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# Dental fluorosis in children from São Paulo, Southeastern Brazil, 1998-2010

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## ABSTRACT

**OBJECTIVE:** To assess the trend of dental fluorosis prevalence in 12-year-old children, in the context of exposure to multiple sources of fluoride.

**METHODS:** An analysis was carried out of the trends in prevalence of dental fluorosis in the city of São Paulo, Southeastern Brazil, between 1998 and 2010. The rates of prevalence were calculated for different years (1998, 2002, 2008 and 2010) using secondary data obtained from epidemiological surveys of representative samples of 12-year-old children. Occurrence of fluorosis was assessed in natural light using the Dean index, recommended by the World Health Organization and categorized into normal, questionable, very mild, mild, moderate and severe. In 1998, 125 children were examined, 249 in 2002, 4,085 in 2008 and 231 in 2010.

**RESULTS:** In 1998 the prevalence of fluorosis was 43.8% (95%CI 35.6;52.8) in 2002 it was 33.7% (95%CI 28.2;39.8), it was 40.3% (95%CI 38.8;41.8) in 2008 and 38.1% (95%CI 32.1;44.5) in 2010. The categories very mild + mild totaled 38.4% (95%CI 30.3;47.6) in 1998, 32.1% (95%CI 26.6;38.2) in 2002, 38.0% (95%CI 36.5;39.5) in 2008 and 36.4% (95%CI 30.4;42.7) in 2010. Severe fluorosis was not observed, with statistical significance, in the analyzed period.

**CONCLUSIONS:** The prevalence of dental fluorosis in children from São Paulo can be classified as stationary between 1998 and 2010, both when considering all categories, and when considering only the categories very mild + mild.

**DESCRIPTORS:** Child. Fluorosis, Dental, epidemiology. Fluoridation, adverse effects. Toothpastes, adverse effects. Dental Health Surveys. Oral Health.

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## INTRODUCTION

Fluoridated water and toothpastes with fluoride are important allies in preventing dental caries, the main oral health problem in the majority of countries.<sup>21</sup> The city of São Paulo has around 11 million inhabitants and around 99% of them have access to tap water, which has been fluoridated since 1985. From 1988 onwards practically all toothpastes commercially available in the city contain fluoride.<sup>22</sup> Studies on the prevalence of dental caries show a consistent decrease in children, indicating the effectiveness of these preventative methods. However, in the context of exposure to multiple sources of fluoride, doubts persist as to prevalence of dental fluorosis in these children.

Products containing fluoride may be improperly used, both in the tap water and in toothpastes. Consequently, the population's levels of dental fluorosis, an alteration in the enamel occurring during the teeth's development due to excessive, prolonged fluoride intake, can rise.<sup>6</sup>

In the classic pattern of occurrence (chronic endemic), the problem appears due to the intake of high concentrations of fluoride in the drinking water, usually from wells.<sup>6</sup> However, the modern pattern of dental fluorosis occurrence is due to exposure to multiple sources of fluoride, in other words, intake of products, usually water and toothpaste, containing levels of fluoride in excess of that tolerated by the organism over long periods of time. Such levels are enough to cause milder forms of fluorosis – in many cases unnoticeable.<sup>12</sup> This form of fluorosis, the population pattern of which is quite different from that exhibited in cases of chronic endemic dental fluorosis, was denominated iatrogenic endemic fluorosis by Narvai.<sup>17</sup> This is distinguished from the chronic endemic form, from an epidemiological point of view, as “mild” and “very mild” cases predominate, with low frequency of “moderate” cases and a very low frequency of “severe” cases.

Menezes et al<sup>12</sup> stated that the alterations classed as “very mild” and “mild” produced by fluoride in tooth enamel are not perceived as a problem by the population. Narvai & Bighetti<sup>15</sup> refer to “aesthetically acceptable” forms of dental fluorosis. With this type of dental fluorosis (iatrogenic endemic), the public health interest is to avoid new cases occurring and maintain the inevitable cases at socially acceptable levels.<sup>15</sup>

Bearing in mind the existence of elevated prevalence of dental fluorosis in some places in Brazil,<sup>8,23,25</sup> it was hypothesized that levels of this health problem were increasing in these locations and in the Brazilian population.<sup>19</sup> This study aimed to evaluate this hypothesis in the state capital of São Paulo, Southeastern Brazil.

