

IN BRIEF

- This study describes the prevalence of tooth erosion in a random sample of 1,753 12-year-old Leicestershire children.
- Of the children surveyed, 59.7% had suffered dental erosion, with 2.7% having exposed dentine.
- The prevalence of erosion was significantly higher in boys than girls, in Caucasian than Asian children and in subjects with caries experience.
- Social deprivation had no overall effect on erosion experience, although socio-economically advantaged Caucasian children had significantly less erosion than other groups.

VERIFIABLE
CPD PAPER

The prevalence of tooth erosion in 12-year-old children

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Objectives To establish the prevalence of tooth erosion in a representative sample of 12-year-old children in Leicestershire and Rutland. To determine if gender, ethnic group, deprivation or caries experience influences the prevalence of erosion.

Methods A random sample of 1,753 12-year-olds resident in Leicestershire and Rutland were examined in 62 schools; 906 were boys and 847 girls; 1,379 were Caucasian and 316 Asian. Tooth erosion was assessed using the index employed in the survey of *Children's Dental Health in England and Wales* (1993). The Townsend index was used to record deprivation.

Results Tooth erosion was found in 59.7% of the children, with 2.7% exhibiting exposed dentine. Significantly more boys than girls; Caucasian than Asian children; and those with caries experience, had erosion present (χ^2 for all $P < 0.01$). Overall no significant difference was found between deprivation categories, however socio-economically advantaged Caucasian children had significantly less tooth erosion than other groups.

Conclusions There was a high prevalence of tooth erosion in 12-year-old children. Significantly more erosion occurred in boys than girls, and culture appeared to influence prevalence. Children with caries experience had a higher prevalence of erosion than those without caries, which may reflect a lower level of dietary care. Deprivation seemed to affect the prevalence of tooth erosion in Caucasian children.

Tooth erosion became a topic of great interest in the last decade of the 20th century, with increasing attention being paid in scientific papers to its prevalence in children, and as part of the aetiological triad in tooth surface loss in adults.

Prevalence studies of tooth erosion in the UK began in 1993 with the *National Survey of Children's Dental Health*,¹ and subsequently they have varied from reports of small convenience samples² and local population studies,³⁻⁷ to national surveys.^{1,8,9} The age of the children examined has varied from 1.5 to 18 years and

some of the studies have examined the difference in prevalence of erosion between different groups within the sample. The 1993 *Survey of Children's Dental Health* recorded that 52% of 5-year-olds and 27% of 12-year-olds had erosion into enamel.¹ The 2000 *National Diet and Nutrition Survey* (NDNS) of young people aged 4 to 18 years,⁹ showed that 58% of 4–6-year-olds and 42% of 11–14-year-olds were affected by dental erosion. Two local studies of 12-year-olds recorded erosion present in 44.8%² and 57%¹⁰ of children. The British Association for the Study of Community Dentistry (BASCD) has been unable to agree upon a suitable index for the recording of tooth erosion.

There is some evidence that socio-economic status has an influence on the prevalence of erosion, although this is not conclusive. The majority of studies suggest that males have a higher prevalence of tooth erosion than females, but all have failed to investigate any difference between ethnic groups. Further investigations are required to extend the limited information on the prevalence of tooth erosion in the general population, and to establish differences between groups in an attempt to distinguish those in greatest need, thereby enabling preventive programmes to be properly targeted.

The aim of the present study was to assess the prevalence of tooth erosion in a random sample of 12-year-old children resident in Leicestershire and Rutland, and to consider if there were differences between genders, ethnic groups, levels of material deprivation, and association with caries experience.

MATERIALS AND METHODS

The community dental service in Leicestershire was due to complete a dental health survey of 12-year-old children in 1997 as part of the BASCD national epidemiology programme. Approximately 2,000 of the 10,500 children attending all 62 secondary schools across the county were randomly selected for inclusion in the survey, with 1,753 attending for examination at their school. This produced a representative sample of the mixed ethnic groups in the population. In addition to recording full BASCD data, each child was examined for tooth erosion. The Leicestershire Research Ethics Committee gave approval for this extension of the BASCD survey, and consent was sought from the parents/guardians of each child.

