Avens Publishing Group
J Pediatr Child Care
March 2023 Volume:9, Issue:1
© All rights are reserved by Sibi D, et al.

Allergic Rhinitis and Asthma in Association with Fungal Pollution of Indoor Environments

Open Access Research Article

Journal of Pediatrics & Child Care

Sibi Das[1]*, Sethi Das C[2], Silvanose C[3] and Jibin VG[4]

[1]*Sri Siddhartha Medical College, Tumkuru, Karnataka, India*
[2]*Aster CMI Hospital, Bengaluru, India*
[3]*Laboratory Manager, Dubai Falcon Hospital, Dubai, UAE*
[4]*Pediatrics Department, District Hospital, Bundi, Rajasthan, India*

***Address for Correspondence:**
Sibi D, Sri Siddhartha Medical College, Tumkuru, Karnataka, India; E-mail: sdsilvanose@gmail.com

Submission: 23 January, 2023
Accepted: 03 March, 2023
Published: 06 March, 2023

Copyright: © 2023 Sibi D, et al. This is an open access article distributed under the Creative Commons Attr-ibution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Keywords: Allergic rhinitis; Asthma; *Aspergillus* species; Antihistamine; Corticosteroid; leukotriene

Abstract

Allergy or asthma is triggered by inhaling allergens such as dust, mites, pet dander, pollens, and fungal molds. Samples were collected from various indoor environments including air conditioner filters, carpets, indoor plant soil, living room air, and pillow covers of residents living in air-conditioned flats for screening the fungal pollution of indoor environments and their role in allergies and asthma. This study included 30 residents with school-aged children suffering from allergies or asthma and a healthy control group of another 20 other residential indoor environments. The fungi isolated from indoor environments include *Aspergillus niger, A. nidulans,A. flavus,A. fumigatus, Alternaria* sp., *Paeciliomyces* species, *Bipolaris* species, *Trichophyton verrucosum,* and *T. rubrum*. *Aspergillus* species were isolated from all environments while *Trichophyton* species were only isolated from indoor plant soil. The fungal presence was higher in the indoor environments of group 1 with allergic rhinitis and asthma with a significant p-value <0.00001 showing its role in allergic rhinitis when compared the group 2 without allergy or asthma. The children suffering from allergies and asthma were further grouped into intermittent (70%), persistent (13%), and asthma or allergic asthma (17%) cases based on symptoms and duration. For the treatment of intermittent allergic rhinitis, a combination of oral antihistamines, and nasal decongestants were used, while persistent allergy symptoms were treated with corticosteroids (oral/intranasal), oral antihistamines, and oral leukotriene receptor antagonists. Asthma cases were treated with salbutamol sulfate, a bronchodilator, and oral leukotriene receptor antagonists with a combination of antiallergic treatments. A combination of treatments with improved indoor hygiene showed better relief for allergic rhinitis and asthma and was significantly reduced from persistent symptoms to intermittent or recovered from allergic symptoms.

Introduction

Rhinitis is a condition that involves nasal inflammation and is characterized by recurrent sneezing, a runny nose, itchy eyes, and nasal congestion that can disrupt sleep. It may also increase the risk of other conditions, such as sinusitis and asthma, as these are common comorbidities associated with allergic rhinitis. Rhinitis can be caused by infections or inhaled allergens, such as dust, pet dander, dust mites, fungal molds, and pollens. However, allergic rhinitis is a hypersensitivity response to a variety of inhaled environmental allergens and is characterized by rhinorrhea, nasal congestion, itching of the nose, and sneezing [1,2]. When allergens are inhaled, they encounter the nasal mucosa and diffuse into nasal tissues. In recent years, evidence of the links between rhinitis and asthma has been strengthened, and their strong correlation may be explained by the theory of the unified airway, which suggests that upper and lower airway inflammation share common pathophysiologic mechanisms, coexist, and communicate via systemic circulation [3,4].

Allergic rhinitis is a chronic respiratory tract condition that can significantly affect a patient's quality of life. The clinical expression of the disease is the result of a cascade of immunological and biochemical events. It is estimated that more than 400 million people worldwide are affected by allergic rhinitis, which includes 10-30% of adults and 40% of children. Among them, 71% of patients are triggered by environmental factors [1,5,6]. Home environmental assessments can be valuable tools for the comprehensive management of asthmatic and allergic diseases. Indoor structures can harbor allergens, making the home a primary target for allergens. Fungi are one of the allergens that tend to inhabit areas with high moisture content and low light levels [7]. Allergic rhinitis and asthma are both chronic inflammatory disorders, with overlapping epidemiology and sharing some treatment approaches [8,9]. This study aims to evaluate the level and biodiversity of fungi in indoor environments, their role in allergic rhinitis and asthma, and to review current treatment options and management.

