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# Dental erosion in Icelandic teenagers in relation to dietary and lifestyle factors

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High consumption of fruit juices and carbonated drinks has been related to dental erosion. Teenage male Icelanders consume about 800 ml of carbonated drinks per day on average and this corresponds with the main age group and gender of patients seen with erosion. This study examined the prevalence of dental erosion in 15-year-old children in Reykjavik and looked at the association between erosion and some lifestyle factors in a case-control study drawn from the same sample. A 20% sample of the 15-year-cohort population ( $n = 278$ ) was selected. Dental erosion was classified by location and severity (1 = enamel erosion; 2 = dentine erosion; 3 = severe dentine erosion) and was seen in 21.6% of subjects (68.3% male; 72% scored as grade 1; 23% grade 2; 5% grade 3). Control subjects were the first healthy subjects examined after a case subject had been diagnosed. In the case-control study, information was gathered by multiple-choice questionnaire on symptoms of gastric reflux, tooth sensitivity, some lifestyle and dietary factors. Several lifestyle and dietary factors, previously shown to be significantly related to dental caries in Icelandic teenagers, showed no significant relationship to tooth erosion. Although dietary factors are probably important in causing erosion, dietary recall questionnaires did not help in discovering individuals likely to develop erosion. □ *Behavioral factors; dental erosion; diet; Iceland*

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Dental erosion has been defined as the irreversible loss of dental hard tissue caused by a chemical process that does not involve bacteria (1, 2). Acids are the main cause of tooth erosion, with gastric and dietary acids being most implicated, although acid from certain industrial environments may also play a part in causing erosion (3). Erosion may be regarded as a distinct form of tooth wear with a chemical etiology, but many cases also involve a frictional component, such as abrasion or attrition.

Anecdotal evidence in Iceland suggests that erosion of tooth enamel is prevalent (4) especially among young people with otherwise reasonably good oral health (DMFS = 5.1) (5). It is known from a national dietary survey of teenagers (6) that males aged 15–19 years consume on average 800 ml of carbonated drinks per day, this rising to over 1 L of acidic drink per day when fruit juices are also considered.

A study of gastric reflux among patients with tooth erosion carried out by Gudmundsson et al. (7) failed to show reflux of gastric acid up into the mouth among many patients with proven gastric reflux problems and dental erosion. It was found, however, that 58% of patients with dental erosion had a low salivary buffering capacity compared with only 20% of controls. There was a clear implication from this study that dental erosion among young people in Iceland was largely a result of excess consumption of acidic soft drinks, and was more pronounced in subjects who in addition had a low salivary buffer capacity. Previous studies on dental caries among preschool children (8) and teenagers (9) in Iceland had been able to link dietary and some 'lifestyle' factors to caries prevalence and incidence. Such links are not

generally found in populations where caries levels are relatively low, as is the case in most Western countries (10), but findings in Iceland have been consistent, largely because the populations studied varied considerably in their patterns of consumption of refined carbohydrate (9). It was therefore thought appropriate to examine a population of Icelandic children with respect to dental erosion, dietary, salivary and lifestyle factors using methods that had previously been found useful in examining dental caries in Icelandic populations. This paper reports findings from a case-control study of children aged 15 years living in Reykjavik, Iceland.

## Materials and methods

### *Study population*

Approval for the study was obtained from the appropriate national ethics committee. Informed consent to participate was obtained from the parents of children aged 15 years who were attending the three largest secondary schools in Reykjavik. This age group was the closest in age that could be conveniently studied to the mean age of subjects (18 years) presenting with erosion to a specialist oral medicine clinic in Reykjavik for investigation (Holbrook, unpublished observations). The schools were geographically well separated and served all socio-economic groups within their respective catchment areas. A total of 278 subjects were examined, which was 20% of the 15-year-old cohort population in the city. No subjects refused examination

*Clinical examination*

Dental erosion was screened by one calibrated examiner with the subject seated in a dental chair and using a dental light and mirror. When a subject was found to have erosion the degree of erosion was recorded following examination by a second calibrated examiner and an agreed score entered into the record. Erosion was classified according to (i) location in the anterior or posterior teeth and (ii) severity, as shown below slightly modified from Lussi et al. (3).