Every child was examined fully reclined on a seven position garden chair, under standardized illumination from a Daray 4000 series Versatile Dental light. The recorder noted the gender, ethnic

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group and home postcode, and checked the date of birth of each child before the BASCD data, including caries experience, were recorded. Subsequent to this, tooth erosion was assessed on the labial and palatal surfaces of upper and lower incisors, and on the buccal, occlusal and lingual surfaces of first molars. The index for evaluating tooth erosion was the same as that used in the study of *Children's Dental Health in the UK 1993*.¹ Codes were as follows:

- 0 - Normal enamel
- 1 - Loss of surface enamel characteristics
- 2 - Loss of enamel sufficient to expose dentine
- 3 - Loss of enamel and dentine resulting in pulp exposure
- 9 - No assessment possible

All examinations were completed by the same individual (CD), an experienced examiner who had previously used the same tooth erosion criteria when participating in the 1993 study. Training and calibration for the dental health criteria were completed in the regional BASCD (TC1296) exercises, and training in the use of the erosion index was obtained from concurrent participation in the NDNS study of young people aged 4–18 years.⁹ A calibration exercise with 120 children was used to assess intra-examiner reproducibility, which produced an un-weighted Kappa of 0.80.

The socio-economic background of the children was assessed by allocating a Townsend score based on the postcode of each child.¹² Subjects with a Townsend Deprivation Index between -5.2 and -1.1 were graded as advantaged, those between -1 and 1.99 as intermediate and those in the range 2 and above as deprived, indicating material deprivation. The Townsend index performs well in explaining variations in true health measures by measuring material deprivation.^{11,12} Data were stored, collated and analysed using *Survey Plus* computer software. Qualitative data were analysed using the Chi-square test, and quantitative data were analysed using Student's *t*-test. Statistical significance was accepted at the 95% confidence level, $P<0.05$.

RESULTS

The sample consisted of 906 (51.7%) boys and 847 (48.3%) girls with a mean age of 12.51 (SD 0.28) years. Of these, 1,379 (78.7%) were Caucasian and 316 (18.0%) were Asian, with both ethnic groups having similar proportions of boys and girls. The mean DMFT was 1.03, with 31% of children having active decay, and 68% lifetime decay experience.

Tooth erosion was recorded in 1,046 (59.7%) children, with 47 (2.7%) exhibiting exposed dentine and no child having erosion exposing the pulp. Significantly more males (63.9%) than females (55.3%) ($P<0.01$) had tooth erosion, as did Caucasian (62.7%) compared with Asian (48.1%) children, ($P<0.01$) (Table 1). Significantly more children with caries experience also had erosion present (66%) compared with those who had no caries experience (54.9%) in their permanent dentition. Conversely children with erosion had a higher mean DMFT score of 1.17 compared with the 0.83 of those with no erosion ($P<0.01$).

Table 1 The prevalence of tooth erosion in the sample

Sample	Proportion with tooth erosion (%)	Proportion with exposed dentine (%)	P
Total	59.7	2.7	
Boys	63.9	3.3	0.0002
Girls	55.3	2.0	
Caucasian	62.7	3.2	<0.001
Asian	48.1	0.3	
Caucasian Boys	66.6	3.9	0.0039
Caucasian Girls	59.0	2.5	
Asian Boys	54.0	0.6	0.0265
Asian Girls	40.7	0	
No caries experience	54.9	2.6	<0.001
Caries experience	66.0	2.7	

Surface data revealed that tooth erosion was symmetrical about the midline and uncommon on lower incisors (13.5%). Erosion occurred most frequently on the palatal aspects of upper incisors (49%) and upper molars (53%), and the buccal surface of lower molars (50%). Dentine was exposed to the greatest extent (2.2%) on the occlusal surfaces of lower molars with less than 1% of the palatal aspects of central incisors exhibiting exposed dentine.

Analysis of Townsend groupings shows that the results indicate that the majority of children did not live in conditions of deprivation (Table 2). The proportions of Caucasian to Asian children differed greatly in each deprivation category; the relationship between ethnicity, deprivation and erosion experience is shown in more detail in Table 3. Different levels of deprivation had no significant effect on erosion experience for the total sample or for Asian children. However, a lower proportion of Caucasian children in the low deprivation group had tooth erosion than did those in the two less deprived groups, $P<0.05$.

Table 2 Numbers and proportions of children by Townsend deprivation score

Townsend Scores	Total Sample*	% Caucasian: % Asian	Caucasian Number	Asian Number	%
-5.2 > -1.1	875	90.9 : 7.0	795	60.5	61
-1 > 1.99	401	76.1 : 21.9	305	23.2	88
2 > 8.9	397	54.2 : 39.0	215	16.3	155

*80 (4.6%) postcodes could not be matched with a Townsend score.

