

Oral health profile of schoolchildren living in regions with endemic dental fluorosis
Perfil de saúde bucal em escolares residentes em uma região endêmica de fluorose dental
Perfil de salud bucal en escolares residentes en una región endémica de fluorosis dental

Received: 18/04/2017

Approved: 21/12/2017

Published: 05/04/2018

Consuelo Fernanda Macedo de Souza¹
Teodomiro Dutra de Abreu²
Gabrielle Stella Dantas Barbosa³
Cynára Liane Jales Ataíde de Melo⁴
Maria Soraya Pereira Franco Adriano⁵

This study aimed at evaluating the oral health of schoolchildren who live in an area which is endemic for dental fluorosis. The region presents a concentration of 5.16 mg/L of fluorine in its water for human consumption. This is an observational, cross-sectional, field research, conducted in the city of São José do Rio do Peixe (PB), in 2016. Two trained examiners analyzed the clinical exam of schoolchildren from 6 to 8 years of age. The CPO-d index, the periodontal index (PSR) and the Dean index to evaluate dental cavities, periodontal health and fluorosis levels, respectively. 13 students from 6 to 8 years of age were analyzed. The CPO-d and Ceo-d presented average levels of 1.0 (DP=10) and 2.6 (DP=3.5), respectively. Regarding their permanent teeth, it was found that 38.5% of volunteers presented a CPO-d level of 0, while 7.7% presented at least three dental elements affected in some level by tooth decay. Regarding the Ceo-d, 30.8% presented at least 4 elements affected by this disease. The fluorosis diagnostic from the TF index showed that all volunteers presented some level of fluorosis. It was concluded that the children from the Vila do Brejo region present active cavities, dental fluorosis in degrees above 2 (TF index) and the presence of gingival bleeding.

Descriptors: Fluorosis; DMF index; Gingivitis.

Este estudo teve como objetivo avaliar a saúde oral de escolares que vivem em área endêmica de fluorose dental. A região apresenta em sua água de consumo humano uma concentração de 5,16 mg/L de flúor. Esta é uma pesquisa do tipo observacional, transversal, de campo, realizada no município de São João do Rio do Peixe (PB) no ano de 2016. Dois examinadores treinados realizaram o exame clínico em escolares de 6 a 8 anos. Foram utilizados os índices de CPO-d, índice periodontal (PSR) e índice de Dean para avaliação de cárie dentária, saúde periodontal e grau de fluorose, respectivamente. Foram analisados 13 alunos com idades entre 6 e 8 anos. Os índices CPO-d e Ceo-d apresentaram valores médios de 1,0 (DP=1) e 2,6 (DP=3,5) respectivamente. Com relação aos dentes permanentes viu-se que 38,5% dos voluntários apresentaram índice CPO-d 0, enquanto 7,7% apresentavam pelos menos três elementos dentários afetados de alguma forma pela doença cárie. Com relação ao Ceo-d, 30,8% apresentaram pelo menos 4 elementos acometidos pela doença. O diagnóstico de fluorose pelo índice TF mostrou que todos os voluntários apresentaram certo grau de fluorose. Conclui-se que as crianças residentes na região da Vila do Brejo apresentam cárie ativa, fluorose dentária em graus acima de 2 (índice TF) e presença de sangramento gengival.

Descritores: Fluorose dentária; Índice CPO; Gengivite.

