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Risk factors for dental erosion in a group of 12- and 16-year-old Brazilian schoolchildren

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Background. Dental erosion is a multifactorial disease and is associated with dietary habits in infancy and adolescence.

Aim. To investigate possible associations among dental erosion and diet, medical history and lifestyle habits in Brazilian schoolchildren.

Design. The sample consisted of a random single centre cluster of 414 adolescents (12- and 16-years old) of both genders from private and public schools in Bauru (Brazil). The O'Brien [Children's Dental Health in the United Kingdom, 1993 (1994) HMSO, London] index was used for dental erosion assessment. Data on medical history, rate and frequency of food and drinks consumption, and lifestyle habits were collected by a self-reported questionnaire. Odds ratios with 95% confidence intervals were used to assess the univariate relationships between variables. Analysis of questionnaire items was performed by multiple logistic regression analysis. The statistical significance level was set at 5%.

Results. The erosion present group comprised 83 subjects and the erosion absent group 331. There were no statistically significant correlations among dental erosion and the consumption of food and drinks, medical history, or lifestyle habits.

Conclusion. The results indicate that there was no correlation between dental erosion and the risk factors analysed among adolescents in Bauru/Brazil and further investigations are necessary to clarify the multifactorial etiology of this condition.

Introduction

Dental erosion is defined as the physical result of a localized, chronic, pathologic, and irreversible loss of dental hard tissue, caused by acids or chelants, without bacterial involvement.[1] It is a complex pathology of multifactorial etiology, in which chemical, biological, and behavioural factors seem to influence the erosive process, making it difficult to identify the risk factors.[2] In addition, dental erosion is influenced by educational, cultural, nutritional, and geographical factors of each studied population.[3]

Among the erosion intrinsic causes that act in the infancy and adolescence, the diseases that cause vomiting or regurgitation, such as gastroesophageal reflux, anorexia, and bulimia nervosa, are the most important.[4] The extrinsic factors include: diet (acidic foods and drinks), occupational factors (swimming in heavily chlorinated swimming pools), medicaments (acidic drugs or drugs that cause reduction in salivary flow), and lifestyle habits (swallowing and drinking habits, consumption of acidic beverage at bedtime).[5] Also, individual susceptibility factors, such as salivary characteristics and tooth and tissue anatomy, seem to exert a great influence in the development of erosive lesions.[6]

Despite the high number of *in vitro* experimental studies showing the erosive potential of fruit juices, soft drinks, and sport drinks,[7–9] few epidemiological studies in children and adolescents have found a strong relationship among dental erosion and the consumption of acidic drinks,[10–14] medical history,[12] or lifestyle habits.[10,12]

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Therefore, the aim of this study was to investigate the associations among diet, medical history, lifestyle factors, and dental erosion in a sample of 12- and 16-year-old brazilian schoolchildren.

Materials and methods

The ethical approval for this study was given by the Ethics Committee of Bauru Dental School, University of São Paulo (Proc. 090/2008). Explanatory information letters and consent forms were distributed to the parents of the selected sample. Subjects were included in the study only if they presented the written positive consent from their parents to participate in this study.

An observational cross-sectional study was carried out in Bauru, São Paulo, Brazil. A sample of 414 adolescents (12- and 16-year old) of both genders, attending public and private schools participated in this survey.

The clinical evaluation was made by two calibrated examiners for the presence of dental erosion using a previously validated index proposed by O'Brien.[15] The clinical exam included the evaluation of the buccal and palatal surfaces of the maxillary permanent incisors and also the occlusal surface of the first permanent molars. Intra- and inter-examiner reproducibility data yielded a weighted kappa-statistic value higher than 0.85, which indicates a high level of agreement. The methods employed for the clinical examination have been published elsewhere.[16] The prevalence of dental erosion reported was 20% with only enamel being involved.[16]

A self-completion questionnaire was applied in the adolescents, and aimed to establish which etiological factors were associated with tooth wear. The questionnaire was completed in a school room before the clinical examination was undertaken. The questionnaire was self-administered, but the adolescents were supervised while completing it. It was pretested in a pilot study and all the subjects considered the questions straightforward. The clinical examiner was blinded to the answers of the questionnaire.

