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Original Article

Assessment of the oral health status of asthmatic children

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ABSTRACT

Objectives: To assess the oral health status and salivary composition in a group of children suffering from bronchial asthma. **Materials and Methods:** The sample consisted of sixty asthmatic children, sixty healthy negative controls, and sixty healthy positive controls of both sexes with age ranging from 4 to 12 years old. The asthmatics were grouped according to disease severity into mild, moderate, or severe asthmatic. All the children were clinically examined to assess their dental caries experience (decayed, indicated for extraction, and filled primary tooth [def] and decayed-missing-filled permanent tooth [DMF]), dental erosion condition (tooth wear index), and gingival health condition (gingival index [GI]). Salivary samples were collected and assessed for salivary flow rate, salivary pH, and the level of calcium, sodium, and potassium. **Results:** The results of this study revealed that asthmatic children presented significantly higher def, DMF score, and GI mean values compared to the control groups. Severe asthmatics significantly presented the highest def and GI score. Salivary analysis revealed reduced stimulated salivary flow rate and altered salivary pH. In addition, significantly elevated mean salivary calcium level found to be associated with higher GI mean score. **Conclusions:** Children suffering from bronchial asthma should receive special dental preventive attention as presented with greater risk for oral and dental diseases as compared to the healthy controls.

Key words: Bronchial asthma, dental caries, gingival inflammation, saliva

INTRODUCTION

Bronchial asthma is an inflammatory respiratory disease characterized by increased hyperresponsiveness of the tracheobronchial tree. The manifestations come as recurrent episodes of dyspnea, coughing, and wheezing. According to the WHO prescribing indicators, asthma is among the top conditions that necessitate antibiotic prescription.[1] The international consensus report on the diagnosis and treatment of asthma emphasized the central role of airway hyperresponsiveness, 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”.[2]

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Bronchial asthma affects approximately 10% of children and the prevalence is rising, possibly due to the rise in allergens in the environment that leads to increased airway responsiveness in atopic children.[3] Asthma is by far, the commonest of all chronic diseases of childhood. Asthma may have its onset at any age. As many as 10%–15% of boys and 7%–10% of girls may have asthma at some time during childhood. About 80%–90% have their first symptom before 4–5 years of age and 30% of them are symptomatic by 1 year of age.[4]

The goals of asthma therapy focus mainly to allow normal activities, restore and maintain normal pulmonary function, and avoid adverse effects from medications. The selection of antiasthmatic drug is based on the frequency and type of asthma. Current guidelines recommend the use of inhaled anti-inflammatory agents (corticosteroids and nonsteroidal drugs) for the prophylaxis of chronic asthma.[5]

Some authors suggest that asthma and/or its medication may be responsible for the higher prevalence of caries in asthma patients and children in particular.[6]

On the other hand, other researches claimed that there are no significant differences concerning caries prevalence in asthmatic children compared to the healthy control group and thus, little evidence for asthma-caries causative relationship.[7] Similar controversy has been also found regarding the effect of asthma or its medication on the gingival condition. Some researchers reported increased periodontal diseases and calculus deposition in asthmatic children while others could not find any statistically significant affection.[8,9] The saliva represents a unique oral fluid that serves as the main defensive mechanism against variable oral diseases. It is effective in maintaining a relatively neutral pH in the oral cavity which could reach up to 7.67 based on its content of different types of buffering system including bicarbonate, phosphate, in addition to urea and other pH rising factors as amino acids, and peptides. Furthermore, the flow of saliva *per se* offers a mechanical cleansing effect against remnants of debris or microbial content that could present potentials for oral diseases.[10]

Asthma could affect dental caries susceptibility directly through different biological mechanisms including changes in salivary composition or indirectly though the effect of the medication used.[11] Many of the antiasthmatic medication revealed a negative effect on the salivary production rate.[12] In addition, many inhalers have a low pH and contain sweeteners as one of their ingredients, which may enhance the cariogenic insult.

Scanty studies focused on the impact of the asthmatic condition on the oral condition where very few emphasized the correlation between salivary characteristics of asthmatics and oral manifestations, particularly in affected children.[13] Understanding the impact of bronchial asthma on dental health would aid to provide comprehensive dental management and early interprofessional consultation.

