**Pesquisa Brasileira em Odontopediatria e Clinica Integrada 2018, 18(1):e3764**
**DOI: http://dx.doi.org/10.4034/PBOCI.2018.181.25**
**ISSN 1519-0501**



**ORIGINAL ARTICLE**

# Tooth Erosion Association with Obesity: Findings from a Brazilian Survey in Schoolchildren

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Academic Editors: Alessandro Leite Cavalcanti and Wilton Wilney Nascimento Padilha

Received: 12 September 2017 / Accepted: 02 February 2018 / Published: 14 February 2018

**Abstract**

**Objective:** To evaluate a possible association between tooth erosion and weight status in Brazilian schoolchildren. **Material and Methods:** 1211 children aged 8-12-year-old from public and private schools in Southern Brazil were selected by a two-stage cluster method. Oral conditions were assessed by six trained and calibrated examiners. Tooth erosion assessment was determined by using the O´Sullivan index. Anthropometric measures were taken in order to obtain the body mass index. Socio-demographic and behavioral data were collected using questionnaires in children and parents. Multivariate Poisson regression model considering the cluster sample was used for data analysis (Prevalence ratio - PR; 95% Confidence Interval - CI). **Results:** Tooth erosion was observed in 25.1% of the children. Obesity and overweight prevalence was 34.6%. In the multivariate adjusted model, tooth erosion was associated with children from private schools (PR 1.68; 95%CI 1.05-2.68) and higher frequency of physical activity weekly (PR 1.48; 95%CI 1.04-2.09), whereas dental crowding in both arches was considered a protective effect (PR 0.55; 95%CI 0.34-0.89). In the stratified analysis regarding the type of school, children from private schools presented a positive association between tooth erosion and obesity (PR 3.26; 95%CI 1.38-7.69). **Conclusion:** Tooth erosion was not associated with obesity in the total sample. Socioeconomic differences seem to influence the relationship tooth erosion and obesity.

**Keywords:** Tooth Erosion; Obesity; Child; Adolescent; Prevalence.

## Introduction

Changes in lifestyles, such as dietary habits, socioeconomic context and industrialization may play an important role in health conditions [1]. As consequence, many physical and psychological disorders are observed more frequently, also in childhood. Obesity is a chronic condition defined as an excessive fat accumulation with adverse health effects. This condition has substantially increased in global prevalence, since children from medium and low-income countries are also affected [1,2]. Worldwide prevalence of childhood obesity increased from 4.2% in 1990 to 6.7% in 2010 [2]. The literature has pointed out obesity as a risk factor to many general and oral health conditions such as hypertension [3], dental trauma [4] and gingivitis [5]. The adoption of unhealthy dietary habits, with elevated consumption of sugary-acidic food and drink [6], socioeconomic position and background, and psychological and behavioral attitudes, such as lack of physical activities and long hours of TV watching [1], have been associated with the increase of overweight and obesity prevalence in children [2,6].

Tooth erosion is responsible for demineralization and wear of tooth enamel and dentine through extended acid contact [7,8]. Previous investigations have shown high consumption of soft drinks to be a risk factor for tooth erosion development, whereas milk, cheese and yogurt have been identified as protective factors [8]. Many more factors have been reported: socio-demographic, behavioral and biologic characteristics, showing that tooth erosion has a multifactor nature [9,10]. Tooth erosion prevalence increases with age in teenage children, with an incidence of 12.8%-24.2% in 2-3 years of follow-up [8].

Obesity and tooth erosion may involve common risk conditions, such as the elevated consumption of sugary drinks and foods, the adoption of unhealthy lifestyle habits and the socioeconomic context, which could modulate the presence of these health conditions in different ways, since tooth erosion and obesity were observed in children from privilege economic background [10,11] whereas the opposite was seen in children from deprived situations [7,9]. However, only few studies investigated a possible relationship between weight status and tooth erosion [12,13]. The studies that explored this association have relevant methodological issues, such as the reduced number of children enrolled and the statistical analysis used, and no clear conclusions could be drawn in either study.

Thus, we hypothesize that an association between tooth erosion and obesity may exist. Moreover, studies have shown that diet was associated with obesity and tooth erosion in children independently, especially if the socioeconomic status is considered [12,13]. Thereby, considering the above explained, this study aimed to assess the relationship between tooth erosion and weight status in Brazilian schoolchildren, when controlling for potentials confounders.

## Material and Methods

Subjects and Ethical Aspects

The present study included a sample of children and adolescents. This study was conducted in accordance with relevant international statutes and national legislation on ethics in research involving human beings. All patients agreed to participate and provided written consent. The study protocol was approved by the Ethics Committee of the Universidade Federal de Pelotas, School of Dentistry, Brazil (Protocol n°160/2010). Only children with written consent form signed by their parents were included in the study.

