Scientific Article

The dental status of asthmatic British school children

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Abstract

Purpose: *This study was performed to determine the prevalence of dental disease in British school children with asthma.*

Methods: *A convenience sample of 100 asthmatic children (aged 4–16 years) was examined for dental caries, periodontal condition, and tooth surface loss. School children, equated for age, sex, race, and socioeconomic status were chosen for comparison. Children were divided into two age ranges; 4–10 and 11–16 years. A significant difference was found in DMFT (0.96 vs. 0.31) and DMFS (1.37 vs. 0.37) between the 4–10-year-old asthmatic children compared with healthy control children.*

Results: *In the 11–16-year age range, the asthmatic children had a DMFT and DMFS of 2.48 and 3.39 compared with the control children who had a DMFT and DMFS of 1.11 and 1.97 respectively. Asthmatic children had significantly more plaque, gingivitis, and calculus compared with the control group. There was a significant difference in the severity and number of teeth affected by tooth surface loss affecting labial surfaces of the anterior teeth and occlusal surfaces of the posterior teeth of asthmatic children.*

Conclusions: *It was concluded that asthmatic children have more decay affecting their permanent teeth, poorer periodontal status, and more tooth surface loss than healthy controls. (Pediatr Dent 20:281–87, 1998)*

Asthma is a chronic inflammatory disorder of the airways. The International Consensus Report on the Diagnosis and Treatment of Asthma[1] emphasized the central role of airway hyper-responsiveness, stating that "in susceptible individuals this inflammation causes symptoms which are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment, and causes an associated increase in airway responsiveness to a variety of stimuli." It affects approximately 10% of children in Britain and the prevalence is rising,[2–4] possibly related to a rise in allergens in the environment that lead to increased airway responsiveness in atopic children.[5] Despite major clinical advances in the understanding and management of asthma, it still remains underdiagnosed and undertreated.[2] Inadequate treatment can result in it being a very disabling and disruptive illness, causing much distress to parents and children. More absence from school is caused by asthma than any other chronic condition, with 30% of asthmatic children missing more than 3 weeks of school each year.[4]

Considering that asthma is such a common disorder affecting children, only a limited number of studies, mainly from Scandinavian countries, have investigated the effects of asthma and its treatment on the oral environment. The few studies in the literature investigating the relationship between asthma and the prevalence of dental caries have conflicting results. Some authors have found no increase in caries prevalence[6,7] with others showing an increased incidence in caries. Some workers believe that this increase in caries is associated with prolonged use of beta 2 agonists, which lead to reduced salivary flow. This has been shown in clinical and animal studies.[8–11] A study of 24 asthmatic children using beta 2 agonists showed that the secretion rates of whole saliva and parotid saliva decreased by 26 and 36%, respectively, in the asthmatic group compared with a healthy control group.[12] The secretion rates of whole and parotid saliva of patients on beta 2 agonists remained low at 20 and 35% respectively.[10] Other studies have shown that the higher rates of caries seen in asthmatics are due to an increased frequency of carbohydrates[13] and sugar-containing drugs.[13,14]

Asthmatic children tend to have more calculus compared with healthy children, possibly related to increased levels of calcium and phosphorus found in submaxillary[15] and parotid[16] saliva. Some studies have shown an increase in gingivitis thought to be due to mouthbreathing and immunological factors.[6] Children taking inhaled steroids have been shown to have increased levels of gingivitis.[6,7]

Hence, asthmatic children have an increased incidence of dental caries, gingivitis, and calculus (in some cases) and an altered salivary composition and flow rate. The aim of this study was to determine the dental status with respect to dental caries, periodontal disease, and tooth surface loss in a population of school children with asthma.

Methods

A total of 100 asthmatic patients were examined between August 1995 and January 1996. The study group consisted of two convenience samples with the first sample consisting of 50 children attending the Paediatrics Outpatients Department at Leeds General Infirmary and the second consisting of 50 children attending two general medical practices in Guiseley and Yeadon, West Yorkshire. All of the patients were aged between 4 and 16 years, had been previously diagnosed with asthma, and were currently using an inhaler. Children who had taken antibiotics within the month prior to the study were excluded. A control group of 149 children was obtained by oversampling a group of 300 school children and then equating them to the asthmatic children with respect to age, sex, race, and socioeconomic status. Socioeconomic status was determined using the Townsend Index.[17] As the study group was a convenience sample consisting of asthmatic children routinely attending their physician, the examiner was fully aware of which children had asthma and hence the study was not "blind".

