

Is there an association between the presence of dental fluorosis and dental trauma amongst school children?

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Abstract *Our objective was to evaluate whether there is an association with the different levels of dental fluorosis and the presence of dental trauma amongst school children. A transversal study was conducted amongst school children from the age of 12. Dental examinations were conducted by 24 well trained and fully qualified dental surgeons. Data was collected from 36 randomly selected public schools amongst 89 schools in a municipality. The criteria used to diagnose dental fluorosis was based on the Dean's fluorosis Index and for diagnosing dental trauma we looked for clinical signs of crown fractures and dental avulsions. Multiple descriptive analysis, which was bivariate, was carried out. Amongst the 2,755 school children that took part in the study 1,089 (39.6%) were diagnosed with dental fluorosis and 106 (3.8%) had one tooth or more with dental trauma. We noted a high prevalence of dental fluorosis, independent of the level of severity, amongst individuals with one tooth or more who had dental trauma. This association was even more evident where there were severely high levels of fluorosis. We also noted that the presence of fluorosis was greater amongst those that actively paid more attention to discoloration on their teeth and who received treatment from a dental professional at their schools. Nevertheless dental fluorosis was associated with the presence of dental trauma, independent of its severity.*

Key words *Oral Hygiene, Fluorosis, Dental trauma, Epidemiology*

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Introduction

Fluoride (fluorine) has been noted as one of the main minerals that prevents and controls dental cavities^{1,2}. The wholesale use of fluoride has contributed to the exponential decline in dental related diseases³⁻⁵. Notwithstanding the obvious benefits of fluoride, it is necessary to be attentive to this ion having possible toxic effects in organisms if it is used in quantities beyond recommended doses. It was highlighted that this toxic effect can be classified as acute and chronic. It is deemed as chronic when, having ingested it on a frequent basis during the period when your teeth are in development, dental fluorosis occurs^{6,7}.

Dental fluorosis is diagnosed based on the porosity levels in the structure of the teeth (hypomineralization)⁷. It becoming aesthetically noticeable depends on the level of doses that the person has taken. Its prevalence in different countries varies widely with percentages ranging from: 16.7% in Brazil⁸, 27.2% in Australia⁹ and 82.0% in India¹⁰. Where it exists, the levels of fluorosis are generally low. Its potential to harm is based on the concentration of fluoride from the plasma which is influenced by the total ingestion of fluorine. It is also influenced by: the type of ingestion that takes place, the functioning of the renal system and metabolic activity¹¹. Clinically speaking, fluorosis can vary in degree from making the teeth's enamel appear opaque to more severe cases where brown blotches appear¹¹.

Histologically speaking, fluorite enamel is very porous and hypomineralized. It contains a high level of prosthetic matrix and this becomes particularly evident when the quantity of fluorosis reaches dangerous levels^{11,12}. Aside from this, teeth with high levels of fluorosis can be more susceptible to deterioration which is probably due to surface irregularities or the loss of the external protective layer^{11,12}. Taking the aforementioned into consideration, the question remains whether fluorite enamel is not made "more fragile" owing to the existence and worsening of injuries from different external impacts such as those related to dental trauma.

Up until this moment in time no identification has been made between the presence of dental fluorosis and dental trauma in epidemiological studies done on populations in this area. Therefore this present study sought to investigate if the presence of dental fluorosis at dangerously high levels has any associations with dental trauma amongst school children.

Methodology

Details of the Study Parameters and the Sample Used

This transversal study was conducted amongst school children from the age of 12 in Montes Claros (Minas Gerais - Brazil) in a Brazilian municipality that has a large population. Information was obtained from the Epidemiological Study on the Oral Hygiene of the population of Montes Claros (hereafter SBMOC)¹³ done in 2010, following the criteria adopted at SB Brazil 2002/2003¹⁴ and which was recommended by WHO¹⁵. We decided to use children from the age of 12 since, at the time of this study, this was the age when children finished primary school. Also in many countries it is the last age where it is possible to obtain reliable samples through school systems¹⁵. The dental examinations were done by highly trained and qualified dental surgeons (Kappa inter-examiners and intra-examiners and the correlation coefficient intra-class ≥ 0.61) with the support of interviewers/note takers. It was conducted in a well-lit area that had natural light with the use of a mirror and a CPI sterilized probe.

