

# Scientific Article

## Dental Erosion in a Group of 12- and 16-year-old Brazilian Schoolchildren

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**Abstract:** ***Purpose:** This study's purpose was to assess the prevalence of dental erosion in adolescents and to investigate the association between erosion and sociodemographic characteristics. **Methods:** This study consisted of a single center cluster random sample of 414 adolescents (12 and 16 years old) of both genders from private and public schools in Bauru, São Paulo, Brazil. Two previously calibrated examiners ( $\kappa=0.85$ ) used the O'Brien (1994) index for assessment of dental erosion on the buccal and palatal surfaces of the permanent maxillary incisors and on the occlusal surfaces of the permanent first molars. Data on gender, type of school, and mean family income were collected by a questionnaire completed by the adolescents. Descriptive statistics were applied to the data, and the associations between erosion and sociodemographic variables were investigated by chi-square test ( $P<0.05$ ). **Results:** The prevalence of dental erosion was 20% ( $n=83$ ), with only enamel being involved (score 1). The labial surface was the most affected (16%). There were no significant differences between the presence of erosion and gender, type of school, and mean family income. **Conclusions:** The results indicate that dental erosion restricted to enamel was observed among adolescents in Bauru/Brazil, and there was no correlation between this condition and sociodemographic factors. (Pediatr Dent 2011;33:23-8) Received August 1, 2009 | Last Revision October 13, 2009 | Accepted October 14, 2009*

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Significant alterations have been reported to occur in the oral health of children and adolescents world-wide, probably due to changes in nutritional patterns. In the last years, mainly in developed countries, there was a decrease in the prevalence of dental caries caused by the success of preventive and educative dental programs.<sup>1</sup> Nevertheless, food habits, changes in lifestyles, and other factors associated with modern society have contributed to the growing awareness of professionals and researchers regarding another dental disorder: tooth wear.<sup>2</sup>

Tooth wear is a multifactorial and accumulative process in which erosion, attrition, and abrasion act in combination. This disorder has been recognized as a great oral health problem, although the contribution of erosion has increased significantly, mainly in infancy and adolescence.<sup>3</sup> Dental erosion could be 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.<sup>4</sup>

The dissolution of mineralized, structured teeth occurs due to the contact with acids introduced in the oral cavity from intrinsic and extrinsic sources.<sup>5</sup> Among the intrinsic

causes that act in infancy and adolescence, diseases that cause chronic vomiting and gastroesophageal reflux are the most important.<sup>6</sup> The extrinsic factors include: diet (acidic food and drinks); occupational factors (heavily chlorinated swimming pools); drugs; and lifestyle (habits and socioeconomic status).<sup>7</sup> Also, individual susceptibility factors, such as salivary flow rates and composition and tooth and tissue anatomy, seem to exert a great influence on the development of erosive lesions.<sup>8</sup>

There is some evidence that sociodemographic variables could have an influence on the prevalence of dental erosion, although this is not clearly demonstrated in the literature. Some surveys indicate that dental erosion is more prevalent in subjects having a higher socioeconomic status,<sup>9-12</sup> while others show more erosion in lower socioeconomic groups.<sup>13-19</sup> Some studies did not find any differences, however, between social class and dental erosion in children and adolescents.<sup>20-24</sup>

Research about prevalence, etiology, and pathogenesis of dental erosion have been carried out throughout the world and indicate that erosion has been affecting an increasing number of children and adolescents.<sup>25</sup> When data from epidemiological surveys conducted in several countries are analyzed, the prevalence of dental erosion in adolescents in the permanent dentition shows a wide variation, reaching values from 13 up to 95% in enamel and from 0 up to 26% in dentine.<sup>10,11,15,16,18,19,22-24,26-34</sup>

Studies conducted in adolescents in Brazil regarding the occurrence of dental erosion are scarce,<sup>24,34</sup> and there is no evidence that this alteration is a relevant public health problem,

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Code 0	Normal
Code 1	Enamel only, loss of surface characterization
Code 2	Enamel and dentine, loss of enamel exposing dentine
Code 3	Enamel into pulp, loss of enamel and dentine resulting in pulp exposure
Code 9	Assessment cannot be made

Figure 1. O'Brien index (1994).

such as dental caries. More epidemiological studies are still necessary to evaluate the prevalence of dental erosion in the younger population and to establish preventive and treatment measures. Effective detection, prevention, and early interventions in adolescents are important to avoid complex future dental treatments in adulthood, since tooth wear occurs in an irreversible manner and tends to increase with age.<sup>25</sup>

Thus, the aim of this study was to assess the prevalence and severity of dental erosion in 12- and 16-year-old schoolchildren from Bauru, São Paulo, Brazil. In addition, this prevalence of dental erosion between genders and socioeconomic status was also compared.

