Prevalence of dental fluorosis in Curitiba, Brazil, in the years of 2006 and 2016

Prevalência da fluorose dental em Curitiba, Brasil, nos anos de 2006 e 2016

DOI:10.34119/bjhrv4n1-018

Recebimento dos originais: 05/12/2020
Aceitação para publicação: 05/01/2021

Mariana Dalledone
PhD, School of Health Sciences, Universidade Positivo
Rua Professor Pedro Viriato Parigot de Souza, 5300, CEP 80740-050, Curitiba, PR, Brasil.
E-mail: mari.pediatria@gmail.com

Viviane de Souza Gubert Fruet
MSc, School of Life Sciences, Pontifícia Universidade Católica do Paraná
Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba, PR, Brasil.
E-mail: vgubert@sms.curitiba.pr.gov.br

Débora Fachinelli Nishi de Souza
DDS, School of Health Sciences, Universidade Positivo
Rua Professor Pedro Viriato Parigot de Souza, 5300, CEP 80740-050, Curitiba, PR, Brasil.
E-mail: de.fachinelli@hotmail.com

Fernanda Mara de Paiva Bertoli
DDS, School of Health Sciences, Universidade Positivo
Rua Professor Pedro Viriato Parigot de Souza, 5300, CEP 80740-050, Curitiba, PR, Brasil.
E-mail: nandabertoli@gmail.com

Giovana Daniela Percharki
PhD, Department of Public Health, Universidade Federal do Paraná, Curitiba
Av. Prefeito Lothário Meissner, 632, CEP 80210-170, Curitiba, PR, Brasil.
E-mail: g_pecharki@yahoo.com.br

Juliana Feltrin Souza
PhD, Department of Stomatology, Universidade Federal do Paraná
Av. Prefeito Lothário Meissner, 632, CEP 80210-170, Curitiba, PR, Brasil.
E-mail: julianafeltrin1@gmail.com

Paula Cristina Trevilatto
PhD, School of Life Sciences, Pontifícia Universidade Católica do Paraná
Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba, PR, Brasil.
E-mail: paula.trevilatto@pucpr.br

Marilisa Carneiro Leão Gabardo
PhD, School of Health Sciences, Universidade Positivo
Rua Professor Pedro Viriato Parigot de Souza, 5300, CEP 80740-050, Curitiba, PR, Brasil.
E-mail: marilisagabardo@gmail.com

Samuel Jorge Moysés
PhD, School of Life Sciences, Pontifícia Universidade Católica do Paraná
Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba, PR, Brasil.
E-mail: samueljorgemoyses@gmail.com

João Armando Brancher
PhD, School of Health Sciences, Universidade Positivo
Rua Professor Pedro Viriato Parigot de Souza, 5300, CEP 80740-050, Curitiba, PR, Brasil.
E-mail: brancher.a@gmail.com

ABSTRACT
Objective. The objective of this study was to describe the prevalence of dental fluorosis (DF) in 12-year-old schoolchildren from Curitiba, Brazil, in the years of 2006 and 2016.
Methods. Participants were randomly selected from municipal, state and private schools. Schoolchildren were randomly chosen from within the Health Districts (HD), and thus a total of 679 and 934 participated in the years of 2006 and 2016 respectively. They were examined and their DF was classified according to the modified Dean index. The data were analyzed to determine distribution and the Chi-square test was used to search for associations between the outcome (DF) and the dependent variables (gender and HD), using SPSS, version 21.0.
Results. There was an overall decrease in DF cases from 27.7% to 17.0 % (OR = 1.83; 95% CI: 1.44 - 2.33) in the period analyzed. There was an increase in cases of moderate DF from 16.5% in 2006 to 20.5% in 2016 however, without statistical significance (OR = 0.76; 95% CI: 0.44 - 1.31). When the variables gender and HD were included in the bivariate analysis, they presented no significant association with the outcome ($p > 0.05$).
Conclusions. The decrease in the prevalence of DF was significant in the period, although the values remained high, and that the dependent variables were not significantly associated with the outcome.

Key words: epidemiology, dental fluorosis, prevalence study.

