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Original Article

Oral health assessment in children aging 8–15 years with bronchial asthma using inhalation medication

Vaibhav Bansal[a], Kolli V.G. Reddy[b], Sugandh Shrivastava[c], Sunil Dhaded[d], Syed Mohammed Noorani[c], Mohd. Ikram Shaikh[e]*

[a]Department of Public Health Dentistry, Sri Aurobindo College of Dentistry, Indore, India, [b]Department of Public Health Dentistry, VSPM's Dental College and Research Centre, Nagpur, India, [c]Department of Prosthodontics, RKDF Dental College and Research Centre, Bhopal, India, [d]Department of Prosthodontics, A.M.E's Dental College, Raichur, India, [e]Department of Oral Medicine and Radiology, Daswani Dental College and Research Center, Kota, India

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Abstract

Objectives: The aim of the present study was to evaluate and compare oral health status of bronchial asthma patients between the age group of 8–15 years with healthy individuals and examines the relationship between the severity of asthma, dose duration, method of taking medication, and use of AeroChamber on the dental health of children diagnosed with asthma. **Materials and Methods:** The present cross-sectional study assessed the oral status of asthmatic patients and compared with a control group of 200 nonasthmatic patients. Both groups were matched in relation to age and gender. The oral health was assessed by measuring oral hygiene, caries status, periodontal health, and candidiasis of participants. Oral hygiene was measured by plaque index, caries assessment was done with the decayed missing filled teeth index/decayed extracted filled (DMFT/def index) and the periodontal status was measured with community periodontal index (CPI) adapted from the WHO (1997). **Results:** Plaque index score among asthmatics group was 1.49 ± 0.65 was significantly higher than healthy group 1.08 ± 0.57. The significant difference was noted in the mean caries (DMFT/def) score for asthmatic patients (2.31 ± 1.65/1.02 ± 0.39) and the controls (1.98 ± 1.54/0.74 ± 0.39). The CPI score was also significantly high in asthmatics (3.19 ± 1.68) in comparison to healthy individuals (2.32 ± 2.07). The candidiasis was absent in healthy individuals while it was present among 28 patients in the asthmatic group. The patients who were taking medication from longer period of time (9–12 months) had significantly worse oral health. The study result did not show any significant difference with the type of inhalation. However it showed significantly improved oral health for patients using AeroChamber in comparison to the patients not using it. **Conclusion:** Oral health was significantly poor in asthmatic patients in comparison with the healthy individuals. Increased frequency of asthma medication use was associated with increased likelihood of poor oral health. Use of AeroChamber improves the oral health of patients.

Keywords: *Asthma, Dental caries, Medications, Oral health, Periodontal health*

Introduction

Asthma is a public health problem that affects people of all ages and is one of the most widespread chronic diseases in the world. The Global Initiative for Asthma describes it as a chronic inflammatory disease characterized by recurring episodes of wheezing, chest tightness, shortness of breath, and coughing, particularly in the early morning [1].

Bronchial asthma is a widespread respiratory condition of 1%–18% prevalence in different populations affecting over 300 million people worldwide, including 10% (*i.e.,* 30 million) in India. Asthma affects peoples of all ages with most cases of asthma between 8 and 15 years [2]. Several studies conducted in India show the prevalence of asthma in children and adolescent (8–15 years) ranged from 2.3% to 11.9%, while the prevalence of asthma in adults varied from 0.96% to 11.03% [3-6]. Asthma, therefore, imposes a tremendous burden on Indian health-care systems and community. The etiology of asthma is not fully understood, but several factors have an impact on the development and prognosis. The risk factors for asthma include host and environmental factors [2]. The two distinct features include a history of respiratory symptoms (such as wheeze, shortness of breath,

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***Address for correspondence:** Dr. Vaibhav Bansal, Department of Public Health Dentistry, Sri Aurobindo College of Dentistry, Indore, Madhya Pradesh, India.
E-mail: vaibhav.golu08@gmail.com

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chest tightness, and cough) that vary over time and in the intensity and limitation of expiratory airflow. During an acute attack, the symptoms such as difficulty breathing, wheezing, coughing, shortness of breath, and difficulty performing normal daily activities appear. Although asthma is a chronic obstructive condition, the airway obstruction in asthma is usually reversible. However, if left untreated, the chronic inflammation from asthma can lead the lungs to become irreversibly obstructed due to airway remodeling [7].