Therefore, this study was conducted to assess oral health status, salivary composition, salivary pH, and stimulated salivary flow rate of asthmatic children in comparison to healthy controls.

The null hypothesis of the present study is that bronchial asthma neither affects the oral health status nor the salivary composition in children.

MATERIALS AND METHODS

The present study was ethically approved by the Institutional Review Board of the Faculty of Dentistry, Umm Al-Qura University, Saudi Arabia (approval number IRB 06_2015), and written informed assent was obtained from each participant's legal guardian before participating in the study.

A total of 180 children aged from 4 to 12 years old were included in this study and equally assorted into Group I (healthy negative control), Group II (healthy positive control), and Group III (asthmatic children). The control groups consisted of healthy children who were not complaining from any chronic medical illness. The negative controls represented healthy children who were caries free with zero decayed, indicated for extraction, and filled primary tooth/decayed-missing-filled permanent tooth (def/DMF) score while those whose score one and more were grouped as positive controls.[14] The controls were equated to asthmatics with respect to age and sex. The asthmatics consisted of children previously diagnosed by pediatric consultant as suffering from bronchial asthma and were further subdivided according to asthma severity into mild, moderate, and severe.[15] Exclusion criteria included children with serious illness or any chronic systemic condition, other than bronchial asthma, as diabetes mellitus, cardiac disease, or renal disorder. In addition, children with a history of trauma affecting deciduous or permanent teeth and children using orthodontic appliances were also not included in the study.

All the participants were clinically examined while sitting on an ordinary chair using sterile disposable diagnostic tools by the same examiner. Dental caries was assessed according to the "WHO recommendations 1987,"[16] a tooth is considered carious if there is a lesion with a detectably softened floor, undermined enamel or softened wall, caries presented around existing filling, and tooth containing temporary filling. For every child, def and DMF indices were calculated separately. Where "def" stands for: decayed, indicated for extraction, and filled primary tooth while the "DMF" score describes the condition of the permanent dentition since stands for decayed, missed and filled permanent tooth.

The erosive lesions were assessed according to the criteria for tooth wear index (TWI) of Smith and Knight, 1984.[17] A tooth is considered to have an erosive lesion if there is loss of enamel surface characteristics and visible dentin is evident.

The gingival index (GI) was used to assess the gingival condition according to the criteria of Loe and Silness as follows: no gingival inflammation (<0.1), mild inflammation (0.1–1.0), moderate inflammation (1.1–1.9), and severe inflammation in case of marked gingival redness and edema with spontaneous bleeding and ulceration (2.0–3.0).[18]

After completing the clinical examination, the salivary flow rate and salivary pH were measured at the same appointment. Stimulated whole saliva was collected in the morning 1–2 h after breakfast.[19] According to the guidelines for collection of stimulated saliva,[20] the child was instructed to set motionless in an upright position and swallow (starting time). A piece of unflavored paraffin wax was given for each child and asked to chew on it with the timer on without swallowing any of secreted saliva, then asked to lean his head slightly foreword over a graduated plastic cup to expectorate stimulated saliva as frequency as possible as depicted in Figure 1. The volume of collected saliva over 5 min was recorded then divided by time, so the result expressed in ml saliva/min. Normal flow rate ranges from 1 to 1.3 ml/min while below 0.7 ml/min considered low flow rate and represented as risk factor. The salivary pH was evaluated using precalibrated digital salivary pH meter (AD1000, ADWA Instruments Kft., Szeged, Hungary).

