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AEROALLERGEN SENSITIZATION PATTERNS IN ALLERGIC RHINITIS WITH AND WITHOUT ASTHMA: INSIGHTS FROM NORTH-WEST INDIA

Otorhinolaryngology

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ABSTRACT

Introduction- Allergic rhinitis, often associated with bronchial asthma, is a growing public health concern affecting quality of life. This observational study was conducted at S.M.S. Hospital, Jaipur, to assess allergen patterns in patients with Allergic rhinitis, with or without Asthma, in north-west India. **Methodology-** A total of 190 patients were included and divided into two groups: Allergic rhinitis alone and Allergic rhinitis with Asthma. Clinical history, demographic data, and environmental exposures were recorded. All subjects underwent allergen testing using skin prick tests, and spirometry was also done. **Results-** House dust mites, pollens, and dust were the most common allergens identified. Patients with coexisting Asthma showed higher sensitization rates to allergens, poor lung function tests and reacted to a wider range of allergens. Seasonal and environmental factors also influenced allergen distribution. **Conclusion-** The study concludes that allergen sensitization is diverse in this region, with greater severity in patients with Asthma. Early identification of allergens can help in better management and improved outcomes.

KEYWORDS

Allergic Rhinitis, Asthma, Skin Prick Testing, House Dust Mite, Pollens

INTRODUCTION

Allergic diseases, including allergic rhinitis (AR) and asthma, are common chronic conditions worldwide, caused by IgE-mediated hypersensitivity to environmental allergens[1,2]. Their prevalence is rising globally and in India, making them a significant public health concern.

AR is an atopic nasal disorder presenting with congestion, rhinorrhea, sneezing, itching, and postnasal drip. Asthma is a chronic airway inflammation causing wheezing, breathlessness, chest tightness, and cough. Both often coexist, forming united airway disease[3,4,5]

Environmental, genetic, and lifestyle factors—including urbanization, pollution, and allergen exposure—contribute to this rise. Allergen patterns vary regionally, and their identification is critical for diagnosis and management [6,7,8]. The prevalence of AR in India ranges from 20–30%, while asthma affects around 2% of the population [9,10,11].

The diagnosis relies on clinical history, physical examination, confirmation via skin prick testing (SPT) and serum-specific IgE can also be done. Skin prick testing has been referred to as the "gold standard" test for evaluation of allergen sensitization patterns. Patients can be mono-sensitized or poly-sensitized, the latter being more common in tropical climates due to year-round exposure to multiple allergens. [12,13]

Rajasthan's semi-arid desert climate, characterized by hot summers, dust storms, grain storage practices, and low humidity, creates a unique allergen ecology with indoor allergens such as dust mites in bedding and fabrics, outdoor desert pollens like *Prosopis juliflora*, and agricultural allergens including grain dust and storage fungi such as *Aspergillus*.

Thus, the allergen spectrum is observed to be different in various regions of India—such as coastal South India, where fungi and mites predominate; Central India, where pollens and insects are more common; and North-East India, where *Blomia* mites and humidity-related allergens prevail—highlighting the importance of region-specific allergen panels for accurate diagnosis [14]. Identifying the relevant allergens guides avoidance strategies and deciding allergen-specific immunotherapy (ASIT) which is the only modality that alters natural course of the disease [15,16,17].

This prospective study was conducted to evaluate different allergen sensitization patterns with the help of Skin prick testing in patients with moderate to severe persistent AR with or without asthma in a tertiary care hospital, Jaipur, Rajasthan, India.

MATERIALS AND METHODS

Study Design

A hospital-based observational cross-sectional study during the period of 1 year.

Study Area

Department of Otorhinolaryngology and Head and Neck Surgery and Respiratory Allergic Clinic, SMS Medical College and Attached Hospitals, Jaipur, Rajasthan, India.

Sample Size

190 patients with above 14 years of age who presented with the symptoms of allergic rhinitis with or without asthma were included in this study.

Inclusion Criteria

1. All consenting patients above the age of 14 years
2. History indicative of moderate to severe persistent Allergic rhinitis with or without asthma
3. Fulfilling the criteria of ARIA (Allergic Rhinitis and its Impact on Asthma) guidelines, i.e. the patient has two or more symptoms out of the following:
   1. itching in nose
   2. sneezing
   3. watery discharge from nose, or
   4. nasal obstruction

   and the symptoms lasting - for 4 or more than 4 days per week - and for 4 or more than 4 consecutive weeks per episode.