Table 3 Tooth erosion prevalence by Townsend deprivation score

Sample	Townsend Grade	Erosion present No.	Erosion absent No.	P
Total	Advantaged	518	59.2	40.8
	Intermediate	252	62.8	37.2
	Deprived	227	57.2	42.8
Caucasian	Advantaged	477	60.0	40.0
	Intermediate	206	67.5	32.5
	Deprived	144	67.0	33.0
Asian	Advantaged	32	52.5	47.5
	Intermediate	43	48.9	51.1
	Deprived	69	44.5	55.5

DISCUSSION

Twelve-year-old children were selected for the present study for several reasons. At this age the index teeth should have been present in the mouth for approximately six years, primarily under aetiological influences experienced in the home environment. Twelve-year-olds are usually more co-operative during epidemiological studies than older children and there are fewer refusals. Also this age group could be identified and revisited at a later date whilst still at school.

Prevalence of tooth erosion has been reported in ten studies in the UK (Table 4). Different indices have been employed, different teeth and surfaces have been examined, and results have been variously presented. Comparability between studies is thus made difficult. Several studies^{4,6,10,13} used modifications of the Tooth Wear Index of Smith and Knight,¹⁴ whilst others^{2,3,5,7} used assessments based on that used in the national children's study of 1993.¹ Sample sizes have varied from 125² in a single school, to 17,061.¹ The prevalence of erosion in 3 year olds was found to be 29% by both Jones and Nunn³ and Hinds and Gregory⁸ although the former study identified a slightly higher proportion of subjects with erosion into dentine; 17% compared with 14%. Several studies have assessed erosion in children around the age of 5 years. In the 1993 national study¹ 52% of subjects had erosion present, with 24% having exposed dentine. Taylor⁵ found that 98% of 5-year-olds in North Warwickshire had erosion but in the latter study both deciduous molars were included in the assessment. Walker *et al.*⁹ scored only primary molars and found 58% of 4–6-year-olds to have erosion, with dentinal involvement present in 19%. Millward *et al.*⁴ found that 48% of 4–5-years-olds had erosion into dentine but in this study all deciduous teeth were included. Prevalence of erosion in 12-year-

Table 4 Prevalence studies of tooth erosion / wear in children resident in the United Kingdom

Author	Year	Country	Age	Sample size	Erosion/Wear	Present (%)	Exposed Enamel (%)	Exposed Dentine (%)	Teeth Examined	Surfaces Examined*
O'Brien <i>et al.</i> ¹	1994	UK	5 12 14	17,061	Erosion	52 27 32		24 1 2	Upper primary incisors Upper permanent incisors Upper permanent incisors	B/P
Millward <i>et al.</i> ⁴	1994	England	4-5	178	Erosion		48.3		All primary teeth	B/P BOL
Milosevic <i>et al.</i> ²²	1994	England	14	1,035	Wear	100	29.7		All permanent teeth	B/I/P BOL
Jones and Nunn ³	1995	England	3	135	Erosion	28.9	7.7			B/P BOL
Hinds and Gregory ⁷	1995	GB	All 1.5-2.5 2.5-3.5 3.5-4.5	1,522	Erosion	19 9 18 29	17 3 6 13		Upper primary incisors Upper primary incisors	B/P B/P
Taylor ⁵	1996	England	5	1,776	Erosion	98.2		33.2	Upper primary incisors and molars	B/P B/O/L
Bartlett <i>et al.</i> ⁹	1998	England	11-14	210	Wear	57			All permanent teeth	BIPC BOLC
Williams <i>et al.</i> ¹⁴	1999	England	14	525	Erosion	24	22.9	1.1	Upper permanent incisors	B/P
Walker <i>et al.</i> ⁸	2000	GB	4-6 7 - 10 11 - 14 15 - 18	1,726	Erosion	65** 61** 52** 62**	58¢ (46) 25¢ (12) 42¢ (26) 56¢ (34)	19¢ (12) 1¢ (0) 3¢ (2) 2¢ (5)	Upper primary incisors and first primary molars Upper permanent incisors and first permanent molars	B/P/O
Milosevic and Bardsley ²²	2000	England	14	2,385	Wear		52.7		Upper incisors and canines and first molars	B/I/P O
Al-Dlaigan <i>et al.</i> ⁶	2001	England	14	418	Erosion		52		All permanent teeth	B/P B/L
Deery <i>et al.</i> ²	2001	Scotland	12	125	Erosion	44.8	44.8	0	Upper permanent incisors	B/P
This study	2002	England	12	1,753	Erosion	59.7	57.0	2.7	Incisors and first molars	

*B = Buccal; I = Incisal; P = Palatal; L = Lingual; O = Occlusal; C=Cervical.