The purpose of treating asthma is to achieve and maintain clinical regulation. Asthma treatments can be classified into controllers and relievers. Controllers are drugs that are taken daily for extended periods of time, primarily to clinically regulate asthma through anti-inflammatory effects. Long-acting inhaled β-agonists along with inhaled glucocorticoids are the most successful controller drugs. Relievers are drug used to quickly reverse bronchoconstriction during acute attacks**.** These include immediate inhaled β-agonists, the inhaled anticholinergic drug short-acting theophylline, and short-acting oral β-agonists. Asthma and medications may be cited as risk factors for oral hygiene in children. Although its systemic effects have been widely studied, few studies have been conducted to evaluate its local effects on oral health. Most drugs are inhalants used with various types of inhalers or nebulizers. A significant portion of the drugs remains in the oral cavity [8]. Various factors, such as the type of corticosteroid, the use of inhalers, propellants, spacers, and the technique of using inhalers, affect the amount of drug maintained in the mouth and pharynx.

The most prevalent diseases in the oral cavity include caries, periodontitis, and candidiasis. Dental caries is the most common chronic oral disease. Its pathogenesis is multifactorial, inclusive of environmental, behavioral, and hereditary factors and includes a complicated process of dissolution and re-mineralization of enamel by organic acids produced by micro-organisms mainly *Streptococcus mutans* in dental plaque. The relationship between asthma and dental caries was reviewed by Maupomé *et al*. [9], in which the authors found no strong correlation between caries and asthma. Oral candidiasis is an opportunistic fungal infection mainly caused by *Candida albicans*. It mostly affects the person having week immune system. Inhaled steroids play a central role in asthma treatment also suppresses the immune system of patients. The periodontium includes gingiva, cementum, periodontal ligament, and alveolar bone. The prevalence of severe periodontitis with attachment loss on multiple teeth is approximately 0.2%–0.5% in children and young adults. Periodontal health seems to be strongly influenced to decreased salivary flow and significant amount of accumulated plaque in asthmatics.

With the increasing prevalence of asthma, it is essential to understand the effects of medications on oral health. The consequences of asthma and its medications on dental health must also be investigated. Hence, the aim of the present study is to assess and compare oral health status of bronchial asthma patients between the age group of 8–15 years with healthy individuals and examines the relationship between the severity of asthma, dose duration, method of taking medication, and use of aerochamber on the dental health of children diagnosed with asthma.

Materials and Methods

The present study is of cross-sectional design conducted in the department of public health dentistry of dental college in India. The study population comprised of patients with a clinical diagnosis of chronic asthma in the age group of 8–15 years taking medication for at least 3 months. Ethical approval for this study was provided by the Institutional Ethical Committee Peoples College of Dental Sciences, Bhopal, (DGCI Registration no: ECR/575/Inst/MP/2014) on February 14, 2014 under project code (Ref/PCDS/2014PHD05). Informed written consent was obtained from parents of all patients before their enrollment in this study. Written permission was obtained from the superintendent in charge of the private hospital and Chief Medical Officer of city for government hospital. Control groups approval was obtained from respective school authorities.