The investigator was trained in three calibration exercises: caries diagnosis, periodontal status, and tooth surface loss. A pilot study was carried out on 20 asthmatic children. In order to test intraexaminer reproducibility for caries and tooth surface loss, 10 patients from the pilot study were reexamined 3 weeks after the initial screening.

Each child was examined while seated with facial illumination being provided by a 60 W Daray lamp (Daray "versatile light" Model No. SL400/222) situated 1 m from the patient. The BASCD criteria[18, 19] were used for caries diagnosis. Each tooth surface was examined using visual-only criteria with a plane mouth mirror. If doubt existed as to the extent of the carious lesion, the lesser code was always chosen. Oral debris, gingival condition, and calculus were assessed using the criteria described by Todd and Dodd.[20] Oral debris was coded as either no deposits, small amounts of recent deposits, or abundant amounts of long-standing deposits. Gingival condition was recorded as either healthy, mildly inflamed, or very inflamed and erythematous. Calculus was recorded as being either present or absent. Tooth surface loss was recorded using the Tooth Wear Index[21] which coded the site and severity of the tooth surface loss. Severity was coded as follows: no loss of enamel (code 0), loss of enamel surface characteristics (code 1), loss of enamel exposing dentin for less than one-third of the surface (code 2), loss of enamel exposing dentin for more than one-third of the surface (code 3), and complete loss of enamel, pulp exposure, or exposure of secondary dentin (code 4). For oral debris, gingival condition, and tooth surface loss, the mouth was divided into six parts (i.e., sextants) with each jaw having three sextants, namely right, left (distal surface of the canine to the distal surface of the most posterior tooth present for either side), and middle (distal surface of the right canine to the distal surface of the left canine). Each tooth unit was given an individual score for the parameter being measured and the highest score was recorded for each sextant.

The data was entered into the Survey Plus Data System (Providence Software Services, Bristol, England) and analyzed in two age groups, 4–10 years and 11–16 years, to determine whether age was a variable affecting the parameters being measured. There were 54 asthmatics and 75 controls in the younger age range and 46 asthmatics and 74 controls in the older age range. There were more subjects in the control group than the study group and all of the statistical analyses took this into account. The Mann-Whitney *U* test was used for analyses of dental caries, tooth surface loss, plaque, and gingivitis. Analysis of calculus data was carried out using chi-square test with Yates' correction for continuity. Probability levels of less than 5% were considered significant for all of the analyses.

Results

There was a high level of agreement between trainer and investigator for caries diagnosis, periodontal condition, and tooth surface loss with respective kappa scores of 0.88, 0.89, and 0.92. Intraexaminer reproducibility was tested at the beginning of the study by re-examining 10 patients from the pilot study and at the end of the study by examining 15 children from

TABLE 1. DENTAL CARIES IN PRIMARY AND PERMANENT TEETH IN A GROUP OF ASTHMATIC CHILDREN COMPARED WITH A CONTOL GROUP

		Control group		*Study group*	
Age (years)		*N*	*mean (± SD)*	*N*	*mean (± SD)*
4–10 yrs	dmft	74	1.77 (± 2.38)	53	2.74 (± 3.07)
	DMFT	75	0.31 (± 0.86)	49	0.96 (± 1.46)*
11–16 yrs	dmft	31	0.87 (± 1.31)	8	0.50 (± 0.71)
	DMFT	74	1.11 (± 1.70)	46	2.48 (± 3.05)†
4–10 yrs	dmfs	74	2.97 (± 4.29)	53	6.32 (± 8.71)
	DMFS	75	0.37 (± 1.08)	49	1.37 (± 2.22)*
11–16 yrs	dmfs	31	1.74 (± 2.60)	8	0.75 (± 1.30)
	DMFS	74	1.97 (± 3.71)	46	3.39 (± 4.48)†

* $P < 0.01$, † $P < 0.05$.

