

## Dental fluorosis in Brazil: a systematic review from 1993 to 2004

Fluorose dentária no Brasil:  
uma revisão sistemática do período 1993/2004

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### Abstract

*The current article proposes a reflection on several aspect pertaining to dental fluorosis in Brazil, based on a systematic review of epidemiological surveys. The authors assess the prevalence and degrees of severity found in different studies and show that in methodological terms, there is a need for progress in procedures for population-based studies on fluorosis. Despite the different data collection approaches, there is some consensus among the different studies as to the limited severity of fluorosis in Brazil, as well as its association with the independent variables age and socioeconomic status. The authors also highlight the importance of adding subjective aspects to the normative diagnosis as a contribution to public health policy decisions, since the use of exclusively clinical criteria gives dental fluorosis more space than society ascribes to it. There is a lack of empirical evidence to reassess the fluoride content in public water supplies, a method that is known to be necessary to improve dental caries epidemiological indicators.*

*Dental Fluorosis; Oral Health; Review Literature*

### Introduction

The use of fluoride to prevent caries is considered one of the ten most important discoveries of the 20th century <sup>1</sup>, becoming the principal agent for prevention of the disease worldwide, including in Brazil, either through water supply fluoridation or use of fluoridated products <sup>2</sup>.

In the 1950s, the American Dental Association <sup>3</sup> was already recommending water supply fluoridation. In Brazil, the process began in 1953 in the Municipality of Baixo Guandu, Espírito Santo State, and there was a major expansion of water fluoridation beginning in the 1980s.

In parallel, clinical signs of the toxic effect of over-fluoridation have been observed, including the condition known as fluorosis. Fluorosis begins with exposure of the tooth bud to high concentrations of fluoride ion during its formation. Other factors such as low body weight, skeletal growth rate, and periods of bone remodeling also affect the severity of this condition <sup>4</sup>.

Epidemiological studies worldwide have reported differences in the prevalence of fluorosis. Cangussu et al. <sup>5</sup> conducted a critical analysis of the available epidemiological data on dental fluorosis, aimed at reflecting on fluorosis as a possible public health problem in Brazil. Using as selection criteria the problems of magnitude, severity, and vulnerability to harm and the degree of interference in individual quality of life, fluorosis was considered a problem that

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can lead to functional and aesthetic alterations and should be assessed from the public health perspective.

On the other hand, Moysés et al.<sup>6</sup> question the epidemiological impact of fluorosis, based on their reading of Brazilian and international studies. Based on the prevalence of dental fluorosis, its clinical, social, and cultural repercussions, and individual self-perception, fluorosis is not a relevant public health problem according to these authors.

Aimed at contributing to the discussion on the relevance and magnitude of fluorosis in Brazil as well as the perceptions of its impact on collective health, the current review of original studies published in Brazil was designed.

## Method

An electronic literature search (SciELO, LILACS, and BBO) was used to locate epidemiological studies focusing on fluorosis in Brazil. The inclusion criterion for the present study was having presented primary data on dental fluorosis in children/adolescents in cross-sectional epidemiological surveys.

The subject descriptors were: *epidemiology, dental fluorosis, and children*. We also used the grouping of these descriptors and the intersection with the country and year of publication. We selected articles starting with 1993, when the 2<sup>nd</sup> Brazilian National Conference on Oral Health was held, publishing a report which listed “*the shameful oral health and disease indicators, expressed by high rates of dental mutilation, dental caries, periodontal diseases, oral cancer, malocclusion, and congenital anomalies that characterize Brazil as one of the countries with the worst oral health in the world*”<sup>7</sup> (p. 6).

At the historical juncture in which the 2<sup>nd</sup> National Conference on Oral Health was held, this enamel alteration was not hardly discussed or appreciated, except in areas where it was endemic. More recently there has been an increase in the number of publications on fluorosis, especially in the last 12 years.

