# Factors associated with dental fluorosis

## Fatores associados à fluorose dentária

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### Abstract

Purpose: To assess the prevalence and severity of dental fluorosis and its associated factors in teenagers attending schools with oral health programs.

Methods: The sample consisted of 535 students (12- and 15-19-year-olds) living in a city in the Southern Region of Brazil. For data collection, clinical examinations were performed using the Dean's index. Exploratory data on demographics, socioeconomic conditions, access to dental service and hygiene habits were collected using a semi-structured questionnaire. Data were analyzed by multiple logistic regression analysis.

Results: The prevalence of dental fluorosis was 25% in this sample, and a very low level of fluorosis was the most frequent category found (18.3%). Fluorosis was associated with female gender (OR=1.55; $CI_{95\%}$1.03-2.32). Drinking water from an artesian well or bottled water was protective against fluorosis (OR=0.51; $CI_{95\%}$ 0.27-0.95).

Conclusion: The prevalence of dental fluorosis in this sample of students was high, but the fluorosis was of low severity. The type of drinking water and gender were shown to be determinant factors of fluorosis in the tested model.

**Key words:** Fluorosis, dental; fluoridation; fluorides; risk factors

### Resumo

Objetivo: Avaliar a prevalência e a severidade da fluorose dentária e verificar os fatores associados em adolescentes de escolas com atividades coletivas de promoção em saúde bucal.

Metodologia: A amostra foi composta de 535 escolares de 12 e 15-19 anos moradores de um município da Região Sul do Brasil. Para a coleta de dados foram realizados exames clínicos utilizando o índice de Dean. As variáveis exploratórias demográficas, socioeconômicas, de acesso a serviços odontológicos e de hábitos de higiene bucal foram coletadas utilizando-se um questionário semi-estruturado. Os dados foram analisados por análise de regressão logística múltipla.

Resultados: A prevalência de fluorose dentária foi de 25%, sendo que o grau predominante foi o muito leve (18,3%). A fluorose foi associada ao sexo feminino (OR=1,55; $IC_{95\%}$1,03-2,32). Beber água de poço artesiano ou engarrafada foi um fator de proteção para fluorose no grupo de escolares investigado (OR=0,51; $IC_{95\%}$ 0,27-0,95).

Conclusão: A prevalência de fluorose dentária nos escolares desta amostra foi elevada, porém sua severidade foi baixa. A água ingerida e o sexo foram associados à fluorose dentária no modelo testado.

**Palavras-chave:** Fluorose dentária; fluoretação da água; fluoretos; fatores de risco

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## Introduction

With the decreasing incidence of dental caries in Brazil since the 1980s, attention has been paid to the control of fluoride content and the quantity of ingested fluorides. The latter has been associated with the increase in prevalence of dental fluorosis in regions with and without public water supply fluoridation. Dental fluorosis often occurs at mild levels without greatly affecting dental esthetics or function, but the control of fluoride ingestion is considered important for the prevention of oral health problems in the general population. Thus, oral health professionals should orient their communities to the correct use of fluorides in several presentations (1).

Recent national data indicate fluorosis prevalence rates of 8.5% in 12-year-old adolescents and 5% in 15-to-19-year-old subjects, confirming the fact that fluorosis is not a major public health problem in Brazil (2). Nevertheless, the prevalence of the disease is high in some cities (3-6). Previous studies have demonstrated an association between dental fluorosis and sociodemographic factors. For example, an association between the quantity and frequency of topical sources of fluorides was observed in the countryside of the Rio Grande do Sul state in the South Region of Brazil (3). Other studies reported that fluorosis was associated with fluoridation of the public water supply (4-6).

Dental fluorosis is a signal of chronic fluoride intoxication during dental formation (7), and children are at risk to develop the disease from birth until 6-8 years of age. The risk period for developing fluorosis in the maxillary central incisors occurs within 15 to 24 months for boys and 21 to 30 months for girls because this is the period of transition and initial maturation of the dental enamel for these teeth (8). Thus, the first two months of a child's life are critical periods for exposure to fluorides at higher levels than recommended (9).

Fluorosis is a disturbance that occurs during tooth formation. It affects dental enamel structure by altering its shape and results in esthetic and functional problems depending on the severity of the lesions. Poor esthetics due to fluorosis may have psychological, financial and behavioral implications for the quality of life of the individual. Therefore, studies on the prevalence of dental fluorosis as well as its characteristics and determinants in the general population are relevant for public health.

