Prevalence and associated factors of dental erosion in children and adolescents of a private dental practice

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Background. The prevalence of dental erosion seems to be rising in young populations, particularly among individuals of higher socioeconomic status.

Aim. To assess the prevalence and associated factors of dental erosion in children and adolescents of a private dental practice.

Design. A total of 232 participants, aged 2–20 years, were examined. Dietary habits, oral hygiene, and medical data were collected from dental records. Logistic regression analyses were conducted.

Results. Dental erosion prevalence was of 25.43% and was highest on the occlusal surfaces (76%).

Introduction

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Dental erosion is clinically defined as the progressive and irreversible loss of dental hard tissue caused by a chemical process of acid dissolution that does not involve bacteria.^{1–3} According to recent studies, there is some evidence that the presence of dental erosion is steadily increasing.⁴ Thus, erosive tooth wear is becoming an important issue in the management of the long-term health of the dentition.^{5,6} Also, the possibility of a dentist coming across cases of dental erosion in their practice is very high.

Acids responsible for the aetiology of dental erosion can be of intrinsic or extrinsic origin.⁷ Gastric acid, which comes into frequent contact with teeth in cases of regurgitation and reflux, constitutes the intrinsic aetiological factor of erosion.⁵ On the other hand, extrinsic factors are many and include acidic foods

Associated factors were: frequent consumption of soft drinks (OR = 2.33; 95% CI = 1.01–5.38) and candies (OR = 3.23; 95% CI = 1.25–8.32); and interaction between these two factors (OR = 3.95; 95% CI = 1.60–9.75). On anterior teeth, associated factors were: frequent consumption of fruits (OR = 2.53; 95% CI = 1.09–5.91); and age (OR = 1.07 95% CI = 1.01–1.14). Milk consumption was associated with a lower prevalence of dental erosion (OR = 0.40; 95% CI = 0.17–0.94).

Conclusions. A relatively high prevalence of erosion was found in association with frequent intake of soft drinks, candies, and fruits. The consumption of milk seemed to protect against dental erosion on anterior teeth.

and beverages, chronic use of medication, swimming in chlorinated pools, among others.

Previous studies have identified many factors associated with the occurrence of dental erosion in the general population, among which is socioeconomic status.^{3,8,9} There are no studies investigating the possible risk factors of erosive tooth wear specifically in a sample derived from a population of patients of a private practice, however. Knowledge of the prevalence and associated factors of dental erosion in such a specific group of individuals may be beneficial to the clinician, enabling early diagnosis, and the institution of effective preventive strategies.

Bearing in mind the above considerations, the aim of this study was to investigate the prevalence of erosive tooth wear and its associated factors among children and adolescents in a private practice.

Material and methods

This study was approved by the Research Ethics Committee of the School of Dentistry of

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The sample was constituted of 232 children and adolescents, aged 2 to 20 years, of both genders, who had sought treatment at a private practice in São Paulo, Brazil (0.7 mg/l F⁻ in water supply) during the period from March of 2004 to March of 2006. Prior to examination, all teeth were cleaned with rubber cup and prophylaxis paste and were dried with cotton rolls and air from the triple syringe.

Clinical examination of all teeth was carried out in a dental chair under artificial lighting and with the aid of a dental mirror. A modified version of the O'Brien index (1994)¹⁰ was used to classify erosive lesions (Table 1). For the assessment of erosive lesion depth, this index assigns the scores 1, 2, and 3, respectively, for lesion into enamel, dentin, and pulp. In a pilot study, where 1000 teeth were examined for erosion, no score 3 for lesion depth of the O'Brien index (i.e., pulpal exposure) was observed. Cases of erosive wear close to the pulp, sometimes with the formation of reparative dentine, were observed, however. Thus, the description of score 3 for the criteria used to assess lesion depth was modified to 'close proximity to pulp'.

The participants' parents answered a structured questionnaire containing information regarding patient identification, dietary habits,

Table 1. Modified O'Brien index used for scoring erosive lesions.

Lesion	depth
LCSION	acpui

- 0 Normal (healthy)
- 1 Enamel only loss of surface characterization
- 2 Enamel and dentine loss of enamel exposing dentine
- 3 Enamel and dentine with pulpal proximity possible to visualize redness of pulp through translucency of remaining tissue
- 9 Assessment cannot be made (missing element or full crown) Lesion area (of the worst depth score)
 - 0 Normal (healthy)
- 1 Less than one-third of surface involved
- 2 One-third, up to two-thirds of surface involved
- 3 More than two-thirds of the surface involved
 - 9 Assessment cannot be made (missing element, restoration, or sealant)

gastric disorder symptoms, oral hygiene habits, and tooth grinding, as shown in Table 2.