Este estudio tuvo como objetivo evaluar la salud oral de escolares que viven en área endémica de fluorosis dental. La región presenta en su agua de consumo humano una concentración de 5,16 mg/L de flúor. Esta es una investigación del tipo observacional, transversal, de campo, realizada en el municipio de São João do Rio do Peixe (PB) en el año 2016. Dos examinadores entrenados realizaron el examen clínico en escolares de 6 a 8 años. Fueron utilizados los índices de CPO-d, índice periodontal (PSR) e índice de Dean para la evaluación de la caries dental, salud periodontal y grado de fluorosis, respectivamente. Fueron analizados 13 alumnos con edades entre 6 a 8 años. Los índices de CPO-d y Ceo-d presentaron valores promedio de 1,0 (DP=1) y 2,6 (DP=3,5) respectivamente. Con relación a los dientes permanentes se vio que 38,5% de los voluntarios presentaron índice de CPO-d 0, mientras que 7,7% presentaban por lo menos tres elementos dentales afectados de alguna forma por la enfermedad caries. Con relación al Ceo-d, 30,8% presentaron por lo menos 4 elementos afectados por la enfermedad. El diagnóstico de fluorosis por el índice TF mostró que todos los voluntarios presentaron cierto grado de fluorosis. Se concluye que los niños residentes en la región de Vila do Brejo presentan caries activa, fluorosis dental en grados por encima de 2 (índice TF) y presencia de sangramento gingival.

Descriptores: Fluorosis dental; Índice CPO; Gingivitis.

1. Dental Surgeon Endodontics Specialist MS in Odontology. PhD in Medication Development and Technological Innovation at the Federal University of Rio Grande do Norte (UFRN). Adjunct Professor of the University Center of João Pessoa (UNIPÊ), João Pessoa-PB, Brazil. ORCID: 0000-0003-3671-1106 E-mail: consuelofernanda79@hotmail.com
2. Dental Surgeon. João Pessoa-PB, Brazil. ORCID:0000-0003-0190-6421 E-mail: teod.miro@gmail.com
3. Dental Surgeon João Pessoa-PB, Brazil. ORCID:0000-0002-4498-553X E-mail: gaby-barbosa1@hotmail.com
4. Dental Surgeon João Pessoa-PB, Brazil. ORCID:0000-0002-1564-8729 E-mail: cynara.88@hotmail.com
5. Dental Surgeon PhD in Health Biotechnology. Assistant Professor of the Technical Health School of the Federal University of Paraíba. João Pessoa-PB, Brazil. ORCID:0000-0001-7888-4430 E-mail: msorayapf@hotmail.com

INTRODUCTION

The use of fluorine is beneficial to the population when in ideal concentrations, diminishing the prevalence of dental cavities. However, when systemically used in high concentrations and for long periods of time, it can lead to dental fluorosis and even to bone fluorosis, which is a more severe type of the disease¹.

Dental fluorosis only happens when there is an excessive ingestion of fluorides in the period of dental formation, while there is no specific period of susceptibility for bone fluorosis².

The World Health Organization recognizes the importance of water fluoridation in the control of cavities since 1958. That fluoridation, however, must be controlled, depending on the temperature levels of the region. The optimal limits for the concentration of fluorides can vary from 0.7 mg/L e 1.2 mg/L².

In Brazil, a large amount of people, especially in rural areas, drink water from artesian wells, which present high residual concentrations of fluorides, leading to the risk of dental or even bone fluorosis².

People who live in regions with high concentrations of fluorides in their drinking water develop dental fluorosis and are not free from tooth decay, since the fluoride will not influence etiologic factors (such as biofilm, dental structure, diet or bacteria). That is why it is so important to study the oral health profile of patients who live in areas with endemic fluorosis, as to alert professionals to the prevalence of other oral problems of these patients¹.

Therefore, this study aimed at evaluating the oral health of schoolchildren who live in an area which is endemic for dental fluorosis.

METHOD

This research took place in the city of São João do Rio do Peixe, which is located in the sertão (a Brazilian northeast sub-region) in the state of Paraíba, 480km away from João Pessoa, the

state's capital, and with an estimated population of 17,929 people according to the Brazilian Institute of Geography and Statistics (IBGE).

This study was conducted in 2016 in the Vila do Brejo, in the rural area of this town, 10km distant from its center. According to the IBGE, São João do Rio do Peixe has a population density of 38.36 hab/km², in a territory of 474.4 km², indicating that, when compared to cities in the countryside of Paraíba, it is a large-sized one.

