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Oral health in preschool children with asthma

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Objective. The aim of this study was to investigate oral health and its determinants in 3-year-old and 6-year-old children with asthma.

Methods and subjects. Caries and gingivitis were examined in 127 asthmatic (all children with asthma in a selected area and born during a specific time period) and 117 matched, healthy control children.The parents were interviewed regarding various oral-health-related factors.

Results. The mean dfs (± standard deviation) in the 3-year-old with asthma was 1.4 ± 3.2 compared with 0.5 ± 1.2 in the controls ($P < 0.05$). The corresponding figures for the 6-year-old were 2.5 ± 3.9 and 1.8 ± 2.8. The 3-year-old asthmatic children had more gingival bleeding than the healthy controls ($P < 0.05$). There were no significant differences in gingivitis in the 6-year-old children. Asthmatic children reported higher consumption of sugar-containing drinks and were more frequently mouth-breathers than healthy children ($P < 0.05$). In 3-year-old children with asthma and immigrant background, the mean dfs was higher compared with immigrant children in the control group ($P < 0.01$).

Conclusion. The results indicate that preschool children with asthma have higher caries prevalence than healthy children. The factors discriminating for caries in asthmatic children are higher intake of sugary drinks, mouth breathing, and immigrant background.

Introduction

Asthma is one of the most common chronic medical conditions in childhood, and it has steadily increased during the last two decades[1,2]. The prevalence of asthma in the world displays large variations. The International Study of Asthma and Allergies in Childhood shows that the highest rates are found in Australia, Peru, New Zealand, Singapore, and the United Kingdom, whereas the lowest are in Albania and Russia[3]. In reports from the Swedish Council on Technology Assessment in Health Care (SBU), about 20% of children under 2 years of age and about 10% of schoolchildren are affected by asthma symptoms[4]. Before puberty, the disease is more common in boys than in girls, whereas the gender incidence is equal after puberty[5].

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In spite of the increasing prevalence of asthma, only a limited number of studies have investigated oral health in preschool children during the last 20 years, and the results are somewhat conflicting. Some authors have reported a correlation between childhood asthma and dental caries in preschool children[6–13], whereas others have found no such connection[14–16]. Eloot *et al.*[17] found that neither the length of the disease period in 3-year-old to 17-year-old children with asthma nor the medication or the severity of the asthma disease had a significant effect on the risk of developing caries or gingivitis. In studies by Ryberg *et al.*[12,13], however, it was shown that asthmatic children who medicated with β_2 agonists had a decreased saliva secretion rate and increased levels of lactobacilli and mutans streptococci, in addition to more caries lesions, compared with healthy children. McDerra *et al.*[8] found that 4-year-old to 10-year-old children with asthma had more plaque, gingivitis, and calculus compared with healthy controls. The lack of consensus in earlier studies of preschool children could perhaps be

attributed to differences in asthma severity or asthma medication, small samples, or inconsistent age groups.

The aim of the present investigation was therefore to study oral health and its determinants in one group of 3-year-old children and one group of 6-year-old children with asthma, with special reference to asthma, severity, period of exposure to medication, and mouth breathing.

Subjects and methods

The study was approved by the ethics committee at Linköping University, and informed consent was given by the parents or care-givers before the children were examined.

Participants

Children with asthma were selected from the Department of Paediatrics at the County Hospital, Ryhov, Jönköping, Sweden and from three child welfare centres in the Municipality of Jönköping, Sweden. The participants comprised all the 3-year-old children ($n = 70$) with asthma, born between April 2001 and January 2002, and all the 6-year-old children ($n = 70$), born between April 1998 and April 1999. Furthermore, two age- and gender-matched control groups were randomly selected from the County Council's register of persons residing in the Municipality of Jönköping. The control group consisted of 3-year-old ($n = 70$) and 6-year-old ($n = 70$) without a diagnosis of asthma (status was confirmed by the parents). The ages of the children at the time of the dental examinations were 3 years (± 2 months) and 6 years (± 2 months).

Four children in the 3-year-old asthma group, and eight in the 3-year-old control group dropped out of the study. The corresponding figures for the 6 years old were 8 and 14, respectively. Moving out of the area or unwillingness to participate was the main reason for dropouts in both age groups. Of the 6-year-old children, one child in the control group was being treated at a specialist clinic of paediatric dentistry and was therefore excluded. Two 6-year-old children (one with asthma and one control) were excluded because of other chronic diseases. The final group of 3-year-old children with asthma therefore comprised 66 children, whereas 61 of the 6-year-old children were asthmatics. The corresponding figures for the control groups were 62 and 55, respectively. The girl/boy ratio in the asthma groups was 16/50 among the 3-year-old children, and 23/38 among the 6-year-old children. The corresponding figures for the control groups were 13/49 and 25/30, respectively.