TABLE 2. PLAQUE SCORES IN A GROUP OF ASTHMATIC CHILDREN COMPARED WITH A CONTROL GROUP

		Maxilla		*Mandible*	
Sextant	*Code*[*]	*Study (N)*	*Control (N)*	*Study (N)*	*Control (N)*
4–10 yrs					
Right	0	9	29[†]	10	31[†]
	1	32	32	36	31
	2	13	14	8	12
Middle	0	3	29[**]	7	29[‡]
	1	30	32	33	33
	2	21	14	14	13
Left	0	6	30[‡]	9	35[‡]
	1	34	32	35	28
	2	14	13	10	12
11–16 yrs					
Right	0	14	28	15	31
	1	17	29	18	29
	2	15	17	13	14
Middle	0	13	26	18	31
	1	15	31	13	27
	2	18	17	15	16
Left	0	15	28	17	33
	1	13	31	18	28
	2	18	15	11	13

[*] 0 = no plaque, 1 = moderate plaque deposits, 2 - numerous plaque deposits.
[†] $P < 0.05$, [**] $P < 0.001$, [‡] $P < 0.01$.

the control group twice on the same day. There was no difference in the assessment of caries, tooth surface loss, or calculus. The kappa scores for plaque and gingivitis were 0.84 and 0.85 respectively.

The results for dmft, dmfs, DMFT, and DMFS in both age ranges are shown in Table 1. There were significant differences in the DMFT and DMFS for the 4–10-year age group ($P < 0.01$) and for the 11–16-year age group ($P < 0.05$).

The 4–10 year olds in the asthma group had significantly more plaque deposits than controls (see Table 2). The maxillary middle sextant was most severely affected with the number of children in the study and control groups with no plaque, moderate plaque, and numerous plaque being 3, 30, and 21 and 29, 32, and 14, respectively ($P < 0.001$). Similarly, there was a highly significant difference in the levels of gingivitis found in the 4–10-year age group; for example, for the maxillary middle sextant the number of asthmatic and control children with healthy gingivae, mild gingival inflammation, and severe gingival inflammation was 22, 22, and 10 compared with 65, 8, and 2, respectively ($P < 0.001$). The results for gingivitis are shown in Table 3. In the younger age group, 42 of the asthmatic children had calculus compared with only 10 control group children. For the older age group 29 asthmatics had calculus compared with 18 of the controls. These differences were highly statistically significant ($P < 0.001$).

While collecting the data for the asthma study group, a general clinical impression emerged of a pattern of tooth surface loss where the labial and incisal surfaces of the anterior teeth and the occlusal surfaces of the posterior teeth were predominantly affected. In analyzing the data, therefore, it was decided to compare the prevalence of the anterior labial surfaces and posterior occlusal surfaces affected by tooth surface loss in both the study and control groups. Only those children with one or more teeth in each sextant at risk from tooth surface loss were included in the analysis. In the 11– 16-year age group, there were insufficient primary teeth for analysis and so this category was eliminated. The Mann-Whitney *U* test was used to identify any differences between the study and control groups. In the primary dentition of 4–10 year olds there was more tooth surface loss in the asthmatic children for the maxillary left sextant ($P < 0.05$). The asthmatic children had significantly more permanent teeth affected by tooth surface loss in both age ranges. In the younger age range, the maxillary middle sextant had significantly more teeth affected by tooth surface loss ($P < 0.05$). More permanent teeth were affected by tooth surface loss in all sextants in the older age range compared with controls. This difference was statistically significant in the maxillary arch ($P < 0.001$).

The severity of tooth surface loss in each sextant was determined by recording the highest score for that sextant. Again, only subjects with one or more teeth at risk per sextant were included in the analyses. The scores of severity per sextant were compared for the study and control children using the Mann-Whitney *U* test. The results for the primary and permanent teeth are shown in Tables 4 and 5, respectively. For the primary teeth, the asthmatic children had significantly more severe tooth surface loss compared with the control children—maxillary sextants ($P < 0.01$), mandibular buccal sextants ($P < 0.05$). For the permanent teeth in the 4- to 10-year age range, the maxillary middle sextant had more severe tooth surface loss ($P < 0.05$). In the 11- to 16-year age range, the asthmatic children had significantly more severe tooth surface loss affecting all sextants but it was most severe in the maxillary arch ($P < 0.001$).

