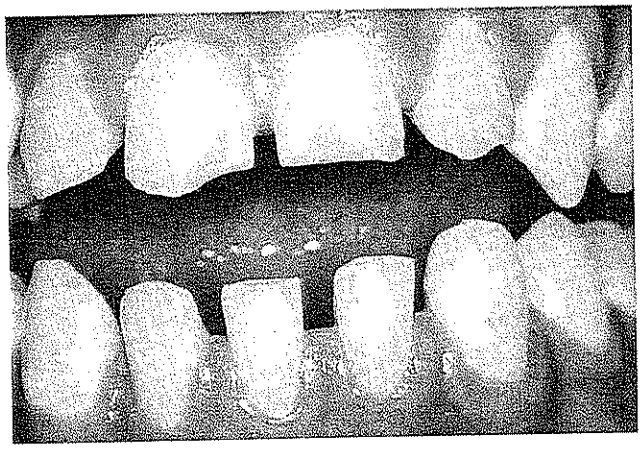

Figure 1. Fourteen-year-old boy showing extensive tooth surface loss due to erosion exposing dentin on the labial aspects of his maxillary incisors. He has been suffering from asthma for some years, but also had a high intake of acidic drinks.

Childhood asthma and dental erosion

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Asthma is a relatively common condition with approximately 10 percent of children affected and a rising prevalence. Children in Britain and Ireland are more likely to suffer from asthma than youngsters almost anywhere in the world.[1] In a very important recent international study, 463,801 children, ages thirteen to fourteen years, completed a questionnaire and an interview using videos. The teenagers were drawn from forty-two countries worldwide. The investigators found enormous variation, but the highest numbers of children complaining of asthma came from the U.K, Australia, New Zealand and Ireland, followed by North, Central and South America.[1] Those in several eastern European countries and developing countries were least affected. In the USA, the number of asthma cases has risen by 60 percent since the early 1980s. Over 5000 Americans die from asthma each year: the prevalence among black children is 26 percent greater than among white children. The researchers suggested that environmental factors are critical to the development of the condition.

Although, as yet, there are no scientifically validated quantitative data, there has been a subjective impression on the part of the dental profession, that dental erosion is also a relatively common condition and that its prevalence is rising.[2] In a recently published paper McDerra, Pollard and Curzon (1998) concluded that children with asthma had more decay of their permanent teeth, poorer periodontal status, and greater loss of teeth than healthy controls.[3] This possible link between asthma and tooth surface loss is worthy of further consideration, particularly in view of the potentially rising prevalence of both conditions. Figures 1 to 4 show two young patients who were referred to Birmingham Dental Hospital with dental erosion; both of them were found to have asthma and had been on medication to control this for some years.

The aim of this investigation was first to assess the prevalence of asthma in a random sample of fourteen-year-old children in Birmingham UK. Secondly, to assess the levels of dental erosion in these children; and thirdly, to see whether there was any correlation between children with asthma and the levels of dental erosion.

MATERIALS AND METHODS

A random sample of fourteen-year-olds was drawn from the large conurbation of Birmingham U.K. This involved twelve secondary schools covering a very broad range of social and ethnic mix. A total of 418 children were sampled, 209 were males and 209 were females. They and their parents/care givers gave informed consent to participate in this study and ethical approval was given by the Birmingham Research Ethics Committee.

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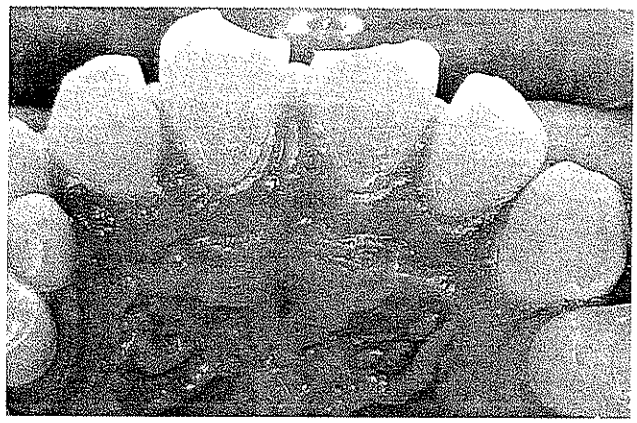
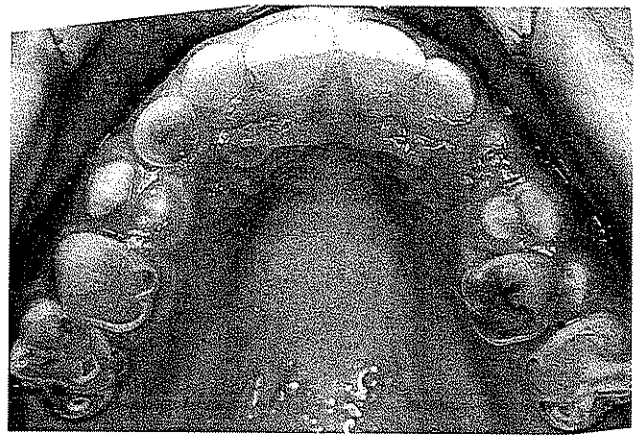


