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Erosive Tooth Wear among 12-Year-Old Schoolchildren: A Population-Based Cross-Sectional Study in Montevideo, Uruguay

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Key Words
Tooth erosion · Prevalence · Risk factors · Epidemiology

Abstract
The aim of this study was to assess the prevalence, extent, severity, intraoral distribution and risk indicators for erosive tooth wear (ETW) among 12-year-old schoolchildren from Montevideo, Uruguay. A population-based, cross-sectional survey was conducted using a representative sample of 1,136 12-year-old schoolchildren attending public and private schools. Parents answered questions on socioeconomic status and general health. Schoolchildren answered questions on dietary and oral hygiene habits. Two calibrated examiners recorded ETW on permanent teeth according to the Basic Erosive Wear Examination (BEWE) score system. Logistic regression models were performed to assess the association between the predictor variables and the prevalence of ETW (overall and severe ETW). Odds ratios (OR) and the respective 95% confidence intervals (CI) were estimated. The prevalence of ETW was 52.9%, being mild erosion (BEWE = 1) in the vast majority of cases (48.5%). Severe erosion (BEWE ≥2) was detected in 4.4% of schoolchildren. The overall prevalence of ETW differed significantly between categories of gender and socioeconomic status, but only between gender in the severe ETW analysis. The overall extent of ETW was significantly different between categories of gender, socioeconomic status, and swish before swallow. The extent of severe ETW differed between categories of swish before swallow and brushing frequency. In the logistic regression analysis, no association was found between the studied variables and the overall prevalence of ETW. Males were more likely to have severe ETW than females (OR = 3.22, 95% CI = 1.50–6.89). ETW may be considered a public health problem among 12-year-old-Uruguayan schoolchildren.

Introduction

Erosive tooth wear (ETW) has been defined as the accelerated loss of mineralised dental tissue due to the combined effects of acid erosion and mechanical wear (abrasion or attrition) [El Aidi et al., 2011]. Its aetiology is multifactorial and complex, and includes patient-related factors (eating-drinking habits, tooth cleaning, saliva and pellicle characteristics, reflux/vomiting) and nutritional factors (acid type, pH, buffering, phosphates, calcium). Other factors such as behaviour, education, health, knowledge, employment and habits, interact to

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determine the onset, progression and/or the arrest of the lesions [Lussi, 2006]. Among 12-year-olds, the reported prevalence of ETW ranges from 3–73% [Bartlett et al., 1998; Ganss et al., 2001; Dugmore and Rock, 2004; Vargas-Ferreira et al., 2010; Arnadottir et al., 2010], with severe erosion into dentine affecting 0–54% [Kreulen et al., 2010]. Upper permanent incisors are the most commonly affected teeth, both on their buccal and palatal surfaces [Ganss et al., 2001; van Rijkom et al., 2002; Peres et al., 2005; Auad et al., 2007; Al-Dlaigan et al., 2001] followed by the lower first molars [El Aidi et al., 2008].

Several studies have tried to predict the occurrence of ETW among children and adolescents; however, few risk factors/indicators are well established in the literature. Most studies evaluating the relationship between gender and ETW have reported a higher prevalence of erosion among males [Bardsley et al., 2004; Al-Dlaigan et al., 2001; El Aidi et al., 2008; Dugmore and Rock, 2004]. Despite these consistent results, two cross-sectional studies have not found differences between genders [Peres et al., 2005; Auad et al., 2007], while Wang et al. [2010] and Huew et al. [2012] showed a higher prevalence of erosion among girls. Similar inconsistencies can be found in the literature regarding the relationship between socioeconomic status and ETW. While some studies have shown a positive association between the presence of ETW and deprived areas [Milosevic et al., 1994; Al-Dlaigan et al., 2001; Mangueira et al., 2009], others have observed either a higher prevalence in children of high socioeconomic status [van Rijkom et al., 2002; Bardsley et al., 2004] or lack of significant association [Dugmore and Rock, 2004; Vargas-Ferreira et al., 2010]. The changes observed in dietary habits, in particular, the increase in the consumption of acidic foods/beverages, is frequently associated with ETW in permanent teeth of children and adolescents [Lussi and Jaeggi, 2006]. When analysing data collected for the NHANES 2003–2004, the frequent intake of apple juice was found to be associated with ETW among North American children and adolescents [Okunseri et al., 2011].

