World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

# Potential for dental caries in asthma patients with inhaler therapy

Delfia Amanda Putri * and Andree Salim

*Department of Orthodontics, Faculty of Dental Medicine, Airlangga University, Surabaya, Indonesia.*

World Journal of Advanced Research and Reviews, 2025, 25(01), 1361-1366

Publication history: Received on 05 December 2024; revised on 12 January 2025; accepted on 14 January 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.25.1.0142

## Abstract

**Introduction**: Asthma is a heterogeneous disease associated with airway hyperresponsiveness and airway inflammation. Some drug treatments in asthma sufferers have a stronger effect on oral health than the disease itself, including causing dental caries. Objective: To determine the potential for caries in asthmatic patients with inhaler therapy.

**Methods**: Systematic literature database search using PubMed and ScienceDirect databases. Literature data search used the following keywords: "Inhaled Therapy", "Inhalation Therapy", "Caries", "Dental Caries", "Asthma Medications", "Asthma", "Asthma Drug", "Oral Health", "Treatment of Asthma". The search was conducted from March 2023 to April 2023 with the inclusion criteria being a clinical trial and a randomized controlled trial, using inhaler therapy as one of the interventions, a population of people with asthma who experienced dental caries, and published in English from 2013 to April 2023.

**Results and Discussion**: The initial search identified a total of 275 articles from 2013 to 2023 across the two databases. After manual review of titles and abstracts and appropriate articles for inclusion, 9 relevant articles were identified in the systematic review. From the literature study conducted, it was shown that the treatment of asthma with inhaler therapy showed the potential for caries to occur with the mechanism of decreasing salivary flow and decreasing the buffering ability of the oral cavity resulting in the proliferation of Streptococcus Mutans and Lactobacillus as aciduric bacteria which play a role in the demineralization of tooth enamel.

**Conclusion**: Prolonged use of inhalation therapy in asthmatic patients has the potential to cause caries. This condition is supported by the awareness of asthma patients about poor oral hygiene.

**Keywords:** Dental caries; Asthma; Inhaler Therapy; Salivary Flow; Aciduric Bacteria

## 1. Introduction

Asthma is a serious global health issue that affects individuals of all age groups. The prevalence of asthma has been increasing in many countries, particularly among children[1]. A fact sheet from the World Health Organization (WHO) reveals that approximately 235 million people worldwide suffer from asthma. This underscores the fact that asthma is a public health concern that transcends the level of economic and structural development of a country. The Global Initiative for Asthma (GINA) emphasizes raising global awareness about asthma and regularly updates guidelines for asthma treatment. The introduction of inhaled corticosteroids, along with short-acting and long-acting beta-agonists, has significantly improved asthma control and reduced the frequency of exacerbations[2].

Asthma is associated with airway hyperresponsiveness and airway inflammation[1]. Several studies suggest that while there is no definitive cure for asthma, the condition can be effectively controlled in most patients through appropriate

* Corresponding author: Delfia Amanda Putri

preventive measures and pharmacological interventions, such as β2 agonists, inhaled bronchodilators, inhaled corticosteroids, and sodium cromoglycate. Inhaled corticosteroids are the standard treatment for most patients. For adults who do not respond adequately to inhaled corticosteroids, long-acting β2 agonists are used in combination with inhaled corticosteroids[3].

Medication treatments for asthma patients have a stronger impact on oral health than the disease itself. Asthma has been associated with an increased risk of dental caries since the 1970s[4]. The use of β2 agonists has shown potential side effects such as hyposalivation and changes in saliva composition. Inhaled medications can alter the quality and quantity of saliva. Reduced salivary flow leads to an increase in oral microbiota, particularly cariogenic microorganisms. Additionally, many inhaled drugs contain sugar as an excipient, serving as a substrate for cariogenic bacteria and altering oral pH. β2 agonists activate β2 receptors in the salivary glands, stimulating the production of cyclic adenosine monophosphate (cAMP), which reduces saliva secretion and protein synthesis. Furthermore, only 10-20% of these drugs reach the lower respiratory tract, while the remainder stays in the oropharynx and upper airway, becoming a substrate for cariogenic bacteria and affecting oral pH[5].

Caries is a multifactorial, non-communicable, and dynamic process caused by bacterial biofilm and influenced by diet, leading to the demineralization of hard dental tissues[6]. The occurrence of carious lesions results from a disrupted balance between dietary-bacterial factors, host factors, and the use of medications. According to several studies, asthma patients undergoing inhaler therapy are at a higher risk of developing dental caries due to reduced salivary secretion, lower pH levels, and an increase in cariogenic bacteria. These factors are exacerbated by improper sugar consumption, inadequate fluoride exposure, poor oral hygiene, and the use of dry powder inhalers[7].

