# Dental Erosion Among Children in an Istanbul Public School

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## ABSTRACT

The aim of this study was to evaluate the prevalence, clinical manifestations, and etiology of dental erosion among children. A total of 153 healthy, 11-year-old children were sampled from a downtown public school in Istanbul, Turkey comprised of middle-class children. Data were obtained via: (1) clinical examination; (2) questionnaire; and (3) standardized data records. A new dental erosion index for children designed by O'Sullivan (2000) was used. Twenty-eight percent (N=43) of the children exhibited dental erosion. Of children who consumed orange juice, 32% showed erosion, while 40% who consumed carbonated beverages showed erosion. Of children who consumed fruit yogurt, 36% showed erosion. Of children who swam professionally in swimming pools, 60% showed erosion. Multiple regression analysis revealed no relationship between dental erosion and related erosive sources ($P>.05$). (J Dent Child 2005;72:5-9)

KEYWORDS: DENTAL EROSION PREVALENCE, FRUIT YOGURT, ISTANBUL, ORANGE JUICE, SWIMMING

Dental hard tissue loss is caused by a number of factors, including dental caries, trauma, and, increasingly, tooth wear—which can occur by abrasion, attrition, and erosion.[1,2] Dental erosion is defined as a loss of dental hard tissue caused by acid and, in contrast to caries, without bacterial involvement. Erosion may be caused by intrinsic as well as by extrinsic factors.[3] The intrinsic factors for dental erosion include vomiting, regurgitation, gastroesophageal reflux, or rumination.[4,5] The extrinsic factors for dental erosion in childhood are related to acids of dietary or medicinal origins and also to behavioral factors.

The consumption of soft drinks such as acidic fruit juices, artificially sweetened fruit drinks, and carbonated beverages are the risk factors most significantly related to this dental hard tissue defect.[6-10] Lifestyle and behavior differences must also be considered important in the etiology of dental erosion.[11] Epidemiological studies have shown that the prevalence of dental erosion in children varies widely between 2% and 57%.[12-15]

As a candidate for the European Union, Turkey has undergone especially rapid development, with commensurate changes in lifestyle and diet. These changes are likely to cause substantial increases in the sale and consumption of acidic products, which could have an effect on children's oral health. This study's objective was to evaluate the prevalence, clinical manifestations, and etiology of extrinsic dental erosion in a sample of 11-year-old Istanbul schoolchildren.

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## METHODS

### SAMPLE

The ethical clearance for this study was obtained from the Pediatric Dentistry Department Review Board of Marmara University Dental School, Istanbul, Turkey. The school was selected because of its established caries-preventive history and because it was representative of middle-class Istanbul children. The district's drinking water fluoride level was stated as <0.05 mg/l.[16]

A total of 153 healthy 11-year-old schoolchildren (75 boys and 78 girls) were randomly sampled. Written informed consent was obtained from the parents. Children were asked to brush their teeth prior to examination for better oral monitoring. Oral examinations were carried out by 1 examiner in well-lit classrooms using a mirror and probe. Following the clinical examination, children completed an extensive questionnaire with the examiner and their parents (Table 1).

### CLASSIFICATION

The dental literature provides useful clinical indices for the epidemiological recording of dental erosion.[6,10,14,17,18] These indices seemed inadequate for the present study.

**Table 1. Questionnaire**

| | | | | |
|---|---|---|---|---|
| A. Medical history (asthma, gastric diseases, etc), drugs used | | | | |
| B. Dental history (caries, orthodontic treatments, etc) | | | | |
| C. Frequency of brushing habit | | | | |
| D. Consumed beverages per day, indicated by number of glasses | | | | |
| Water | Buttermilk | Fruit juice | Iced tea | Nesquik |
| Fresh orange juice | Tea | Coca-Cola | Pop soda | Milk |
| Tang | Cappy | Fanta | Sprite | Seven up |
| Other | | | | |
| E. Time of consuming the aforementioned beverages | | | | |
| At meal | Between meals | Before bed | Irregular | |
| F. Consumed fruit per day | | | | |
| Orange | Melon | Grapefruit | Pear | |
| Strawberry | Lemon | Banana | Peach | |
| Grapes | Kiwi | Apple | Other | |
| G. Consumed fruit yogurt per week by cups | | | | |
| H. Type of consumption | | | | |
| Oral | Oral | Unusual drinking | Straw | Other |
| Slowly | Quickly | | | |
| I. Swimming in the pool | | | | |
| Regularly | | | Irregularly | |
| Professionally—summer school | Professionally—all year | | (only in summer holiday, less than a month) | |
| Since last year | More than a year | | | |