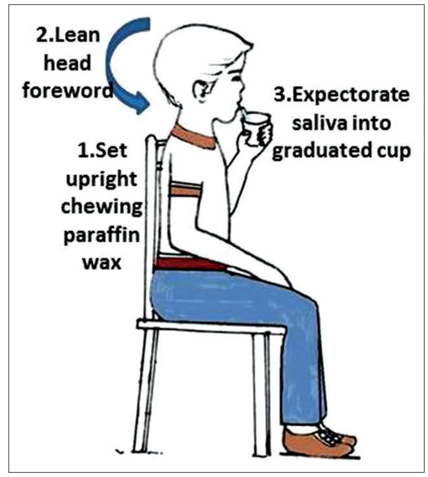

Figure 1: The steps of stimulated salivary sample collection

Statistical analysis

The collected data were tabulated and statistically analyzed using SPSS v. 16 program for Windows (Statistical Package for the Social Sciences, SPSS Inc., Chicago, IL, USA) to test for significance. Repeated measure ANOVA was used to compare the mean ± standard deviation of the different variables among the groups followed by multiple comparisons Tukey's *post hoc* test. Chi-square test was used to compare countable variables of the groups. Level of significance was tested at 0.05.

RESULTS

The mean age values of the included participants were 7.82 ± 2.6, 7.23 ± 1.92, and 7.52 ± 3.02 year for Group I (negative control), Group II (positive control), and Group III (asthmatics), respectively ($P > 0.05$). The distribution of gender among the groups is presented in Table 1. The results of the present study regarding dental caries experience, gingival condition, salivary flow rate, salivary pH, and salivary composition are shown in Table 2. The results revealed that group III presented significantly the highest def and DMF mean values, gingival inflammation score, and total calcium count. However, Group III showed significantly the lowest salivary flow rate and pH value. The effect of asthma severity can be explored through the results in Table 3. Severe asthmatics presented statistically significant elevated def mean value, GI score, and total salivary calcium content while showed statistically significant reduced salivary flow rate and salivary pH. As presented in Table 4, asthmatic children exhibited statistically significant higher experience of dental erosive lesions.

Table 1: Gender distribution among the study groups

Groups	Gender		Total (%)
	Female (%)	Male (%)	
Group I	27 (45.0)	33 (55.0)	60 (100.0)
Group II	31 (51.7)	29 (48.3)	60 (100)
Group III	30 (50.0)	30 (50.0)	60 (100)
Total	88 (48.9)	92 (51.1)	180 (100)

χ^2=0.34, *P*=0.562

Table 2: Mean and standard deviation values of different variables among the groups (*n*=60)

Variable	Group I	Group II	Group III
def	0.00[a]	5.47±2.16[b]	6.84±1.81[c]
DMF	0.00[a]	1.05±1.16[b]	2.35±1.41[c]
GI	1.69±0.66[a]	2.92±1.12[b]	5.07±0.83[c]
Flow rate	1.26±0.91[a]	0.97±0.85[a]	0.84±0.39[b]
pH	7.02±2.11[a]	6.35±1.74[a]	6.06±0.73[b]
Ca (mg/dl)	1.86±0.83[a]	1.62±0.89[a]	3.72±1.16[b]
Na (mEq/L)	26.82±6.57[a]	27.15±6.83[a]	26.41±7.46[a]
K (mEq/L)	22.97±7.09[a]	22.47±7.35[a]	24.62±4.44[a]

Different lower case superscripts in the same row indicate significance. GI: Gingival index, DMF: Decayed-missing-filled permanent tooth, def: Decayed, indicated for extraction, and filled primary tooth

Table 3: Mean and standard deviation values of different variables among mild, moderate, and severe asthmatics

Variable	Mild (*n*=15)	Moderate (*n*=22)	Severe (*n*=23)
def	5.75±1.48[a]	6.40±1.67[a]	8.15±0.81[b]
DMF	2.40±1.72[a]	2.10±1.02[a]	2.55±1.39[a]
GI	3.79±1.18[a]	4.86±1.14[b]	6.55±0.72[c]
Flow rate	1.05±0.09[a]	0.84±0.20[b]	0.64±0.06[c]
pH	6.39±0.41[a]	6.18±0.37[a]	5.52±0.14[b]
Ca (mg/dl)	2.53±0.17[a]	3.77±0.35[b]	4.85±0.29[c]
Na (mEq/L)	25.99±3.47[a]	26.75±2.76[a]	26.62±2.86[a]
K (mEq/L)	20.2±6.25[a]	25.69±6.19[a,b]	28.79±8.38[b]

Different lower case superscripts in the same row indicate significance. GI: Gingival index, DMF: Decayed-missing-filled permanent tooth, def: Decayed, indicated for extraction, and filled primary tooth

