

## EPIDEMIOLOGY OF ALLERGIC RHINITIS IN INDIA: A SYSTEMATIC REVIEW

V. Sundararaman<sup>1</sup>, A. Sathish Ponni<sup>2</sup>

<sup>1</sup>Senior Assistant Professor, Department of ENT, KAPV Government Medical College, Tiruchirapalli, India

<sup>2</sup>Assistant Professor, Department in ENT, Pudukottai Medical College, Pudukottai, India

Received : 05/09/2023  
Received in revised form : 01/10/2023  
Accepted : 12/10/2023

**Keywords:**

Allergic Rhinitis, Epidemiology, India, Prevalence, Risk Factors, Treatment, Prevention, Vulnerable Populations, Allergens, and Diagnosis.

Corresponding Author:

**Dr. V.Sundararaman,**  
Email: g3vsr04@gmail.com

DOI: 10.47009/jamp.2023.5.5.279

Source of Support: Nil,  
Conflict of Interest: None declared

*Int J Acad Med Pharm*  
2023; 5 (5); 1408-1413



### Abstract

Allergic rhinitis (AR) is a prevalent inflammatory ailment affecting the nasal passages within the Indian population. This systematic review and meta-analysis offer an extensive overview of AR in the Indian context. AR, primarily triggered by immune responses mediated by IgE antibodies, exerts a substantial influence on the populace, with a prevalence ranging from 20% to 30%. AR has a considerable impact on individuals' quality of life, contributing to various complications and associated health issues. This study explores the epidemiological aspects, predisposing factors, clinical presentation, diagnostic methodologies, therapeutic alternatives, and regional discrepancies concerning AR in India. This study also investigates preventive measures aimed at reducing the prevalence of AR and its impact. Furthermore, it underscores populations susceptible to AR, encompassing children, adolescents, the elderly and expectant mothers. Preventive measures are also explored to mitigate the burden of AR. The study's results are meant to offer valuable insights to healthcare professionals and policymakers. These insights can assist in the formulation of guidelines and strategies for the efficient management and mitigation of AR's impact on the Indian population.

## INTRODUCTION

AR, primarily presenting as allergic rhinitis, is an inflammation of the nasal membranes. It is characterized by a combination of symptoms such as sneezing, nasal congestion, nasal itching, and rhinorrhea. It's important to note that allergic rhinitis itself is generally not life-threatening unless it occurs alongside severe asthma or anaphylaxis.<sup>[1]</sup> It is characterized by an immune response mediated by IgE antibodies, primarily directed against inhaled antigens. This immune reaction has an immediate phase, followed by a late phase driven by leukotrienes. However, the condition can lead to substantial morbidity.<sup>[2]</sup> It affects a considerable portion of the population, with estimates suggesting that it impacts up to 40% of individuals. Among all the causes of mucosal inflammation, allergic rhinitis (AR) stands out as the most prevalent, affecting approximately 1 in every 6 people.<sup>[3]</sup> In the past, allergic rhinitis (AR) was primarily considered a condition affecting only the nasal airway. However, the emergence of the unified airway theory has redefined AR as a constituent of a broader systemic allergic response. This theory recognizes that AR is part of a systemic pathology that extends beyond the nasal airway and is linked to other related conditions like asthma and atopic dermatitis, which share a common underlying systemic pathology.<sup>[4]</sup> This

description outlines the assessment and management of allergic rhinitis, emphasizing the importance of the interprofessional healthcare team in enhancing patient care for this condition.

### Classification of Allergic Rhinitis

According to the Allergic Rhinitis and its Impact on Asthma (ARIA guidelines), allergic rhinitis can be classified:

#### a. Based on Etiology

It is categorized as IgE-mediated, autonomic, infectious, and idiopathic.