## 2. Material and methods

A systematic literature search was conducted using PubMed and ScienceDirect. The search employed the following keywords: "Inhaled Therapy," "Inhalation Therapy," "Caries," "Dental Caries," "Asthma Medications," "Asthma," "Asthma Drug," "Oral Health," and "Treatment of Asthma." The search period spanned from March 2023 to April 2023. Filters applied during the search included free full-text access, open access, and publications within the last 10 years (from 2013). The inclusion criteria were clinical trials and randomized controlled trials that used inhaler therapy as an intervention, a population of asthma patients experiencing dental caries, and publications in English from 2013 to April 2023. The exclusion criteria included other study designs, manuscripts in languages other than English, publications outside the target timeframe, and clinical trials and randomized controlled trials not involving inhaler therapy as an intervention.

## 3. Results and discussion

The initial search identified a total of 275 articles published between 2013 and 2023 from two databases. This included 58 articles from PubMed and 217 articles from ScienceDirect. Among these, 187 duplicate records were identified and removed. After eliminating duplicates, 30 articles remained. Of these, 15 articles met the inclusion criteria, while 15 were excluded based on exclusion criteria. Following a manual review of titles and abstracts, 9 relevant articles were identified for the systematic review.

**Table 1** Summary of Article and Journal Contents

| No | Author, Year | Article Title | Method | Result |
|---|---|---|---|---|
| 1 | Świątkowska-Bury. et al., 2022 | The use of anti-asthmatic inhalation therapy and the risk of dental caries in a group of Polish children: a prospective study | This study involved 208 patients, with 114 in the study group and 94 in the control group. Dental examinations were conducted using the DMFT/dmft and DMFS/dmfs indices, the ICDAS II classification, and Nyvad criteria to differentiate non-cavitated white spot lesions. Additionally, saliva assessments for *S. mutans* (SM) and *Lactobacillus* spp. (LA) were performed using the CRT Bacteria test (Ivoclar Vivadent). | The analysis of the results did not reveal a statistically significant difference in the mean values of the dmft/DMFT/DMFs/dmfs indices, or the presence of non-cavitated white spot lesions or bacterial colony density between the groups. However, a significant correlation was found between DMFt/dmft and combination therapy, the duration of inhaled |

| | | | | |
|---|---|---|---|---|
| | | | | corticosteroid therapy, and the use of DPI. |
| 2 | Samec, T., Amaechi, B.T. and Jan, J., 2021 | Influence of childhood asthma on dental caries: A longitudinal study | The study population consisted of children aged 2-17 years (n = 138) who had been using asthma medication for at least 1 year. The control group comprised non-asthma siblings (n = 140). The International Caries Detection and Assessment System-II was used to assess the caries status. After 3 years, 106 initial participants (53 asthma patients and 53 non-asthma siblings) were re-examined. Questionnaires were completed by parents, and data was collected from the patients' medical records. | Asthma children had significantly higher average d12fs and D12MFS scores and fewer caries-free individuals. In asthma children, the 3-year average increase in D12MFS was significantly higher. Lower caries experience in asthma children was associated with low-dose use of inhaled glucocorticoids, the use of leukotriene antagonists, and daily consumption of milk and cheese. |
| 3 | Arafa et al., 2019 | Impact of Secretory Immunoglobulin A Level on Dental Caries Experience in Asthmatic Children | A total of 60 asthma children and 60 control children of both genders, aged 4 to 12 years, participated in the study. All children were clinically examined to assess their dental caries experience, and stimulated saliva samples were collected to measure salivary pH, flow rate, α-amylase, and changes in sIgA levels. The data were statistically analyzed using the SPSS software. | Asthma children showed significantly higher average def-t scores, as well as significantly reduced stimulated salivary flow and sIgA levels compared to healthy controls. Severe asthma patients showed significantly the lowest average sIgA levels and the most reduced salivary flow rate. |
| 4 | Ashuja RB, Nandini DB, Vidyasagar B, Ashwini R, Donoghue M, Madhushankari GS., 2018 | Oral carriage of cariogenic bacteria and Candida albicans in asthmatic adults before and after anti-asthma medication: A longitudinal study | Samples were collected from 20 newly diagnosed adult asthma patients and 20 controls to estimate the microbial count at the 3rd and 6th months after starting treatment among the cases. | Asthma patients initially had a higher microbial count compared to the control group. Asthma patients showed an overall increase in microbial count compared to the control group. |
| 5 | Bozejac, B.V. et al., 2017 | Impact of inhalation therapy on the incidence of carious lesions in patients with asthma and COPD | This study involved 80 participants aged between 18 and 65 years. The experimental group consisted of 40 participants who had previously been diagnosed with asthma or Chronic Obstructive Pulmonary Disease (COPD) and had been undergoing inhalation therapy for more than five years. The control group also consisted of 40 participants, matched for age and gender with the experimental group. Dental status was determined by the number of decayed, missing, and filled teeth (DMFT index). The quantity and pH of saliva were measured in the laboratory. | In the experimental group, the average salivary flow rate and pH values were statistically significantly lower compared to the control group. Patients in the experimental group had higher DMFT index scores compared to the control group, although the difference was not statistically significant. The average number of decayed and missing teeth in the experimental group was statistically significantly higher than in the control group. |

