Diet and dental erosion in young people in south-east Brazil

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Background. The regular consumption of acidic foods and drinks may be associated with dental erosion, and soft drink consumption appears to be increasing both in developed and developing countries. Dentists are aware that an acidic diet can contribute to the development of erosion; however, there may be confusion within the profession concerning the general health message of eating five portions of fruits and vegetables each day.

Objective. The aim of this study was to investigate associations between dental erosion and the consumption of acidic foods and beverages in school-children in south-east Brazil. The objective was to gather information, by means of a dietary question-naire, on frequency of intake and patterns of consumption of acidic foods and drinks in a group of schoolchildren. The hypothesis was that the experience of dental erosion among the study sample was associated with the frequency and pattern of consumption of soft drinks, fruit juices, fruits, and yogurt.

Introduction

There is a growing body of evidence to suggest that acidic foods and soft drinks may be important in the development of erosion¹. Within the dental profession generally, there is awareness that an acidic diet may cause erosion; however, confusion could exist when professionals are called upon to provide dietary advice to individual patients because, in the UK, the government is promoting the consumption of at least five portions of fruits and vegetables per day for children and adults². This could lead to conflicting advice from

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Methods. A cross-sectional study was conducted in Três Corações, south-east Brazil. A sample of 458 schoolchildren, mean age 13.8 (SD 0.39) years, completed the study. Information about potential dietary risk factors for dental erosion was collected through a questionnaire survey completed by the schoolchildren. For the dental examinations, the subjects were examined for dental erosion in a school room. Associations between dental erosion and the variables under study were investigated through processes of bivariate and multivariate analyses. The statistical significance level was set at 5%. **Results.** Analysis of the questionnaire surveys showed that the frequency of consumption of

showed that the frequency of consumption of sugared carbonated drinks was the only variable independently associated with the erosive process, with subjects who had a daily consumption of such drinks having a greater likelihood of having erosion (P = 0.015, odds ratio 1.752, 95% confidence interval 1.116–2.750).

Conclusions. Of all tested factors in this sample of schoolchildren the consumption of sugared carbonated drinks is most associated with dental erosion.

dental practitioners who may recommend to a patient, at risk of developing erosion, that they should reduce their fruit intake because of its acidic nature. Added to this, the availability of acidic drinks, particularly carbonated ones, is increasing both in developed and developing countries^{3,4}. In Brazil, 12.2 billion litres of carbonated drinks were sold in 2004, compared with the 6.4 billion litres sold in 1994⁵.

The impact of an acidic diet has been studied widely, and results suggest an association with erosion^{6–15}. Early case reports suggested that unusual patterns of consumption of fruits cause erosion^{16,17}. A European-based epidemiological study has associated citrus fruit consumption with erosion¹⁸. However, other work has failed to find an association between fruit consumption and erosion¹⁹. An increasing number of studies suggest a more important role of soft drinks

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in the aetiology of dental erosion; however, many did not simultaneously investigate fruit consumption as a dietary risk factor. If clinicians are to provide evidence-based dietary advice, there is a need for clarification of the association between fruit consumption, soft drinks, and dental erosion.

The aim of this study was to investigate associations between dental erosion and the consumption of soft drinks, fruit juices, fruits, yogurt, and other acidic foods in schoolchildren in Brazil.

The objective was to gather information, by means of a dietary questionnaire, on frequency of intake and patterns of consumption of soft drinks, fruit juices, fruits, yogurt, and other acidic foods in a group of 13- to 14-year-old Brazilian schoolchildren.

The hypothesis was that the experience of dental erosion among the study sample is associated with the frequency and pattern of consumption of soft drinks, fruit juices, fruits, and yogurt.

Materials and methods

Ethical approval was obtained from the Ethics Committee of the Federal University of Minas Gerais, Brazil. Written consent was obtained from the subjects and their parents/guardians before recruitment into the study.

Schoolchildren were included in the study if they were aged 13 years and 14 years, and were present at school on the day of the proposed dental examination.

A dietary questionnaire was completed by all subjects who participated in the concurrent clinical study investigating the prevalence of dental erosion conducted in 14 schools within the area of Três Corações, Brazil. The clinical examination involved a dental examination by one calibrated examiner (S.M.A.). The collection of data for dental erosion was based on the form and index used in the oral health component of the UK National Diet and Nutrition Survey¹⁹. The methods employed for the clinical examinations and results obtained have been published elsewhere. However, the prevalence of dental erosion reported from the clinical investigation was 34.1% and involved only enamel²⁰. The examiner involved in the clinical

examinations was blinded to the individual answers for the questionnaire.