- IgE-Mediated (Allergic) rhinitis- It is characterized by inflammation of the nasal mucosa driven by IgE antibodies, leading to eosinophilic and Th2-cell infiltration of the nasal lining. It can further be categorized as intermittent or persistent.<sup>[5]</sup>
- Autonomic rhinitis- It is related to the autonomic nervous system and encompasses conditions such as vasomotor rhinitis, drug-induced rhinitis (rhinitis medicamentosa), rhinitis associated with hypothyroidism, hormonal-related rhinitis, and non-allergic rhinitis with eosinophilia syndrome (NARES).<sup>[5]</sup>
- Infectious rhinitis- It is triggered by various infections, with viral infections being the most common. It can also result from bacterial or fungal infections, with symptoms arising due to the inflammatory and immune responses to these pathogens.<sup>[5]</sup>

- Idiopathic rhinitis presents a challenge as its cause or origin cannot be determined, making it difficult to identify a specific trigger or etiology for this type of rhinitis.<sup>[5]</sup>

#### **b. Based on symptom duration and severity**

It is categorized into four categories, mild intermittent, mild persistent, moderate-to-severe intermittent, and moderate-to-severe persistent forms.

Allergic rhinitis can be classified into several categories based on the frequency and severity of symptoms.

- Intermittent Allergic Rhinitis- It refers to symptoms occurring for less than four days a week or less than four consecutive weeks.
- Persistent Allergic Rhinitis- It is characterized by symptoms persisting for four days a week or more and lasting for at least four consecutive weeks.
- Mild Allergic Rhinitis- In this type, the symptoms have a minimal impact on the quality of life and
- Moderate-to-severe Allergic Rhinitis- In this type, the symptoms significantly affect the individual's quality of life.

These classifications provide a useful framework for understanding and managing allergic rhinitis (AR).<sup>[5,6]</sup>

#### **Impact of Allergic Rhinitis on Quality of Life**

However, when compared to asthma, allergic rhinitis is typically seen as a less persistent and relatively milder ailment. It can significantly impact various dimensions of a patient's quality of life, encompassing areas such as employment, education, and overall productivity.<sup>[7]</sup> Furthermore, allergic rhinitis often coexists with other respiratory tract conditions, and the cumulative expenses associated with managing this condition can exert adverse effects on the socioeconomic aspects of the patient's life. The quality of life is compromised in individuals with this condition due to the direct consequences of its primary symptoms. Additionally, allergic rhinitis tends to give rise to sleep disturbances, fatigue, cognitive impairment, depression, and related issues, all of which collectively contribute to a diminished quality of life.<sup>[8]</sup>

## **MATERIALS AND METHODS**

**Data Extraction:** Comprehensive literature searches will be conducted using electronic databases such as PubMed, and Google Scholar. Keywords and Medical Subject Headings (MeSH) terms related to allergic rhinitis and India will be used, including "allergic rhinitis," "hay fever," "epidemiology," "prevalence," and "India."

#### **Study selection Criteria**

##### **Inclusion Criteria**

- Studies reporting on the epidemiology of allergic rhinitis in India, including prevalence, incidence, risk factors, and associated co- morbidities.

- Studies utilizing various study designs such as cross-sectional, cohort, case-control, and surveillance data.

##### **Exclusion Criteria**

- Studies conducted outside India
- Studies not providing enough data on allergic rhinitis epidemiology
- Duplicates and non-peer-reviewed sources.

##### **Epidemiology in India:**

##### **Prevalence rate of allergic rhinitis in various regions of India:**

India is the residence of approximately 20% of the world's population, totaling 1.35 billion individuals.<sup>[9]</sup> Epidemiological investigations have revealed an escalation in the occurrence of allergic conditions in India over the past two decades. Among non-communicable health conditions, allergic diseases like allergic rhinitis (AR) and asthma seem to have experienced a rise in prevalence in India during recent decades. Nonetheless, with a population exceeding 1.3 billion, the burden of allergic rhinitis, asthma, and atopic dermatitis remains substantial, and this is exacerbated by an unmet need for qualified allergy specialists and deficiencies in the healthcare infrastructure. There exists considerable regional variation in the prevalence of allergic diseases across different geographical areas in India, and the underlying causes for this discrepancy remain unclear at present. The prevalence of allergic rhinitis is significant, accounting for approximately 55% of all allergic conditions. Furthermore, around 20-30% of the Indian population experiences at least one allergic ailment. The documented occurrence of allergic rhinitis in India also falls within the range of 20% to 30%.<sup>[10]</sup>