Exclusion Criteria

1. Patients with other pathology of nose i.e. –
   1. Non allergic rhinitis,
   2. Atrophic rhinitis,
   3. Occupational rhinitis,
   4. Vasomotor rhinitis,
   5. Drug induced rhinitis
   6. Nasal polyposis

2. Patients not given informed and written consent
3. Uncooperative patients
4. Patient less than 14 years of age
5. Medically unfit patients.
6. Past history of severe allergic reactions
7. Pregnancy

Plan of Action:

All patients attending the ENT and Respiratory OPD of the S.M.S. medical college and attached hospitals with a history suggestive of Allergic rhinitis with or without asthma and fulfilling the inclusion criteria were included in this study.

A detailed history was taken including family history of Allergic rhinitis with or without asthma. Diagnosis was based on clinical history and physical examination. All subjects underwent ENT examination, complete haemogram profile, Total Eosinophil count (TEC), Total serum IgE estimation, Chest X-ray and Spirometry. They were subjected to Modified Skin Prick Test (MSPT) in the Allergy clinic of Department of Medicine; the test included 97 common aero allergens: -

1. 47 different pollens/plants
2. 15 different fungi
3. 14 different types of dusts and mites
4. 12 different types of insects
5. 9 different types of animal's dander

Participants were advised to stop antihistaminic medications for a minimum of 3 days prior to MSPT. The objectives of the study were to identify region-specific allergen patterns among symptomatic individuals using the MSPT, assessing the clinical profile and severity of allergic rhinitis, evaluation of the associated laboratory parameters including TEC and Serum IgE levels. The study also compared the sensitization patterns between patients with allergic rhinitis alone and those with coexisting asthma. The findings aimed to guide allergen avoidance strategies and support consideration for ASIT in selected cases.

Modified Skin Prick Test

The modified skin prick test was conducted according to the technique described by Pepys and Bernstein after obtaining informed consent from all the participants for allergy testing. The volar aspect of both forearms was selected as the test site. The skin was first cleaned with methylated spirit and allowed to air dry. The test areas were then marked and numbered, maintaining an interval of approximately 1.25–1.5 cm between adjacent marks. A drop of glycerinated histamine acid phosphate was applied as the positive control, while glycerinated buffered saline served as the negative control. Subsequently, a small drop of each allergen extract was placed on the corresponding marked areas on the volar surface of the forearm.

A sterile blood lancet measuring approximately 3 mm in length was then passed through the allergen drop and inserted into the epidermis at an angle of about 45°, directed away from the skin surface. The lancet was gently lifted to raise a small portion of the epidermis without producing bleeding, a technique referred to as tenting, which facilitates penetration of the allergen solution into the skin. After an interval of 15–20 minutes, the wheal responses were measured in millimeters. The interpretation of results was performed by comparing the wheal produced by the allergen extract with those obtained from the positive control (histamine) and the negative control (saline). The ratio between the allergen-induced wheal and the histamine-induced wheal was used for assessment. Wheal size was calculated as the average of the longest diameter and the perpendicular diameter drawn through its midpoint. A wheal measuring 3 mm or more than that of the negative control was considered indicative of a positive reaction (Figure 1). [10]

Figure 1 - 'Wheal' and 'Flare' Reactions After MSPT to Different Allergens

RESULTS

A total of 190 participants were included in the study: 112 males (58.95%) and 78 females (41.05%), giving a male-to-female ratio of 1.4:1. The 26–35year age group had the highest proportion (30%), followed by the 15–25year group (23.2%). Together, these groups accounted for 53.2% of cases, indicating that moderate to severe allergic rhinitis was more common among young adults.

Sneezing was the most common symptom (89.5%), followed by nasal blockage (83.2%), watery nasal discharge (74.7%), and nasal itching (70.5%). Ocular symptoms (itching, redness, watering) occurred in 67.9%. Cough was reported by 57.9%, while asthma-related symptoms (breathlessness, wheeze, chest tightness) were present in 45.3% (as shown in table no. 1). These findings indicate that Allergic rhinitis mainly presents with upper respiratory symptoms, often with associated lower respiratory involvement in patients with Asthma.

Table 1 – Clinical Symptom Distribution Among Patients with Moderate to Severe Allergic Rhinitis

Symptoms	Number of patients	Percentage (%)
Sneezing	170	89.5%
Nasal blockage	158	83.2%
Watery discharge	142	74.7%
Nasal itching	134	70.5%
Eye symptoms	129	67.9%
Cough	110	57.9%
Asthma- related (SOB/wheeze)	86	45.3%

47 patients experienced symptoms for less than 6 months, while 72 patients had symptoms lasting 6–12 months, and 71 patients reported symptoms for more than 12 months. Regarding severity, 56.8% of patients were classified as having moderate symptoms, whereas 43.2% experienced severe symptoms of Allergic rhinitis.