The irreversible characteristics of ETW and the high prevalence reported in some studies justify the investigation of possible risk indicators for its occurrence in young populations. There is no study assessing the occurrence of ETW in Uruguay. Therefore, the aim of this study was to assess the prevalence, extent, severity, intraoral distribution and risk indicators for ETW among 12-year-old schoolchildren from Montevideo, Uruguay.

Subjects and Methods

A cross-sectional survey was conducted in Montevideo, Uruguay, from August 2011 to July 2012, to assess the oral health status (dental caries, fluorosis and erosive tooth wear) of 12-year-old schoolchildren attending public and private schools.

Ethical Aspects

The study protocol was approved by the School of Dentistry's Ethics Committee from the University of the Republic (Uruguay), resolution n° 25. Health and education councils were contacted and provided necessary information and authorization. All participants and their parents/legal guardians provided written informed consent.

Sample Size Calculation and Sampling Strategy

For sample size calculation, the following parameters were used: prevalence of ETW of 60% [Dugmore and Rock, 2004], the 95% confidence interval (CI), a precision level of ±4% and a design effect of 1.3 (to control for the underestimation of the variance in a complex sample design). Finally, a non-response rate of 30% was added, thus resulting in a sample size of 1,235 individuals. A multistage stratified cluster sample was adopted. The primary sampling unit consisted of the public and private schools from Montevideo. Forty-four schools were randomly selected, 32 public and 12 private. All the 12-year-old children attending such schools were invited to participate in the study, irrespective of the school year.

Data Collection

Data was collected using two structured questionnaires and clinical oral examination. Details about the medical, socioeconomic and demographic backgrounds were collected in a questionnaire completed by the children's parents or legal guardians. In the schoolroom before the clinical examination, children answered another questionnaire on their dietary and behavioural habits. The questionnaire provided information on the frequency of consumption of acid beverages and fruits, and on oral hygiene habits (frequency of brushing and flossing).

Clinical examinations were conducted at the school with the children in a supine position, using artificial light, sterile clinical mirror and a periodontal probe. Cross-infection control measures were followed. Prior to examination, the schoolchildren received professional brushing and flossing by a dental hygienist. Cotton rolls were used to control moisture, and gauze pads were used to dry dental surfaces. Two calibrated examiners (Licet Alvarez – LA – and Anunzziatta Fabruccini – AF) recorded ETW on the labial, palatal/lingual and occlusal surfaces of all erupted permanent teeth according to the Basic Erosive Wear Examination (BEWE) [Bartlett et al., 2008]. BEWE classifies free surfaces into 4 scores, as follows: 0 without erosive wear; 1, initial loss of surface texture; 2, distinct defect, hard tissue loss <50% of surface area*; 3, distinct defect, hard tissue loss ≥ 50% of the surface area* (*dentin usually involved). A tooth was considered erupted when more than a half of their crown was clinically visible. Children with fixed orthodontic appliances and carious or heavily restored surfaces were not included in the study.

Reproducibility

The calibration process included theoretical activities and diagnosis of photographic images of dental erosion, conducted by a benchmark dental examiner (Luana Severo Alves). Before the be-

ginning of the survey, intra-examiner Cohen's Kappa (unweighted) for BEWE was 0.89 (LA) and 0.71 (AF) and 0.85 for the inter-examiner reproducibility. During the survey, data collection was repeated on 5% of the sample with a minimal time interval between examinations of 7 days. The minimal intra-examiner Cohen's Kappa (unweighted) obtained was 0.89 (LA) and 0.82 (AF).

Non-Response Analysis

Of the 334 and 1,399 schoolchildren who were invited to participate in private and public schools, 114 and 465 were not included in the study, yielding response rates of 66.2 and 66.7%, respectively. The reasons for non-participation (n = 579) were: 439 (75.8%) schoolchildren did not return the informed consent or questionnaire, 83 (14.3%) parents/guardians did not give their consent to the children's participation and 57 (9.8%) students were not available at school during the normal survey schedule.

Data Analyses

The overall prevalence of ETW was defined as the percentage of schoolchildren presenting at least one tooth with BEWE ≥1, whereas ETW extent was defined as the number of affected surfaces. Regarding severity, ETW was classified as absent (all surfaces with score 0), mild (≥1 surface with score 1), or severe (≥1 surface with score 2 or 3). Based on the severity classification, the prevalence of severe ETW was defined as the percentage of schoolchildren presenting at least one tooth with BEWE ≥2.