## METHODS

An analysis of trends in the prevalence of dental fluorosis between 1998 and 2010 was carried out, following the recommendations for “panel” studies. The rates of prevalence were calculated for different years (1998, 2002, 2008 and 2010), based on secondary data from epidemiological oral health surveys carried out by the State and Municipal Health Departments; and the 2002 and 2010 studies were part of a broader study known as the SBBrazil Project.<sup>14,24</sup> Although the sampling plans were different in these population surveys, due to their different aims, the samples were considered representative of 12-year-old children in the city of São Paulo, as they met the criteria proposed by the internationally standardized World Health Organization (WHO) methodology.<sup>24</sup> To evaluate prevalence, the dental fluorosis index proposed by Dean<sup>6</sup> and recommended by the WHO was used. In all four surveys, the examinations were carried out in natural light. The examiners' training in these studies met the requisites required for epidemiological surveys of dental fluorosis.<sup>24</sup> In 1998, 125 children were examined, 249 in 2002, 4,085 in 2008 and 231 in 2010. In order to analyze trends in prevalence, 1998 was used as the reference for comparisons, which took into consideration the respective 95% confidence intervals at the four times. Rates of prevalence and their respective confidence intervals of the different degrees of dental fluorosis were also analyzed comparatively. In the “normal” and “questionable” categories, enamel appeared normal in natural light, with the surface appearing smooth, shiny and generally white or light beige. In the “very mild” category, small irregularly dispersed white and opaque patches appear on less than 25% of the tooth's surface. The “mild” category is similar to the above, but involving more than 50% of the tooth surface. In “moderate” fluorosis, the enamel surface appears worn and there are brown stains. Fluorosis is classified as severe when the surface of the enamel is severely affected and the hypoplasia is so accentuated that the anatomy of the tooth is compromised. Brown stains occur all over the surface and the tooth often appears corroded.

## RESULTS

The prevalence of dental fluoride in 1998, 2002, 2008 and 2010 is shown in Figure. No statistically significant difference was observed in the prevalence of this health problem between the comparatively analyzed years and 1998, the reference year.

The percentages according to severity of the health problem are shown in the Table and demonstrate that, on comparing all of the categories of the variable,

no statistically significant differences are recorded in the respective prevalence. Together, the categories “mild” + “very mild” totaled 38.4% (95%CI30.3;47.6) in 1998, 32.1% (95%CI 26.6;38.2) in 2002, 38.0% (95%CI 36.5;39.5) in 2008 and 36.4% (95%CI 30.4;42.7) in 2010. With regards the figure for 1998, there were no statistically significant differences observed in the subsequent years. One “severe” case of fluorosis was observed in 1998 (0.1%), but there was no record of this category of the variable in 2002, 2008 and 2010.

## DISCUSSION

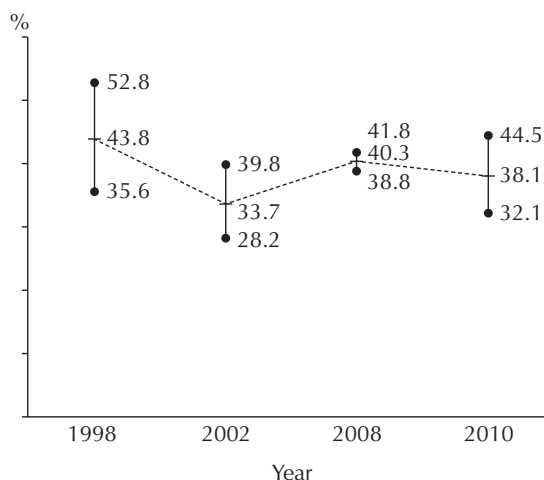
In the classic, 20<sup>th</sup> century studies of dental fluorosis, the link between dental fluorosis and public water supplies with high levels of fluoride was well-established.<sup>16</sup> It was also from these studies that the correlation between low levels of fluoride in the water and lower prevalence of dental caries was discovered.<sup>3</sup> At almost the same time as the concept of dental fluorosis was scientifically consolidated, it was discovered that appropriate levels of fluoride in the tap water constituted an important protection factor against dental caries. This discovery radically changes public health intervention strategies for preventing and controlling dental caries. Throughout the 20<sup>th</sup> century, the use of fluoridated products increased, driven by the tap water and toothpastes.<sup>1</sup>