The self-completion questionnaire was developed with reference to a previously validated questionnaire¹⁹. It was piloted in the UK and Brazil for content and face validity, and designed to investigate the types and frequencies of consumption of foods and drinks and included questions on general health, medication intake, exercising habits, pattern of dental attendance, oral habits, oral hygiene, and knowledge about oral health. To obtain as much detail as possible about the subjects' dietary habits, questions related to the consumption of food and drink at home, school, and bedtime were included. The questionnaire was completed in a school room before the clinical examination was undertaken.

As can be seen from Tables 1 and 2, drinks were categorized as acidic (including carbonated – sugared and non-sugared, fruit flavoured, sports and energy drinks, fruit juices, and carbonated water) and non-acidic (including tea and water). Intake of acidic drinks was dichotomized into higher (once per day, two or more times per day) and no/lower (never, once per week or less, two to four times per week) consumption. Acidic foods included fruits (all fresh, canned, and frozen) and yogurt. The intake of acidic foods was also dichotomized as shown in Table 3. A high intake of fruit was classed as a daily intake of two or more. The habit of chewing gum was also investigated.

Associations between the experience of erosion and dietary information were tested through a process of bivariate analysis, using the exact versions of the non-parametric tests chi-squared, Fisher's, and linear association. Odds ratio (OR) and 95% confidence intervals (CIs) were calculated for 2×2 tables. Only two-sided tests were used. The statistical level of significance was set at 5%. A multivariate analysis was undertaken, using a forward stepwise logistic regression model to determine the variables independently associated with the experience of erosion. Variables that were statistically associated with the experience of erosion at 5% level were included.

Results

Four hundred and fifty-eight subjects completed the dietary questionnaire and underwent clinical

Table 1. Significance of association (*P*, OR, 95% CI) between the number (*N*) and proportion (%) of subjects with and without erosion, and the dichotomized frequency of consumption of soft drinks, categorized by the type of soft drinks consumed.

		Frequency o						
	Higher consumption ^a		No or lower consumption ^b				95% Confidence interval	
Soft drink	Erosion N (%)	No erosion N (%)	Erosion N (%)	ErosionNo erosionN (%)N (%)		Odds ratio	Lower	Upper
Sugared carbonated drink	53 (43.1)	70 (56.9)	100 (30.7)	226 (69.3)	0.014*	1.711	1.116	2.624
Fruit-flavoured drink	48 (39.3)	74 (60.7)	107 (32.7)	220 (67.3)	0.220	1.334	0.867	2.051
Non-sugared carbonated drink	7 (50.0)	7 (50.0)	141 (33.1)	285 (66.9)	0.249	2.021	0.695	5.875
Sports drink	3 (42.9)	4 (57.1)	153 (34.8)	287 (65.2)	0.699	1.407	0.311	6.367
Natural fruit juice	35 (34.7)	66 (65.3)	117 (34.1)	226 (65.9)	0.906	1.024	0.642	1.634
Iced tea	4 (33.3)	8 (66.7)	147 (34.7)	277 (65.3)	1.000	0.942	0.279	3.181
Energy drink	2 (33.3)	4 (66.7)	153 (34.8)	287 (65.2)	1.000	0.938	0.170	5.179
Carbonated water	10 (33.3)	20 (66.7)	137 (34.0)	266 (66.0)	1.000	0.971	0.442	2.132

^aCombines the frequencies: 'once a day' and 'twice a day or more'.

^bCombines the frequencies: 'never', 'once a week or less', and 'two to four times a week'.

*Statistically significant at P < 0.05 level.

