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PREVALENCE AND PATTERN OF RESPIRATORY ALLERGEN SENSITIZATION AMONG OUTPATIENTS IN A TERTIARY CARE CENTRE: AN IMMUNOBLOT-BASED CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Respiratory allergic diseases, particularly allergic rhinitis and bronchial asthma, are common chronic disorders associated with immunoglobulin E-mediated sensitization to environmental allergens. The distribution of inhalational allergens varies according to geographical location, climate, housing conditions, and environmental exposure. Identification of locally prevalent allergens is important for accurate diagnosis, targeted avoidance, and individualized treatment. The aim is to determine the prevalence and pattern of respiratory allergen sensitization among outpatients attending a tertiary care centre using an immunoblot-based assay.

Materials and Methods: A hospital-based cross-sectional observational study was conducted among 100 outpatients with symptoms suggestive of respiratory allergy. Demographic characteristics, clinical presentation, family history, smoking status, residence, and relevant exposure history were recorded. Blood samples were analysed for absolute eosinophil count, total serum IgE, and allergen-specific IgE using an immunoblot assay. Participants with immunoblot positivity to at least one inhalational allergen were considered sensitized. Data were summarized as mean±standard deviation or frequency and percentage. The chi-square test, Fisher's exact test, and independent-samples t-test were applied as appropriate. A p-value <0.05 was considered statistically significant.

Results: The mean age of participants was 34.9±12.6 years, and 54% were female. Urban residents constituted 62% of the study population. Respiratory allergen sensitization was detected in 72% of participants (95% CI: 62.7%–81.3%), while 28% were non-sensitized. Among the 72 sensitized patients, 43 (59.7%) had multiple sensitization and 29 (40.3%) had single sensitization. House dust mite was the most common allergen, detected in 52.8%, followed by cockroach in 40.3%, grass pollen in 36.1%, fungal spores in 29.2%, mixed weed pollen in 27.8%, tree pollen in 25.0%, animal dander in 22.2%, and feather allergens in 15.3%. Allergic rhinitis was the most frequent clinical diagnosis. Sensitization was significantly associated with urban residence ($p=0.004$), positive family history of allergy ($p<0.001$), higher absolute eosinophil count (518±174 versus 339±121/µL; $p<0.001$), and higher serum total IgE levels (462±228 versus 212±108 IU/mL; $p<0.001$). Age and gender were not significantly associated with sensitization.

Conclusion: Respiratory allergen sensitization was highly prevalent among symptomatic outpatients, and polysensitization was more common than monosensitization. House dust mite and cockroach were the predominant indoor allergens, while grass and weed pollens were important outdoor allergens. Urban residence, family history of allergy, eosinophilia, and elevated serum IgE were significantly associated with sensitization. Immunoblot-based allergen-specific IgE testing can serve as a useful, minimally invasive method for defining regional sensitization patterns and guiding individualized allergen-avoidance and therapeutic strategies.

Keywords: Respiratory allergen sensitization; Immunoblot; House dust mite.

INTRODUCTION

Respiratory allergic diseases constitute one of the most common chronic disorders worldwide and represent a major public health concern because of their increasing prevalence, recurrent symptoms, reduced quality of life, and substantial healthcare costs. Allergic rhinitis and bronchial asthma are the predominant manifestations of respiratory allergy and are characterized by immunoglobulin E (IgE)-mediated hypersensitivity responses to inhaled environmental allergens. According to the World Allergy Organization and Global Initiative for Asthma, nearly 20–30% of the global population experiences one or more allergic disorders, with respiratory allergies accounting for a significant proportion of these conditions. The burden of respiratory allergy has steadily increased over the last few decades due to rapid urbanization, industrialization, environmental pollution, climate change, and altered lifestyle patterns.[1]

In India, respiratory allergic diseases have become increasingly common because of diverse climatic conditions, increasing levels of airborne pollutants, widespread exposure to house dust mites, fungal spores, pollens, insect allergens, animal dander, and occupational allergens. Environmental pollution, particularly fine particulate matter (PM2.5), diesel exhaust particles, biomass fuel exposure, and indoor pollutants, contributes significantly to airway inflammation and allergen sensitization. The identification of specific allergens responsible for respiratory symptoms is therefore essential for accurate diagnosis, avoidance strategies, and formulation of individualized treatment plans.[2]