A new, reproducible index for the measurement of erosion in children designed by O'Sullivan was used.[19] This index scores: (1) tooth surfaces affected (codes A to F); (2) dental erosion severity (codes 0 to 9); and (3) surface area affected (code +,-). The following grades of progression were employed:

1. erosion site on each tooth:
   a. code A=labial or buccal only;
   b. code B=lingual or palatal only;
   c. code C=occlusal or incisal only;
   d. code D-labial and incisal/occlusal;
   e. code E=lingual and incisal/occlusal;
   f. code F=multisurface.
2. grade of severity (worst score for an individual tooth recorded):
   a. code 0=normal enamel;
   b. code 1=matte appearance of the enamel surface with no loss of contour;
   c. code 2=loss of enamel only (loss of surface contour);
   d. code 3=loss of enamel with exposure of dentine (dentinoenamel junction visible);
   e. code 4=loss of enamel and dentine beyond dentinoenamel junction;
   f. code 5=loss of enamel and dentine with exposure of the pulp;
   g. code 9=unable to assess (eg, tooth crowned or large restoration).
3. surface area affected by erosion:
   a. code + = less than half of surface affected;
   b. code - = more than half of surface affected.

For the purpose of differential diagnosis, all detectable disorders of the dental hard tissue were recorded. These included:

1. developmental defects of enamel[20-21];
2. dental fluorosis community index $F_{ci}$ (the fluorosis index described by Dean using natural light; the teeth were examined moist)[21-22]; and
3. posteruptive disturbances of dental hard tissue, such as coronal damage from injury, or facets on incisal and occlusal surfaces of teeth resulting from attrition.

### QUESTIONNAIRE

A questionnaire was prepared to elicit the following types of information:

1. personal demographic details;
2. dental and medical history;
3. brushing frequency;
4. habits of consuming beverages, fruits, ice cream, and fruit flavored yogurt;
5. time and type of consumption;
6. swimming habits.

### DATA ANALYSIS

All data were entered onto a computer using SPSS 10.0 for Windows statistical program. The association between dental erosion and factors was determined using a chi-square test. Besides the univariate analysis, multivariate regression analysis was performed. Statistical significance was established at the 5% level.

## RESULTS

There was no significant difference between girls (32%) and boys (24%) regarding the prevalence of dental erosion ($P>.05$; Table 2). Eighty-five permanent teeth were scored as (A2-), (B1-), (C2+), (F2-), (F3+). The highest frequent code was (C2+), and the most severe erosion coded was (F3+; Table 3).

Eighty-six children consumed a mean of 1.76±1.47 cups of acidic beverages per day; 38 consumed 1 cup of fresh orange juice daily, and 13 of these children showed erosion; 12 consumed 2 cups of fresh orange juice daily, 3 of whom showed erosion ($P=.09$); and 36 consumed other acidulated beverages (carbonated beverages) per day.

Of the latter 36 children; 15 consumed 1 cup of carbonated beverages—9 of whom showed erosion; and 17 consumed 2 cups of carbonated beverages, 4 of whom showed erosion ($P=0.5$).