The first phase of the study was done with school children from the age of 12 ($n = 357$ school children) in which we identified the prevalence of dental cavities (39.2%) and fluorosis (49.0%). We did our calculations on a representative sample of school children from the age of 12 in the municipality. They were not representatives with reference to these problems^{13,16}. Data was collected from 36 randomly selected public schools out of 89 schools in the municipality. This was the number needed to obtain a representative sample. We included in this study school children that were evaluated with reference to the presence or absence of dental fluorosis.

Evaluated Conditions

Dental fluorosis

We registered the existence of fluorosis through following the recommendations from the WHO¹⁵ by using the Dean's fluorosis Index. The index is based on the visual aspects of the dental enamel ranging from normal/questionable to severe. It has six categories¹⁷. In terms of measuring the index, a clinical evaluation of all of the teeth in the oral cavity was done. Specific consideration was given to the two most affected teeth and a score was registered based on the

WHO¹⁵ recommendations. A construction of the dependent variables was done based on the variable outcome with the presence of fluorosis. Due to uncertain diagnosis, the condition considered normal (without fluorosis) was understood through putting together the “normal” and “questionable” scores. This parameter has been used in other previous studies^{18,19}. Two variable dependents were made with the first giving consideration to the presence of fluorosis based on putting together the “low” and “very low” scores (with fluorosis). For the second, the presence was characterized by putting together the “moderate” and “severe” scores (with fluorosis). Both were compared to the absence of fluorosis (normal/questionable).

Dental Trauma

An evaluation of dental trauma took into account proposed criteria given by the WHO in 1997¹⁵ for epidemiological studies in oral health and it used the SB Brazil 2002/2003¹⁴. This included clinical signs of crown fractures and dental avulsions for the top incisors and the bottom permanent ones. Based on the clinical criteria used, we evaluated: the presence of fractures of the enamel (a small loss of a portion of the crown around the enamel), fractures of the enamel and dentine (a loss of the greater part of the crown around the enamel and dentine), fractures of the enamel and dentine with exposure to the pulp (loss of the greater part of the crown around the enamel, dentine and exposure to the pulp) and the absence of a tooth owing to trauma (due to dental avulsion).

In the present study the variable was presented in a dichotomous way. This is because for cases involving dental trauma on at least one tooth, irrespective of the type of fracture, it was characterized as dental trauma on one or more teeth. Where no teeth were affected by dental trauma, this fact was recorded as “absence of dental trauma”.

Independent Variables

The rest of the independent variables were put together in four groups, with their respective subcategories namely: personal determinants, health services/health costs, behavior related to health and health outcomes.

The personal determinants were: sex (female, male), race was self-declared (white/Asian, indigenous/native South American)/black/mix-race) and type of abode (your own or not). The vari-

ables that related to health services/health costs were: the use of odontological services (yes/no), the type of odontological services used (public, private/business agreement/philanthropy), the reasons for using the odontological services (routine check-ups, booked treatments), access to oral health guidance through odontological services (yes, no) and odontological assistance at school (no, yes). Behavior related to health was evaluated: the frequency of daily oral hygiene care (2 times or more, once), the means used to ensure oral hygiene (brushing teeth and doing other things, just brushing teeth) and rinsing the mouth with fluoride at school (yes, no). In relation to health care outcomes, we considered as a normal condition, the presence of tooth decay (0, 1 or more teeth). The subjective conditions for oral health that were evaluated were: self-perception of the presence of teeth stains (no/yes), the need for treatment (no, yes) and satisfaction with their teeth's appearance (yes, no).