##### **Variations in prevalence based on urban vs.**

**Rural settings:** Currently, the factors that increase the susceptibility to atopic and allergic diseases and those that protect against them have not been clearly defined. However, there is some indication that genetic factors, in conjunction with cultural and environmental factors like dietary choices, exposure to secondhand smoke, air pollution, and residing in urban areas, may play a role in influencing these conditions.<sup>[11]</sup> Environmental Tobacco Smoke (ETS) poses a significant concern in both rural and urban households. Research conducted in Chandigarh, located in the state of Punjab, revealed that adolescents residing in homes where their parents smoked experienced an elevated occurrence and severity of asthma in comparison to households with a smoke-free environment.<sup>[12]</sup> Nevertheless, due to the insufficient availability of comprehensive epidemiological research in India, especially in rural and suburban regions, this figure may not accurately reflect the actual extent of this ailment.

##### **Age and gender distributions of allergic rhinitis:**

According to the International Study of Asthma and Allergies in Childhood (ISSAC) Phase 1 conducted in 1998, in India, nasal symptoms alone were reported in 12.5% of children aged 6-7 years and 18.6% of those aged 13-14 years. Additionally,

allergic rhinoconjunctivitis was observed in 3.3% and 5.6% of children in the respective age groups. However, in the ISSAC Phase 3 study conducted in 2009, the prevalence of nasal symptoms increased to 12.9% and 23.6% among children aged 6-7 and 13-14 years, respectively. Furthermore, the prevalence of allergic rhino conjunctivitis increased to 3.9% and 10.4% in the same age groups. Over 15 years, there has been a consistent upward trend in allergic rhinitis among children aged 6-14 years.<sup>[13]</sup> Allergic rhinitis is associated with several coexisting conditions, including asthma, sinusitis, otitis media, atopic dermatitis, and nasal polyps.<sup>[14]</sup>

#### **Etiology and risk factors:**

**Common allergens responsible for allergic rhinitis:** Allergic rhinitis often occurs due to exposure to perennial or seasonal allergens present in both indoor and outdoor settings. Pollen from grass, trees, and weeds are the primary culprits behind seasonal allergic rhinitis, while house dust mites, pets, and molds are the leading causes of perennial allergic rhinitis. However, it's worth noting that in tropical and subtropical regions, pollen can become a year-round allergen.<sup>[15]</sup>

- **Pollen:** Pollen originating from a variety of plants, including grasses, trees (such as neem and banyan), and weeds, stands as a notable instigator of seasonal allergic rhinitis, notably during the spring and early summer seasons.<sup>[16]</sup>
- **Dust Mites:** House dust mites, particularly *Dermatophagoides pteronyssinus*, and *Dermatophagoides farinae*, flourish in India's humid climate. They represent a significant trigger for perennial allergic rhinitis, given their year-round presence in bedding, rugs, and upholstered furnishings.<sup>[16,17]</sup>
- **Molds:** The warm and moisture-laden conditions prevalent in many Indian regions encourage the proliferation of mold spores. Mold allergies can incite allergic rhinitis, particularly during the monsoon season when humidity levels are elevated.<sup>[16,17]</sup>
- **Pet Allergens:** Household pets like cats and dogs serve as common sources of allergenic substances. Proteins found in their skin cells, urine, and saliva can elicit allergic rhinitis symptoms in individuals predisposed to allergies.<sup>[16,17]</sup>
- **Air Quality Concerns:** Elevated levels of air pollution in many Indian cities can irritate the nasal passages and exacerbate the manifestations of allergic rhinitis. Particulate matter, emissions from vehicles, and industrial pollutants are among the factors contributing to this issue.<sup>[16,17]</sup>
- **Fungal Spores:** Fungal spores, present in damp environments such as bathrooms and basements, can also possess allergenic properties and contribute to the onset of allergic rhinitis.<sup>[16,17]</sup>

