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Prevalence of Allergic Bronchopulmonary Aspergillosis in Asthmatic and Allergic Rhinitis Patients at a Tertiary Care Centre

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ABSTRACT

Background: Allergic bronchopulmonary aspergillosis (ABPA) is a Th2-mediated pulmonary disorder triggered by *Aspergillus fumigatus*, primarily affecting individuals with bronchial asthma and allergic rhinitis. Characterized by eosinophilia, elevated IgE levels, and structural lung abnormalities, ABPA remains underdiagnosed, especially in resource-constrained settings, resulting in progressive airway damage and long-term morbidity.

Aim and Objectives: This study aimed to evaluate the prevalence of ABPA among patients with asthma and allergic rhinitis at a tertiary care centre. Specific objectives included assessment of hypersensitivity using skin prick testing (SPT), evaluation of immunological markers through ELISA, and correlation of seropositivity with radiological findings.

Materials and Methods: An observational study was conducted from May 2023 to November 2024 at the Integral Institute of Medical Sciences and Research, enrolling 160 patients with clinically diagnosed asthma and/or allergic rhinitis. All participants underwent SPT using *Aspergillus fumigatus* antigens. Peripheral eosinophilia was assessed via differential leukocyte count and absolute eosinophil count (AEC). Serum total IgE, and *A. fumigatus*-specific IgE and IgG levels were determined using ELISA. Chest radiographic evaluation and contrast-enhanced computed tomography (CECT) were performed in selected cases.

Results: Of the 160 patients, bronchial asthma was diagnosed in 47.05%, allergic rhinitis in 28.75%, and both conditions in 23.75%. SPT positivity was observed in 58.1% of cases, with a higher rate among females (67.69%). Elevated AEC was noted in 73% of patients. Among 77 SPT-positive individuals undergoing CECT, 90.9% showed abnormal findings—predominantly bronchiectasis (26%) and pulmonary opacity (23.4%). ELISA revealed *A. fumigatus*-specific IgE in 15.05% and specific IgG in 13.98% of SPT-positive patients. Elevated total IgE was observed in 19.35%, predominantly in asthma cases. These findings indicate a significant burden of ABPA-related immunological and radiological markers in patients with allergic airway diseases.

Keywords: *Allergic bronchopulmonary aspergillosis, asthma, allergic rhinitis, skin prick test, Aspergillus fumigatus, IgE, IgG, CECT, eosinophilia.*

1. INTRODUCTION

Allergic bronchopulmonary aspergillosis (ABPA) is an immunological lung disorder caused by a hypersensitive response—primarily of the Th2 type—to *Aspergillus fumigatus*. It predominantly affects individuals with pre-existing asthma or cystic fibrosis. Hallmark features of ABPA include elevated serum IgE levels, peripheral eosinophilia, bronchial wall thickening, and recurrent lung opacities, which, if left untreated, may lead to progressive and irreversible bronchiectasis. Worldwide, the prevalence of ABPA in adult asthma patients has been reported to vary between 2.5% and 11%, mainly based on data from tertiary care centers (Denning et al., 2013; Agarwal et al., 2023). Denning and colleagues (2013) estimated that approximately 4.8 million individuals out of 193 million asthma patients globally might be affected by ABPA, assuming a 2.5% prevalence. Within India, both community-based and hospital-based estimates indicate a relatively higher disease burden. A community-level estimate suggested a prevalence of around 5%, while certain hospital-based studies reported rates as high as 22.3% (Agarwal et al., 2010). This study aims to determine the prevalence of ABPA among asthmatic and

allergic rhinitis patients at a tertiary care centre in North India, using a comprehensive diagnostic approach that integrates clinical, serological, and radiological assessments.

2. MATERIALS AND METHODS

Study Design and Setting An observational study was conducted at the Integral Institute of Medical Sciences & Research (IIMSR), Lucknow, over a period of 18 months, from May 2023 to November 2024.

Study Population A total of 160 patients with clinically diagnosed asthma and allergic rhinitis were enrolled.

Sample Collection and Processing Clinical specimens were collected from all patients and processed in the Department of Microbiology for mycological evaluation..