One study examined 633 students (aged 12 or 15-19 years old) attending 26 elementary schools without oral health programs in Passo Fundo in the countryside of the Rio Grande do Sul state. This study showed that the prevalence of dental fluorosis was 32.8%, and the most frequent type was very mild fluorosis (78%) (10). Eight schools in the same city provided their students with an oral health program under the supervision of dental surgeons beginning during childhood. The procedures include supervised tooth brushing, topic and systemic application of fluoride and educational discussion. This study aimed to assess the prevalence and severity of dental fluorosis and its associated factors in teenagers attending those schools with oral health programs.

## Methods

This investigation was approved by the Ethical Committee from the Institute of Cardiology of Porto Alegre (Process # 174/05), in Porto Alegre, RS, Brazil, in agreement with Brazilian Resolution 196/96 and the international standards for conducting research with human beings.

### Study location

This cross-sectional study was performed in the city of Passo Fundo, Rio Grande do Sul state, in the South Region of Brazil. The city population estimate is 185,279 inhabitants. The city has a predominantly temperate climate (temperatures varying from 3 to 36ºC), altitude of 687 m, total area of 780 $km^2$ and demographic density of 219.05 inhabitants/$km^2$ (11). The city has had fluoridation of the public water supply since 1972, with adequate levels of 0.7 ppm F.

### Sample selection

From a census of the students attending the eight elementary schools with oral health programs in the city of Passo Fundo, a sample of adolescents 12 and 15-19 years in age was selected after calculating the sample size. The inclusion criteria were: being a resident in the city since birth or moving to the city before 2 years of age; being present in one of two visits for data collection; absence of fixed orthodontic appliance; signature of an informed consent form by parents or legally responsible person. A total of 710 students of the established ages were enrolled; however, 119 students were excluded and 56 lost during data collection, resulting in a final sample of 535 subjects.

Investigator calibration and fluorosis classification were performed in an earlier epidemiological study carried out in 26 schools from the same city (10). A pilot study with three examiners and 40 students revealed high intra- and inter-examiner agreement for the use of the Dean's index (Kappa=0.91 and Kappa from 0.88 to 0.90, respectively).

Data were collected from November to December 2007 in two steps. First, clinical examinations were carried out using sterilized dental mirrors and probes. The students were evaluated under natural and artificial light after careful drying of the teeth. The prevalence and severity of dental fluorosis was assessed by using the Dean's index, with levels from 0 to 5 following the WHO recommendations (12).

In the second step, a self-applied questionnaire was used to collect data on demographic, socioeconomic, dental care access and oral hygiene variables. The information on demographic and socioeconomic variables was checked against the student enrollment files at the schools.

### Statistical analysis

Independent variables were combined into the following four categories (blocks): demographic, socioeconomic, access to dental services and oral health habits. The dependent variable dental fluorosis was categorized according the degrees of severity as follows: 0 (no fluorosis), 1 (questionable) and degrees 2, 3, 4 and 5 with ascending degrees of fluorosis.

Data were stored in a database built in the Epi Data 3.1 program and imported into SPSS 15.0 software for statistical analysis.

After exploratory analysis to obtain descriptive statistics, inferential statistical testing was performed to examine the association between the outcome variable and other independent variables. Statistical testing used a bivariate analysis with a Chi-square test and a significance level of 5%. To assess the effect of variables that showed a significant association with the outcome (identified in the simple logistic regression analysis), multivariate analysis was performed with the variables with p-values less than or equal to 0.20 in the bivariate analysis. A backward stepwise method was used for variable selection in the construction of the model.

To verify the influence of independent variables and the outcome of dental fluorosis using a multiple logistic regression model, a hierarchic model classifying explanatory variables into blocks via levels of a multivariate model was used. For this, a theoretical model was built for the associations among different variables and the outcome with the explanatory demographic factors as block 1 (first level), the variables describing access to dental services as block 2 (second level), the socioeconomic variables as block 3 (third level) and the oral hygiene variables as block 4 (fourth level, the closest to the outcome measure) (Fig. 1). A backwards stepwise regression model was used to test for possible risk and protective factors associated with dental fluorosis. Confidence intervals (95%) were calculated, and associations with a p-value larger than 0.05 were considered statistically significant.

