

Tooth erosion and dental caries in schoolchildren: is there a relationship between them?

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Abstract

Aim: To identify a possible association between the occurrence of dental caries and tooth erosion and to correlate the dietary factor with an increased risk of dental caries. **Methods:** A cross-sectional study in a multistage random sample of 1,211, 8 to 12-years-old Brazilian schoolchildren in private and public schools was conducted in Pelotas, Brazil. The prevalence of dental caries and tooth erosion was assessed. Dietary habits data were collected by a structured questionnaire. Data were analyzed using Poisson regression model taking into account the cluster sample (Prevalence ratio - PR; 95% Confidence Interval - CI). **Results:** The prevalence of dental caries and tooth erosion was 32.4% (95% CI: 30.0; 35.2) and 25.0% (95% CI: 23.4; 29.0), respectively. Most children had high consumption of sweets (65%). Consumption of fruits, such as oranges (31%), strawberries (23.6%), pineapple (12%), and natural fruit juices (oranges, lemon) was low. Soft drinks consumption, 3 or more times a week was observed in 40% of the children. **Conclusions:** Dental caries was not statistically associated with tooth erosion. The consumption of acidic fruits/drinks was not associated with dental caries. Dental caries and dental erosion were not associated with each other and with acidic fruits or drinks consumption.

Keywords: dental caries; tooth erosion; epidemiology; child; diet.

Introduction

Dental caries is the main oral disease affecting children and adolescents, particularly among underprivileged groups in the developed and developing countries¹. Data from Brazil in 2010 show that 43.5% of 12-year-old children had dental caries, with a mean DMFT (decayed, missed, filled teeth) of 2.07². Despite the high prevalence of caries in children, there is a worldwide trend of caries reduction³, raising interest for other oral health problems, such as the increase of tooth erosion, mainly in young individuals⁴.

Tooth erosion has been defined as a progressive loss of hard dental tissue due to a chemical process that does not involve bacteria⁵. It has the potential to substantially impact on dentition, due to its cumulative and progressive nature⁶. The prevalence of tooth erosion in Brazilian children (age 6 to 16 years old) ranged from 7.2 to 26 percent⁷⁻¹⁰.

It is well established that dietary habits play an important role in promoting and maintaining oral health among individuals. Dietary habits are important risk factor for dental caries¹¹ and also main source of acids, contributing to the development of tooth erosion¹⁰. It has been suggested that children with dental caries may also be predisposed to tooth erosion¹². Many types of food and soft drinks are not only acidic but also contain high percentage of sugar¹³ and, therefore,

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dental erosion and caries may occur simultaneously in the same individual, but on different tooth surfaces¹⁴⁻¹⁵.

However, this potential association remains unclear and contradictory, while some studies found an association between the two diseases, others did not find any association^{12,14,16}. Variability between investigations regarding localization and the studied population may influence the results¹⁴⁻¹⁵. We hypothesized that presence of caries is associated with tooth erosion and diet.

The aim of this study was to test if dental caries occurrence may be associated with tooth erosion in Brazilian schoolchildren. Additionally, it was tested whether dietary habit patterns may increase the risk for dental caries.

Material and methods

Study population and design

In 2010, a cross-sectional study was performed in the city of Pelotas, RS, Brazil, using a multi-stage random representative sample of 8-12-year-old schoolchildren of the city. Pelotas is a middle-sized city of the southern region of Brazil, which has 328,275 inhabitants, nearly 85% residing in the urban area. More detailed information can be found elsewhere¹⁷.

For the sample calculation to assess the prevalence and association between dental caries and independent variables, the following parameters were used: caries prevalence of 39.3 percent¹⁸, a standard error of 4 %, a confidence interval (CI) of 95% and power equal to 80%. A design effect of 1.4⁹ was considered and the sample size was increased by 20% for possible refusals or losses. The ratio of unexposed to exposed tooth erosion was 3:1 and the prevalence ratio to be detected was at least 1.6, and the minimum sample size to satisfy these requirements was 616 children. A two-stage random sampling procedure was adopted to select the sample. The first stage units were public and private schools of the city. Twenty schools were randomly selected. The second stage units were the classrooms. In each school, five classes, from 2nd to 6th grade, were randomly selected and all children enrolled in these classes were initially eligible for the study. Subjects intellectually and physically able to answer the questionnaire were included in the study.