The study evaluated schoolchildren from 6 to 8 years who study in the Public Basic and Elementary Education School Raimundo Rodrigues dos Santos, and have lived in the area since birth, since these children would be in a situation of chronic consumption of fluorides. This locality was chosen as the population of the area have high levels of fluorosis.

Clinical exams were conducted in the school itself, using a mouth mirror and a periodontal probe (WHO), by two evaluators previously calibrated under natural light, after the volunteer agreed to participate by signing the consent and assent forms.

This is an observational and cross-sectional field research, and its analysis only took place after approval from the Research Ethics Committee (1.594.917).

RESULTS

13 students aged from 6 to 8 years of age were evaluated, from which 46.2% were male and 53.8% female. 19 students were enrolled in the school, but six refused to participate.

The CPO-d and Ceo-d presented average levels of 1.0 (DP=10) and 2.6 (DP=3.5), respectively. Regarding their permanent teeth, it was found that 38.5% of volunteers presented a CPO-d level of 0, while 7.7% presented at least three dental elements affected in some level by tooth decay. Regarding the Ceo-d, 30.8% had at least 4 elements affected by the disease (Charts 1 and 2).

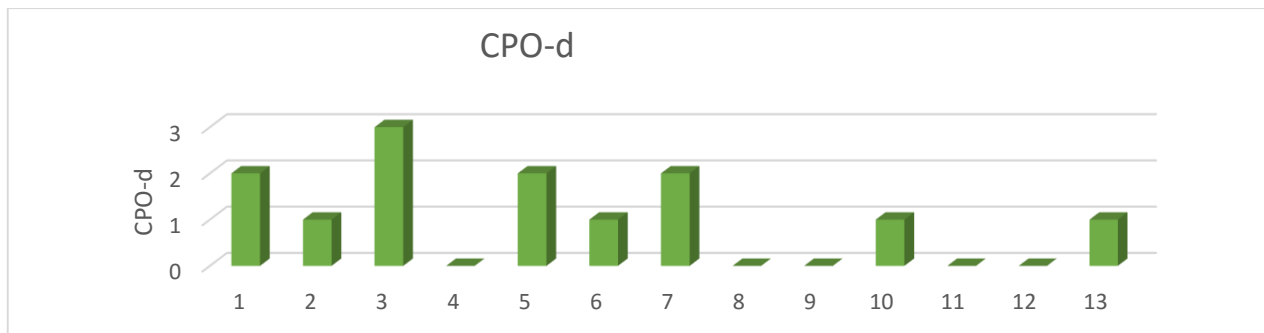


Chart 1: CPO-d Index per volunteer. São José do Rio do Peixe, PB, 2016.

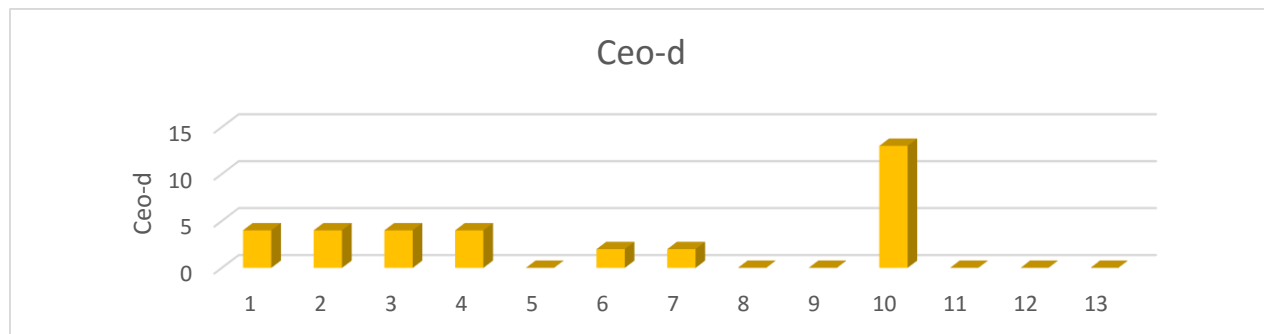


Chart 2: Ceo-d Index per volunteer. São José do Rio do Peixe, PB, 2016.