Table 4: Erosion lesion distribution among the groups

Groups	Dental erosion		Total (%)
	Present (%)	Absent (%)	
Group I	2 (1.11)	58 (32.22)	60 (33.33)
Group II	6 (3.33)	54 (30)	60 (33.33)
Group III	48 (26.7)	12 (6.67)	60 (33.33)
Total	56 (31.11)	124 (68.88)	180 (100)

χ^2=82.275, *P*≤0.001

DISCUSSION

A considerable increase in wheeze and asthma prevalence in children has been reported since the late 1980s.[21] During recent years, dentists' attention has been drawn to the possible association between increased risk for oral diseases and bronchial asthma.[7]

The use of def and DMF indices for the assessment of dental caries remains highly recommended by the WHO owing to their high reliability and validity in estimating dental caries experience.[22] Furthermore, the WHO also recognized the International Caries Detection and Assessment System and Caries Assessment Spectrum and Treatment as novel caries assessment indices developed for use in extended surveys to provide a comprehensive description of dental caries progressive stages.[23,24] Similarly, the GI was created to assess the gingival condition and to record qualitative changes in the gingiva. The GI has been used frequently in clinical research as it can provide a good standard of sensitivity and reproducibility in assessing pathological condition affecting the gingival tissues.[25]

The use of TWI for the assessment of dental erosion, offered simple but highly reliable mean to assess erosion affecting the hard tooth structure. In addition, TWI found to provide a standardized method to preserve the validity of diagnostic criteria needed for future comparison.[26] In systemic conditions with expected reduced salivary secretions, the use of stimulated salivary flow rate presented more reliable technique for comparison.[20]

The results of the present study indicate strong evidence against the null hypothesis that asthmatic children presented significantly higher dental caries affecting the primary dentition in particular as compared to their matching control.

The current results indicate significant association between dental caries experience, particularly the primary dentition and bronchial asthma. The more the severity of asthma condition, the higher dental caries experienced particularly in primary dentition.

Similar to the results of the present study, Shulman *et al*. evinced strong impact of bronchial asthma yielding increased dental caries occurrence in primary teeth but no adverse effect as the children mature.[27] The results of a study by Stensson *et al.* also indicated that preschoolchildren with asthma have a higher prevalence of caries than children without asthma.[28] Reddy *et al.* added also that with the increase in asthma severity, there is an increase in dental caries affection.[29] However, other researchers did not find an association between dental caries and bronchial asthma. It was also reported that neither the asthma condition nor its severity would affect dental caries prevalence even under extended period of exposure to the antiasthmatic medications.[30] Vázquez *et al.* reported that asthma disease possesses no effect on dental caries, but only nocturnal type could be linked to caries in primary dentition.[31]

This controversy could be as a result of differences in the medication types, community water fluoridation, variation in the lifestyle of the individual, the extent of sugar consumption and caries prevention behavior as well as due to increased attention and intensified caries-preventive interventions in asthma patients after the suggestion of the presence of relation between asthma and oral diseases.[7,11,32]

The increase in caries experience of asthmatics could be attributed to number of reasons. The antiasthmatic medicaments claimed to possess a significant role in dental caries progression directly through being sugar added and indirectly through the adverse effect of beta-2 agonist antiasthmatics in reducing the salivary flow rate. In turn, the reduction in salivary flow rate, as also found in this study, would result in depriving the oral environment from the protective mechanism of saliva by mean of the antimicrobial effect and might thrust the patient for increased consumption of drinks and cariogenic ones in particular.[33]

A large proportion of the inhaled drug is retained in the oropharynx, ranging from 80% with a metered-dose inhaler and dry powder to 60% with an extension tube and inhalers contain sugar, so the patient can taste when the drug has been delivered and to mask the unpleasant taste of the drug, especially for children. Although lactose is one of the least cariogenic sugars used to deliver beta-2 agonists, the frequent oral inhalation of sugar, combined with the decrease in salivary flow rate, may contribute to an increase in caries experience.[34]