## Methods

The ethical approval for this study was given by the Ethics Committee of Bauru Dental School, University of São Paulo, Bauru, São Paulo. Explanatory information letters and consent forms were distributed to parents. Subjects were included in the study if they were 12 or 16-years-old and registered at a public or private school. Additionally, they had to be present on the day of the clinical examination with written consent forms signed by their parents.

An observational cross-sectional study was carried out in Bauru. This city has a population of 347,601, most of whom (98%) live in urban areas. A sample of 414 adolescents (12- and 16-years-old) of both genders, attending 3 public and 3 private schools participated in this survey.

The sample size calculation was based on a 10% prevalence of dental erosion among 12- and 16-year-old children found in a previous pilot study, because Brazilian data were scarce at the time the study was designed. The standard error was set at 3%, and 20% was added to the minimum sample size obtained. Thus, a sample of at least 400 subjects was calculated to achieve a 95% confidence interval.

For the dental examination, 2 examiners previously calibrated ( $\kappa=0.85$ ) made the clinical evaluation of the presence of dental erosion at a school room, and the adolescents were clinically examined in a school chair, facing the light source. The relevant tooth surfaces were dried and cleaned with sterilized gauze to remove gross debris. Strict cross-infection control measures were applied.

The prevalence of dental erosion was assessed using a previously validated index proposed by O'Brien<sup>26</sup> and described in Figure 1. The clinical exam included the evaluation

of the buccal and palatal surfaces of the permanent maxillary incisors and the occlusal surfaces of the permanent first molars. For the visualization of the palatal and occlusal surfaces, a no. 5 plane surface mirror was used. Data were recorded by a trained assistant. Teeth with large restorations, extensive caries, fractures, and/or hypoplasia were not evaluated, and code no. 9 was applied. Individuals wearing fixed orthodontic appliances were excluded from the sample.

The sociodemographic data were collected by means of a questionnaire completed by the adolescents, which included questions about age, gender, type of school, and mean family income. Type of school refers to the differentiation of students enrolled

in public and private schools. In Brazil, private schools require the payment of fees, while public schools are maintained by the government and are free of charge. Consequently, children attending private schools are expected to have a higher socioeconomic status than those enrolled in public schools. The family income was categorized using Brazilian Institute of Geography and Statistics criteria.<sup>35</sup> The following categories were included: less than 1 legal minimum wage; from 1 to 3 legal minimum wages; and more than 4 legal minimum wages. The legal minimum wage during the study was approximately \$200 (US) per month.

To assess reproducibility of the diagnostic criteria application, the intra- and interexaminer calibration was performed. An intraexaminer test was conducted by re-examining 50 randomly selected subjects 10 days after the first examination. In this case, the examiner was blinded to the previous erosion score. The interexaminer test was performed during the pilot study. The level of both intra- and interexaminer agreement was measured using Cohen's kappa statistics.

The data were entered into a personal computer using Statistic for Windows 5.1 (Stat Soft Inc, Tulsa, Okla). Descriptive and analytical approaches were used for data analysis. Differences in the prevalence of dental erosion, according to gender, type of school, and family income, were tested in terms of frequencies using the nonparametric chi-square test. The level of significance was set at 5%.

## Results

Written consents were obtained from 518 of 750 pupils (69% response rate). Of these, 37 were absent from school on the day of the examination and 67 wore orthodontic appliances and were excluded from the sample. Therefore, a total of 414 children were examined and represented the final study sample. Of these, 196 (47%) were boys and 218 (53%) were girls; 262 (63%) were 12-years-old, and 152 (37%) were 16-years-old. In relation to the type of school, 372 (90%) subjects attended a public school, while 42 (10%) attended private schools. Most subjects had a mean family income of 1 to 3 legal minimum wages (62%), while 35% had more than 4 minimum wages and only 4% has less than 1 minimum wage.