Preventive programmes

Children and adolescents living in the County of Jönköping take part in a basic dental preventive programme starting at 1 year of age. The parents of the children were informed about preventive measures and were recommended to brush their children's teeth with fluoridated toothpaste twice a day. Furthermore, individually intensified preventive programmes are designed for children with special needs, such as a high caries risk or mental or physical disabilities.

Classification of children with asthma

The asthmatic children were divided into four groups by a senior paediatrician, according to the classification of severity in the Swedish guidelines on the management of asthma, Swedish Paediatric Society, Section of Paediatric Allergy, as follows: (i) mild: 3 years old ($n = 49$), 6 years old ($n = 43$), 'Exacerbations are rare and symptoms at night uncommon (≤ once a month). No use of inhaled steroids and only intermittent use of short-acting β_2 agonists'. (ii) Moderate: 3 years old ($n = 13$), 6 years old ($n = 15$), 'Exacerbations are more frequent and symptoms at night more common (2–3 times a month). Periodic use of inhaled steroids in low to moderate doses (≤ 400 μg/day) in combination with short-acting β_2 agonists'. (iii) Severe: 3 years old ($n = 3$), 6 years old ($n = 3$), 'Exacerbations weekly and regular use of inhaled steroids 100–400 μg/day and in combination with long-acting β_2 agonists or leukotriene receptor antagonists'. (iv) Very severe: 3 years old ($n = 1$), 6 years old ($n = 0$), 'Exacerbations

weekly and symptoms every day. Regular use of inhaled steroids 400–800 μg/day in combination with long-acting β_2 agonist or leukotriene receptor antagonists'.

According to the length of exposure time to the asthma drugs, the children were divided into two groups: (i) children with exposure for ≤ 2 years; and (ii) children with exposure for > 2 years. According to the regularity of inhaled steroid medication, the children were divided into two groups: (i) intermittent use in periods ≥ 1 time/day; and (ii) regular use daily ≥ 1 time/day.

Methods

Clinical examination

All the children were examined by one of the authors (M.S.) at the children's ordinary Public Dental Service (PDS) clinics (n = 10). Before the start of the study, the examiner was calibrated to an experienced dentist in terms of diagnostic criteria. Each examination took 30–45 min, and was performed with a mirror and probe, and under optimal light conditions.

Caries. Both initial and manifest caries lesions were diagnosed on all surfaces in the 3-year-old group. In order to avoid interference with exfoliated teeth, initial and manifest caries were only diagnosed on primary molars and canines in the 6-year-old group. Clinically visible initial caries was defined as 'a demineralized surface with a chalky appearance'. Clinically visible manifest caries was registered according to the criteria formulated by Koch[18], and defined as 'the minimal level that could be verified as cavities by gentle probing which, on probing in fissures, caused the probe to get stuck at slight pressure'.

Oral hygiene. Gingival inflammation was diagnosed as 'bleeding' or 'no bleeding' after gentle probing according to Loe and Silness[19] in all primary tooth surfaces in 3-year-old children (80 surfaces), and in all primary molars and canines in 6-year-old children (60 surfaces). Plaque was measured after drying the teeth with air as 'visible' or 'no visible' plaque, according to Silness and Loe[20]. Plaque was registered buccally on primary upper incisors in the 3-year-old group (four surfaces), and in all surfaces in primary molars and canines in the 6-year-old group (60 surfaces).

Radiographic examination

Two posterior bitewings were taken in 6-year-old children with a special film holder (Kwik-bite Trollhätteplast, Trollhättan, Sweden). Initial proximal caries was defined as 'a caries lesion in the enamel that has not reached the enamel–dentine junction or a lesion that reaches or penetrates the enamel–dentine junction but does not appear to extend into the dentine'. Manifest proximal caries was defined as 'a caries lesion that clearly extends into the dentine'. The bitewings were analysed by two of the authors by using a viewing box and binoculars according to Mattsson[21]. One of the examiners was not aware of the group to which the child belonged. In the event of disagreement, the findings from the radiographs were discussed until consensus was reached.

