Enamel Fluorosis Prevalence after a 7-year Interruption in Water Fluoridation in Jaú, São Paulo, Brazil

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Abstract

Objectives: *This paper analyzes the impact of a 7-year interruption in water fluoridation on the prevalence of enamel fluorosis in Jaú, state of São Paulo, Brazil.* **Methods:** *Fluorosis prevalence (TF index) was evaluated in permanent maxillary central incisors of children (9–14 years old) that were 36 (n=81; cohort −36), 27 (n=81; cohort −27), and 18 months old (±1 month; n=89; cohort −18) in October 1991, when the break started, and 18 months old (±1 month; n=70; cohort 18) after that date. Children brushed their teeth prior to examination, which was conducted under natural light by three calibrated examiners (agreement 87.8–93.8%, kappa 0.72–0.85).* **Results:** *The fluorosis prevalence (TF≥1) was 7.41 percent, 3.70 percent, 7.87 percent, and 18.57 percent, respectively, for cohorts −36, −27, −18, and 18. The difference between cohort 18 and the other groups was statistically significant (Kruskall-Wallis test, P=.05).* **Conclusions:** *These results suggest that the fluoridated water is not an important risk factor for enamel fluorosis, since the prevalence of enamel fluorosis was low in the cohorts −36, −27, and −18 when fluoridated water was used. [J Public Health Dent 2004;64(4):205-8].*

Key Words: fluoridation, fluorosis, epidemiology, children.

There has been a decline in dental caries prevalence and incidence during the last two decades, both in economically developed (1,2) and in some economically developing countries (3,4). This decrease is considered to be due largely to the widespread use of fluoride. Concurrent with the decline in caries, an increase in the prevalence of enamel fluorosis has been documented in communities with (5,6) and without fluoridated drinking water (5,7). The severity of enamel fluorosis is affected by the amount of fluoride intake. Fluoride in water supplies, dietary supplements, fluoridated dentifrices, and infant formulas have been reported as the main sources of fluoride intake (8). Some commercially available beverages and foods may also contribute toward the total fluoride intake (8).

Water fluoridation is a cost-effective and safe method for the prevention of dental caries. In Brazil, it began in 1953 in Baixo Guandu (state of Espírito Santo). In 1974, the federal law 6.050 was promulgated, which regulated water fluoridation (9). On December 22, 1975, Determination 76.872 added more details to the federal law 6.050 (10). Recent government data report that 71.23 percent of the Brazilian population are supplied with adjusted fluoridated water. In the state of São Paulo, 92 percent of the cities are supplied with fluoridated water (10). Jaú, a city located at the midwest of the state of São Paulo, began water fluoridation in August 1984. However, its water fluoridation was interrupted from October 1991 until June 1999. Since June 1999, Jaú has been supplied with artificially fluoridated water containing 0.7 ppm fluoride. Thus, for more than seven years Jaú was supplied with nonfluoridated water. Moreover, in 1989, the Sanitary Vigilance Cabinet (Health Ministry, Brazil) regulated the incorporation of fluoride into Brazilian dentifrices (Determination #22, December 20) (11) and the use of fluoridated dentifrices immediately became widespread and accounted for 90 percent of dentifrice sales in Brazil (12).

Dean et al. (13) observed that fluoride levels in the drinking water around 1 ppm promoted the best effect on the prevention of dental caries and also the least effect on the development of enamel fluorosis, with 10–12 percent of the population presenting very mild and mild fluorosis. At higher fluoride concentrations, enamel fluorosis was more prevalent and severe (14).

This study takes advantage of an unplanned break in the artificial public water fluoridation in the city of Jaú, São Paulo, Brazil, over a seven-year period, to evaluate the influence of optimally fluoridated water on the prevalence of enamel fluorosis on the permanent maxillary central incisors. In addition, it was also investigated whether children between 18 and 36 months of age are more susceptible to the development of enamel fluorosis.

Methods

Sampling. The study design was a cross-sectional comparison of birth cohorts. Cohorts were defined by age, with the name of each cohort being the number of months before or after fluoridation ceased in October 1991. The time interval between the cohorts was chosen because of the critical period for fluoride exposure in maxillary central incisors, which is believed to be between 15 and 30 months of age (15). Thus, we selected the period between 18 and 36 months of age as the focus of

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this study. This period of 18 months was then subdivided into two, giving three cohorts: 18, 27, and 36 months (Figure 1).

Inclusion criteria of children in this study were the following: children who were born and raised in the city, students of public schools that agreed to participate) children born in the specific months of each cohort, and those whose parents allowed examination and signed a consent form. A total of 321 children who were born 36, 27, or 18 months (±1 month) before October 1991 (supplied with fluoridated water) and 18 months (±1 month) after this date (supplied with nonfluoridated water) were included in this study (Table 1). The research protocol was reviewed and approved by the Ethics Committee in Human Research of Bauru Dental School, University of São Paulo, before the study began. Informed written consent was received from parents or guardians of all subjects prior to the study. The children were identified by using the lists of the schools. This registry included each child's name, birth date, sex, address, and phone number.