Intra- and interexaminer reproducibility data yielded a weighted kappa statistic value higher than 0.85, which indicates a high level of agreement.

Of the 414 adolescents examined, 331 (80%) did not exhibit any clinical signs of dental erosion and 83 (20%) showed erosion in at least 1 dental surface. In all the examined eroded surfaces, only enamel was affected. There was no evidence of erosion in dentine (score 2) and exposing pulp (score 3).

Table 1 shows the prevalence of dental erosion according to age and gender. Forty-one (21%) boys and 42 (19%) girls had dental erosion. There was no significant difference between gender and dental erosion. Dental erosion was more prevalent at the age of 16, with 24% of adolescents showing signs of dental erosion vs 18% among 12-year-olds. This difference, however, was not statistically significant.

Analysis according to the affected surface is given in Table 2. Dental erosion was more frequent in the buccal surface of the maxillary incisors (16%), followed by the palatal

**Table 1. PREVALENCE OF DENTAL EROSION IN 12- AND 16-YEAR-OLD SCHOOLCHILDREN ACCORDING TO GENDER AND AGE IN BAURU, SÃO PAULO, BRAZIL, IN 2008**

Erosion variable	Erosion absent N (%)	Erosion present N (%)	Total N (%)	P-value
<b>Gender</b>				
Male	154 (79)	41 (21)	195 (100)	>.67
Female	175 (81)	42 (19)	217 (100)	
<b>Age (ys)</b>				
12	213 (82)	47 (18)	260 (100)	.17
16	116 (76)	36 (24)	152 (100)	

**Table 2. PREVALENCE OF DENTAL EROSION IN 12- AND 16-YEAR-OLD SCHOOLCHILDREN ACCORDING TO THE SURFACE AFFECTED IN BAURU, SÃO PAULO, BRAZIL, IN 2008**

Erosion variable	Erosion absent N (%)	Erosion present N (%)	Total N (%)
Buccal	343 (84)	66 (16)	409 (100)
Palatal	363 (89)	47 (12)	410 (100)
Occlusal	381 (99)	5 (1)	386 (100)

**Table 3. PREVALENCE OF DENTAL EROSION IN 12- AND 16-YEAR-OLD SCHOOLCHILDREN ACCORDING TO MEAN FAMILY INCOME AND TYPE OF SCHOOL IN BAURU, SÃO PAULO, BRAZIL, IN 2008**

Erosion variable	Erosion absent N (%)	Erosion present N (%)	Total N (%)	P-value
<b>Mean family income (min wage)</b>				
<1	13 (87)	2 (13)	15 (100)	>.45
1-3	199 (81)	48 (19)	247 (100)	
>4	108 (78)	30 (22)	138 (100)	
<b>School type</b>				
Public	296 (80)	74 (20)	370 (100)	<.83
Private	33 (79)	9 (21)	42 (100)	

surface of the maxillary incisors (12%) and by the occlusal surface of the permanent first molars (1%).

The prevalence of dental erosion rose as family income increased. Dental erosion was more prevalent in subjects whose families received more than 4 minimum wages, followed by 1 to 3 minimum wages and less than 1 minimum wage. A higher proportion of private school students had erosion (21%) vs public school students (20%). Despite these differences, however, the univariate analysis did not show any statistically significant association between the experience of erosion and family income or type of school (Table 3).

## Discussion

The sampling procedure used was designed to provide a group that was representative of 12- and 16-year-old adolescents in the city. The differences in the number of signed, informed consents obtained, with fewer subjects in private schools returning their forms, suggest an element of bias. Nevertheless, the group included adolescents from a great spectrum of social classes.