The Index of Socioeconomic Level (INSE) was used to classify the families of the children into one of three strata according to the cutoff of the INSE 2006, as follows: low, medium, or high [University of the Republic, 2006]. The educational levels of mothers were classified in elementary school, high school and college/university.

Soft drinks and yogurt were classified in two strata according to the frequency of consumption: ≤once a day or ≥three times a day. Tooth brushing frequency was categorised as ≤once a day, twice a day or ≥three times a day. Gastroesophageal disorders and asthma were classified as absent or present.

Data analyses were performed using the free software, R Core Team 2012 (R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria ISBN 3-900051-07-D, http://www.R-project.org/). A weighting variable was created to adjust for possible biases arising from discrepancies between subjects who did participate and those who were not eligible due to their age. The probability of selection was constructed by dividing the population size by the number of individuals included in the sample and multiplying the result by the total population divided by the number of children aged 12 at the time of examination. Finally, the sample weight was adjusted post-stratification by the number of subjects involved and the gender and type of school variables.

Descriptive and bivariate analyses were conducted to provide summary statistics and preliminary assessment of the association between predictor variables and the presence of ETW (Chi-square test and Wald test). Unadjusted and adjusted logistic regression models taking into account the clustered sample were performed to assess the association between the predictor variables and the prevalence of ETW (overall ETW and severe ETW). The odds ratios (OR) and the respective 95% confidence intervals (CI) were calculated. Model estimation was done by steps in the descending hierarchical way (backward stepwise procedure) to remove nonsignificant variables. Explanatory variables presenting a p value ≤0.25 in the unadjusted analyses were included in the fitting of model.

Results

A total of 1,154 schoolchildren were examined. Eighteen schoolchildren with fixed orthodontic appliances and severe caries lesions were excluded, resulting in a final sample of 1,136 schoolchildren (19.1% from private schools and 80.9% from public schools).

The overall prevalence of ETW was 52.9% (n = 601), whereas severe ETW was detected in 4.4% of the sample (n = 47). The preliminary analysis on the relationship between ETW and socio-demographic, dietary habits, controlling and general health variables is shown in table 1 (overall ETW) and table 2 (severe ETW). The overall prevalence of ETW differed significantly between categories for gender, socio-economic status (table 1) and only between gender in the severe ETW analysis (table 2). The overall extent of ETW was significantly different between categories for gender, socioeconomic status, and swishing drinks before swallowing them (table 1). The extent of severe ETW differed significantly between categories for swishing drinks before swallowing them and brushing frequency (table 2). None of the children who presented severe ETW had gastroesophageal disorders.

When studying the association between the overall prevalence of ETW and the predictor variables (logistic regression analysis), there were no significant results. For this reason, no table showing this analysis was presented. Table 3 shows the association between severe ETW and the predictor variables. In the adjusted analysis, it was observed that males (OR = 3.22, 95% CI = 1.50–6.89) and those schoolchildren who reported the consumption of yoghurts ≥3 times a day (OR = 3.98, 95% CI = 1.18–13.47) were more likely to have severe ETW. No association was found with other sociodemographic variables, dietary, sports, general health or controlling variables. Since none of the schoolchildren with severe ETW presented gastroesophageal disorders, the association between them could not be investigated.

The most frequently affected teeth were the palatal surfaces of the upper incisors (fig. 1). The majority of teeth with ETW showed initial loss of surface texture (BEWE = 1). Severe ETW (BEWE = 2) was mostly found on the palatal surfaces of upper incisors and the occlusal surfaces of lower molars. No tooth surfaces presented BEWE surface score = 3 in this population.

Table 1. Frequency distribution of the sample, overall prevalence and extent (number of affected surfaces) of ETW by predictor variables