**Environmental factors and genetic predisposition contributing to allergic rhinitis:** While the primary risk factors for allergic rhinitis (AR) typically involve environmental exposures and genetic factors, several

emerging environmental, social, and behavioral risk elements, such as the proximity of waste disposal sites to residential areas, the proximity of vehicular traffic to homes, and nighttime exposure to artificial lighting, have been linked to AR. Many of the environmental factors that contribute to the development of asthma and chronic rhinosinusitis (CRS) are associated with the disrupted interaction between epithelial barriers, particles, allergens, and microorganisms.<sup>[18]</sup> In atopic asthma and allergic rhinitis (AR), there is a prevalent type 2 biased inflammation characterized by the recruitment of eosinophils, basophils, and T-cells, as well as the release of cytokines. Epithelial cells come into contact with microorganisms, and it has become increasingly evident that these microorganisms play a role in inflammatory diseases. When it comes to the risk of these conditions, genetic inheritance is estimated to account for 25–80% of the risk for asthma and up to 90% of the risk for AR.

The onset of allergic rhinitis (AR) involves intricate interplays between genetic susceptibility and exposure to various environmental elements, with the primary emphasis on the involved allergen.<sup>[19]</sup> There is an evident genetic factor in AR, which has been strongly supported by segregation studies and research involving twins. In recent times, significant interest has been directed toward the genes that might play a role in allergic rhinitis (AR). Throughout the years, over 100 genes have been associated with atopic conditions, with none of these individual genes accounting for more than 75% of the observed traits.<sup>[20]</sup>

#### **Clinical presentation of allergic rhinitis in Indian population:**

AR exhibits a range of symptoms, both nasal and non-nasal. Nasal symptoms encompass anterior or posterior rhinorrhea (runny nose at the front or back of the nostrils), sneezing, nasal blockage, and nose itching. These symptoms can persist for hours following exposure to allergens that trigger mucosal inflammation.

Non-nasal symptoms manifest as ocular issues, including allergic rhinoconjunctivitis, characterized by eye itching, redness, and tearing, which frequently occur in AR patients. Other symptoms involve palate itching, postnasal drip, and coughing.<sup>[21]</sup> It can also be commonly categorized into two groups: "sneeze runners" and "blockers" due to their unique clinical characteristics, necessitating distinct treatment strategies.

Hypersensitivity reactions can be observed in various conditions, including AR. Alarmingly, more than 30% of AR patients endure severe allergic symptoms that can lead to profound disability and life-threatening circumstances like anaphylaxis. In severe cases, individuals may experience intense bronchospasms, laryngeal edema, cyanosis, hypotension, and shock.<sup>[22]</sup>

Concerning the severity of AR, it can be categorized as either mild or moderate/severe, by the AR and its Impact on Asthma (ARIA) guidelines.<sup>[23]</sup> This classification hinges on four key aspects: disruptions

in sleep patterns, hindrance in daily activities, impairment in school or work performance, and the presence of troublesome symptoms. Patients who do not encounter the aforementioned problems are considered to have mild AR, whereas those facing one or more of these challenges are categorized as having moderate/severe AR. Furthermore, ARIA guidelines also distinguish between intermittent and persistent AR symptoms based on the duration of symptom occurrence. Intermittent symptoms arise for less than four days per week or less than four consecutive weeks, while persistent symptoms persist for more than four days per week and more than four consecutive weeks.

**Diagnostic approaches:** For mild allergies, a visit to the physician may suffice, where need to undergo a general examination. The doctor may then recommend one of two allergy tests. Although the serum IgE test is the preferred choice for diagnosing allergic rhinitis, sometimes a skin prick test is prescribed. It's important to note that the skin prick procedure can be uncomfortable and exhausting for many individuals, primarily due to its time-consuming nature, immobility during the test, and complexity.<sup>[24]</sup>

The second method for testing allergic rhinitis involves a blood test, specifically a serum IgE test. This test measures the quantity of immunoglobulin E (IgE) antibodies generated when a specific allergen is introduced into the bloodstream.