RESUMO
Objetivo. O objetivo deste estudo foi descrever a prevalência da fluorose dentária (DF) em crianças de 12 anos de idade em idade escolar de Curitiba, Brasil, nos anos de 2006 e 2016.
Métodos. Os participantes foram selecionados aleatoriamente de escolas municipais, estaduais e particulares. As crianças em idade escolar foram escolhidas aleatoriamente dentro dos Distritos de Saúde (HD), e assim um total de 679 e 934 participaram nos anos de 2006 e 2016, respectivamente. Eles foram examinados e seu DF foi classificado de acordo com o índice Dean modificado. Os dados foram analisados para determinar a distribuição e o teste Qui-quadrado foi usado para procurar associações entre o resultado (DF) e as variáveis dependentes (sexo e HD), usando o SPSS, versão 21.0.

Resultados. Houve uma diminuição geral nos casos DF de 27,7% para 17,0 % (OR = 1,83; 95% CI: 1,44 - 2,33) no período analisado. Houve um aumento nos casos de DF moderado de 16,5% em 2006 para 20,5% em 2016, porém sem significância estatística (OR = 0,76; 95% CI: 0,44 - 1,31). Quando as variáveis sexo e HD foram incluídas na análise bivariada, elas não apresentaram associação significativa com o resultado (p> 0,05).
Conclusões. A diminuição da prevalência do DF foi significativa no período, embora os valores tenham permanecido altos, e que as variáveis dependentes não foram associadas significativamente com o resultado.

Palavras-chave: epidemiologia, fluorose dentária, estudo de prevalência.

1 INTRODUCTION

The use of fluoride in the prevention of dental caries has had a large positive impact on the oral health of populations. In fact, the fluoridation of public water supplies, in particular, is an important public health measures and has been recommended by international health organizations (1). In areas where water fluoridation was proposed, the issue of caries decreased substantially (2). Consistent reviews have pointed to water fluoridation's safe and beneficial effects for individuals (3). Furthermore, dental expenses are lower in communities with fluoridated water (4).

However, the issue is still controversial in the literature (5). Some authors dispute that the control of dental caries was not directly associated with water fluoridation, while the risk of dental fluorosis is high (DF) (6). In Brazil, legislation sets a limit of 0.6 to 1.7 parts per million (ppm) of fluoride in drinking water (7). Consumption of fluoridated water has been implicated with values greater than 50% (8) of the maximum daily ideal of 0.05 to 0.07mg F / kg (9). As well as the amount of fluoride contained in toothpastes, where the Brazilian regulation (ANVISA, Resolution 79, dated August 28, 2000) monitors the maximum amount (0.15%, 1,500 ppm F), but does not establish the minimum quantity for this. It is suggested that the regulation on fluoride toothpastes needs to be revised to assure the efficacy of those products for caries control in Brazil (10).

The prevalence and severity of DF are related to the amount of ingested fluoride (11), a fact that has been demonstrated in several studies (12). The prevalence of DF around the world varies between 7.7% and 80.7%(13,6) and in Brazil, DF has been increasing significantly to the point of being considered a public health problem (13). The enamel alteration stems not only from the intake of fluoridated water, but from the length of time during which it is consumed (14), bringing attention to the ingestion of fluorides

from other potentially causative sources, such as food and beverages, pharmacological supplements, use of dentifrices and fluoridated mouthwash (13,14).

The justification for the present research is that Curitiba became the first Brazilian capital to have a fluoridated public water supply in 1958(15), with a fluoride concentration of about 0.7 ppm (16) to 0.8 ppm (17). Historically, the prevalence of DF in the city is high and above that of neighboring cities (18). Therefore, the objective of this study was to evaluate the prevalence of DF in 12-year-old schoolchildren in the city of Curitiba, Paraná, in the years of 2006 and 2016.

2 MATERIALS & METHODS

2.1 ETHICAL ASPECTS

With a cross-sectional approach, two collections were carried out in two moments: 2006 and 2016. Twelve-year-old schoolchildren, whose parents or legal guardians signed a free and informed consent form, were invited to participate, under the approval of Institutional Human Research Ethics Committees (nº 487/2005 and nº 1,184,196 / 2014). The students' guardians answered a questionnaire about their minor's general health and oral hygiene habits. Children with a history of development of systemic diseases and those with orthodontic equipment were not included in the study.