**Proportion with erosion in either dentition

¢ = Palatal surfaces of upper incisors

olds has been reported as 27%, with 1% of subjects having exposed dentine,¹ whilst Deery *et al.*² found 45% with loss of enamel, but none with dentine exposed. This compares with the 60% and 2.7% respectively in the present study, which included assessment of first molars. Other studies of erosion on permanent teeth in children have found 52% and 57% respectively to have erosion of enamel surfaces.^{9,10} In the NDNS study of 11–14-year-olds, 3% had dentine exposure.⁹

In the present study boys had a significantly higher prevalence of erosion than girls, which confirms the findings of several authors,^{5,6,13,15} although others^{9,10} found no difference between the genders. Adult studies of tooth wear,^{16–20} of which erosion is an integral part in combination with attrition and abrasion, have found that wear is present in significantly more men than women, indicating that trends established in youth continue into adulthood.

The link between ethnic group and erosion prevalence has not previously been recorded. The present study revealed that a significantly higher proportion of Caucasian (62.7%) than Asian (48.1%) children had erosion present ($P<0.01$), with this reflected in the respective proportions of subjects with dentine exposed. Exposure to potential aetiological factors and different modifying factors may explain this.

In eight studies which investigated the association between socio-economic status and tooth erosion or tooth wear in children (Table 5), five different indices have been employed to determine

socio-economic status/deprivation. This reflects the indices available to different authors at the time of their research. Overall this present study found no difference between socio-economic groups, which supports other findings.⁵ Several studies have found a lower level of tooth erosion in the high socio-economic group, as was the case for Caucasian children in the present study.^{3,6,13,21} Conversely Millward *et al.*⁴ recorded a higher prevalence in higher socio-economic groups. Walker *et al.*⁹ reported that although there was no difference between the socio-economic groups in 4–6 and 7–10-year-olds, erosion prevalence was higher in lower socio-economic groups of 11–14 and 15–18-year-olds. As there is no clear association established to date, this should be further investigated, preferably using agreed socio-economic and erosion indices, with consideration being given to the ethnic make up of the population investigated.

A significantly higher proportion of 12-year-old children with caries experience (66.0%) had erosion present than those with no caries experience (54.9%, $p<0.01$). Only one study has previously considered this association, when it was found that a slightly higher proportion of 2–5-year-olds in Saudi Arabia with caries also had erosion present (33%), compared with caries free individuals (27%), the difference was not significant.²² In 12-year-olds, it may be that those individuals who fail to care for their teeth by failing to maintain a potentially non cariogenic diet, also fail to maintain a potentially non erosive diet.

Table 5 Socio-economic status and prevalence of tooth erosion

Author	Year	Age (years)	Sample size	Index used	Findings
Millward <i>et al.</i> ⁴	1994	4	178	Not stated*	High in High Socio-Economic group
Milosevic <i>et al.</i> ²²	1994	14	1,035	Jarman*	High in Low Socio-Economic group
Jones and Nunn ³	1995	3	135	Reg Gen Class Occ	High in Low Socio-Economic group
Taylor ⁵	1996	5	1,776	Super Profiles	No difference between groups
Milosevic and Bardsley ²²	2000	14	2,385	Jarman/Townsend	Weak but significant correlation
Walker <i>et al.</i> ⁸	2000	4-6; 7-10 11-14;15-18	845 881	Reg Gen Class Occ (Non-man vs Man)	No difference between groups
Al-Dlaigan ⁶	2001	14	418	ACORN	High in Low Socio-Economic group. High in Low and Low in High Socio-Economic groups
This study	2002	12	1,753	Townsend	No difference between groups (Caucasians - Low in High Socio-Economic group)

*Socio-economic status derived from the location of school rather than by individual

The present study demonstrates a high prevalence of erosion in 12-year-olds, although the proportion of children with exposed dentine was less than 3%. Boys had significantly more erosion than girls, and a significant difference in the prevalence of tooth erosion was observed between Caucasian and Asian children. No difference in the prevalence of erosion between socio-economic groups was apparent in the overall sample. This was however influenced by the ethnic proportions of each group, as a significantly lower proportion of the least deprived Caucasian children had tooth erosion. There was a positive relationship between caries experience and erosion. However, since 68% of children had caries involving dentine whilst only 2.7% had erosion into dentine, it may be concluded that tooth erosion in this age group is not a serious public health problem at the present time. Prevalence studies completed to date in the UK reveal a lack in unity of approach and reporting. It is desirable to rectify this in order to achieve improved clarity and comparability of results in future. Further research is required to monitor prevalence and establish clearer associations between erosion and socio-economic status, ethnic groups and other variables, to enable resources to be targeted towards preventive programmes. Commencement of data collection in BASCD co-ordinated studies would be of immense benefit, as a unified and consistent approach would be established, allowing valid comparability of nationwide results.