From the 1,744 children invited to participate, 1,211 children were enrolled in the study with a 70% response rate. Reasons for non-participation were mainly due to the lack of parental consent and absence on the examination day. The actual sample size was larger than the minimum size to satisfy the sample size requirements because this study was part of a major project including other outcomes that required a larger sample.

Data were collected with structured interviews and clinical oral examinations, and six calibrated dentists participated. The calibration included theoretical activities for the diagnostic criteria for dental caries (DMFT)¹⁹ and tooth erosion²⁰. To assess inter-examiner consistency for caries, a calibration exercise was performed on 10 children that were not included in the final sample, which were re-examined

by the same examiners 2 weeks after the first examination. For tooth erosion, a range of different levels of erosion – based on the diagnosis of photographic images – was used in the calibration exercise (*in lux*), in agreement with the literature. For dental caries and tooth erosion, inter-examiner kappa values ranged from 0.68 to 0.90 and from 0.60 to 0.65, respectively.

Examinations were conducted in the classrooms, with children in a sitting position, under artificial light, using periodontal probes (CPI; “ball point”) and dental mirrors. Sterile gauze pads were used to clean and dry the tooth surfaces. Dental caries was assessed in all teeth, using the DMFT – decayed, missed, filled teeth index according to the WHO recommendations¹⁹ which measure the lifetime experience of tooth caries in permanent dentition. Tooth erosion was assessed by the modified version⁸ of the O’Sullivan index²⁰ on maxillary incisors, by visual examination of facial, lingual, and incisal surfaces²⁰. For this study, tooth erosion was dichotomized as present or not. The presence of one erosive lesion was considered “with tooth erosion”. Site of erosion, severity and affected tooth surface area were not analyzed.

A previously used questionnaire based on the literature^{7,9}, was employed to investigate dietary habits (type and frequency of consumption of acidic drinks, including non-diet/non-light and diet/light soft drinks, fruit and sweets). Data were completed in schoolroom before the clinical examination. Dietary foods and drinks consumption was initially recorded by three frequencies: never, 1 or 2 times and 3 times or more (during a week) and later dichotomized in two categories: low (never or 1-2 times a week consumption) and high (3 or more times a week consumption)⁹. This cut off was chosen because in Brazilian children, the acidic uptake more than three times a week was observed to increase twice the chances for tooth erosion⁷. To assess the applicability of the questionnaire, a pre-test was performed with 10 % of the study population before the survey, showing satisfactory levels of acceptability and ease of completion.

Data analyses were performed using STATA software 12.0 (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 (dental caries) was performed using the chi-square Pearson and Mann-Whitney test. 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.

The study was approved by the Human Research Ethics Committee of the Federal University of Pelotas (approval

protocol n°160/2010) and informed consent was obtained prior of starting data collection.

Results

Demographic, socioeconomic, behavioral and clinical characteristics of the sample are presented in Table 1. There were 574 (47.4%) boys and 637 (52.6%) girls. Prevalence of dental caries and tooth erosion were 32.4% (95%CI 30.0; 35.2) and 25.0% (95%CI 23.4; 29.0) respectively. In relation to sweets consumption, a prevalence of 65% was found. For the 1,211 schoolchildren the DMFT index result was 0.64 (Standard Deviation $\pm$ 1.18). The mean DMFT index was not statistically different for children with tooth erosion 0.75 ($\pm$ SD 1.35) compared with those without erosion 0.59 ($\pm$ SD 1.11). In the preliminary assessment, the outcome (dental caries) was not associated with any dietary or clinical factors (tooth erosion) (Table 2). In the multivariate analysis, dental caries was not associated with dietary habits (PR:1.15; 95% CI: 0.97;1.35) (Table 3). Similarly, dental caries was not associated with tooth erosion (PR: 1.15; 95% CI: 0.96;1.37) (Table 3).