Only one examiner performed all tests during the study. The investigator was trained and calibrated in the department of public health dentistry to minimize the diagnostic variability. A pilot study was carried out on asthmatic patients, in order to identify the suitable age group for the study. The participants of the survey included cases and comparison groups. The cases included asthmatic patients who were on asthmatic inhalation medications for at least 3 months and using an inhaler device for the administration. Control group consisted of healthy nonasthmatic (school children) from the same age group denying the use of inhaled corticosteroids or any other medications. The sample size was derived according to the prevalence of caries in asthmatic individuals in pilot study. The minimum sample size was 140 but in order to avoid bias, final sample size was adjusted to 200 asthmatic individuals and 200 healthy counterparts for comparison. The cases and controls were group matched with respect to age and gender. Convenient sampling method was utilized for the selection of patients in hospitals. The control group participants were selected from the healthy individuals, accompanying the patients and from schools, with close vicinity of the selected hospitals.

The survey was systematically scheduled to spread over a period of 6 months from January 2016 to August 2016. A detailed monthly schedule was prepared well in advance by informing and obtaining approvals from the authorities of respective study centers. On an average, 2–3 participants were examined each day. The clinical examination was carried out using aseptic precautions. All the instruments were used once in a day and were autoclaved afterwards for next time use. Disposable gloves and mouth masks were used. The examination of the subjects was carried out in the selected hospitals and participants were examined under natural light or using artificial light sitting on a stool with the examiner standing at about 10 o'clock position.

The general information such as age, gender, and residential address was recorded. Information regarding the disease condition and medications was obtained from the medical records of the patients. The oral health assessment was done

by measuring oral hygiene, caries status, periodontal health of participants, and prevalence of oral candidiasis. Plaque index was measured to measure oral hygiene caries assessment was done with the decayed missing filled teeth index/decayed extracted filled (DMFT/def index) and the periodontal status was measured with Community Periodontal Index (CPI) adapted from WHO (1997). Oral candidiasis was measured on the basis of sign and symptoms of disease.

The asthmatic group was further divided on the basis of severity of asthma, dosage of medication, duration of medication, mode of administration, and use of aerochamber. They were grouped on the basis of asthma severity: (1) mild, (2) moderate, and (3) severe asthma; on the dose of the drug: (1) low dose, (2) medium dose, and (3) high dose; on the duration of the drug: (1) 3–6 months, (2) 6–9 months, (3) 9–12 months, and (4) 12 months, on the use of the aerochamber for taking the drug (1) metered dose inhalation (MDI) and (2) direct powder inhalation (DPI) and on the use of the aerochamber for taking the drug (1) Patients using aerochamber and (2) patients not using aerochamber.

The data was transformed from precoded survey form to computer. The job of data entry, validity checks, and formation of desired results (as per analysis plan) were done using the SPSS version 22.0 (IBM Corporation, Statistical Package for the Social Sciences. N.Y., USA). Caries, periodontal, and plaque index values between the groups were compared by using the unpaired Student's *t*-test while the prevalence of candida was compared using the Chi-square test. The effect of severity of asthma, dose of medication, duration of medication, and method of taking medication was compared by one-way ANOVA test and unpaired Student's *t*-test. The level of statistical significance was set at $P \leq 0.05$.

Results

The mean plaque index score among asthmatics group was 1.49 ± 0.65 was significantly higher than healthy individuals with plaque index score of 1.08 ± 0.57. The significant difference was noted in the mean caries (DMFT/def) score for asthmatic patients (2.29 ± 1.65/1.02 ± 0.39) and the controls (1.24 ± 1.13/0.74 ± 0.39). The CPI score was also significantly high in asthmatics (3.19 ± 1.68) in comparison to healthy individuals (2.32 ± 2.07) [Table 1]. The candidiasis was absent in healthy individuals while it was present in 28 patients in the asthmatic group [Table 2].

Further comparisons were made in the asthma patients group on the basis of severity, duration, dosage, and mode of drug administration. The result of the study found severity of oral diseases had increased with the severity of asthma. A total of 88 (44.0%) participants were classified as mild, 63 (31.5%) as moderate, and 49 (24.5%) as severe asthma patients. The severe asthma patients group was found to have higher DMFT scores ($P < 0.001$), deaf scores ($P < 0.001$), average plaque index scores ($P < 0.001$), and CPI scores ($P < 0.001$) [Table 3].