Statistical analyses were carried out using the SPSS[®] (IBM, Somers, NY, USA) and Epi-InfoTM (CDC, Atlanta, GA, USA) softwares. For the assessment of erosive lesion distribution and severity, the tooth was considered as the unit of analysis. When analyzing the prevalence of erosion also for the regression analyses, the participant was considered as the unit of analysis, as it is more intuitive because this is an investigation on the prevalence of erosion in individuals.

Independent variables were dichotomized according to risk to investigate their association with dental erosion and a univariate analysis was performed using chi-square tests. The variables investigated are shown on Table 2. All analyses were performed considering two outcome variables: presence of erosive lesions on any tooth or presence of erosive lesions on anterior teeth. Following a *forward stepwise* approach, unconditional logistic regression analysis was performed to select only variables with a *P*-value of ≤ 0.20 to enter the multivariate model. Explanatory variables remained in the final model only if they had a *P*-value of ≤ 0.05 .

Results

Of the 232 participants, 58 (25%) had erosive tooth wear. Table 2 shows the distribution of participants regarding dental erosion prevalence according to age, gender, and type of dentition. In both primary and permanent dentitions, the occlusal surface was the most commonly affected by erosive lesions (77.14%). These lesions involved over two-thirds of the surface and presented with loss of enamel characterization. The least affected surfaces were the buccal ones (0.92%).

The variables age, gender, and type of dentition were not significantly associated with dental erosion (P > 0.05). Concerning dietary habits, frequent consumption of soft drinks was strongly associated with dental erosion (P = 0.006). Other types of drinks and the method of drinking were not significantly associated with erosion (Table 2). Also, no Table 2. Prevalence of erosive tooth wear in children and adolescents of a private practice according to age, gender, type of dentition, dietary habits, gastrointestinal disorder symptoms, oral hygiene habits, and presence of bruxism.

Independent variables	Total N	Erosion on anterior teeth N (%)	OR (95% CI)	Total erosion N (%)	OR (95% CI)
Patient identification					
Gender					
Female	116	12 (10.3)	1.00	27 (23.3)	1.00
Male	116	15 (12.9)	1.29 (0.57–2.88)	31 (26.7)	1.20 (0.66-2.18)
Age (mean ± SD)	9.5 ± 6.7	12.9 ± 9.3*	1.08 (1.02–1.15)	11.4 ± 7.9*	1.06 (1.01–1.10)
Type of dentition					
Primary or mixed	138	12 (8.7)	1.00	29 (21.0)	1.00
Permanent	94	15 (16.0)	1.99 (0.89–4.48)	29 (30.9)	1.68 (0.92–3.05)
Dietary habits – drinks					
Soft drink intake					
No	36	5 (13.9)	1.00	10 (27.8)	1.00
Yes	196	22 (11.2)	0.78 (0.28–2.23)	48 (24.5)	0.84 (0.38–1.87)
Frequency of soft drink intake				()	
Never/only on weekends	1/5	16 (9.1)	1.00	36 (20.6)	1.00
During the week	57	11 (19.3)*	2.38 (1.03–5.48)	22 (38.6)*	2.43 (1.27–4.64)
Type of soft drink	100	12 (0.0)	1.00	22 (24 0)	1.00
Regular	133	1Z (9.0) 1E (1E 2)		33 (24.8) 25 (25.2)	1.00 1.02 (0 EC 1.97)
Diel Temperature of soft drink	99	15 (15.2)	1.80 (0.80–4.04)	ZO (ZO.3)	1.02 (0.50-1.87)
	133	17 (12 8)	1.00	34 (25.6)	1.00
Cold/room temperature	90	17 (12.8)	0.77 (0.33_1.76)	34(23.0)	0.03 (0.51_1.70)
	55	10 (10.1)	0.77 (0.55-1.70)	24 (24.2)	0.95 (0.51-1.70)
No	21	4 (19 1)	1 00	7 (33 3)	1 00
Yes	211	23 (10.9)	0.52 (0.16–1.68)	51 (24 2)	0.64 (0.24–1.67)
Frequency of juice intake	211	25 (10.5)	0.02 (0.10 1.00)	51 (21.2)	0.01 (0.21 1.07)
Some days	89	14 (15.7)	1.00	26 (29.2)	1.00
Everyday	143	13 (9.1)	0.54 (0.24-1.20)	32 (22.4)	0.70 (0.38-1.28)
Sports drink intake					
No	163	18 (11.0)	1.00	35 (21.5)	1.00
Yes	69	9 (13.0)	1.21 (0.51–2.84)	23 (33.3)	1.83 (0.93–3.42)
Milk (regular, soy, or fermented) intake					
No	70	14 (20.0)	1.00	23 (32.9)	1.00
Yes	162	13 (8.0)*	0.35 (0.15–0.79)	35 (21.6)	0.56 (0.30–1.05)
Tea intake					
No	140	19 (13.6)	1.00	35 (25.0)	1.00
Yes	92	8 (8.7)	0.61 (0.25–1.45)	23 (35.0)	1.00 (0.54–1.84)
Usual drinking method	100	22 (11 C)	1.00		1.00
Swallows immediately/using a straw	198	23 (11.6)		52 (26.3)	
Diotary babits food	34	4 (11.8)	1.01 (0.33–3.14)	0(17.7)	0.60 (0.24–1.54)
Citrus fruits intako					
No	40	8 (20 0)	1 00	13 (32 5)	1 00
Vos	192	19 (9 9)	0.44 (0.18_1.09)	15 (52.5) 15 (23.4)	0.64 (0.30-1.33)
Frequency of citrus fruit intake	152	15 (5.5)	0.44 (0.10 1.00)	45 (25.4)	0.04 (0.50 1.55)
Never or occasionally	151	13 (8.6)	1.00	32 (21.2)	1.00
Evervdav	81	14 (17.3)*	2.22 (1.00-4.98)	26 (32.1)	1.76 (0.96–3.23)
Acidic sauces/dressings					
No	133	16 (12.0)	1.00	34 (25.6)	1.00
Yes	99	11 (11.1)	0.91 (0.40-2.07)	24 (24.2)	0.93 (0.51–1.70)
Acidic candies					
No	99	12 (12.1)	1.00	25 (25.3)	1.00
Yes	133	15 (11.3)	0.92 (0.41-2.07)	33 (24.8)	0.98 (0.54–1.78)
Frequency of acidic candy intake					
Never/only on weekends	186	18 (9.7)	1.00	38 (20.4)	1.00
During the week	46	9 (19.8)	2.27 (0.95–5.45)	20 (43.5)*	3.00 (1.51–5.93)