Statistical Analysis and Ethical Considerations

In order to analyze the data we used the software SPSS® *Statistics* 18.0. Descriptive analysis was used in order to obtain the absolute and relative (%) frequencies (n) of the variables. After this, bivariate analysis was done where consideration was given for multiple analysis of the variables that presented significant levels (value-p) that were equal to or less than 0.20. We used logistic regression to estimate the odds ratio with the significant level of 5% and confidence intervals at 95% (OR/CI 95%) for the variables associated to the presence of dental fluorosis. This remained in the models for variables with significant levels of up to 5%. The main ethical issues for this study were deemed to be in accordance with the National Council Resolution for Health (hereafter CNS) in Brazil number 196/96, under the approval of the Ethics Committee for Research Ethics (hereafter CEP/Unimontes.) All of the participants in the study agreed to take part in the tests and they signed a consent form demonstrating that decided to take part based on their own free will.

Results

We included in this study 2,755 school children who were interviewed and evaluated with reference to the presence of fluorosis. Of the children that took part, 1089 (39.6%) were diagnosed with

having dental fluorosis in at least one of the levels (low or severe). With reference to dental trauma, only 106 of the school children had one or more teeth with this condition (3.8%). The majority of the school children were: female (53.2%) and self-declared themselves as being indigenous native South Americans/black/mix-raced (79.3%), who used public odontological services (62.1%) and who did not receive odontological assistance at school (50.6%) (Table 1).

In the bivariate analysis the presence of low/very low levels of fluorosis was found which was statistically associated ($p \leq 0,20$) with variables belonging to dental trauma, health services, be-

havior and health care outcomes. The level of fluorosis being moderate/ severe was different in relation to the other levels being very low or low because there associations were maintained. This was also the case for the personal determinants and the health care outcomes (Table 2).

In the multiple analysis we identified that the presence of dental fluorosis was very low/low and this was the case for school children with one or more teeth with dental trauma ($p = 0,029$). They had the self-perception of the presence of stains on their teeth ($p = 0.001$). In relation to fluorosis levels being moderate/severe its prevalence was greater amongst school children with one

Table 1. The existence of dental fluorosis and the other independent variables amongst school children in Montes Claros (MG - Brazil) 2008/2009. n = 2755.

Variables	n	%	Variables	n	%
Dental fluorosis			Receive odontological assistance at school		
Normal	1632	59.2	No	1395	50.6
Questionable	34	1.2	Yes	1360	49.4
Very low	448	16.3	Behavior related to health		
Low	192	7.0	Frequency of daily oral hygiene		
Moderate	276	10.0	2 times or more	2569	93.3
Severe	173	6.3	Once	185	6.7
Principal independent variable			Ways to take care of oral hygiene		
Teeth with dental trauma			Brush teeth and other ways (dental floss, use of mouthwash, clean tongue)	2389	86.8
0	2649	96.2	Only brush teeth	363	13.2
1 or more	106	3.8	Rinse mouth with fluoride at schools		
Personal determinants			Yes	842	30.6
Gender			No	1913	69.4
Female	1466	53.2	Health care outcomes		
Male	1288	46.8	Normal conditions for oral health		
Race self-declared ^a			Teeth that are decaying		
White	568	20.7	0	254	81.8
Asian, indigenous (native South American), black and mix-raced	2182	79.3	1 or more	501	18.2
Health services / health costs			Subjective conditions for oral health		
Use of odontological services			Self-perception of the presence of discoloration of teeth		
Yes	2516	91.3	Absent	1732	62.9
No	239	8.7	Present	1023	37.1
The type of odontological service used ^b			Self-perception of the need for odontological treatment		
Public (SUS)	1562	62.1	Yes	1786	96.2
Private/ Business agreement/ Philanthropy	654	37.9	No	106	3.8
Reason for using odontological service ^b			Satisfaction with the appearance of teeth		
Routine Check-up	1032	41.0	No	1190	43.2
Appointment for prearranged treatment	1484	59.0	Yes	1565	56.8
Access to guidance on oral hygiene at odontological clinics ^b					
Yes	2435	96.8			
No	80	3.2			

^a variation in the number n. ^b considering only the schools that used odontological services.

