Oral health and habits in children with asthma related to severity and duration of condition

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Abstract. Aim This study was designed to examine the oral health status of asthmatic children and to compare the oral health condition and habits of different groups of asthmatic children. Methods 140 asthmatic children were involved in the present study. Of those, 30 were younger than 7 years of age, 73 were between 7 and 12, 37 were older than 12. Dental caries was scored according to the guidelines of the BASCD. No radiographs were taken. The gingival health and the amount of plaque were assessed using the bleeding index described by Mühlemann and Son [1971] and the plaque index of Silness and Löe [1964] respectively. To differentiate between the asthmatic children three explanatory variables were used: the time the asthmatic symptoms had lasted, the exposure time to the medication and the severity of the asthmatic condition. Finally the parents and children were asked to fill in a questionnaire referring to oral health habits. Results The mean dmft was 1.99 (SD±2.74) and the mean DMFT was 1.10 (SD±1.98). Non-parametric correlation and multiple logistic regression analyses showed no significant difference between the caries (dmft/s, DMFT/S), the gingival health (bleeding index) and plaque indices and the three explanatory variables. The impact of possible compensatory factors as oral hygiene and dietary habits was of no significant importance. Conclusion This analysis revealed that neither the period (of the disease and the medication) nor the severity of the asthma had a significant influence on the risk of caries and gingivitis in asthmatic children. No reported oral health and dietary habits could explain this lack of correlation.

Keywords: Children, Asthma, Oral health condition, Severity.

Introduction

In the literature there is a lack of consensus regarding the relationship between dental caries risk and asthma in a child population. Some studies concerning medically compromised children [Storhaug, 1985; Arnrup et al., 1993] reveal that children with asthma have a significant increased caries prevalence compared to other chronically sick children. Bjørkeborn et al. [1987] found no statistically significant difference between dfs-scores of asthmatic children and non-asthmatic controls. They warned, however, of a decrease of secretion rate of saliva found in asthmatic children taking beta-adrenergic agonists. Compared with a non-asthmatic age and sex-matched control group, a 4-year follow-up study of Ryberg et al. [1987, 1991] reported that asthmatic children exhibited a significant increase of DFS-scores. In the study of Kankaala et al. [1998] the timing of the first fillings in permanent first molars did not significantly differ between asthmatic and non-asthmatic children. The asthmatic group, however, showed more restorations and extractions of primary molars than controls. Despite the fact that some recent studies [Meldrum et al., 2001; Shulman et al., 2001] provided little evidence for an asthma-caries causative relationship, most reports have concluded that the asthmatic condition, through either its disease status or its pharmacotherapy, carries several factors for an increased caries risk.

The rationale mostly reported in support of this hypothesis is the risk related to the pharmacological aspects of the disease, in particular the effect of the medication on the salivary flow and the salivary and plaque pH. A decrease of the salivary and plaque pH has been detected in asthmatic children after the use of aerosol metered-dose inhalers [Kargül et al., 1998].
Inhalant powders (Diskhaler), as the powdered form of Flixotide (Fluticasone) and Serevent (Salmeterol), contain lactose as a carrier for the active substance of the medicine. The pH values of most inhalant powders are less than 5.5 [O'Sullivan and Curzon, 1998]. Of the dose inhaled by a Diskhaler, 80% precipitates in the mouth. This low pH value of the inhaled drug, associated with a reduced salivary flow rate, may make asthmatics more susceptible to erosion [Shaw et al., 2000; Al-Dlaigan et al., 2002].

Lenander-Lumikari et al. [2000] examined the effect of three different steroids on plaque pH. The dry powder inhalers containing lactose caused a decrease in plaque pH, but all values remained above the critical level of pH 5.5. The use of a Turbohaler (no lactose carrier) did not affect plaque pH.

A recent study of Tootla et al. [2004] evaluated the acidogenic potential of asthma inhalers, metered dose inhaler and dry powder inhaler formulations. Although none of the inhalers were able to demonstrate an acidogenic response below the “critical” pH, the substantial pH drops observed with the lactose-based dry powder inhalers may be an important consideration for enamel demineralisation.

With exception of the study of Kargül et al. [1998] thus far no other published report could prove a significant oral pH reducing effect of inhalers to or below the critical level of pH 5.5.