Design and Study Population

This cross-sectional study was conducted in 2010 with children aged 8-12-year-old, in Pelotas, southern Brazil. The city population is estimated in 330,000 people (Brazilian Institute of Geography and Statistics, 2010) and the city presents 25 private and 91 public schools, with approximately 25,000 schoolchildren regularly attending school within the age range studied.

In order to select a representative sample of schoolchildren, a cluster selection sample was adopted. To select the sample, 20 public private and public schools were randomly selected, considering the number of children in each school and the proportion of schools in the city. Children aged 8-12-year-old, enrolled in grade 2 to 6 of primary education, were invited to participate. Detailed information about the methodological aspects of this study have been provided elsewhere [14].

This cross-sectional study assessed several outcomes, including tooth erosion, the sample size (prevalence and association) was calculated using an assumed prevalence of tooth erosion of 13.0% [10], a sampling error of 4%, and a confidence level of 95%. In addition, a design effect of 1.4 was applied, adding 20% to compensate refusals and 10% to control confounding factors. The sample size was estimated to be 1042 children and adolescents. Schools were visited several times to avoid more than 10% of absence in each school.

Data Collection

Data collection was obtained at schools, and was composed of structured questionnaires sent to the parents, with socio-demographic information; interviews with the children; and clinical and oral examinations. Besides the socio-demographic information, behavioral aspects, dietary and oral health habits were also asked. Questionnaires, based on previous research [15] were pre-tested and used by trained interviewers. Questions were related to children´s age (complete years), gender, type of school (private or public), mothers' education (categorized in ≥12, 9-11, 5-8 and ≤ 4) and household income (collected in Brazilian Minimum Wage/month and later categorized into quartiles). Habits information was self-reported and included physical activity practice (dichotomized; active: ≥300min/week; inactive: <300min/week), brushing frequency (one, two and three or more times daily), frequency of mouthrinse use, consumption of drinks at night and food and drinks consumption frequency (acid fruits: lime, orange, pineapple and strawberry; acid foods: soft

drink and candies). Frequency of mouthrinse use and drink and food consumption was recorded at three levels: never, 1 or 2 times, and 3 times or more per week.

Six examiners, previously trained and calibrated, with experience in epidemiological studies performed the oral examinations. The calibration process consisted of 40 hours of theoretical activities and discussions about the outcomes. Tooth erosion training and calibration used the in lux method. A benchmark dental examiner conducted the complete examiner training and the calibration process. Children were examined at school with sterilized mouth mirrors, CPI ("ball point") probes and gauze pads to clean and dry the tooth surface [10,15], under artificial light and in a sitting position. Tooth erosion was assessed by the modified O´Sullivan index [16]. Central maxillary incisors were analyzed through visual examination of facial, lingual, and incisal surfaces. For tooth erosion, inter-examiner kappa values ranged from 0.60 to 0.65. Other clinical conditions were also evaluated such as dental crowding and malocclusion (Dental Aesthetic Index, DAI) [17]. The DAI comprises 10 parameters for assessment of clinical and aesthetic aspects of dentofacial anomalies: missing teeth, incisal crowding, incisal spacing, midline diastema, anterior maxillary irregularity, anterior mandibular irregularity, maxillary overjet, mandibular overjet, anterior open bite, and anteroposterior molar relation. The final score is obtained by adding the component scores, multiplied by their respective weights, to the constant 13 [17]. Anthropometric measures were taken in order to obtain the body mass index (BMI). The Cole criteria were used to determine the weight status considering child's sex and age [18].

Data Analysis

Data were recorded in duplicate (Epi Info 6.0 software) and the analyses were carried out in Stata 12.0 (Stata Corp., College Station, TX, USA). Descriptive and bivariate analyses were performed to assess the association between predictor variables and the outcome using Pearson's chi-square test, or Linear Trend, depending on the type of variable.

After, a multivariate Poisson regression model was performed, considering the cluster sample design. Variables with $p<0.25$ were maintained in the fitting model, and estimated their Prevalence Ratio (PR) and their 95% confidence of interval. Variables with $p<0.05$ in the adjusted model were considered statistically significant. However, the variables "household income", "BMI", and all variables related to drink and food consumption were maintained in all multivariate models, independent of their p-value. The variable "BMI" was maintained since it was the main independent variable studied, presenting a close relationship with the socioeconomic status, measured by the variable "household income" and "type of school". The variables related with drink and food consumption were maintained in the model for being considered relevant mediators with the outcome "tooth erosion". Analyses were also stratified by the type of the school (private or public), in order to investigate the effects of independent variables according to socioeconomic status.