Among 190 patients, dust mite sensitization was most common (81.05%), followed by house dust (39.47%), pollens/plants (35.79%), and fungi (24.21%). Lower rates were seen with grain dust (17.37%), insects (14.74%), and animal dander (11.05%) as shown in table no. 2. The table no. 2 also compares allergen sensitization in AR alone and AR with asthma. In AR with Asthma also, Dust mites were the most common allergens (91.86%), followed by house dust (51.16%) and pollens/plants (46.51%). These results show predominant indoor allergen sensitization, especially from House dust mites. Overall, sensitization was higher in AR with asthma, indicating broader allergen sensitivity, especially to indoor allergens in such patients.

Table 2 – Allergen-specific Skin Prick Test Positivity in AR Only Versus AR with Asthma

Allergen type	AR only (n=104)	Percen-tage (%)	AR with asthma (n=86)	Percen-tage (%)	Total Number	Percen-tage (%)
Dust mite	75	72.12	79	91.86	154	81.05%
House dust	31	29.81	44	51.16	75	39.47%
Grain dust	13	12.50	20	23.26	33	17.37%
Pollens/plant	28	26.92	40	46.51	68	35.79%
Fungi	19	18.27	27	31.40	46	24.21%
Insects	12	11.54	16	18.60	28	14.74%
Animal Dander	9	8.65	12	13.95	21	11.05%

The sensitization to Dermatophagoides farinae (DF) and Dermatophagoides pteronyssinus (DP) was higher in AR with Asthma than AR only, though not statistically significant as shown in table no.3. Combined DF + DP sensitization was significantly higher in AR with Asthma. These results highlight stronger indoor allergen polysensitization (particularly dust mites and house dust) in patients with coexisting asthma suggesting that such exposures may play a critical role in the pathophysiology of unified airway disease.

The statistical analysis of pollen sensitization showed it was significantly higher in AR with Asthma than AR only as shown in table no.3. Prosopis juliflora sensitization was significantly greater in AR with Asthma. However, sensitization to Holoptelea integrifolia and Cassia occidentalis was also higher in AR with asthma, but was not statistically significant. These results suggest Prosopis juliflora pollen, a prevalent allergen in the semi-arid regions of Rajasthan, may be linked to Asthma comorbidity in a sensitized patient (Figure 2).

Overall fungal sensitization was higher in AR with Asthma than in AR only. Amongst fungal allergen, Aspergillus flavus showed the highest rate, nearly double in AR with Asthma as shown in table no. 3. Sensitization to Aspergillus fumigatus, Aspergillus niger, and Fusarium solani was also higher in AR with Asthma but not statistically significant. These findings suggest that fungal allergens, especially Aspergillus sensitization may be more common in AR patients with asthma.

In the category of animal allergens, sensitization to pigeon feather, dog and cow dander was higher in AR with Asthma patients as shown in table no.3. Although rates were consistently higher in the AR with Asthma group, differences were not statistically significant, indicating AR with Asthma did not significantly influence sensitization rates to these animal dander allergens in this study.

Table 3 – Comparison of Different Types of Dust Mite, Pollen, Fungal and Animal Allergens Sensitization in AR Only Versus AR with Asthma

Allergen name	AR only (n=104)	AR with Asthma (n=86)	P value
Dust mite			
Dermatophagoides farinae (DF)	47	48	0.15
Dermatophagoides pteronyssinus (DP)	28	31	0.18
DF+DP (combined)	75	79	0.001*
House dust	31	44	0.003
Grain dust	13	20	0.048
Pollens			
Holoptelea integrifolia	11	14	0.225
Prosopis juliflora	9	16	0.037
Cassia occidentalis	8	10	0.370
Total	28	40	0.001*
Fungal allergens			
Aspergillus flavus	6	10	0.078
Aspergillus fumigatus	4	5	0.356
Aspergillus niger	6	7	0.463
Fusarium solani	3	5	0.242
Animal allergens			
Pigeon feather	4	5	0.356
Dog dander	2	3	0.77
Cow dander	3	4	0.228