The first questions were designed to establish general medical history with particular reference to medication and chronic disorders. A list of 14 food and drink items, which had erosive potential, and the amount and frequency of intake were recorded. Further questions asked whether acidic drinks are drunk at bedtime and if they have the habit of holding the drink in the mouth before swallowing. The last question asked about swimming in chlorinated pools.

The data were analysed using the Statistic for Windows version 5.1 software (Stat Soft Inc., Tulsa, USA), with descriptive and analytical approaches. Odds ratios with 95% confidence intervals were used to assess the univariate relationships between variables. Analysis of questionnaire items was performed by multiple logistic regression analysis to identify which variables were best associated with dental erosion. Multiple logistic regression analysis with a stepwise selection procedure was used to investigate the influence of risk factors to the outcome of erosion. Thereby, the criterion for the independent variables to enter the model was set at 0.3. The level of significance was set at 5%.

Results

A total of 414 subjects completed the questionnaire and underwent clinical examination. The individuals were divided into two groups: erosion present (having erosion in at least one surface) and erosion absent group (not having any type of erosion lesion). The erosion present group comprised 83 subjects and the erosion absent group 331.

The results showed that there is not any evidence that systemic diseases and use of chronic medication are risk factors associated with dental erosion (Table 1). Twenty children (4.9%) reported the use of chronic medication and in only four there were clinical signs of erosion. The most frequent systemic diseases were diabetes (1.2%), asthma (3.3%), and gastrointestinal disorders (15.7%). None of the adolescents reported bulimia, anorexia nervosa, and gastroesophageal reflux disease. Of the subjects, 18 (4.4%) reported frequent episodes of vomiting without specific cause.

Consume of food and drinks was dichotomized in high (once per day; more than once

Table 1. Association between dental erosion and medical history.

Medical history \ Erosion	Erosion absent *n* (%)	Erosion present *n* (%)	Total *n* (%)	*P*-value	OR	OR 95% CI Lower	OR 95% CI Upper
Disease							
Yes	77 (84.6)	14 (15.4)	91 (100)	0.199	0.66	0.35	1.25
No	252 (78.5)	69 (21.5)	321 (100)				
Diabetes							
Yes	5 (100)	0 (0)	5 (100)	0.258	0.00	0.00	0.00
No	324 (79.6)	83 (20.4)	407 (100)				
Asthma							
Yes	13 (92.9)	1 (7.1)	14 (100)	0.217	0.3	0.04	2.30
No	316 (79.4)	82 (20.6)	398 (100)				
Gastric disorders							
Yes	54 (83.1)	11 (16.9)	65 (100)	0.48	0.78	0.39	1.56
No	275 (79.2)	72 (20.8)	347 (100)				
Vomit							
Yes	16 (88.9)	2 (11.1)	18 (100)	0.328	0.48	0.11	2.14
No	313 (79.4)	81 (20.6)	394 (100)				
Medicaments							
Yes	16 (80)	4 (20)	20 (100)	0.995	1.00	0.32	3.07
No	311 (80)	78 (20)	389 (100)				
Vitamin C tablets							
Yes	269 (81)	63 (19)	332 (100)	0.531	0.8	0.40	1.61
No	41 (77.4)	12 (22.6)	53 (100)				

OD, odds ratio.

per day) and low (less than once per week; once per week; never or rare) consumption. In relation to the intake of acidic drinks, the majority of the adolescents related a high consume of fruit juices (58.9%) and soft drinks (43.3%) and only 3% of the sample (12) had a high consume of sport drinks. Although, there was no significant correlation between the intake of acidic drinks and the occurrence of dental erosion (Table 2).