The year 2004 concluded the study period for the current study, marked by the 3<sup>rd</sup> National Conference on Oral Health, whose final report recommends “*the implementation of the SISÁGUA system with information made available to the entire Brazilian population along with viable alternatives for cases of fluorosis*”<sup>8</sup> (p. 60), reflecting the change of emphasis on this enamel alteration.

## Epidemiological aspects of dental fluorosis in Brazil

Using the Dean index, Cypriano et al.<sup>9</sup> verified the prevalence and severity of fluorosis, estimating the treatment needs related to this condition. So-called “very mild” cases were the most frequent. Only 1.4% of 5-year-old children and 2.1% of 6-year-olds presented “mild” to “moderate” cases.

Using the same index, Alves et al.<sup>10</sup> conducted a study to evaluate potential trans-placental exposure to fluoride, evaluating the deciduous dentition of children upon enrolment in the oral health program in the Municipality of Marília, São Paulo State. In relation to the degree of fluorosis, 92% of the children were normal. No statistically significant differences were observed by age or sex. According to Paiva et al.<sup>11</sup>, variation in fluorosis was also independent of sex, but there was a progressive age-related increase.

In Mendonça et al.<sup>12</sup>, gender and fluoride concentration in the water supply did not affect fluorosis; however, undernourished children showed a higher fluorosis prevalence, with a predominance of “mild” cases according to the Dean index.

Cangussu et al.<sup>13</sup> observed a 29.6% fluorosis prevalence rate in Salvador, Bahia, mainly of the “very mild” type. The authors observed differences between the city’s different health districts, with Liberdade showing dental fluorosis prevalence rates in 12 and 15-year-olds of 72.4% and 57.3%, respectively, thus emphasizing the need for oral health surveillance.

Using the Dean index as well, Frazão et al.<sup>14</sup> detected predominantly “very mild” cases, while moderate to severe fluorosis was observed in only 1% of the children.

In 2001, Cangussu et al.<sup>15</sup> used the Dean index and showed that dental fluorosis is a problem in Itatiba, São Paulo State, with the highest prevalence at 12 years of age. There was a direct association between fluorosis prevalence and higher income areas, probably due to access to other fluoridated products besides water fluoridation. The authors recommend using epidemiology for planning and evaluating health services in order to diagnose oral health conditions in the population at ages 5, 12, and 15 years, identifying the priority groups for intervention and the population’s treatment needs.

Menezes et al.<sup>16</sup> proposed to evaluate whether dental fluorosis, resulting from both water fluoridation and fluoridated dentifrices, was perceived by the 57 10-to-14-year-old students examined in a public school in Piracica-

ba, São Paulo, and how they reacted to this clinical condition. Fluorosis was measured by applying the Dean index and the students' own perception, using a semi-structured, previously validated questionnaire under supervision. This enamel alteration was detected in 72% of the adolescents. Analyzing individual satisfaction and presence of fluorosis, the results suggested that fluorosis was not perceived by the population. However, the authors discuss whether it would be prudent to take measures to decrease the risks of worsening dental fluorosis.

Moysés et al.<sup>6</sup> showed no significant association between fluorosis and any concern over tooth color, leading the authors to conclude that dental fluorosis is not a relevant epidemiological problem. Mean prevalence of fluorosis was 23% when including grades 2 to 5 in the Dean index.

The Thylstrup and Fejerskov index, like the Dean index, has been used to assess dental fluorosis. In the Northeast Region of Brazil, even where water for human consumption shows naturally moderate to high fluoride levels, few studies have investigated the issue of dental fluorosis. Forte et al.<sup>17</sup> assessed the prevalence of dental fluorosis in schoolchildren in Princesa Isabel, Paraíba. Some 20% of the children examined presented dental fluorosis, predominantly in males and in the premolar teeth.

Unlike the previous study, Silva & Maltz<sup>18</sup> used the same index to assess the prevalence and severity of fluorosis in 12-year-old schoolchildren in Porto Alegre, Rio Grande do Sul, but did not observe statistically significant differences by sex. Fluorosis was detected in 52.9% of the children. The authors reported an increase in the prevalence of dental fluorosis in the last decade, noting however that the degree of severity does not justify any public health measure.