The patients were divided on the basis of dose of medication. It was also found that oral disease indexes had significantly higher scores among patients taking higher doses of medications. Their DMFT score ($P = 0.001$), deaf score ($P = 0.001$), mean plaque index score ($P = 0.001$), and CPI score ($P = 0.001$) were significantly higher [Table 4].

Table 1: Assessment of oral health status of bronchial asthma patients and comparison with healthy individuals

Categories	Cases	Controls	*t*	*P*
Caries				
DMFT	2.29±1.65	1.24±1.13	8.24	0.001*
deft	1.02±0.39	0.74±0.39	6.38	0.001*
Mean plaque index score	1.49±0.65	1.08±0.57	6.56	0.001*
CPI score	3.19±1.68	2.32±2.07	4.63	0.001*

*Significant. Student's *t*-test. CPI: Community periodontal index, DMFT: Decayed missing filled teeth index, deft: Decayed extracted filled index for deciduous teeth

Table 2: Assessment of candidal status of bronchial asthma patients and comparison with healthy individuals

Candidiasis	Group		χ^2	*P*
	Case, *n* (%)	Control, *n* (%)		
Absent	172 (86.0)	200 (100.0)	30.18	0.001*
Present	28 (14.0)	0		
Total	200 (100)	200 (100)		

*Significant, Chi-square test

The same result was seen with the duration of taking medication. The group of patients who had been taking the drug for a longer duration (≥12 months) had significantly worse oral health. Their DMFT score ($P = 0.001$), deaf score ($P = 0.02$), mean plaque index score ($P = 0.001$), and CPI score ($P = 0.02$) were significantly higher [Table 5].

The study results did not show significant difference between the different ways of taking medicine [Table 6]. However, patients using AeroChamber had better oral health in comparison to the patients not using it [Table 7]. The group of patients using AeroChamber had lower DMFT scores ($P = 0.004$), deaf scores ($P = 0.02$), average plaque index scores ($P = 0.002$), and CPI scores ($P = 0.02$).

Discussion

Asthma and caries

Millions of people worldwide suffer from chronic respiratory diseases particularly asthma. It had account for about 300 million individuals globally in the recent reports. The present study is a cross-sectional study conducted to access the oral health status of asthmatic patients. For the present study, participants between 8 and 15 years of age were chosen, as this range of age group presented the peak incidence of the disease under study. The control group consisted of healthy children of the same age and gender who did not use any medication daily. The statistical difference was seen in both dentitions. In primary dentition, mean deft in the study and control groups was 1.01 ± 0.39 and 0.74 ± 0.25, respectively. In the permanent dentition, mean DMFT was (2.29 ± 1.39) in comparison to controls (1.24 ± 1.13).

The high caries rate in asthma patients is due to the fermentable carbohydrates present in the medicines to treat it. A significant proportion of drug particles

Table 3: Assessing the effect of severity of asthma on oral health of patients

Category of asthma	Mild (*n*=88)	Moderate (*n*=63)	Severe (*n*=49)	*F*	*P*
Caries status					
DMFT	1.44±1.07	2.89±1.34	3.07±1.06	52.14	0.001*
def	0.77±0.25	1.17±0.26	1.21±0.28	27.11	0.001*
Mean plaque index score	1.06±0.47	1.77±0.61	1.88±1.06	48.728	0.001*
CPI score	2.55±1.58	3.63±1.50	3.77±1.68	12.69	0.001*

*Significant. One-way ANOVA test. CPI: Community periodontal index, DMFT: Decayed missing filled teeth index, def: Decayed extracted filled index for deciduous teeth

Table 4: Assessing the effect of dose of inhaled medication on oral health of asthmatic patients

