Prevalence of tooth erosion and associated factors in 11-14-year-old Brazilian schoolchildren

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Keywords
epidemiology; tooth erosion; risk factors; children.

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Received: 1/15/2010; accepted 7/23/2010.

doi: 10.1111/j.1752-7325.2010.00194.x

Abstract

Objective: Prevalence data about tooth erosion has attracted increasing attention in the dental community; however, population-based studies that assessed the impact of demographic, socioeconomic, and dietetic predictors on tooth erosion are scarce. This investigation assessed the prevalence of this condition of a sample of 11-14-year-old schoolchildren and the etiological factors.
Method: A cross-sectional study in a multistage random sample of 944, 11-14-year-old Brazilian schoolchildren was conducted in Santa Maria, Brazil. We recorded the prevalence and severity of tooth erosion, dental caries, and dental enamel hypoplasia. Socioeconomic and habits/dietetic data were collected by a structured questionnaire. Data were analyzed using Poisson regression model taking into account the cluster sample.
Results: Prevalence of tooth erosion was low (7.2%). The most affected teeth were the maxillary incisors. Labial surfaces were more often affected than palatal ones. All the erosive lesions observed were confined to the enamel. Older children [prevalence ratio (PR) = 1.71; 95% confidence interval (CI): 1.06-2.76] with dental enamel hypoplasia (PR = 1.98; 95% CI: 1.21-3.22) were more likely to have tooth erosion. No significant association was observed between tooth erosion, dental caries, habits and dietary patterns, and socioeconomic factors.
Conclusion: The data suggest that tooth erosion was associated with age and presence of hypoplasia. It may indicate the need of strategies to diagnose in early stages and to minimize consequences.

Introduction

Erosive tooth wear or tooth erosion has been defined as a progressive loss of hard dental tissue by a chemical process that does not involve bacteria (1). Tooth erosion may be caused by intrinsic, extrinsic, or idiopatic factors (1-3). Studies have reported the etiology of erosion and its association with clinical conditions (dental enamel hypoplasia and caries), behavioral (dietary habits and oral hygiene), gastroesophageal reflux disease (GERD), demographic, and socioeconomic factors (age, gender, social class, educational level, type of school, and household income) (4-22).

Data on the prevalence of erosive lesions of the permanent dentition have been published in recent years (1,2,5-22), with results ranging from 3 to nearly 100 percent. In Brazil, data regarding the prevalence of erosion are scarce. In general, the results of such studies demonstrated a prevalence that ranged from 13.0 to 38.2 percent (15,16,20,21). The factors associated with tooth erosion in Brazil were type of school (15,16,21), type of diet (19,20), salivary conditions (20), and social class (15,16,21).

There is a lack of information about the influence of socioeconomic variables on tooth erosion. Previous studies have shown contradictory results. Some investigations showed a significant positive relationship between tooth erosion experience and socioeconomically deprived areas (5,8,17). In contrast, other studies have observed more erosive lesions in children from higher socioeconomic groups (6,10,12,15,18,21). Overall, in previous studies, authors (9,11,14,16) have not found the difference between

socioeconomic groups and presence of tooth erosion. Thus, the data are inconclusive. Studies about possible prediction for tooth erosion are important, and this might lead to the diagnosis of lesions in an early stage and to the identification of their possible causes, aiming to maintain the oral health of children (12).

Therefore, the aim of this study was to evaluate the prevalence of tooth erosion and its association with socioeconomic, dietary habits, and clinical factors in a population-based sample of schoolchildren in a Brazilian city.

Method

Study population and design

A cross-sectional study was conducted in a representative sample of 11-14-years-old schoolchildren from Santa Maria, a southern city in Brazil. The city has an estimated population of 263,403 including 3,180 children regularly attending 39 public schools (23). For the sample calculation, the following parameters were used: prevalence of tooth erosion of 38.2 percent (21), a standard error of 4 percent, the 95 percent confidence interval (CI), a design effect of 1.4, and adding 10 percent to losses. The minimum sample size required for this study was 870 schoolchildren.

A two-stage random sampling procedure was adopted to select the sample. The first stage units were all public schools in the city. A total of 20 schools were randomly selected (24). Since the schools had different sizes, an equal probability selection method – probability proportional to the size – was used to ensure that all children would have the same chance to be selected (24). The second stage units were the 11-14-year-old children enrolled in each selected school.