**Table 2. Dental Erosion Prevalence Among Children With and Without Dental Erosion According to Gender**

| | | Dental erosion |
|---|---|---|
| Gender | | N |
| Male | Without | 47 (76%) |
| | With | 18* (24%) |
| Female | Without | 53 (68%) |
| | With | 25* (32%) |
| Total | Without | 110* (72%) |
| | With | 43* (28%) |

**P>.05 (chi-square test).*

**Table 3. Distribution of Permanent Teeth Showing Dental Erosion (N=85)**

| Erosive source | Dental erosion index | | | | |
|---|---|---|---|---|---|
| | (A2-) | (B1-) | (C2+) | (F2-) | (F3+) |
| Orange juice (1 cup/day) | 5 | 0 | 11 | 5 | 3 |
| Orange juice (2 cups/day) | 2 | 2 | 3 | 3 | 0 |
| Carbonated beverages (1 cup/day) | 1 | 0 | 9 | 2 | 3 |
| Carbonated beverages (2 cups/day) | 2 | 4 | 0 | 1 | 0 |
| Carbonated beverages (4 cups/day) | 0 | 0 | 0 | 3 | 0 |
| Fruit yogurt (1 cup/week) | 2 | 0 | 3 | 0 | 0 |
| Fruit yogurt (2 cups/week) | 0 | 0 | 0 | 0 | 3 |
| Fruit yogurt (6 cups/week) | 0 | 2 | 0 | 0 | 4 |
| Swimming (summer) | 2 | 2 | 6 | 2 | 4 |
| Swimming (all year) | 0 | 0 | 4 | 0 | 3 |

Twenty-two children consumed a mean of 2.68±2.07 cups of fruit yogurt per week, 8 of whom showed erosion ($P$=.2). Prevalence of dental erosion in relation to consumption of fruits and ice cream was stated as negligible ($P$>.05). Four of the 9 children who used straws showed erosion.

Twenty-five children swam professionally in the summer in chlorinated swimming pools, and 15 of them showed erosion ($P$=.3). Five of these children swam year round in chlorinated swimming pools, 3 of whom showed erosion.

## DISCUSSION

A wide-ranging prevalence of dental erosion has been reported in both primary and permanent dentitions. This may be due to the relatively small number of subjects in the majority of studies and the use of different criteria for diagnosis.[3] The erosion index described by O'Sullivan[19] was designed to be more appropriate for use in children where pattern and progression of tooth tissue loss may be different from adults. Turkey has a young population of 20 million children aged 0 to 14 years old.[23] Sales management techniques and advertisements, therefore, are mostly established regarding the dietary habits of children.

Consumption of acidic foods and beverages has been shown to contribute to dental erosion.[6] In the present study, 28% of 11-year-old children showed erosion. A nationwide study in the United Kingdom found that dental erosion occurred in 25% of 11-year-old children on the palatal and vestibular surfaces of upper incisors.[12] Dental erosion has been reported at an incidence of 17% in a total of 1,010 Cuban children.[9] In Saudi Arabia, 31% of 2- to 5-year-old boys[24] and 26% of 12- to 14-year-old boys showed signs of dental erosion.[25]

When judging erosion frequency, one has to distinguish between erosive effects and other types of damage to dental hard tissue, attrition, incisal and coronal fractures, and toothbrush abrasion. In the present study, 3 cases of incisal fractures of enamel and dentin were recorded while hypoplasias were not observed.

According to the data collected from the children, 4 sources emerged in relation to dental erosion: (1) fresh orange juice consumption; (2) carbonated beverage consumption; (3) fruit yogurt consumption; and (4) swimming. Consumption of other fruit juices, fruits, and ice cream was rather negligible. It has been reported before that orange juice and carbonated beverages were important etiological factors of dental erosion.[26-28] It is clear that orange juice has obvious health and nutritional benefits for growing children. The deleterious effects of orange juice on the population's oral health will only be overcome when dentists and the population are thoroughly acquainted with and informed about the risks involved.[12]

In the present study, 32% of children who consumed orange juice showed erosion while 40% of children who consumed carbonated beverages showed erosion. Linnett and Seow[3] found that orange juice caused less erosion than carbonated cola beverages. Mathew et al[24] had similar findings regarding erosive effects of fruit juices and carbonated drinks.

In the present study, no relationship between the consumption of orange juice, carbonated beverages and dental erosion was found. It should be noted, however, that mouthrinsing should be recommended after consuming any acidic drink. Of children who consumed fruit yogurt, 36% showed dental erosion. It has been shown, however, that milk products do not cause demineralization because of their high calcium and phosphate content, although this is also dependent on the product's pH value.[29-32] In the present study, univariate and multivariate regression analysis showed that consuming fruit yogurt was not associated with the occurrence of erosion.