Discussion

In this study a prevalence of 32.4% of dental caries was found among 8- to 12-year-old children (95% CI: 30.0;35.0). This prevalence was lower than observed in other studies^{21,22}. A significant decrease in caries prevalence in Brazilian children was observed in the last decades^{10,23}. Some longitudinal investigations indicated an increase of erosion incidence in children²⁴⁻²⁵. The prevalence found in this study (25.0%) was higher than those observed in other Brazilian studies investigating mixed and/or permanent dentitions⁸⁻⁹. Different indexes used or dietary habits between countries and regions may account for this variability. Younger children (aged 8 to 12 years) were included in the present study, turning the acidic contact with tooth structure as the main potential etiologic factor⁷.

In this study, 8.9% of children had caries and tooth erosion. However, the mean DMFT scores were not statistically different for children with tooth erosion (0.75) compared to those without erosion (0.59). Similar findings were observed in children aged 13-14 years in Brazil, England and Libya^{10,15,26}. In a Brazilian study with adolescents, while 35% of them had dental caries and tooth erosion, 32% without caries had also tooth erosion, and no association was detected between the two outcomes¹⁰. In Australia, children who had caries were more likely to have severe tooth erosion in both dentitions¹². In an English cohort, tooth erosion was associated with dental caries and with high consumption of carbonated drinks at age 12¹⁶. In Saudi Arabia, direct relationship between tooth erosion and dental caries was observed, suggesting that the carious process could be a potential risk factor for tooth erosion, with possible common risk factors¹⁴. Children may fail to maintain a non-cariogenic diet, which could also be a potentially erosive

Table 1- Clinical, demographic, behavioral and socioeconomic characteristics of the sample. Pelotas, Southern Brazil, 2010. (N = 1,211)

Variables/Category	N*	%
Gender	1,211	
Male	574	47.0
Female	637	53.0
Skin color	1,173	
White	856	73.0
Dark-skinned Black	189	16.0
Light-skinned Black	128	11.0
Age (years)	1,211	
8	182	15.0
9	312	26.0
10	295	24.5
11	259	21.0
12	163	13.5
Family income (quartiles)	1,030	
1 st (poorest)	246	24.0
2 nd	271	26.2
3 rd	241	23.0
4 th (richest)	279	27.0
Mother's schooling (years)	1,176	
< 12	502	43.0
9-11	121	10.0
5-8 > 4	127426	11.036.0
Consumption of sweets	1,208	
Low	423	35.0
High	785	65.0
Consumption of natural orange juice	1,208	
Low	779	64.5
High	429	35.5
Consumption of natural lemon juice	1,207	
Low	976	81.0
High	231	19.0
Consumption of flavored juice	1,206	
Low	792	66.0
High	414	34.0
Consumption of soft drink	1,208	
Low	727	60.0
High	481	40.0
Consumption of strawberry	1,207	
Low	922	76.4
High	285	23.6
Consumption of pineapple	1,207	
Low	1,067	88.0
High	140	12.0
Consumption of orange	1,206	
Low	832	69.0
High	374	31.0
Dental caries	1,210	
Present	392	32.4
Absent	818	67.6
Tooth erosion	1,202	
Present	302	25.0
Absent	900	75.0

*Values lower than 1,211 due to incomplete information

Table 2 – Prevalence of dental caries and associated factors, Pelotas, Southern Brazil, 2010. (N=1,211)

	Dental caries	p value*
Tooth erosion		0.117
Without	622	278
With	194	108
Natural orange juice		0.439
Low	532	246
High	284	145
Natural lemon juice		0.627
Low	662	313
High	153	78
Flavored fruit juices		0.342
Low	527	264
High	287	127
Soft drinks		0.116
Low	504	223
High	312	168
Strawberry		0.904
Low	624	297
High	192	93
Pineapple		0.889
Low	722	344
High	94	46
Orange		0.541
Low	568	264
High	248	125
Sweets		0.922
Low	82	40
High	734	351

* Chi-squared (χ^2) test**Table 3** – Prevalence of dental caries and associated factors (Prevalence Ratio: 95% CI), Pelotas, Southern Brazil, 2010. (N=1,211)