2.2 SAMPLE GROUP SELECTION

For the sample calculation, data were taken from the Brazilian Institute of Geography and Statistics of 2000 and 2010, and the State Office of Education of Curitiba. The prevalence of DF in this population was estimated at 12% (19,20), with an accuracy of 3%. The limit value for the rejection area was 1.96 and the design effect was 1.5. We used the stratified sampling technique by health district. The schools were randomly selected to compose the HD groups and, within each stratum, simple random samples of students were taken. That is, each element of its respective group had an equal chance (1/N) of belonging to the sample.

Following this estimate of DF prevalence, in 2006 Brancher *et al.*(21), selected and examined 679 unrelated children of both sexes with a mean age of 12 years, from six public schools (municipal and state) and six private schools in Curitiba that represented the HD of the municipality. The twelve schools were chosen randomly and there were no two public or private schools from the same HD.

In 2016, Bertoli *et al.* (22) examined 934 children of both sexes with a mean age of 12 years (10 to 14 years), taken from 21 public (municipal and state) and private schools of the same municipality. Once again, the schools were chosen randomly and were representative of the health districts.

2.3 CLINICAL EXAMINATION

The clinical examination was performed under natural light, in the school environment, by two trained and calibrated examiners. To assess the consistency of each examiner (inter- and intraexaminer reproducibility), duplicate examinations were conducted on 10% of the sample and the Kappa test was used to measure reliability. The diagnosis of DF was recorded according to the modified Dean index (23) as: normal, questionable, very mild, mild, moderate and severe. The inter- and intra-examiner agreement was greater than 0.75.

2.4 STATISTICAL ANALYSIS

The dependent variable DF was dichotomized into: present (very mild, mild, moderate and severe) and absent (normal and questionable). Data were analyzed in the SPSS software, version 21. After the univariate analysis, associations between DF and the independent variables (gender and HD) were sought using the chi-square test with a significance level of 5%.

3 RESULTS

In 2006, 679 children were examined, 54.9% being girls and 45.1% boys. In 2016, the gender distribution of the children examined remained practically the same, since 934 children participated in the study, 55.1% being girls and 44.9% boys. There were no significant differences in age and gender distribution among the groups of children examined. The independent characteristics of the samples surveyed are shown in Table 1.

The prevalence of DF decreased from 27.7% in 2006 to 17.2% in 2016, and the distribution of cases in the very mild/ mild, moderate and severe classes remained practically unchanged (OR = 1.83; 95% CI: 1.44 - 2.33) (Table 2). There was an increase in cases of moderate DF from 16.5% in 2006 to 20.5% in 2016 (OR = 0.76; 95% CI: 0.44 - 1.31). Also, the geographic distribution by HD remained similar, except for the Health

Districts of Pinheirinho, Portão and Santa Felicidade, which were subdivided to create the HD of the Industrial City of Curitiba (CIC) (Table 3).

4 DISCUSSION

This study investigated the prevalence of DF in 12-year-old schoolchildren living in Curitiba, Paraná, in the years of 2006 and 2016. In this period, the prevalence of DF in the sample population decreased from 27.7% to 17.2%.

A systematic review of the literature indicates that the prevalence of DF varies according to several factors, including exposure time to fluoride present in water, air, diet and other sources (14). The use of fluoride is directly associated with a decrease in the prevalence of dental caries in populations (1), However, there are controversies in the literature (5) and this positive effect of controlling caries has also been accompanied by the increase in cases of DF in several localities (21,13), even indicating that the amount of fluoride ingested is directly related to the severity of DF (6,11,).

It should be noted that fluoridated public drinking water is considered safe for human health (3) whose main effect is the mitigation of dental caries (2). Despite the exhaustive search for an association between fluoridated water supplies and DF, the various sources of fluoride in everyday life, such as food, beverages and dentifrices, should still be taken into account (14,24). However, in a systematic review it was evaluated the effects of water fluoridation (artificial or natural) on the prevention of dental caries and DF. The authors concluded that with regard to DF, the percentage of participants with DF of aesthetic concern was approximately 12% considering a fluoride level of 0.7 ppm; this value increases to 40% when any level of DF was considered (6).