Table 2. Continued.

	Total	Erosion on		Total	
Independent variables	N	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Gastric disorder symptoms					
Frequent vomiting					
No	221	25 (11.3)	1.00	55 (24.9)	1.00
Yes	11	2 (18.2)	1.74 (0.36–8.52)	3 (27.3)	1.13 (0.29–4.42)
Reported gastroesophageal re	eflux				
No	214	25 (11.7)	1.00	52 (24.3)	1.00
Yes	18	2 (11.1)	0.95 (0.21–4.36)	6 (33.3)	1.56 (0.56–4.36)
Reported gastrointestinal disc	orders				
No	221	25 (11.3)	1.00	52 (23.5)	1.00
Yes	11	2 (18.2)	1.74 (0.36-8.52)	6 (54.6)*	3.90 (1.14–13.30)
Oral hygiene habits					
Type of toothbrush					
Extra-soft or soft	192	21 (10.9)	1.00	49 (25.5)	1.00
Medium or hard	40	6 (15.0)	1.44 (0.54–3.83)	9 (22.5)	0.85 (0.38–1.90)
Frequency of toothbrushing					
Once or twice a day	91	13 (14.3)	1.00	26 (28.6)	1.00
More than twice a day	141	14 (9.9)	0.66 (0.30–1.48)	32 (22.7)	0.73 (0.40–1.34)
Mouth rinse use					
No	198	24 (12.1)	1.00	51 (25.8)	1.00
Yes	34	3 (8.8)	0.70 (0.20-2.47)	7 (20.6)	0.75 (0.31–1.82)
Tooth grinding					
Bruxism					
No	180	17 (9.4)	1.00	41 (22.8)	1.00
Yes	52	10 (19.2)	2.28 (0.97–5.35)	17 (32.7)	1.65 (0.84–3.24)

*Statistically significant association.

significant associations were seen with citrus fruit intake or the use of acidic sauces or dressings. Consuming acidic candies more frequently than just on the weekends was a risk indicator for the development of erosive lesions (P = 0.001) (Table 2). Regarding general health problems, the presence of gastric disorders was significantly associated with dental erosion (P < 0.03) (Table 2).

