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Dental fluorosis and its influence on children's life

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Abstract: This study verified the prevalence of dental fluorosis in 12-year-old children and its association with different fluoride levels in the public water supply, and evaluated the level of perception of dental fluorosis by the studied children. To assess fluorosis prevalence, clinical examinations were performed and a structured instrument was used to evaluate the self-perception of fluorosis. The water supply source in the children's area of residence since birth was used as the study criterion. In total, 496 children were included in the study. Fluorosis was diagnosed in 292 (58.9%) children; from these, 220 (44.4%) children were diagnosed with very mild fluorosis, 59 (11.9%) with mild fluorosis, 12 (2.4%) with moderate fluorosis, and 1 (0.2%) child with severe fluorosis. A significant association (p = 0.0004) was observed between the presence of fluorosis and areas with excessive fluoride in the water supply. Among the 292 children that showed fluorosis, 40% perceived the presence of spots in their teeth. The prevalence of fluorosis was slightly high, and the mildest levels were the most frequently observed. Although most of the children showed fluorosis to various degrees, the majority did not perceive these spots, suggesting that this alteration did not affect their quality of life.

Keywords: Fluorosis, Dental; Epidemiology; Oral Health; Self Concept.

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Introduction

Questions regarding the correct use of fluoride are common given the disadvantages related to incorrect fluoride use in children during the developmental phase, among which is dental fluorosis, observed as spots in dental enamel.[1] There is evidence that children between 3 and 6 years old have a higher risk of developing dental fluorosis because this represents the period of permanent dentition development.[2]

The recommendation for fluoridation of public water supply is widely accepted because the benefits of caries reduction are greater than the risks of dental fluorosis.[3,4] Public water supply fluoridation became obligatory in Brazil in 1975 with the implementation of National Law number 6,050. Nevertheless, the increased prevalence of dental fluorosis worldwide has caused esthetic displeasure in children, which may lead to psychological and behavioral complications in affected individuals.[4,5] The spots caused by "very mild" and "mild" fluorosis do not constitute a public health problem, although they do represent an abnormality. However, some studies have evaluated the levels at which dental fluorosis is self-perceived by children as a problem.[2] Consequently,

researchers are being encouraged to investigate the effects of the signals of dental fluorosis on an individual's perception and their quality of life.[6,7]

In Brazil, most cities have more than one water supply source and these sources have not yet been appropriately studied regarding fluorination levels. Therefore, population-based studies are required, especially considering that the population currently has access to various additional sources of fluoride, in particular fluoridated dentifrice. Studies that associate clinical conditions with self-perception are important in public health to analyze the need for treatment and for the planning of health programs. Therefore, this study aims to verify the prevalence of dental fluorosis in 12-year-old children and its association with different fluoride levels in the public water supply source, and to evaluate the degree to which dental fluorosis is perceived by the studied children.

Methodology

This research is characterized as an epidemiological observational and cross-sectional study and was approved by the Ethics Committee on Research Involving Humans of Araçatuba Dental School (Protocol no. 2006-01515). Written consent was obtained and all dictates of the Declaration of Helsinki were respected.

The study population consisted of all 12-year-old children registered in the public schools of Birigui, São Paulo, Brazil, where approximately 83% of children are registered in public schools (n = 496). The city of Birigui has 108,728 inhabitants[8] and has been performing public water supply fluoridation controlled by the Department of Water and Drainage of Birigui since 1984. The city's complex water source system includes two deep wells that naturally contain fluoride at concentrations between 1.1 and 1.2 mgF/l, as well as semi-artesian wells. The city has two different areas: one where the fluoride concentration is maintained at optimal levels (approximately 0.7 mgF/l) and another where the fluoride level is higher than the recommended limits. The study participants were divided into two groups: those who had always lived in an area with excessive fluoride (1.2 mgF/l) and those who had always lived in an area with ideal fluoride levels (0.7 mgF/l) in the water supply. Only children who always lived at the same address and have studied in schools supplied by the same water source were selected for the study; thus, the fluoride levels in their school and home water supplies were similar. Further, only children who always consumed water from the public water supply system as opposed to bottled mineral water were included in the study.