Table 2. Bivariate analysis of the factors associated with the presence of dental fluorosis (low/very low and moderate/severe) amongst school children in Montes Claros (MG - Brazil), 2008/2009.

Variables	Fluorosis very low and low			Fluorosis moderate and severe		
	%	OR (IC95%)	p	%	OR (IC95%)	p
Principal independent variable						
Teeth with dental trauma						
0	95.3	1.00		93.8	1.00	
1 or more	4.7	1.65(1.04-2.64)	0.033	6.2	2.24(1.39-3.61)	0.001
Personal determinants						
Gender ^a						
Female	55.9	1.00		50.2	1.00	
Male	44.1	0.88(0.74-1.06)	0.205	49.8	1.11(0.90-1.37)	0.296
Race self-declared ^a						
White	20.4	1.00		17.9	1.00	
Asian, indigenous (native South American), black and mix-raced	79.6	1.07(0.85-1.34)	0.550	82.1	1.26(0.96-1.64)	0.091
Health services						
Use of odontological services						
Yes	92.7	1.00		92.7	1.00	
No	7.3	0.75(0.53-1.05)	0.098	7.3	0.75(0.50-1.11)	0.152
The type of odontological service used ^b						
Public (SUS)	63.9	1.00		64.9	1.00	
Private/ Business agreement/ Philanthropy	36.1	0.87(0.71-1.06)	0.170	35.1	0.83(0.66-1.04)	0.111
Reason for using odontological service ^b						
Routine Check-up	41.0	1.00		38.0	1.00	
Appointment for prearranged treatment	59.0	1.03(0.85-1.2)	0.709	62.0	1.17(0.94-1.47)	0.154
Access to guidance on oral hygiene at odontological clinics ^b						
Yes	97.1	1.00		95.7	1.00	
No	2.9	0.95(0.54-1.68)	0.883	4.3	1.46(0.84-2.56)	0.177
Receive odontological assistance at school						
No	50.9	1.00		45.9	1.00	
Yes	49.1	1.03(0.86-1.24)	0.710	54.1	1.26(1.02-1.56)	0.026

it continues

or more teeth with dental trauma ($p = 0.001$). Within the same group they received odontological assistance at school ($p = 0.021$) and they had self-perception of the presence of stains on their teeth ($p = 0.000$) (Table 3).

In relation to the distribution of the presence of dental trauma in accordance with the seriousness of the dental fluorosis, we noted that moderate levels of fluorosis were most prevalent for dental trauma (Graphic 1).

Discussion

The prevalence of dental fluorosis in this study was registered as 39.6% which is a value that was higher than that which was registered in a representative sample of Brazilian children from the age of 12 (16.7%)⁸. However, it was less than those registered in other countries such as Australia⁹ and India¹⁰. Other studies carried out in the state of Minas Gerais showed variations of 11.4 to 62.7%^{20,21}, however consideration needs to be given to different regional characteristics of the state and the individuals in the study. The other relevant factor is the need for executing