Liquid oral medication containing sugars taken for long term can also lead to an increased caries activity. The intake of medication at night before retiring to bed was commonly seen, and due to low patient and parental awareness, no oral hygiene measures were usually taken after the medication. Diminution of salivation and lack of masticatory movements during the night might have further increased the cariogenic potential of the medicines.[29]

In addition, asthmatic children lead restricted lifestyles, missing so much school days, and not being able to play sports and participate in normal activities, and the family may overindulge them with frequent consumption of sweets leading to increase in dental caries. Furthermore, due to the increased attention given to the general asthmatic condition, they may play little importance to the oral hygiene procedures.[35]

The reduction in salivary flow rate found to be usually associated with reduced salivary pH as well.[36] This reduction in salivary pH, similar to the results of the present study, not only favors dental caries activity but also creates more propitious environment for the development of dental erosion.

This study has shown similar results to that reported by Shaw *et al*.[37] and Al-Dlaigan *et al*.[38] and confirms that children with asthma are at an increased risk of developing dental erosion than the healthy control. Several possible reasons could be hypothesized for the link between dental erosion and asthma. This finding can be attributed to the prolonged use of beta-2 agonists such as salbutamol (ventolin) or terbutaline (bricanyl) resulting in reduced salivary flow and taste disturbances.[33] In addition, the beta-2 agonists and drugs such as aminophylline and theophylline, which are also used as both bronchodilators for reversing the airway obstruction and act as smooth muscle relaxants, could induce significant relaxation of other smooth muscles such as the lower esophageal sphincter. This relaxation is associated with gastroesophageal reflux which is considered to be a factor in the etiology of dental erosion. Gastric reflux predominantly affects the palatal surfaces of the upper incisor and the buccal surfaces of the posterior teeth.[39] Furthermore, as a result to the drug-related reduction in the salivary flow, there will be an increased consumption of drinks to compensate for the oral dehydration. Usually, these drinks have got low pH and high titratable acidity, which could also cause dental erosion.[40] In addition, the medication used to control asthma is acidic by itself, and almost had a pH significantly reduced for hydroxyapatite dissolution, thus favoring the formation of not only dental caries but also erosive lesions.[41]

As regards the gingival condition, the results of the current study showed that the asthmatic children had significantly more gingival inflammation score than their corresponding control where the gingival condition deteriorates as the asthma condition becomes more severe. This increase in gingivitis in the asthmatic children is in agreement with the findings of Mehta *et al*. who reported a significant increase in accumulated plaque and gingival inflammation in asthmatics.[42] Similarly, Harrington *et al.* indicated the presence of strong association between the asthma condition or its medication and the extent of gingival inflammation or periodontal affection while Chakiri *et al.* evinced that the asthma condition would present a risk for gingival affection with or without accompanied medication.[43,44] The increased gingival inflammation could be attributed to the reduction in the salivary protective action due to the reduced salivary flow and altered composition.[45]

In addition, asthmatics usually develop mouth breathing habit owing to the frequent airway obstruction, especially during the episode of rhinitis or an acute asthmatic attack, which in turn would result in dehydration of the alveolar mucosa.[46] Furthermore, enhanced calcium level in the saliva of asthmatic children, as found in the present study, would favor more calculus deposition.[2] This increase in calcium level may be in response to beta-adrenergic bronchodilator drug such as the isoprenaline used as antiasthmatic drugs or may be even due to the pathological condition itself.[45]

Moreover, remnants of antiasthmatic inhaled corticosteroids reported to be absorbed into the systemic circulation inducing suppression of adrenal gland function and diminishing bone density. Systemic bone deprivation particularly for extended period would leave an unavoidable influence on incidence and development of periodontal affection.[47] In addition, an increased salivary mineral content and calcium level in particular, similar to the results of this study, found to be associated with prolonged use of antiasthmatic beta-2 agonists which in turn would leave its effect in favoring calculus formation and increased gingival affection.[48]

CONCLUSIONS

Under the limitations of the present study, it can be concluded that:

1. Asthmatic children are at higher risk of dental caries and erosion in the primary dentition
2. Bronchial asthma can be considered a risk factor for increased gingival inflammation
3. Bronchial asthma severity increases the intensity of risk for dental caries and gingival affection.

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Conflicts of interest

There are no conflicts of interest.

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