Variables	With Dental caries			
	PR ^c (95%CI)	p value*	PR ^{adj} (95%CI)	p value*
Tooth erosion		0.111		0.130
Without	1.00		1.00	
With	1.16 (0.97;1.39)		1.15 (0.96;1.37)	
Soft drinks		0.114		0.101
Low	1.00		1.00	
High	1.14 (0.97;1.34)		1.15 (0.97;1.35)	

*Wald test; PR^c = Crude prevalence ratio; PR^{adj} = Adjusted prevalence ratio; CI = Confidence interval

diet¹⁵. Higher levels of *mutans streptococci* were found in children at risk of tooth erosion²⁷. The loss of protective factors, such as saliva, may place the children at risk for both diseases¹².

Tooth erosion and caries have a multifactorial etiology⁵. The acids responsible for erosion are not produced by the oral biofilm, but derived from dietary intrinsic acids or occupational sources⁵. On the opposite, caries development relies on the acids produced by the oral biofilm. Studies have shown an association between tooth erosion, dental caries and dietary habits^{14,16}. In the present study it was

assessed the type and frequency of consumption of acidic food and drinks. These variables were not statistically associated with caries, in agreement with another previously reported investigation¹⁰. This result could be attributed to the frequency of consumption of acidic diet. Frequent consumptions, more than 3 times a day, increased the risk for both oral conditions 1.5 times¹⁶. The increased consumption of beverages and foods, containing high percentage of sugar and acidic products rises concerns for their impact on general health, especially in children and adolescents, being associated with cardiopathy, diabetes and obesity¹².

It should be highlighted that the process and site specificity are different for both conditions. In general, the surfaces more prone to erosion are not those where caries occurs²⁶ and tooth erosion is often located in plaque-free areas, in opposition to dental caries, which is located in plaque accumulation sites⁵. Dental caries and tooth erosion can occur independently. The association between them may not always be found, and in some cases, the rapid and destructive nature of caries may force removal of the clinical evidence of erosion⁵.

The lack of association between dental caries, tooth erosion and dietary habits may be due to the influence of other factors, such as quantity and composition of saliva, tooth composition and structure, oral hygiene practices and medical conditions^{4,7,10}. Moreover, tooth erosion has been mostly studied in populations where the prevalence of dental caries is low and the association may be more difficult to demonstrate¹⁴. Studies have focused on dietary habits because there is a possible connection between the two conditions by one common item, sugary and acidic “soft drinks”¹⁴.

To have a better understanding of dietary consumption, for both oral conditions, one possibility is to evaluate the diet for 3 days at least^{6,14}. This could not be done in the present study together other oral and systemic health outcomes because it was carried out in schools making it difficult to include extensive questionnaires or successive visits were investigated.

The reliability of self-reporting dietary habits by the schoolchildren may be an other limitation, as there is possibility of under- or over-reporting¹⁰. Unfortunately, there is no standardized questionnaire for tooth erosion in epidemiological surveys and this may be associated to those findings⁹.

The obtained data must be considered with caution. The findings are limited by the cross-sectional nature of data collection. This study design cannot show the temporal effect²⁷ of the diet on the development of caries and/or tooth erosion. Dental caries and tooth erosion may not occur together in some point of the time. The severity of tooth caries and tooth erosion could make the presence of both conditions in the same individual more or less obvious. In permanent teeth, superimposition of a greater and more rapid destruction of caries could mask or remove any evidence of erosion¹⁴.

Further investigations with longitudinal designs using the life course epidemiology approach²⁸ are required to confirm these findings and to clarify the association between dental caries and tooth erosion.

It has been shown that dental caries is suffering a phenomenon called polarization, with most of the disease concentrated in a small part of the population, especially those more deprived. Therefore, the investigation of factors that could be associated with caries occurrence should be investigated in epidemiological surveys in order to establish preventive measures²⁹.

In the present study, there was no statistically significant association between dental caries and tooth erosion in Brazilian schoolchildren. Dietary habits were not associated with all dental caries.

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