Among active cavities found in dental elements, 13 were found in the first permanent molars. The diagnostic of the presence of fluorosis

was found through the TF index. All volunteers presented some level of fluorosis, as shown in the following chart (Chart 3). Chart 4 correlates the three variables: CPO-d, Ceo-d and fluorosis.

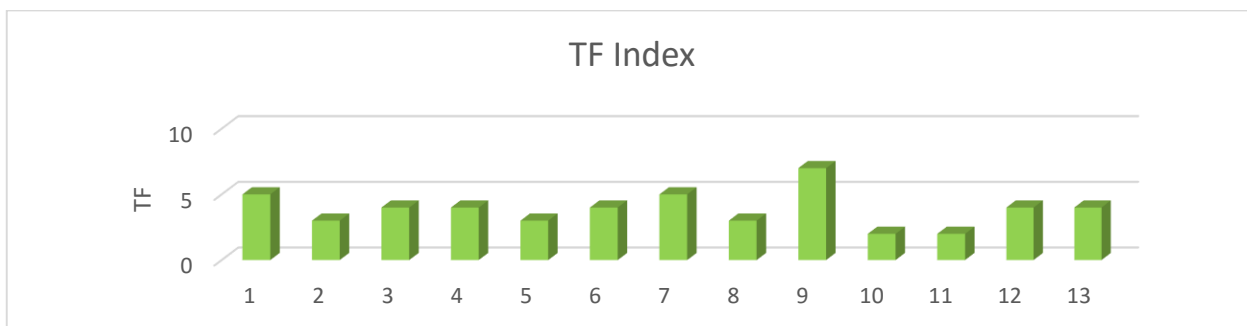


Chart 3: TF Index per volunteer. São José do Rio do Peixe, PB, 2016.

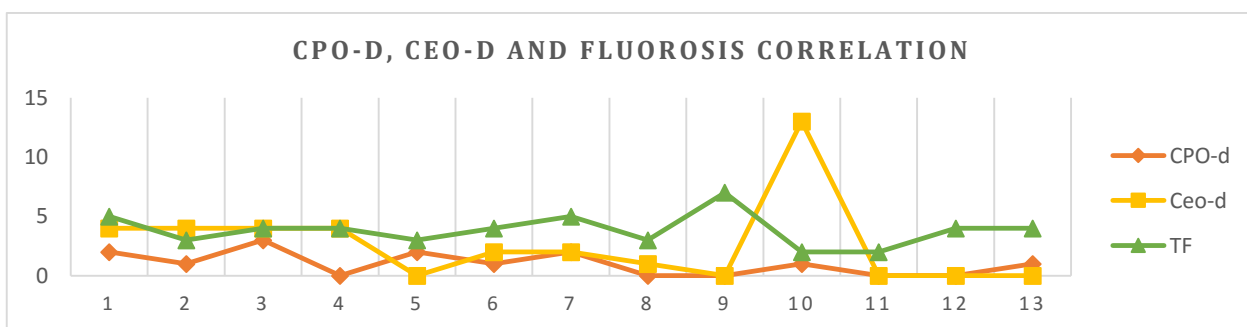


Chart 4. Correlation between tooth decay and fluorosis levels. São José do Rio do Peixe, PB, 2016.

Regarding periodontal health, a three volunteers presented healthy volunteer presented two sextants of their periodontal conditions. Nine suffered mouth with moderate periodontitis. Only bleeding during the examination (Table 1).