**Results**

A total of 1,211 children participated in the study. The response rate was 69.3% of all invited children (n=1,744) for all outcomes involved in this cross-sectional study. The main reasons for refusal were lack of parental consent (24.0%) and absence in the examination days (6.7%). Response rate between public and private schools was not different. The distribution of the sample according to predictors and outcome and the bivariate analysis are presented in Table 1.

Children were predominantly girls (52.6%), white (72.8%) and 79.0% of the total number of children attended public schools. Regarding maternal education, 53.0% studied 9 or more years. The prevalence of tooth erosion was 25.1% (95% CI: 23.4; 28.6). Erosive lesions were commonly presented in multiple surfaces in a single tooth (48.4%) followed by the palatal surface (42.0%). Most lesions were localized in enamel, had matt appearance without any contour loss (20.3%) and presented less than a half of the surface affected (64.6%), which indicates the lowest severity level. Children with excessive fat accumulation (obesity and overweight) made up 34.6% of the studied sample (Table 1).

Older children (p<0.01), children who attended public schools (p<0.01), and children from the richest income quartiles (p=0.05), had higher prevalence of erosion than their counterparts. Children with dental crowding in both arches showed lower erosive lesions than their counterparts (p=0.006) (Table 1).

**Table 1. Sample distribution and presence of tooth erosion according to sociodemographic and biological variables (N=1.211).**

| Variables | | Total | | Tooth Erosion | | p-value |
|---|---|---|---|---|---|---|
| | | N | % | N | % | |
| Sex | Male | 574 | 47.4 | 149 | 26.0 | 0.641 |
| | Female | 637 | 52.6 | 153 | 24.0 | |
| Skin color | White | 858 | 72.8 | 219 | 25.6 | 0.502 |
| | Non-white | 319 | 27.2 | 80 | 25.1 | |
| Type of school | Public | 958 | 79.0 | 261 | 27.3 | 0.001 |
| | Private | 253 | 21.0 | 41 | 16.2 | |
| Age | 8-10 | 789 | 15.0 | 168 | 21.3 | 0.001 |
| | 11-12 | 425 | 65.0 | 134 | 31.8 | |
| Household income (quartiles) | 1st | 246 | 23.7 | 52 | 21.2 | 0.05 |
| | 2nd | 271 | 26.1 | 68 | 25.1 | |
| | 3rd | 241 | 23.2 | 71 | 29.5 | |
| | 4th | 279 | 26.9 | 77 | 27.6 | |
| Maternal schooling | ≥ 12 | 502 | 43.0 | 32 | 23.4 | 0.25 |
| | 9-11 | 121 | 10.3 | 85 | 23.3 | |
| | 5-8 | 127 | 11.0 | 58 | 23.4 | |
| | ≤ 4 | 426 | 36.2 | 115 | 27.0 | |
| Body Mass Index (BMI) | Normal | 787 | 65.4 | 197 | 25.0 | 0.688 |
| | Overweight | 257 | 21.4 | 63 | 24.5 | |
| | Obese | 160 | 13.2 | 37 | 23.1 | |
| Physical activity (min/week) | ≥300 | 342 | 30.9 | 87 | 25.5 | 0.065 |
| | <300 | 767 | 69.1 | 196 | 25.6 | |
| Soda consumption (frequency/week) | ≥3 | 481 | 39.8 | 134 | 28.0 | 0.273 |
| | 1-3 | 669 | 55.4 | 150 | 22.4 | |
| | 0 | 58 | 4.8 | 18 | 31.0 | |
| Pineapple consumption (frequency/week) | ≥3 | 140 | 11.6 | 38 | 27.2 | 0.760 |
| | 1-3 | 459 | 37.9 | 113 | 24.6 | |
| | 0 | 608 | 50.5 | 151 | 24.8 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Strawberry consumption (frequency/week) | ≥3 | 285 | 23.8 | 70 | 24.6 | 0.510 |
| | 1-3 | 474 | 39.2 | 123 | 25.9 | |
| | 0 | 448 | 37.0 | 109 | 24.3 | |
| Orange consumption (frequency/week) | ≥3 | 374 | 30.9 | 90 | 24.1 | 0.635 |
| | 1-3 | 616 | 50.9 | 154 | 25.0 | |
| | 0 | 216 | 18.2 | 58 | 26.9 | |
| Lime consumption (frequency/week) | ≥3 | 231 | 19.2 | 64 | 27.1 | 0.964 |
| | 1-3 | 347 | 28.8 | 84 | 24.2 | |
| | 0 | 629 | 52.0 | 153 | 24.3 | |
| Candy consumption (frequency) | Daily | 123 | 10.2 | 26 | 21.1 | 0.087 |
| | Weekly | 662 | 54.7 | 181 | 27.3 | |
| | Never | 423 | 35.0 | 94 | 22.2 | |
| Drinking before sleeping (frequency/week) | 6-7 times | 220 | 18.2 | 45 | 20.5 | 0.444 |
| | 4-5 times | 64 | 5.3 | 12 | 18.8 | |
| | 1-3 times | 197 | 16.3 | 53 | 26.9 | |
| | <1 time | 81 | 7.0 | 22 | 27.2 | |
| | Never | 644 | 53.2 | 170 | 26.4 | |
| Dental Erosion | Yes | 302 | 25.6 | - | - | - |
| | No | 900 | 74.4 | - | - | |
| Dental crowding (arch) | Absence | 774 | 74.0 | 210 | 27.1 | 0.006 |
| | 01 arch | 332 | 27.5 | 76 | 22.9 | |
| | 02 arch | 103 | 8.5 | 16 | 15.5 | |
| Dental Aesthetic Index (DAI) | 0 | 721 | 59.5 | 193 | 26.8 | 0.139 |
| | 1 | 260 | 21.5 | 58 | 22.3 | |
| | 2 | 113 | 9.4 | 27 | 23.9 | |
| | 3 | 117 | 9.6 | 24 | 20.5 | |
| Dental caries experience | Yes | 704 | 58.7 | 123 | 24.9 | 0.640 |
| | No | 495 | 41.3 | 176 | 25.0 | |
| Frequency of tooth brushing (times/daily) | 1 | 697 | 59.0 | 294 | 42.7 | 0.226 |
| | 2 | 106 | 9.0 | 52 | 49.5 | |
| | 3 | 382 | 32.0 | 179 | 47.0 | |
| Mouthrinse use (frequency) | Daily | 129 | 13.6 | 30 | 20.8 | 0.135 |
| | Weekly | 136 | 11.7 | 233 | 25.9 | |
| | Never | 898 | 74.7 | 28 | 20.6 | |
| Total | | 1.211 | 100 | 302 | 24.9 | |