Improper monitoring of pH in gas chlorinated swimming pools has been reported to be the cause of dental erosion in competitive swimmers.[33] Centerwall et al[34] showed that, despite daily pH measurements, the pool water's pH had, at times, been allowed to drop to as low as 2.7. Milosevic et al[35] found the prevalence of dentinal erosion to be 36% in swimmers. In the present study, 60% of children who swam professionally in chlorinated swimming pools, both in summer school and all throughout the year, showed dental erosion.

This section will address biological and behavioral factors that must also be considered important in the etiology of dental erosion. It makes sense that a diet composed of foods or beverages with a low pH value would have erosive effects on human teeth. pH alone, however, is not a good indicator of any substance's erosive potential. Buffering capacity, fluoride, calcium, and phosphate content play a biological role in the process of erosion. Unusual drinking, eating, and swallowing habits, which increase the direct contact time of acidic foods and beverages with the teeth, are considered to be behavioral factors that increase the risk of dental erosion.[36] Time of consumption (such as bedtime) has also been implicated.[37,38] Direct contact time of erosive sources might be limited by use of a straw. In the present study, however, 44% of children who used straws showed erosion. Several case reports indicating that unusual methods of drinking fruit juice with a straw caused marked erosion of the anterior teeth.[39]

It is important to learn more about the etiology of erosion lesions before they can be accurately diagnosed, confidently treated, and, more importantly, prevented. Early diagnosis of the process and adequate preventive measures are, therefore, important. Personal interviews may give better information about dietary habits. Preventive advice to children, teenagers, parents, and health care providers should include a warning about the dangers of erosive sources to the teeth.

## CONCLUSIONS

In the present study—using erosion as the dependent variable and carbonated beverages, fruits, fruit juices, ice cream, fruit yogurts, and swimming as independent factors—analysis revealed no statistically significant association between dental erosion and related erosive sources.

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## REFERENCES

1. Nunn JH. Prevalence of dental erosion and the implications for oral health. Eur J Oral Sci 1996; 104:156-161.
2. Imfeld T. Dental erosion. Definition, classification, and links. Eur J Oral Sci 1996;104:151-155.
3. Linnett V, Seow WK. Dental erosion in children: A literature review. Pediatr Dent 2001;23:37-43.
4. Aine L, Maki M, Collin P, Keyrilainen O. Dental enamel defects in celiac disease. J Oral Pathol Med 1990;19: 241-245.
5. Meurman HJ, Ten Cate JM. Pathogenesis and modifying factors of dental erosion. Eur J Oral Sci 1996;104:199-206.
6. Lussi A. Dental erosion: Clinical diagnosis and case history taking. Eur J Oral Sci 1996;104:191-198.
7. Scheutzel P. Etiology of dental erosion: Intrinsic factors. Eur J Oral Sci 1996;104:178-190.
8. Grenby TH. Lessening dental erosive potential by product modification. Eur J Oral Sci 1996;104:221-228.
9. Künzel W, Cruz MS, Fischer T. Dental erosion in Cuban children associated with excessive consumption of oranges. Eur J Oral Sci 2000;108:104-109.
10. Zero DT. Etiology of dental erosion: Extrinsic factors. Eur J Oral Sci 1996;104:162-177.
11. Guertsen W. Rapid general dental erosion by gas-chlorinated swimming pool water: Review of the literature and case report. Am J Dent 2000;13:291-293.
12. O'Brien M. Children's dental health in the United Kingdom 1983. London: HMSO, Office of Population Censuses and Surveys; 1994.
13. Bartlett DW, Coward PY, Nikkah C, Wilson RF. The prevalence of tooth wear in a cluster sample of adolescent schoolchildren and its relationship with potential explanatory factors. Br Dent J 1998;184:125-129.
14. Milosevic A, Young P, Lennon M. The prevalence of tooth wear in 14-year-old schoolchildren in Liverpool. Community Dent Health 1993;11:83-86.
15. Eccles JD. Dental erosion of nonindustrial origin: A clinical survey and classification. J Prosthet Dent 1979; 42:649-653.
16. Turkish Ministry of Health. Water fluoride map of Turkey. Ankara: Ministry Press; 2003:201.
17. Smith BGN, Knight JK. An index for measuring the wear of teeth. Br Dent J 1984;156:435-438.
18. Mannenberg F. Appearance of tooth surfaces as observed in shadowed replicas, in various age groups, in long term studies, after toothbrushing, in cases of erosion, and after exposure to citrus fruit juice. Odontol Revy 1960;11(suppl 6):1-116.
19. O'Sullivan EA. A new index for the measurement of erosion in children. Eur J Paediat 2000;1:69-74.
20. *Oral Health Surveys. Basic Methods*. Geneva: World Health Organization; 1971, 1977, 1987.
21. Dean AT. Classification of mottled enamel diagnosis. J Am Dent Assoc 1934;21:1421-1426.
22. Galagan EJ, Lamson CG. Climate and endemic dental fluorosis. Public Health Rep 1953;68:497-508.
23. *World Population Prospects. The 2000 Revision and World Urbanization Prospects.* New York: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat; 2001.
24. Al-Malik MI, Holt RD, Bedi R. The relationship between erosion, caries, and rampant caries and dietary habits in preschool children in Saudi Arabia. Int J Paediat Dent 2001;11:430-439.
25. Al-Majed, Maguire A, Murray JJ. Risk factors for dental erosion in 5- to 6-year-old and 12- to 14-year-old boys in Saudi Arabia. Community Dent Oral Epidemiol 2002;30:38-46.
26. Rugg-Gunn AJ, Maguire A, Gordon PH, McCabe JF, Stephenson G. Comparison of erosions of dental enamel by four drinks using an intra-oral appliance. Caries Res 1998;32:337-343.