Although tooth wear is a cumulative and multifactorial process in which erosion, attrition, and abrasion could act synergistically, in infancy and adolescence erosion is considered the major contributing factor.<sup>16,22</sup> To overcome some of the difficulty in distinguishing erosion from abrasion and attrition, measurement was confined to the buccal and palatal surfaces of the maxillary incisors and to the occlusal surfaces of the first molars. Ganss reported that the shallow defects on smooth surfaces localized coronally from the enamel cementum junction could be diagnosed as a pathognomonic sign of dental erosion.<sup>36</sup> The diagnostic criteria on incisal and occlusal surfaces, however, is more difficult to achieve.<sup>37</sup>

The incisal surfaces were excluded for the dental exam, since they are more susceptible to attrition rather than erosion, which is similar to many surveys conducted on young people.<sup>9,12,14-17,21,22,24,26-28</sup> In the occlusal surfaces, erosion could be distinguished from attrition, which is characterized by well-demarcated wear facets observed in the cusps tips in opposing surfaces. Therefore, attrition was not included in the analysis.<sup>38</sup> The main characteristic of erosion in the occlusal surface is rounding and cupping of the cusps and restorations rising above the level of the adjacent tooth surfaces.<sup>38</sup> Much more difficult is the distinction between occlusal erosion and abrasion, because of the similar shape.<sup>39</sup>

Abrasion is not a common feature in children and adolescents, however, since the physical wear due to tooth-brushing is a very slow process and its occurrence becomes more evident with increasing age.<sup>40</sup> Therefore, the presence of cupping on the occlusal surfaces in young people is indicative of dental erosion.<sup>36</sup>

Measuring dental erosion is difficult, and no single index has been universally accepted. The index used in the present study was previously validated in the National Child and Health Survey and has been applied in many epidemiological surveys in children and adolescents.<sup>12,14,15,20,22,24,27,28,32</sup> Therefore, this study's findings could be compared with those of previous studies.

Investigating erosion by sampling 12- and 16-year-old children was selected for several reasons. First, at the age of 12, the incisors and permanent first molars are present in the oral cavity for at least 5 years and probably have been exposed to etiologic factors for dental erosion.<sup>16</sup> Additionally, most surveys have used this age as a reference, making it easier to compare the results with the literature.<sup>19,22,23,26,32,34</sup> Secondly, 16-years-old was selected for the analysis, since dental erosion increases with increasing age, and it is possible to compare the prevalence of erosion in 2 different age ranges.

The prevalence of dental erosion in this study among 12- and 16-year-olds was 20% in the permanent dentition. When comparing with studies conducted in Brazil, this prevalence is higher than that reported by Peres et al<sup>34</sup> in 12-year-old subjects (13%) and less than that obtained by Auad et al<sup>24</sup> in adolescents between 13 and 14 years (34%). Auad et al<sup>24</sup> used the same criteria applied in this study, while Peres et al<sup>34</sup> applied the O'Sullivan index. Also, Sales-Peres et al<sup>41</sup> found a prevalence of 27% among 12-year-olds in Bauru, but they evaluated tooth wear in general and not dental erosion in particular.

The prevalence of dental erosion found in this study in the permanent dentition is similar to the results obtained in surveys carried out in different countries, like the United Kingdom,<sup>26,27</sup> Cuba,<sup>29</sup> Iceland,<sup>31</sup> Turkey,<sup>33</sup> Netherlands<sup>23</sup> and Australia.<sup>18</sup> Higher prevalence values were described in surveys of 11- and 14-year-olds in the United Kingdom,<sup>11,13,16,42</sup> although these authors evaluated all types of tooth wear, including erosion, attrition, and abrasion. Ganss et al<sup>37</sup> found lower prevalence scores, but they evaluated erosion from study models, and with this method, it is difficult to detect erosion in early stages. This discrepancy observed in the prevalence of dental erosion among the different studies can be justified by the differences in diagnostic criteria, indices, and sample population. In addition, the frequency and clinical appearance of tooth wear presents a wide variance among populations, probably due to the influence of educational, cultural, nutritional, and geographical factors in each studied population.<sup>43</sup>

The prevalence of dental erosion was numerically higher among 16-year-olds (24%) vs 12-year-olds (18%). A similar trend was observed in longitudinal surveys in adolescents,<sup>19,37,44</sup> in which the progression and severity of dental erosion increased in the same subject with time. It should be emphasized, however, that the present study provides cross-sectional data and no real inferences can be drawn as to the true incidence of dental erosion.