Studies indicate that, despite the ingestion of water with optimal levels of fluoride, children have exceeded the maximum recommended dose, probably due to diet and the use of toothpaste during brushing, influencing the DF outcome (24), given that DF is a defect in the mineral structure of a tooth, resulting from the incorporation of fluoride during tooth formation, which occurs in some stages of childhood (25).

Curitiba follows the ideal concentration of fluoride in water recommended by Brazilian legislation (7), as well as by the literature, with the concentration in the Brazilian capitals varying from 0.6 to 0.9 mg/L, mainly for the purpose of preventing dental caries (17). This is due to the *Companhia de Saneamento do Paraná* - Paraná Water and Sanitation Company's (SANEPAR) strict control over the process. In 2006, data showed that the monthly average concentration of fluoride in the water supply was 0.69

(± 0.09) ppm. In 2016, this value was 0.75 (± 0.01) ppm (24). Also, there is no significant difference in the fluoride concentration of waters from different health districts, conferring the homogeneity reflected in the distribution of the cases of DF between HD in the present study.

In Brazil, the federal government carried out epidemiological surveys on oral health in 2003 and 2010 (19,20). The data obtained in both revealed a decline in the prevalence of dental caries in Curitiba (19,20). Regarding DF prevalence, data from these same projects indicated a national increase during the decade analyzed: in 2003 it reached 10.7% among the 12-year-olds surveyed, and in 2010 it had worsened to 14.8%. However, Freitas *et al.* (27), showed that is not possible to analyze trends in DF in Brazil using the data available from these national surveys, because different models of analysis were used in both, serving the data as exploratory indicators of the prevalence of DF. The authors emphasize the importance of surveys, provided that these limitations are considered.

Cangussu *et al.* (13) critically reviewed DF in Brazil and indicated global values of the malady in Curitiba at 25.6%, and specifically for the moderate/severe classes it was 0.27%. This present study in Curitiba reveals a decrease in DF from 2006 to 2016, but the results are still higher than the official national data, which for 12-year-olds was 9% in 2003 (20) and 16.7% in 2010 (19).

In the two moments of the present study, 1613 children were examined. Overall, 349 children (21.6%) presented some degree of DF, a value similar to that found by Jordão *et al.*(28), who also performed analyses at different times in 2003 and 2010. In comparison, the populations of Pakistan and India presented global values (of DF prevalence among 12-year-olds) of 63.6% (29) and 4.1% (30), respectively. In Brazil, some surveys with schoolchildren revealed a prevalence of DF of almost 80% (31).

Regarding the level of severity of DF, the moderate and severe classes in this study comprised 3.9% and 1.8% of the sample, respectively, similar to that found in the Indian (32). Higher prevalence rates for these classes have also been found, reaching 23.2% in central Mexico (33) and 50.5% in Quetta, Pakistan (29). In Brazil, the prevalence of dental fluorosis in 12-year-old children was 16.7%, with 1.5% of moderate, and severe was considered null (19).

All the children included in this study were born and raised in Curitiba and, irrespective of the region in which they lived, they received treated and fluoridated water for at least 10 consecutive years. The study by Ramesh *et al.* (34) shows that children

who lived their first five years of life in regions with high concentrations of fluoride in water developed more DF lesions than those living in similar areas between five and 10 years of age. An investigation in several databases on the prevalence of DF revealed that in the age group of 6 to 18 years, with exposure between 6 and 8 years of life to fluoridated water (0.7 ppm), DF was estimated at 12.9%. These reports corroborate the work of Fejerskov *et al*. (26), who affirm that the first and second childhood are critical phases for the development of DF.

In the present study, adolescents consumed water at an ideal fluoride concentration for over a decade (16,17) and a decrease in DF prevalence was observed, indicating that most likely this condition is not only associated with exposure to fluorine through the water supply. The lack of association of DF solely to the consumption of fluoridated water is supported by several publications (13,14). Research points to the time of exposure to fluoridated water and access to other sources of fluoride as important determinants of the condition (13,14).