There are only a few reports [Bjerkeborn et al., 1987; Shulman et al., 2001] from studies that compare the caries risk of different groups of asthmatic children with differences in asthma severity or duration. This approach could help to clarify some variability in caries risk, as suggested by Kankaala et al. [1998]. If the asthmatic condition is causal, then the risk of caries should be related to the degree of severity and duration of the exposure.

The aim of this study was, therefore, to examine the oral health status of asthmatic children and to compare the oral health condition and habits of different groups of asthmatic children based on the severity and the duration of the condition.

**Materials and methods**

This study was approved by the ethical committee of the University of Ghent. Informed consent was given by the parents before examining their children.

**Sampling and clinical examination.** During their routine examination at the paediatric clinic (University Clinic of Ghent, period 1999-2001) a convenience sample of 140 asthmatic children was selected for the present study. The age of the children in the sample ranged from 3 years 2 months to 17 years 7 months. Of the 140 children, 30 were less than 7 years old, 87 between 7 and 12, 23 older than 12. The male/female ratio was 93/47, which is in accordance with the reported distribution of asthma in children. Until puberty, asthma is more common in boys than in girls, but after puberty the incidence is equal [Nicolai et al., 2003].

In order to distribute the children into different groups, information from the medical files of the patients was used. The onset and the severity of the asthmatic condition were based on the reports made by a physician (FD). To differentiate between the asthmatic children three explanatory variables were used: the time the asthmatic symptoms had lasted (<2 years, 2-5 years, 5-10 years, >10 years), the exposure time to the medication (<2 years, 2-5 years, 5-10 years, >10 years) and the severity of the asthmatic condition (occasional/mild, moderate, severe and very severe). The distribution of these variables is reported in Table 1. Asthma was graded as:

- occasional/mild (19.4% of the asthmatic children) when exacerbations were rare (≤1/month), symptoms at night were uncommon (≤2/month) and only intermittent use of β2-mimetics was needed;
- moderate (33.3%) when exacerbations were more frequent (2-3/month), symptoms at night were more common (>2/month), β2-mimetics were needed nearly every day and a low daily dose of inhalation corticoids was prescribed (<400 mcg/day);
- severe/very severe (47.3%) when exacerbations appeared weekly, symptoms occurred every day, frequently at night, physical activity was limited and higher doses of inhalation corticoids were needed (severe asthma >400 mcg/day and very severe asthma >1000 mcg/day) or when an extra oral intake of corticoids was necessary (in case of very severe asthma) [Baran et al., 1997].

The oral health of the children was assessed by a clinical oral examination performed by a single calibrated examiner (AE) who was blind to individual children’s group allocation. Calibration was done in the course of a large epidemiologic study in which the examiner had participated. The examiner’s kappa-score for intra-examiner reliability was 0.86. The examination was performed in daylight conditions with an extra source of light. Dental caries was scored according to the guidelines of the British Association for the Study of Community Dentistry, BASCD [Pitts et al., 1997].
Hard tissues were evaluated with a mirror and a WHO/CPITN type E probe. Decay was recorded at the level of cavitation. No radiographs were taken. The gingival health and the amount of plaque (of the Ramfjord teeth) were assessed using the sulcus bleeding index described by Mühleman and Son [1971] and the plaque index of Silness and Löe [1964], respectively.

**Oral health and dietary habits.** Information on oral health habits was collected using a questionnaire, completed by the parents of the children. This questionnaire consisted of inquiries referring to dental attitudes, dental awareness, oral hygiene and the use of fluoride and dietary habits. At the time of the examination the parents were partially interviewed to verify the reliability of the answers.

Criteria for the judgement of the dietary habits were the quality (sweet/non sweet) of the basic meals and the between-meal snacks and the frequency of intake of these snacks. An overall score was given using different weights for the different components. The highest weight was given to the frequency of intake of sugared between-meal snacks. This concept, of weighting, based on the impact of the different parameters, was based on previous research assessing risk indicators for dental caries in primary school children in Flanders [Vanobbergen et al., 2001].

Oral hygiene was scored on the basis of several variables: frequency of brushing, moment of brushing in relation to the intake of medication and meals, use of an electric toothbrush, rinsing the mouth with water after taking the inhalers, use of fluoride supplements, and two questions with regard to attitude: about the consequence of oral hygiene for general health and about the importance of brushing the teeth. Most weight was attached to the frequency of brushing [Vanobbergen et al., 2001]. Depending on the analysis these variables were used both as a discrete or as a dichotomised variable, using the median as a cut-off point.