27. Lussi A, Schaffner M, Hotz P, Suter P. Dental erosion in a population of Swiss adults. Community Dent Oral Epidemiol 1991;19:286-290.
28. Mathew T, Casamassimo PS, Hayes JR. Relationship between sports drinks and dental erosion in 304 university athletes in Columbus, Ohio. Caries Res 2002; 36:281-287.
29. Lussi A, Jaeggi T, Scharer S. The influence of different factors on in vitro enamel erosion. Caries Res 1993;27:387-393.
30. Rytomam I, Meurman JH, Koskinen J, Laakso T, Gharazi L, Turunen R. In vitro erosion of bovine enamel caused by acidic drinks and foodstuffs. Scand J Dent Res 1988;96:324-333.
31. Lussi A, Kohler N, Zero D, Schnaffer M, Megert B. A comparison of the erosive potential of different beverages in primary and permanent teeth using an in vitro model. Eur J Oral Sci 2000;108:110-114.
32. Kargul B, Caglar E, Tanboga I, Reich ME. A new animal model: In vitro erosion of minipig enamel caused by fruit yogurt. J OHDMBSC 2003;2:8-12.
33. Savad EN. Enamel erosion multiple cases with a common cause. N J Dent Assoc 1982;53:32-37.
34. Centerwall BS, Armstrong CW, Funkhouser GS, Elzay RP. Erosion of dental enamel among competitive swimmers at a gas-chlorinated swimming pool. Am J Epidemiol 1986;123:641-647.
35. Milosevic A, Kelly MJ, McLean AN. Sports supplement drinks and dental health in competitive swimmers and cyclists. Br Dent J 1997;182:303-308.
36. Lussi A, Hellwig E. Erosive potential of oral care products. Caries Res 2001;35(suppl 1):52-56.
37. Millward A, Shaw L, Smith AJ, Rippin JW, Harrington E. The distribution and severity of tooth wear and the relationship between erosion and dietary constituents in a group of children. Int J Paediat Dent 1994;4:152-157.
38. Smith AJ, Shaw L. Baby fruit juice and tooth erosion. Br Dent J 1987;162:65-67.
39. Mackie IC, Hobson P. Case reports: Dental erosion associated with unusual drinking habits in childhood. Pediat Dent 1986;2:89-94.