The modified Dean's index, which classifies dental fluorosis into categories and is recommended by the WHO, was used for diagnosing dental fluorosis prevalence.[9] The modified Dean's index used in the present study allows comparison among many dental fluorosis studies and evaluations of its reproducibility show excellent concordance. This study was performed by a trained group composed of two examiners, two people to record the results, one coordinator, and two assistants. The researcher training was performed over a 3-day period, beginning with a study of 4 h to review all questions about dental fluorosis and a "gold standard" guide for obtaining an estimate of the extent and nature of diagnosis. Oral exams were performed to obtain an acceptable concordance that was maintained over a 0.91 (Kappa statistic).[10] The exams were performed in the schools under natural light at a standardized time of day, using school chairs and desks and a sterilized plane oral mirror.

A previously validated, structured questionnaire was presented to the subjects who presented with fluorotic spots, under the supervision of the responsible researcher, in order to obtain their esthetic perception in relation to dental fluorosis. Data processing and statistical analysis was performed using the Epi-Info Program version 3.5.3 (Centers for Disease Control and Prevention, Atlanta, USA).[11] To verify associations between fluorosis prevalence and the researched variables, a chi-square statistical test or Fisher's exact test was applied with a 5% level significance.

Results

Of the 496 children who participated in this study, 259 (52.2%) were girls. The majority of the subjects (58.9%) showed fluorosis, out of which 220 (44.4%) presented with very mild fluorosis (level 2), 59 (11.9%) with mild fluorosis (level 3), 12 (2.4%) with moderate fluorosis (level 4), and 1 (0.2%) with severe fluorosis (level 5). Some children (5.6%) showed questionable

fluorosis (level 1), whereas 176 (35.5%) showed no signs of clinical fluorosis (level 0) (Table 1).

Fluorosis was observed in 58.9% of the examined children, and the "very mild" level was the most prevalent (44.4%) without an association with gender ($p = 0.7849$), according to Fisher's test. Less than half of the children who presented with dental fluorosis (40.1%) perceived the clinical signals in their teeth and, among these, the majority (94.9%) expressed a wish to remove the fluorosis spots, 18 (15.4%) said that they avoided smiling due the spots, and 92 (78.6%) affirmed that the spots negatively influenced social engagement or play (Table 2).

Data about the distribution of dental fluorosis they show that an excessive concentration of fluoride in the public water supply was related to half of examined children (41.5%) and had an association with the presence of dental fluorosis ($p = 0.0004$) (Tables 3 and 4). According to Fisher's test, no significant difference was observed in the associations between areas with and without excessive fluoride and very mild and mild fluorosis levels ($p = 0.0781$) or areas with and without excess fluoride and moderate and severe fluorosis levels ($p = 0.4615$).

Although the percentage of girls who perceived the fluorosis signals in their teeth was slightly higher

Table 1. Distribution of the numerical and percentage values of the 496 twelve-year-old children examined, according to fluorosis level. Birigui, SP, Brazil, 2014.

Criterion	No Fluorosis		With Fluorosis				Total
Level	Normal	Questionable	Very mild	Mild	Moderate	Severe	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Children	176 (35.5)	28 (5.6)	220 (44.4)	59 (11.9)	12 (2.4)	1 (0.2)	
n (%)	204 (41.1)		292 (58.9)				496 (100)

Table 2. Distribution of examined children according to the prevalence of fluorosis prevalence, self-perception, and their feelings and attitudes about the clinical symptoms. Birigui, SP, Brazil, 2014.

Variable	n	%
Confirmed fluorosis	292	58.9
Questionable fluorosis	28	5.6
No fluorosis	176	35.5
No perception about fluorosis	175	59.9
Perception about fluorosis	117	40.1
Wish to remove the spots	111	94.9
Consult a dentist to remove the spots	8	6.8
Avoids smiling due the spots	18	15.4
The spots negatively influence engagement or playing	92	78.6
The spots interfere in daily life	32	27.4
Total	496	100

Table 3. Distribution of numerical and percentage values of the 496 twelve-year-old children examined, according to area with and without excess fluorine and level of fluorosis. Birigui, SP, Brazil, 2014.