Measures

Data were collected through clinical oral examinations and structured interviews. Children were clinically examined in their schools by two examiners. The examiners were previously trained and calibrated for data collection before the survey. The calibration process lasted for 36 hours, and included theoretical activities with discussion on the diagnostic criteria for tooth erosion. Moreover, a range of different levels of tooth erosion – based on the diagnosis of photographic images – was used in the calibration exercise (16,20). The examiners were also calibrated for the assessment of dental caries and dental enamel hypoplasia (24). For this purpose, a total of 15 children were examined twice by the same examiners, with an interval of 2 weeks between each examination. A benchmark dental examiner conducted the complete examiner training and the calibration process.

Table 1 Index for the Measurement of Tooth Erosion

Site of erosion on each tooth	
Code A	Labial or buccal only
Code B	Lingual or Palatal only
Code C	Occlusal or incisal only
Code D	Labial and incisal/occlusal
Code E	Lingual and incisal/occlusal
Code F	Multi-surface
Grade of severity	
Code 0	Normal enamel
Code 1	Matt appearance of the enamel surface with no loss of contour
Code 2	Loss of enamel only (loss of surface contour)
Code 3	Loss of enamel with exposure of dentine (ADJ visible)
Code 4	Loss of enamel and dentine beyond ADJ
Code 5	Loss of enamel and dentin with exposure of the pulp
Code 9	Unable to assess (e.g., tooth crowned or large restoration)
Area of surface affected by erosion	
Code –	Less than half of surface affected
Code +	More than half of surface affected

ADJ, amelodentinal junction.

Clinical examinations were carried out under natural light, using periodontal probes (CPI; "ball point") and dental mirrors. Sterile gauze pads were used to clean and to dry the tooth surfaces (15,16). The tooth erosion index (25) was adopted and was adjusted to assess the four upper incisors (15) and first molars (Table 1). Children with fractured teeth, extensive restorations, or who were wearing orthodontic appliances were excluded from this study.

Socioeconomic backgrounds of the samples were collected through a questionnaire that was completed by the children's parents. The questionnaire provided information about the age, gender, ethnic background, parents' level of education, parents' occupation, and household income. The feasibility of the questionnaire was verified with reapplication in 10 percent of the sample.

A questionnaire based on the literature (2,19) was employed to investigate the presence of GERD and patterns of dietary habits (types and frequencies of consumption of acidic drinks). The data were completed in a schoolroom before the clinical examination. Drinks were dichotomized into higher (frequently or every day) and lower (never or rarely) consumption. Children were asked about symptoms of gastric disorders.

Data analysis

Data analyses were performed using STATA software 9.0 (Stata Corp., College Station, TX, USA). Descriptive and bivariate analyses were conducted to provide summary statistics and preliminary assessment of the association of predictor variables and the outcome. Poisson regression model

taking into account the cluster sample (prevalence ratio and 95 percent confidence interval) was performed to assess the association between the predictor variables and the outcome. A backward stepwise procedure was used to include or exclude explanatory variables in the fitting of models. Explanatory variables presenting a *P*-value ≤ 0.20 in the assessment of correlation with each outcome (bivariate analyses) were included in the fitting of the model. Explanatory variables were selected for the final models only if they had a *P*-value ≤ 0.05 after adjustment.

Ethics

The study was approved by the Human Research Ethics Committee of the Federal University of Santa Maria and informed consent was obtained prior to beginning the data collection.

Results

A total of 944 children, 42.5 percent boys and 57.5 percent girls, were enrolled in this study. The response rate was 94 percent of all children invited. Reasons for non-participation were mainly due the lack of parental consent and absence on the day of the exam. The actual sample size was larger than the minimum size to satisfy the requirements ($n = 870$) because this study was part of a major project including other outcomes that required larger samples. For tooth erosion, inter-examiner and intraexaminer kappa values ranged from 0.70 to 0.80 and from 0.75 to 0.88, respectively.

Children were predominately white (79.4%); more than half of the parents were employed and half of them had a household income equal or greater than two Brazilian Minimum Wages (Table 2). Prevalence of tooth erosion, caries, and dental enamel hypoplasia were 7.2, 35.3, and 19.7 percent, respectively (Table 2). Labial surfaces of upper incisors were more often affected than the palatal ones; the majority of teeth with erosion showed less than half of surface affected and with lower grades of severity (Table 3).

Tooth erosion was associated with dental caries (PR: 0.56; 95% CI: 0.32-0.97), dental enamel hypoplasia (PR: 1.95; 95% CI: 1.20-3.15), age (PR: 1.63; 95% CI: 1.03-2.59), and GERD (PR: 1.71; 95% CI: 0.95-3.08) in the univariate analysis (Table 4). When we applied the multivariate analysis, the oldest children with dental enamel hypoplasia were more likely to have tooth erosion than their counterparts (Table 4). There were no significant differences in any aspect of the tooth erosion between low- and high-deprivation children. Likewise, erosive tooth wear was not associated with the presence of GERD and consumption of acidic drinks.