Respiratory allergen sensitization occurs when susceptible individuals produce allergen-specific IgE antibodies following exposure to inhaled allergens. Subsequent exposure leads to mast cell degranulation and release of inflammatory mediators such as histamine, leukotrienes, and cytokines, resulting in symptoms including sneezing, rhinorrhoea, nasal obstruction, wheezing, cough, breathlessness, and conjunctival irritation. Common inhalational allergens include house dust mites (Dermatophagoides species), pollens, moulds, cockroach allergens, animal dander, feathers, and occupational dusts. The prevalence and pattern of sensitization vary considerably according to geographical region, climatic conditions, environmental exposure, and genetic susceptibility.[3]

Several diagnostic methods are available for identifying allergen sensitization, including skin prick testing, serum total IgE estimation, allergen-specific IgE assays, ELISA, and immunoblot techniques. Although skin prick testing remains the traditional diagnostic method, it is contraindicated in some patients and carries a small risk of systemic allergic reactions. Immunoblot-based allergen-specific IgE detection has emerged as a reliable in-vitro diagnostic technique offering simultaneous detection of antibodies against multiple respiratory allergens using a single serum sample. The technique is highly sensitive, specific, minimally invasive, and particularly useful in patients who cannot undergo skin testing or are receiving antihistamines.[4]

Understanding the local spectrum of respiratory allergens is essential because allergen prevalence differs significantly across geographical regions. Knowledge of region-specific sensitization patterns helps clinicians implement effective allergen avoidance measures, optimize immunotherapy, and improve long-term disease control. Furthermore, documenting demographic and clinical factors associated with allergen sensitization provides valuable epidemiological information for planning preventive strategies.[5]

Aim: To determine the prevalence and pattern of respiratory allergen sensitization among outpatients attending a tertiary care centre using an immunoblot-based assay.

Objectives

1. To determine the prevalence of respiratory allergen sensitization among outpatients attending a tertiary care hospital.
2. To identify the pattern of sensitization to various inhalational allergens using immunoblot technology.
3. To evaluate the association between demographic and clinical characteristics and respiratory allergen sensitization.

MATERIALS AND METHODS

Source of Data: The data were collected from patients attending the outpatient departments of the tertiary care teaching hospital who were clinically suspected to have respiratory allergic diseases. Relevant demographic, clinical, laboratory, and immunoblot findings were recorded using a predesigned case record form.

Study Design: A hospital-based cross-sectional observational study was conducted.

Study Location: The study was conducted in the Department of Microbiology in collaboration with the Departments of General Medicine, Pulmonary Medicine, ENT, and Dermatology of the tertiary care teaching hospital.

Study Duration: The study was conducted over a period of 12 months after obtaining Institutional Ethics Committee approval.

Sample Size: A total of 100 consecutive eligible patients fulfilling the inclusion criteria were included in the study.

Inclusion Criteria

- Patients aged ≥18 years.
- Patients attending outpatient departments with symptoms suggestive of respiratory allergy such as allergic rhinitis, bronchial asthma, recurrent sneezing, nasal obstruction, rhinorrhoea, wheezing, chronic cough, or recurrent respiratory allergy.

- Patients willing to provide written informed consent.
- Patients who agreed to provide blood samples for laboratory investigations.

Exclusion Criteria

- Patients with acute respiratory infections.
- Patients receiving allergen-specific immunotherapy.
- Patients with autoimmune disorders or immunodeficiency disorders.
- Patients unwilling to participate.
- Patients with inadequate or haemolysed blood samples.

Procedure and Methodology: After obtaining approval from the Institutional Ethics Committee, eligible patients attending the outpatient departments were recruited consecutively. Written informed consent was obtained from every participant before enrolment.

A detailed clinical history was obtained, including age, gender, occupation, residential area, smoking history, family history of allergy, environmental exposure, occupational exposure, pet ownership, seasonal variation of symptoms, previous allergic illnesses, asthma, allergic rhinitis, eczema, and drug history.

General physical examination and relevant systemic examination findings were recorded.

Approximately 5 mL of venous blood was collected under aseptic precautions.

The blood sample was used for:

- Complete blood count
- Absolute eosinophil count (AEC)
- Serum total IgE estimation
- Allergen-specific IgE detection using Immunoblot technique

The immunoblot assay was performed according to the manufacturer's protocol. Membrane strips containing immobilized respiratory allergens were incubated with diluted patient serum. Following washing, enzyme-labelled anti-human IgE conjugate was added. After incubation and washing, substrate solution was applied. Development of coloured bands indicated allergen-specific IgE positivity. Band intensity was interpreted using the manufacturer's reference chart and dedicated software wherever applicable.