Criterion	No Fluorosis		With Fluorosis				
Level	Normal	Questionable	Very mild	Mild	Moderate	Severe	n
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Fluoride excess	55 (26.7)	10 (4.9)	112 (54.3)	22 (10.7)	7 (3.4)	0 (0.0)	206 (100)
No fluoride excess	121 (41.7)	18 (6.2)	108 (37.2)	37 (12.8)	5 (1.8)	1 (0.3)	290 (100)
n	176 (35.5)	28 (5.6)	220 (44.4)	59 (11.9)	12 (2.4)	1 (0.2)	496 (100)
Total (%)	204 (41.1%)		292 (58.9%)				

Table 4. Distribution of numerical and percentage values of the 496 twelve-year-old children examined, according to the presence or absence of fluorosis, and water with and without fluorine excess in the water supply. Birigui, SP, Brazil, 2014.

Fluoride concentration in water supply	Fluorosis		
	Presence	Absence	Total
	n (%)	n (%)	n (%)
Fluoride excess	141 (68.4)	65 (31.6)	206 (100)
No fluoride excess	151 (52.1)	139 (47.9)	290 (100)
Total	292 (58.9)	204 (41.1)	496 (100)

(p = 0.0004)

(54.7%) than that of boys (45.3%), this association was not statistically significant (p = 0.9633). Among the 292 children who had some clinical signs of fluorosis, 98.3% had no knowledge on the meaning of fluorosis. Tables 5 and 6 show the social and economic features of the families of the children included in the study.

Discussion

Several studies regarding dental fluorosis in Brazil have found the prevalence of fluorosis to be less than 30% in urban areas with up to 0.8 mgF/l in the water supply.[6,12] The prevalence of fluorosis in areas over this level has been attributed to the combined effects of exposure to several fluoridated products.[6]

In this study, the children showed fluorosis indices higher (58.9%) than those found by the Brazilian Oral Health Epidemiological Survey, in the southeast region of Brazil (12%) and Brazil, in general (9%).[13] In an epidemiological survey carried out in São Paulo in 1998, the fluorosis prevalence in cities with fluoridated water was 14.9% and was classified as "very mild" (11.7%), "mild" (2.3%), "moderate" (0.8%), and "severe" (0.1%).[14] In another study performed in the same state in 2002 in cities with a fluoridated water supply, the prevalence of the disease was 13.8% and was classified as "very mild" (10.9%), "mild" (2.2%), "moderate" (0.6%), and "severe" (0.1%).[15]

In the present study, the "very mild" and "mild" levels predominated, in agreement with Cangussu *et al.*[2] deserving highlight the fact of having been found in the city of Birigui, carriers of moderate and severe fluorosis.

When chronic fluorosis prevalence becomes established in some populations, any child that shows some level of fluorosis can be classified as a carrier of this condition.[16] "Questionable fluorosis" is not included in the "normal" classification because of alterations in the dental enamel and should be considered as pathological. According to Ripa,[17] it is better to exclude questionable fluorosis and consider these cases as dubious, thus avoiding an overestimation of fluorosis prevalence. Although 58.9% (n = 292) of the studied population presented

Table 5. Absolute and perceptual distribution of fathers and mothers, according to their schooling and job. Birigui, SP, Brazil, 2014.

Variable	Father	Mother
Schooling	n (%)	n (%)
Illiterate	5 (1.0)	6 (1.2)
Capable of reading and writing	5 (1.0)	4 (0.8)
Did not complete elementary school	154 (31.1)	209 (42.1)
Completed elementary school	98 (19.8)	80 (16.1)
Did not complete high school	30 (6.0)	42 (8.5)
Completed high school	85 (17.1)	94 (19.0)
University	13 (2.6)	14 (2.8)
No answer	106 (21.4)	47 (9.5)
Total	496 (100.0)	496 (100.0)
Job		
Registered work	266 (53.6)	270 (54.5)
Self-employed	148 (29.9)	76 (15.3)
Temporary work	10 (2.0)	18 (3.6)
No defined work	3 (0.6)	2 (0.4)
Student or unemployed	6 (1.2)	6 (1.2)
Retired	17 (3.4)	10 (2.0)
Domestic households	-	111 (22.4)
No information	46 (9.3)	3 (0.6)
Total	496 (100.0)	496 (100.0)

Table 6. Social and economic characteristics of the studied children's family, according to the number of family members and total monthly income. Birigui, SP, Brazil, 2014.