Regarding the distribution of DF by gender, there was no significant difference. Jordão *et al* .(28) also did not identify an association between this variable and the outcome. However, Ramesh *et al*. (34) found that DF affected more boys, with the explanation being that they consume more water because of their higher frequency of physical activity compared to girls. Since high local temperatures could determine higher consumption of fluoridated water, studies that investigated this context did not identify the gender association (25).

The limitations of this research are due to the cross-sectional nature of the study, because it does not allow the establishment of causal relationships, nor does it consider access to other sources of fluoride at the time of examination. Yet its findings regarding indices of dental fluorosis hold validity due to the methodological care taken with the sample representativity in the study. In order to estimate the prevalence of DF, the modified Dean index (23) was used because it is a simple method that allows reliable diagnoses, especially when examining large populations of individuals outside the clinic setting. Moreover, this method is recommended for sites where the concentration of fluorine in water is less than 5 ppm (35). However, this index does not clearly distinguish important degrees of the more severe forms of the disease, given the grouping into a single “severe” category (26).

Although the current findings indicate the existence of the DF condition, an issue under debate in public health (12,13), fluoridation of public water supplies is an effective

method in the prevention of dental caries (12) and has an important social impact, especially for the Brazilian population (5). Finally, the prevalence of DF in the city of Curitiba, although still holding relevant values, has decreased significantly over the analysis of one decade. Moreover, the independent variables analyzed (gender and health district) were not associated with the outcome.

ACKNOWLEDGEMENTS

The authors would like to thank all the directors of the schools visited, the State Department of Education, and all participants in the research.

REFERENCES

1. The World Oral Health report 2003. Geneva: WHO; 2003. Accessed September 22 2017 from https://www.who.int/oral_health/media/en/orh_report03_en.pdf

2. Narvai PC. Cárie dentária e flúor: uma relação do século XX. Cien Saude Colet. 2000; 5:381-92.

3. McDonagh MS, Whiting PF, Wilson PM, Sutton AJ, Chestnut I, Cooper J, et al. Systematic review of water fluoridation. BMJ. 2000; 321:855-9.

4. Ran T, Chattopadhyay SK, Community Preventive Services Task Force. Economic Evaluation of Community Water Fluoridation: A Community Guide Systematic Review. Am J Prev Med. 2016; 50:790-6.

5. Moysés SJ, Moysés ST, Allegretti ACV, Argenta M, Werneck R. Fluorose dental: ficção epidemiológica? Rev Pan Salud Publica. 2002; 12:339-46.

6. Iheozor-Ejiofor Z, Worthington HV, Walsh T, O'Malley L, Clarkson JE, Macey R, et al. Water fluoridation for the prevention of dental caries. Cochrane Database Syst Rev. 2015; CD010856.

7. Brasil. Projeto SB Brasil: Condições de Saúde Bucal da População Brasileira 2002 -2003 – Resultados Principais. Ministério da Saúde. Secretaria de Atenção à Saúde. Secretaria de Vigilância em Saúde. Brasília: Ministério da Saúde; 2004. 52 p.

8. Lima-Arsati YBO, Gomes ARLF, Santos HKA, Arsati F, Oliveira MC, Freitas VS. Exposure to fluoride of children during the critical age for dental fluorosis, in the semiarid region of Brazil. Cien Saude Colet. 2018; 23:1045-54.

9. Burt BA. The changing patterns of systemic fluoride intake. J Dent Res. 1992; 71:1228-37.

10. Cury JA, Caldarelli PG, Tenuta LMA. Necessity to review the Brazilian regulation about fluoride toothpastes. Rev Saúde Pública. 2015; 49:74.

11. Fejerskov O, Manji F, Baelum V. The nature and mechanisms of dental fluorosis in man. J Dent Res. 1990; 69 (Spec No):692-700; discussion 721.

12. McGrady MG, Ellwood RP, Maguire A, Goodwin M, Boothman N, Pretty IA. The association between social deprivation and the prevalence and severity of dental caries and fluorosis in populations with and without water fluoridation. BMC Public Health. 2012; 12:1122.

13. Cangussu MCT, Narvai PC, Fernandez RC, Djehizian V. A fluorose dentária no Brasil: uma revisão crítica. Cad Saúde Pública. 2002; 18:7-15.