A medical procedure known as an allergen-specific immunoglobulin E (IgE) test enables doctors to extract a small blood sample from a person and identify their specific allergies. Typically, this test is employed to identify allergies to common triggers

like pets, pollen, foods, and other common irritants.<sup>[25]</sup>

## RESULTS

### Treatment and management

**Non-pharmacological approaches:** Non-pharmacological approaches encompass allergen mitigation, which proves to be a viable course of action when the allergenic substances have been pinpointed, whether through patient self-identification or allergy testing. In such instances, patients can adopt measures to diminish their exposure to specific allergens, be it pollen, mold, or animal dander. It is imperative to underscore that allergen avoidance should constitute an integral component of a comprehensive treatment plan that incorporates pharmacotherapy. Notably, pet avoidance demonstrates evident advantages in this regard.

Lifestyle adjustments also come into play, with recommendations for individuals with AR to keep windows closed during high pollen seasons and to shower and change clothes after outdoor activities to minimize pollen contact. Additionally, the avoidance of tobacco smoke and environmental pollutants can contribute to symptom reduction.

Furthermore, patients should be educated on proper nasal irrigation techniques, like saline nasal sprays, which can help alleviate nasal congestion and reduce the need for medication. Moreover, incorporating stress-reduction techniques, such as yoga or mindfulness practices, may indirectly benefit AR patients by helping to modulate their immune responses and symptom severity.<sup>[28]</sup>

**Table 1: Pharmacological Treatment Options in India**

Drug Class	Drug Name (Generic)	Mechanism of Action	References
Antihistamines	Cetirizine	Blocks histamine receptors, reducing allergy symptoms	[26, 27]
	Loratadine	Inhibits histamine release and action	
Intranasal Corticosteroids	Fluticasone	Reduces inflammation and allergic reactions in the nose	[26, 27]
	Mometasone	Suppresses inflammation and immune response	
Decongestants	Pseudoephedrine	Shrinks blood vessels in the nasal passages, reducing congestion	[26, 27]
	Oxymetazoline	Provides temporary relief by narrowing blood vessels	
Leukotriene Receptor Antagonists	Montelukast	Blocks leukotrienes, which contribute to allergic reactions	[26, 27]
Mast Cell Stabilizers	Cromolyn Sodium	Prevents the release of histamine and other chemicals	[26, 27]
Intranasal Anticholinergics	Ipratropium Bromide	Reduces nasal secretions by blocking cholinergic receptors	[26, 27]

### Geographical variations:

**Regional differences in the prevalence and patterns of allergic rhinitis in India:** Variations in the occurrence and characteristics of allergic rhinitis across different regions of India have been identified. India displays regional disparities in the occurrence and features of allergic rhinitis, primarily attributable to factors such as geographical location, climate, air quality, and local lifestyles.

In the northern parts of the country, such as Delhi and Punjab, where air pollution levels frequently reach elevated levels, there is a higher incidence of allergic rhinitis. This is often exacerbated by the presence of allergens like pollen and dust mites in these regions, which intensify the symptoms associated with allergic rhinitis.<sup>[29]</sup>

In contrast, in the southern regions like Kerala, where the climate is generally milder and air quality is

better, the reported prevalence of allergic rhinitis tends to be lower. Nevertheless, different allergens, including mold spores and specific plant pollens, may still trigger allergic responses in these areas.<sup>[30]</sup>

Moreover, lifestyle elements like dietary choices and housing environments can have an impact on the prevalence and attributes of allergic rhinitis. Consumption of diets abundant in spicy ingredients, a common practice in specific regions of India, may exacerbate the intensity of symptoms in individuals afflicted with allergic rhinitis.

#### **Vulnerable populations:**

**Impact of allergic rhinitis on children and adolescents in India:** Allergic rhinitis can exert a substantial influence on the well-being of children and adolescents in India. It can manifest as adverse effects on their academic achievements, overall life satisfaction, regular school attendance, concurrent co-occurring health issues, psychological and social welfare, as well as the financial stability of their families. It is imperative to acknowledge and tackle these issues to enhance the holistic health and welfare of this susceptible demographic.