As using fluoride constituted an effective strategy, with no damage to human health, technologies based on this scientific evidence grew noticeably.<sup>21</sup> Dental fluorosis, the only undesirable side effect of using fluoride in these public health strategies, took on, in this context, an epidemiological pattern opposite to that described by Dean in pioneering epidemiological studies on its occurrence in communities exposed to one sole source, with elevated levels of fluoride.<sup>5</sup> Thus, bearing in mind the new epidemiological pattern, modern use of the expression “dental fluorosis” requires a description of this health problem, according to the category. As at the moment it is the “very mild” and “mild” categories which predominate, it is necessary to clarify the significance of the occurrence of “moderate” and “severe” cases in each context.<sup>17</sup> This characteristics of dental fluorosis, in its present manifestation in the context of fluoride added to water and toothpaste, has called into question its epidemiological relevance.<sup>13</sup> Against this background, especially in the West, scientifically based objections to the use of fluoride in public health, motivated by caution related to the possible occurrence of moderate or severe dental fluorosis in proportions relevant in terms of population, have practically ceased. Thus, although 27.8% of the children examined in a location in Brazil had some degree of dental fluorosis, Peres et al<sup>20</sup> affirm that this was not a significant factor in dissatisfaction with appearance.

The principal result of this study is that the trend of prevalence of dental fluorosis in the city of São Paulo is stable (Figure), with no elements to sustain the hypothesis that prevalence is increasing. This result is similar to that found in Salvador, in the first decade of the 21<sup>st</sup> century, in which no trend for increased prevalence or severity of dental fluorosis was found.<sup>18</sup> However, these findings differ from those in Porto Alegre and Arroio do Tigre, in Rio Grande do Sul, where a prevalence was found to have increased from 7.7% to 32.6% and from 0.0% to 29.7% respectively, between 1987 and 1997.<sup>11</sup>

Moreover, in this study, the “very mild” and “mild” categories prevailed, a situation compatible with iatrogenic endemic fluorosis,<sup>17</sup> which is characterized by the aesthetics and function of the affected teeth being uncompromised. The population characteristic of this type of fluorosis, which affects a large number of individuals simultaneously, also differs from typical iatrogenic dental fluorosis, as it is caused by inappropriate fluoride intake by of one or more products containing fluoride by a single individual.<sup>4</sup> Although they did not qualify it in this way, Cury & Usberti<sup>5</sup> report a typical case of iatrogenic dental fluorosis in Brazil, in the municipality of Piracicaba. Fejerskov et al<sup>7</sup> mention this type of dental fluorosis, which they call “idiopathic”, the occurrence of which is verified without “apparent history of significant exposure to fluoride”. The authors admit that this type is “extremely rare”.

Incidentally, two aspects of the occurrence of “moderate” cases of fluorosis, in contexts in which there was no prolonged exposure to high levels of fluoride in wide-reaching collective vehicles (e.g. in tap water), are worth noting. The first concerns the variability of the individuals with regards use of products containing fluoride, as a consequence of incorrect prescriptions or other factors which could lead them to prolonged



**Figure.** Prevalence of dental fluorosis and 95% confidence intervals in 12-year-old children. Municipality of São Paulo, Southeastern Brazil, 1998, 2002, 2008 and 2010.

**Table.** Number and percentage of 12-year-olds according to degree of dental fluorosis. Municipality of São Paulo, Southeastern Brazil, 1998, 2002, 2008 and 2010.

