 µg), which should be taken into account by programs to promote adolescent health.

Although the study design specified a population cross-section, this level of representativeness cannot be guaranteed since there was a greater percentage of refusals among males and also in regions with higher socioeconomic status. This bias could limit the conclusions on sex and socioeconomic conditions. The use of 24-hr dietary recall could also be a limiting factor. Nevertheless, the mean folate intake of all dietary recalls was well below the mean for the reference population (EAR), leaving no doubt that there is a risk of inadequate consumption in this population.

The data reported here suggest that these adolescents present a risk for insufficient folate intake and that this behavior was associated with the higher age group, waist circumference above the eightieth percentile, no habitual consumption of beans and dark green vegetables.

Further investigation is necessary with the objective of assessing the contribution that the national public health policy of obligatory flour fortification has to the intake levels of this group and to promote practical proposals for including foods rich in folate in school meals programs.

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