Clinical and Demographic Data Collection A detailed patient proforma was used to document demographic and clinical information, including age, sex, socio-economic status, lesion distribution, duration of illness, and predisposing risk factors.

Skin Prick Testing (SPT) All patients underwent skin prick testing using *Aspergillus fumigatus*-specific antigens to assess hypersensitivity

Hematological and Immunological Investigations Differential leukocyte count (DLC), absolute eosinophil count (AEC), and total serum IgE levels were measured using standard hematology techniques and ELISA kits. Additionally, *A. fumigatus*-specific IgE and IgG antibody levels were quantified using commercially available ELISA kits, following the manufacturer's instructions.

Correlation and Analysis The seropositivity rate among SPT-positive patients was determined. These results were further correlated with fungal culture positivity to evaluate the diagnostic accuracy and reliability of the integrated testing approach.

Ethical Considerations The study was approved by the Institutional Research Committee (IRC) and the Ethical Research Committee (ERC) under protocol number IEC/IIMSR/2023/10.

Inclusion and Exclusion Criteria This study enrolled patients of all age groups presenting with a confirmed clinical diagnosis of asthma and allergic rhinitis at the outpatient department. Patients were excluded if they: (i) declined to provide informed consent; (ii) presented with acute exacerbations; (iii) were pregnant; (iv) had chronic urticaria or dermographism; or (v) were unable to discontinue antihistamines or leukotriene receptor antagonists for at least seven days prior to skin testing.

3. RESULTS

As illustrated in fig.1 of the 160 patients evaluated, bronchial asthma was the most frequently observed diagnosis, affecting 76 individuals (47.05%). Allergic rhinitis alone was identified in 46 participants (28.75%). Notably, 38 patients (23.75%) exhibited co-existing bronchial asthma and allergic rhinitis, reflecting a substantial clinical overlap between lower and upper airway allergic manifestations

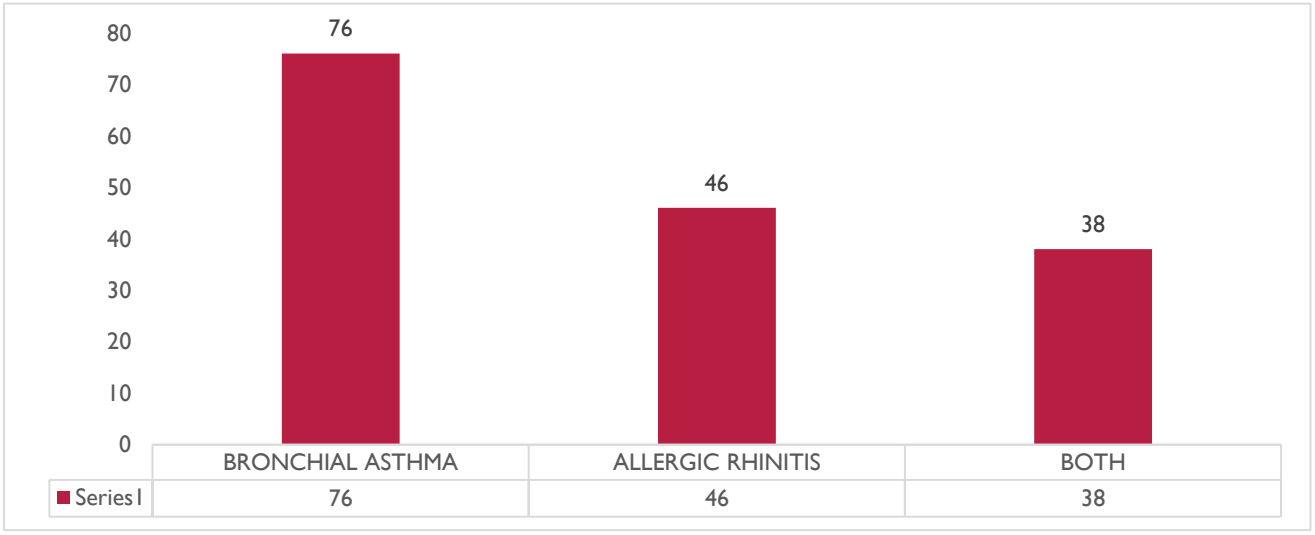

Figure 1. Distribution of clinical conditions among the study population (N = 160)

Table 1 presents the age-wise distribution of the study participants. The majority of patients were between 21 and 40 years of age (n = 55; 34.37%), indicating a peak prevalence of allergic respiratory conditions among younger adults. This was followed by the 41–60 years age group, comprising 39 patients (24.37%). Individuals aged >60 years accounted for 38 cases (23.75%), while the lowest number of cases was observed in the 0–20 years age group (n = 28; 17.5%). These findings suggest a higher disease burden in early adulthood, with a declining trend in older populations.