Figure 2. View of the palatal aspect of the maxillary incisors of the same patient as in Figure 1. Tooth surface loss can be seen on incisor teeth, but there is also evidence of this on the canine and premolar teeth.



Figures 3 and 4. Extensive dental erosion in an eleven-year-old asthmatic boy of both primary and permanent dentitions. Figure 3 shows dentin exposure on both maxillary first permanent molars and near pulp exposures on the maxillary primary canine and left maxillary second primary molar. Figure 4 shows the palatal aspects of the maxillary permanent incisors with loss of the cingulum and surface anatomical features and exposure of dentin.

All the children were examined clinically within their schools under standard illumination from a Daray light using two-plane mouth mirrors. The surfaces of all teeth were scored for dental erosion according to the criteria shown in Table 1. This is based on the Tooth Wear Index of Smith and Knight, which has been used, with varying modifications, in many epidemiological investigations.[5] All the children were examined by the same person (Y.H.A), who had previously undergone extensive training and calibration exercises in the use of this index. The data were recorded by a trained assistant. In cases of doubt the lower score was assigned.

Following the clinical examination, all children completed an extensive questionnaire. As they included a wide range of educational attainment, some children required help to undertake this through a structured interview basis with standardized prompts. The questionnaire covered details of medical history and medication as well as an extensive range of other intrinsic factors that might be related to erosion such as gastroesophageal reflux, feeding and drinking habits, parafunctional activity, and toothbrushing procedures.

All the data were analyzed using SPSS, and the analyses included: t-test, analysis of variance, Spearman correlation and loglinear analysis. A P value of ≤ 0.05 was accepted as significant.

RESULTS

A total of 418 children completed both the clinical examination and the questionnaire. There were 209 girls and 209 boys. Sixty-six children (15.8 percent) reported that they had asthma; thirty-one girls and thirty-five

Table 1. Diagnostic Criteria for Tooth Wear Index (Modified from Smith and Knight, 1984[5])

Code: Scores	Surfaces	Criteria
0.	B/L/I	No loss of enamel surface characteristics.
1.	B/L/O/I	Loss of enamel surface characteristics.
2.	B/L/O	Loss of enamel, visible dentin for less than 1/3 of the surface.
	I	Loss of enamel just exposing dentin.
3.	B/L/O	Loss of enamel, visible dentin for > 1/3 of the surface.
	I	Loss of enamel and substantial loss of dentin, but not exposure of pulp or secondary dentin.
4.	B/L/O	Complete loss of enamel, or pulp exposure, of secondary dentin.
	I	Pulp exposure or exposure of secondary dentin.
9.	B/L/O/I	Excluded from analysis (missing tooth, partially erupted, orthodontic band, composite restoration, any crowns, tooth fracture, and fissure sealant).

Key: B = Buccal or Labial, L = Lingual or Palatal, O = Occlusal, I = Incisal.
* In case of doubt a lower score was given.

Table 2 ☐ Number of children with a significant medical history and medication taken from the random sample of 418 fourteen-year-old children from Birmingham, U.K.

Type of medical condition	Number and percentage of children with medical condition	
	No.	(%)
Asthma	66	(15.8)
Indigestion	19	(4.5)
Vomiting	4	(1)
Heartburn	15	(3.6)
Stomach problems	29	(7)
Hay fever	6	(1.4)
Eczema	5	(1.2)
Heart condition	3	(0.7)
Epilepsy	3	(0.7)
Allergies	3	(0.7)
Migraines	2	(0.5)
Hearing problem	2	(0.5)
Other medical condition	12	(3)
Currently taking tablets	41	(10)
Currently taking inhalers	60	(14.4)
Currently taking medicine (liquid)	18	(4.3)

Table 3 ☐ Medication and length of time taken by sixty-six fourteen-year-olds with asthma.