Also in the State of Rio Grande do Sul, Maltz et al.<sup>19</sup> compared the prevalence and severity of dental fluorosis at two different moments in time (1987 and 1997-1998), examining students in a municipality with artificially fluoridated water (Porto Alegre) and another with a naturally low fluoride level in the water (Arroio do Tigre). Children who had lived in these two cities since birth were examined using the Thylstrup and Fejerskov index. The percentage of children with fluorosis increased from 7.7% to 32.6% in Porto Alegre and from 0% to 29.7% in Arroio do Tigre. Prevalence of fluorosis in the second epidemiological survey was similar in the two cities, but the degree of severity was greater in Porto Alegre.

In the city of São Paulo, Ribas et al.<sup>20</sup> assessed the occurrence of dental fluorosis in pri-

vate schoolchildren in the Penha district, where ideal amounts of fluoride are added regularly to the public water supply. The Thylstrup and Fejerskov index was used, with 29.47% of the children showing some degree of fluorosis.

Oliveira & Milbourne<sup>21</sup> investigated the prevalence and intensity of dental fluorosis in children from 7 to 12 years of age, in relation to age at initial use of dentifrices and the occurrence of dental fluorosis. The authors used the Thylstrup and Fejerskov index and observed a prevalence rate of 7.9%. The intensity varied from 1 to 3, while 77% of the affected teeth showed grade 1. The small number of cases may be due to the children's lower exposure to fluorides, since the fluoride levels in the water supply in the city of Rio de Janeiro have not been maintained satisfactorily.

Using the Dean and Thylstrup and Fejerskov indices, Tomita et al.<sup>22</sup>, assessed dental fluorosis in schoolchildren in Piratininga, São Paulo. Some 34.44% of the children showed "very mild" to "moderate" dental fluorosis, which indicates the need to discuss health surveillance issues in relation to external control of water fluoridation.

The use of other fluorosis indices can be found in other studies in the Brazilian literature. For example, Campos et al.<sup>23</sup> recognize that dental fluorosis is more serious in permanent than deciduous teeth. First, because mineralization of deciduous teeth occurs before birth, and the placenta purportedly acts as a passive barrier against the passage of high concentrations of fluoride from the maternal blood to the fetus, besides the fact that the mineralization time for deciduous teeth is shorter. The permanent upper anterior teeth were examined, using the tooth surface index of fluorosis (TSIF) proposed by Horowitz et al.<sup>24</sup>. Only 14.64% presented fluorosis, varying from grades 1 to 3, that is, "very mild" to "moderate" levels.

Dini et al.<sup>25</sup> assessed the prevalence of dental caries and enamel defects and their association in children 9 and 10 years of age living in areas with different levels of fluoride in the water supply. Diffuse opacities affected 14.3% of the children in the area with fluoridation since 1963, compared to 2.4% in the area fluoridated since 1998.

Other studies related to dental fluorosis in Brazil include: Lima & Cury<sup>26</sup>, who determined the total dose of fluoride provided by diet and brushing with fluoridated dentifrices in children from 20 to 30 months of age in a daycare center in Piracicaba, São Paulo State, and found a mean total dose of 0.090mgF/Kg. Although exposure to fluoridated water or fluoridated

dentifrice alone was in agreement with the safety parameters (admitting 0.07mgF/Kg as the limit for a clinically acceptable dental fluorosis), the authors concluded that the children were exposed to a total dose involving risk of dental fluorosis.

Silva et al.<sup>27</sup> conducted an epidemiological survey of fluorosis and analyzed aesthetic self-perception of 44 schoolchildren 11 to 12 years of age who presented fluorosis. They used a form applied on the day of examination. Their study concluded that 22.73% of the schoolchildren perceived the presence of fluorosis; 70% of these reported that the fluorosis stains interfered with their social relations, but only 50% would go to the dentist to treat the problem, and none of them could define fluorosis.