Table 2. Significance of association (*P*) between the number (*N*) and proportion (%) of subjects with and without experience of erosion, and the frequency of consumption of non-acidic drinks, categorized by the type of drinks consumed

	Experience of erosion		Frequen	Total	D (linear			
Drink		Never N (%)	≤ 1/Week <i>N</i> (%)	2–4/Week <i>N</i> (%)	1/Day N (%)	≥2/Day <i>N</i> (%)	missing cases) N (%)	association exact test)
Теа	Yes	114 (40.0)	19 (20.0)	8 (36.4)	8 (34.8)	4 (22.2)	153 (34.5)	0.043*
	No	171 (60.0)	76 (80.0)	14 (63.6)	15 (65.2)	14 (77.8)	290 (65.5)	
Milk	Yes	22 (28.6)	29 (39.2)	24 (30.4)	36 (33.3)	42 (38.2)	153 (34.2)	0.383
	No	55 (71.4)	45 (60.8)	55 (69.6)	72 (66.7)	68 (61.8)	295 (65.8)	
Flavoured milk	Yes	30 (34.5)	44 (33.3)	22 (31.0)	28 (37.3)	31 (39.2)	155 (34.9)	0.432
	No	57 (65.5)	88 (66.7)	49 (69.0)	47 (62.7)	48 (60.8)	289 (65.1)	
Water	Yes	1 (10.0)	5 (25.0)	19 (38.8)	16 (43.2)	112 (33.2)	153 (33.8)	0.552
	No	9 (90.0)	15 (75.0)	30 (61.2)	21 (56.8)	225 (66.8)	300 (66.2)	
Coffee and milk	Yes	55 (36.4)	26 (30.6)	18 (30.0)	19 (30.6)	32 (40.0)	150 (34.2)	0.817
	No	96 (63.6)	59 (69.4)	42 (70.0)	43 (69.4)	48 (60.0)	288 (65.8)	
Coffee	Yes	30 (31.9)	22 (40.7)	16 (36.4)	33 (33.0)	50 (33.8)	151 (34.3)	0.923
	No	64 (68.1)	32 (59.3)	28 (63.6)	67 (67.0)	98 (66.2)	289 (65.7)	

*Statistically significant at P < 0.05 level.

examination. The mean age was 13.8 (SD 0.39) years, ranging from 13 years to 14 years.

Drink consumption patterns

The consumption of soft drinks was widespread; 444 (96.9%) subjects reported drinking sugared carbonated drinks, 369 (80.6%) reported natural fruit juices, and 357 (77.9%) reported

fruit-flavoured drinks; smaller numbers consumed other acidic drinks (Table 1). When erosion experience was dichotomized for drink type, a statistically significant association was observed for sugared carbonated drinks only (P = 0.014) (Table 1).

A statistically significant negative association was observed between the experience of erosion and the consumption of tea (P = 0.043).

Table 3. Significance of association [*P*, odds ratio (OR), and 95% confidence interval (CI)] between the number (*N*) and proportion (%) of subjects with and without experience of erosion, and the dichotomized frequency of consumption of foods, categorized by the type of foods consumed

		Frequency of						
	Higher ^a experience of erosion		No or lower ^b experience of erosion				95%	cı
Foods	Yes N (%)	No N (%)	Yes N (%)	No N (%)	P (Fisher's exact test)	OR	Lower	Upper
Pickles	2 (40.0)	3 (60.0)	150 (34.9)	280 (65.1)	1.000	1.244	0.206	7.530
Yogurt	30 (32.6)	62 (67.4)	118 (34.1)	228 (65.9)	0.901	0.935	0.573	1.525
Mustard	4 (40.0)	6 (60.0)	146 (33.7)	287 (66.3)	0.739	1.311	0.364	4.717
Ketchup	12 (40.0)	18 (60.0)	143 (34.1)	276 (65.9)	0.553	1.287	0.603	2.745
Vinegar	19 (40.4)	28 (59.6)	134 (34.0)	260 (66.0)	0.419	1.317	0.709	2.444
Sweets (includes acidic and non-acidic)	69 (36.5)	120 (63.5)	81 (31.2)	179 (68.8)	0.265	1.271	0.855	1.887
Fruits (includes all fruits)	33 (41.2)	47 (58.8)	121 (32.4)	253 (67.6)	0.152	1.468	0.895	2.409

^aFor pickles, yogurt, mustard, ketchup, vinegar, and sweets: includes the frequencies of 'once a day' and 'two or more times a day'. For fruits: includes the frequency of 'two or more times a day'.

^bFor pickles, yogurt, mustard, ketchup, vinegar, and sweets: includes the frequencies of 'never', 'once a week or less', and 'two to four times a week'. For fruits: includes the frequencies of 'never', 'once a week or less', 'two to four times a week', and 'once a day'.