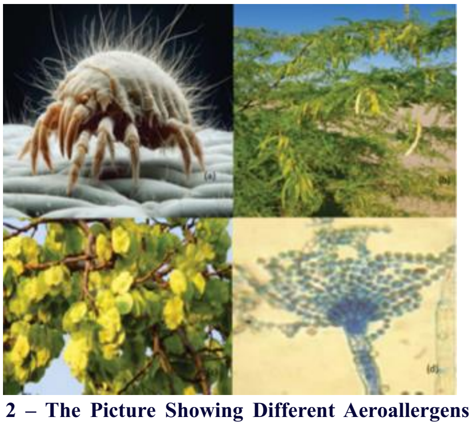

Figure 2 – The Picture Showing Different Aeroallergens – (a) House Dust Mite, (b) Prosopis Juliflora, (c) Holoptelea Integrifolia, (d) Aspergillus Flavus

The mean serum IgE level was 290 ± 95 IU/mL (range 120–580) in the AR-only group and significantly higher at 440 ± 130 IU/mL (range 180–750) in the AR with Asthma group ($p < 0.001$). This indicates greater allergic sensitization and immune response in AR with Asthma patients.

The AR with Asthma group had significantly lower lung function than the AR-only group as shown in table no.4. The FEV_1/FVC ratio was reduced (0.67 ± 0.05 vs 0.82 ± 0.03, $p < 0.001$), indicating airway obstruction. PEFR was also statistically significantly lower in AR with the Asthma group (310 ± 60 vs 430 ± 55 L/min, $p < 0.001$). Reversibility testing showed <5% change in AR only, but ≥12% improvement in AR with Asthma, confirming reversible airflow obstruction in Asthma patients. Overall, these findings illustrate significant impairment in pulmonary function among patients with AR with Asthma compared to those with AR-only.

Table 4 - Spirometry Parameters in AR and AR with Asthma Patients

Parameter	AR (n=104)	AR with Asthma (n=86)
FEV1(% predicted)	92.5 +/- 5.8	71.2 +/- 9.3
FVC (% predicted)	95.1 +/- 6.2	78.4 +/- 8.7
FEV1/FVC ratio	0.82 +/- 0.03	0.67 +/- 0.05
PEFR (L/min)	430 +/- 55	310 +/- 60
Reversiblity post SABA	<5% change	> /= 12 % improvement

DISCUSSION

An increasing trend in the prevalence of Allergic rhinitis (AR) has been observed over the past few years, partly attributed to factors such as global urbanization, with several studies reporting higher prevalence in urban areas than in rural populations.

In our study, most cases occurred in ages 15–35, confirming allergies affect young adults which may have implications on their quality of life and work productivity. Jain et. al. (2022) reported that 62% of patients were between 15–35 years. Ranjana K. et. al. (2023) showed mean age 29 years, highlighting young age predominance. Bröms K et. al. (2013) in preschool children demonstrated the early co-occurrence of AR/asthma, confirming AR is often an early-onset disease. [18,19,20]

Mites constitute a highly diverse group of arthropods and are distributed across nearly all ecological habitats. Among them, house dust mites are the most common allergens and are typically abundant in indoor settings, particularly in bedding, mattresses, upholstered furniture, carpets, curtains, and clothing [21].

The most striking result in our study was house dust mite positivity in 81% of patients, with dust mite combined sensitization higher in AR with Asthma group. This confirms that indoor allergens dominate in semi-arid zones like Rajasthan, where poor ventilation, fine desert dust, and mite persistence in textiles/furnishings are important. Palliyalthodi RH et. al. (2020) also showed dust mites in 65–74%, very similar to our study results. Deb T. et. al. (2022) showed dust mites in 90%, again consistent with our results. Contrary to our study results, Jain S et. al. (2022) showed mites positivity only 18%, highlighting regional variation (Central India pollen-dominant vs. Rajasthan dust-mite dominant)[22,23,18].

Prosopis juliflora (vilayati babool) is an invasive desert shrub with high allergenicity reported in Rajasthan. The study done by Jain S et al. (2020) showed pollens as the most sensitised allergen (78.5%) in his study. Ranjana et.al (2023) showed pollen sensitization in 84% participants. However, our study shows lower pollen sensitization, probably because dust overshadows pollens in arid regions. But interestingly among pollens, Prosopis juliflora had significant association with asthma ($p = 0.037$), indicating it as a potent asthma trigger[18,19]

Rajasthan's warm/dry climate is not as conducive to fungi compared to coastal India, yet agricultural settings favor storage fungi exposure. Contrary to our findings of around 24% fungal allergen sensitization, a study done by Ranjana et.al (2023) showed Aspergillus in 62%, possibly higher due to humid climate. Jain S et al. (2020) reported 30% fungal sensitization similar to our results. A systematic review of Indian studies by Agarwal R et. al (2023) showed the pooled prevalence of Aspergillus in Asthma was 30.9%. Thus, fungi are prevalent seasonal/occupational sensitizers in Asthma, contributing meaningfully to the burden of allergic respiratory conditions [19,18,24].