## Discussion

A reading of the epidemiological approach to dental fluorosis in Brazil shows few studies approaching the entire national territory at different points in time.

The SB Brazil Project (2002-2003)<sup>28</sup> recently evaluated the Brazilian population's oral health conditions. Although the publication resulting from the SB Brazil epidemiological survey does not meet the search criteria used in the present review, it is important to report that a 9% fluorosis prevalence rate was observed at 12 years of age. The highest values were found in the Southeast and South of the country (some 12%) and the lowest in the Central-West and Northeast (approximately 4%). These national data corroborate those presented in the current literature review, with a predominance of the "very mild" and "mild" grades<sup>8,9,11,12,13,21</sup>, which does not lead to functional impairment in populations described in localized studies based on schools and preschools, municipalities, and local regions.

Thus, more than an increase in its prevalence, the choice of fluorosis as an important public health problem at present may mean a possible search for new horizons and challenges, given the decline in caries.

In relation to the results published on fluorosis, the first major difficulty relates to the comparability of the studies, due to the diversity of indices used (Table 1). The Dean index, with six categories, even though describing the severity of fluorosis with less variation, is widely used, and is the index recommended by the World Health Organization (WHO), since it can be used safely in relation to public health<sup>29</sup>. The Thylstrup and Fejerskov index classifies

dental fluorosis in nine grades of severity in order to describe the different categories and impairment to dental enamel, which gives it greater precision, so it is recommended for populations with a higher prevalence of the disease<sup>30</sup>. Other indices are used less frequently, since they are not conducive to comparative approaches.

In addition, the design of various studies available in the Brazilian literature shows differences in the sample planning, sample size, age bracket, inter-examiner data reliability, reproducibility, health surveillance data accuracy, and territorial base.

According to Moysés et al.<sup>6</sup>, only nine studies in the Brazilian literature met the proposed criteria for an evidence-based evaluation.

Still, important contributions can result from epidemiological surveys held in different parts of the country, using methodologies with a minimum of standardization so as to allow understanding the distribution of fluorosis in different populations and at a given moment in their history. Considering the socio-environmental and health context and the spatial and demographic characteristics of a given population group, the production of epidemiological data on fluorosis should allow an understanding of the health-disease situation, even though offering limited conditions for the comparability of findings.

Thus, the epidemiological studies presented here vary greatly in the prevalence rates for dental fluorosis in different places and different time periods. This has called the attention of the scientific community to join with health officials in controlling a purported increase in this condition by reducing the fluoride levels in the available vehicles, including the public water supply. However, the findings by Holloway & Ellwood<sup>31</sup> indicate that dental fluorosis has increased not only in places with optimum water fluoridation, but also in areas with deficient fluoridation.

This observation is consistent with that of Narvai<sup>32</sup>, who emphasizes that interrupting water fluoridation would be scientifically untenable, as demonstrated by Kunzel<sup>33</sup> and Lemke et al.<sup>34</sup>, and would especially be socially unfair considering the Brazilian socioeconomic reality, in which a large portion of the population that accesses the benefits of a fluoridated water supply would not have access by other means.

In addition, no longitudinal studies can be found in Brazil to explain the change in the epidemiological profile of fluorosis. Scientific evidence to justify a decision to interrupt water fluoridation is scarce and/or inconsistent.

Temporal series studies in Brazil<sup>14,19</sup> are less frequent in relation to methodological aspects,

Table 1

Characteristics of Brazilian epidemiological studies on dental fluorosis according to year, place, index, sample, age group, and prevalence.