| | | | | |
|---|---|---|---|---|
| 6 | Heidari A. et al., 2016 | Relationship Between Different Types and Forms of Anti-Asthmatic Medications and Dental Caries in Three to 12 Year Olds | A cross-sectional study was conducted at the Asthma and Allergy Department of Children's Medical Center in Tehran, Iran. A total of 85 individuals aged between 3 and 12 years who had been diagnosed with asthma participated in the study. Participants and their parents were interviewed, and oral examinations were performed by a qualified dentist. Data were collected using a questionnaire and analyzed through stepwise multivariate linear regression analysis using SPSS version 16. A p-value of <0.05 was considered statistically significant. | There was a significant correlation between the number of cetirizine and ketotifen tablets taken and the dmf/DMF scores. However, no correlation was found between the number of sprays consumed and the dmf/DMF scores, the duration of medication therapy, or the type of medication taken, including β2 agonists, antihistamines, steroids, or their combinations. |
| 7 | Sivadas, G. et al., 2016 | Effect of anti-asthmatic drugs on dental health: A comparative study | This study was conducted to compare the prevalence of dental caries in asthma children and healthy children, as well as to evaluate the correlation between *S. mutans*, *Lactobacillus*, and dental caries in both groups. | In this study, the average score for decayed, missing, and filled teeth in the study group was higher compared to the control group. The levels of *S. mutans* and *Lactobacillus* in the study group were higher than in the control group. Subjects using inhaled corticosteroids were more susceptible to dental caries than those in the control group. |
| 8 | Khalifa, M.A. et al.,2014 | Salivary composition and dental caries among children controlled asthmatics | In this triple-blind analytical case-control study, children were selected based on inclusion criteria and divided into Group 1 as asthma patients (n = 60), who were treated with β2 agonists and corticosteroids for at least 6 months. The control group (Group II) consisted of first-degree relatives (n = 60) matched for age. | The results showed a higher prevalence of caries in asthma patients (Group I) compared to the control group (Group II). There was also a positive correlation between asthma duration and caries index. *S. mutans* levels and the number of *Lactobacillus* bacterial colonies were higher in asthma patients than in the control group. |
| 9 | Godara et al., 2013 | Evaluation of cariogenic potential of dry powder inhalers: A case-control study | This study was conducted on 100 asthma patients aged between 10 and 45 years who had been using Dry Powder Inhalers for at least one year. The control group (n = 100) was selected from non-asthmatic individuals and matched with the study group based on age, gender, and socioeconomic status. | The results revealed that asthma subjects exhibited a higher incidence of dental caries compared to the control group, but the difference was not statistically significant. It was also found that an increased frequency of Dry Powder Inhaler use was associated with a significant risk of caries. |

The primary goal of asthma management in patients is to effectively control symptoms and prevent or minimize the risk of asthma exacerbations. The most commonly used control medications for children under 12 years old include inhaled glucocorticoids/corticosteroids, long-acting beta agonists (LABA), or oral leukotriene receptor antagonists (LTRA), often in combination with inhaled glucocorticoids/corticosteroids[8].

Inhaler therapy is generally used to treat respiratory conditions characterized by airway obstruction, such as asthma and chronic obstructive pulmonary disease (COPD). Asthma patients typically undergo inhaler therapy at high doses

over extended periods. The prolonged use of high-dose inhaler therapy has been strongly associated with several side effects on oral tissues[9]. A significant portion of inhaled medications remains in the oral cavity and oropharynx, potentially disrupting the normal physiology of oral tissues[10].