- a. **Academic Performance:** The symptoms of allergic rhinitis, such as nasal congestion, sneezing, and fatigue, can hinder concentration and disrupt sleep in children and adolescents. These challenges may lead to reduced academic performance, lower grades, and educational difficulties.<sup>[31]</sup>
- b. **Quality of Life:** Persistent allergic rhinitis can markedly diminish the quality of life for young individuals. The chronic nature of the condition, along with bothersome symptoms like itching, runny nose, and impaired sense of smell, can curtail their daily activities and overall well-being.<sup>[32]</sup>
- c. **Missed School Days:** Severe allergic rhinitis episodes may cause children and adolescents to miss school days, resulting in educational setbacks. Frequent absenteeism can impede their educational progress and social interactions.
- d. **Psychosocial Impact:** Living with chronic allergic rhinitis can also have psychosocial consequences. Adolescents may face social stigma due to visible symptoms like sneezing and nasal congestion, which can impact their self-esteem and peer relationships.

**Impact on elder populations:** Allergic rhinitis can exert a comprehensive influence on the well-being of elderly individuals in India. This impact encompasses various facets, such as health complications, diminished quality of life, impaired cognitive abilities, increased healthcare demands, emotional distress, and an increased likelihood of falls. Identifying and addressing these issues is necessary for enhancing the overall health and welfare of this susceptible demographic.

- a. **Health Complications:** Allergic rhinitis can exacerbate pre-existing health conditions in elderly individuals, leading to a higher risk of complications such as respiratory infections and

exacerbations of chronic respiratory diseases like asthma or chronic obstructive pulmonary disease (COPD).<sup>[33]</sup>

- b. **Reduced Cognitive Performance:** The persistent symptoms of chronic allergic rhinitis have the potential to negatively affect cognitive abilities among the elderly. Disturbed sleep and the discomfort linked to the condition could be factors contributing to declines in cognitive function and memory-related issues.<sup>[34]</sup>

**Impact on pregnant populations:** Allergic rhinitis in pregnant women in India can result in pregnancy-related complications, disruptions in sleep patterns, mistrust regarding medication usage, potential consequences for fetal health, emotional strain, and a diminished overall quality of life. Recognizing and addressing these issues is vital for ensuring the well-being of both the expectant mother and the developing fetus.<sup>[35]</sup>

#### **Special Considerations**

- a. **Medication Selection:** It's important to ensure that any allergy medications prescribed are safe for both the pregnant woman and the developing fetus. Non-pharmacological treatments and allergen avoidance strategies should be explored as the first line of defense.
- b. **Emotional Support:** Pregnant women with allergic rhinitis may experience emotional stress due to discomfort and concerns about medication safety. Providing emotional support and reassurance can be valuable in managing these concerns.<sup>[36]</sup>

**Preventive measures:** Preventive measures for allergic rhinitis in India involve minimizing allergen exposure, including avoiding common allergens such as pollen and dust mites, maintaining clean indoor environments, staying informed about pollen forecasts, practicing good personal hygiene, avoiding tobacco smoke, following a healthy diet, staying hydrated, consulting allergists for specific triggers and guidance, considering pharmacological treatments when necessary, and exploring allergen immunotherapy for severe cases, all while utilizing educational resources to enhance management and awareness of the condition.<sup>[37]</sup>

## **CONCLUSION**

Allergic rhinitis is a widespread and significant health concern in India, impacting a substantial portion of the population. This condition is multifaceted and complex, demanding a comprehensive understanding of its epidemiology, effects, and management. The prevalence of allergic rhinitis can vary across different regions of India, influenced by factors such as geographical location, climate, air quality, and lifestyle choices.<sup>[38]</sup> Northern areas characterized by high levels of air pollution tend to report elevated incidence rates, while southern regions with milder climates typically exhibit lower prevalence rates. Although not

inherently life-threatening, allergic rhinitis can significantly diminish the quality of life, hinder educational achievements in children and adolescents, and entail various social, psychological, and financial consequences.<sup>[39]</sup> Comprehending the epidemiological aspects of allergic rhinitis is vital for the efficient implementation of management and intervention measures aimed at enhancing the holistic welfare of individuals impacted by this ailment in India. Moreover, public health initiatives and awareness campaigns can play a pivotal role in reducing the burden of allergic rhinitis and enhancing the overall health and quality of life for affected individuals across the country.