Table 2 Clinical and Demographic Characteristics of the Sample

Variable	*n**	%
Gender	943	
Male	401	42.5
Female	542	57.5
Ethnics	942	
White	748	79.4
Nonwhite	194	20.6
Age (years)	944	
11-12	637	67.5
13-14	307	32.5
Household income (BMW)	855	
≥2	455	53.2
<2	400	46.8
Mother's schooling (years)	937	
≥8	533	56.9
<8	404	43.1
Father's schooling (years)	921	
≥8	515	56.0
<8	406	44.0
GERD	944	
Without	839	88.9
With	105	11.1
Consumption of acid drinks	944	
High	416	44.0
Low	528	56.0
Tooth erosion	944	
Without	903	92.8
With	68	7.2
Enamel hypoplasia	944	
Without	758	80.3
With	186	19.7
Dental caries	944	
DMF = 0	611	35.3
DMF > 0	333	64.7

* Values lower than 944 due missing data.

BMW, Brazilian minimum wage; GERD, gastroesophageal reflux disease; DMF, decayed, missing, filling.

Discussion

This study demonstrated a low prevalence of tooth erosion in Brazilian schoolchildren. Nevertheless, we found that the development of such lesion was not influenced by socioeconomic status.

A 7.2 percent prevalence of tooth erosion was found among 11 to 14-year-old schoolchildren (95% CI = 5.5%-8.8%). The prevalence found in this study was lower than the majority of findings reported by several other authors in different countries (2,7,10,15,16,20,21). In Brazil, the prevalence of tooth erosion showed different results, ranging from 13 to 38 percent. This difference may be related to the criteria employed by the authors (15,16,20,21). The reasons for these different results may be explained by the absence of a standardized index, type of teeth examined, sample size, age, and

Table 3 Characteristics of Tooth Erosion in Relation to the Number of Affected Teeth in Santa Maria, Brazil

	n (%)							
Teeth	11	12	21	22	16	26	36	46
Surface								
Labial only	38 (4.0)	1 (0.1)	35 (3.7)	0	0	0	0	0
Palatal only	3 (0.3)	2 (0.2)	3 (0.3)	2 (0.2)	0	0	0	0
Incisal or oclusal	0	0	0	0	1 (0.1)	1 (0.1)	12 (1.3)	11 (1.2)
Labial and incisal/oclusal	1 (0.1)	0	1 (0.1)	0	0	0	0	0
Palatal and incisal/oclusal	0	0	0	0	0	0	0	0
Multi-surface	13 (1.4)	0	16 (1.7)	0	0	0	0	0
Grade of severity								
Normal enamel	893 (94.6)	941 (99.7)	898 (95.1)	942 (99.8)	943 (99.9)	943 (99.9)	933 (98.8)	931 (98.8)
Matt appearance of the enamel surface with no loss of contour	41 (4.3)	2 (0.2)	38 (4.0)	1 (0.1)	1 (0.1)	1 (0.1)	11 (1.2)	11 (1.3)
Matt appearance of the enamel surface with loss of contour	10 (1.1)	1 (0.1)	8 (0.9)	1 (0.1)	0	0	0	0
Area affected								
Less than half	50 (5.3)	1 (0.1)	51 (5.4)	1 (0.1)	1 (0.1)	1 (0.1)	11 (1.2)	12 (1.3)
More than half	2 (0.2)	1 (0.1)	5 (0.5)	1 (0.1)	0	0	1 (0.1)	1 (0.1)
Total	52 (5.5)	2 (0.2)	56 (5.9)	2 (0.2)	1 (0.1)	1 (0.1)	12 (1.3)	11 (1.4)

socioeconomic and geographical factors that could influence the outcome.

It has been suggested that the early forms of erosive tooth wear may be easily overlooked as it is accompanied by few clinical signs and rarely any symptoms (26), and it is almost impossible to distinguish between the influence of tooth erosion, attrition, or abrasion during clinical examination without introducing bias into the assessment procedure (26). Likewise, the majority of the studies employed the tooth wear index with minor modifications (4,8,9,18). This index assesses tooth erosion irrespective of the causes (12); thus, it can overestimate the prevalence of tooth erosion (15), because it includes pure attrition (12). The index and criteria used in the present study were designed by another author (25) and it is specific to diagnostic erosion in children and adults. Another advantage of this index is the evaluation of different criteria: site of erosion, severity, and affected tooth surface area (21). Previous studies conducted in Brazil (15,21) employed this index and this may facilitate future comparison.