Degree <sup>a</sup>	1998		2002		2008		2010	
	n	%	n	%	n	%	n	%
Normal	56	44.7	131	52.6	2,052	50.2	108	46.7
95%CI		36.4;53.5		46.4;58.7		48.7;51.8		40.4;53.2
Questionable	14	11.5	34	13.7	387	9.5	35	15.2
95%CI		6.8;17.9		9.9;18.5		8.6;10.4		11.1;20.3
Very mild	36	28.7	62	24.9	1,218	29.8	67	29.0
95%CI		21.6;37.3		19.9;30.6		28.4;31.2		23.5;35.2
Mild	12	9.8	18	7.2	335	8.2	17	7.4
95%CI		5.6;16.0		4.6;11.1		7.4;9.1		4.7;11.5
Moderate	6	4.9	4	1.6	93	2.3	4	1.7
95%CI		2.2;10.1		0.6;4.1		1.9;2.8		0.7;4.4

<sup>a</sup> Only one case was recorded in the "severe" category, in 1998

exposure to inappropriate levels. In a meta-analysis study covering research published in England between 1966 and 1997, it was highlighted that the use of fluoride supplements in communities without access to fluoridated water, during the first six years of life, is associated with a significantly increased risk of developing dental fluorosis.<sup>9</sup> The second aspect is concerned with the difficulties involved in epidemiological population based research. In such studies, it is recognized that many "cases" of dental fluorosis (including "moderate" and "severe" cases) may have been false positives, given the difficulties in adequately calibrating the examiners, due to the high level of subjectivity of the indices, even those used in population surveys. Add to this the fact that defects and opacities in the enamel are often recorded as dental fluorosis when they are, effectively, no such thing. The improper inclusion of such cases of false positives constitutes a significant error in many epidemiological studies of fluorosis, conducted without proper planning.

Thus, it is necessary to consider the practical difficulties observed in epidemiological studies of dental fluorosis, related to the problem of diagnosis. Differentiating cases of fluorosis from other cases in which changes occur in the enamel which are not related to fluorosis will always be a challenge for examiners, leading to recording false positive cases. Among these alterations are: white patches due to dental caries, hypoplasia of the enamel, amelogenesis imperfecta, dentinogenesis imperfect and tetracycline stains. This means that researchers and analysts should draw their conclusions prudently and cautiously, as the results are often "contaminated" by incorrect figures. This is a significant limitation to the data used in this study. Another relevant limitation concerns the number of individuals examined in the surveys used in the analysis, which oscillated at the four points in time and resulted in sampling plans which differed from each other.

However, even when only the descriptive epidemiological resources and the limits mentioned are considered, the results shown in this article show the differences in prevalence and severity of dental fluorosis in São Paulo compared with the classic epidemiological pattern.

Moreover, in order for socially acceptable levels of iatrogenic dental fluorosis to be tolerated, ethically and aesthetically (ethical acceptance of the problem is included given the ethics of public health),<sup>10</sup> it is essential that monitoring activities take place, controlling the level of fluoride which products contain, as well as epidemiological monitoring, controlling the number and types of cases in the population. Such double monitoring falls to the sanitation authorities, which are recommended, before confirming fluorosis, to identify the type, whether "endemic chronic" or "iatrogenic endemic" and to then adopt the measures appropriate to the type.<sup>2</sup>

One objection which could be made against this study is concerned with the use of secondary data. As mentioned, these data were produced in epidemiological surveys which had different sampling plans, due to the different objectives for which they were carried out. The sample sizes differed markedly, varying from 125 oral examinations in 1998 to 4,085 in 2008. It could be argued that these samples were "small" in 1998 and "large" in 2008. However, these disparate samples in the four surveys produced population estimates which were statistically the same. In addition, it should be considered that 21 comparisons were made, not just two or three, and no differences were observed. If this had not been the case, the analysis would indicate statistically significant differences in at least one comparison, and therefore, these different sample sizes would require caution and close attention to the conclusions drawn from data with this origin. In this case it is recognized that any limitations of the study

derived from the heterogeneity of the samples, although relevant in statistical terms, may not compromise the conclusions in essential terms. Moreover, it should be borne in mind that such heterogeneity is characteristic of studies of this type, which evaluate secondary data produced from different surveys, as, in such contexts, sampling plans are rarely the same or even similar. Therefore, it needs to be recognized that comparisons refer to estimates of population parameters, both for points and for confidence intervals. Thus, it can be

stated that the samples are, more often than not, limitations in studies of this type in which analyses of trends are used based on population estimates produced from two or more cross-sectional studies, and is not unique to this analysis. For this reason, in light of the results analyzed in this study, it seems valid to recognize that the prevalence of dental fluorosis in children in Sao Paulo can be classified as stable between 1988 and 2010, overall and when considering only its “mild” and “very mild” manifestations.

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