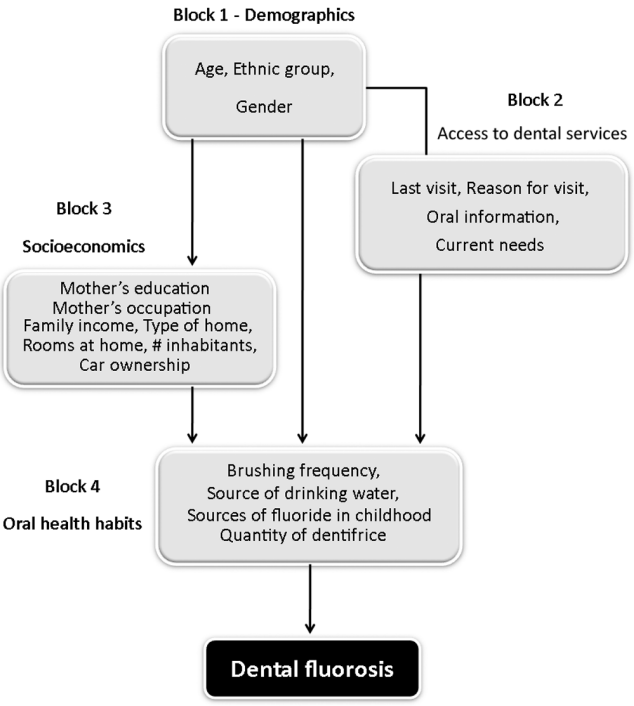


**Fig. 1.** Hierarchical model of the variables used for the dental fluorosis analysis.

## Results

### Sample descriptive analysis (Table 1)

The majority of the students were 12 years old (73.1%), male (53.6%) and Caucasian (61.5%). With regard to socioeconomic data, most mothers worked out of the home (57.9%), and the most frequent family income was two minimum-wage incomes (71.4%). In relation to the access to dental services, most students (66.9%) had had a dental appointment within the previous 12 months (mostly for routine visits, 72.5%) and had received information from dental professionals regarding the prevention of oral problems (57.9%); however, they still reported having current dental treatment needs (64.1%). For oral hygiene, half of the sample reported brushing their teeth 3 times per day (50.5%). The most frequently used water source for daily ingestion was the public water supply (78.7%). With regard to dental fluorosis, 69.5% of the students did not show any signs of fluorosis and 5.4% were questionable. The prevalence of fluorosis was 25%, with levels of severity categorized as very mild (18.3%), mild (5.2%) and moderate (1.5%).

### Bivariate analysis of fluorosis and the explanatory variables (Table 1)

For the demographic variables, a significant association was found between fluorosis and gender ($P$=0.048), with female subjects (prevalence of fluorosis in girls: 29%) being at higher risk for fluorosis (OR=1.48; $CI_{95\%}$1.00-2.19). Fluorosis was more common in 12-year-old subjects (26.1%) and in non-Caucasians subjects (28.3%), but no significant association was found. Dental fluorosis was not significantly associated with any socioeconomic factors or variables describing access to dental services. With regard to the oral hygiene habit variables, dental fluorosis was associated with the source of ingested water ($P$=0.007); drinking water from a well or bottled water instead of water from the public supply system was a factor of protection against dental fluorosis (OR=0.46; $CI_{95\%}$ 0.25-0.85). Most subjects with fluorosis reported brushing their teeth 3 or more times per day (26.3%) with the use of some kind of fluoride during childhood (gel, rinsing or both); however, no statistically significant difference was found.

### Multiple logistic regression and final model (backward stepwise) (Table 2)

All variables with a p-value ≤0.20 in the bivariate analyses of association with the outcome dental fluorosis were selected for inclusion in the multiple logistic regression model. The demographic variables of block 1 included in the model were gender ($P$=0.048) and ethnic group ($P$=0.172). No variables describing access to dental services (block 2, second level) were associated with fluorosis, and so none were included. From block 3, the socioeconomic variables entered into the model were having a car ($P$=0.076) and mother's education ($P$=0.087). For block 4, the source of drinking water ($P$=0.007) was included.

**Table 1.** Bivariate analysis of demographic, socioeconomic, access to dental services and oral hygiene habit variables associated with dental fluorosis. Passo Fundo, RS, Brazil, 2008.