The identified allergens were categorized into:

- House dust mites
- Pollens
- Fungal allergens
- Animal dander
- Cockroach allergens
- Feather allergens
- Mixed environmental allergens

Patients showing positivity to one or more allergens were considered sensitized.

Sample Processing: Blood samples were collected in plain and EDTA vacutainers.

EDTA blood was processed immediately for complete blood count and absolute eosinophil count.

Plain blood samples were allowed to clot at room temperature and centrifuged at 3000 rpm for 10 minutes to separate serum.

Serum aliquots were stored at −20°C until immunoblot testing and total IgE estimation.

All laboratory procedures were performed under standard operating procedures with appropriate internal quality control measures.

Statistical Methods: The collected data were entered into Microsoft Excel and analysed using SPSS version 26.0.

- Continuous variables were expressed as Mean ± Standard Deviation (SD).
- Categorical variables were expressed as frequency and percentage.
- Chi-square test or Fisher's exact test was used to compare categorical variables.
- Independent Student's t-test was used to compare continuous variables between two groups.
- Odds ratios with 95% confidence intervals were calculated wherever appropriate.
- A p-value <0.05 was considered statistically significant.

Data Collection

Data were collected using a structured Case Record Form comprising:

- Demographic details
- Clinical history
- Presenting symptoms
- Family history of allergy
- Environmental exposure
- Smoking history
- Occupational exposure
- Clinical diagnosis
- Absolute eosinophil count
- Total serum IgE
- Immunoblot findings
- Identified respiratory allergens
- Final interpretation of allergen sensitization.

RESULTS

[Table 1] presents the demographic and clinical characteristics of the 100 study participants enrolled to determine the prevalence and pattern of respiratory allergen sensitization. The mean age of the participants was 34.9 ± 12.6 years (95% CI: 32.40–37.40 years), which was statistically significant ($t=27.70$, $p<0.001$). The largest proportion of participants belonged to the 31–45 years age group (39.0%), followed by 18–30 years (36.0%), 46–60 years (19.0%), and more than 60 years (6.0%), indicating a significant variation in age-group distribution ($\chi^2=12.84$, $p=0.005$). Females constituted a slightly higher proportion (54.0%) than males (46.0%), although the gender distribution was not statistically significant ($\chi^2=0.64$, $p=0.423$). Most participants resided in urban areas (62.0%), while 38.0% were from rural areas, showing a statistically significant predominance of urban residents ($\chi^2=5.76$, 95% CI: 8.6%–35.4%, $p=0.016$). Regarding

occupation, office workers represented the largest occupational group (27.0%), followed by homemakers (25.0%), farmers (18.0%), students (16.0%), and industrial workers (14.0%), with a significant difference in occupational distribution (χ^2=18.61, p<0.001). A positive family history of allergy was reported by 42.0% of participants, whereas 58.0% had no such history; however, this difference was not statistically significant (χ^2=2.56, p=0.109). Smoking history was present in 21.0% of participants and absent in 79.0%, demonstrating a highly significant predominance of non-smokers (χ^2=33.64, p<0.001). The mean absolute eosinophil count was 468 ± 181/µL (95% CI: 432–504/µL), and the mean total serum IgE level was 392 ± 215 IU/mL (95% CI: 349–435 IU/mL), both of which were significantly elevated (p<0.001), reflecting the allergic profile of the study population.

Table 1: Demographic and clinical profile of study participants (N=100)

Variable	Category	n (%) / Mean±SD	Test of significance	95% CI	p-value
Age (years)	Mean±SD	34.9±12.6	t=27.70	32.40–37.40	<0.001*
Age group	18–30 years	36 (36.0)	χ^2=12.84		0.005*
	31–45 years	39 (39.0)			
	46–60 years	19 (19.0)			
	>60 years	6 (6.0)			
Gender	Male	46 (46.0)	χ^2=0.64	−17.5% to 9.5%	0.423
	Female	54 (54.0)			
Residence	Urban	62 (62.0)	χ^2=5.76	8.6% to 35.4%	0.016*
	Rural	38 (38.0)			
Occupation	Office worker	27 (27.0)	χ^2=18.61		<0.001*
	Homemaker	25 (25.0)			
	Farmer	18 (18.0)			
	Student	16 (16.0)			
	Industrial worker	14 (14.0)			
Family history of allergy	Present	42 (42.0)	χ^2=2.56	−5.4% to 29.4%	0.109
	Absent	58 (58.0)			
Smoking history	Present	21 (21.0)	χ^2=33.64		<0.001*
	Absent	79 (79.0)			
Absolute eosinophil count (/µL)	Mean±SD	468±181	t=25.87	432–504	<0.001*
Total serum IgE (IU/mL)	Mean±SD	392±215	t=18.24	349–435	<0.001*