## REFERENCES

- Lakhani N, North M, Ellis AK. Clinical manifestations of allergic rhinitis. *Journal Allergy Therapy* 2012;S5:007.
- Nathan RA. Management of patients with allergic rhinitis and asthma: literature review. *South Med J* 2009;102(9):935–41.
- Stewart M, Ferguson BJ, Fromer L. Epidemiology and burden of nasal congestion. *Int J Gen Med* 2010;3:37–45.
- Ellegard EK. Clinical and pathogenetic characteristics of pregnancy rhinitis. *Clin Rev Allergy Immunol* 2004;26(3):149–59.
- Brożek JL, Bousquet J, Agache I, Agarwal A, Bachert C, Bosnic-Anticevich S, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) Guidelines-2016 revision. *J Allergy Clin Immunol*. 2017;140(4):950-8.
- Rondón C, Romero JJ, López S, Antúnez C, Martín-Casañez E, Torres MJ, Mayorga C, R-Pena R, Blanca M. Local IgE production and positive nasal provocation test in patients with persistent nonallergic rhinitis. *J Allergy Clin Immunol*. 2007;119(4):899–905.
- M. Small, J. Piercy, P. Demoly, H. Marsden. Burden of illness and quality of life in patients being treated for seasonal allergic rhinitis: A cohort survey. *Clinical and Translational Allergy*. 2013; 3(1): 33.
- I. C. Camelo-Nunes, D. Solé. Allergic rhinitis: Indicators of quality of life. *Jornal Brasileiro de Pneumologia*. 2010; 36(1) : 124-133.
- Prasad R, Kumar R. Allergy situation in India: what is being done? *Indian J chest dis allied Sci*. 2013;55:7-8.
- Varshney J, Varshney. Allergic rhinitis: an overview. *Indian J otolaryngol Head Neck Surg*. 2015;67(2):143-9.
- Saini A, Gupta M, Sharma B, Kakkar M, Chaturvedy G, Gupta M. Rhinitis, sinusitis and ocular disease-2085. Prevalence of allergic rhinitis in urban school children, Jaipur city India. *World allergy Org J*. 2013;6(1):164.
- Gupta D., Aggarwal A.N., Kumar R., Jindal S.K. Prevalence of bronchial asthma and association with environmental tobacco smoke exposure in adolescent school children in Chandigarh, north India. *J Asthma*. 2001;38(6):501–507. doi: 10.1081/jas-100105871. PubMed PMID: 11642417.
- Sanjana JM, Mahesh PA, Jayaraj BS, Lokesh KS. Changing trends in prevalence of asthma and allergic rhinitis in children in Mysore, South India. *ERJ*. 2014;44(58):1187.
- Pherwani A, Mankekar G, Chavan K, Periera C, Bansode G. The study of comorbid conditions in adults with allergic rhinitis from Mumbai, Maharashtra, India and their comparison with children. *Ind J otolaryngol Head Neck Surg*. 2009;61(1):5-8.
- Mattila P, Renkonen J, Toppila-Salmi S, Parviainen V, Joenväärä S, Alff-Tuomala S, et al. Time-series nasal epithelial transcriptomics during natural pollen exposure in healthy subjects and allergic patients. *Allergy Eur J Allergy Clin Immunol*. 2010;65(2):175–83.
- Stewart GA, Robinson C. Indoor and outdoor allergens and pollutants. In: Middleton's allergy essentials 2017 Jan 1 (pp. 73-116). Elsevier.
- Gill NK, Singh A, Dhaliwal AK, Gill S. House dust mites and pollens as risk factors in allergic manifestations. *Indian Journal of Scientific Research*. 2016;7(1):131-42.
- Laulajainen-Hongisto A, Toppila-Salmi S, Luukkainen A, Kern R. Airway Epithelial Dynamics in Allergy and Related Chronic Inflammatory Airway Diseases. *Front Cell Dev Biol*. 2020;8(204).
- Feijen M., Gerritsen J., Postma D.S. Genetics of allergic disease. *Br Med Bull*, 56, 2000, 894-907.
- Tod A.M., Ono S.J. Genomics and proteomics of allergic disease. *Immunology*. 106, 2002, 1-10.