Reference	Year of study	City (State)	Index	Sample	Age (years)	Prevalence
Cypriano et al. <sup>9</sup>	1999	Piracicaba (São Paulo)	Dean	2,805	5 and 6	5 years: 2.6% "questionable", 1.2% "very mild", 1.1% "mild", and 0.3% "moderate". 6 years: 4.4% "questionable", 4.0% "very mild", 1.4% "mild", and 0.7% "moderate".
Cangussu et al. <sup>13</sup>	2001	Itatiba (São Paulo)	Dean	300	5, 12, and 15	5 years: 4.6% "very mild". 12 years: 38.2% "very mild", 3.30% "mild", and 1.10% "moderate". 15 years: 28.3% "very mild".
Alves et al. <sup>10</sup>	2002	Marília (São Paulo)	Dean	994	3 to 6	3.8% "questionable", 2.8% "very mild", 0.9% "mild", 0.3% "moderate", and 0.2% "severe".
Menezes et al. <sup>16</sup>	2002	Piracicaba (São Paulo)	Dean	57	10 to 14	35.1% "questionable", 24.5% "very mild", 12.4% "mild".
Frazão et al. <sup>14</sup>	2004	Ribeirão Pires (São Paulo)	Dean	733 (Study A) and 307 (Study B)	5 to 15 (Study A) and 12 (Study B)	Study A: 59.1% "very mild", 3.1% "mild", and 0.4% "moderate". Study B: 27.1% "very mild", 5.2% "mild", and 0.9% "moderate".
Tomita et al. <sup>22</sup>	1995	Piratininga (São Paulo)	Dean/Thylstrup and Fejerskov	270	6 to 14	Dean: 27.8% "very mild", 4.40% "mild", and 2.20% "moderate". Thylstrup and Fejerskov: 20.0% TF=1, 7.78% TF=2, 4.44% TF=3, 1.85% TF=4, and 0.37% TF=5.
Ribas et al. <sup>20</sup>	1999	São Paulo (São Paulo)	Thylstrup and Fejerskov	553	6 and 12	71.78% TF=1, 21.47% TF=2, and 6.75% TF=3.
Oliveira & Milbourne <sup>21</sup>	2001	Rio de Janeiro (Rio de Janeiro)	Thylstrup and Fejerskov	266	7 and 12	77% TF=1, 33% TF=2 or TF=3.
Moyisés et al. <sup>6</sup>	2002	Curitiba (Paraná)	Dean	1,494	12	17.7% "questionable", 13.5% "very mild", 6.2% "mild", 2.2% "moderate", and 0.6% "severe".
Paiva et al. <sup>11</sup>	1993	Urussanga (Santa Catarina)	Dean	299	5 to 10	–
Silva & Maltz <sup>18</sup>	2001	Porto Alegre (Rio Grande do Sul)	Thylstrup and Fejerskov	1,000	12	45.9% TF=1, 6.1% TF=2, and 0.9% TF=3.
Maltz et al. <sup>19</sup>	2000	Porto Alegre and Arroio do Tigre (Rio Grande do Sul)	Thylstrup and Fejerskov	117 and 135 (1987) and 110 and 101 (1997-1998)	8 and 9	1987: 0.0% (Arroio do Tigre); 6.84% TF=1 and 0.86% TF=2 (Porto Alegre). 1997-1998: 29.70% TF=1 (Arroio do Tigre); 25.15% TF=1, 3.71% TF=2, and 0.74% TF=3 (Porto Alegre).
Mendonça et al. <sup>12</sup>	1998	Belo Horizonte (Minas Gerais)	Dean	797	7 and 10	4.9% "questionable", 82.7% "mild", and 12.3% "severe".
Campos et al. <sup>23</sup>	1998	Brasília (Federal District)	TSIF	833	8 and 12	10.44% grade=1, 3.60% grade=2, and 0.60% grade=3.
Cangussu et al. <sup>13</sup>	2004	Salvador (Bahia)	Dean	3,313	12 to 15	12.1% "questionable", 25.4% "very mild", 4.0% "mild", and 0.2% "moderate".
Forte et al. <sup>17</sup>	2001	Princesa Isabel (Paraíba)	Thylstrup and Fejerskov	142	10 to 15	14.00% TF=1, 5.00% TF=2, 1.00% TF=3, 0.20% TF=4, and 0.05% TF=5.
Minitério da Saúde <sup>28</sup>	2002-2003	Brazil	–	–	12 and 15 to 19	9% in children 12 years of age; 5% in adolescents (15-19 years).

and a more accurate reading indicates the need for more evidence to give the findings consistency. In other words, the lack of historical series using standardized procedures in epidemiological surveys held in the same territorial or geographic base makes it very difficult to sustain the “increased fluorosis” hypothesis or its promotion to the status of a public health problem<sup>6</sup>.