Table 1. Distribution of Patients according to age groups

Age Group (years)	Number of Patients (n)	Percentage (%)
0 - 20	28	17.05%
21 - 40	55	34.37%
41 – 60	39	24.37%
>60	38	23.75%

Fig 2. Gender Distribution of the Study Population Among the total patients evaluated, 59% were male and 41% were female, indicating a higher proportion of male participants. This male predominance suggests a potentially greater susceptibility or healthcare-seeking behavior among men for the condition under investigation

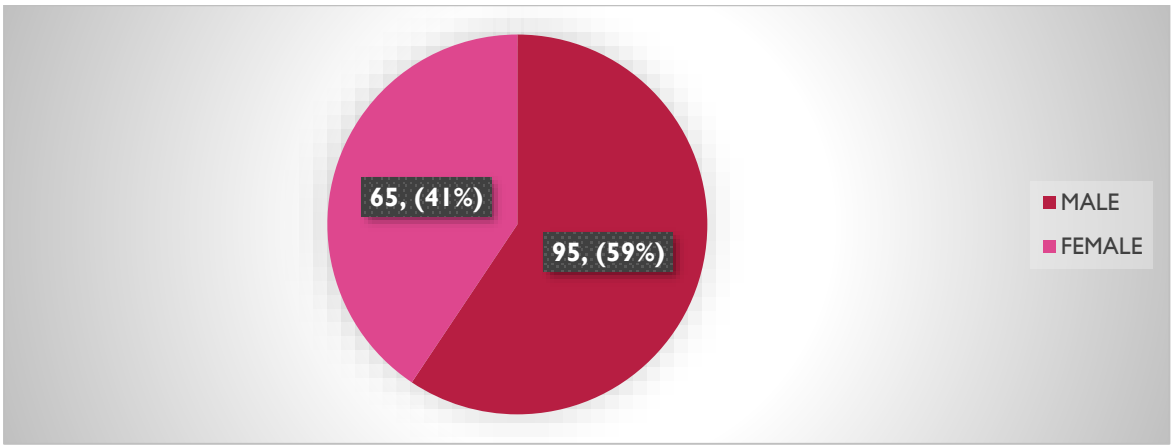

Figure 2: Gender-wise distribution of the study population

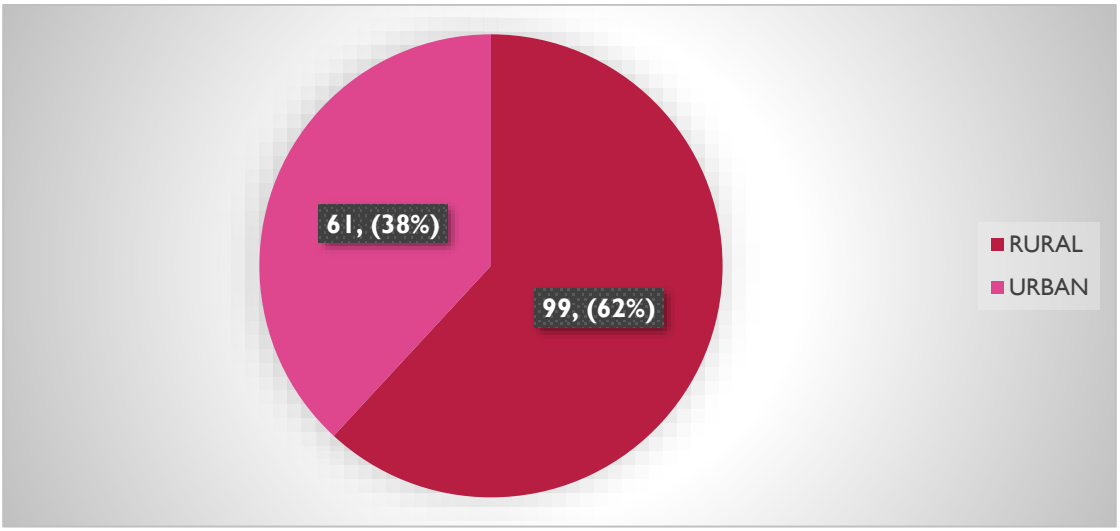

Figure 3. Residence-based distribution of the study population

Fig 3 shows, a larger proportion of patients were from rural areas (62%; n=99) compared to those from urban regions (38%; n=61). This indicates a greater prevalence of the condition among individuals residing in rural settings