(Continue)

| | DENTAL FLUOROSIS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | | Yes | | Total | | P | OR | $CI_{95\%}$ |
| | n | % | n | % | n | % | | | |
| **DEMOGRAPHICS** | | | | | | | | | |
| Age | | | | | | | 0.360 | 0.810 | 0.515-1.274 |
| 12 years old | 289 | 73.9 | 102 | 26.1 | 391 | 100.0 | | | |
| 15-19 years old | 112 | 77.8 | 32 | 22.2 | 144 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Gender | | | | | | | 0.048* | 1.485 | 1.002-2.199 |
| Male | 225 | 78.4 | 62 | 21.6 | 287 | 100.0 | | | |
| Female | 176 | 71.0 | 72 | 29.0 | 248 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Ethnic Group | | | | | | | 0.172 | | |
| Caucasian | 254 | 77.0 | 76 | 23.0 | 330 | 100.0 | | 1.319 | 0.886-1.962 |
| Non-Caucasian | 147 | 71.7 | 58 | 28.3 | 205 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| **SOCIOECONOMICS** | | | | | | | | | |
| Mother's Education | | | | | | | 0.087 | 0.693 | 0.454-1.057 |
| 4th grade | 104 | 69.8 | 45 | 30.2 | 149 | 100.0 | | | |
| 5th and 8th grade | 297 | 76.9 | 89 | 23.1 | 386 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Mother's occupation | | | | | | | 0.943 | 1.015 | 0.683-1.508 |
| Housewife | 169 | 75.1 | 56 | 24.9 | 225 | 100.0 | | | |
| Working out of the home | 232 | 74.8 | 78 | 25.2 | 310 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Family income | | | | | | | | | |
| 2 minimum wages | 284 | 74.3 | 98 | 25.7 | 382 | 100.0 | 0.608 | 0.892 | 0.575-1.382 |
| More than 2 minimum wages | 117 | 76.5 | 36 | 23.5 | 153 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Type of home | | | | | | | 0.615 | 0.865 | 0.491-1.524 |
| Rented | 340 | 74.6 | 116 | 25.4 | 456 | 100.0 | | | |
| Not rented | 61 | 77.2 | 18 | 22.8 | 79 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Number of inhabitants | | | | | | | 0.740 | 0.935 | 0.630-1.388 |
| 1 to 4 | 167 | 74.2 | 58 | 25.8 | 225 | 100.0 | | | |
| 5 or more | 234 | 75.5 | 76 | 24.5 | 310 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Rooms at home | | | | | | | 0.862 | 1.037 | 0.691-1.555 |
| 1 to 5 | 150 | 75.4 | 49 | 24.6 | 199 | 100.0 | | | |
| 6 or more | 251 | 74.7 | 85 | 25.3 | 336 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Car ownership | | | | | | | 0.076 | 0.699 | 0.470-1.039 |
| No | 204 | 71.8 | 80 | 28.2 | 284 | 100.0 | | | |
| Yes | 197 | 78.5 | 54 | 21.5 | 251 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| **ACCESS TO DENTAL SERVICES** | | | | | | | | | |
| Appointment in the previous 12 months | | | | | | | | | |
| No | 59 | 71.1 | 24 | 28.9 | 83 | 100.0 | | | |
| Yes | 342 | 75.7 | 110 | 24.3 | 452 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Reason for visit | | | | | | | 0.968 | 1.074 | 0.661-1.745 |
| Routine visit | 291 | 75.0 | 97 | 25.0 | 388 | 100.0 | | | |
| Caries/pain | 110 | 74.8 | 37 | 25.2 | 147 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |

**Table 1.** Bivariate analysis of demographic, socioeconomic, access to dental services and oral hygiene habit variables associated with dental fluorosis. Passo Fundo, RS, Brazil, 2008.

(Conclusion)

| | DENTAL FLUOROSIS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | | Yes | | Total | | P | OR | $CI_{95\%}$ |
| | n | % | n | % | n | % | | | |
| Oral information from professional | | | | | | | 0.593 | 0.898 | 0.605-1.333 |
| No | 166 | 73.8 | 59 | 26.2 | 225 | 100.0 | | | |
| Yes | 235 | 75.8 | 75 | 24.2 | 310 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Current needs | | | | | | | 0.821 | 1.048 | 0.696-1.578 |
| No | 145 | 75.5 | 47 | 24.5 | 192 | 100.0 | | | |
| Yes | 256 | 74.6 | 87 | 25.4 | 343 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| **HYGIENE HABITS** | | | | | | | | | |
| Brushing frequency | | | | | | | 0.292 | 1.266 | 0.816-1.966 |
| 2 times | 124 | 78.0 | 35 | 22.0 | 159 | 100.0 | | | |
| 3 or more times | 277 | 73.7 | 99 | 26.3 | 376 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Source of drinking water | | | | | | | 0.007* | 0.468 | 0.256-0.858 |
| Public water supply | 321 | 72.8 | 120 | 27.2 | 441 | 100.0 | | | |
| Water from well and/or bottled water | 80 | 85.1 | 14 | 14.9 | 94 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Sources of fluoride in childhood | | | | | | | 0.501 | 1.144 | 0.773-1.692 |
| Not used | 201 | 76.2 | 63 | 23.8 | 265 | 100.0 | | | |
| Fluoride gel and/or rinsing solution | 199 | 73.7 | 71 | 26.3 | 270 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |
| Quantity of dentifrice | | | | | | | 0.712 | 0.912 | 0.558-1.490 |
| 1/3 to half of the length of the bristles of the toothbrush | 75 | 73.5 | 27 | 26.5 | 102 | 100.0 | | | |
| 2/3 to all of the length of the bristles of the toothbrush | 326 | 75.3 | 107 | 24.7 | 433 | 100.0 | | | |
| **Total** | 401 | 75.0 | 134 | 25.0 | 535 | 100.0 | | | |