Table 3 shows that coffee, tea, and yogurt are not frequently consumed by the studied sample, with only 20.5% (81) consuming a high intake of coffee, 9% (36) of tea, and 25.2% (102) of yogurt. The consumption of milk and water were very high, with 74.3% (304) and 94.8% (382) of the adolescents reporting a diary intake of this drinks, respectively. The intake of coffee, tea, milk, water, and yogurt was not different in the group of

Table 2. Association between dental erosion and the consumption of acidic drinks.

Drinks \ Erosion	Erosion absent *n* (%)	Erosion present *n* (%)	Total *n* (%)	*P*-value	OR	OR 95% CI Lower	OR 95% CI Upper
Fruit juice							
Low consumption	136 (80.5)	33 (19.5)	169 (100)	0.793	1.07	0.65	1.75
High consumption	193 (79.4)	50 (20.6)	243 (100)				
Carbonated drink							
Low consumption	185 (80.4)	45 (19.6)	230 (100)	0.958	1.01	0.62	1.66
High consumption	142 (80.2)	35 (19.8)	177 (100)				
Sport drink							
Low consumption	311 (79.9)	78 (20.1)	389 (100)	0.314	0.36	0.05	2.85
High consumption	11 (91.7)	1 (8.3)	12 (100)				

OD, odds ratio.

Table 3. Association between dental erosion and the consumption of other drinks.

Erosion / Drinks	Erosion absent *n* (%)	Erosion present *n* (%)	Total *n* (%)	*P*-value	OR	OR 95% CI Lower	OR 95% CI Upper
Milk							
Low consumption	83 (79)	22 (21)	105 (100)	0.788	0.93	0.54	1.61
High consumption	244 (80.3)	60 (19.7)	304 (100)				
Coffee							
Low consumption	257 (81.6)	58 (18.4)	315 (100)	0.437	1.27	0.70	2.30
High consumption	63 (77.8)	18 (22.2)	81 (100)				
Tea							
Low consumption	291 (79.7)	74 (20.3)	365 (100)	0.605	0.79	0.32	1.96
High consumption	30 (83.3)	6 (16.6)	36 (100)				
Water							
Low consumption	14 (66.7)	7 (33.3)	21 (100)	0.12	0.48	0.19	1.23
High consumption	308 (80.6)	74 (19.4)	382 (100)				
Yogurt							
Low consumption	235 (78.1)	66 (21.9)	301 (100)	0.115	0.61	0.33	1.13
High consumption	87 (85.3)	15 (14.7)	102 (100)				

OD, odds ratio.

Table 4. Association between dental erosion and the consumption of acidic food.

Erosion / Food	Erosion absent *n* (%)	Erosion present *n* (%)	Total *n* (%)	*P*-value	OR	OR 95% CI Lower	OR 95% CI Upper
Fruits							
Low consumption	224 (78.9)	60 (21.1)	284 (100)	0.432	0.81	0.43	1.38
High consumption	102 (82.3)	22 (17.7)	124 (100)				
Vinegar							
Low consumption	279 (79.9)	70 (20.1)	349 (100)	0.339	0.65	0.26	1.55
High consumption	37 (86)	6 (14)	43 (100)				
Ketchup							
Low consumption	282 (79.4)	73 (20.6)	355 (100)	0.507	0.75	0.32	1.76
High consumption	36 (83.7)	7 (16.3)	43 (100)				
Sweets							
Low consumption	208 (78.8)	56 (21.2)	264 (100)	0.554	0.86	0.51	1.43
High consumption	117 (81.3)	27 (18.7)	144 (100)				

OD, odds ratio.

Table 5. Association between dental erosion and lifestyle habits.