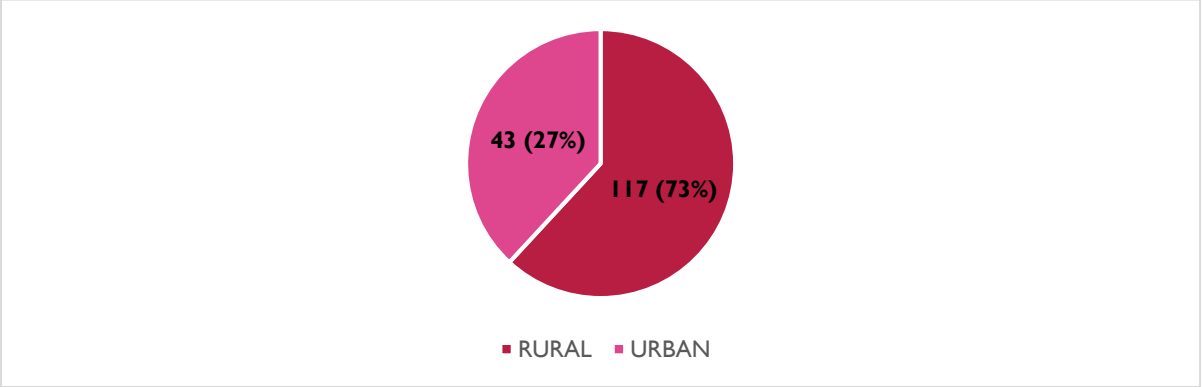

Table 2. Distribution of Absolute Eosinophil Count (AEC) among study participants

AEC Status	Number of Patients (n = 160)	Percentage (%)
Elevated AEC	117	73.0%
Normal AEC	43	27.0%

Table 2. shows that among the 160 clinically suspected patients, elevated AEC levels were observed in 117 individuals (73%), while 43 patients (27%) exhibited values within the normal range. A heightened eosinophil count reflects underlying eosinophilic inflammation, which may enhance allergen-specific reactivity and potentially influence skin prick test (SPT) outcomes.

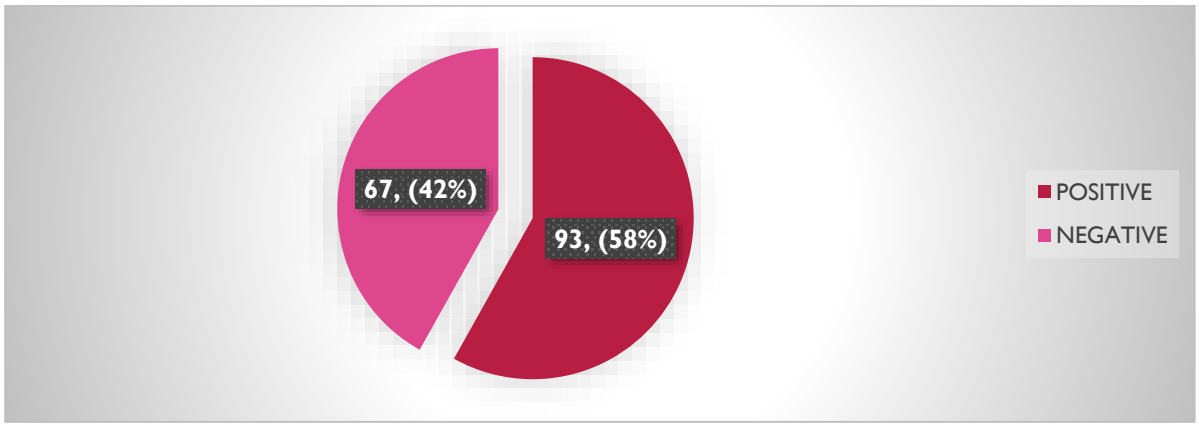

Figure 4. Distribution of Skin Prick Test (SPT) Outcomes among Symptomatic Patients

