

Dental Fluorosis, Dental Caries, and Quality of Life Factors among Schoolchildren in a Colombian Fluorotic Area

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Objective: To assess dental fluorosis, dental caries and quality of life factors associated with dental fluorosis among schoolchildren living in a Colombian endemic dental fluorosis area. **Method:** 110 12-year olds were visually examined for dental caries (ICDAS) and dental fluorosis (TF) and a self-administered quality of life and fluorosis questionnaire was applied. **Results:** The prevalence of dental fluorosis reached 100% in this sample with most children falling within the TF 3 severity category. Varying degrees of severity were observed as follows for TF 1 to 6: 1%, 16%, 62%, 16%, 4%, 2%. The prevalence of caries experience (DF-S₂) was 54%. The DF-S₂ mean was 4.4 (sd 4.3). The principal contributor to the DF-S₂ outcome was the decayed component. When initial caries lesions were included (ICDAS-scores 1-3) the mean DF-S_{1,2} increased to 10 (sd 5.1). The association between fluorosis and dental caries was not statistically significant ($p>0.05$). Children not only detected the presence of something abnormal in their teeth but also reported feeling embarrassed, and worried due to their dental appearance. Almost 60% of the children reported avoiding smiling because of their teeth's appearance. **Conclusions:** The high prevalence of dental fluorosis and dental caries combined with the schoolchildren's negative perception about their dental health reflects the need to propose effective dental public health policies to regulate multiple exposures to fluoride at an early age, and to improve health outcomes in a highly vulnerable population.

Key words: dental fluorosis, dental caries, quality of life, schoolchildren, ICDAS, TF index

Introduction

The incidence of dental caries has declined worldwide (Marthaler, 2004) and it has been mainly attributed to the use of fluoride. The addition of fluoride to water and salt ensures that regular application can be achieved with little or no individual effort (Ellwood *et al.*, 2008). Public health delivery systems will usually have to rely on a model where fluoride systemic absorption is inevitable, and it will result in some dental fluorosis in these populations (Ellwood *et al.*, 2008). Colombia has had salt fluoridation for the whole population as a public health measure since 1989 (180–220mg F/kg of salt) (República de Colombia, 1984). The estimated prevalence of dental fluorosis in 6–7 and 12-year olds was 20.3% in 1998 according to the National Oral Health Survey (Dean's Index) (Ministerio de Salud, 1999). For the same age group, the estimated prevalence was 25.3% in the central region, including the referred endemic fluorotic municipality located in the state of Huila. The State of Huila is well known for being considered as an endemic fluorotic area with 21 out of 37 municipalities reporting a fluoride concentration in both home tap and brook drinking water sources above 0.5ppm, considered as risk in Colombia (Secretaría de Salud Departamental del Huila, 2007). Fluoride in salt samples in the state has been found to maintain accepted range limits (Secretaría de Salud Departamental del Huila, 2007). It is not known whether ingestion of this concentration of naturally fluoridated water affects caries prevalence within different levels of fluorosis in this population.

The presence of dental caries and fluorosis in childhood may pose a negative effect in the daily life of children and their caregivers, not only acting as an important disease burden but also affecting the psychosocial functioning of individuals (McGrath *et al.*, 2004). In particular, dental fluorosis is regarded as a condition that may impact on the self-esteem and self-confidence of individuals at very early stages of life (Do *et al.*, 2007). However, Martinez-Mier *et al.* (2004) reported that children are rarely asked about their perception of dental fluorosis and the impact it may have on activities conducted daily such as smiling and interacting with other children.

Oral diseases are generally measured using clinical indicators recorded by examiners during dental evaluations such as the TF index for dental fluorosis (Thylstrup and Fejerskov, 1978). Also, the number of decayed, missing and filled surfaces is calculated with the traditional DMF-S or the ICDAS system (Ismail *et al.*, 2007). These measurements indicate the presence and severity of an oral condition. However, a better understanding of the oral health status of the patient is achieved when perceptions of oral health are reported by those individuals who experience the condition (McGrath *et al.*, 2004). The aim of this study was to assess dental fluorosis, dental caries and quality of life factors associated with dental fluorosis among schoolchildren living in a Colombian endemic dental fluorosis area.