Saliva sampling

A paraffin-stimulated whole saliva sample was collected in the 6-year-old group. The sample was shaken on a mechanical mixer for 30 s and serial diluted in 0.05 M phosphate buffer (pH 7.3). Then, 25 μL portions were plated in duplicate on mitis salivarius with bacitracin (MSB) agar for the growth of mutans streptococci, and in Rogosa selective lactobacilli (SL) agar for the growth of lactobacilli. The Rogosa SL agar plates were incubated aerobically at 37 °C for 3 days. The MSB agar plates were incubated in candle jars at 37 °C for 2 days. The number of colony-forming units (CFUs) of mutans streptococci was counted on the MSB agar and identified by their characteristic colony morphology. All CFUs in Rogosa SL agar were considered to be lactobacilli. The number of CFU was transformed to logarithms before the statistical analysis. The buffer capacity of saliva was estimated by using the Dentobuff Strip test (Orion Diagnostica, Espoo, Finland), according to the manufacturer's instructions.

Table 1. Mean dfs (standard deviation) and distribution in children with or without asthma: both initial (i) and manifest (m) caries.

	3 Years old		6 Years old	
	Asthma (*n* = 66)	**Control (*n* = 62)**	**Asthma (*n* = 61)**	**Control (*n* = 55)**
With caries (%)	29	19	49	44
Mean dfs_m	0.6 (2.6)	0.1 (0.4)	1.3 (3.0)	0.9 (2.0)
Mean dfs_i	0.8 (1.6)	0.4 (1.0)	1.2 (1.9)	0.9 (1.7)
Mean dfs_{m+i}	1.4 (3.2)*	0.5 (1.1)	2.5 (3.9)	1.8 (2.8)
Mean dfs_{m+i} in children with caries	4.7 (4.4)	2.4 (1.1)	5.1 (4.2)	4.1 (2.9)
% with $dfs_{m+i} = 6$	9*	0	15	9
% with $dfs_{m+i} = 9$	2	0	10	2

*$P < 0.05$.

Interview

In connection with the clinical examination, a semistructured interview was performed. The parent/care-giver of the child was interviewed about prior and current medication, mode of administration and duration of asthma medication, immigrant background (defined as at least one parent born outside the Nordic countries), toothbrushing habits, use of fluorides, mouth breathing during the last year, and dietary habits (drinking during the night and number of daily intakes of caries risk products). The intake frequency of each risk product was registered according to Wendt and Birkhed[22], and each risk product was assigned 'points' corresponding to its regularity: 7 points indicate once a day, 1 point indicates once a week, and so on. The sum of the points for each child was then divided by seven to calculate the average number of intakes of caries risk products per day.

Statistical analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS) 13.0 software program (SPSS Inc., Chicago, IL, USA). After the computation of univariate statistics, bivariate analyses explored the association of asthma status and caries experience, whereas chi-squared tests were used to test the association with categorical dependent variables. Mann–Whitney *U*-tests were used for continuous dependent variables. Univariate and multiple logistic regression analyses were performed to explore the effects on caries of dietary habits, presence of plaque, bleeding on probing (gingivitis), mouth breathing, immigrant status, period of exposure to medication, regular use of asthma drugs, and severity of the disease. The level of significance was set at $P < 0.05$.

Results

Caries

The results are shown in Table 1. There was a general trend for asthmatic children to have somewhat higher caries prevalence than children without asthma, but it was only significant for the 3-year-old group. The caries data relating to children who dropped out of the study were collected from records from the children's ordinary PDS clinics, and revealed that 75% of the 3-year-old children were caries free, which is in accordance with the children participating in the study: 71% of the 3-year-old children in the asthmatic group and 81% of the 3-year-old children in the control group were caries free. The corresponding figures for the 6-year-old group were 66%, 51%, and 56%, respectively.

Oral hygiene and dietary habits

Data are shown in Table 2. There was no significant difference when it came to the frequency of toothbrushing between asthmatic and non-asthmatic children, and all the children used fluoridated dentifrice.

Table 2. Number and percentage of distribution of 3-year-old and 6-year-old children in accordance to characteristics with relevance to dental health.

	3 Years old				6 Years old			
	Asthma (n = 66)		Control (n = 62)		Asthma (n = 61)		Control (n = 55)	
	n	%	*n*	%	*n*	%	*n*	%
Sugary drinks > 1 times/day	24	36*	10	16	26	43	18	33
Presence of plaque	16	24	11	18	22	36	22	41
Gingivitis	9	14*	0	0	10	16	5	9
Mouth breathing frequently	17	26*	5	8	19	31	9	17
Immigrant status	18	27	25	40	7	12	7	13

*$P < 0.05$.