14. Goodarzi F, Mahvi AH, Hosseini M, Nedjat S, Nabizadeh Nodehi R, Kharazifard MJ, et al. The prevalence of dental fluorosis and exposure to fluoride in drinking water: A systematic review. J Dent Res Dent Clin Dent Prospects. 2016; 10:127-35.

15. Amarante LM, Jitomirski F, Amarante CLF. Flúor: benefícios e controvérsias dos programas de fluoretação. Rev Bras Odontol. 1993; 50:22-30.

16. Motter J, Moysés ST, França BHS, Carvalho ML, Moysés SJ. Análise da concentração de flúor na água em Curitiba, Brasil: comparação entre técnicas. Rev Panam Salud Publica. 2011; 29:120-5.

17. Frazão P, Peres MA, Cury JA. Qualidade da água para consumo humano e concentração de fluoreto. Rev Saúde Pública. 2011; 45:964-93.

18. SMS-Curitiba. Secretaria Municipal de Saúde de Curitiba. Fluorose – um estudo em crianças de 12 anos de Curitiba. Boletim Epidemiológico e Saúde Oral de Curitiba. 1997; 1:3-4.

19. Brasil. Projeto SB Brasil 2010: Pesquisa nacional de saúde bucal - Primeiros resultados. Ministério da Saúde. Secretaria de Atenção à Saúde. Secretaria de Vigilância em Saúde. Brasília: Ministério da Saúde; 2012. 116 p.

20. Brasil. Projeto SB Brasil: Condições de Saúde Bucal da População Brasileira 2002 -2003 – Resultados Principais. Ministério da Saúde. Secretaria de Atenção à Saúde. Secretaria de Vigilância em Saúde. Brasília: Ministério da Saúde; 2004. 52 p.

21. Brancher JA, Pecharki GD, Doetzer AD, Medeiros KGS, Cordeiro CA, Sotomaior VS, Bauer P, Trevilatto PC. Analysis of polymorphisms in the lactotransferrin gene promoter and dental caries. Int J Dent. 2011; 2011: 571726.

22. Bertoli FMP, Bruzamolin CD, Pizzatto E, Losso EM, Brancher JA, Souza JF. Prevalence of diagnosed temporomandibular disorders: A cross-sectional study in Brazilian adolescents. PLoS One. 2018; 13: e0192254.

23. Dean HT. The investigation of physiological effects by epidemiological method. In: Moulton FR, editor. Fluorine and dental health. Washington (DC): American Association for the Advancement of Science; 1942. pp. 23-31.

24. Companhia de Saneamento do Paraná (SANEPAR). Accessed June 10 2017 from http://site.sanepar.com.br/noticias/agua-do-sistema-publico-ajuda-prevenir-carie

25. Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes--a longitudinal study. J Public Health Dent. 2009; 69:111-5.

26. Fejerskov O, Manji F, Baelum V, Möeler IJ. Fluorose dentária: um manual para profissionais de saúde. São Paulo: Santos; 1994. 122 p.

27. Freitas CH, Sampaio FC, Roncalli AG, Moysés SJ. Methodological discussion about prevalence of the dental fluorosis on dental health surveys. Rev Saude Publica. 2013; 47(Suppl 3):138-47.

28. Jordão LM, Vasconcelos DN, Moreira Rda S, Freire Mdo C. Dental fluorosis: prevalence and associated factors in 12-year-old schoolchildren in Goiânia, Goiás. Rev Bras Epidemiol. 2015; 18:568-77.

29. Sami E, Vichayanrat T, Satitvipawee P. Caries with dental fluorosis and oral health behaviour among 12-year school children in moderate-fluoride drinking water community in Quetta, Pakistan. J Coll Physicians Surg Pak. 2016; 26:744-7.

30. Plaka K, Ravindra K, Mor S, Gauba K. Risk factors and prevalence of dental fluorosis and dental caries in school children of North India. Environ Monit Assess. 2017; 189:40.

31. Moura MS, Barbosa PR, Nunes-Dos-Santos DL, Dantas-Neta NB, Moura Lde F, de Lima Mde D. Epidemiological surveillance of dental fluorosis in a city with a tropical climate with a fluoridated public drinking water supply. Cien Saude Colet. 2016; 21:1247-54.