Figure 4. shows that among the 160 clinically symptomatic outpatient participants, all underwent Skin Prick Testing (SPT). A total of 93 patients (58.1%) demonstrated a positive SPT response, whereas 67 patients (41.9%) tested negative. These findings indicate that more than half of the studied individuals exhibited sensitization to one or more allergens detectable by SPT. The substantial proportion of SPT-positive cases reflects a high prevalence of allergen-specific hypersensitivity in this population. Conversely, the presence of 67 SPT-negative patients despite clinical symptoms suggests alternative etiologies or non-IgE-mediated mechanisms of disease

Table 3 Gender-wise Distribution of Skin Prick Test (SPT) Reactivity

Gender	Total Patients (n = 160)	SPT Positive (n = 93)	SPT Negative (n = 67)
Male	95	49 (51.58%)	46 (48.42%)
Female	65	44 (67.69%)	21 (32.30%)
Total	**160**	**93 (58.12%)**	**67 (41.88%)**

Table 3 illustrates, out of 160 patients enrolled in the study, 95 (59.38%) were males and 65 (40.63%) were females. Among male participants, 49 (51.58%) tested positive for SPT, while 46 (48.42%) were negative. In contrast, 44 of the 65 female participants (67.69%) were SPT-positive, and 21 (32.30%) tested negative. The overall SPT positivity rate was 58.12%, with a negativity rate of 41.88%. A statistically significant association was observed between gender and SPT reactivity (Chi-square test, $p = 0.0425$), indicating that female participants exhibited a higher rate of sensitization to Aspergillus fumigatus compared to males. These findings suggest potential gender-based immunological differences in allergen-specific hypersensitivity. The observed disparity may reflect variations in immune response, environmental exposures, or genetic predispositions. Further research is warranted to elucidate the underlying mechanisms contributing to this gender-related trend in SPT reactivity.

Table 4 Contrast-Enhanced Computed Tomography (CECT) of the Thorax Findings Among Skin Prick Test-Positive Patients (n = 77)

S. No.	CECT Finding	Number of Patients (n)	Percentage (%)
1	Normal	7	9.1
2	Opacity	18	23.4
3	Consolidation	13	16.9
4	Effusion	5	6.5
5	Bronchiectasis	20	26.0
6	Cavity	10	13.0
7	Mucous plugging	4	5.2
	Total	**77**	**100.0**

Table 4. shows among the 93 patients who tested positive on the Skin Prick Test (SPT), 77 underwent Contrast-Enhanced Computed Tomography (CECT) of the thorax. Abnormal radiological findings were identified in 70 patients (90.90%), while 7 patients (9.10%) demonstrated no detectable abnormalities. Bronchiectasis was the most frequently observed pathology, reported in 20 patients (26.0%), suggesting chronic structural airway changes potentially linked to prolonged hypersensitivity inflammation. Pulmonary opacities were seen in 18 patients (23.4%), and consolidation was present in 13 patients (16.9%), consistent with active inflammatory or allergic processes. Cavity formation, indicative of chronic or necrotizing infection, was noted in 10 patients (13.0%). Pleural effusion and mucous plugging were identified in 5 (6.5%) and 4 (5.2%) patients, respectively, suggesting variable presentations of allergic airway disease. These imaging findings underscore the burden of structural lung changes in patients with positive allergen sensitization and support the role of CECT in the evaluation of suspected ABPA.