* $P<0.05$ indicates a statistically significant difference.

**Table 2.** Multiple logistic regression model. Odds Radio (OR) and confidence interval ($CI_{95\%}$) of factors associated with dental fluorosis. Passo Fundo, RS, Brazil, 2008.

| | Dental Fluorosis | | | |
|---|---|---|---|---|
| | Crude OR ($CI_{95\%}$) | P* | Adjusted OR ($CI_{95\%}$) | P* |
| **Block 1** | | | | |
| *Gender* | | | | |
| Male | 1 | 0.048 | 1 | *0.032 |
| Female | 1.485 (1.002-2.199) | | 1.552 (1.038-2.321) | |
| *Ethnic Group* | | | | |
| White | 1 | 0.172 | 1 | 0.246 |
| Non-white | 1.319 (0.886-1.962) | | 1.276 (0.845-1.926) | |
| **Block 3** | | | | |
| *Car ownership* | | | | |
| No | 1 | 0.076 | 1 | 0.329 |
| Yes | 0.699 (0.470-1.039) | | 0.815 (0.541-1.229) | |
| *Mother's Education* | | | | |
| 4th grade 5th and 8th grade | 1 | 0.087 | 1 | 0.170 |
| | 0.693 (0.454-1.057) | | 0.740 (0.482-1.137) | |
| **Block 4** | | | | |
| *Source of drinking water* | | | | |
| Public water supply | 1 | 0.007 | 1 | *0.036 |
| Water from well and/or bottled water | 0.468 (0.256-0.858) | | 0.513 (0.276-0.956) | |

* $P<0.05$ indicates a statistically significant difference.

After adjustment of the final model, variables with no significant association with fluorosis were ethnic group, having a car and mother's education ($P$>0.05). The variable gender showed significant association ($P$=0.032), and girls had 1.5-times greater chance of having fluorosis than boys (OR=1.55; $CI_{95\%}$1.03-2.32). The source of drinking water variable was also significantly associated with fluorosis ($P$=0.036), and drinking water from a well or bottled water was protective against dental fluorosis (OR=0.51; $CI_{95\%}$ 0.27-0.95).

## Discussion

Students in this sample showed a high prevalence of fluorosis (25%) considering the fact that the city has excellent levels of fluoride in the public water supply. The frequency was lower than that reported in a previous epidemiological study of the city, where the subjects were students who attended schools without programs of oral health promotion (prevalence: 32.8%) (10). In contrast to the present investigation, the authors of that study classified the 'questionable' severity degree as an occurrence of dental fluorosis. Even when those data were reassessed with questionable fluorosis considered as the absence of fluorosis, the prevalence of fluorosis in that sample is 30% (10) – still higher than the findings of the present study.

The cross-sectional design was a limitation of this study because it did not allow the assessment of causality between the explanatory variables and the outcome measure. Nevertheless, the present findings are related to the oral health of a young population and may be relevant to prevent health and social problems derived from possible risks factors for dental fluorosis. Cangussu et al. (13), in a critical review on fluorosis in Brazil, reported that dental fluorosis is a public health problem in the country and that more epidemiological studies are needed to record the prevalence and severity of the disease due to its significant variability in different regions.