Table 1 Periodontal health evaluation (PSR). São José do Rio do Peixe, PB, 2016.

Volunteers	*17-16	11	*26-27	*36-37	*31	*47-46
1	1	0	1	0	0	0
2	3	1	1	3	0	0
3	0	0	0	0	1	0
4	1	0	1	0	0	0
5	0	0	0	0	0	0
6	0	0	1	0	0	0
7	1	1	1	0	1	0
8	1	0	0	0	0	0
9	1	0	1	1	1	0
10	0	0	1	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0

* Evaluated dental elements.

It was also found that 100% of volunteers stated to know that there were stains on their teeth, 23.1% said to feel discomfort due to these stains, 69.2% said to feel embarrassed to smile and 76.9% would like to undergo some type of treatment to remove the stains caused by fluorosis.

DISCUSSION

Most of Brazilian's northeast territory is under a semi-arid climate, characterized by scarce rains due to low annual precipitation levels. Due to this scarcity of drinking water, well water has been an important strategy to meet the needs of the population.

Obtaining underground non-characterized and non-analyzed water, however, may present risks to human health, since it may be enriched by minerals from the leaching process that takes place in the groundwater tables, in addition to other contaminating sources.

Among minerals that may be undesirable when in moderate or elevated concentrations is fluorine. Fluorine, despite being one of the most efficient preventive measures against tooth decay, is present in elevated concentrations in the waters of artesian wells and, therefore, can lead to the development of dental or bone fluorosis³.

At least three regions in the state of Paraíba can be considered risk areas for dental fluorosis³. All these areas are in semi-arid places of the state and many studies have mapped and evaluated the problem in these regions^{3,5}.

The target region of this research is one of these three regions, and according to a research⁶, the region of Vila do Brejo presents a mean concentration of 5.16 ppm of fluorine in the drinking water. The area is considered endemic in dental fluorosis and subject to cases of bone fluorosis.

Fluorine is the only chemical element capable of preventing a disease, the tooth decay, while simultaneously provoking another, fluorosis⁷.

As opposed to northeastern urban zones, the prevalence of dental fluorosis in children in the countryside of Paraíba has practical connections only to the concentration of fluorine in the water, since the water is still the main conduit for the ingestion of fluorine in the region^{8,9}.

The percentage of children affected by dental fluorosis in the countryside of Paraíba is 31%, 61% and 71.4%, respectively, for fluorine levels of 0.10-0.070; 0.71-1.00; and above 1.00 (up to 3.50) mg/L.

In some locations, the ingestion of

fluorine by children from Paraíba has been increasing yearly, due to better access to fluorinated toothpastes, and in some locations, due to an increase in the consumption of industrialized foods^{4,10}.

In this study, 100% of children evaluated presented TF between 2 and 7, and from these, 53% presented an index from 4 to 5, meaning that their entire enamel surface was white and dull, with tissue loss areas. These results corroborate another investigation⁶ which examined 650 children from rural areas of Paraíba, including Vila do Brejo, and found that 30.5% of children who drank water with fluorine concentrations below 0.7 ppm had dental fluorosis, as did 61.1% of those who lived in places where the drinking water had concentrations between 0.7 and 1 ppm, and 71.4% of those who drank water with concentrations above 1.0 ppm.

The prevalence of fluorosis is significantly related to the concentration of fluorine in drinking water. The severity of the disease varied from TF 1 to 3 in the groups with low fluorine concentrations and was higher than 7 in the others⁵.

Other places around the world also have high levels of fluorosis. In a study conducted in India in 2008, the prevalence and severity of dental fluorosis was evaluated in children from 11 to 15 years of age. The study evaluated 1800 children and found that the prevalence of dental fluorosis was higher among children who consumed artesian well water, when compared to those who consumed piped water¹¹.

Dental fluorosis is related to the excessive and prolonged ingestion of fluoride during the formation of teeth. Therefore, a period of susceptibility can be inferred for dental fluorosis in permanent teeth, a period that goes up to a child's 5-6 year of age¹².