Table 5. Chest X-ray Findings in Patients with Positive Skin Prick Test for Aspergillus Sensitization (n = 93)

S. No.	X-ray Findings	No. of Patients	Percentage (%)
1	Normal	16	17.2%

2	Opacity	19	20.4%
3	Consolidation	13	14.0%
4	Pleural Effusion	4	4.3%
5	Bronchiectasis	20	21.5%
6	Cavity Formation	13	14.0%
7	Mucous Plugging	8	8.6%
	Total	**93**	**100%**

Table 5 illustrates**,** Among the 93 patients who tested positive for the skin prick test (SPT), chest radiographic analysis revealed that 16 individuals (17.2%) exhibited normal findings, indicating that a proportion of sensitized individuals may not present with overt radiological abnormalities. Among the abnormal findings, bronchiectasis was the most frequently observed pathology (20 patients, 21.5%), followed by opacity (19 patients, 20.4%) and consolidation (13 patients, 14.0%). These patterns suggest chronic structural damage and inflammatory or infectious processes in a considerable proportion of the population. Cavity formation, also seen in 13 patients (14.0%), may reflect chronic infection or post-inflammatory sequelae. Mucous plugging was documented in 8 patients (8.6%), typically associated with obstructive airway disease, while pleural effusion, the least frequent abnormality, was observed in 4 patients (4.3%). Overall, these findings demonstrate that the majority of SPT-positive individuals manifest underlying pulmonary changes detectable via chest X-ray. While chest radiography identified normal lungs in 17.2% of patients, comparative analysis with contrast-enhanced computed tomography (CECT) showed a lower rate of normal findings (9.1%), underscoring the superior sensitivity of CECT in detecting subtle parenchymal changes. The high burden of structural lung abnormalities in this cohort emphasizes the need for comprehensive radiological evaluation and long-term respiratory monitoring in sensitized individuals.

Table 6. Comparison of CECT and Chest X-ray Findings Among SPT-Positive Patients

S. No.	Pulmonary Finding	CECT Findings (n = 77)	Chest X-ray Findings (n = 93)
1	Normal	7	16
2	Opacity	18	19
3	Consolidation	13	13
4	Effusion	5	4
5	Bronchiectasis	20	20
6	Cavity	10	13
7	Mucous plugging	4	8
	Total	**77**	**93**

Table 6 shows, among the 93 SPT-positive patients, chest X-ray identified normal findings in 17.2% (n = 16), while CECT detected normal scans in only 9.1% (n = 7) of the 77 patients who underwent the procedure, indicating superior sensitivity of CECT in detecting pulmonary abnormalities. Bronchiectasis was observed equally by both modalities (n = 20), and consolidation was consistent in both (n = 13). Opacity was noted in 19 patients on X-ray and 18 on CECT.

Differences were observed in other findings: effusion was slightly more frequent on CECT (n = 5) compared to X-ray (n = 4); cavity formation was more commonly detected on X-ray (n = 13) than on CECT (n = 10); mucous plugging was noted in 8 patients on X-ray and 4 on CECT. Statistical analysis revealed no significant correlation between the two imaging modalities (p = 0.6884). These findings indicate that while both tools detect similar abnormalities, CECT offers a more comprehensive evaluation of lung pathology. Chest X-ray remains useful for initial assessment, particularly in detecting bronchiectasis and mucous plugging

Table 7. ELISA findings among skin prick test-positive patients (n = 93)

S. No.	ELISA Parameter	Clinical Condition	No. of Patients
1	Specific IgE to *A. fumigatus*	Bronchial Asthma (BA)	2
		Allergic Rhinitis (AR)	6
		Both BA and AR	6
2	Specific IgG	BA	1
		AR	4
		Both	8
3	Total IgE	BA	10
		AR	6
		Both	2

Table 7 shows, that among 93 SPT-positive patients, ELISA testing revealed varying degrees of immunological responses to *Aspergillus fumigatus*. Specific IgE was detected in 14 patients (15.05%), with distribution as follows: bronchial asthma (BA) – 2 (2.15%), allergic rhinitis (AR) – 6 (6.45%), and both BA and AR – 6 (6.45%). Specific IgG was observed in 13 patients (13.98%), comprising 1 (1.08%) with BA, 4 (4.30%) with AR, and 8 (8.60%) with both conditions. Elevated total IgE levels were present in 18 patients (19.35%), predominantly among BA patients (10 cases, 10.75%), followed by AR (6 cases, 6.45%) and both conditions (2 cases, 2.15%). These findings suggest that total IgE elevation is more associated with asthma, whereas specific IgG responses are more common in patients presenting with both AR and BA, indicating a potentially heightened immune sensitization in individuals with overlapping allergic disorders.