Mouth breathing

The results are shown in Table 2. There was a general trend for asthmatic children to have a somewhat higher prevalence of mouth breathing than children without asthma, although it was not significant for 6-year-old children. In 3-year-old children with asthma and frequent mouth breathing, the mean dfs was 3.1 ± 5.0 compared with 0.8 ± 1.9 in asthmatic children without mouth breathing ($P < 0.05$). At 6 years of age, there was no significant difference in caries prevalence between mouthbreathers and non-mouthbreathers.

Immigrant status

The results are shown in Table 2. Immigrant children with asthma had a mean dfs of 2.0 ± 2.8 compared with 0.3 ± 0.7 for children in the control group with an immigrant background ($P < 0.01$). In 6-year-old immigrants with asthma, the mean dfs was 3.5 ± 5.3 compared with 0.4 ± 0.8 in immigrants in the control group ($P = 0.1$).

Salivary and microbiological factors

One 6-year-old child in the asthma group and seven in the control group did not cooperate with the saliva sampling. Of the remaining 108 children, no mutans streptococci or lactobacilli were detected in about 60% of the children, the same results in both groups. The mean numbers (log CFU/mL) of mutans streptococci were 4.66 ± 0.71 in the asthma group, and 4.73 ± 1.61 in the control group. The corresponding figures for lactobacilli were 3.60 ± 0.97 and 3.87 ± 1.78, respectively. The distribution of buffer capacity classes according to Dentobuff was about the same in the two groups: only one child in the asthma group and three in the control group displayed a low buffering capacity. None of the differences relating to the microbiological and salivary factors was statistically significant.

Medication

The most common mode of administering the asthma drugs was by inhalation using a metered dose inhaler in both age groups. Inhalation using a dry powder inhaler occurred more frequently in the 6-year-old group than in the 3-year-old group. The mean dfs was 2.6 ± 5.5 for 3-year-old children who medicated regularly with steroids (n = 22) compared with 1.2 ± 1.9 for 3-year-old children who medicated intermittently (n = 40). Among the 6-year-old children, the corresponding figures were 3.0 ± 5.0 (n = 29) compared to 2.0 ± 3.0 (n = 32). None of the differences were statistically significant.

The mean period of exposure of asthma medication was 21 months for the 3-year-old children, and 40 months for the 6-year-old children. There was no statistically significant difference in mean dfs in children who had medicated for more than 2 years compared with children who had medicated for 2 years or less.

Severity of the disease

In the 3-year-old children with mild asthma (n = 49), the mean dfs was 1.1 ± 2.1 compared with 5.5 ± 9.7 in children with severe/very

Table 3. Independent variables in relation to caries (dependent variable) in 3-year-old and 6-year-old children with asthma.

Independent variables	3 Years old (*n* = 66)						6 Years old (*n* = 61)					
	Univariate logistic regression			Stepwise multiple regression			Univariate logistic regression			Stepwise multiple regression		
	OR	CI	*P*	OR	CI	*P*	OR	CI	*P*	OR	CI	*P*
Sugary drinks > 5 times/week	3.8	1.2–12.1	0.02									
Visible plaque	5.1	1.5–17	0.01	4.6	1.0–20.1	0.04	6.8	2.1–22.6	0.00	6.8	2.1–22.6	0.00
Mouth breathing	9.4	2.7–32.8	0.002	7.5	1.9–30.5	0.00						
Immigrant status	3.8	1.2–12.1	0.02	5.3	1.3–22.3	0.02						

CI, 95% confidence interval; OR, odds ratio; *P*, *P* value.

severe asthma ($n = 4$). The corresponding figures for 6-year-old children were 2.4 ± 3.4 ($n = 43$) and 3.7 ± 6.4 ($n = 3$), respectively. The differences were not statistically significant.

Multiple logistic regression analyses

The results of the multiple logistic regression analyses for different outcome variables in the asthma groups are presented in Table 3. Variables that indicated an increased risk of caries development in 3-year-old children with asthma were sugary drinks more than once a day, presence of plaque, mouth breathing, and immigrant background. In the stepwise logistic regression analyses for 6-year-old children with asthma, the presence of plaque was the only variable that indicated an increased risk of caries development. In a similar analysis performed for children in the control groups, no independent variable showed an increased risk of caries development.