32. Bali RK, Mathur VB, Talwar PP, Chanana HB. National oral health survey and fluoride mapping 2002-2003 India. New Delhi: Dental Council of India; 2004. p. 132.

33. García-Pérez Á, Irigoyen-Camacho ME, Borges-Yáñez SA, Zepeda-Zepeda MA, Bolona-Gallardo I, Maupomé G. Impact of caries and dental fluorosis on oral health-related quality of life: a cross-sectional study in schoolchildren receiving water naturally fluoridated at above-optimal levels. Clin Oral Investig. 2017; 21:2771-80.

34. Ramesh M, Narasimhan M, Krishnan R, Chalakkal P, Aruna RM, Kuruvilah S. The prevalence of dental fluorosis and its associated factors in Salem district. Contemp Clin Dent .2016; 7:203-8.

35. Rozier RG. Epidemiologic indices for measuring the clinical manifestations of dental fluorosis: overview and critique. Adv Dent Res. 1994; 8:39-55.

TABLE 1 Distribution of the independent variables of the sample of 12-year-old students in the years 2006 and 2016 (Curitiba, Paraná, Brazil)

Variables	**2006 (n = 679) n (%)**	**2016 (n = 934) n (%)**
Gender		
Female	370 (54.5)	515 (55.1)
Male	309 (45.5)	419 (44.9)
Health District		
Portão	113 (16.7)	35 (3.74)
CIC	*	135 (14.4)
Bairro Novo	*	96 (10.2)
Cajuru	109 (16.0)	108 (11.6)
Boqueirão	104 (15.3)	99 (10.6)
Matriz	**	75 (8.0)
Boa Vista	109 (16.0)	147 (15.7)
Pinheirinho	133 (19.6)	87 (9.3)
Santa Felicidade	111 (16.4)	152 (16.2)

** District excluded from the sample because they are not expressively representative of the city.
* District not founded in 2006.

TABLE 2 Prevalence of DF and severity in the sample of 12-year-old schoolchildren in 2006 and 2016 (Curitiba, Paraná, Brazil).

Variable	**2006 (n = 679) n (%)**	**2016 (n = 934) n (%)**	**p value***
DF			
Absent	491 (72.3)	773 (82.7)	**<0.001**
Present	188 (27.7)	161 (17.3)	
DF Classification			
Very mild and mild	138 (73.4)	117 (72.7)	
Moderated	31 (16.5)	33 (20.5)	0.397
Severe	19 (10.1)	11 (6.8)	

Note: Bold values are statistically significant. * Chi-square test ($p < 0.05$).

TABLE 3 Association between prevalence of DF and independent variables of the sample of 12-year-old schoolchildren, in the years 2006 and 2016 (Curitiba, Paraná, Brazil).

Variable	**2006**			**2016**		
	DF		**p value***	**DF**		**p value***
	Present (n = 188)	**Absent (n = 491)**		**Present (n = 161)**	**Absent (n = 773)**	
Gender	**n (%)**	**n (%)**		**n (%)**	**n (%)**	
Female	90 (47.9)	219 (44.6)		96 (59.6)	419 (54.2)	
Male	98 (52.1)	272 (55.4)	0.444	65 (40.4)	354 (45.8)	0.208
Health District			0.225			0.472
Portão	36 (19.1)	77 (15.6)		9 (5.6)	26 (3.4)	
Cajuru	33 (17.6)	76 (15.5)		17 (10.6)	91 (11.8)	
Boqueirão	25(13.3)	79 (16.1)		18 (11.2)	81 (10.5)	
Boa Vista	31 (16.5)	78 (15.9)		26 (16.1)	121 (15.7)	
Pinheirinho	27 (14.4)	106 (21.6)		17 (10.6)	70 (9.1)	

Santa Felicidade	36 (19.1)	75 (15.3)	19 (11.8)	133 (17.2)

* Chi-square test ($p < 0.05$).
Note: Districts created later and included in the analysis:
CIC: Yes (n = 23; 14.3%); No (n = 112; 14.5%)
Bairro Novo: Yes (n = 14; 8.7%); No (n = 82; 10.6%)
Matriz: Yes (n= 18; 11.2%). No (n = 57; 7.4%)