Tables 3 and 4 show the final model of the *forward stepwise* model regarding the variables assessed. Variables that were kept in the model were frequency of soft drink intake (OR = 2.43 [CI 95% (OR) = 1.27-4.64]), frequency of acidic candy intake (OR = 3.00 [CI 95% (OR) = 1.51-5.93]), and the presence of gastric disorders (OR = 3.90 [CI 95% (OR) = 1.14-13.30]).

When only anterior teeth were assessed, it was possible to observe that individuals who consumed citrus fruits everyday had a 2.5 times greater chance of developing erosive lesions. Milk was considered to be a protective indicator for erosion in anterior teeth and participants who frequently drank milk

Table 3. Associations between erosive tooth wear in anterior teeth and predictive variables related to citrus fruit intake, milk intake, and age.

Independent variable	Adjusted OR (Cl 95%)	Р
Frequency of citrus fruit intake	9	
Never or occasionally	1.00	
Everyday	2.53 (1.09–5.91)	0.031*
Milk (regular, soy, or fermente	ed) intake	
No	1.00	
Yes	0.40 (0.17-0.94)	0.037*
Age	1.07 (1.01–1.14)	0.028*

*Statistical significance determined using Hosmer-Lemeshov test = 0.313. Model's P = 0.001.

had 60% less chance of having erosion. Furthermore, it was possible to observe that older children had a higher prevalence of erosive tooth wear in anterior teeth than younger children (Table 3).

Table 4 contains the multiple regression model relating independent variables to the presence of erosion in any tooth. In relation to beverage intake, participants who frequently consumed soft drinks had a two times greater

Table 4. Associations between erosive tooth wear on any tooth and predictive variables related to soft drink and acidic candy intake.

Independent variable	Adjusted OR (Cl 95%)	Ρ
Frequency of soft drink and acidic candy intake		
Never or only on weekends	1.00	
Soft drinks during the week	2.33 (1.01–5.38)	0.047*
Acidic candies during the week	3.23 (1.25-8.32)	0.015*
Soft drinks and acidic candies during the week	3.95 (1.60–9.75)	0.003*

*Statistically significant. Model's P = 0.003.

chance of having dental erosion (P = 0.047) than those who only consumed soft drinks on weekends or did not consume them at all. Acidic candy intake was also significantly associated with dental erosion and increased the chance of developing erosive lesions in three times. Moreover, individuals who frequently consumed both soft drinks and acidic candies had a four times greater chance of having dental erosion.

Discussion

Owing to the fact that there is no universally accepted or validated index to classify erosive lesions,¹¹ a modified version of the O'Brien (1994)^{6,10} index was chosen for this study because it is the most commonly used index in the primary dentition¹² and it possesses most of the ideal characteristics of an index, as listed by Bardsley (2008).¹³ Such characteristics include being: simple to understand and use, clear in its scoring criteria, reproducible,^{3,14–16} useful for research into the aetiology, prevention and monitoring of lesions, and essentially an epidemiological and clinical tool.¹³

The prevalence of erosive tooth wear observed among children and adolescents of a private practice in this study was of 25%. This result concurs with the findings of previous studies on the prevalence of dental erosion in Brazilian populations. For instance, Mangueira *et al.* $(2009)^{17}$ analysed 983 children aged 6–12 years and found that 19.9% of them had erosion. Another study examined the primary dentition of Brazilian

6-year-olds and found slightly higher prevalence values with 34.8% of incisors, 64.7% of canines, and 40.7% of molars affected by tooth wear.¹⁸ Among individuals aged 12–13 years in Brazil, prevalences range from 13¹⁹ to 34.1%.¹⁵ Moreover, the prevalence found in this study is also in agreement with internationally observed erosion prevalences for children and adolescents, 24% in the Netherlands,²⁰ 28% in Turkey,²¹ and 21.6% in Iceland.²²

Most previous studies investigated the presence of erosive lesions only on index teeth, mainly upper incisors^{3,17,23,24} and lower molars.^{9,15,20,25} This procedure, however, provides no information about the distribution of erosive lesions in the whole primary dentition.²⁶ For this reason, all teeth were examined in this study and it was possible to observe that the occlusal surfaces were the most commonly affected by erosion (77.136%)^{26,27} and the least affected surfaces were the buccal ones (0.924%).²⁶

Regarding lesion characteristics, in accordance with other papers, most erosive lesions observed in this study were confined to the enamel^{10,25,27} and involved over two-thirds of the dental surface, being wide but shallow.^{10,28} Erosive lesions were generally smooth and shiny,²⁸ with rounded cusps² and the formation of cuppings/grooving on occlusal surfaces.^{29,30} Considering that the most common presenting sign of erosion caused by gastric acid is wear on the palatal surfaces of upper incisors,³¹ the low occurrence of such lesions in this study can be explained by the low number of participants with gastrointestinal disorders (Table 2).