*Anterior teeth*

- Grade 0 No erosion
- Grade 1 Loss of surface enamel, dentine not involved
- Grade 2 Erosion extending into dentine in at least 1 tooth
- Grade 3 Severe dentine erosion in at least 4 anterior teeth and or pulp chamber visible

*Posterior teeth*

- Grade 0 No erosion
- Grade 1 Enamel erosion of fissure system or cusps that cannot be attributed to attrition, amalgam restorations stand proud above the enamel surface
- Grade 2 Erosion into dentine that cannot be attributed to attrition, especially palatal aspects of maxillary molar cusps and buccal aspects of mandibular molar cusps
- Grade 3 Erosion extending close to the pulp

*Questionnaire on clinical symptoms, dietary and lifestyle factors*

A subject found to have erosion and the next healthy subject, who served as a control, were asked to complete a dietary and lifestyle questionnaire. This was a multiple-choice design similar to questionnaires the authors had used previously for studies on diet and dental caries (8, 9), but modified for studying tooth erosion. The questionnaire aimed at determining the amount and frequency of consumption of acidic drinks and fruits and asked specifically about the consumption of these with meals and between meals the previous day (see Table 3). Subjects were asked to report symptoms such as dentine hypersensitivity and gastric reflux or vomiting. Furthermore, the questionnaire was used to gain information concerning lifestyle factors, such as participation in sport outside school. Questions were specifically asked about drinking habits after sports and training sessions and about use of inhalers for asthma.

*Salivary buffer capacity*

A specimen of stimulated saliva was collected from erosion subjects and their case controls to allow chairside determination of buffer capacity using Dentobuff strips (Vivadent, Schaan, Liechtenstein), exactly following the manufacturer's instructions. Buffer capacity was recorded as low, medium, or high according to the color change of the Dentobuff strip at the end of the test.

*Analysis*

Bivariate analysis was performed with odds-ratio

calculations, and confidence intervals were calculated using standard methods. Logistic regression analysis of the factors measured was performed.

*Results*

Of the 278 subjects examined, 47.8% were male. Tooth erosion was seen in 21.6% of subjects, 68.3% of whom were male. Location and severity of the erosions found are given in Tables 1 and 2. Odds ratios (OR) were determined for gender and erosion, where it was found that the OR for male subjects was 2.74 at 95% CI [1.5;5.0].

Similarly, odds ratios were also determined for the individual lifestyle factors and both presence and severity of erosion. Results from the clinical symptoms and dietary questionnaire (Table 3) showed that all erosion subjects and their controls had consumed acidic drinks and or foods the day prior to examination. No significant associations were found in the consumption habits or lifestyle factors between the subjects with erosion and their controls.

Salivary buffer capacity was low in 22% of both subjects with erosion and their controls. The combination of a low buffer capacity and consumption of acidic drinks was not more significantly associated with erosion subjects than controls. There was, however, a trend for subjects who drank fruit juice after sports training to have erosion OR 3.23 at 95% CI [0.62;16.73]. The regression analysis model failed to show any one putative risk factor as being significantly associated with erosion.

Table 1. Distribution of subjects with erosion ( $n = 278$ ) by severity of the disease; 21.6% ( $n = 60$ ) of subjects had erosion

Grade	Total	Female	Male
1	43 (72%)	15 (76%)	28 (69%)
2	14 (23%)	5 (24%)	9 (23%)
3	3 (5%)	0	3 (8%)

Table 2. Distribution of erosion classified according to severity, location, and gender

Grade	$n$	Female	Male
<i>Posterior teeth</i>			
0	249	137	112
1	19	7	12
2	7	2	5
3	3	0	3
<i>Anterior teeth</i>			
0	228	131	97
1	39	13	26
2	10	2	8
3	1	0	1