In the present study, the age of the adolescents was not associated with the dental fluorosis outcome. Conversely, a study performed in 8- to 16-year-old subjects from Brasilia (14), the national capital located in the Centre-West Region of Brazil, reported a higher frequency of children than adolescents with fluorosis; further, fluorosis became more severe as age decreased. A systematic review on fluorosis work in Brazil from 1993 to 2004 revealed a certain consensus regarding its association with age (15). Campos et al. (16) also found that younger children were more severely affected by fluorosis. One possible explanation for these results, which are contradictory to those in the present study, may involve exposure to fluoride since birth. Water fluoridation in Passo Fundo began 37 years ago, and the students may have been exposed to the same levels of fluoride from other sources.

Ethnic group was not associated with outcome in the multivariate model; to avoid possible cluster factors, therefore, it was not kept in the final adjusted model. Another study in Feira de Santana in the state of Bahia, Northeast Region of Brazil, found a high prevalence of fluorosis but no association between fluorosis and ethnic group (17). A study that assessed two cities with different concentrations of fluoride in the state of Sao Paulo showed similar results, in which the ethnic group variable was significant in the bivariate analysis but lost significance in the adjusted model (6).

ender was associated with dental fluorosis, and girls had a 1.5-times greater chance of having dental fluorosis than boys. In a study with students born and residing in São Paulo, where the public water supply has a concentration of 0.7 ppm of fluoride, 49% of the youngest children (mostly females) showed chronic intoxication by fluoride (5). Similar results were found in different locations of the country (18,19) (e.g., in the state of Paraiba in the Northeast of Brazil, boys showed a higher prevalence of fluorosis than girls) (20). Conversely, some studies did not find any association between gender and fluorosis in subjects living in the states of Minas Gerais, Bahia and Santa Catarina, located in the Southeast, Northeast and South regions of Brazil, respectively (17,21,22).

Socioeconomic variables (e.g., mother's education and occupation and family income) did not show significant association with fluorosis. Education and family income were factors associated with the outcome at first but were dropped from the final model after the adjustment in the multivariate analysis. Toassi and Abegg (3) showed that parental education was a significant factor in a sample from the Southern region of Brazil, but Buscariolo et al. (5) and Meneghim et al. (23) did not observe any association between the prevalence of fluorosis and the socioeconomic status of students when they investigated risk factors for fluorosis in cities with fluoridated water. Socioeconomic factors should not be evaluated isolated due to the need for a composite of several indicators instead of a single criterion (24). Other variables related to the type of home, number of people living in the same house, number of rooms or ownership of a car were not associated with fluorosis in the final model. In contrast, Catani et al. (6) reported that subjects from families with cars had a lower chance of developing fluorosis.

No variable describing access to dental services showed an association with dental fluorosis or the quantity of dentifrice used for brushing. However, the present study might not have accurately assessed previous exposure to fluoride; for example, the quantity of dentifrice used/ingested when the subjects were younger may be have been influenced by poor recall. Despite this, the findings suggest that the early use of fluoridated dentifrice is an important risk factor for dental fluorosis because children at younger ages ingest a considerable amount of dentifrice while brushing. The amount of ingested dentifrice was shown to be inversely proportional to the child's age (1). In the present study, the source of fluoride and the frequency of daily tooth-brushing were not associated with fluorosis. In Santa Tereza in the Rio Grande do Sul state, however, the quantity and frequency of topical fluoride exposure were significant risk factors for fluorosis (3). The only variable related to oral hygiene habits

associated with the outcome in the multivariate analysis was the type of water used for drinking. In comparison to the public water supply, drinking water from a well or bottled water seemed to be protective against dental fluorosis in this sample of students. Several studies in Brazil have described the significant association between the ingestion of fluoridated public water and dental fluorosis (4-6,24). Mandatory fluoridation in cities with water treatment stations was required by Brazilian Federal Law 6050 in March 1974, but it is important to monitor water fluoridation via epidemiological surveillance to assess the effectiveness of the measure. Although bottled water was protective against fluorosis, Villena et al. analyzed 104 commercial brands of bottled mineral water in Brazil and found that 7.7% contained levels higher than 1 ppm of fluoride.

Although fluorosis occurred at mild levels in this sample, health educational actions should focus on the risks of this disturbance in children up to 8 years in age. Further studies are necessary to clarify the effect of fluoridated water over time and to assess the effectiveness of monitoring water fluoridation on the incidence of fluorosis.

## Conclusions

Based on the findings presented and considering the limitations of the present study, it was possible to conclude that:

- the prevalence of dental fluorosis in this sample of adolescents was high but that the severity level was mostly very mild or mild;
- females were more likely than males to exhibit fluorosis, and the ingestion of water from wells or bottled water was a protection factor.

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