Table 4. S	Significance of associa	ition (P) between th	ne number (N) a	and proportion	(%) of subjects v	with and without e	experience
of erosion	n, and the frequency	of chewing gum					

	Experience of erosion						
	Yes		No		Total*		
Frequency of chewing gum	N	%	N	%	N	%	P (Linear Association exact test)
≥ 1/Day	44	40.4	65	59.6	119	100.0	0.013**
1/Day	33	37.9	54	62.1	87	100.0	
2–4 Times/week	28	34.6	53	65.4	81	100.0	
≤ 1/Week	23	23.7	74	76.3	97	100.0	

*Totals were calculated in a row basis.

**Statistically significant at P < 0.05 level.

No other associations were noted between consumption of non-acidic drinks and erosion (Table 2).

Acidic food consumption patterns

With the exception of fruits and yogurt, the intake of other acidic foods including ketchup, vinegar, and pickles was low. When yogurt and fruit consumption were dichotomized, no statistically significant association was observed for yogurt (P = 0.901) nor fruit (P = 0.152). However, those with a higher consumption of yogurt had a lower experience of erosion when compared with those with low or no

consumption, but this did not reach statistical significance (Table 3).

Chewing gum use was reported by 386 (84.3%) of subjects, the majority (358, 92.7%) of whom chewed sugared gum. The proportion of subjects with experience of erosion rose with the increasing frequency of chewing gum, and was statistically significant (P = 0.013) (Table 4).

Food and drink consumed at bedtime

One hundred and fifty-nine (34.7%) children reported drinking at bedtime; however, for the majority, this was water. Only 4.8% of the 458

subjects consumed acidic drinks at bedtime. There were no statistically significant differences in the experience of erosion between those who consumed a drink at bedtime and those who did not (P = 0.918, OR = 1.026, 95% CI 0.684–1.539).

Eating food at bedtime was reported by 140 (30.6%); again, there was no significant difference in experience of erosion between those consuming foods at bedtime and those who did not (P = 0.522, OR = 1.152, 95% CI 0.759–1.746).

Food and drinks consumed at school

Types of school drinks were reported by 423 subjects (92.3%), the majority of whom (345, 81.6%) consumed only water. At school, carbonated drinks and fruit juices were consumed by 5.7% (24) and 1.4% (6), respectively. A lower experience of erosion (32.2%) was observed among subjects who drank only water at school, compared with those who drank other drinks in addition to water (41%), but this was not significant (P = 0.146, OR = 1.467, 95% CI 0.885–2.429).

The majority of subjects (381, 83.2%) ate food at school, usually provided by the school. There was no statistically significant difference in eating patterns during the school day and the experience of erosion (P = 0.688).

Logistic regression model

The variables included in the logistic regression model were derived from those that were significant from the bivariate analyses for the whole questionnaire (Fisher's exact test and linear association exact test) and included a knowledge-based variable; whether subjects considered acidic drinks bad for teeth (P = 0.010), together with several dietary variables; frequency of chewing gum (P = 0.013), frequency of consumption of sugared carbonated drinks dichotomized (P = 0.014), and frequency of consumption of tea (P = 0.043). The results from the forward stepwise logistic regression model indicate those children with a daily consumption of sugared carbonated drinks had a greater likelihood of having erosion (*P* = 0.015, OR 1.752, 95% CI 1.116–2.750).

Discussion

The main findings of this study were a significant association between the consumption of sugared carbonated soft drinks and dental erosion. coupled with a lack of association between fruit and yogurt consumption and erosion, as well as a potentially protective effect of tea. Previous studies have not simultaneously investigated all these factors; however, these studies have also shown significant positive associations between the consumption of various soft drinks (e.g. squashes, sports drinks, cola and other carbonated drinks) and erosion^{18,22-30}. In contrast with this study, some authors have not found an association between consumption of soft drinks and dental erosion^{31,32}. Data were also analysed relating to the consumption of acidic foods and drinks at school, home, and bedtime in order to obtain as much detailed information as possible about the subjects' dietary habits.

In this study, sugared carbonated drinks were consumed 'more than once a day' by 17% of the study population – a proportion similar to that found by others¹⁹. Consumption of these drinks 'once a day or more' compared with a lower intake, gave an OR of having erosion of 1.7. From the viewpoint of clinical management and dental health promotion, these data would suggest that individuals drinking sugared carbonated drinks on a daily basis may require targeted preventive advice.