Methods

A non-probability sample of 110 12 year-olds (53% females, 47% males) from a public school in the Colombian state of Huila (central region of the country) was examined.

Oral examinations were conducted at the school by one experienced examiner (SM) (intra/reproducibility Kappa Coefficients >0.70 both for ICDAS and TF criteria), with an assistant recording the observations. Fluorosis was measured using the TF on buccal and occlusal surfaces after children brushed their teeth. The dentition was inspected using dental mirror, ball-ended probe and three-in-one syringe. Illumination was obtained by a headlamp. Dental caries experience was assessed by means of ICDAS criteria (Ismail *et al.*, 2007) and fillings (F) on all surfaces. The conventional caries experience included only ICDAS-scores 4-6 (as dentine/cavitated lesions and is referred as DF-S₂; when considering ICDAS-scores 1-3 (initial caries lesions) the caries experience was referred as DF-S₁).

Quality of life factors (QoL) were assessed using a 12- item questionnaire (Martinez-Mier *et al.*, 2004) with a five-point scale, related to the physical (question regarding distress - During the past two months, how embarrassed have you been about the way your teeth look?) social (question regarding smile avoidance - Dur-

ing the past two months, how much has the way your teeth look limited you from smiling?), and psychological domains (question regarding worry - During the past two months, how much has the way your teeth look worried you?). The instrument also asked about perceptions of discolorations and other oral conditions including tooth colour. Test-retest, internal reliability, construct and criterion validities had been previously tested in English and Spanish (Martinez-Mier *et al.*, 2004).

Statistical Analysis

Data were analysed using SAS version 9.1. Univariate (frequency distributions) for dental fluorosis and means for dental caries were generated. Bivariate analyses (Chi-square/Fisher's exact test) were conducted to evaluate the relationship between dental fluorosis and QoL factors. Statistical significance was set at a p<0.05. The most severe fluorosis score observed on the teeth evaluated was used to categorize children into TF severity levels. TF scores are presented based on the distribution of subjects across TF grades, and with the following collapsed TF grades: TF 1/2, TF 3/4 and TF 5/6.

Results

Epidemiologic data showed that the prevalence of caries experience (DF-S₂) was 54%. The DF-S₂ mean was 4.4 (sd 4.3). The principal contributor to the DF-S₂ outcome was the D component. When initial caries lesions were included (D₁, ICDAS-scores 1-3) the mean number of surfaces with caries experience increased to 10 (5.1), with a higher mean number for females, 11.0, than males, 8.9 (Table 1). The highest number of carious (D₁ and D₂) and filled surfaces was found in occlusal, followed by buccal/lingual and mesial/distal as shown in Table 2. In addition, the prevalence of dental fluorosis (TF) reached 100% with most children falling within the TF 3 severity category. The distribution by TF scores TF 1 to TF 6 were: 1%;

Table 1. Mean Number of Decayed and Filled Surfaces by Gender

| | DFS ₁ * | | DFS ₂ ** | | DFS total | |
|--------|--------------------|-------|---------------------|-------|-----------|-------|
| | n | (sd) | n | (sd) | n | (sd) |
| Male | 5.2 | (3.4) | 3.7 | (4.3) | 8.9 | (4.7) |
| Female | 5.8 | (4.5) | 5.1 | (4.2) | 11.0 | (5.3) |