**Statistical analysis.** The correlation between the different variables included in the analyses - the outcome, oral health (caries, plaque and gingivitis), intermediate (diet and oral hygiene) as well as the three explanatory variables - was calculated by non-parametric correlation analysis. Spearman significance test was used for association.

Multiple logistic regression models adjusted for age were used to further estimate the association between the explanatory variables and the presence or absence of caries in the primary and permanent dentition, favourable or unfavourable oral hygiene habits and tooth friendly or rather tooth unfriendly dietary pattern. Odds ratios and their 95% confidence intervals were computed for each outcome. A level of significance of 0.05 was chosen. SPSS version 10.0 was used to conduct the analyses.

**Results**

**Descriptive analysis.** The distribution of the explanatory variables ‘duration of the asthmatic symptoms’ and ‘exposure time to the medication’ is reported in Table 1. Table 2 shows the mean dmf/DMF values for teeth and surfaces, the mean plaque indices and bleeding indices of the total study group and the different age groups. The reported oral hygiene was moderate or good in 79.7% of the asthmatic population, 20.3% had an unfavourable oral hygiene behaviour. The reported dietary habits were moderate or good in 71.9% of the study population. Of the asthmatic children 28.1% had tooth unfriendly dietary habits.

**Inferential analysis.** No significant correlation (Spearman correlation) was found between the immediate oral health outcome variables (dmf/DMF, plaque indices and bleeding indices) and the explanatory variables (duration of asthma, time of intake of medication and severity of asthma). When searching for possible compensatory factors no correlation could be found between the lifestyle intermediate variables (oral hygiene and dietary habits) and the explanatory variables.

The results of the multiple logistic regression analyses for the different outcome variables are reported in Table 3. In the present analyses the dmf index, oral hygiene and diet were used as response variables and dichotomised: caries versus no caries, favourable versus non favourable oral hygiene and a tooth friendly versus tooth unfriendly diet. A caries-
free dentition (dmf=0), a favourable oral hygiene and a tooth friendly dietary pattern contributed as references to the results of the logistic regression analyses. No significant differences were found between the dmf-values of groups with different duration of asthma, exposure to medication and difference in severity of the disease.

**Discussion**

As the asthmatic condition is difficult to examine, the disagreement of examiners about the relation between asthma and caries is understandable. The disease, its severity and the medication are often fluctuating in time and according to the seasons. The start of the asthmatic condition is difficult to assess.

This study contributes useful information to further substantiate the relationship between asthma and caries, investigating an extra criterion in the concept of causality: the dose-response relationship. If the asthmatic condition is causal, then the risk of caries should be related to the degree of severity and duration of this exposure. However, the presence of an observed dose-response relationship, as useful as it may seem, has to be taken with proper reservation. A dose-response relationship, based on the severity and the duration of the disease, does not always mean that the association is one of cause and effect. It may merely reflect the effect of an uncontrolled confounding factor. For example, medication, inherent in asthmatic conditions, could be the confounding factor [McDerra et al., 1998]. These days there is a wide range of medications used to treat and prevent airway obstruction. Approximately 80% of inhalant powders, such as Diskhaler, are retained in the mouth. Only 6 to 12% of the inhaled dose precipitates intra-bronchially. The oral and pharyngeal precipitation after use of a Turbohaler is much lower (50%) [Baran et al., 1997]. To control for this confounding effect, medication was incorporated in the analyses but one of the limitations

<table>
<thead>
<tr>
<th>Group</th>
<th>dmft (SD*)</th>
<th>dfmfs (SD)</th>
<th>DMFT (SD)</th>
<th>DMFS (SD)</th>
<th>Bleeding index (SD)</th>
<th>Plaque index (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total study group</td>
<td>1.99 (2.74)</td>
<td>5.15 (7.95)</td>
<td>1.10 (1.98)</td>
<td>2.07 (4.45)</td>
<td>0.20 (0.37)</td>
<td>0.91 (0.28)</td>
</tr>
<tr>
<td>0-6 year old</td>
<td>1.97 (3.28)</td>
<td>4.97 (9.94)</td>
<td>0.13 (0.52)</td>
<td>0.13 (0.52)</td>
<td>0.15 (0.28)</td>
<td>0.82 (0.62)</td>
</tr>
<tr>
<td>7-12 year old</td>
<td>2.03 (2.50)</td>
<td>5.31 (7.00)</td>
<td>0.92 (1.52)</td>
<td>1.58 (3.07)</td>
<td>0.22 (0.42)</td>
<td>0.94 (0.51)</td>
</tr>
<tr>
<td>&gt;12 year old</td>
<td>2.39 (3.20)</td>
<td>5.13 (7.73)</td>
<td>0.20 (0.22)</td>
<td>0.91 (0.57)</td>
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*Standard Deviation

**Table 2** - The mean ±SD dmft(s)/DMFT(S) values, bleeding and plaque indices for the total study group and the different age groups in a study on asthmatic children.