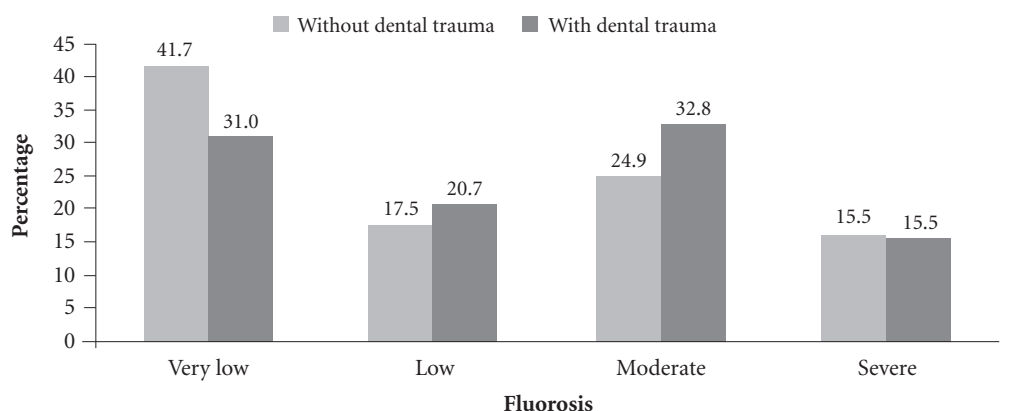
Table 2. continuation

Variáveis	Fluorosis very low and low			Fluorosis moderate and severe		
	%	OR (IC95%)	p	%	OR (IC95%)	p
Behavior						
Frequency of daily oral hygiene						
2 times or more	92.2	1.00		93.3	1.00	
Once	7.8	1.25(0.88-1.78)	0.197	6.7	1.06(0.69-1.61)	0.773
Ways to take care of oral hygiene ^a						
Brush teeth and other ways	85.3	1.00		88.0	1.00	
Only brush teeth	14.7	1.15(0.89-1.50)	0.268	12.0	0.92(0.67-1.26)	0.611
Rinse mouth with fluoride at schools						
Yes	32.2	1.00				
No	67.8	0.90(0.74-1.10)	0.338	29.8	1.00	
Health care outcomes				70.2	1.01(0.80-1.27)	0.906
Normal conditions						
Teeth that are decaying						
0	81.7	1.00		78.2	1.00	
1 or more	18.3	1.07(0.85-1.36)	0.528	21.8	1.34(1.04-1.74)	0.023
Subjective conditions						
Self-perception						
of the presence of discoloration						
of teeth						
Absent	59.5	1.00		52.6	1.00	
Present	40.5	1.37(1.14-1.66)	0.001	47.4	1.82(1.47-2.25)	0.000
of the need for odontological						
treatment						
Yes	68.3	1.00		66.1	1.00	
No	31.7	0.79(0.65-0.96)	0.021	33.9	0.87(0.70-1.09)	0.240
Satisfaction with the appearance						
of teeth						
No	43.4	1.00		47.2	1.00	
Yes	56.6	0.94(0.78-1.13)	0.537	52.8	0.81(0.65-0.99)	0.049

^a variation in the number n. ^b considering only the schools that used odontological services.

Table 3. Multiple analysis between the presence of dental fluorosis (low/very low and moderate/severe) adjusted by variables statistically significant ($p \leq 0,05$), amongst school children in Montes Claros (MG - Brazil), 2008/2009.

Variables	Fluorosis very low and low		Fluorosis moderate and severe	
	OR (IC95%)	p	OR (IC95%)	p
Principal independent variable				
Teeth with dental trauma				
0	1.00		1.00	
1 or more	1.68(1.05-2.67)	0.029	2.28(1.40-3.71)	0.001
Health services				
Receive odontological assistance at school				
No			1.00	
Yes	--	--	1.28(1.03-1.58)	0.021
Subjective conditions				
Self-perception of the presence of				
discoloration of teeth				
Absent	1.00		1.00	
Present	1.38(1.14-1.66)	0.001	1.83(1.48-2.26)	0.000



Graphic 1. Distribution of the seriousness of dental fluorosis in relation to dental trauma amongst school children in Montes Claros (MG) 2008/2009. n = 2755.

and providing information on: the external control of fluoridation of the state's water, the use of different sources of fluoride and access to toothpaste with fluoride. Aside from this, considering the relevant role of health education in changing behaviors and in health care outcomes²²⁻²⁴, such measures ought to be considered with the intention to avoid the inappropriate use of fluoride.

A worrying result was identified in relation to the existence of fluorosis at severe levels, being 6.3%, when according to the epidemiological research on oral health for Brazilian (2010), such dangerous levels for children from the age of 12 was considered practically no-existent in the country⁸. We noted that these children lived in regions with fluoridated water (0.74 mg/L de F) where the concentration was within the limits considered acceptable for Brazil (0,6-0,8 mg/L)²⁵. Therefore there is a possibility that the ingestion of fluoride occurred through other sources like toothpaste. In studies conducted amongst Brazilian children with the intention of estimating the total dosage of fluoride to which children are exposed through their diets (water and food) and toothpaste with fluoride, it was identified an average of 0.090 mg F/kg body weight/day²⁶. These were values above normal safe levels for fluorosis to be statistically acceptable (0.05-0.07 mg F/kg body weight/day)²⁷. However in this study our findings did not allow us to establish how much exposure to fluoride the children were submitted to. In addition to the results on its registered existence, we identified an association of dental fluorosis at various levels with: dental trauma, odont-

ological assistance at schools and the self-perception of the presence of stains on their teeth.