* DFS₁: Including non-cavitated lesions only

** DFS₂: Including dentine/cavitated lesions only

Table 2. Mean Number of Decayed and Filled Surfaces by Type of Surface

| | DFS ₁ * | | DFS ₂ ** | | DFS total | |
|--------------------|--------------------|-------|---------------------|-------|-----------|-------|
| | n | (sd) | n | (sd) | n | (sd) |
| All surfaces | 5.5 | (4.0) | 4.4 | (4.3) | 10 | (5.1) |
| Occlusal | 3.7 | (3.0) | 2.6 | (3.1) | 6.4 | (3.9) |
| Buccal and Lingual | 1.7 | (1.6) | 1.6 | (1.8) | 3.3 | (2.1) |
| Mesial and Distal | 0.1 | (0.3) | 0.2 | (0.5) | 0.3 | (0.6) |

* DFS₁: Including non-cavitated lesions only

** DFS₂: Including dentine/cavitated lesions only

Table 3. Mean Number of Decayed and Filled Surfaces by Category of Fluorosis

| | DFS ₁ * | | DFS ₂ ** | | DFS total | |
|--------|--------------------|-------|---------------------|-------|-----------|-------|
| | n | (sd) | n | (sd) | n | (sd) |
| TF 1/2 | 6.0 | (3.9) | 3.8 | (5.6) | 9.8 | (5.3) |
| TF 3/4 | 5.4 | (4.0) | 4.6 | (4.0) | 10.0 | (5.0) |
| TF 5+ | 6.1 | (3.5) | 3.6 | (3.8) | 9.8 | (6.4) |

* DFS₁: Including non-cavitated lesions only

** DFS₂: Including dentine/cavitated lesions only

Chi-square p-value of association: 0.57

16%; 62%; 16%; 4%; 2%. Twenty-two percent of the children with TF scores 3 and 4 also had a high proportion of ICDAS code 2 (distinct visual change in enamel). These children also had the lowest proportion of fillings (45%) compared to children who fell within TF 1/2. There was no association between fluorosis and dental caries ($p=0.57$).

Regarding the association of quality of life factors with dental fluorosis, almost a tenth of children reported feeling embarrassed (a lot to considerable) at their teeth's appearance, and two-fifths reported "being worried" (very/considerably) about their teeth (Table 4). Moreover, the proportion of children who felt very/considerably worried seemed to be higher with the more severe TF grades (TF 1/2, 44%; TF 3/4, 42%; TF 5/6, 50%; Table 5). As shown in Table 4, over half of reported avoiding smiling because of their teeth's appearance. Around a quarter to a third considered their teeth somewhat/very unpleasant, somewhat crowded or somewhat to very weak. In addition, almost half of them felt very to considerably worried about their perceived lack of dental health and this percentage increased linearly with severity of dental fluorosis. Even though all the sample had some form of

fluorosis, with more than 83% of the children classified as having TF ≥ 2 stages of the condition, only about a quarter of them recognized the colour of their teeth as unpleasant and with an "ugly" look.

Discussion

The study was conducted to assess dental fluorosis, dental caries and quality of life factors associated with dental fluorosis among schoolchildren living in a Colombian endemic dental fluorosis area. Epidemiologic data showed that the prevalence of caries experience (DF-S₂) reached 54% and the principal contributor to the DF-S₂ outcome was the D component, an indicator of poor access to dental services in this area. The total DF-S (DF-S_{1,2}) doubled when non-cavitated lesions were included. This is a clear indication of the under-estimation of caries experience when less sensitive criteria for caries diagnosis are used in epidemiological studies (Martignon *et al.*, 2010).