With Jaipur as a trade hub, many subjects (transporters, warehouse workers) are exposed to cereal/grain dust, which is under-represented in Western allergen panels. This confirms observations by Jain S et.al. (2020) who reported 38% grain dust positivity similar to our study findings of 17% grain dust sensitization in AR and 23 % in AR with Asthma patients. The relative scarcity of similar data in Western cohorts underscores the regional specificity of allergen profiles and highlights the need for geographically tailored diagnostic and management strategies [18].

Our study results showed insects (mosquito, cockroach, moth) in 15%, animal dander in 11% (cow, dog, pigeon feather). These are lower than dust/pollen but clinically relevant in urban households. Ranjana et.al (2023) showed cockroach sensitization in 75% of patients which was much higher, probably due to coastal/urban slum exposure [19].

The AR-only patients had near-normal spirometry, whereas AR with Asthma showed significant airway obstruction, reversibility on bronchodilatation, reduced FEV1/FVC ratio. This demonstrates physiological progression of pathology from upper to lower airway tract. Mahesh PA et al (2019) proposed serial spirometry even in AR-only patients to detect early asthma and our study findings strongly support this notion [25].

Serum IgE levels were also statistically significantly higher in AR with the Asthma group (440 vs 290 IU/mL, $p<0.001$). These patients also had derangement in spirometry profile of obstructive pattern and reversibility on bronchodilatation. These findings confirm that patients with AR and asthma represent a severe end of spectrum, with polysensitization and higher systemic allergic load. Study results of Shen et.al (2019) found asthma in 39% AR patients and broader sensitization of allergens in the combined group. Palliyalthodi et.al (2020) showed multi allergen positivity correlated with combined AR with Asthma. Özdemir et.al (2025) also showed 32% AR patients had asthma and broader polysensitization pattern of allergens. Thus, our data align globally, validating AR as a risk factor and precursor for Asthma [26,22,27].

The study findings suggest a high prevalence of indoor allergen sensitization, particularly to dust mites, underscoring the importance of environmental control measures in the management of AR and Asthma. Allergen Avoidance Strategies like Dust mite control (encasing mattresses, frequent washing, HEPA filters), reducing exposure to Prosopis pollens (urban forestry re-evaluation) and Grain dust precautions (masks, mechanized storage) should be encouraged. Region specific MSPT panels should be prepared for diagnostic purposes and should not rely only on Western panels that emphasize ryegrass, birch pollen rather it should include dust mites, Prosopis, Aspergillus, grain dust for Rajasthan.

Correct identification of allergens also directs the physician to emphasize on integrated treatment of AR and asthma. Allergen specific immunotherapy (SLIT/SCIT) can be considered for the management of common allergen sensitization in moderate to severe persistent cases. Trade/warehouse/transport workers/farmers can be encouraged to wear masks at their workplaces and the educational programs can be tailored for the identification and prevention of the unified airway disease.

CONCLUSION

Allergic rhinitis in North-West India is predominantly associated with dust mite sensitization, with additional reactivity to regional pollens, fungi, and occupational allergens. Asthma comorbidity shows higher polysensitization, elevated IgE, and reduced lung function, supporting the unified airway concept and highlighting the need for region-specific diagnosis, integrated management, preventive strategies and implementation of allergen specific immunotherapy.

Limitations

The study has the following limitations -

1. Cross-sectional nature precludes causal inference i.e cannot demonstrate progression from AR to asthma longitudinally.
2. Hospital-based sample (SMS Jaipur) may over-represent severe cases.
3. Environmental measurements not done (actual dust/pollen levels were not quantified).
4. Seasonal variation not accounted

ABBREVIATIONS

AR – Allergic rhinitis
MSPT – Modified skin prick test
TEC – Total eosinophil count
DF – Dermatophagoides farina
DP – Dermatophagoides pteronyssinus
FEV1 – Forced expiratory Volume in 1 second
FVC – Forced Vital Capacity
PEFR – Peak Expiratory Flow Rate
SLIT – Sublingual Immunotherapy
SCIT – Subcutaneous Immunotherapy

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