Materials & Methods

This study was conducted in fifty indoor environments of residents living in air-conditioned multistoried buildings in Dubai, United Arab Emirates to assess the indoor fungal presence. It includes 30 residents with children 5 to 12 years with allergic rhinitis or asthma and 20 with healthy children without allergic rhinitis or asthma. Samples were collected from air conditioner filters, carpets, indoor plant soil, pillow covers, and indoor air using an air sampler and transported to the microbiology lab for fungal culture and identification. The fungal colonies were counted and identified by cultural characteristics and morphology of hyphae and spores under microscopy using lactophenol aniline blue stain.

A survey was done to assess the children having any type of allergy or asthma and recorded the details of clinical diagnosis and treatment from clinics or hospitals prescribed by a pediatrician. The samples collected from the healthy group were included in Group 2 and those who suffer from allergies were included in Group 1, based

ISSN: 2380-0534

on the symptoms and duration of the diseases sub-categorized into intermittent, persistent, and asthma or allergic asthma cases. A follow-up screening was performed after 3 months with improved conditions such as weekly cleaning of air condition filters, indoor air purification with a HEPA filter air purifier, frequent change of bedding, and removal of indoor plants from the living room.

Results

The symptoms of allergic rhinitis were rhinorrhea, nasal congestion, itching of the nose, and sneezing. Allergic rhinitis was further sub-grouped into intermittent (70%), characterized by allergic symptoms ≤ 3 days in a week; persistent (13%), characterized by allergic symptoms >3 days a week with disturbed sleep and lack of regular activity, or if symptoms persist >4 consecutive weeks. Asthma or allergic asthma cases (17%) were together as they have a similar treatment approach. Common asthma signs and symptoms in children include coughing, particularly at night, wheezing, breathing difficulty, chest tightness, or discomfort.

The main difference between intermittent and persistent allergic rhinitis was the frequency, degree, and duration of symptoms. Both types of allergic rhinitis shared some similarities in symptoms, while there were also differences in the severity of symptoms and their impact on daily life. Symptoms of intermittent allergic rhinitis include sneezing, runny nose, nasal congestion, and itchy or watery eyes. Persistent allergic rhinitis had these same symptoms, with additional symptoms noticed as sore throat, coughing, and fatigue. The symptoms of intermittent allergic rhinitis were generally less severe than those of persistent allergic rhinitis and lasted for a short period of time. In contrast, persistent allergic rhinitis symptoms were more severe and lasted for weeks or even months in some cases. This can have a significant impact on quality of life. Intermittent allergic rhinitis was not severe enough to impact daily life. On the other hand, persistent allergic rhinitis had a significant impact on daily life, making it difficult to carry out daily activities.

All children in the survey were between 5 and 12 years old, and the treatments they received from various pediatric clinics were documented and summarized in Table 1. Treatment for intermittent allergic rhinitis includes a combination of oral antihistamines and nasal decongestants, while persistent allergy symptoms are treated with corticosteroids (oral/intranasal), oral antihistamines, and oral leukotriene receptor antagonists. Asthma cases are treated with salbutamol sulfate, a bronchodilator, and oral leukotriene receptor antagonists, in combination with antiallergic treatments.

Table 2 presents the fungi isolated from various indoor environments of people suffering from allergy or asthma (Group 1), while Table 3 shows fungi isolated from various indoor environments of people without allergy or asthma (Group 2). In Group 2, residents did not use carpets and did not have indoor plants. The presence of fungi in the indoor environments of Group 1 was significantly higher (p-value <0.00001) than in Group 2, demonstrating its role in allergic rhinitis compared to those without allergies. Figure 1 illustrates the biodiversity of fungi in the indoor environment of Group 1.

A follow-up study recorded all cases of allergic rhinitis and asthma were either reduced from persistent to intermittent or completely recovered.

Discussion

Allergic rhinitis is a prevalent health problem that affects up to 40% of the global population, with higher rates among children [1,5]. Individuals with severe and persistent rhinitis are at greater risk of developing asthma, which can cause chest tightness, breathlessness, and nocturnal coughing [8,11]. Both allergies and asthma can be triggered by inhaling common allergens such as dust, pet dander, mites, pollens, and mold. Previous studies have shown that the biodiversity of fungi in indoor environments varies depending on climatic conditions like temperature and humidity [7,10]. *Aspergillus* species were frequently found in the air conditioning filters of hospitals, schools, cars, and homes, while Trichophyton species are common in soil and indoor plant soil [7,10,12,13]. The incidence of fungi was higher in Group 1, particularly in indoor plant soil, A.C. filters, and carpets, and the fungal colonization may contribute to allergic rhinitis or trigger allergy symptoms in residents.