The children evaluated in this research had from 6 to 8 years of age and were permanent residents of the region, as were their parents. Thus, all of them had some level of fluorosis in their deciduous or permanent teeth, and since they drank water with high fluorine concentrations since birth, including the period of susceptibility, their permanent elements will also be affected by fluorosis. The

individuals who lived their lives in the region will also be under the risk of developing bone fluorosis.

The enamel under fluorosis is not necessarily richer in fluoride, actually being hypomineralized in its sub-surface, which can be observed due to the high porosity of the area. Therefore, the fluoridated teeth is no longer resistant to the development of tooth decay - just the opposite.

This study found a general index of cavities, dental loss or obturations of 3.6, and there was no significant correlation ($p=0.3$) between CPO-d and Ceo-d indexes and the TF index. These results corroborate a study¹³ conducted in South Africa, in which 282 children from 10 to 15 years of age were evaluated, all of which had lived since birth in three areas where the drinking water was naturally fluorinated (LeeuGamka, 3.0; Kuboe 0.48; e Sanddrif 0.19 p.p.m. F).

Their teeth were examined and the CPO-d and Dean indexes were used to evaluate dental fluorosis. The prevalence of fluorosis (categorized in levels 2, 3, 4 and 5) was that of 42.5% in Sanddrif, 50% in Kuboes and 95% in LeeuGamka. The fluorosis levels significantly vary among the residents of the LeeuGamka (3.0 ppm) and other two regions. The experience of cavities in the area with the most fluoridation in drinking water was significantly higher than that of the other two locations. There was a positive association between high fluorine concentrations in the drinking water and tooth decay, and there was no difference between CPO-e index and fluorosis in the areas of low fluorine concentration¹³.

In another investigation¹⁵, 1500 randomly selected children, from different regions with naturally occurring fluorine, were examined. Fluorosis was found in 74.9% of children and tooth decay in 56.5%. The prevalence of cavities and the CPO-d were lower in regions of low fluorine concentrations. There was a moderate prevalence of fluorosis and a high prevalence of tooth decay in areas where the concentration of fluorine was lower than adequate¹⁴.

In another research¹⁵, the relation

between CPO-s, CFI (Community Fluorosis Index), individual CPO-s and the Dean index were assessed. 1435 12-year-old children from 11 regions of Puerto Rico were examined, and no statistical differences between CPO and CFI were found between the regions. It was found that moderate to severe fluorosis was associated to high CPO levels, and that, despite it being vitally important to control the levels of dental fluorosis, this is fact is not related to the presence of tooth decay¹⁵.

Some factors may have undermined the analysis of the correlation between the emergence of cavities and fluorosis degrees, such as the small sample size. Since the population in the studied area is small, it was not possible to evaluate a higher number of individuals. Another factor is the lack of control of patients who live in areas with low concentration of fluorine in drinking water. This is associated to the use of this index for the analysis of dental fluorosis. The Dean index or the TF index can be used, and it becomes difficult to compare the results.

Clinically, fluorosis can present itself in many forms, depending on fluoride concentrations and exposure time. The dark-brown staining of the enamel due to fluorosis is not a direct result from defective amelogenesis, but from artificial dyes in foods eaten after tooth eruption. This is one of the negative aspects for the use of the Dean index, which considers the presence of these stains in the evaluation of case severity. That is why this research opted to use the TF index. Therefore, the fact that each research uses a different index makes it difficult to compare.

To assess the periodontal situation of the volunteer in this research, the SPR (Simplified Periodontal Record) was the chosen method, as it is a system that allows for the exam of periodontal structures in a fast and simple way. Most volunteers presented bleeding (69%) during the examination. Few studies evaluate the association of periodontal diseases and patients with dental fluorosis.