The prevalence of dental fluorosis of aesthetic concern (i.e. TF ≥ 3) (McDonagh *et al.*, 2000) was 84% in this sample, showing that naturally fluoridated water is a key contributing factor to dental fluorosis. This prevalence

Table 4. Quality of Life Factors Associated to Dental Fluorosis

| | % | n |
|----------------------------------------------------------------------|----|----|
| <i>1. The appearance of your teeth has caused you?</i> | | |
| A lot of embarrassment | 5 | 6 |
| Considerable embarrassment | 5 | 5 |
| Some embarrassment | 18 | 20 |
| A little bit of embarrassment | 36 | 39 |
| No embarrassment at all | 36 | 40 |
| <i>2. Has the appearance of your teeth limited you from smiling?</i> | | |
| A lot | 5 | 5 |
| Considerably | 8 | 9 |
| Somewhat | 46 | 51 |
| Not at all | 41 | 45 |
| <i>3. Have you been worried about the appearance of your teeth?</i> | | |
| Very worried | 20 | 22 |
| Considerably worried | 23 | 25 |
| Somewhat worried | 27 | 30 |
| A little bit- Not worried at all | 30 | 33 |
| <i>4. My teeth are?</i> | | |
| Very nice | 19 | 21 |
| Somewhat nice | 35 | 39 |
| Neither nice nor unpleasant | 18 | 20 |
| Somewhat- very unpleasant | 27 | 30 |
| Very straight | 9 | 10 |
| Somewhat straight | 51 | 56 |
| Neither straight nor crowded | 11 | 12 |
| Somewhat crowded | 30 | 32 |
| Somewhat- very white | 58 | 64 |
| Neither white nor stained | 18 | 20 |
| Somewhat- very stained | 24 | 26 |
| Very healthy | 26 | 28 |
| Somewhat healthy | 37 | 41 |
| Neither healthy nor weak | 13 | 14 |
| Somewhat- very weak | 25 | 27 |

Table 5. Frequencies and percentages of selected quality of life factors by dental fluorosis levels

| <i>*Worried</i> | <i>Very to Considerably</i> | | <i>Somewhat</i> | | <i>A Little bit</i> | |
|-----------------|-----------------------------|----------|-----------------|----------|---------------------|----------|
| | <i>n</i> | <i>%</i> | <i>n</i> | <i>%</i> | <i>n</i> | <i>%</i> |
| TF 1/2 | 8 | 44 | 7 | 39 | 3 | 17 |
| TF 3/4 | 36 | 42 | 22 | 26 | 28 | 33 |
| TF 5+ | 3 | 50 | 1 | 17 | 2 | 33 |

| <i>*Limited Smiling</i> | <i>A lot to Considerably</i> | | <i>Somewhat</i> | | <i>Not at all</i> | |
|-------------------------|------------------------------|----------|-----------------|----------|-------------------|----------|
| | <i>n</i> | <i>%</i> | <i>n</i> | <i>%</i> | <i>n</i> | <i>%</i> |
| TF 1/2 | 2 | 11 | 6 | 33 | 10 | 56 |
| TF 3/4 | 12 | 14 | 42 | 49 | 32 | 37 |
| TF 5+ | 0 | 0 | 3 | 50 | 3 | 50 |

was higher than that reported in populations with fluoride concentrations in water of 1.0ppm (12.5%) (McDonagh *et al.*, 2000). Studies concerning factors related to fluorosis have shown association with starting age of toothbrushing with a fluoridated toothpaste (Browne *et al.*, 2005) also in four Colombian cities (Franco *et al.*, 2005). Environmental factors have also been related to dental fluorosis. In Mexico, Grimaldo *et al.* (1995) showed association with environmental factors such as temperature, boiled water and foods prepared with boiled water; in Nigeria differences in fluorosis prevalence have been found associated to differences in altitude (Akosu *et al.*, 2009). Other environmental factors explored have been enhanced saltiness and fluoride content in the underground soil and water associated to climate changes (Misra *et al.*, 2007), and fertilizers (Loganathan *et al.*, 2008).

The inconsistencies between fluoride concentration in drinking water and dental fluorosis in the state of Huila have not yet been explained and support the Public Health National Plan (República de Colombia, 2007) which highlights the need to improve oral health through the epidemiological surveillance, prevention and control of dental fluorosis.