All erosion lesions found in this study were confined to enamel. This fact can be attributed to the low intensity of the risk factors and to the relatively low contact time with the etiologic factors. This agrees with the findings of most studies on adolescents,<sup>10,15,19,22-24,26-29,32-34</sup> in which lesions involving dentine are rarely found. In studies where all the surfaces and types of tooth wear were evaluated, however, the wear in dentine was very high in young people, varying from 30% to 53%.<sup>11,13,16</sup>

Regarding the site of erosion, buccal surfaces were most commonly affected by dental erosion (16%), agreeing with

reports from other studies,<sup>16,22,27,28,30,34</sup> while other research groups found that palatal<sup>9,15,24,26,32</sup> or occlusal<sup>10,13,23</sup> surfaces were the most involved. The location of the buccal surface predisposes it to erosion caused by acids from diet,<sup>45</sup> which is considered the main etiologic factor in infancy and adolescence. The erosion in the palatal surface of the maxillary incisors was found in 12% of the present sample.

It has been suggested that palatal erosion is frequently associated with diseases that cause vomit and regurgitation, due to the direct effect of gastric acid in this region.<sup>45</sup> In addition, the abrasive effect of the tongue on demineralized enamel during speech and deglutition could contribute to the higher loss of dental tissue in this area.<sup>46</sup> Also, the protective effect of saliva in anterior maxillary teeth is decreased, since the thickness of salivary pellicle is lower in this location.<sup>47</sup> Jarvinen et al,<sup>48</sup> however, reported that the location of the lesions does not indicate if the cause is extrinsic or intrinsic, because the action and movement of the soft tissues could affect the distribution of the lesions.

In this study, the erosion on the occlusal surface was a rare finding, comprising only approximately 1% of the sample, similar to the findings reported by Auad et al<sup>24</sup> in Brazilian adolescents. This is probably due to the fact that the initial signs of dental hard tissue loss on the occlusal surface are difficult to detect and are frequently confounded with attrition and abrasion. Moreover, the presence of large restorations, fissure sealants, or dental caries in the permanent first molars was a very common finding in the present sample, and these teeth could not be recorded for erosion.

In the present study, the experience of dental erosion was similar between genders, which confirms the findings of several authors,<sup>12,15,18,24,28,33,34,42</sup> although others have found a significantly higher prevalence of dental erosion in males vs females.<sup>11,13,16,19,22,23,31</sup> Only in the study by Kunzel et al<sup>29</sup> in Cuba were more erosive lesions observed in girls due to their habit of consuming citric fruits.

Socioeconomic status can affect the occurrence of erosion, since differences in dietary habits and hygiene practices between distinct social classes exist. Indicators of social class in the present study included school type and family income. In Brazil, children who study in private schools generally come from families with high socioeconomic status, since public schools are free of charge. Therefore, the type of school could give an indication of the socioeconomic status of the subject. In this study, no significant differences were found in the prevalence of erosion between adolescents from public or private schools, similar to the findings by Auad et al<sup>24</sup> in southeast Brazil. By contrast, Peres et al<sup>34</sup> showed more erosion in adolescents attending private schools in a city in south Brazil.

Previous studies have reported inconsistent findings in the relationship between erosion and social factors. Our results showed that family income is not related to dental erosion, which agrees with some studies that reported no association between socioeconomic status and dental erosion.<sup>20-24</sup> Some surveys have found more erosion lesions in high socioeconomic groups,<sup>9-12</sup> while other studies have found an inverse relationship (ie, children from a relatively lower social

background demonstrated a higher risk of developing dental erosion).<sup>13-19</sup> These contradictory results could be justified by the fact that the investigation of socioeconomic status/deprivation was made through different indices and indicators, which could interfere in the results.

The prevalence of 20% of adolescents with clinical signs of dental erosion in enamel indicates that many risk factors are present in the population evaluated. Thus, if preventive and control measures are not implemented, the progression of erosion will occur in adulthood and may cause irreversible consequences for oral health. Other cross-sectional epidemiological and longitudinal surveys are necessary to evaluate the prevalence and severity of dental erosion in infancy and adolescence and to clarify whether erosion is a public health problem.

## Conclusions

1. Considering the studied sample of 12- and 16-year-old Brazilian schoolchildren, 20% had dental erosion with only the enamel affected.
2. There was no clear relationship between erosion and social deprivation, which indicates that erosion is found regardless of socioeconomic status.

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