Clinical Examinations. All children brushed their teeth before the examination. The labial surfaces of permanent maxillary central incisors were examined for enamel fluorosis using the TF Index (16). Teeth were dried with gauze and allowed to dry for at least 30 seconds before coding. Examinations were done under natural light by three examiners (BSA, KPKO, and VESC). The examiners standardized their diagnostic criteria over a two-day training period prior to data collection. Percent agreement for fluorosis among the examiners was between 87.8 percent and 93.8 percent; kappa scores ranged from 0.72 to 0.85.

Statistical Analysis. Epi Info v.6.04c and GraphPad InStat were used for data management and statistical analysis. Kruskal-Wallis test was used to detect statistical significant differences in the prevalence of enamel fluorosis among the cohorts. Dunn's test was used as a post hoc test. A significance level of 5 percent was selected.

Results

Table 1 shows the age and number of children examined according to the cohort. Cohorts were named according to the months children had lived with and without fluoridated water. Cohorts born before the cessation of fluoridation were designated by a minus sign (–) and the cohort born after the break is designated by a plus sign (+).

Table 2 shows that the prevalence of enamel fluorosis was 7.41 percent, 3.70 percent, 7.87 percent, and 18.57 percent for cohorts –36, –27, –18, and +18, respectively, and differed significantly among the groups (P<.0001). No significant differences were observed on the prevalence of enamel fluorosis for cohorts –36, –27, and –18 (P>.05). However, the prevalence of enamel fluorosis was significantly higher for cohort +18 when compared to cohorts –36 (P<.001), –27 (P<.001), and –18 (P<.05). The enamel fluorosis index reached TF=3. The values indicate a low prevalence and severity of enamel fluorosis in maxillary central incisors of the children examined.

FIGURE 1
Timeline of Children's Birth Date, Their Respective Age (Months) at Time of Break of Fluoridation, and Date of Break in Water Fluoridation

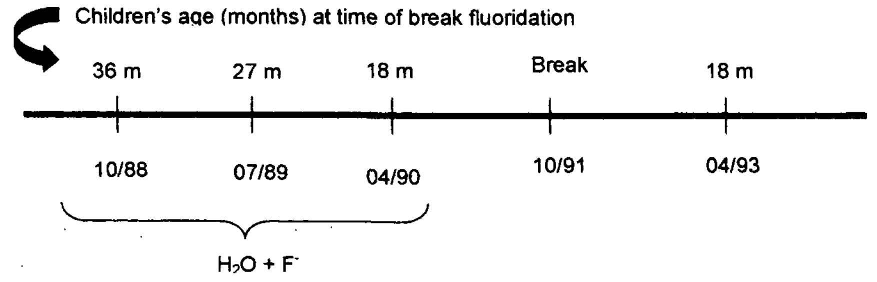

TABLE 1
Age and Number of Children Examined According to Cohort (Months Before and After Water Fluoridation Interruption)

Cohort	Children's Age (Years)	*n*
–36*	14	81
–27†	13	81
–18‡	12	89
18¶	9	70
Total		321

*Children born between September and November 1988.
†Children born between June and August 1989.
‡Children born between March and May 1990.
¶Children born between March and May 1993.

Discussion

The Centers for Disease Control and Prevention described water fluoridation as one of the 10 public health measures in the world (17). Water fluoridation is economically feasible, and it is also an efficient and safe method for the prevention of dental caries. To be effective as a public health measure, the maintenance of optimal water fluoride levels by cities is required.

Recent epidemiologic data describe an increased prevalence of enamel fluorosis and a decreased prevalence of dental caries in communities with or without fluoridated drinking water due to the exposure to other sources of fluoride (5). This tendency also was observed in the present study, where the prevalence of enamel fluorosis increased from 7.41 percent to 18.57 percent (Table 2) in children that were born between September 1988 (cohort –36) and May 1993 (cohort +18), respectively.

This was the first study on enamel fluorosis conducted in the city of Jaú. Thus there are no previous data on the prevalence of enamel fluorosis with which to compare our results. Some few results of an epidemiologic survey conducted in the state of São Paulo in 1998 exist. The prevalence found was 11 percent in 12-year-old children (18). More recent data show a prevalence of enamel fluorosis of 11.76 percent in 12-year-old children in the state of São Paulo. However, in both surveys the Dean Index was used (19).