Allergy to fungal spores is an immune response that occurs

Table 1: Overview of pharmacologic treatment received by the patients in group 1with allergic rhinitis or asthma.

Allergic Rhinitis/Asthma (30)	Treatment type	Pharmacology	Dosage
Intermittent allergic symptoms (21)	Oral antihistamine	Cetirizine (Zyrtec)or Loratadine (Claritin/Clara)	5 mg PO once daily*
	Nasal decongestant or Hypertonic saline	Xylometazoline hydrochloride and ipratropium bromide (Otrivin 0.05%/Xylolin 0.05%) Rinofast/Physiol	1 spray in each nostril twice a day
Persistent allergic symptoms (4)	Intranasal corticosteroids	Budesonide (Rhinocort/Pulmicort)	1spray in each nostril once a day
	Oral antihistamine	Cetirizine (Zyrtec) or Loratadine (Claritin/Clara)	5 mg PO once daily*
	Oral corticosteroids or	Prednisolone (Gupisone)	5 mg PO twice daily
	Oral leukotriene receptor antagonist	Montelukast (Singulair/Cinfalair/Montas)	4 mg PO once daily
Asthma or allergic asthma (5)	Intranasal corticosteroids	Budesonide (Rhinocort/Pulmicort)	1spray/nostril once daily
	Oral leukotriene receptor antagonist	Montelukast (Singulair/Cinfalair/Montas)	4mg once PO daily
	Beta-2 agonist (Bronchodilator)	Salbutamol sulfate(Ventolin or Butalin: tab or syrup or inhaler/nebulizer)	2 mg once a day or Nebule equivalent to 2.5mg or 1 to 2 puff
	Oral corticosteroids	Prednisolone (Gupisone)	5mg PO twice daily

*In two cases dosage was adjusted based on age and weight.

ISSN: 2380-0534

Table 2: Fungi isolated from the various indoor environment of people suffering from allergy (Group 1).

Samples (n)	Fungi isolated	CFU* (Median)	CFU* (range)	Unit
Air conditioner filter (30)	*A.niger* *A.nidulans* *A.versicolor* *Alternaria sp* *Paeciliomyces sp*	1,149,120 210400 22100 480 820	410,400 - 2,462,400 120500 – 228000 13470 – 27600 300 – 640 410 - 1200	MPN/ filter
Pillow cover (30)	*A.niger* *A. flavus* *A. nidulans* *Alternaria sp*	369 20 36 6	0 – 1100 0 – 90 0 – 72 0 -12	MPN/pillow
Carpets (18)	*A.niger* *A. nidulans* *A. flavus* *Paeciliomyces sp*	420,000 16700 810 610	300,000 – 600,000 8200 – 19900 410 – 1870 170 -300	MPN/m^2
Plant soil surface (12)	*Aspergillus niger* *A. fumigatus* *Bipolaris sp* *T.verrucosum* *T. rubrum*	2,63450 22710 710 2,002,478 328,478	1,45400 - 2,988,70 16800 – 32700 210 - 980 1,832,040 - 2,488,750 1,832,00 - 4,488,00	MPN/pot surface soil
Indoor air (30)	*A.niger* *A.nidulans* *A. versicolor* *Alternaria sp* *Paeciliomyces sp*	□1540 640 160 20 620	70-1610 20 – 860 40 – 210 0 – 40 0 - 810	MPN/m^3

n = Number of samples; *CFU – Colony Forming Unit; MPN - Most Probable number

Table 3: Fungi isolated from the various indoor environment of people without allergy (Group 2).

Samples (n)	Fungi isolated	CFU (Median)	CFU (Range)	Unit
Air conditioner filter (20)	*Aspergillus niger* *A.nidulans* *A.versicolor*	329,200 10840 1070	310,400 - 620,800 9150 - 11260 980 - 2600	MPN/ filter
Pillow cover (20)	*Aspergillus niger*	130	0 - 760	MPN/ pillow
Indoor air (20)	*Aspergillus niger* *Aspergillus nidulans* *Aspergillus versicolor*	800 380 40	40-720 0-420 0-80	MPN/m^3

n = Number of samples; *CFU – Colony Forming Unit; MPN - Most Probable number

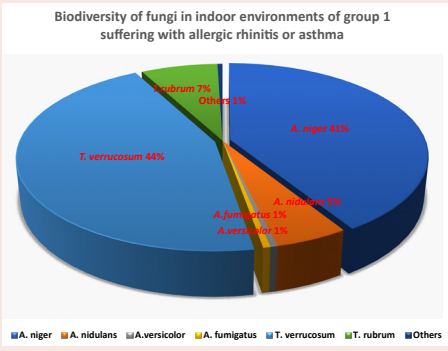

Figure 1: Shows the biodiversity of fungi in the indoor environment of group 1.