Table 2 presents the crude and adjusted prevalence ratios of multivariate Poisson regression for dental erosion according to the independent variables. The multivariate analysis revealed that children from public schools were statistically different (PR 1.68; 95% CI: 1.05; 2.68) from those in private schools, showing 68% higher prevalence of tooth erosion. In relation to the practice of physical activity, children considered active (≥300min/week) presented a higher prevalence of dental erosion (PR 1.48; 95%CI: 1.04; 2.09). The presence of dental crowding in both arches was associated with lower prevalence of erosion (PR 0.55; 95% CI: 0.34; 0.89).

**Table 2. Crude (c) and adjusted (a) Prevalence Ratios (PR) for tooth erosion occurrence in schoolchildren, according to independent variables.**

| Variables | Tooth Erosion | | | |
|---|---|---|---|---|
| | PR[c] (95%IC) | p | PR[a](95%IC) | p |
| Age (years) | | 0.172 | | - |
| 8-10 | 1.0 | | - | |
| 11-12 | 1.23 (0.91; 1.64) | | - | |
| Type of School | | 0.133 | | 0.030 |
| Private | 1.0 | | 1.0 | |
| Public | 1.45 (0.89; 2.35) | | 1.68 (1.05; 2.68) | |
| Household Income** | | 0.184 | | 0.174 |
| 1 (poorer) | 1.19 (0.73; 1.95) | | 1.16 (0.76; 1.77) | |