TABLE 3. GINGIVITIS SCORES IN A GROUP OF ASTHMATIC CHILDREN COMPARED WITH A CONTROL GROUP

		Maxilla		*Mandible*	
Sextant	*Code**	*Study (N)*	*Control (N)*	*Study (N)*	*Control (N)*
4–10 yrs					
Right	0	32	67†	24	68†
	1	18	6	25	6
	2	4	2	5	1
Middle	0	22	65†	26	67†
	1	22	8	20	6
	2	10	2	8	2
Left	0	29	67†	30	68†
	1	18	7	18	6
	2	7	1	6	1
11–16 yrs					
Right	0	24	59†	23	59†
	1	14	13	16	12
	2	8	2	7	3
Middle	0	21	56†	21	56†
	1	10	15	16	15
	2	15	3	9	3
Left	0	26	59††	23	60†
	1	14	13	16	11
	2	6	2	7	3

* 0 = healthy gingivae, 1 = mild gingival inflammation, 2 = severe gingival inflammation.
† $P < 0.001$, †† $P < 0.01$.

Discussion

The asthmatic children had more caries in both primary and permanent teeth, although no significant difference was found for primary teeth when compared with the control children. The large standard deviations indicated that the caries experience data for these children was not normally distributed, showing that some children had a lot of decay and some children had very little. This may be partly explained by the practice group having a higher socioeconomic profile than the hospital group; it is well documented that higher socioeconomic groups have better dental health than lower groups.[20, 22]

There may be a number of reasons for the higher level of caries experience in asthmatic children. One important factor is the medication these children were taking in the form of inhalers and liquid medicines. The majority of patients in the asthma group were taking a beta 2 agonist. The increase in caries associated with these medications is thought to be due to reduced salivary gland function[8–10] and reduced salivary flow has been shown to contribute to the formation of caries.[23] The form of inhaled medication may also be an important factor. A large proportion of the inhaled drug is retained in the oropharynx, ranging from 80% with a metered dose inhaler and dry powder inhaler to 60% with an extension tube.[24] In addition, some dry powder inhalers contain sugar, so the patient can taste when the drug has been delivered. The Rotahaler® capsule and Diskhaler® blister each contain 25 mg of lactose and the Accuhaler® (Allen & Hanburys Ltd, Uxbridge, UK) contains 12.5 mg per dose.[25, 26] Although lactose is one of the least cariogenic sugars, being less cariogenic than sucrose, glucose, and maltose,[27] it is noted that all of the above dry powder inhalers are used to deliver beta 2 agonists. The frequent oral inhalation of sugar, combined with a decrease in salivary flow rate, may contribute to an increase in caries. Liquid oral medication containing sugars taken long term can also lead to an increased caries rate,[13, 14] although in this study, oral medicines were only taken intermittently, usually for the treatment of upper respiratory tract infections. One of the difficulties in this study was the complexity of the combinations of medication and frequent alterations in the type of medication, dose, and form of inhaler. As dental caries takes months to develop, it was not considered appropriate to correlate the current medication and type of inhaler with caries experience.

Another reason for the increased caries rate in asthmatics may be an increased frequency of consumption of cariogenic drinks. During the collection of the data, the parents of asthmatic children often commented that their asthmatic children were more thirsty than their nonasthmatic siblings. This was merely an anecdotal observation but an increased thirst in these patients could be related to a number of factors including attempting to wash away the taste of the inhaled medication, the desiccating effect of mouth-breathing, and the reduction in saliva flow caused by beta 2 agonists. In addition, asthmatic children often lead restricted lifestyles, missing so much school and not being able to play sports and participate in other normal activities that these children may be overindulged and may frequently consume sweets, thus leading to increased caries levels.

In the younger group, there were significantly more plaque deposits in the mouths of asthmatic children, although there was no significant difference in the plaque levels of the study and control children in the older age range. It may be that the parents of asthmatic children are less likely to view teeth of great importance

TABLE 4. SEVERITY OF TOOTH SURFACE LOSS IN THE PRIMARY TEETH OF THE ASTHMATIC CHILDREN COMPARED WITH A CONTROL GROUP

	Severity	Maxilla		Mandible	
Sextant	Score	Study (N)	Control (N)	Study (N)	Control (N)
4–10 yrs					
Right	0	20*	42	21†	39
	1	12	26	11	26
	2	14	4	13	3
	3	6	1	3	2
	4	0	0	0	0
Middle	0	46*	70	46	70
	1	0	0	0	0
	2	2	0	0	0
	3	0	0	0	0
	4	0	0	0	0
Left	0	20**	42	22†	40
	1	11	26	14	27
	2	13	4	9	4
	3	8	1	5	2
	4	0	0	0	0

* $P < 0.01$, † $P < 0.05$, ** $P < 0.001$.

compared with the asthma itself. On the other hand older children may be more likely to look after their own teeth.