when the body's immune system overreacts to the presence of these spores. When the fungal spores are inhaled, the immune cells called dendritic cells capture them and present them to T-helper cells. The T cells activate B-cells and produce specific antibodies called Immunoglobulin E (IgE) against the spores, and that will bind to mast cells and basophils. The activated mast cells and basophils release inflammatory mediators, such as histamine, leukotrienes, and prostaglandins. These mediators cause allergy symptoms such as swelling, itching, and mucus production. In response to the inflammatory mediators, other immune cells, such as eosinophils and neutrophils, are recruited to the site of the immune response. These cells release additional inflammatory molecules and enzymes that cause tissue damage and exacerbate the allergic reaction [14-16]. Similarly, exposure to fungal spores can trigger an asthma attack in some people, leading to symptoms such as wheezing, coughing, chest tightness, and difficulty breathing. Individuals with allergies or asthma should be especially vigilant in monitoring and managing indoor air quality to reduce the risk of exacerbating their symptoms [17].

The pathologic features of allergic rhinitis and asthma have many similarities as both conditions involve the activation of CD4+ T cells, eosinophils, and mast cells by allergens [3,8,11]. The immediate allergic reaction is coordinated by mast cells, and their mediators, histamines, and leukotrienes are responsible for causing the symptoms of allergic rhinitis, including smooth muscle constriction and mucus secretion [3,8]. Second-generation antihistamines are preferred treatment options in children as they are considered safe and have less sedation compared to older antihistamines [9]. They are highly effective at relieving the symptoms of histamine-mediated allergic rhinitis, such as sneezing, itching, and runny nose. Intranasal antihistamines have advantages over oral antihistamines as they provide a higher concentration of medication to a specific, targeted area with fewer adverse effects [9].

Allergic rhinitis and asthma are often associated, and the two disorders interact at various levels, with rhinitis typically preceding the development of asthma. The presence and type of asthma will be influenced by sensitization and the duration and severity of allergic rhinitis. A study found that 78% of asthma patients have allergic rhinitis, while 38% of allergic rhinitis patients have asthma, showing that persistent allergic rhinitis may develop into asthma [8]. Once the

ISSN: 2380-0534

diagnosis is confirmed, the next step is to identify the allergen and reduce the patient's exposure to allergens. Medical treatment must also be to manage the symptoms of allergic rhinitis, such as nasal blockage, itchiness, and sneezing. These nasal medications are steroid sprays for the nose, which could be taken regularly over periods, and oral antihistamine medications to alleviate all symptoms of allergic rhinitis. Since allergic rhinitis and asthma are inflammatory disorders with similar pathophysiology, they also share common treatment approaches, steroids being the mainstay of treatment for both.

The treatment options for allergic rhinitis include intranasal corticosteroids, oral and topical antihistamines, decongestants, intranasal anticholinergics, and leukotriene receptor antagonists. Intranasal corticosteroids are effective as a first-line therapy for mild to moderate disease. Second-line therapies, including antihistamines, decongestants, and leukotriene receptor antagonists, are used for moderate to severe disease [9,11]. In a study using budesonide nasal corticosteroid spray for allergic rhinitis, it was found that nasal corticosteroids are effective with or without antihistamines in the treatment of the condition. Glucocorticoid nasal sprays are presently the most effective single-agent maintenance therapy for allergic rhinitis and cause very few side effects at the recommended doses. They are particularly effective in relieving nasal congestion. Antihistamines relieve the itching, sneezing, and runny nose of allergic rhinitis but do not relieve nasal congestion. Antihistamines are available in a nasal spray or oral formulation such as tablets or syrup.

Leukotrienes are another mediator and play a crucial role in allergic rhinitis and asthma by causing airway muscle constriction, leading to breathing difficulties, and increased mucus production. Montelukast, a leukotriene LTD4 receptor antagonist, is an effective treatment option for moderate to severe persistent symptoms of allergic rhinitis with asthma and can be used in combination with intranasal corticosteroids or antihistamines [4,8,9,11].