Table 2: Prevalence of respiratory allergen sensitization (N=100)

Variable	Category	n (%)	Test of significance	95% CI	p-value
Respiratory allergen sensitization	Positive	72 (72.0)	χ^2=19.36	62.7–81.3%	<0.001*
	Negative	28 (28.0)			
Number of allergens	Single sensitization	29 (40.3)	χ^2=9.74	29.0–51.6%	0.008*
(Among positives, n=72)	Multiple sensitization	43 (59.7)			
Clinical diagnosis	Allergic rhinitis	33 (33.0)	χ^2=17.82		<0.001*
	Bronchial asthma	24 (24.0)			
	Rhinitis + Asthma	15 (15.0)			
	No sensitization	28 (28.0)			

[Table 2] demonstrates the prevalence of respiratory allergen sensitization among the study participants. Overall, 72.0% of patients tested positive for respiratory allergen sensitization by immunoblot assay, whereas 28.0% were negative. This prevalence was statistically significant (χ^2=19.36, 95% CI: 62.7%–81.3%, p<0.001). Among the 72 sensitized patients, 43 (59.7%) exhibited multiple allergen sensitization, while 29 (40.3%) showed sensitization to a single allergen, indicating that polysensitization was significantly more common than monosensitization (χ^2=9.74, 95% CI: 29.0%–51.6%, p=0.008). Regarding clinical diagnosis, allergic rhinitis was the most frequent presentation, affecting 33.0% of participants, followed by bronchial asthma (24.0%) and combined allergic rhinitis with asthma (15.0%), while 28.0% had no demonstrable sensitization. The distribution of clinical diagnoses differed significantly across participants (χ^2=17.82, p<0.001), suggesting that allergic rhinitis was the predominant clinical manifestation among sensitized individuals.

Table 3: Pattern of respiratory allergen sensitization by immunoblot (Positive patients n=72)

Respiratory allergen	Positive n (%)	Test of significance	95% CI	p-value
House dust mite (Dermatophagoides spp.)	38 (52.8)	χ^2=14.92	41.3–64.3%	<0.001*
Cockroach	29 (40.3)	χ^2=6.81	29.0–51.6%	0.009*
Grass pollens	26 (36.1)	χ^2=4.82	25.0–47.2%	0.028*
Tree pollens	18 (25.0)	χ^2=0.50	15.0–35.0%	0.479
Fungal spores	21 (29.2)	χ^2=1.39	18.7–39.7%	0.238
Animal dander	16 (22.2)	χ^2=1.78	12.6–31.8%	0.182
Feather allergens	11 (15.3)	χ^2=5.44	7.0–23.6%	0.020*
Mixed weed pollens	20 (27.8)	χ^2=0.89	17.4–38.2%	0.346

[Table 3] illustrates the pattern of respiratory allergen sensitization detected by immunoblot among the 72 sensitized patients. House dust mite (Dermatophagoides spp.) was identified as the most common allergen, sensitizing 38 (52.8%) patients, and this prevalence was highly significant (χ^2=14.92, 95% CI: 41.3%–64.3%, p<0.001). The second most frequent allergen was cockroach, affecting 29 (40.3%) patients (χ^2=6.81, p=0.009), followed by grass pollens, which sensitized 26 (36.1%) individuals (χ^2=4.82, p=0.028). Sensitization to fungal spores was observed in 21 (29.2%), mixed weed pollens in 20 (27.8%), tree pollens in 18 (25.0%), and animal dander in 16 (22.2%), although these distributions were not statistically significant (p>0.05). Feather allergens demonstrated sensitization in 11 (15.3%) patients and showed a statistically significant distribution (χ^2=5.44, p=0.020). Overall, house dust mite emerged as the predominant inhalational allergen, followed by cockroach and grass pollens, indicating that indoor allergens constituted the major source of respiratory allergen sensitization in the study population.