| | | | | |
|---|---|---|---|---|
| 2 | 1.43 (0.85; 2.38) | | 1.45 (0.94; 2.24) | |
| 3 | 0.88 (0.56; 1.37) | | 0.90 (0.64; 1.27) | |
| 4 (richer) | 1.0 | | 1.0 | |
| Maternal schooling (years) | | 0.652 | | - |
| ≥ 12 | 1.0 | | - | |
| 9-11 | 1.10 (0.62; 1.96) | | - | |
| 5-8 | 0.78 (0.45; 1.32) | | - | |
| ≤ 4 | 1.18 (0.68; 2.04) | | - | |
| Body Mass Index (BMI)** | | 0.972 | | 0.646 |
| Normal | 1.0 | | 1.0 | |
| Overweight | 0.88 (0.61; 1.25) | | 0.93 (0.64; 1.35) | |
| Obese | 1.07 (0.64; 1.80) | | 1.11 (0.65; 1.87) | |
| Physical Activity (min/week) | | 0.060 | | 0.026 |
| <300 | 1.0 | | 1.0 | |
| ≥300 | 1.41 (0.99; 2.06) | | 1.48 (1.04; 2.09) | |
| Soft drink consumption (frequency/week)** | | 0.712 | | 0.601 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 0.62 (0.35; 1.46) | | 0.57 (0.27; 1.20) | |
| ≥3 | 0.71 (0.35; 1.46) | | 0.64 (0.30; 1.36) | |
| Pineapple consumption (frequency/week)** | | 0.932 | | 0.647 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 0.88 (0.64; 1.21) | | 0.91 (0.65; 1.25) | |
| ≥3 | 1.24 (0.74; 2.08) | | 1.34 (0.80; 2.24) | |
| Strawberry consumption (frequency/week)** | | 0.562 | | 0.505 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 1.17 (0.80; 1.71) | | 1.23 (0.89; 1.72) | |
| ≥3 | 1.41 (1.01; 1.96) | | 1.16 (0.78; 1.71) | |
| Orange consumption (frequency/week)** | | 0.839 | | 0.670 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 1.25 (0.91; 1.72) | | 1.16 (0.86; 1.58) | |
| ≥3 | 1.25 (0.81; 1.67) | | 1.04 (0.70; 1.58) | |
| Lime consumption (frequency/week)** | | 0.754 | | 0.562 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 1.12 (0.75; 1.68) | | 0.96 (0.66; 1.40) | |
| ≥3 | 0.93 (0.65; 1.33) | | 1.21 (0.72; 1.73) | |
| Candy consumption (frequency)** | | 0.07 | | 0.359 |
| ≥3 | 1.0 | | 1.0 | |
| 1-3 | 0.79 (0.42; 1.46) | | 1.21 (0.67; 2.21) | |
| Never | 0.56 (0.30; 1.05) | | 0.85 (0.46; 1.58) | |
| Drinking acid beverage before sleeping (frequency/week)** | | 0.402 | | 0.289 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 1.35 (0.85; 2.06) | | 1.37 (0.86; 2.17) | |
| Dental crowding (arch) | | 0.555 | | 0.017 |
| 0 | 1.0 | | 1.0 | |
| 1 | 1.23 (0.85; 1.79) | | 1.28 (0.87; 1.87) | |
| 2 | 0.52 (0.32; 0.84) | | 0.55 (0.34; 0.89) | |
| Dental Aesthetic Index (DAI) | | 0.806 | | - |
| 0 | 1.0 | | - | |
| 1 | 0.88 (0.58; 1.33) | | - | |
| 2 | 0.72 (0.49; 1.05) | | - | |
| 3 | 1.08 (0.57; 2.05) | | - | |
| Frequency of tooth brushing (times/daily) | | 0.833 | | - |
| 1 | 1.0 | | - | |
| 2 | 1.25 (0.83; 1.90) | | - | |
| 3 | 1.17 (0.80; 1.73) | | - | |
| Mouthrinse use (frequency) | | 0.160 | | - |
| Never | 1.0 | | - | |
| 1-3 | 0.98 (0.55; 1.75) | | - | |
| ≥3 | 0.61 (0.55; 1.74) | | - | |

Even controlling for potential confounders (socioeconomic, behavioral and clinical variables), among children from private school, adjusted Poisson regression revealed that obese schoolchildren presented a greater chance of having dental erosion (PR 3.26; 95% CI: 1.38; 7.69). The outcome was also associated with higher frequency of soft drink consumption (PR 2.17; 95% CI: 1.31; 7.38), higher

frequency of pineapple consumption (PR 9.38; 95% CI: 3.50; 27.63), dental crowding in both arches (PR 0.55; 95% CI: 0.34; 0.89) was associated with less dental erosion, and more frequent mouthrinse use (weekly: PR 0.31; 95% CI: 0.11; 0.87; daily: PR 0.28; 95% CI: 0.13; 0.31) indicating a protective factor (Table 3). Among children from public schools, the weight status was not associated with erosion in the final model, while lower consumption of candies (PR 0.49; 95% CI: 0.20; 0.98) was associated (Table 4).

**Table 3. Crude (c) and adjusted (a) Prevalence Ratios (PR) for tooth erosion occurrence in schoolchildren from private school.**