According to Sivadas et al.[11], one of the main reasons for the increased prevalence of dental caries in asthma patients is the reduction in salivary flow, coupled with the increased levels of *Streptococcus mutans* and *Lactobacillus* in saliva. This is because the salivary glands may contain target systems for many drugs, such as beta-receptor drugs. Theoretically, saliva can influence the occurrence of dental caries in four stages. First, it provides mechanical cleaning, resulting in less plaque accumulation. Second, it reduces enamel solubility through calcium, phosphate, and fluoride. Third, it buffers and neutralizes acids produced by cariogenic organisms or introduced directly through food. Fourth, it has antibacterial activity[9]. Asthma medications indirectly play a significant role in caries development through the harmful effects of β2-agonist antiasthmatics in reducing salivary flow rates[8].

The long-term use of β2-agonist antiasthmatics results in an overall reduction of salivary flow by 26%, with a 36% decrease in parotid gland secretion. This reduction in salivary flow leads to a functional imbalance of saliva in the oral cavity. According to Arafa et al.[12], the decrease in salivary flow in asthma patients is significantly correlated with lower levels of secretory immunoglobulin A (sIgA). A reduction in salivary flow also disrupts the buffering capacity of the oral cavity, prolonging the acidic environment in the mouth. This encourages the growth of aciduric bacteria such as *Streptococcus mutans* and *Lactobacillus*. These bacteria thrive in acidic conditions and continuously metabolize carbohydrates in a low-pH environment[13]. This statement aligns with findings from Ashuja et al.[14], which demonstrated that the asthma group showed an increased microbial load compared to the control group.

Additionally, to mask the bitter taste of the medication and improve patient tolerance, 60% of powdered inhalation medications contain fermentable carbohydrates in the form of lactose to deliver beta-2 agonists[11]. Lactose can be fermented by cariogenic bacteria to produce acids, leading to tooth demineralization, a process that contributes to dental caries[15]. Furthermore, inhaler therapy is often administered at night before bedtime. This habit is associated with a low awareness of oral health among patients and parents, leading to a lack of oral hygiene practices typically performed after medication use. Reduced salivary flow and the absence of chewing movements during the night may further increase the cariogenic potential of the medications[11].

The occurrence of caries is a series of processes involving demineralization and remineralization, which are the body's efforts to repair carious lesions. Early demineralization is often subclinical but can lead to the development of carious lesions in various areas, with increased opacity and porosity of enamel, eventually forming clear cavities[15]. Research studies conducted by Bozejac et al.[7], Arafa et al.[12], and Samec et al.[15] showed that the analysis of the dmft/DMFT scores in asthma patients was higher compared to the control group of non-asthma individuals. However, the analysis by Świątkowska-Bury et al.[16] did not reveal a statistically significant difference in the mean values of the dmft/DMFT/DMFs/dmfs indices or the presence of non-cavitated white spot lesions or bacterial colony density between the test and control groups. Nevertheless, a significant correlation was found between DMFt/dmft and combination therapy, the duration of inhaled corticosteroid therapy, and the use of Dry Powder Inhalers.

## 4. Conclusion

Prolonged use of inhalation therapy in asthma patients has the potential to cause dental caries through mechanisms such as reduced salivary flow and decreased oral buffering capacity. This creates an environment conducive to the proliferation of Streptococcus mutans and Lactobacillus, aciduric bacteria involved in the demineralization of tooth enamel. Additionally, asthma patients' awareness of oral hygiene and their consumption of carbohydrate-rich diets significantly influence the increased risk of caries during inhaler therapy.

## Compliance with ethical standards

### *Acknowledgments*

Sincere gratitude is extended to the Faculty of Dental Medicine for their generous support, inspiration, and insightful guidance throughout this research.

### *Disclosure of conflict of interest*

There are no conflicts of interest to disclose.

## References


[1] Reddel HK, Bacharier LB, Bateman ED, Brightling CE, Brusselle GG, Buhl R, et al. Global Initiative for Asthma Strategy 2021. Respirology [Internet]. 2021 Oct 20;27(1):14–35. Available from: https://doi.org/10.1111/resp.14174

[2] Rehman A, Amin F, Sadeeqa S. Prevalence of asthma and its management: A review. PubMed [Internet]. 2018 Dec 1;68(12):1823–7. Available from: https://pubmed.ncbi.nlm.nih.gov/30504949

[3] Wang Q, Zhang W, Liu L, Yang W, Liu H. Effects of physical therapy on lung function in children with asthma. Medicine [Internet]. 2019 Apr 1;98(15):e15226. Available from: https://doi.org/10.1097/md.0000000000015226