	n (%)	Prevalence		Extent	
		% (95% CI)	p*	mean (95% CI)	p**
Socio-demographic characteristics					
Gender			0.01		0.05
Female	594 (52.3)	49.5 (42.1–56.8)		5.58 (4.13–7.02)	
Male	542 (47.7)	56.1 (48.8–63.4)		6.11 (4.58–7.65)	
Socioeconomic status[a]			0.03		0.05
High	273 (24.4)	60.4 (49–71.9)		3.91 (2.67–5.15)	
Medium	566 (50.5)	54.6 (47.3–62)		7.03 (5.05–9.01)	
Low	281 (25.1)	41.2 (29.0–53.4)		5.91 (4.24–7.58)	
Mother' education level[a]			0.2		0.1
College-university	196 (17.9)	55.4 (45.8–64.9)		7.07 (4.89–9.26)	
High school	573 (52.4)	55.7 (49.2–62.2)		6.10 (4.62–7.58)	
Elementary	325 (29.7)	44.9 (30.2–59.6)		4.37 (2.67–6.07)	
School			0.07		0.47
Private	208 (18.3)	61.3 (52.8–69.9)		5.63 (3.69–7.57)	
Public	928 (81.7)	50.0 (41.2–58.7)		6.49 (5.40–7.58)	
Dietary habits					
Soft drinks consumption[a]			0.30		0.28
≤Once a day	846 (75.3)	51.8 (44.8–58.9)		5.59 (4.15–7.89)	
≥Three times a day	278 (24.7)	56.1 (46.1–66.1)		6.74 (3.96–9.52)	
Yoghurt[a]			0.31		0.57
≤Once a day	1,067 (96.1)	52.8 (44.5–59.7)		5.85 (4.02–7.60)	
≥Three times a day	43 (3.9)	63.7 (46.4–80.9)		6.78 (4.32–9.24)	
Drink of the end of sports[a]			0.72		0.74
Water	806 (82.8)	50.2 (44.2–53.3)		6.01 (4.62–7.41)	
Soft drink and/sport drink	126 (12.9)	56.0 (34.5–77.5)		6.51 (3.03–9.99)	
Others	42 (4.3)	56.3 (38.2–74.4)		6,63 (4.40–8.85)	
Swish before swallow[a]			0.09		0.02
Yes	135 (13.8)	60.3 (46.5–73.5)		7.97 (4.83–11.12)	
No	840 (86.2)	50.1 (43.4–53.6)		5.83 (4.40–7.25)	
How to drink[a]			0.11		0.42
Mouth of the bottle	161 (14.2)	52.1 (43.3–60.8)		5.29 (3.98–6.60)	
With sorbet	80 (7.1)	67.0 (51.8–62.0)		6.62 (4.27–8.98)	
Drinking glass	889 (78.7)	52.0 (44.4–59.2)		5.91 (4.20–7.63)	
Controlling variables					
Bruxism[a]			0.64		0.76
Yes	164 (14.7)	54.7 (44.5–64.9)		5.65 (4.22–7.08)	
No	954 (85.3)	52.3 (44.9–59.8)		5.84 (4.26–7.42)	
Brushing frequency[a]			0.8		0.33
≤Once a day	238 (21.4)	50.9 (38.5–63.3)		4.54 (3.22–5.85)	
Twice a day	377 (33.9)	55.1 (46.6–63.5)		4.56 (4.56–6.86)	
≥Three times a day	496 (44.7)	51.9 (42.4–61.4)		6.53 (4.16–8.90)	
Sports					
Swimming[a]			0.96		0.69
Yes	177 (17.3)	51.2 (40.1–61.8)		6.22 (4.38–8.06)	
No	795 (81.8)	50.98 (44.4–57.9)		6.05 (4.46–7.64)	
General health					
Respiratory disorders[a]			0.5		0.78
Present	168 (15.1)	56.3 (42.9–69.7)		6.12 (3.95–8.28)	
Absent	947 (84.9)	52.6 (45.8–59.4)		5.85 (4.36–7.35)	
Gastro-esophageal disorders[a]			0.6		0.34
Present	63 (5.7)	57.4 (41.1–73.6)		4.70 (3.01–6.40)	
Absent	1,044 (94.3)	52.7 (45.4–59.9)		5.95 (4.38–7.52)	
Total	1,136 (100)	52.9 (46–59.8)		5.85 (4.38–7.32)	

* Chi-square test; ** Wald test; [a] Missing data. CI = Confidence interval.