Table 3. Results of the clinical, dietary and lifestyle questionnaire

	Odds ratio upper and lower 95%
Male	2.74 [1.5;5.0]*
Clinical symptoms	
Tooth sensitivity	1.1 [0.5;2.3]
Gastric reflux	0.7 [0.3;1.6]
Sports activity	
Three times or more often per week	0.7 [0.3;1.5]
Type of drinks following sports activity	
Water	0.9 [0.4;1.9]
Carbonated	1.7 [0.5;5.5]
Sports drink	1.4 [0.3;6.4]
Fruit juice	3.2 [0.6;16.7]
Recall of consumption of soft drinks between meals the previous day	
Water	0.7 [0.3;1.5]
Acidic drink	1.1 [0.5;2.3]
Recall of consumption of soft drinks with meals the previous day	
Water	0.5 [0.2;1.1]
Acidic drink	0.9 [0.4;1.8]
Biting nail and cheek habits	1.3 [0.6;2.6]
Use of sugar-free gum	0.8 [0.4;1.6]
Use of inhalers for asthma	1.3 [0.4;3.7]

\* Significant.

## Discussion

Dental erosion has changed in recent years from being a disease largely associated with bulimia and gastroesophageal reflux disease (11) to being one commonly seen in young healthy adults (12). Nevertheless, the increasing literature, largely from European countries, is not consistent in the type of patient reported as having erosion. Some studies report the disease among young children with erosion in the deciduous and early permanent dentition (13), others report the disease largely among teenagers (14). Lussi et al. (3) reported erosion among adults in Switzerland. Erosion is thought to be caused predominantly by dietary acid (14–17). Lussi et al. (3) and Larsen & Nyvad (18) have also reported laboratory studies indicating the considerable erosive potential of soft drinks. Nowadays there are few reports of environmental acids in the working environment causing dental erosion in European countries and none from Iceland. Lussi et al. (3) found erosion of the labial surfaces of the maxillary incisors to be the most common, whereas many other authors have found the palatal surfaces of these teeth to be the most frequently affected (14, 16). In this survey, no labial erosion of the maxillary incisors was seen.

This present survey has found erosion to be present more frequently in males than in females, which is at variance with the higher prevalence among females found by Milosevic et al. (14) in a study in Liverpool. This could reflect the higher consumption of acidic drinks by Icelandic teenage males compared with females (6).

The prevalence of dental erosion also varies greatly between countries and between surveys (3, 13, 14). In this Icelandic investigation, only children aged 15 years were

examined, because that was close to the average age of patients referred for investigation because of tooth erosion (4), and coincided with an age group that had recently taken part in a national dietary survey. The finding that 21.6% of subjects had some degree of erosion gives cause for concern, not least in a country where dental health with respect to caries has only recently undergone dramatic improvement (5). Methods that had successfully shown associations between diet and dental caries in Icelandic populations (9) were not successful when applied to erosion. Although diet is a difficult parameter to investigate and measure by questionnaire, the assumption had been made that erosion had fewer confounders than caries. Furthermore, this investigation may have failed to detect a strong association between erosion and acidic drinks, because their use is too homogeneous within the study population for the association to become apparent. Details of how the drinks were consumed, such as swishing the drink around the mouth before swallowing, using a drinking straw, drinking all at once or over a long period, were not considered. Effects of tooth brushing following consumption of acid drinks, salivary clearance of the drink, and the role of the oral soft tissues also need to be investigated in future studies. The slight link between use of asthma sprays and erosion may reflect the low pH of these steroid sprays and their increasing use by young people in urban communities (15).

In this study, the degree of erosion in affected individuals was considerably lower than that reported in other investigations where a strong link has been found between erosion and consumption of acidic drinks (14). Indeed, a referred group of Icelandic patients with more severe erosion did show a stronger association with both consumption of acidic drinks and self-reported gastric symptoms (4). Time is an important parameter in the development of erosion, but this study used data on recent drinks exposure only, while erosion occurs over a longer term. The recent emergence of erosion as a problem may, however, reflect a change in consumption of soft drinks among young people in the past decade. Longitudinal studies are therefore relevant both to observe possible development of erosion and to study the progression of, or cessation of, erosion following a change in circumstances.

Erosion appears to be a more complex multi-factorial disease than was assumed at the beginning of this present study. A similar conclusion was reached by Bartlett et al. (19) in an investigation of erosion among adolescents in the UK. The etiological factors measured seem to explain only a small proportion of the variation of erosion seen. Furthermore, methods that have proved reasonably successful in explaining variation in caries experience do not seem to be appropriate for investigating erosion. Further refinements of the techniques as well as a search for other possible aetiological factors are necessary.

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