Dose of inhaled medication	Low (*n*=58)	Medium (*n*=89)	High (*n*=53)	*F*	*P*
Caries status					
DMF	1.17±1.21	2.52±1.17	3.51±0.87	93.8	0.001*
def	0.40±0.13	0.99±0.26	1.21±0.29	38.77	0.001*
Mean plaque index score	0.92±0.41	1.52±0.52	2.08±0.70	75.19	0.001*
CPI score	2.37±1.72	3.24±1.46	4.00±1.60	12.69	0.001*

*Significant, One-way ANOVA test. *n*: Number of patients, CPI: Community periodontal index, DMFT: Decayed missing filled teeth index, def: Decayed extracted filled index for deciduous teeth

Table 5: Assessing the effect of duration of taking inhaled medication on oral health of asthmatic patients

Duration	3-6 months (*n*=56)	6-9 months (*n*=57)	9-12 months (*n*=45)	>12 months (*n*=42)	*F*	*P*
Caries status						
DMF	1.14±1.54	2.31±0.94	2.89±1.06	3.63±1.02	65.50	0.001*
def	0.51±0.23	0.97±0.45	1.11±0.36	1.17±0.49	23.42	0.001*
Mean plaque index score	0.93±0.49	1.44±0.49	1.64±0.55	2.12±0.51	45.03	0.001*
CPI score	2.03±1.59	3.26±1.52	3.80±1.32	4.00±1.54	12.69	0.001*

*Significant, One-way ANOVA test. n: Number of patients, CPI: Community periodontal index, DMFT: Decayed missing filled teeth index, def: Decayed extracted filled index for deciduous teeth

Table 6: Assessing the effect of method of taking inhaled medication on oral health of asthmatic patients

Type of medications	MDI (*n*=146)	DPI (*n*=54)	*t*	*P*
Caries status				
DMF	2.07±1.67	2.38±1.60	0.43	0.66
def	1.12±0.34	1.20±0.47	0.94	0.38
Mean plaque index score	1.46±0.65	1.56±0.66	0.92	0.35
CPI Score	3.24±1.91	3.17±1.60	0.23	0.66

Student's *t*-test, *n*: Number of patients, CPI: Community periodontal index, DMFT: Decayed missing filled teeth index, def: Decayed extracted filled index for deciduous teeth, MDI: Metered dose inhalation, DPI: Direct powder inhalation

(medication, carbohydrate, and sugar) would precipitate in the oral cavity leading to higher dental caries in these patients. Another reason is that medication and asthma itself reduces the flow of saliva, changes the composition of saliva, including changes in pH, and possibly increases the frequency of dental plaque accumulation [10-13]. Botelho *et al*. [14] and Ersin *et al*. [15] observed an increased dental biofilm in the asthma group, as well as salivary levels of *Streptococcus mutans* and *lactobacilli* among asthmatics. The results of the present study were consistent with those of Stensson *et al*. [16], Milano *et al*. [8], Ersin *et al*. [15], Dugmore and Rock [17], and Eloot *et al*. [18] who also found a correlation between the use of corticosteroids among asthmatics and DMFT score.

The present study contributed useful information to further substantiate the relationship between asthma and caries and it helps further to investigating the concept of causality, the exposure time, the inhaled daily dose, the form, and mode of administration. The present study found that DMFT scores were significantly higher in patients with severe asthma. The results were in accordance with Shashikiran *et al*. [19] who also finds similar result in their study. The study results also revealed positive association between drug duration, dosage, and DMFT score. The probable reason might be that there was the high level of *Streptococcus mutans* associated with a high dose and duration of the inhaled corticosteroids.

In the present, cross-sectional study, the score of dental caries shows no significant difference between dry powder inhaler (DPI) and metered dose inhaler (MDI) using patients. The result was in agreement with Tootla *et al*. [20]. The study also indicated that asthmatic children using inhalers with AeroChamber have a lower DMFT/deft score, which was similar to the findings Khalilzadeh *et al*. [21]. The use of large volume spacers induces oropharyngeal deposition of drugs thereby reducing their local effects.