- Bousquet J, Khaltaev N, Cruz AA, Denburg J, Fokkens WJ, Togias A, et al. Allergic rhinitis and its impact on asthma (ARIA) 2008 update (in collaboration with the world health organization, GA(2)LEN and AllerGen). *Allergy*. (2008) 63(Suppl. 86):S8–160. doi: 10.1111/j.1398-9995.2007.01620.x
- Justiz Vaillant AA, Zito PM. Hypersensitivity Reactions, Immediate. Treasure Island, FL: Statpearls (2018).
- Brozek JL, Bousquet J, Agache I, Agarwal A, Bachert C, Bosnic-Anticevich S, et al. Allergic rhinitis and its impact on asthma (ARIA) guidelines-2016 revision. *J Allergy Clin Immunol*. (2017) 140:950–8. doi: 10.1016/j.jaci.2017.03.050.
- Bryan WT, Bryan MP. Cytologic diagnosis in otolaryngology. *Trans Am Acad Ophthalmol Otolaryngol* 1959;63:597–612.
- Gendo, K., Larson, E.B., 2004. Evidence-based diagnostic strategies for evaluating suspected allergic rhinitis. *Annals of internal medicine* 140, 278–289.
- Van Hoecke H, Vandenbulcke L, Van Cauwenberge P. Histamine and leukotriene receptor antagonism in the treatment of allergic rhinitis: an update. *Drugs*. 2007;67(18):2717-26.
- Lagos JA, Marshall GD. Montelukast in the management of allergic rhinitis. *Ther Clin Risk Manag*. 2007;3(2):327-32.
- Swain SK, Sahu MC, Baisakh MR. Nasal myiasis in clinical practice. *Apollo Med*. 2018;15(3):128-31.
- Bhattacharya K, Sircar G, Dasgupta A, Gupta Bhattacharya S. Spectrum of allergens and allergen biology in India. *International archives of allergy and immunology*. 2018 Jul 27;177(3):219-37.
- Mishra S, Perkins JM, Khan PK, Kim R, Mohanty SK, Subramanian SV. Variation in chronic diseases across households, communities, districts, and states in India. *American Journal of Preventive Medicine*. 2019 Nov 1;57(5):721-31.
- Balakrishnan U, Tsaneva M. Air pollution and academic performance: Evidence from India. *World Development*. 2021 Oct 1;146:105553.
- Papapostolou G, Kiotseridis H, Romberg K, Dahl Å, Bjermer L, Lindgren M, Aronsson D, Tunsäter A, Tufvesson E. Cognitive dysfunction and quality of life during pollen season in children with seasonal allergic rhinitis. *Pediatric Allergy and Immunology*. 2021 Jan;32(1):67-76.
- Mudgal P, Wardhan R. The increased risk of elderly population in India in COVID-19 pandemic. *Int J Health Sci Res*. 2020;10:166-75.
- Ganguly BB, Kadam NN. Age-related disease burden in Indian population. *Journal of the National Medical Association*. 2020 Feb 1;112(1):57-73.
- Manjrekar S, Patil S. Perception and attitude toward mental illness in antenatal mothers in rural population of Southern India: A cross-sectional study. *Journal of neurosciences in rural practice*. 2018 Oct; 9(04):473-7.
- Ayers S, Bond R, Webb R, Miller P, Bateson K. Perinatal mental health and risk of child maltreatment: A systematic review and meta-analysis. *Child abuse & neglect*. 2019 Dec 1;98:104172.
- Iyengar SR. Prevention and Control Measures in Management of Allergic Diseases. *Allergy and Asthma: Practical Diagnosis and Management*. 2016:559-68.
- Deb A, Mukherjee S, Saha BK, Sarkar BS, Pal J, Pandey N, Nandi TK, Nandi S. Profile of patients with allergic rhinitis (AR): a clinic based cross-sectional study from Kolkata, India. *Journal of Clinical and Diagnostic Research: JCDR*. 2014 Jan;8(1):67.
- Sinha B, Singla R, Chowdhury R. Allergic rhinitis: a neglected disease—a community based assessment among adults in Delhi. *Journal of postgraduate medicine*. 2015 Jul;61(3):169.