Asthma is a respiratory disease characterized by inflammation and bronchospasm, different from allergies. It is not necessary to have people with asthma who always have allergies. Airway inflammation is formed when the lining of the airways becomes swollen and clogged with mucus and fluid. Bronchospasm is formed when the muscles around the airways tighten and contract. These conditions leave a patient with cough, wheezing, chest tightness, and shortness of breath, and when breathing issues become severe, it is referred to as an asthma attack [8,11]. A cough associated with allergic rhinitis was noted with asthma. Allergic diseases may occur in those who have an overactive immune system, and in some cases, the immune response causes the airways to swell and overproduce mucus due to an allergen and leading to allergy-induced asthma [8,11]. People with allergic asthma experience the same symptoms as those with non-allergic asthma, including coughing, wheezing, chest tightness, and shortness of breath.

Conclusion

Aspergillus species were the most common fungi isolated from the indoor environment while *Trichophyton* species were also isolated from the plant soil surface. A high incidence of fungi was seen in the indoor environment of residents suffering from allergies and asthma. Many therapeutic options are effective against allergic rhinitis, including a combination of antihistamines, corticosteroids (intranasal and oral), and anti-leukotrienes. The treatment efficiency was improved with hygienic environmental conditions by avoiding fungal contaminants which were the major trigger in indoor environments.

Acknowledgment

The authors would like to thank Al Hayat Pharmaceuticals, Sharjah, UAE for their cooperation in this study

References

1. Tran NP, Vickery J, Blaiss MS (2011) Management of Rhinitis: Allergic and Non-Allergic. Allergy Asthma Immunol Res. 3: 148-156.
2. Quillen DM, Feller DB (2006) Diagnosing Rhinitis: Allergic vs. Nonallergic. Am Fam Physician 73: 1583-1590.
3. Liva GA, Karatzanis AD, Prokopakis EP (2021) Review of Rhinitis: Classification, Types, Pathophysiology. J Clin Med 10: 3183.
4. Small P, Keith PK, Kim H (2018) Allergic rhinitisAllergy, Asthma & Clinical Immunology. Allergy Asthma Clin Immunol, 14: 51.
5. Lizanne N, Adam F, George D T, Gideon L (2017) Diagnosis and management of allergic rhinitis in children. Prescribing in children, Allergic rhinitis.
6. Mahboub B, Al-Hammadi S, Prakash VP, Sulaiman N, Blaiss MS, et al. (2014) Prevalence and triggers of allergic rhinitis in the United Arab Emirates. World Allergy Organ J 7:19.
7. Dales RE, Miller D, Mcmullen ME (1997) Indoor air quality and health: Validity and determinants of reported home dampness and moulds. Int J Epidemiol 26: 120-125.
8. Bergeron C, Hamid Q (2005) Relationship between Asthma and Rhinitis: Epidemiologic, Pathophysiologic, and Therapeutic Aspects. Allergy Asthma Clin Immunol 1: 81-87.
9. Denise KS, Stephanie S (2010) Treatment of Allergic Rhinitis. American Family Physician 81: 12.
10. Sharma R, Deval R, Priyadarshi V, Gaur SN, Singh VP (2011) Indoor fungal concentration in the homes of allergic/asthmatic children in Delhi, India. Allergy Rhinol (Providence) 2: 21-32.
11. Kim H, Bouchard J, Renzi PM (2008) The link between allergic rhinitis and asthma: A role for antileukotrienes? Can Respir J 15: 91-98.
12. Shelton BG, Kirkland KH, Flanders WD, Morris GK (2002) Profile of Airborne fungi in buildings and outdoor environments in the United States. Appl Environ Microbiol 68: 1743-1753.
13. Simmons RB, Noble JA, Rose L, Price DL, Crow SA, et al. (1997) Fungal colonization of air filters from hospitals. Am Ind Hyg Assoc J 58: 900-904.
14. Knutsen AP, Bush RK, Demain JG, Denning DW, Dixit A, et al. (2012) Fungi and allergic lower respiratory tract diseases. J Allergy Clin Immunol 129: 280-291.
15. Denning DW, Pashley C, Hartl D, Wardlaw A, Godet C (2017) Fungal allergy in asthma-state of the art and research needs. Clin Transl Allergy 4: 14.
16. Piggott DA, Higgins KE, Bunning VK (2014) Allergy to fungi. Clin Rev Allergy Immunol 47: 362-368.
17. Samson RA, Flannigan B, Flannigan ME, Verhoeff AP, Adan OC G (Eds.) (2011) Health implications of fungi in indoor environments: An overview. In Fundamentals of mold growth in indoor environments and strategies for healthy living (pp. 287-302). Wageningen Academic Publishers.