CONCLUSIONS

Of a random sample of 12-year-old Leicestershire children, 59.7% had suffered dental erosion, with 2.7% having exposed dentine. Erosion was significantly more prevalent in boys than girls, in Caucasian than Asian children and in subjects with caries experience. Social deprivation had no overall effect on erosion experience, although socio-economically advantaged Caucasian children had significantly less erosion than other groups.

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1. O'Brien M. *Children's Dental Health in England and Wales, 1993*. London: HMSO, 1994.
2. Deery C, Wagner M L, Longbottom C, Simon R, Nugent Z J. The prevalence of dental erosion in a United States and a United Kingdom sample of adolescents. *Ped Dent* 2001; **22**: 505-510.
3. Jones S G, Nunn J H. The dental health of 3 year old children in East Cumbria. *Comm Dent Health* 1995; **12**: 161-166.
4. Millward A, Shaw L, Smith A J. Dental erosion in 4 year old children from different socioeconomic backgrounds. *J Dent Child* 1994; **July-Aug**: 263-266.
5. Taylor C L. *The prevalence and distribution of dental erosion in 5 year old children attending schools in North Warwickshire*. MCDH Dissertation. University of Birmingham, 1996.
6. Al-Dlaigan, Shaw L, Smith AJ. Dental erosion in 14 year old children from differing socioeconomic backgrounds. *Br Dent J* 2001; **190**: 145-149.
7. Williams D, Croucher R, Marceres W, O'Farrell M. The prevalence of dental erosion in the maxillary incisors of 14 year old school children living in Tower Hamlets and Hackney, London, UK. *Int Dent J* 1999; **49**: 211-216.
8. Hinds K, Gregory J R. *National Diet and Nutrition Survey Children aged 1½ to 4½ years. Volume 2: report of the dental survey*. London: HMSO, 1995.
9. Walker A, Gregory J, Bradnock G, Nunn J, White D. *National Diet and Nutrition Survey: Young people aged 4 to 18 years*. London: HMSO, 2000.
10. Bartlett D W, Coward P Y, Nikkah C, Wilson R F. The prevalence of toothwear in a cluster sample of adolescent schoolchildren and its relationship with potential explanatory factors. *Br Dent J* 1998; **184**: 125-129.
11. Morris R, Carstairs V. Which deprivation? A comparison of selected deprivation indexes. *J Pub Health Med* 1991; **13**: 310-326.
12. Dolan S A, Jarman B. Measuring disadvantage: changes in the underprivileged area, Townsend and Carstairs scores 1981-1991. *J Epi Comm Health* 1995; **49** (Supp2): 30-33 [145].
13. Milosevic A, Young P J, Lennon M A. The prevalence of toothwear in 14 year old school children in Liverpool. *Comm Dent Hlth* 1994; **11**: 83-86.
14. Smith B G N, Knight J K. An index for measuring the wear of teeth. *Br Dent J* 1984; **156**: 435-438.
15. Árnadóttir I B, Saemundsson S R, Holbrook W P. Dental erosion in Icelandic teenagers and related lifestyle factors. *J Dent Res* 1998; **77**: 1344 (Abs. S-11).
16. Smith B G N, Robb N D. The prevalence of toothwear in 1007 dental patients. *J Oral Rehab* 1996; **23**: 232-239.
17. Kelly M, Steele J, Nuttal N et al. *Adult dental health survey. Oral health in the UK 1998*. London: The Stationery Office. 2000.
18. Donachie M A, Walls A W G. Assessment of toothwear in an ageing population. *J Dent* 1995; **23**: 157-164.
19. Steele J G, Walls A W G, Ayatollahi S M T, Murray J J. Major clinical findings from a dental survey of elderly people in three different English communities. *Br Dent J* 1996; **180**: 17-23.
20. Steele J G, Sheiham A, Marceres M, Walls A W G. *National diet and nutrition survey: people aged 65 years and over*. London: HMSO, 1998.
21. Milosevic A, Bardsley P F. Aetiological factors and toothwear in 14 year old schoolchildren. *J Dent Res* 2000; **79**: 1172 (Abs 13).
22. Al-Malik M, Holt RD, Bedi R. Erosion, caries and rampant caries in Saudi preschool children. *J Dent Res* 2000; **79**: 610 (Abs 3734).