We noted an association with very low/low levels of fluorosis and the existence of dental trauma. Considering the multidimensional character of the risk factors for the existence of dental trauma²⁸ such as age, sex, body weight, the closure of the lips, trauma to the deciduous dentition and the practice of sports²⁹, is it possible to say that there is an association with dental trauma and very low/low levels of fluorosis. This could have occurred by chance as severely higher levels were expected. The above was noted due to there being severely high levels of fluorosis with the identification of greater porosity of the enamel and a greater tendency for physical deterioration^{11,12}. However these factors were not explored in this study.

The presence of dental fluorosis was at its highest levels amongst school children with at least one tooth that had dental trauma, considering the low/very and moderate/severe degrees. This association was at its highest for the moderate/severe levels. This was expected because the highest level of fluorosis increases the porosity of the dental structure and there is an increase in the possibility of deterioration¹¹. The histological changes in the fluorite enamel such as very high levels of porosity^{11,12}, can lead to a reduction in the mechanical resistance of the dental structure. This can increase the possibility of the existence and worsening of dental trauma. However due to the design and nature of this study, the results need to be taken with caution and can be better

evidenced through laboratory studies. We were unable to find relevant journals with epidemiological studies that focused on an association with fluorosis and dental trauma.

The existence of fluorosis at moderate/severe levels was most evident amongst school children that received odontological assistance at their schools. Oral health and access to odontological services is a priority for health care officials responsible for children. This has been established by the Health Ministry in Brazil³⁰. Greater use of odontological services amongst children from the age of 12 in Brazil has been identified^{8,24}. Aside from this, the use of odontological services, albeit at schools or at other places, can bring with it the identification of oral problems such as dental fluorosis that was not detected beforehand. Other dental problems such as tooth decay is associated with the levels of odontological assistance amongst children and Brazilian teenagers^{31,32}.

We noted an association between the presence of fluorosis (very low/low and moderate/severe) with self-perception of the presence of blotches on teeth. This was the case with school children. The marks on the teeth may be related to fluorosis that have come from other dental problems like tooth decay. A study carried out in India amongst 840 school children showed that in spite of 82.04% of the sample having been diagnosed with dental fluorosis, only 42.3% were aware of the presence of the disease¹⁰. It's worth noting

that in the field of oral health, self-perception can modify behaviors in relation to health and the importance given to oral problems³³. This can be very helpful in the search for treatments. Aside from this, moderate and severe levels of fluorosis can lead to a high level of awareness and worry with the presence of dental problems for children and their parents³⁴.

Amongst the limitations of this transversal study is that it was not possible to establish a relationship between cause and effect. Through the use of data from epidemiological research on oral health of the population and not specific data on fluoride ingestion by school children when their teeth are developing, we were not able to investigate other factors that could be related to dental traumas. In spite of this, our findings indicate an important association between the presence of fluorosis and dental trauma. This finding has not been greatly explored in scientific journals and thus needs to be investigated in future studies. This association exists at different levels of dental fluorosis (very low/low and moderate/severe). An association of the presence of dental fluorosis with variables referring to odontological services was identified as were other subjective questions on oral health. Future studies on the effects of the alterations that occur in the mechanical resistance of the dental structure of the fluorite enamel, needs to be done. This may influence the existence of dental trauma.

Collaborations

LFB Oliveira, CC Oliveira and AMEBL Martins participated in the concept and design of the project. They also collected and analyzed the data for this present draft. JGS Souza, PIP Mendes e CV Lima collected and analyzed the data for the final draft. RCN Oliveira participated in the drafting of this paper.

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