Table 2. Prevalence and extent (number of affected surfaces) of severe ETW (BEWE ≥2) by predictor variables

	Prevalence		Extent	
	% (95% CI)	p*	mean (95% CI)	p**
Socio-demographic characteristics				
Gender		0.05		0.12
Female	2.3 (1.0–4.0)		1.35 (1.01–1.68)	
Male	6.4 (3.0–10.0)		2.06 (1.34–2.79)	
Socioeconomic status		0.71		0.22
High	5.7 (1.0–10.0)		2.23 (1.22–3.23)	
Medium	4.1 (1.0–7.0)		1.72 (1.10–2.33)	
Low	3.96 (2.0–6.0)		1.64 (1.22–2.07)	
Mother' education level		0.29		0.73
College-university	5.3 (2.0–9.0)		1.85 (1.17–2.53)	
High school	3.4 (1.0–6.0)		1.93 (1.25–2.61)	
Elementary	5.7 (2.0–9.0)		1.86 (1.31–2.41)	
School		0.13		0.06
Private	5.1 (3.0–7.0)		1.76 (1.22–2.29)	
Public	2.3 (0.0–5.0)		2.65 (1.95–3.36)	
Dietary habits				
Soft drinks consumption		0.31		0.39
≤Once a day	3.5 (1.6–5.5)		2.07 (1.63–2.51)	
≥Three times a day	6.6 (1.4–11.7)		1.66 (0.88–2.48)	
Yoghurt		0.29		0.74
≤Once a day	4.1 (2.3–5.91)		1.94 (1.32–2.55)	
≥Three times a day	10.2 (0–21.2)		1.68 (0.67–2.73)	
Drink of the end of sports		0.11		0.08
Water	4.2 (2.0–7.0)		2.00 (1.47–2.53)	
Soft drink and/sport drink	9.7 (–2.0 to 21)		1.26 (0.80–1.73)	
Others	1.1 (–1.0 to 3.0)		2.00 (2.00–2.00)	
Swish before swallow		0.42		0.02
Yes	8.6 (4.0–13)		2.02 (1.48–2.57)	
No	4.2 (2.0–6.0)		1.23 (0.90–1.56)	
How to drink		0.51		0.75
Mouth of the bottle	2.1 (0.0–4.0)		1.90 (0.94–2.85)	
With sorbet	4.5 (0.0–10)		1.45 (0.50–2.40)	
Drinking glass	4.9 (3.0–7.0)		1.92 (1.37–2.47)	
Controlling variables				
Bruxism		0.84		0.14
Yes	4.1 (1.0–7.0)		1.42 (1.02–1.81)	
No	4.5 (2.0–7.0)		1.97 (1.41–2.53)	
Brushing frequency		0.74		0.05
≤Once a day	3.8 (1.0–7.0)		1.84 (1.01–2.67)	
Twice a day	4.0 (0.0–8.0)		2.67 (1.88–3.46)	
≥Three times a day	5.2 (3.0–8.0)		1.46 (1.07–1.85)	
Sports				
Swimming		0.87		0.15
Yes	4.9 (2.0–7.0)		1.36 (1.04–1.68)	
No	4.6 (2.0–8.0)		1.90 (1.25–2.56)	
General health				
Respiratory disorders		0.36		0.07
Present	3.0 (0.0–6.0)		1.46 (1.29–1.63)	
Absent	4.7 (3.0–7.0)		1.94 (1.42–2.46)	
Gastro-esophageal disorders				
Present	0		0	
Absent	4.7 (3.0–7.0)	–	1.89 (1.42–2.37)	–
Total	52.9 (46–59.8)		5.85 (4.38–7.32)	

* Chi-square test; ** Wald test. CI = Confidence interval.

Table 3. Association between severe ETW (BEWE ≥2) and predictor variables. Unadjusted and adjusted logistic regression analyses