The children in the study group had significantly more gingivitis than the control group. This increase in gingivitis in asthmatics is in agreement with the findings of Hyyppä et al.,[28] who suggested that the gingivitis in asthmatic children could be explained in part by an altered immune response and by their tendency to mouthbreathe, especially during an episode of rhinitis or an acute asthmatic attack. The results from the older age group in this study showed that gingivitis predominantly affected the upper anterior gingivae. Our results are supported by a previous study which found that 55 children with enlarged adenoids had more gingivitis affecting the maxillary anterior region compared with healthy controls.[29] The author concluded that this was due to dehydration of the alveolar mucosa during mouthbreathing. Asthmatic children in our study had a higher prevalence of calculus, supporting the findings of another study.[16] This may be related to the increased levels of calcium and phosphorus found in submaxillary saliva[15] and parotid saliva.[16]

Tooth surface loss is a combination of attrition, erosion, and abrasion, with differing proportional effects.[30] In this study, attrition and erosion appeared to be the predominant types of tooth surface loss. A small amount of attrition in primary teeth is considered to be normal and so the incisal edges of teeth in the middle sextants were excluded from the analysis so that the prevalence of "pathological" tooth surface loss could be determined and "normal" tooth surface loss excluded.[31,32]

There may be many reasons for an increase in tooth surface loss in asthmatic children. The reduction in salivary flow and other possible causes of frequent fluid consumption in asthmatic patients has already been discussed. In this present study, 22% of the asthmatic study group rinsed their mouths out with water after taking inhaled medication. A larger proportion said they sometimes took a drink after using their inhaler, although this number was not recorded. The majority of the study group consumed erosive drinks on a regular basis. Erosion, caused by frequent consumption of acidic drinks affects sites where the acid takes longest to clear, principally the labial and palatal surfaces of upper anterior teeth.[32] This is partially in keeping with the findings of this study, where the labial sites were significantly more affected than controls but the palatal sites were relatively unaffected. Another cause of erosion in children is gastroesophageal reflux.[33] This condition is three times as prevalent in asthmatic children and adults[34] and can be an important trigger factor in asthma, especially at night. In the present study only 6% of the study group reported that they had suffered from gastric reflux at an early age; they had been treated and were now symptomless. Gastric reflux predominantly affects the palatal surfaces of the upper incisors and the buccal and occlusal surfaces of the lower molar teeth.[32] In this study, none of the patients who had suffered from gastric reflux had this pattern of tooth surface loss, suggesting that the condition had been successfully treated at an early age before much damage to the teeth could have been caused.

It is possible that the inhaled medication itself may contribute to erosion but it is pertinent to always keep in mind the multi-factorial nature of erosion. Further research is needed to investigate to the deposition and clearance of asthmatic drugs within the oral cavity.

Conclusions

Asthmatic British children have poorer dental health than healthy children. Asthmatic children have more decay affecting their permanent teeth and more tooth surface loss affecting predominantly the labial surfaces of anterior teeth and occlusal surfaces of posterior teeth. They were also shown to have poorer periodontal status.

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TABLE 5. SEVERITY OF TOOTH SURFACE LOSS IN THE PERMANENT TEETH OF ASTHMATIC CHILDREN COMPARED WITH A CONTROL GROUP

	Severity	*Maxilla*		*Mandible*	
Sextant	*Score*	*Study (N)*	*Control (N)*	*Study (N)*	*Control (N)*
4–10 yrs					
Right	0	43	74	47	73
	1	2	0	0	1
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
Middle	0	35•	71	42	75
	1	2	0	2	0
	2	1	0	0	0
	3	0	0	0	0
	4	0	0	0	0
Left	0	42	72	45	72
	1	2	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
11–16 yrs					
Right	0	38†	74	40•	72
	1	6	0	3	2
	2	2	0	2	0
	3	0	0	1	0
	4	0	0	0	0
Middle	0	39†	74	43•	74
	1	7	0	3	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
Left	0	38†	74	40•	72
	1	5	0	3	2
	2	3	0	2	0
	3	0	0	1	0
	4	0	0	0	0

• $P < 0.05$, † $P < 0.001$.

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