Medication and its periodicity	Number and percentage of children	
	No.	(%)
1. Type of medication.		
• Salbutamol (Ventolin)	29	(48)
• Beclomethasone (Becotide)	13	(22)
• Fluticasone (Flixotide)	2	(3)
• Other medications	5	(8)
• Inhaler used-name unknown.	27	(45)
2. The length of time children under medication.		
• Less than One year	4	(7)
• From One year to Five years	16	(26.5)
• From Six years to Ten years	10	(16.5)
• Over Eleven years	12	(20)
• Non-response/Don't know	18	(30)
3. Children not using any medication	6	(9)

boys. Table 2 gives brief details of the medical history questionnaire. Of the children with asthma, over 90 percent were taking inhaled medication to control their symptoms. Asthma was by far the single most common medical problem reported, although a number of these teenagers (10 percent) complained about gastrointestinal disorders and of "stomach problems," "heartburn," and vomiting.

Salbutamol (Ventolin) was the most frequently used medication by children with asthma, almost half of them currently using it, and with histories of using medication over periods of several years. Forty-five percent of the children did not know, however, the name of the medication that they were taking, and 30 percent did not know for how long they had received treatment (Table 3).

Tables 4 and 5 show the Tooth Wear Index scores for surfaces of all teeth present; there are consistently higher surface scores in the asthmatic children. To enable easier comparison, the data are expressed as a percentage of the tooth surfaces affected. For example, of the sixty-six teenagers with asthma, when considering the labial surfaces of the maxillary central incisor teeth, 31 percent of the right and 29 percent of the left were classified as score 2, with visible dentin. The comparative percentages for the 352 nonasthmatic children were 24 percent in both sides. The more severe erosion coded 3 was more commonly found in asthmatic children. There was also a highly significant correlation between children currently using inhalers for asthma and erosion with a Spearman's correlation $p < 0.001$.

Assessment of the other factors analyzed on the questionnaire, including acidic food and drink intake and parafunctional activity, showed no statistically significant differences between children with asthma and the other fourteen-year-olds with no medical problems. There were also no differences in the prevalence of gastrointestinal problems between the groups or their oral hygiene practices.

DISCUSSION

The current investigation has shown that a random sample of fourteen-year-olds from Birmingham, U.K, have relatively high levels of dental erosion. This compares with the study reported by Milosevic *et al* in 1994 also involving fourteen-year-old children, of whom 30 percent showed evidence of tooth wear.[5] Both these studies, unlike most previously published surveys, involved a random sample drawn from the general population and both used standardized diagnostic criteria based on the Tooth Wear Index of Smith and Knight with extensively trained examiners who had shown high levels of interexaminer and intraexaminer reproducibility. They also assessed all the surfaces of all teeth present, unlike the U.K. Child Dental Health Survey of 1993, which only assessed incisor teeth in five-year-olds and eleven- year-olds.[2] In this National survey 25 percent of eleven-year-olds, however, showed clinically apparent dental erosion.

The present study has not only shown a high prevalence of erosion in the random sample of fourteen-year-olds, but also a higher level in children who suffer from asthma. The presence of this medical condition was entirely unknown to the examiner at the time of the clinical assessment. The levels of erosion were greater in girls with asthma than in boys. This is in marked contrast to the study reported by Milosevic *et al* (1994), when boys from the general population were found to

Table 4 ☐ Tooth Wear Index: Percentage of surfaces affected for each surface score: sixty-six fourteen-year-old children with asthma.

	Tooth number													
	7	6	5	4	3	2	1	1	2	3	4	5	6	7
Maxillary teeth														
Surfaces														
Buccal														
1	89	94	92	85	88	70	62	62	77	92	88	92	92	83
2				2	6	26	31	29	19	2	12			
3							3	3						
4														
9	11	6	8	13	6	4	4	6	4	6	10	8	8	17
Occlusal/Incisal														
1	83	71	86	80	60	42	27	30	45	75	82	83	67	79
2	2	17	5	5	38	58	71	66	53	23	6	6	15	3
3							2	2						
4														
9	15	12	9	15	2			2	2	2	12	11	18	18
Palatal														
1	89	94	96	88	98	98	94	92	96	98	91	95	92	83
2						2	6	4	2					
3								2						
4														
9	17	6	4	12	2			2	2	2	9	5	8	17
Mandibular teeth														
Surfaces														
Buccal														
1	83	91	94	86	77	65	60	61	65	86	85	92	89	76
2		2		2	15	30	37	34	30	8		3	3	
3								2						
4														
9	17	7	6	12	8	5	3	3	5	6	15	5	8	24
Occlusal/Incisal														
1	64	32	84	73	44	9	3	8	18	50	68	73	21	44
2	14	56	12	15	53	91	95	92	82	46	17	25	66	29
3							2			2			2	
4														
9	22	12	4	12	3					2	15	2	11	27
Lingual														
1	83	96	97	88	97	100	100	100	98	98	86	98	92	75
2									2				2	2
3														
4														
9	17	4	3	12	3					2	14	2	6	23

have more tooth-wear than girls. Where the other factors that were analyzed on the questionnaire, including acidic food and drink intake and parafunctional activity, were assessed, there were no statistically significant differences between children with asthma and the other fourteen-year-olds with no medical problems.