Results from *in vitro* and *in situ* studies suggest that natural fruit juices and fruit-flavoured drinks have a high erosive potential^{12,33–37}. Their consumption has been associated clinically and statistically with the experience of erosion in young people^{25,30}. However, others report the converse^{28,32,38}. The present findings show that natural fruit juices and fruit-flavoured drinks were consumed by large proportions of subjects (81% and 78%, respectively) with 22% and 27% reporting daily consumption, respectively. Despite this, there was no statistically significant association found between these drinks and dental erosion.

Interestingly, in this study, a statistically significant negative association was observed between the consumption of tea and erosion (P = 0.043). Those who reported drinking tea

at a frequency greater than 'two to four times a week' had a lower experience of erosion. It may be argued that the results suggest a protective effect related to tea drinking. In Brazil, tea is usually taken without milk, and chilled tea is also consumed. Tea leaves contain fluoride, and this may provide some localized enamel resistance to the erosive process³⁹. The experience of erosion increased with increasing frequency of chewing gum use (P = 0.013). The questionnaire was not designed to evaluate the types of gum chewed by the schoolchildren, but fruit-flavoured gums are available in Brazil. Fruit-flavoured gums contain citric acid, and may account for the observed increase in erosion. There are few data available about the erosive potential of sugared chewing gums, but it is thought that chewing gum use increases salivary flow rate, buffering, and the oral clearance of acids^{40,41}.

In this study, subjects reporting a daily intake of two or more portions of fruits did not have a higher risk of erosion compared with those with low consumption. This suggests it would be unwise to advise a reduction in the consumption of fruits within a healthy, balanced diet, especially in light of the recent World Health Organization's recommendations to consume at least 400 g per day to prevent the onset of chronic conditions including obesity, cardiovascular disease, diabetes, and cancer¹.

Total fruit intake was also assessed. To investigate the intake of individual fruits (e.g. citrus fruits) was out with the scope of the study. The World Cancer Research Fund recommends the consumption of a wide variety of fruits and vegetables; at least 20 different types per week⁴². Therefore, a high intake of citrus fruits can be avoided by a diet with mixed fruit and vegetable intake. In agreement with the current findings, other studies also found no association between total fruit consumption and dental erosion in children^{28,32}. Furthermore, *in vitro* studies suggest that the erosive potential of fresh fruits is lower than that of fruit juices^{10,43}.

Yogurt provides an important source of dietary calcium, and a significant proportion of the Brazilian schoolchildren (78%) in this study consumed yogurt/yogurt drinks. No significant association was found between yogurt consumption and erosion experience, suggesting it is not an important risk factor for dental erosion. This in part could be because of its high concentration of calcium, phosphate, and casein – all of which are known to protect enamel^{44–46}.

This study did not find an association between bedtime consumption habits and dental erosion. This is in contrast to the finding of Millward *et al.*⁴⁷. In this study, however, the proportion of schoolchildren who reported consuming an acidic drink at bedtime was very low.

This study supports limiting sugared carbonated drinks for young people, but not limiting fruits and yogurt as part of a healthy, balanced diet. The findings also provide further evidence of a protective role of tea, which warrants further investigation.

Conclusions

Subjects with a daily consumption of sugared carbonated drinks had a statistically significantly higher experience of erosion than those with a lower consumption.

The experience of erosion decreased with the increasing frequency of consumption of tea.

In relation to the pattern of food intake, the frequency of chewing gum was the only variable associated with the experience of erosion, as subjects who chewed gum with a higher frequency ('once a day or more') had statistically significantly higher experience of erosion.

The results suggest that dietary advice for oral health is in line with that for general health, which recommends the intake of fruits and vegetables, but discourages the consumption of sugared carbonated drinks.

- Data from a developing country related to erosion in schoolchildren to add to the relatively sparse non-European global data.
- This paper assesses the impact of acidic and non-acidic foods and drinks upon the experience of erosion.

Why this paper is important to paediatric dentists

- This paper explores the relationship between diet and dental erosion in young people.
- This paper highlights that important dental-health-related dietary advice should be related to wider health-promotion messages.

What this paper adds

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