Table 4: Association between demographic/clinical characteristics and respiratory allergen sensitization

Variable	Sensitized (n=72)	Not sensitized (n=28)	Test	95% CI	p-value
Age (years), Mean±SD	33.6±11.8	38.4±13.5	t=1.72	−10.31 to 0.71	0.089
Female gender	42 (58.3)	12 (42.9)	χ^2=2.02	−4.2% to 35.0%	0.155
Urban residence	51 (70.8)	11 (39.3)	χ^2=8.52	11.2% to 51.8%	0.004*
Family history of allergy	38 (52.8)	4 (14.3)	χ^2=12.18	18.2% to 58.8%	<0.001*
Smoking history	11 (15.3)	10 (35.7)	χ^2=5.12	−39.2% to −1.6%	0.024*
Absolute eosinophil count (/µL)	518±174	339±121	t=5.82	118–240	<0.001*
Serum IgE (IU/mL)	462±228	212±108	t=7.01	179–321	<0.001*
Multiple sensitization	43 (59.7)			46.8–71.5%	

[Table 4] compares demographic and clinical characteristics between sensitized (n=72) and non-sensitized (n=28) participants. The mean age was slightly lower among sensitized patients (33.6 ± 11.8 years) than among non-sensitized patients (38.4 ± 13.5 years), but this difference was not statistically significant (t=1.72, 95% CI: −10.31 to 0.71, p=0.089). Similarly, the proportion of females was higher among sensitized participants (58.3%) than among non-sensitized participants (42.9%), although the association was not significant (χ^2=2.02, p=0.155). In contrast, urban residence was significantly associated with respiratory allergen sensitization, with 70.8% of sensitized individuals residing in urban areas compared with 39.3% of non-sensitized participants (χ^2=8.52, 95% CI: 11.2%–51.8%, p=0.004). A positive family history of allergy was also strongly associated with sensitization, being present in 52.8% of sensitized patients compared with only 14.3% of non-sensitized patients (χ^2=12.18, 95% CI: 18.2%–58.8%, p<0.001). Smoking history was significantly less common among sensitized individuals (15.3%) than among non-sensitized participants (35.7%) (χ^2=5.12, 95% CI: −39.2% to −1.6%, p=0.024). Sensitized patients had significantly higher absolute eosinophil counts (518 ± 174/µL) than non-sensitized patients (339 ± 121/µL) (t=5.82, 95% CI: 118–240, p<0.001). Likewise, serum IgE levels were markedly elevated in sensitized patients (462 ± 228 IU/mL) compared with non-sensitized patients (212 ± 108 IU/mL) (t=7.01, 95% CI: 179–321, p<0.001). Among sensitized individuals, 59.7% demonstrated multiple allergen sensitization, indicating that polysensitization was a common feature in this cohort.

DISCUSSION

The present immunoblot-based cross-sectional study evaluated the prevalence, clinical profile, and pattern of respiratory allergen sensitization among 100 outpatients. Overall, respiratory allergen sensitization was detected in 72% of participants, with polysensitization in 59.7% of sensitized individuals. House dust mite was the predominant allergen, followed by cockroach and grass pollen. Urban residence, family history of allergy, absolute eosinophil count, and serum total IgE were significantly associated with sensitization. The findings broadly support previous Indian and Asian studies, although differences in study populations, geographical conditions, allergen panels, and diagnostic techniques must be considered. The variables selected for analysis were also consistent with the demographic, immunological, and allergen-related factors assessed in the source dissertation.

[Table 1] Demographic and clinical profile

The mean age of participants in the present study was 34.9±12.6 years, with 75% belonging to the 18–45-year age range. The 31–45-year age group constituted the largest proportion at 39%, followed by the 18–30-year group at 36%. This concentration of respiratory allergy cases among young and middle-aged adults may reflect greater occupational, domestic, and environmental exposure to aeroallergens. Khan et al,[3] (2018) studied patients with rhinitis and asthma in Eastern India and reported a relatively young population, with an overall mean age of 25.6 years and an age range of 2–68 years. The lower mean age in their study was partly attributable to the inclusion of 30 children. Similarly, Chogtu et al,[2] (2017) observed that allergen sensitivity was common among younger patients with asthma or allergic rhinosinusitis attending a tertiary centre in Southern India. However, age was not significantly associated

with sensitization in the present study, as sensitized patients were only modestly younger than non-sensitized patients. This indicates that exposure pattern and atopic predisposition may be more influential than chronological age alone.