| Variables | Tooth Erosion | | | |
|---|---|---|---|---|
| | PR[c] (95%IC) | p | PR[a](95%IC) | p |
| Age (years) | | 0.562 | | - |
| 8-10 | 1 | | - | |
| 11-12 | 0.80 (0.37; 1.69) | | - | |
| Household Income** | | 0.170 | | 0.218 |
| 4 (richer) | 1.0 | | 1.0 | |
| 3 | 0.26 (0.07; 0.96) | | 0.32 (0.09; 1.11) | |
| 2 | 0.65 (0.10; 4.20) | | 0.58 (0.07; 4.34) | |
| 1 (poorer) | 0.82 (0.13; 4.98) | | 1.52 (0.51; 4.51) | |
| Maternal schooling (years) | | 0.166 | | - |
| ≥ 12 | 1.0 | | - | |
| 9-11 | 0.94 (0.35; 2.52) | | - | |
| 5-8 | 0.28 (0.08; 1.02) | | - | |
| ≤ 4 | 0.45 (0.06; 3.17) | | - | |
| Body Mass Index (BMI)** | | 0.772 | | 0.021 |
| Normal | 1.0 | | 1.0 | |
| Overweight | 0.63 (0.29; 1.39) | | 0.92 (0.31; 2.69) | |
| Obese | 1.54 (0.35; 6.69) | | 3.26 (1.38; 7.69) | |
| Physical Activity (min/week) | | 0.160 | | 0.120 |
| ≥300 | 1.36 (0.42; 4.43) | | 1.82 (0.70; 2.74) | |
| <300 | 1.0 | | 1.0 | |
| Soft drink consumption (frequency/week)** | | 0.820 | | 0.024 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 0.76 (0.28; 2.06) | | 0.84 (0.20; 3.43) | |
| ≥3 | 0.93 (0.32; 2.69) | | 2.17 (1.31; 7.38) | |
| Pineapple consumption (frequency/week)** | | 0.557 | | 0.001 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 0.70 (0.31; 1.56) | | 1.64 (0.70; 3.84) | |
| ≥3 | 2.69 (0.71; 10.17) | | 9.83 (3.50; 27.63) | |
| Strawberry consumption (frequency/week)** | | 0.402 | | 0.073 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 2.38 (1.02; 5.57) | | 0.37 (0.10; 1.31) | |
| ≥3 | 0.83 (0.37; 1.83) | | 1.18 (0.49; 2.83) | |
| Orange consumption (frequency/week)** | | 0.862 | | 0.634 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 1.01 (0.42; 2.40) | | 1.24 (0.51; 3.04) | |
| ≥3 | 1.26 (0.43; 3.64) | | 0.83 (0.36; 1.90) | |
| Lime consumption (frequency/week)** | | 0.754 | | 0.224 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 1.12 (0.75; 1.68) | | 0.46 (0.15; 1.38) | |
| ≥3 | 0.93 (0.65; 1.33) | | 1.35 (0.73; 2.47) | |
| Candy consumption (frequency)** | | 0.147 | | 0.125 |
| ≥3 | 1.0 | | 1.0 | |
| 1-3 | 0.43 (0.10; 1.86) | | 0.89 (0.34; 2.34) | |
| Never | 0.29 (0.06; 1.24) | | 0.47 (0.14; 1.58) | |
| Drinking acid beverage before sleeping (frequency/week)** | | 0.291 | | 0.230 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 0.60 (0.35; 1.05) | | 0.44 (0.09; 2.14) | |
| ≥3 | 0.84 (0.25; 2.77) | | 0.63 (0.07; 5.79) | |
| Dental crowding (arch) | | 0.237 | | 0.010 |
| 0 | 1.0 | | 1.0 | |
| 1 | 0.87 (0.23; 3.23) | | 1.28 (0.87; 1.87) | |

| | | | | |
|---|---|---|---|---|
| 2 | 0.27 (0.04; 1.84) | | 0.55 (0.34; 0.89) | |
| Dental Aesthetic Index (DAI) | | 0.109 | | 0.115 |
| 0 | 1.0 | | 1.0 | |
| 1 | 0.84 (0.19; 3.61) | | 0.76 (0.32; 1.83) | |
| 2 | 0.37 (0.11; 1.20) | | 0.51 (0.10; 2.48) | |
| 3 | 0.32 (0.07; 1.33) | | 0.37 (0.10; 1.36) | |
| Frequency of tooth brushing (times/daily) | | 0.827 | | |
| 1 | 1.0 | | - | |
| 2 | 0.97 (0.25; 3.73) | | - | |
| 3 | 0.88 (0.29; 2.77) | | - | |
| Mouthrinse use (frequency) | | 0.030 | | 0.016 |
| Never | 1.0 | | 1.0 | |
| 1-3 | 0.37 (0.14; 0.99) | | 0.31 (0.11; 0.87) | |
| ≥3 | 0.23 (0.07; 0.75) | | 0.28 (0.13; 0.61) | |