Discussion

The relationship between the asthmatic condition and caries prevalence in preschool children is difficult to examine. The asthma disease, its severity, and the medication often fluctuate over time according to the seasons. Furthermore, the start of the asthmatic disease is difficult to assess. Despite this, this study has revealed a difference in caries prevalence in asthmatic and non-asthmatic preschool children, even though it was not significant for 6-year-old children. The difference between the two age groups, 3 years and 6 years of age, might be because of the fact that the group of asthmatic 3-year-old children is more homogeneous in terms of the onset of the disease than the group of asthmatic 6-year-old children. One of the strengths of this study is that, unlike most other studies[7–9,11] conducted in preschool children with asthma, this study comprised all the children registered as having asthma within the selected geographical areas, and the children were all 3 years or 6 years of age at time for examination. One limitation, however, is that all participating children came from geographical areas with a high socioeconomic profile and thereby had a lower caries prevalence than a random sample of preschool children from the Municipality of Jönköping[23].

A series of factors could influence the statistical outcome of this study. One such factor could be the skewed distribution of caries prevalence, and another could be the large standard deviation, which results in difficulty obtaining statistically significant differences. The present investigation, however, has revealed differences in caries prevalence in children with and without asthma. This is in line with previous studies[7–13], which have shown a correlation between childhood asthma and dental caries. Wogelius *et al.*[24] compared children with asthma drug use with children without asthma drug use, and 'found no increased risk of dental caries in the deciduous teeth, while in the newly erupted permanent teeth, the risk was increased'. Furthermore, in this study, 9% of the 3-year-old asthmatic children had six or more caries lesions, compared with none in the control group, and 10% of the 6-year-old children with asthma had nine or more caries lesions, compared

with 2% of the children in the control group (Table 1). This indicates that asthma triggers caries development in asthmatic children.

The multiple logistic regression analyses showed that sugary drinks, presence of visible plaque, mouth breathing, and immigrant status were more common in 3-year-old children with asthma and caries than in 3-year-old children with asthma but without caries. These factors are well-known risk factors for caries development in young preschool children[22,25,26]. However, none of these risk factors showed an increased risk of caries development in 3-year-old children without asthma. Reasons to why none of these risk factors could be identified among the non-asthmatic 3-year-old children might be the skewed distribution of caries or that all children came from areas with high socioeconomic profile.

In agreement with previous studies[27], mouth breathing was more prevalent in preschool children with asthma than in healthy preschool children. This may explain why 3-year-old children with asthma experienced significantly more bleeding on probing (gingivitis) than preschool children without asthma, and why plaque was more prevalent in both 3-year-old and 6-year-old children with asthma compared with children without asthma. Mouth breathing could also be an explanation for the frequent consumption of sugar-containing drinks in asthmatic 3-year-old children.

It has been suggested that the main reasons for the increased caries prevalence in asthmatic children could be reduced salivary flow, and increased levels of mutans streptococci and lactobacilli in saliva[13]. In this study, no connection between caries prevalence and microbiological factors in 6-year-old children could be demonstrated.

In line with a study by Eloot *et al.*[17], this study was unable to demonstrate any connection between the severity of the asthma, the period of exposure to medication, and caries prevalence. If such a connection is to be assessed, preschool children with early asthma onset should be followed for a long time. Further longitudinal research is therefore needed to clarify how the severity of the disease and the period of exposure to medication affect the oral health of asthmatic children.

To conclude, the main differences between asthmatic children who did and did not develop caries lesions were mouth breathing, the consumption of sugar-containing drinks, and the presence of plaque for the 3-year-old children and the presence of plaque and gingivitis for the 6-year-old children. The parents of preschool children with asthma should therefore be encouraged to brush their children's teeth carefully twice a day with fluoridated dentifrice, and to give their children water to drink when they are thirsty.

Conclusions

The results of this investigation show that: (i) preschool children with asthma have a higher caries prevalence than healthy children; (ii) asthmatic 3-year-old children with caries consume sugar-containing drinks more frequently than caries-free asthmatic 3-year-old children; and (iii) bleeding gingivitis was more prevalent in asthmatic 6-year-old children with caries than in caries-free asthmatic 6-year-old children.

What this paper adds

- This study shows that preschool children with asthma have higher caries prevalence than preschool children without asthma.
- The results of this study reveal that asthmatic preschool children with caries had more visible plaque than asthmatic caries-free preschool children.

Why this paper is important to paediatric dentists

- It points to the importance of developing preventive dental programmes for preschool children with asthma.
- It points to the importance of developing collaboration between dental and medical care-givers in relation to children with asthma.

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