Females accounted for 54% of the study population, but gender distribution was not statistically significant. Female participants were also more frequent in the sensitized group than in the non-sensitized group, although this association did not attain statistical significance. Khan et al,[3] (2018) similarly found no statistically significant relationship between gender and total IgE levels. In contrast, Lou et al,[4] (2017) in a large Chinese study of 7,148 patients with self-reported allergic rhinitis, found that sensitization patterns varied according to age, gender, and geographical region, with most allergen sensitization rates being higher among males. These variations may be explained by differences in occupation, hormonal influences, environmental exposure, and age composition.

Urban residents formed 62% of the present study population, significantly exceeding rural residents. This finding may reflect increased exposure to traffic-related pollutants, construction dust, indoor dampness, cockroach infestation, and poorly ventilated indoor environments. Urban residence was also significantly more frequent among sensitized patients than non-sensitized patients. Lee et al,[5] (2019) reported that aeroallergen sensitization among urban children was associated with altered upper- and lower-airway function, and that the effects differed according to the responsible allergen. Kumar et al,[9] (2021) also demonstrated the clinical relevance of cockroach exposure in a metropolitan Indian population, reporting that 57% of asthmatic patients were sensitized to at least one common aeroallergen and 34% were sensitive to cockroach.

Office workers and homemakers were the largest occupational groups in the present study. Indoor occupational and domestic exposure may promote sensitization to dust mites, cockroaches, moulds, furnishings, and cleaning agents. Farmers and industrial workers represented smaller proportions but may have experienced higher exposure to pollens, storage mites, fungal spores, grain dust, chemicals, or industrial particulate matter. The significant occupational distribution should, however, be interpreted cautiously because the statistical test primarily indicated unequal representation of occupational categories and did not independently establish occupation as a risk factor for sensitization.

A family history of allergy was present in 42% of participants. Although its overall distribution was not statistically significant in Table 1, family history was strongly associated with immunoblot positivity when sensitized and non-sensitized groups were compared. This supports the importance of hereditary atopic susceptibility. Al-Ghamdi et al,[6] (2019) found that immunological markers, including elevated IgE and eosinophils, were significantly associated with adult asthma, reinforcing the role of underlying atopic and immune predisposition. Smoking was reported by 21% of participants. The predominance of non-smokers should not be interpreted as evidence that smoking protects against allergy, because smoking may produce non-allergic respiratory symptoms and alter immune responses, while the lower proportion of smokers among sensitized patients may also reflect age, gender, or selection differences.

The mean absolute eosinophil count was 468±181 cells/µL, and mean serum IgE was 392±215 IU/mL, suggesting a substantial type-2 inflammatory burden in the study population. Meher et al,[10] (2021) reported a mean eosinophil count of 576±427 cells/mm³ and a considerably higher mean total IgE of 800.9±883.2 IU/mL among children with asthma. Khan et al,[3] (2018) reported median total IgE levels of 402 kU/L in 2015 and 509 kU/L in 2016, which were broadly comparable to the present mean IgE value. Differences in IgE levels across studies may reflect age, disease severity, parasitic exposure, number of sensitizing allergens, and laboratory assay characteristics.

[Table 2] Prevalence of respiratory allergen sensitization

The prevalence of respiratory allergen sensitization in the present study was 72%, with a 95% confidence interval of 62.7–81.3%. This indicates a high burden of IgE-mediated sensitization among symptomatic tertiary-care outpatients. The rate was similar to Khan et al,[3] (2018) who found that 76 of 106 patients, approximately 71.7%, demonstrated sensitization to at least one aeroallergen, while 28.3% showed no sensitization. The close agreement supports the reliability of in-vitro allergen-specific IgE testing for identifying sensitization among patients with rhinitis or asthma.

The observed prevalence was higher than the 57% aeroallergen sensitization reported by Kumar et al,[9] (2021) among 200 patients with bronchial asthma. It was also higher than the 44% sensitization identified through intradermal testing by Erel et al,[7] (2017) among patients with allergic rhinitis and asthma. Conversely, Lou et al,[4] (2017) reported that 88.7% of individuals with self-reported allergic rhinitis had at least one positive skin-prick reaction. These variations demonstrate the influence of referral patterns, clinical eligibility criteria, regional allergen exposure, age composition, test sensitivity, positivity thresholds, and number of allergens included in the panel.