The majority of the investigations about tooth erosion in permanent dentition focused on 12-year-old children (1,7,15,16,20,21). However, many studies have employed a random sample of 14-year-old children for several reasons (6,10,13,16,17). This is an age where most of the permanent teeth have erupted and the incisors and first molars are present in the mouth for a number of years (8). Therefore, in this age, teeth are exposed to possible intrinsic and extrinsic etiological factors for some time (1,8). In our study, incisors were the most commonly affected teeth and these results are in agreement with other investigations (2,6-8,10,15,16,22). The buccal surface predilection for tooth erosion in permanent teeth was in agreement with previous studies (6,8,15) and this may be explained by the pattern of exposure of specific factors. However, a high prevalence of erosion in palatal surface has been observed in other reports (1,16,21). It has been suggested that the abrasive effects of the tongue on softened, demineralized enamel may contribute to a greater loss of tooth surface palatally (12).

Regarding severity, first degree involving the enamel alone was most common, as has been reported in most of the studies in the literature for a similar age (2,8,10,15,16,20,21). The majority of teeth with erosion showed less than half of the surface affected. One hypothesis is that these schoolchildren may have been exposed to tooth erosion risk factors at low levels, or for a relatively short period of time (15).

There is scarce information about the impact of demographic and socioeconomic factors on the prevalence of tooth erosion. Generally, the results are contradictory. In this study, there was no difference between girls and boys in the prevalence of tooth erosion (6,15-17,20). Contrasting results have also been reported in the literature: authors (5,8,11,14,21) found statistically significant more erosive lesions in boys than girls. It has been suggested that a higher rate of tooth erosion could be attributed to differences in the strength of musculature and biting forces, and also to a higher consumption of acidic drinks among boys (12).

In the present study, socioeconomic factors were not associated with the prevalence of tooth erosion, a result that is in accordance with previous findings (1,9,11,14,16). Other studies, however, have shown a correlation between socioeconomic status and tooth erosion (4,6,10,12,15,18,21). In general, children from high socioeconomic backgrounds showed a higher prevalence of tooth erosion. In a Brazilian

Table 4 Prevalence of Tooth Erosion and Associated Factors (Prevalence Ratio: 95% CI)

	With tooth erosion				
Variable	*n* (%)	PR (95% CI)	*P*	PR_{adj}(95% CI)	*P*
Gender	68		0.43	*	*
Boys	32 (6.64)	1			
Girls	36 (7.98)	0.83 (0.53-1.31)			
Age (years)	68		0.03		0.03
11-12	38 (5.97)	1		1	
13-14	30 (9.77)	1.63 (1.03-2.59)		1.69 (1.05-2.73)	
Ethnics	67		0.57	*	*
White	55 (7.35)	1			
Nonwhite	12 (6.19)	0.84 (0.46-1.54)			
Household income (BMW)	61		0.08		0.07
≥2	39 (8.57)	1		1	
<2	22 (5.50)	0.64 (0.39-1.06)		0.63 (0.39-1.03)	
Mother's schooling (years)	68		0.86	*	*
≥8	38 (7.13)	1			
<8	30 (7.43)	1.04 (0.66-1.65)			
Father's schooling (years)	68		0.99	*	*
≥8	38 (7.38)	1			
<8	30 (7.39)	1.00 (0.63-1.58)			
GERD	68		0.07		0.08
Without	56 (82.35)	1		1	
With	12 (17.65)	1.71 (0.95-3.08)		1.66 (0.93-2.97)	
Consumption of acid drinks	67		0.81	*	*
Low	37 (54.41)	1			
High	30 (44.12)	1.06 (0.77-1.38)			
Dental caries	68		0.04		0.07
DMF = 0	52 (8.51)	1		1	
DMF > 0	16 (4.80)	0.56 (0.32-0.97)		0.60 (0.35-1.04)	
Enamel hypoplasia	68		0.007		0.005
Without	46 (67.65)	1		1	
With	22 (32.35)	1.95 (1.20-3.15)		2.03 (1.05-2.73)	

* Variables not included after adjustment.

BMW, Brazilian minimum wage; GERD, gastroesophageal reflux disease; DMF, decayed, missing, filling.

study, tooth erosion was significantly more prevalent among 12-year-old children at private schools when compared with those registered at public schools. Therefore, the type of school was considered as an indicator for socioeconomic status (15). This approach is valid for Brazilian surveys and it has been already applied elsewhere (15). Recently, another study (21) found that children from higher-income families and whose parents had a high educational level showed more tooth erosion than that from low-income families. Other studies reported opposing results, with children living in socioeconomically deprived areas presenting more erosive lesions than their counterparts (5,8,17).