Erosion / Habit	Erosion absent *n* (%)	Erosion present *n* (%)	Total *n* (%)	*P*-value	OR	OR 95% CI Lower	OR 95% CI Upper
Acidic drink bedtime							
Yes	67 (79.8)	17 (20.2)	84 (100)	0.827	0.88	0.48	1.60
No	261 (81.8)	58 (18.2)	319 (100)				
Hold drink before swallowing							
Yes	28 (84.8)	5 (15.2)	33 (100)	0.476	0.96	0.55	1.69
No	298 (79.7)	76 (20.3)	374 (100)				
Swimming							
Yes	23 (82.1)	5 (17.9)	28 (100)	0.744	0.85	0.31	2.30
No	304 (79.6)	78 (20.4)	382 (100)				

OD, odds ratio.

subjects with and without erosion. The consumption of others acidic food (vinegar, fruits, ketchup, and sweets) are described in the Table 4. None of them was related to the occurrence of dental erosion.

Consumption of an acidic drink at bedtime was reported by 32.2% of the subjects (90). There were, however, no statistically significant differences in the experience of erosion between those who consumed an acidic drink at bedtime and those who did not. The habit of retaining the drink in the mouth before swallowing was observed in 8.1% of the subjects, but it could not be related to the occurrence of dental erosion ($P = 0.476$). Swimming in chlorinated pools was reported by only 28 subjects (6.8%) and was not associated with dental erosion (Table 5)

The possible association between erosion and the risk factors was analysed by multiple logistic regression analysis. Thereby, the criterion to enter was set at 0.3. Nevertheless, most variables failed the final model. The final model included only five variables: disease ($P = 0.249$), diabetes ($P = 0.999$), asthma ($P = 0.694$), water ($P = 0.145$), and yogurt ($P = 0.230$). Even so, all variables failed significance.

Discussion

There is consensus in the literature related to the influence of alimentary habits of the population and the presence of erosive lesions in the dental surface.[4] In the last years, changes in the quality of the diet have caused an increase in the consumption of fruit juices, soft drinks and sport drinks among children and adolescents.[17] The consumption of carbonated drinks increased substantially in the last years in all around the world, mainly in children and adolescents, because of low cost and high availability.[18] Whereas some authors[10–14] have found an association between the frequent consumption of carbonated drinks and dental erosion, the present study did not observed relation between the ingestion of these drinks and dental erosion, as reported by Bartlett *et al.*,[19] Deery *et al.*[20] and Arnadottir *et al.*[21]

Citric acid, which is found in the majority of citrus fruits and in their juices, has higher potential to cause erosion than other types of acids, possibly because its chelating action on calcium enamel continues with the pH increases.[22] As described in other studies in children and adolescents,[14,20,23–25] the results of this research did not identify a significant association among citric fruits and juice fruits consumption and dental erosion. In contrast, many authors found that citric fruits and their juices are dietary components of high impact in the occurrence of erosive lesions.[10–13,26]

In the last years, the consumption of sports drinks has been increasing progressively, primarily in adolescents who frequently take physical activities, because it rehydrates the organism and rapidly replace the mineral loss that is lost during transpiration.[27] *In vitro* studies have shown that sport drinks have a low pH and have a high potential to cause erosion.[7,9] In this investigation, a low number of patients reported a high-frequency intake of sport drinks (3%) and they did not have more predisposition to the development of erosive lesions, which corroborates with the majority of the studies.[14,26,27]

Milk and its products, such as yogurt, have a protective effect against dental erosion, since they contain large quantity of calcium and phosphate in their composition.[7] The low consumption of milk has been considered a risk factor for dental erosion.[26] In this study, the frequency of milk ingestion was high (74.3%), but this factor could not be considered as a protector factor against erosion. Also, Waterhouse *et al.*[14] and Milosevic *et al.*[12] did not find a difference in the consumption of milk between the groups with and without erosion. This study could not establish a positive relationship between yogurt and dental erosion, similar to the reports of Millward *et al.*[11] and Waterhouse *et al.*[14]

Other acidic dietary components, such as vinegar, sweets, tea, and ketchup, have an acidic pH and could be associated with dental erosion.[28] The results of this study did not find a relation between this components and dental erosion, like other studies in the literature.[10–14,26] In contrast, some authors found

that vinegar,[10,12,26] sweets,[13] and ketchup[10,12] are risk factors for dental erosion.