Among the 72 sensitized patients, 59.7% had multiple sensitization, while 40.3% were sensitized to a single allergen. This predominance of polysensitization suggests repeated or simultaneous exposure to several indoor and outdoor allergens. Khan et al,[3] (2018) reported polysensitization among 40% of the children included in their investigation and noted frequent combined sensitivity to dust mites, cockroach, weed, tree, and grass pollens. Lou et al,[4] (2017) also observed that multiple sensitizations were associated with allergic-rhinitis comorbidities. Karadoğan et al,[8] (2020)

found particularly high polysensitization among mould-sensitive asthmatic patients, with 92.8% of mould-sensitive participants reacting to multiple allergens. The lower rate in the present study may reflect a smaller allergen panel, broader clinical spectrum, or differences in the definition of polysensitization.

Allergic rhinitis was the most frequent clinical diagnosis at 33%, followed by bronchial asthma at 24% and combined rhinitis with asthma at 15%. Thus, manifestations involving the upper airway were more frequent than isolated lower-airway disease. Katel et al,[11] (2021) similarly emphasized the substantial clinical burden of aeroallergen sensitization in adult patients with allergic rhinitis, although the number and pattern of allergens were not consistently related to rhinitis severity. The occurrence of combined rhinitis and asthma in the present study also supports the concept of integrated or united airway disease, in which upper- and lower-airway allergic inflammation frequently coexist.

[Table 3] Pattern of sensitization to inhalational allergens

House dust mite was the most common sensitizing allergen in the present study, affecting 52.8% of sensitized patients. This finding is consistent with several Indian studies. Dey et al,[1] (2016) found house dust mite to be the leading inhalational allergen among children with asthma and allergic rhinitis in Kolkata, followed by cockroach. Khan et al,[3] (2018) reported approximately 60% sensitization to both Dermatophagoides pteronyssinus and Dermatophagoides farinae. Chauhan et al,[12] (2020) found house dust mite sensitization in 93% of children with bronchial asthma, substantially higher than the present rate. Such variation may be related to climatic humidity, housing conditions, bedding, indoor ventilation, age, and diagnostic method.

Cockroach sensitization was the second most frequent pattern, affecting 40.3% of sensitized patients. This was comparable to the allergen-specific IgE findings of Khan et al,[3] (2018) who observed cockroach sensitization in approximately 43–50% of the study population across the two study years. Kumar et al,[9] (2021) reported cockroach sensitivity in 34% of 200 asthma patients and noted significantly higher total IgE among those exposed to cockroaches. Dey et al,[1] (2016) similarly identified cockroach as one of the leading indoor allergens after house dust mite. Together, these observations highlight the importance of domestic pest control, safe food storage, reduction of indoor moisture, and environmental cleaning in respiratory allergy management.

Grass-pollen sensitization was recorded in 36.1%, while mixed weed and tree-pollen sensitivities were found in 27.8% and 25%, respectively. Khan et al,[3] (2018) reported grass sensitization in approximately 22–32%, tree pollen sensitization in 16–29%, and ragweed or Parthenium-related sensitization in approximately 26–31%. These values closely resemble the present findings. In contrast, Jain et al. (2020),[13] in a Central Indian study of moderate-to-severe allergic rhinitis, reported pollens as the leading allergen group, affecting 78.5%, followed by insects at 64.5%. These geographical differences emphasize that pollen sensitization depends on local flora, flowering seasons, climate, and duration of outdoor exposure.

Fungal-spore sensitization occurred in 29.2% of sensitized patients, a higher proportion than the approximately 8–10% mould sensitization reported by Khan et al (2018).[3] However, Chauhan et al. (2020),[12] reported appreciable sensitization to Candida, Aspergillus, and other indoor allergens among children with asthma. Fungal sensitization is strongly influenced by humidity, damp housing, agricultural exposure, ventilation, and the particular fungal extracts included in the test panel. Animal-dander sensitivity was present in 22.2%, closely corresponding to the approximately 21–23% reported by Khan et al. Feather sensitization was least common at 15.3%, suggesting that animal and feather allergens contributed less than mites, cockroach, or pollen to the overall burden in this population.

[Table 4] Factors associated with respiratory allergen sensitization

The mean age of sensitized patients was lower than that of non-sensitized patients, but the difference was not significant. Similarly, female gender was not significantly associated with sensitization. These results indicate that age and gender alone were not strong determinants of immunoblot positivity in the present sample. They are broadly compatible with Khan et al,[3] (2018) who found no significant gender difference in total IgE. However, larger studies such as Lou et al,[4] (2017) have demonstrated age- and gender-related variation in sensitivity to individual allergens, suggesting that the present study may have lacked sufficient power to detect modest subgroup effects.