In the present study, the prevalence

TABLE 2
Prevalence of Enamel Fluorosis According to Cohort

Cohort	TF 0 % (*n*)	TF 1 % (*n*)	TF 2 % (*n*)	TF 3 % (*n*)	TF≥1 % (*n*)
–36†	92.59 (75)	3.70 (3)	3.70 (3)	0.00 (0)	7.41 (6)
–27‡	96.30 (78)	2.47 (2)	0.00 (0)	1.23 (1)	3.70 (3)
–18¶	92.13 (82)	4.49 (4)	2.25 (2)	1.12 (1)	7.87 (7)
18§	81.43 (57)	10.00 (7)	7.14 (5)	1.43 (1)	18.57 (13)*

*Significantly different ($P<.05$) from percentage with TF≥1 in other three cohorts..
†Children born between September and November 1988.
‡Children born between June and August 1989.
¶Children born between March and May 1990.
§Children born between March and May 1993.

of enamel fluorosis was 7.41 percent, 3.70 percent, 7.87 percent, and 18.57 percent for cohorts –36, –27, –18, and 18, respectively. Selwitz et al. found a prevalence of enamel fluorosis of 18.5 percent and 15.1 percent in 8–10-year-old and 13–16-year-old children, respectively. These children consumed artificially fluoridated water containing 1 ppm F. In two hypofluoridated cities the prevalence was 18.4 percent and 17.7 percent for 8–10-year-old children and 2.1 percent and 9.2 percent for 13–16-year-old children (20). The prevalence among 9-year-old children in our study is in agreement with these data. However, for the older children Selwitz et al. found a higher prevalence of enamel fluorosis than our study.

The prevalence of enamel fluorosis was similar for cohorts –36, –27, and –18. Despite the limitations of this study, these results suggest that all this period may be considered critical for the development of enamel fluorosis in the central permanent maxillary incisors. These findings are in agreement with Bardsen et al. (21), but in disagreement with the findings of Burt et al. (22). Burt et al. assessed the impact of an unplanned break of 11 months in water fluoridation and concluded that enamel fluorosis is sensitive to even small changes in fluoride exposure from drinking water, and this sensitivity is greater at 1 to 3 years of age than at 4 or 5 years of age. However, in a subsequent study (23), the prevalence of enamel fluorosis, which was expected to increase in the next cohort examined due to the resumption of fluoridation, remained stable. The authors suggested that the break probably was not long enough to lead to a reduction of fluorosis prevalence. However, in our study, the interruption in water fluoridation remained for more than seven years, and even so, no decrease in prevalence of enamel fluorosis was observed.

In fact, an unexpected finding of this study was an increase in the prevalence of enamel fluorosis in children who had no access to fluoridated drinking water in their first years of life. The reasons for this are not known. It can be speculated that other sources of exposure to fluoride may have contributed to this finding. Sato et al. (24) reported that children aged 30 to 66 months who brushed their teeth up to twice a day and who lived in communities with a nonfluoridated water supply did not present any risk for the development of enamel fluorosis. However, in a fluoridated area toothbrushing with a fluoridated dentifrice could be considered a risk factor. In Brazil, in 1989, the Sanitary Vigilance Cabinet (Health Ministry, Brazil) regulated the incorporation of fluoride into the dentifrices (Determination #22, December 20) (11). This is a relevant fact, since the oldest participant children in this study were born in 1988 and presented low prevalence of enamel fluorosis compared to the youngest children. We did not find any study in the Brazilian literature about the consumption of fluoridated dentifrices at that time. However, there is a large body of evidence showing that fluoride swallowed from dentifrices is a contributing factor for enamel fluorosis, especially in small children (25,26).

Risk factors for enamel fluorosis other than the water and fluoridated dentifrices have also been described. Some authors have identified supplements (27), infant formulas (28), and commercially available foods and beverages (8,28,29) as additional risk factors for enamel fluorosis. The dietary habits during infancy changed substantially in the last decades, increasing the consumption of commercially available products (30). This is a critical period in which the optimal levels of ingested fluoride must not be exceeded. Several previous studies have determined the fluoride content of infant foods, such as milk (27,31,32), dinners, and desserts (28,33,34) and beverages (8,35). In telephone interviews we tried to assess the consumption of fluoride from other sources than the water. However, the response rate was very low (less than 50%) and no definitive conclusions could be drawn. Other possible explanations are that these are presumably the youngest children, and fluorosis may be more evident on their teeth than in older children in the other cohorts (36). Another possible explanation is examiner or measurement error in the fluorosis examination. This latter hypothesis is less likely, since there was good intra- and interexaminer agreement.

In conclusion, the findings of this study provide additional support for controlled water fluoridation. In the period between 18 and 36 months of age, the risk of enamel fluorosis on the central permanent maxillary incisors seems to be similar among the cohorts. There was a significant increase in the prevalence of enamel fluorosis for children born 18 months after the resumption of fluoridation, suggesting that fluoridated water was not an important risk factor in enamel fluorosis development.

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