**Table 4. Crude (c) and adjusted (a) Prevalence Ratios (PR) for tooth erosion occurrence in schoolchildren from public school.**

| Variables | Tooth Erosion | | | |
|---|---|---|---|---|
| | PR[c] (95%IC) | p | PR[a](95%IC) | p |
| Age (years) | | 0.562 | | - |
| 8-10 | 1 | | - | |
| 11-12 | 1.04 (0.64; 1.68) | | - | |
| Household Income** | | 0.866 | | 0.224 |
| 1 (poorer) | 0.82 (0.13; 4.98) | | 0.65 (0.30; 1.39) | |
| 2 | 1.89 (0.94; 3.88) | | 0.77 (0.42; 1.37) | |
| 3 | 1.29 (0.67; 2.49) | | 1.07 (0.55; 2.06) | |
| 4 (richer) | 1.0 | | 1.0 | |
| Maternal schooling (years) | | 0.854 | | - |
| ≥ 12 | 1.0 | | - | |
| 9-11 | 0.84 (0.41; 1.70) | | - | |
| 5-8 | 0.39 (0.21; 0.74) | | - | |
| ≤ 4 | 0.77 (0.40; 1.46) | | - | |
| Body Mass Index (BMI)** | | 0.805 | | 0.833 |
| Normal | 1.0 | | 1.0 | |
| Overweight | 0.79 (0.39; 1.60) | | 0.77 (0.37; 1.59) | |
| Obese | 0.98 (0.43; 2.23) | | 1.02 (0.46; 2.26) | |
| Physical Activity (min/week) | | 0.322 | | 0.242 |
| ≥300 | 1.32 (0.75; 2.30) | | 1.42 (0.78; 2.58) | |
| <300 | 1.0 | | 1.0 | |
| Soft drink consumption (frequency/week)** | | 0.523 | | 0.381 |
| ≥3 | 0.48 (0.12; 1.85) | | 0.47 (0.12; 1.86) | |
| 1-3 | 0.46 (0.12; 1.79) | | 0.48 (0.12; 1.84) | |
| Never | 1.0 | | 1.0 | |
| Pineapple consumption (frequency/week)** | | 0.472 | | 0.241 |
| ≥3 | 0.91 (0.32; 2.61) | | 0.69 (0.22; 2.19) | |
| 1-3 | 0.74 (0.45; 1.22) | | 0.61 (0.32; 1.16) | |
| Never | 1.0 | | 1.0 | |
| Strawberry consumption (frequency/week)** | | 0.473 | | 0.262 |
| ≥3 | 1.18 (0.68; 2.03) | | 1.19 (0.65; 2.19) | |
| 1-3 | 1.34 (0.68; 2.65) | | 1.53 (0.73; 3.19) | |
| Never | 1.0 | | 1.0 | |
| Orange consumption (frequency/week)** | | 0.922 | | 0.753 |
| ≥3 | 1.27 (0.69; 2.32) | | 1.54 (0.89; 2.65) | |
| 1-3 | 1.45 (0.88; 2.35) | | 1.37 (0.64; 2.92) | |
| 0 | 1.0 | | 1.0 | |
| Lime consumption (frequency/week)** | | 0.451 | | 0.486 |
| ≥3 | 0.91 (0.50; 1.64) | | 0.91 (0.52; 1.60) | |
| 1-3 | 1.32 (0.67; 2.60) | | 1.29 (0.60; 2.76) | |
| Never | 1.0 | | 1.0 | |
| Candy consumption (frequency)** | | 0.075 | | 0.048 |
| ≥3 | 1.0 | | 1.0 | |
| 1-3 | 0.78 (0.34; 1.79) | | 0.79 (0.33; 1.92) | |
| Never | 0.48 (0.19; 1.19) | | 0.49 (0.20; 0.98) | |
| Drinking acid beverage before sleeping (frequency/week)** | | 0.288 | | 0.230 |
| ≥3 | 1.02 (0.47; 2.22) | | 1.03 (0.45; 2.34) | |
| 1-3 | 0.66 (0.29; 1.50) | | 0.69 (0.28; 1.69) | |
| Never | 1.0 | | 1.0 | |

| | | | | |
|---|---|---|---|---|
| Dental crowding (arch) | | 0.237 | | - |
| 0 | 1.0 | | - | |
| 1 | 0.87 (0.55; 3.23) | | - | |
| 2 | 0.27 (0.04; 1.84) | | - | |
| Dental Aesthetic Index (DAI) | | 0.597 | | |
| 0 | 1.0 | | - | - |
| 1 | 1.01 (0.19; 1.86) | | - | |
| 2 | 0.61 (0.33; 1.11) | | - | |
| 3 | 1.68 (0.63; 1.84) | | - | |
| Frequency of tooth brushing (times/daily) | | 0.235 | | - |
| 1 | | | | |
| | 1.0 | | - | |
| 2 | 1.54 (0.84; 2.83) | | - | |
| 3 | 1.69 (0.92; 3.04) | | - | |
| | | | | |
| Mouthrinse use (frequency/week) | | 0.680 | | - |
| Never | 1.0 | | - | |
| 1-3 | 1.38 (0.79; 2.39) | | - | |
| ≥3 | 0.89 (0.43; 1.84) | | - | |

**Discussion**

The present study showed that tooth erosion was positively associated with obesity only in children from private schools after controlling for potential confounders. In addition, children attending private schools with tooth erosion consumed significantly more frequently soft drinks and pineapples. In private schools, lower prevalence of tooth erosion in children was associated with dental crowding and frequent use of mouth rinses.