Table 8. Gender-wise Distribution of ELISA-Positive Cases Among SPT-Positive Patients

S. No.	ELISA Parameter	Total Positive	Male (n)	Female (n)
1	Specific IgE to *A. fumigatus*	14	10	4
2	Specific IgG	13	10	3
3	Total IgE	18	12	6

The gender-wise distribution of ELISA-positive cases among 93 SPT-positive patients revealed no significant association between sex and seropositivity. Specific IgE to *Aspergillus fumigatus* was detected in 14 patients (15.05%), comprising 10 males (71.43%) and 4 females (28.57%). Specific IgG positivity was observed in 13 patients (13.98%), with 10 males (76.92%) and 3 females (23.08%). Elevated total IgE levels were noted in 18 patients (19.35%), including 12 males (66.67%) and 6 females (33.33%). Statistical analysis showed no significant correlation between gender and ELISA positivity ($p = 0.8237$), indicating that fungal sensitization in this cohort was independent of sex.

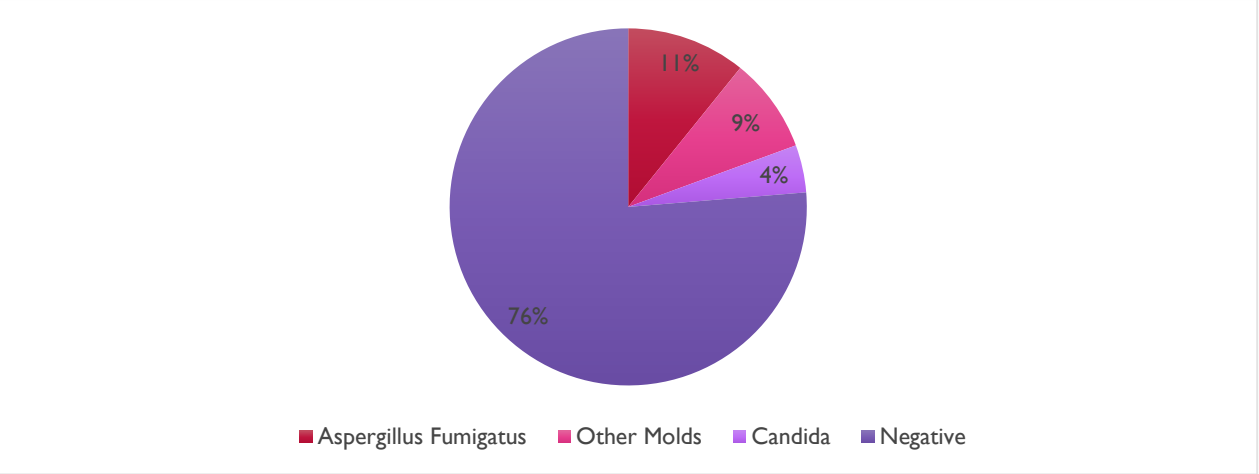

Fig. 5: Culture Test Results Among Tested Samples The pie chart illustrates the distribution of fungal culture results. A majority of the samples (76%) showed no fungal growth. *Aspergillus fumigatus* was isolated in 11% of cases, while other molds were identified in 5%. *Candida* species were detected in 4% of the tested samples. These findings highlight the predominance of negative cultures, with *A. fumigatus* being the most frequently isolated fungal pathogen among the positives.

Table.10 Gender-wise Distribution of Culture-Positive Cases

Gender	**No. of Culture-Positive Cases**
Male	7
Female	3

Table 10 shows that among the 10 culture-positive cases, 7 (70%) were male and 3 (30%) were female, indicating a higher prevalence of fungal isolation in male patients.

Table. 11 Clinical Condition-wise Distribution of Culture-Positive Cases

Clinical Condition	**Culture-Positive Cases**
BA	5
AR	1
Both	4

Table 11 illustrates that**,** out of 10 culture-positive cases, 5 (50%) were from patients with bronchial asthma (BA), 1 (10%) from allergic rhinitis (AR), and 4 (40%) from patients presenting with both conditions. These results indicate a higher prevalence of fungal positivity, particularly Aspergillus fumigatus, among patients with BA. The findings also highlight a male predominance and a greater association with elevated specific IgE, IgG, and total IgE levels in this group.