Several possible reasons could be hypothesized for the link between erosion and asthma. First, the prolonged use of the βeta 2 adrenoceptor stimulants such as Salbutamol (Ventolin) or terbutaline (Bricanyl) leads to reduced salivary flow and taste disturbances. Lenander-Lumikari *et al* (1998) compared the composition of stimulated whole saliva from adult asthmatic patients with nonasthmatic individuals.[6] The mean flow rate was lower in the asthmatic group with higher concentrations of myeloperoxidase. There may be a protective effect of high salivary flow and increased buffering capacity to the development of dental erosion. Secondly, the βeta 2 adrenoceptors and drugs such as aminophylline and theophylline, which are also used as bronchodilators for reversible airway obstruction, act as smooth muscle relaxants. They will also cause relaxation of other smooth muscles such as the lower esophageal sphincter. This relaxation is associated with gastroesophageal reflux, known to be an important factor in the etiology of dental erosion. There was no difference, however, in the reported prevalence of gastrointestinal problems in the asthmatic and nonasthmatic teenagers. Thirdly, there are also secondary effects from the drug-related reduction in salivary flow. It is possible that there will be an increased consumption of drinks to compensate for oral dehydration, often drinks with a low pH and a high titratable acidity, which could also cause erosion. This present study has shown slightly increased consumption of soft drinks in asthmatic children compared with nonasthmatic children, but this was not statistically significant. Fourthly, the medication used to control asthma may itself be acidic.

Table 5 ☐ Tooth Wear Index: Percentage of surfaces affected for each surface score: 352 fourteen-year-old children with asthma.

	Tooth number													
	7	6	5	4	3	2	1	1	2	3	4	5	6	7
Maxillary teeth														
Surfaces														
Buccal														
1	85	88	88	81	88	73	63	63	71	82	82	88	87	80
2			1	5	6	16	24	24	16	3				1
3							1	1		1				
4														
9	15	12	11	18	14	11	12	12	13	14	18	12	13	19
Occlusal/Incisal														
1	82	68	93	80	67	56	39	37	54	74	82	93	69	80
2	1	18	3	4	30	33	59	62	45	24	3	3	19	1
3														
4														
9	17	14	4	16	3	1	7	1	1	2	15	4	13	19
Palatal														
1	85	90	95	84	96	97	97	96	98	96	85	95	88	81
2					1	2	2	2	1	1				1
3								1						
4														
9	15	10	5	16	3	1	1	1	1	3	15	5	12	18
Mandibular teeth														
Surfaces														
Buccal														
1	78	87	88	83	80	61	58	59	65	80	84	89	89	74
2	1	1	3	4	12	30	34	33	27	10	3	2	1	1
3						1	1	1						
4														
9	21	12	9	13	8	8	7	7	8	10	13	9	10	25
Occlusal/Incisal														
1	71	32	80	74	47	12	11	10	19	56	74	77	24	57
2	4	53	16	16	51	87	88	88	80	42	15	18	59	12
3		1			1	1	1	1	1	1		1	1	
4														
9	25	14	4	10	1			1		1	11	4	16	31
Lingual														
1	78	89	95	90	98	98	98	97	98	97	80	95	91	74
2	1	1			1	2	2	2	2	2				
3														
4														
9	21	10	5	10	1			1		1	10	5	9	25

O'Sullivan *et al* (1999), tested the main asthmatic drugs in current use and found the powder forms to be more acidic than the aerosol varieties.[7] Almost all the powdered drugs had a pH less than the critical level of 5.5 for hydroxyapatite dissolution. Labeling of these drugs advised children to rinse their mouths with water directly after taking the drugs. Kargul *et al* (1998), using pH micro-electrodes interdentally, observed a fall in pH values for interdental plaque and saliva during the thirty minutes following the use of inhaler medication for asthma.[8] They advised that children with asthma treated by inhaler drugs should receive special preventive attention.

This current investigation has shown that children with asthma are at an increased risk of developing dental erosion. Further investigation is required, however, to establish a clear picture about the relationship between dental erosion and asthma and any other contributory etiological factors.

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