Number of family members	%
2	2.8
3	19.0
4	40.3
5 or more	37.9
Monthly income (in minimum wages)	
Less than 1	1.8
1 to 2	28.2
3 to 5	54.5
6 to 10	11.3
More than 10	0.7
No information	3.4

with dental fluorosis to some degree, it was possible to observe that fluorosis, as diagnosed by this work, had not been perceived by the majority of the subjects. Most of the interviewed subjects (59.9%) did not indicate self-perception to any type of spots in their teeth, including fluorosis spots, showing that the presence of the disease did not promote an impairment in their quality of life, which corroborates the findings of previous studies.[18] On the other hand, a study carried out in 55 children aged between 12 and 16 years old affected with fluorosis showed that fluorosis can be considered a concern factor on the esthetics of those affected.[19] Divergence can be attributed to the different methods of assessment or to the different cultural standards of the studied populations. Further, more serious dental problems not investigated in this study such as dental occlusion may have diverted the attention from the fluoridated spots.

Previous studies have shown that spots and enamel defects, even if the spots are perceived by children, do not interfere the children's quality of life.[15,20] However, other studies have shown that higher levels of severity of the disease promoted a higher social and psychological discomfort.[21] The clinical characteristics of fluorosis lead to shy, sad, and quiet children who cover their faces with their hands to express happiness, smile with closed lips, do not participate in school social activities, and avoid talking with their classmates and smiling due to the shame of their dental appearance.[22]

In this study, few children who perceived the presence of fluorosis in their teeth demonstrated a wish to change their dental appearance. These results are in agreement with the findings of Bhagyajyothi and Pushpanjali,[19] but it should be noted that the self-perception of fluorosis by children was greater in the present study and that Brazilian children were less disturbed with their dental appearance compared with Indian children.

When patients perceive differences in their oral condition and when this causes changes to their social life, it is expected that they will visit a dentist to resolve the problem. However, accessing esthetic treatment is difficult due to the social and economic conditions of patients and given the limited treatment available without the coverage of prepaid health plans or public health services. This result show the difficulty of access by children that participated of this study and it was possible to notice that the majority of teenagers have the average 4 elements on their family with incomes varying from 3 to 5 and 1 to 2 minimum wages. Further, as indicated by the analyses performed, most parents had not completed junior high school.

Although there are no associations between gender and the self-perception of fluorosis as was also observed in the results of previous studies,[22] some studies have shown a higher esthetic perception by girls than boys,[1] probably due to their higher vanity.

In addition, it should be noted that the studied city is located in a region with a hot climate, where consumption of liquids is high, and therefore the risk of dental fluorosis is higher even if the water contains values near the fluoride concentration limits.[23] Therefore, the control of external sources of fluoride in areas with high fluoride concentration in the public water supply is recommended.

Current studies have found that the prevalence and severity of dental fluorosis has equally increased in regions with a fluoridated water supply and in areas without this benefit. This increase has been attributed to fluoride consumption from other sources such as fluoride toothpaste and diet and nutritional supplements with fluoride.[9]

According to Ahokas *et al*.,[23] the possible risk factors associated with dental fluorosis include living in regions with water supply fluoridation even at ideal concentrations, the use of fluoride supplements, fluoride levels in toothpaste, early age of toothpaste use for hygiene, a high frequency of oral hygiene with toothpaste and ingestion of toothpaste, early weaning, and a long period of consumption of infant formula. Therefore, studies on fluoride ingestion are necessary for the ideal monitoring of dental fluorosis in these communities considering the importance of public water fluoridation, whose positive effect can be seen in the decrease of the prevalence of caries, as observed in national oral health epidemiological studies.[24] Dental fluorosis cannot be attributed only to public water supply fluoridation; however, there may be a relation with fluoride levels in some cities where levels are higher than the recommended parameters when associated with other sources of fluoride intake. Water

fluoridation is an effective and safe means of preventing dental caries; therefore, monitoring of the quality of the public water supply and its fluoride levels is necessary and should be a priority in health vigilance activities.[25,26,27] The results of this study will assist municipal health services by demonstrating that a 1.2 ppm fluoride concentration does not greatly affect the population and, therefore, there is no need for costly investments in the adequacy of the water supply system.

Conclusion

The majority of children did not perceive fluorosis spots, demonstrating that fluorosis did not affect their quality of life. It is recommended that subjective or self-perception indicators of oral health be coupled with objective indicators in order to detect the effects of oral health problems on the patients' quality of life, given that the normative perception can overestimate this factor.

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