	Unadjusted		Adjusted	
	OR (95% CI)	p	OR (95% CI)	p
Socio-demographic characteristics				
Gender				
Female	ref.		ref.	
Male	2.84 (1.11–7.29)	0.04	3.22 (1.50–6.89)	0.006
Socioeconomic status				
High	1.47 (0.64–3.35)	0.37		
Medium	1.02 (0.44–2.39)	0.96		
Low	ref.			
Mothers' education level				
College-university	0.93 (0.36–2.38)	0.87	1.06 (0.33–3.44)	0.93
High school	0.58 (0.28–1.34)	0.17	0.65 (0.29–1.47)	0.31
Elementary	ref.		ref.	
School				
Private	2.27 (0.64–8.06)	0.21	2.42 (0.76–7.78)	0.15
Public	ref.		ref.	
Dietary habits				
Soft drinks consumption				
≤Once a day	ref.		ref.	
≥Three times a day	1.91 (0.69–5.29)	0.22	1.62 (0.71–3.72)	0.26
Yoghurt				
≤Once a day	ref.		ref.	
≥Three times a day	2.64 (0.89–7.89)	0.09	3.98 (1.18–13.47)	0.04
Drink of the end of sports				
Water	ref.		ref.	
Soft drink and/or sport drink	2.44 (0.45–13.26)	0.31	2.28 (0.54–9.58)	0.28
Others	0.26 (0.03–2.28)	0.23	0.21 (0.02–2.40)	0.22
Swish before swallow				
Yes	2.16 (0.99–4.69)	0.06	1.32 (0.57–3.06)	0.53
No	ref.		ref.	
How to drink				
Mouth of the bottle	ref.			
With sorbet	0.46 (0.1–2.11)	0.31		
Drinking glass	1.09 (0.25–4.69)	0.91		
Controlling variables				
Bruxism				
Yes	0.92 (0.4–2.12)	0.84		
No	ref.			
Brushing frequency				
≤Once a day	ref.			
Twice a day	1.05 (0.32–3.47)	0.94		
≥Three times a day	1.37 (0.54–3.44)	0.51		
Sports				
Swimming				
Yes	1.08 (0.43–2.7)	0.87		
No	ref.			
General health				
Respiratory disorders				
Present	0.63 (0.2–2.0)	0.44		
Absent	ref.			

OR = Odds ratio; CI = confidence interval; ref. = reference category.

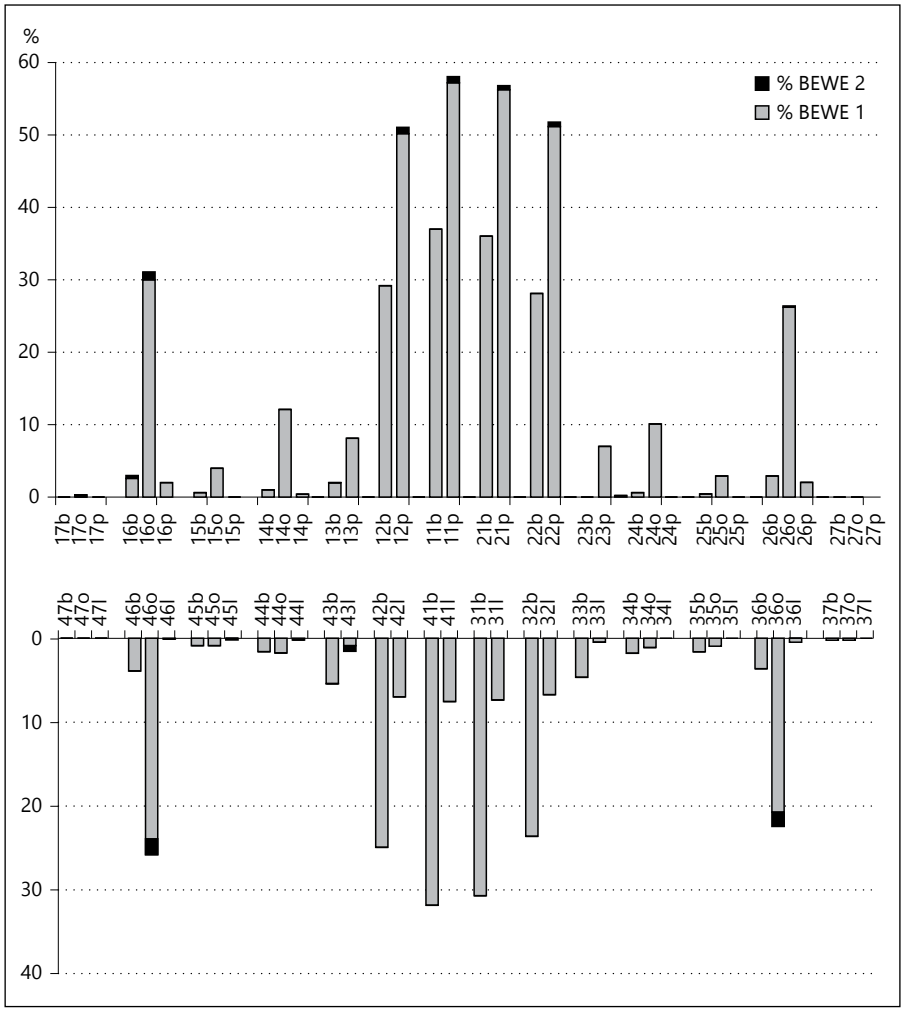

Fig. 1. Intraoral distribution of erosive tooth wear (BEWE = Basic Erosive Wear Examination; b = buccal; o = occlusal; p = palatal; l = lingual).