Although some authors have observed a higher prevalence of dental erosion among boys than among girls,^{17,20,32,33} gender was not a significant risk indicator according to our results and to those of previous researches.^{3,9,19,26,34} Concerning age, when total erosion prevalence was considered, no significant differences were found. Yet, when considering the prevalence of erosion only in anterior teeth, it increased significantly with age (P = 0.028) (Table 3), in accordance with previous findings, including those of a systematic review⁴ regarding primary teeth.

Moreover, although a few studies have found dental erosion to be more prevalent in the primary than in the permanent dentition,^{9,17} in this study no significant differences were found, perhaps because there were only 94 participants with permanent dentition.

Many previous reports have found dental erosion to be significantly associated with the dietary habits^{3,23,35–37} although some have not.³⁸⁻⁴⁰ Of the many acidic beverages and foods investigated in this study, only the frequent intake of soft drinks^{14,23,35,36,41} and acidic candies³⁵ was significantly associated with dental erosion (Tables 2 and 3). This association with soft drinks was expected as the per capita consumption of soft drinks in Brazil is high and has been rising in recent vears.⁴² Furthermore, when the presence of erosive lesions was assessed only on anterior teeth, the consumption of citrus fruits was associated to a 2.5 times greater chance of having erosion, as in previous studies.43,44 The demineralizing effect of citric acid is exceptionally strong because of its chelating action on enamel calcium, which continues even after the pH increases at the tooth surface.⁴⁴ Also when considering only anterior teeth, the frequent intake of milk was associated to protection against erosive tooth wear. This can be explained by the presence of remineralizing proteins in milk, such as casein,45 which justifies the use of milk in the prevention of dental erosion. Moreover, it is of interest to note that an in vitro study demonstrated that the consumer addition of UHT milk to carbonated beverages reduced their capacity to bring about dental erosion.46

It is known that the temperature⁴⁷ of the drink and the type of drinking method (e.g., swallowing, swishing, holding in mouth, using a bottle, or using a straw)^{3,14,48} can influence the progression rate of erosive tooth wear. Our results, however, did not reveal significant associations between such variables and dental erosion, in agreement with other studies.^{24,26} Also, as previously reported in literature, ^{3,14,18,34} oral hygiene habits were not significantly associated with erosion in this study.

In spite of the low number of participants with gastric disorders, the presence of such disorders was significantly associated with dental erosion in this study (P < 0.03) (Table 2). This finding concurs with the results of other studies.^{24,37,49} A noteworthy aspect of cases of intrinsic dental erosion is that some patients who proclaim of deteriorating dental health/aesthetics may not be aware of their underlying medical condition and the dentist may be the first healthcare professional to detect a gastric disorder.⁵⁰

Milosevic *et al.* (2004)³⁷ found a weak but significant association between dental erosion and bruxism. Yet, in this study, a low number of participants (Table 2) had the habit of tooth grinding and no such association was observed. Nonetheless, as tooth wear is a phenomena caused by the simultaneous occurrence of abrasion, attrition, and erosion, where the presence of one type of wear may exacerbate the occurrence of another, this issue is worth investigating in future researches.

Early diagnosis of erosive lesions and the identification of the aetiological acidic sources, through careful medical and dental history taking, constitute the cornerstone for the prevention and management of dental erosion. Thus, the knowledge that a relatively high prevalence of erosive tooth wear can be found among patients of a private clinic and the awareness of the factors most commonly associated with erosion in such individuals provide valuable tools to clinicians in their daily practices.

Conclusions

A relatively high prevalence of erosive tooth wear was observed, mainly on the occlusal surfaces. Significant risk indicators for dental erosion were: a high frequency of intake of soft drinks and acidic candies and the presence of gastric disorders.

When considering the occurrence of erosive lesions exclusively on anterior teeth, significant associated factors included: a high frequency of consumption of soft drinks and citrus fruits. The frequent consumption of milk was considered as a protective agent against erosion.

What this paper adds

• It is one of the first to report on the prevalence of erosive tooth wear among patients of a private practice.

Why this paper is important to paediatric dentists

• It adds to the knowledge of paediatric dentists as it discusses the pattern of occurrence and factors associated with erosive tooth wear, which is very common among children and adolescents.

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