The prevalence of tooth erosion among schoolchildren from private and public schools is not clear in the literature. While some studies showed that children from private schools presented lower prevalence of tooth erosion [19], other found an inverse association [10]. In our study, children from public schools presented higher prevalence of tooth erosion, however, the association with obesity only occurred among schoolchildren from private schools. Socioeconomic context could influence the presence of tooth erosion and obesity, modulating behaviors such as diet or lifestyle habits. In medium- and low-income countries, high prevalence of tooth erosion was presented in children from privileged economic backgrounds [10], whereas, in other studies performed in high-income countries, tooth erosion was commonly found in children with deprived economic situations [7,9]. Obesity has a similar pattern, since in developed countries, the socioeconomic background of children is inversely related to childhood obesity [20], and, in developing countries, children attending private schools had higher prevalence of overweight and obesity than those from public schools [11]. Economic situation is cyclic and the pattern could change. Indeed when the economy increases, the population tends to be more urban and habits changes, generally to a more sedentary status with different eating habits [1]. This fact could be a reasonable explanation for observing the association between tooth erosion and obesity only in private schools.

Higher prevalence of tooth erosion in obese children from private schools could be also related to diet, since children with tooth erosion consumed significantly more soft drinks than those without tooth erosion in private schools. Certain characteristics of some food and drinks could modulate the presence of both conditions. Industrial food usually is salty, fatty, highly sweet and acidic in nature. Tooth erosion presence has been associated with high consumption of industrial

drinks - such as soft drinks, food, candy, or different kind of sauces - in children, as has obesity and overweight [7-9]. Other studies found similar associations, supporting our findings [7-9]. The easy access to carbonated soft drinks in school cafeterias and their low prices have been highlighted to explain the high consumption of soft drinks by children and adolescents [6]. Soft drink intake in children and adolescents had tripled in the last years [21], unlike the consumption of healthy food groups, such as milk and fruit juice, which is decreasing. In Brazil 32.7% of children consumed soft drinks at least 5 times a week [22].

Children with dental crowding in both arches presented significantly lower prevalence of tooth erosion than their counterparts. A previous report showing a similar result suggested that the lack of alignment of teeth could result in saliva pooling around teeth, promoting a protective effect [7]. Crowding may also reduce abrasive forces produced by the tongue after enamel softening.

Limitations of this study should be addressed. The cross-sectional design of the study allowed to observe these findings in one specific moment, without being able to consider the causal and temporal relationship. The reliability of self-reporting dietary habits by schoolchildren is limited, since the possibility of under or over-reporting is real. Unfortunately, there is not a standardized questionnaire to assess acidic diet specific for tooth erosion that could be used in epidemiological surveys [15]. Finally, the refusal rate obtained in our study could have resulted in a sample bias, since non-examined children may present a different profile in relation to the outcome and the independent variables.

Regardless the limitations, this study presented valuable data in terms of a possible interaction between general and oral health. In summary, there was no association between weight status and tooth erosion in the total sample. A positive association was only observed in schoolchildren from private schools, demonstrating a potential influence of socioeconomic position in this relationship.

Finally, our findings could be used not only as a baseline for further investigations, with longitudinal design, but also re-force the importance of public health policies focused in dietary habits. In addition, it's necessary a special training of the dental professionals who treat children and adolescents in their clinical practice to perform an adequate and appropriate clinical diagnosis of erosive tooth wear [23].

## Conclusion

Our findings showed that tooth erosion was not associated with obesity and socioeconomic aspects are related to the outcome. It has been suggested that tooth erosion and obesity may be associated and share common key risk factors, so their treatment should be based on common risk approach.

## Acknowledgments

The authors are grateful to the State secretary of Education, the Municipal Secretary of Education and the Direction of Private Schools, which allowed the study to be performed. The authors would like to thank Brazilian National Council for Scientific and Technological Development (CNPq) for the research grant (process #402350/2008-1 and 579996/2008-5) provided to the Principal Investigator (FFD) and to the CNPq/TWAS (process 83903402087/ 190268/2010-7) for the full-Time Postgraduate Fellowship provided to the first author.

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