Asthma and dental plaque

In the present study, there were significantly more plaque deposits in the oral cavities of asthmatic group. This observation may be due to a higher number of pathogenic bacteria and a decrease in salivary flow. The present finding was in agreement with Yaghobee *et al*. [22], Lenander-Lumikari *et al*. [23] Shashikiran *et al*. [19] but

Table 7: Assessing the effect of using AeroChamber on oral health of asthmatic patients

Use of AeroChamber	Without AeroChamber (*n*=166)	With AeroChamber (*n*=34)	*t*	*P*
Caries status				
DMF	2.36±1.62	1.74±1.28	3.19	0.004*
def	1.10±0.34	0.76±0.12	2.14	0.02*
Mean plaque index score	1.56±0.65	1.13±0.54	3.57	0.002*
CPI score	3.32±1.60	2.55±1.92	2.17	0.02*

*Significant. Student's *t*-test. *n*: Number of patients, CPI: Community periodontal index, DMFT: Decayed missing filled teeth index, def: Decayed extracted filled index for deciduous teeth

differ from the studies conducted by Ersin *et al*. [15], Eloot *et al*. [18] and Shulman *et al*. [24].

Our study result showed considerable increase in plaque score among patients with respect to the dose, duration of taking inhaled corticosteroids, and severity of asthma. This could be probably due to the inverse relationship was between salivary flow rate and asthma severity, dose and duration of taking inhaled medication as shown by Paganini *et al*. [25] but not comparable with the results of Eloot *et al*. [18].

Asthma and periodontal disease

The participants in the study group had significantly poor periodontal health than the control group (3.19 for cases and 2.32 for controls). The result was in agreement with Shashikiran *et al*. [19], Hyyppä and Paunio [26] and Stensson *et al*. [16] while contradictory finding was reported by Bjerkeborn *et al*. [27], who found no significant difference in the periodontal health of the two groups.

The reasons for the increase in periodontal disease in asthma patients are as follows: First, pathological activation of immune and inflammatory processes can be associated with both asthma and periodontal disease. Second, there was a decrease in the salivary flow rates [24] and finally by their tendency to breathe through the mouth [26].

Our results have revealed an increased mean sextant score having periodontal disease among patients who were taking medications in high doses for longer duration. The high doses of inhaled medications like β agonist and corticosteroids by asthmatics can lead to suppression of adrenal function, which can lead to decreased bone mineral density in one way or another as far as dose is concerned. There had been significant decrease in mean sextant score among patients using AeroChamber which may be due to significant decrease in plaque score among patients using AeroChamber.

Asthma and oral candidiasis

In the present study, the prevalence of oral candidiasis was 14.0% in the asthma patients group, while none of the participants in the control group had the disease. The increased rate of candidiasis among asthmatic patients was due to corticosteroid use and this result showed agreement with report given by Shaw and Edmunds [28] (10.6%). This should be due to the local effects of the drugs used for treatment, as only 10%–20% of the inhaler dose reaches the lungs and the rest remains in the oral cavity. The immunosuppressive effects of steroids also play a part in increasing the prevalence of candidiasis.

Conclusion

Oral health was significantly poor in asthmatic patients in comparison with the healthy individuals. The plaque index score, CPI index score, and DMFT/def index score were significantly high. The prevalence of oral candidiasis among asthmatic patients was 14.0%. The increased frequency of asthma medication use was coupled with increased likelihood of caries experience and increased severity of periodontal disease. Dose and duration of taking asthma medication use was also associated with increased likelihood of caries experience and increased severity of periodontal disease. Method of taking medication (MDI and DPI) had no significant effect on oral health. The use of AeroChamber had improved the oral health of patients.

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Conflicts of interests

There are no conflicts of interests.

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