Urban residence was significantly associated with respiratory allergen sensitization: 70.8% of sensitized participants were urban residents compared with 39.3% of non-sensitized participants. Urban housing may increase continuous exposure to dust mites, cockroaches, indoor moulds, vehicle emissions, construction dust, and other pollutants that can damage epithelial barriers and enhance allergic inflammation. The urban predominance is consistent with Lee et al,[5] (2019) who demonstrated clinically relevant associations between aeroallergen sensitivity and airway function in an urban population.

A positive family history was found in 52.8% of sensitized patients compared with 14.3% of non-sensitized patients, confirming a strong association between familial atopy and allergen sensitization. This observation supports the interaction between inherited susceptibility and environmental exposure in the development of respiratory allergy. Although family history was not significantly distributed in the full study population, its strong association with immunoblot positivity suggests that it may be

clinically useful when selecting symptomatic patients for allergen-specific testing.

The sensitized group had a substantially higher mean eosinophil count than the non-sensitized group, 518±174 versus 339±121 cells/μL, and markedly higher serum IgE, 462±228 versus 212±108 IU/mL. Al-Ghamdi et al,[6] (2019) reported that elevated total IgE and eosinophil levels were significantly associated with adult asthma, with adjusted odds ratios of 1.84 and 2.85, respectively. Lee et al,[5] (2019) also found that serum eosinophil counts and total IgE were associated with airway abnormalities, although the relationships differed according to the specific aeroallergen involved. Meher et al,[10] (2021) documented raised eosinophil counts and serum IgE among sensitized children with asthma. These findings support the usefulness of AEC and total IgE as supportive markers of type-2 inflammation; however, neither test identifies the responsible allergen, and allergen-specific assays remain essential.

CONCLUSION

The present immunoblot-based cross-sectional study demonstrated a high prevalence of respiratory allergen sensitization among symptomatic outpatients attending a tertiary care centre. Of the 100 participants, 72% showed sensitization to at least one inhalational allergen, while multiple-allergen sensitization was more frequent than single-allergen sensitization. House dust mite was the most common sensitizing allergen, followed by cockroach, grass pollen, fungal spores, mixed weed pollen, tree pollen, animal dander, and feather allergens. Allergic rhinitis was the most frequent clinical presentation, followed by bronchial asthma and combined allergic rhinitis with asthma.

Respiratory allergen sensitization was significantly associated with urban residence, a positive family history of allergy, elevated absolute eosinophil count, and increased serum total IgE levels. Age and gender were not significantly associated with sensitization. Immunoblot testing proved useful for simultaneously identifying sensitization to multiple inhalational allergens using a small serum sample. Identification of locally prevalent allergens can support targeted allergen-avoidance measures, improve diagnostic precision, guide appropriate pharmacotherapy and allergen-specific immunotherapy, and potentially reduce recurrent symptoms and disease-related morbidity.

Limitations of the study

1. The study was conducted at a single tertiary care centre; therefore, the findings may not be generalizable to the wider community or to populations from different geographical and climatic regions.
2. The sample size was limited to 100 participants, which may have reduced the statistical power for subgroup analyses and detection of weaker associations.
3. The hospital-based sampling method may have introduced referral and selection bias, as patients attending a tertiary care centre may have had more persistent or severe symptoms than patients in the community.
4. The cross-sectional design established associations but could not determine temporal or causal relationships between environmental exposures and allergen sensitization.
5. Allergen sensitization was assessed using an immunoblot-based serum-specific IgE assay without confirmation by skin-prick testing, nasal provocation testing, or bronchial challenge testing.
6. A positive allergen-specific IgE result indicated sensitization but did not necessarily confirm clinically relevant allergy in every participant.
7. The allergen panel was restricted to the inhalational allergens included in the commercial immunoblot kit; locally important allergens not represented in the panel could have been missed.
8. Seasonal variation in exposure to pollen, fungal spores, and other aeroallergens was not assessed through repeated sampling across different seasons.
9. Environmental allergen concentrations in participants' homes, workplaces, and surrounding areas were not directly measured.
10. Information regarding family history, smoking, occupational exposure, pet ownership, and environmental exposure was based on participant reporting and was therefore subject to recall bias.
11. Potential confounding factors, including socioeconomic status, housing conditions, air pollution exposure, medication use, parasitic infection, and comorbid diseases, were not fully adjusted through multivariable analysis.
12. Total serum IgE and absolute eosinophil count are non-specific markers and may be elevated in conditions other than respiratory allergy.
13. The study did not assess clinical outcomes after allergen avoidance, pharmacological treatment, or allergen-specific immunotherapy.

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