It is well established that fluoride protects against dental caries (Ellwood *et al.*, 2008). However clinical trade-offs between caries and dental fluorosis may exist with varying levels and timing of exposure to fluorides increasing the risk of dental fluorosis without having a fully protective effect against dental caries (Do *et al.*, 2007). In more severe forms of dental fluorosis (TF 5/6), post-eruptive changes lead to the formation of pits or the flaking-off of the outer enamel. Such damage to the surface enamel increases the risk of retention of microbial deposits associated with the development of dental caries. The incorporation of stains into the damaged parts of the fluorotic enamel may result in an appearance that may be misdiagnosed by the inexperienced as caries (Thylstrup and Fejerskov, 1978).

Generally at the individual level, paediatric patients do not participate in the diagnostic process of their own oral condition, and their perception of what constitutes an oral health problem is overlooked (Meneghin *et al.*, 2007). Different theoretical aspects of oral health-related quality of life include the understanding patients may have

on absence of disability, disease or symptoms; correct physical functioning associated with chewing and pain status; emotional functioning associated with smiling; social functioning related to being capable of having normal roles in daily life; positive self-perception of oral health; and absence of social and cultural issues due to dental problems (Allen *et al.*, 2003; Gift *et al.*, 1997).

The exploration of factors associated with quality of life may allow identification of specific characteristics among schoolchildren, in a stage where cognitive as well as cultural determinants are established for the adoption of healthy practices (Kay *et al.*, 1996; Reisine *et al.*, 1989). This information may be used as new knowledge to guide better attitudes and practices towards dental fluorosis prevention.

The last National Oral Health Survey revealed that 42% of individuals aged 12-17 thought having a healthy mouth was determined by how white and/or straight the teeth were (Ministerio de Salud, 1999). This highlights the importance of the impact of conditions such as dental fluorosis on patients' aesthetic perceptions and potentially their quality of life.

Studies on self-perception of dental fluorosis among children have yielded mixed results. A Brazilian study demonstrated that 12 year-old children who had fluorosis level TF 1, did not notice stains on their teeth nor had any negative perception about this dental problem (Meneghin *et al.*, 2007). This is in accordance with the literature review about the aesthetic perceptions of dental fluorosis and their relationships with psychosocial aspects and oral health-related quality of life (Chankanka *et al.*, 2010) where it is shown that mild fluorosis is not a concern. Nonetheless, as in this study, other studies have suggested that affected children may have the ability to note changes in tooth colour caused by dental fluorosis (Do *et al.*, 2007; Martinez-Mier *et al.*, 2004;). The perceived opinion that dental fluorosis is only and properly diagnosed by trained examiners was not supported in this study as children not only detected the presence of something abnormal in their teeth but also reported feeling embarrassed ("a lot of embarrassment" to "a little bit": 64%), worried ("very worried" to "somewhat worried": 70%), and avoided smiling ("a lot" to "somewhat": 59%) due to their dental fluorosis status.

One study presented differences in the aesthetic concerns of children in different cities (Indianapolis and Mexico City), suggesting that cultural and/or socio-economic status differences might affect perceptions in children (Martinez-Mier *et al.*, 2004).

For future studies, we propose to analyze dental fluorosis in the light of the necessary conditions to be considered as a public health problem: a) the epidemiology of the condition in the population; b) the epidemiology of dental caries in the population; c) the impact on individual quality of life and self-perception of the problem; and d) the availability of efficient methods for its control or prevention.

Conclusions

The high prevalence of dental fluorosis and dental caries combined with the schoolchildren's negative perception about their dental health reflects the need to propose effective dental public health policies to regulate multiple exposures to fluoride at an early age, and to improve health outcomes in a highly vulnerable population.

Acknowledgments

We gratefully acknowledge our colleague Dr. Wilson Mejia for his constructive comments, and Dr. Angeles Martinez-Mier from Indiana University School of Dentistry for facilitating the Spanish version of her questionnaire.

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