A research¹⁶, however, evaluated 1029 volunteers aged from 15 to 74 years and observed that gingivitis and periodontitis

were more common among women (65.9% to 32.8% in men) and that, as the age of patients grew, gingivitis reduced from 81% to 42.9%. Periodontitis, on the other hand, increase with age, from 18% to 57.1%. These results suggest a strong connection between the occurrence of periodontitis and regions with high fluorine concentrations¹⁶.

Regarding the perception of the patient when it comes to dental fluorosis, all of them seemed to be aware of the presence of the stains, feeling ashamed about smiling. The perception of health can be associated to quality of life. It is known that there are cultural differences when it comes to the individual perception of what is an aesthetically acceptable smile. That is, people who live in rural areas would have different aesthetic requirements than those who live in urban areas.

People who live in rural areas are more easily satisfied regarding their self-image than those who live in urban regions, since these individuals are under more mediatic pressure to fit in a perfect stereotype.

A research¹⁷ showed that teenagers who live in urban areas are more dissatisfied regarding their appearance (65.4%) than those who live in rural areas (52.6%)¹⁷. However, another study¹⁸ did not find statistically significant differences associating image self-perception and geographic location.

In this research, it was found that children show a certain level of preoccupation regarding the appearance of their teeth. However, few studies on this topic involve children¹⁸.

The fluorinated enamel is not more resistant to the development of cavities; just the opposite, it is more fragile, which means that the individual with dental fluorosis has a higher chance of presenting tooth decay. This corroborates the results of this research, since it was found that most children evaluated presented active cavities. Therefore, it is necessary to develop projects to prevent cavities in the Vila do Brejo community.

CONCLUSION

It was found that children living in the region

of Vila do Brejo had active cavities, dental fluorosis with scores above 2 (TF index) and gingival bleeding.

The CPOD index, however, had no significant relation to dental fluorosis. With regards to perception, it was found that all volunteers were aware of the presence of stains on their teeth.