<table>
<thead>
<tr>
<th>Outcome variables</th>
<th>Duration of asthmatic symptoms OR (CI)**</th>
<th>Exposure time to medication OR (CI)</th>
<th>Severity of asthma OR (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caries deciduous dent</td>
<td>1.61 (0.64/4.03)</td>
<td>0.31</td>
<td>0.80 (0.36/1.79)</td>
</tr>
<tr>
<td>Caries permanent dent</td>
<td>1.15 (0.58/2.29)</td>
<td>0.70</td>
<td>0.84 (0.46/1.53)</td>
</tr>
<tr>
<td>Oral hygiene</td>
<td>0.86 (0.35/2.10)</td>
<td>0.74</td>
<td>1.32 (0.58/3.00)</td>
</tr>
<tr>
<td>Diet</td>
<td>0.99 (0.51/1.93)</td>
<td>0.98</td>
<td>0.74 (0.40/1.35)</td>
</tr>
</tbody>
</table>

*Odds Ratio
**95% Confidence Interval

**Table 3** - Statistical values by multiple logistic regression models (odds ratios, 95% confidence intervals and p-values, adjusted for age), with caries in the primary and permanent dentition, oral hygiene and diet respectively as outcome variables and duration of asthmatic symptoms, exposure time to medication and severity of asthma as explanatory variables.
of this study might be that only the exposure time to the medication was used in the analyses and not the type of medication, the inhaled daily dose, the form and mode of administration. All these factors were recorded in the questionnaire, but because of their complexity and their alterations they were not retained in the analyses. Furthermore, as dental caries is an evolutionary process, it is not appropriate to correlate the actual presence of caries with the current medication (type, form and dose) [McDerra et al., 1998]. The frequent and long term intake of liquid medicines, such as antibiotic and antihistaminic agents, can also lead to an increase in the actual caries prevalence [Karjalainen et al., 1992; Maguire et al., 1996]. Some of the asthmatic children intermittently used these oral medications, especially at night before bedtime. The present study did not take these syrups into account because of the variability of their use.

It also appears to be a reasonable assumption that, precisely because these children are under medical supervision and are considered as ‘problems’, asthmatics will be encouraged to intensify measures of dental self-care. Nowadays, in general, parents’ care of their children’s oral hygiene has improved. In this study 79.9% of the asthmatic children had a reasonable reported oral hygiene. The reported dietary habits were moderate or even good for 71.9% of the children in the study group.

The oral health habits and dietary habits could be seen as an effect modification, that is, when the association between the exposure (severity, duration) and disease (caries) varies by levels of this third factor (hygiene and dietary habits). They could influence the amount of caries without having an effect on the severity and the duration of the asthma. But there were no differences in relationship between severity and duration of asthma and caries prevalence for varying levels of oral health habits. Probably this effect modification was of no significant importance.

Another limitation of the study is the use of a convenience sample, composed of children treated in university hospital premises. This will limit the external validity of the study. It is known that parents of hospitalised children give more care and attention to their children in order to control the disease. The potential for selection bias, due to this hospital based procedure, could result in a higher proportion of children with severe asthma. The use of a convenience sample also resulted in an unequal number of children in each age group. Most of the children (62%) were situated in the middle age group (7-12 year) and consequently were in the mixed dentition. This is an important factor as specific guidelines exist in the asthma medical literature for age-appropriate inhaler devices. So if any deleterious oral effect were to result from the use of specific types of inhaler devices, this effect would probably be biased in the present study.

**Conclusion**

The results of the present investigation reveal no dose-response relationship between the severity and duration of asthma and caries. This could confirm the results of more recent studies that provide little or no evidence for an asthma-caries causative relationship [Meldrum et al., 2001; Shulman et al., 2001]. This analysis could not demonstrate that either the duration (of asthma), prolonged use of anti-asthmatic medication, or the severity of the asthma had a significant influence on the risk of caries and gingivitis in asthmatic children. No compensatory effect of reported oral health and dietary habits could be found to explain this lack of correlation.

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**References**