Recent concern over fluorosis can produce biases in the reading of the meaning of the epidemiological profile with enamel alterations and defects. As the result of “preventionism”<sup>35</sup>, the irrational uses of fluorides in populations with some access to goods and services may be implicit in the genesis of some iatrogeny. Meanwhile, populations subject to historical social inequalities experience precarious or nonexistent access to essential goods and services like treated water.

Thus, to see the interruption of water supply fluoridation as a solution to the problem of fluorosis can be considered imprudent in Brazil’s collective health context.

Another important aspect of fluorosis relates to the social impact and costs of decisions based on public policies. For many decades, dental caries was a public health problem. Fluoride’s preventive efficacy has led to a global decline in caries. The extensive use of fluoride, especially in public water supply fluoridation, has proven to have an important impact on dental caries<sup>36</sup> and is considered one of the ten most important discoveries of the 20<sup>th</sup> century<sup>32</sup>.

The 3<sup>rd</sup> Brazilian National Conference on Oral Health reaffirmed the importance of “de-

*fending fluoridation of the water supply and toothpastes as essential public goods for promoting oral health. It is also necessary for health surveillance agencies to control the quality of water, toothpastes, and all other products containing fluoride”*<sup>8</sup> (p. 60).

## Final remarks

Some reflections on the possibilities for implementing measures to prevent dental fluorosis have involved questioning the need to continue the broad use of fluoride by children. A risk-benefit decision should weigh a probable increase in caries prevalence as the result of interrupting public water supply fluoridation<sup>6</sup>. The fluorosis observed in Brazil has been predominantly grades “very mild” and “mild”<sup>9,10,13,13,14,22</sup>, with no functional impairment. Although the possibility of relevant aesthetic impairment has been raised, it is not observed when the assessment extends beyond normative aspects<sup>6</sup>. This shows that fluorosis is not an important cause of disorders (either functional or aesthetic) according to the self-perception of those who display it. Considering this prevalence of grades “very mild” and “mild” of fluorosis and the population’s perception of the issue, it is important that a reflection on individual aspects find room on the collective health agenda, thereby aiding the decision-making process, historically based on normative criteria.

## Resumo

*O presente trabalho propõe uma reflexão sobre alguns aspectos relativos à fluorose dentária no Brasil, a partir de uma revisão sistemática de estudos e inquéritos epidemiológicos. A prevalência e os níveis de severidade encontrados nos diferentes estudos são avaliados, verificando-se que, quanto aos aspectos metodológicos, há necessidade de avançar no que diz respeito aos procedimentos para estudo da fluorose em âmbito populacional. Apesar das diferentes abordagens para coleta de dados, há algum consenso, entre os diferentes estudos, quanto à baixa severidade da fluorose no Brasil e a sua associação com as variáveis independentes idade e condição sócio-econômica. Destaca-se tam-*

*bém a importância de incluir aspectos subjetivos ao diagnóstico normativo, como uma contribuição às decisões que envolvem o planejamento de políticas públicas de saúde, uma vez que o uso de critérios exclusivamente clínicos oferece à fluorose dentária um espaço maior que aquele que lhe confere a sociedade. Nota-se a ausência de evidência empírica para a reavaliação dos teores de flúor nas águas de abastecimento público, um método reconhecidamente necessário no contexto brasileiro para a melhoria dos indicadores epidemiológicos de cárie.*

*Fluorose Dentária; Saúde Bucal; Literatura de Revisão*

## Contributors

N. E. Tomita conducted the article's theoretical design and discussion. L. F. Cunha was in charge of the data survey and drafting the article.

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