REFERENCES

1. Leal SD, Carvalho SF, Carvalho CAP. Conhecimento de alunos do Curso de Odontologia sobre o uso racional do flúor. *Rev Odontol UNESP*. 2015; 44(1):51-58.
2. Frazão P, Peres MA, Cury JA. Qualidade da água para consumo humano e concentração de fluoreto. *Rev Saúde Pública*. 2011; 45(5):964-73.
3. Sampaio FC, Ramm Von Der Fehr F, Arneberg P, Petrucci Gigante D, Hatloy A. Dental fluorosis and nutritional status of 6- to 11-year-old children living in rural areas of Paraíba, Brazil. *Caries Res*. 1999; 33(1):66-73.
4. Forte FDS, Freitas CHSM, Sampaio FC, Jardim MCAM. Fluorose dentária em crianças de Princesa Isabel, Paraíba. *Pesqui Odontol Bras*. 2001; 15(2):87-90.
5. Sampaio FC, Silva FDSCM, Silva ACB, Azevedo ATBM, Araújo DAM, Sousa EM. Natural fluoride levels in the drinking water, water fluoridation and estimated risk of dental fluorosis in a Tropical Region of Brazil. *Oral Health Prev Dent*. 2010; 8(1):71-5.
6. Souza CFM, Lima JFJ, Adriano MS, Carvalho FG, Forte FD, Farias Oliveira R, et al. Assessment of groundwater quality in a region of endemic fluorosis in the northeast of Brazil. *Environ Monit Assess*. 2013; 185(6):4735-43.
7. Narvai PC. Cárie dentária e flúor: uma relação do século XX. *Ciênc Saúde Coletiva*. 2000; 5(2):381-92.
8. Lima YBO, Cury JA. Ingestão de flúor por crianças pela água e dentifrício. *Rev Saúde Pública*. 2001; 35(6):576-81.
9. Moura MS, Barbosa PRR, Santos DLN, Dantas-Neta NB, Moura LFAD, Lima MDM. Vigilância epidemiológica da fluorose dentária em município de clima tropical com água de abastecimento público fluoretada. *Ciênc Saúde Coletiva*. 2016; 21(4):1247-54.
10. Fujibayashi SY, Archetti FB, Pizzatto S, Losso ES, Pizzatto E. Severidade de fluorose dental em um grupo de escolares. *RSBO*. 2011; 8(2):168-73.
11. Baskaradoss JK, Clement RB, Narayanan A. Prevalence of dental fluorosis and associated risk factors in 11-15 year old school children of Kanyakumari District, Tamilnadu, India: a cross sectional survey. *Indian J Dent Res*. 2008; 19(4):297-303.
12. Thylstrup A, Fejerskov O. Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dent Oral Epidemiol*. 1978; 6(6):315-28.
13. Grobleri SR, Louw AJ, Van Kotze TJ. Dental fluorosis and caries experience in relation to three different drinking water fluoride levels in South Africa. *Int J Paediatr Dent*. 2001; 11(5):372-9.
14. Shanthi M, Reddy BV, Venkataramana V, Gowrisankar S, Reddy BV, Chennupati S. Relationship between drinking water fluoride levels, dental fluorosis, dental caries and associated risk factors in 9-12 years old school children of Nelakondapally Mandal of Khammam District, Andhra Pradesh, India: a cross-sectional survey. *J Int Oral Health*. 2014; 6(3):106-10.
15. Elias-Boneta AR, Toro MJ, Rivas-Tumanyan S, Murillo M, Orraca L, Encarnacion A, et al. Persistent oral health disparity in 12-year-old hispanics: a cross-sectional study. *BMC Oral Health*. 2016; 16:10.
16. Vandana KL, Reddy MS. Assessment of periodontal status in dental fluorosis subjects using community periodontal index of treatment needs. *Indian J Dent Res*. 2007; 18(2):67-71.
17. Triches R, Giugliani E. Insatisfação corporal em escolares de dois municípios da região Sul do Brasil. *Rev Nutr*. 2007; 20(2):119-28.
18. Welch C, Gross S, Bronner Y, Dewberry-Moore N, Paige D. Discrepancies in body image perception among fourth-grade public school children from urban, suburban, and rural Maryland. *J Am Diet Assoc*. 2004; 104(7):1080-5.

CONTRIBUTIONS

Consuelo Fernanda Macedo de Souza took part in the conception, design, analysis and interpretation of data, as well as in the writing and critical review of the text. **Teodomiro Dutra de Abreu** and **Gabrielle Stella Dantas Barbosa** took part in the design and in data collection. **Cynára Liane Jales Ataíde de Melo** contributed to the writing, analysis and result interpretation. **Maria Soraya Pereira Franco Adriano** took part in the conception, design, analysis and interpretation of data, as well as in the critical review of the text.

How to cite this article (Vancouver)

Souza CMF, Abreu TD, Barbosa GSD, Melo CLJA, Adriano MSPF. Oral health profile of schoolchildren living in regions with endemic dental fluorosis. REFACS [Internet]. 2018 [cited in insert day, month and year of access];6(2):181-188. Available from: insert access link. DOI: insert DOI link.

How to cite this article (ABNT)

SOUZA, C. M. F. et al. Oral health profile of schoolchildren living in regions with endemic dental fluorosis REFACS, Uberaba, v. 6, n. 2, p. 181-188, 2018. Available from: <insert access link>. Access in: insert day, month and year of access. DOI: insert DOI link.

How to cite this article (APA)

Souza, C. M. F.; Abreu, T. D.; Barbosa, G. S. D.; Melo, C. L. J. A. & Adriano, M. S. P. F. (2018). Oral health profile of schoolchildren living in regions with endemic dental fluorosis REFACS, 6(2), 181-188. Recovered in: insert day, month and year of access from insert access link. DOI: insert DOI link.