Individual medical history could give some indication of the presence of dental erosion risk factors. In this study, a disease such as asthma was not common and could not be associated with dental erosion. Also, Walker *et al.*,[17] and Milosevic *et al.*[12] did not find evidence that asthma could be a risk factor for dental erosion. In addition, none of the studied subjects reported the presence of anorexia and bulimia nervosa or regurgitation. The use of chronic medication with an acidic composition or that causes reduction in salivary flow rate could increase the risk for dental erosion.[4] In this investigation, few subjects reported the use of chronic medication and it was not associated with dental erosion, corroborating the works of Milosevic *et al.*[12] and Wiegand *et al.*[29] Vitamin C tablets are also frequently associated with dental erosion, mainly in the effervescent or chewing form.[10] Some studies[10,26] found that the risk for dental erosion is increased with the chronic consumption of vitamin C. In this study, 13.8% of the subjects reported a chronic use of vitamin C, but no significant differences were found between the group with or without erosion.

Many authors reported that the subjects with the habit of holding drinks in the mouth before swallowing could have a greater susceptibility to erosion.[17,26] There were, however, no differences in the occurrence of dental erosion between the subjects with or without this habit. Other condition that could predispose to dental erosion is the ingestion of acidic drinks at bedtime, because the salivary flow is diminished during this period.[11] In the present investigation, however, the consumption of acidic drinks at bedtime was not associated with dental erosion, similar to the findings reported by Milosevic *et al.*[12] and Waterhouse *et al.*[14] in adolescents. Few subjects reported the habit of frequent swimming in this study, and it was not related to the development of erosive lesions, similar to the epidemiologic survey of Williams *et al.*[30]

Multiple regression analysis was performed with the data, contributing to the fact that determinants are unlikely to have completely independent effects. None of the dietary and medical factors emerged as significant in relation to erosion. Despite this lack of association, it must be emphasized that these factors when acting in children or adolescents probably initially may seem innocuous but the cumulative lifetime erosive effect in combination with other factors could be significant. In adults, the determinants for dental erosion have been present much longer and the establishment of the association may be more evident. In addition, dental erosion is clearly a multifactorial disease and there are many factors that were not investigated in this study and could be associated with dental erosion, such as the protective effect of saliva and the association between erosion and abrasion.[2,3,6] It could be assumed also that other factors such as cultural, social, and occupational and inter- and intra-individual host factors might be relevant in the occurrence of dental erosion.[30]

Another flaw of this study might be the utilization of a structured questionnaire to record the ingestion and frequency of acidic foods and drinks. The questionnaire was completed by the adolescents with the investigator supervision and the questions and type of applied questionnaire were based in previous studies.[11,12,19–21] Nevertheless, the erosive wear is caused by the effect of past chemical exposure to different sources and some of them could not be identified in questionnaires.[11] Mainly in children and adolescents, the accuracy of the symptoms, the diet, and the lifestyle record could be subjected to variations and interpretations by the responder.

The identification of etiological factors associated with erosion is very important for the establishment of preventive measures. Epidemiologic and case-control studies have been developed in the last years to elucidate possible causal determinants for dental erosion. These studies could show associations and indicative risk factors, but they could not identify the etiologic factors, because for this a prospective study would be necessary. Other studies are still necessary to explain the etiology of dental erosion, focusing in the biological, chemical, and behavioural factors involved, in order to implement adequate preventive strategies.

Conclusion

Considering the studied sample of 12- and 16-year-old Brazilian schoolchildren, the results of this study indicate that there was no association among dental erosion and diet, medical history, and lifestyle habits. Dental erosion is a multifactorial and complex process and its etiology requires further investigation.

What this paper adds

- This paper highlights the risk factors associated with dental erosion in infancy and adolescence and the importance of the early prevention in the clinical practice

Why this paper is important to paediatric dentists

- Paediatric dentists should be aware that dental erosion is prevalent in children and adolescents and it is necessary to identify the risk factors associated with erosion for the establishment of preventive measures.

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