[4] Heidari A, Seraj B, Shahrabi M, Maghsoodi H, Kharazifard MJ, Zarabian T. Relationship between different types and forms of Anti-Asthmatic medications and dental caries in three to 12 year olds. DOAJ (DOAJ: Directory of Open Access Journals) [Internet]. 2016 Aug 1;13(4):238–43. Available from: https://doaj.org/article/dc67ac7482a64cd993a80d02a943b49a

[5] Chumpitaz-Cerrate, V., Bellido-Meza, J. A., Chávez-Rimache, L., & Rodríguez-Vargas, C. Impact of inhaler use on dental caries in asthma pediatrics patients: A case-control study. Archivos Argentinos De Pediatria [Internet]. 2019 Dec 27;118(1). Available from: https://doi.org/10.5546/aap.2020.eng.38

[6] Pitts NB, Zero DT, Marsh PD, Ekstrand K, Weintraub JA, Ramos-Gomez F, et al. Dental caries. Nature Reviews Disease Primers [Internet]. 2017 May 24;3(1). Available from: https://doi.org/10.1038/nrdp.2017.30

[7] Bozejac BV, Stojšin I, Đuric M, Zvezdin B, Brkanić T, Budišin E, et al. Impact of inhalation therapy on the incidence of carious lesions in patients with asthma and COPD. Journal of Applied Oral Science [Internet]. 2017 Oct 1;25(5):506–14. Available from: https://doi.org/10.1590/1678-7757-2016-0147

[8] Sköld UM, Birkhed D, Xu JZ, Lien KH, Stensson M, Liu JF. Risk factors for and prevention of caries and dental erosion in children and adolescents with asthma. Journal of Dental Sciences [Internet]. 2022 Apr 9;17(3):1387–400. Available from: https://doi.org/10.1016/j.jds.2022.03.007

[9] Khalifa MAAA, Abouelkheir HM, Khodiar SEF, Mohamed GAM. Salivary composition and dental caries among children controlled asthmatics. Egyptian Journal of Chest Diseases and Tuberculosis [Internet]. 2014 Jun 7;63(4):777–88. Available from: https://doi.org/10.1016/j.ejcdt.2014.05.003

[10] Bozejac BV, Stojšin I, Đuric M, Zvezdin B, Brkanić T, Budišin E, et al. Impact of inhalation therapy on the incidence of carious lesions in patients with asthma and COPD. Journal of Applied Oral Science [Internet]. 2017 Oct 1;25(5):506–14. Available from: https://doi.org/10.1590/1678-7757-2016-0147

[11] Chellaih P, Sivadas G, Chintu S, Vedam VKV, Arunachalam R, Sarsu M. Effect of anti-asthmatic drugs on dental health: A comparative study. Journal of Pharmacy and Bioallied Sciences [Internet]. 2016 Jan 1;8(5):77. Available from: https://doi.org/10.4103/0975-7406.191973

[12] Arafa A, AlDahlawi S, Hussien A. Impact of secretory immunoglobulin A level on dental caries experience in asthmatic children. International Journal of Clinical Pediatric Dentistry [Internet]. 2019 Jan 1;12(5):414–8. Available from: https://doi.org/10.5005/jp-journals-10005-1663

[13] Godara N, Khullar M, Godara R, Singh V. Evaluation of cariogenic potential of dry powder inhalers: A case-control study. Lung India [Internet]. 2013 Jan 1;30(2):113. Available from: https://doi.org/10.4103/0970-2113.110418

[14] Nandini D, Ashuja R, Vidyasagar B, Ashwini R, Donoghue M, Madhushankari G. Oral carriage of cariogenic bacteria and Candida albicans in asthmatic adults before and after anti-asthma medication: A longitudinal study. Journal of Oral and Maxillofacial Pathology [Internet]. 2018 Jan 1;22(1):144. Available from: https://doi.org/10.4103/jomfp.jomfp_235_15

[15] Samec T, Amaechi BT, Jan J. Influence of childhood asthma on dental caries: A longitudinal study. Clinical and Experimental Dental Research [Internet]. 2021 May 8;7(6):957–67. Available from: https://doi.org/10.1002/cre2.436

[16] Świątkowska-Bury M, Kulus M, Olczak-Kowalczyk D. The use of anti-asthmatic inhalation therapy and the risk of dental caries in a group of Polish children: a prospective study. PubMed [Internet]. 2022 Jun 1;23(2):157–62. Available from: https://pubmed.ncbi.nlm.nih.gov/35722850