Discussion

This population-based study was conducted to assess ETW in a representative sample of Uruguayan schoolchildren. To the best of our knowledge, this is the first study assessing the occurrence of ETW among Uruguayan children. A high prevalence of ETW was recorded (52.9%), being mild erosion in the vast majority of cases (48.5%). Severe erosion was found in 4.4% of the children.

The high prevalence of ETW observed in the present study is similar to that found in previous studies conducted in the United Kingdom [Al-Dlaigan et al., 2001; Dugmore and Rock, 2004], but higher than in the majority of studies conducted on 12-year-old children in South America [Peres et al., 2005; Auad et al., 2009; Mangueira et al., 2009; Vargas-Ferreira et al., 2010]. It is difficult to make direct comparisons between studies due to differences in the diagnostic criteria, type and number of examined teeth, sample sizes and socioeconomic and cultural factors [Truin et al., 2005; Vargas-Ferreira et al., 2010; Arnadottir et al., 2010; Al-Dlaigan et al., 2001; Wang et al., 2010]. We could speculate that the characteristics of examination (supine position, the use of artificial light, tooth cleaning and drying) and the degree of reproducibility of the examiners (inter- and intra-examiner Kappa ≥0.7 and ≥0.8, respectively) may have increased the sensitivity of the examination, thus contributing to the higher prevalence of ETW found in this schoolchildren population. Despite the high prevalence of ETW, it was mostly mild erosion (BEWE = 1), which is in agreement with the majority of studies assessing dental erosion on the permanent dentition of children and adolescents in different populations [van Rijkom et al., 2002; Peres et al., 2005; Auad et al. 2009; Correr et al., 2009; Al-Dlaigan

et al., 2001; Mangueira et al., 2009]. This can be attributed to the short period of action of the risk factors, and possibly due to a low intensity of these risk factors.

The distribution of the lesions showed a higher prevalence of ETW on the upper incisors, followed by the lower incisors and the first molars, which is in agreement with previous studies [Ganss et al., 2001; van Rijkom et al., 2002; Peres et al., 2005; Auad et al., 2009; Vargas-Ferreira et al., 2010; Caglar et al., 2005; Al-Dlaigan et al., 2001; El Aidi et al., 2008]. These tooth groups have been exposed to the oral environment for a longer period of time than canines, premolars and second molars, thus being more susceptible to the negative effects of the acid challenges that lead to ETW. At the surface level, the palatal surface of the upper incisors was the most commonly affected, as previously described [Arnadottir et al., 2010; Mangueira et al., 2009]. It can be attributed to issues related with the duration of time that drinks are retained in the mouth and tongue movements that may possibly play a role in the erosive process by abrading softened tooth enamel immediately after the acidic challenges [Al Majed and Murray, 2002; Arnadottir et al., 2010]. Moreover, the acquired pellicle is thinner on the palatal surfaces, decreasing the protective role of saliva at this surface [Amaechi et al., 1999].

Systematic reviews have established that tooth wear is a common disease and that its prevalence increases with age [Kreulen, 2010]. However, it is not clear which factors are associated with this increased risk. The present study found that males were more affected by ETW than females, which is in agreement with previous findings [Bardsley et al., 2004; Milosevic et al., 1994; Al-Dlaigan et al., 2001; El Aidi et al., 2001; Milosevic et al. 2004; Dugmore and Rock, 2004]. Boys showed a higher prevalence and extent of ETW than girls, which was consistently observed both in the overall (table 1) and the severity (table 2) analysis. Furthermore, the risk for severe ETW was around three-fold higher in boys than in girls (OR = 3.22, 95% CI = 1.50–6.89), even after the adjustment for important cofactors. These findings can be attributed to differences between genders concerning physical, behavioral and lifestyles characteristics. It has been shown that boys present a higher bite force than girls [Bardsley et al., 2004], which could be related to a higher prevalence of ETW on the occlusal surfaces of molars. Boys tend to prefer sour foods and drinks when compared with girls [Allesen-Holm et al., 2009]. Furthermore, boys are involved in more physical activities than girls thus being more susceptible to the modifications on the quality and quantity of saliva that occurs during intense sports [Lussi and Jaeggi, 2006; Mulic et al., 2012]. In conjunction, these characteristics may explain, at least in part, the higher occurrence of ETW among boys.