In this study, the oldest children were more likely to have erosive lesions than the younger ones (PR = 1.63; 95% CI: 1.03-2.59), a result that is in accordance with previous findings (3,10,14,22). In a longitudinal study (27) that assessed the incidence of tooth erosion in children over a period of 1.5 years, tooth erosion was present in 32.2 percent of the 622 children and it increased to 42.8 percent. It has been suggested that the erosive process is cumulative and it tends to progress (14,27). Therefore, the monitoring of children and adolescents with initial signs of tooth erosion is recommended (27).

In this study, dental enamel hypoplasia was associated with tooth erosion (PR = 1.95; 95% CI: 1.20-3.15). Our result is in agreement with other findings (17), which showed that dental enamel hypoplasia were also present in the same teeth with erosion, suggesting that abnormal enamel development may be a risk factor for tooth erosion. The authors hypothesize that the reduced or altered mineralization observed in enamel defects may lead to greater ease of dissolution by acids and secondary tooth structure loss through attrition and abrasion.

Dietary habits were not associated with erosion in this study and this is in agreement with other studies (2,3,6,10,13,16). However some studies demonstrated significant association (8,9,13,18-20,28,29) between consumption of acidic drinks

and tooth erosion. The influence of dietary habits or practices, such as the consumption of acidic drinks and foods in the development of tooth erosion has been assessed in cross-sectional and case-control studies (2,3,6,8-10,13,16,18-20,28,29). However, these results are contradictory. In a study involving 418 14-year-olds in the UK, Al-Dlaigan *et al.* (8) reported that orange squash, cola drinks, and other carbonated drinks were consumed by 81, 80, and 76 percent of the subjects, respectively. Approximately, 50 percent of the adolescents had a relatively low consumption of these drinks, between one and seven intakes per week. However, 13 percent of the subjects had a high consumption, with more than 22 intakes per week. To determine the risk indicators for tooth wear (erosion) in Sri Lanka adolescents, authors (30) assessed only the frequency of consumption, which was recorded on a 7-point scale; their results showed that the frequency of consumption is more important than the overall quantity.

Unfortunately, there is not a standardized questionnaire in epidemiological surveys related to tooth erosion and this might be associated to contradictory results. The lack of association between erosion and dietary habits might be due to the influence of other factors, such as quantity and composition of saliva, tooth composition and structure, oral hygiene practices, medical conditions, and socioeconomic factors (3,6,14,16,20,22). Nevertheless, it has been suggested that the assessment of consumption of acidic sources without proper analyses of possible confounder factors is too simplistic and could not reveal the real impact of dietary habits on tooth erosion (28).

In relation to the presence of GERD, there is little information about the influence of this medical condition on teeth. Our result is in agreement with another study (31) that did not find a correlation between stomach problems and tooth erosion. In a recent study, Pace *et al.* (32) searched two databases to identify studies in which investigators compared GERD with tooth erosion. They showed that the associations were based on multiple diagnostic measures, trial types, patient identification schemes, and outcomes; therefore, those studies were not comparable among themselves and it is uncertain to correlate these conditions.

Some methodological considerations need to be discussed when considering the results reported here. The findings are limited by the cross-sectional nature of the data. Therefore, it is not possible to establish a temporal relationship between the outcomes and the predictor variables. However, cross-sectional designs are useful to identify risk indicators that can be confirmed in further longitudinal designs (27).

Despite of its limitation, our study brings important information about socioeconomic background in tooth erosion involving Brazilian schoolchildren. Our results may help the governmental implementation and monitoring of local dental health strategies, facilitating the targeting of resources. Another limitation refers to the lack of a standardized questionnaire in this study (2,15); nevertheless, our findings are in agreement with other studies (2,6,10,13). We used a representative sample with a random selection process in different schools, including children living in all of the administrative regions of the city. This random process avoided bias, which might occur if the sample is collected in a clinical setting, for example. Therefore, such process provides sound conclusions in relation to the research question for all 11-14-year-old children living in the city. Furthermore, the high response rate and the acceptable level of inter/intra-rate agreement increase the internal validity of this study.

This study suggests that an increase in age and the presence of dental enamel hypoplasia are risk factors associated with tooth erosion. Further epidemiological investigation is required in order to identify the pathways for the influence of socioeconomic background on the prevalence and severity of tooth erosion in children.

Acknowledgments

The authors would like to thank all the children, parents and schools for their cooperation, and the Municipal Education Authorities of Santa Maria, RS, for all the information and authorization related to this study.

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