The relationship between socioeconomic indicators and ETW has shown to be contradictory in the literature. The higher prevalence of ETW in children from high socioeconomic status found in the present study is in agreement with previous studies [van Rijkom et al., 2002; Bardsley et al., 2004; Peres et al., 2005; Al-Dlaigan et al., 2001]. Nevertheless, no association was found between ETW and socioeconomic status or the other variables used to capture the socioeconomic characteristics such as the type of school and educational level of the mother.

Changes in the lifestyle of the modern society resulted in new behaviors that do not always affect the health positively. Changes in dietary habits due to social, economic and family modifications associated with new conceptions of body image has made the oral cavity more exposed to acid challenges from an early age [Lussi, 2006]. The consumption of soft drinks was frequently associated with ETW in a young population [Li et al., 2012]. The 2nd National Survey of Adolescent Health on 3,524 13–15 year-old Uruguayan students showed that 71% of schoolchildren drank soft drinks ≥once a day [Ministry of Public Health, 2012]. Despite these results, we have not observed any relationship between this variable and ETW.

Our results have also found that schoolchildren who drink yoghurt ≥3 times a day had a 4-fold higher risk for severe ETW than those who never drink yoghurt or those who did it rarely (OR = 3.98, 95% CI = 1.18–13.47). Despite the magnitude of this effect, it is important to highlight that this association is based on a reduced sample size (prevalence of 10.2% out of 43 individuals reporting the consumption of yoghurts ≥3 times a day). Furthermore, this finding is not in agreement with the available literature. In vitro studies showed that milk products and yoghurts are essentially nonerosive due to their saturation in relation to hydroxyapatite [Lussi, 2006], and the meta-analysis conducted by Li et al. [2012] showed no association between the consumption of yoghurt products and ETW (OR = 1.05, 95% CI = 0.28–3.96). We could speculate that, given the high frequency of consumption reported in the present study, the low pH of yogurt products may be too great a challenge for the protective effect attributed to calcium. However, no conclusion can be drawn and further investigations may elucidate if this is a spurious association.

Diseases that cause regurgitation or frequent vomiting may contribute to the development of ETW. Gastroesophageal disorder is common in the pediatric popula-

tion, and a systematic review has shown a prevalence of ETW between 14 and 87% in 1–18 year-old individuals with this condition [Mariscano et al., 2013]. Children with reflux were at a higher risk to develop ETW and its severity was associated with the presence of reflux. In the present study, only 63 children reported having a gastroesophageal disorder and none of them presented severe ETW. Asthmatics have an increased risk of reflux and the medication they use has a low pH and may decrease salivary flow [Shaw et al., 2000]. However, no association was found between asthma and ETW in this population.

To distinguish the effects of erosion, attrition and abrasion, we collected data on brushing frequency and bruxism, in order to use them as controlling variables for abrasion and attrition, respectively. Although a borderline p-value was found between the extent of severe ETW among categories of brushing frequency, no association was found in the risk assessment analysis. Furthermore, the lack of a plausible gradient among categories (with individuals in the intermediate category of brushing frequency showing the highest extent of severe ETW) contributes to discredit this finding. The index (BEWE) used in the present study is specific for diagnosis of ETW, not including the incisal edges, and the age of the participants decreases the chances of presenting abrasion injuries [Millward et al., 1994].

In conclusion, the present study found a high prevalence of ETW, being mild erosion in the vast majority of cases. The upper incisors were the most commonly affected teeth. Males were at an increased risk for severe ETW than females. Since ETW is a progressive and cumulative condition, and has an irreversible pathology, the results found in this study suggest that this pathology may be considered a public health problem among 12-year-old Uruguayan schoolchildren.

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Role of Authors

L. Alvarez: Data collection, data analysis and paper writing.
A. Fabruccini: Data collection.
R. Alvarez: Data analysis.
L.S. Alves and M. Maltz: Study design and paper writing.

Disclosure Statement

We, Licet Alvarez Loureiro, Anunzziatta Fabruccini Fager, Luana Severo Alves, Ramón Alvarez Vaz, and Marisa Maltz, declare that we have no proprietary, financial, professional or other personal interest of any nature or kind in any product, service, and/or company that could be construed as influencing the position presented in, or the review of, the manuscript 'Erosive tooth wear among 12-year-old schoolchildren: a population-based cross-sectional study in Montevideo, Uruguay'.

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