Table. 12 Correlation of ELISA Findings with *Aspergillus fumigatus* Culture Results

ELISA Finding	**Total Positive (n)**	**Culture Positive for *A. fumigatus* (n, %)**	**Culture Negative (n, %)**
Specific IgE	14	10 (71.43%)	4 (28.57%)
Specific IgG	13	7 (53.85%)	6 (46.15%)
Total IgE	18	10 (55.56%)	8 (44.44%)

Table 12 illustrates the correlation between ELISA parameters and *Aspergillus fumigatus* culture results among skin prick test-positive patients demonstrates a notable pattern. Of the 14 patients positive for specific IgE, 10 (71.43%) were also

culture positive. Similarly, among 13 specific IgG-positive cases, 7 (53.85%) were culture positive. Out of 18 patients with elevated total IgE, 10 (55.56%) were culture positive. These findings highlight a stronger culture positivity in patients with raised specific IgE levels, suggesting a potential role in indicating active or recent fungal exposure.

4. DISCUSSION

Bronchial asthma (BA) and allergic rhinitis (AR) are prevalent inflammatory airway diseases that may present independently or concurrently. In the present study, bronchial asthma was the most commonly diagnosed condition (47.5%), followed by allergic rhinitis (28.75%), while 23.75% of patients exhibited both conditions. This overlap reinforces the concept of a unified airway disease and supports existing literature underscoring the close pathophysiological relationship between asthma and allergic rhinitis.

An age-wise distribution revealed the highest prevalence in the 21–40 years age group (32.93%), followed by 41–60 years (23.35%) and >60 years (22.75%), with the lowest incidence in individuals aged 0–20 years (16.77%). These findings are comparable to reports by Asano et al., who noted that allergic bronchopulmonary aspergillosis (ABPA) typically manifests between 30 and 40 years of age. Similarly, Prasad et al. reported that 69% of their cohort fell within the 20–40 years age bracket, aligning with our observations and suggesting a greater disease burden among younger adults.

In terms of gender distribution, a male predominance was observed (59% males vs. 41% females), consistent with findings by Prasad et al., who also reported higher asthma prevalence in males. In contrast, studies by Chowdhury et al. and Honkamäki et al. reported a greater prevalence among females, attributing these differences to hormonal influences, environmental exposures, and sociocultural factors. Despite such disparities, our findings suggest that males in our study population were more frequently affected, potentially reflecting region-specific risk factors.

These demographic insights highlight the need for targeted awareness and intervention strategies, particularly among younger adults and males, who appear to be at greater risk.

A noteworthy observation was the place of residence: 66% of patients resided in rural areas, compared to 34% from urban settings. The higher prevalence in rural regions may be linked to increased exposure to environmental allergens, poor air quality, and limited access to healthcare services, which together contribute to delayed diagnosis and inadequate management of allergic airway diseases.

Among the 160 patients who underwent skin prick testing (SPT), 93 (58.13%) tested positive for *Aspergillus* allergens, and of these, 44 (47.31%) exhibited sensitivity to multiple *Aspergillus* species. This proportion is markedly higher than that reported by Maurya et al., where only 21% of patients were positive for common aeroallergens including *Aspergillus*, and 71.4% were negative. Notably, 65.3% of the *Aspergillus*-negative patients in their study exhibited reactivity to other aeroallergens, indicating atopy.

Our findings are closely aligned with those of Sovio et al., who reported 59.5% SPT positivity for *Aspergillus* among 205 patients, with 48.3% reacting to multiple *Aspergillus* allergens. Among the 40.4% who tested negative for *Aspergillus*, 83.1% were atopic to other aeroallergens. Taken together, our data suggest a comparatively higher burden of *Aspergillus*-sensitized individuals in our population, implicating *Aspergillus* allergens as key contributors to allergic sensitization.

The diagnostic performance of *Aspergillus fumigatus*-specific immunoglobulins was also evaluated. Specific IgE was detected in 15.05% of patients—2.15% with BA, 6.45% with AR, and 6.45% with both conditions. Specific IgG was observed in 13.98% of individuals, with higher frequencies among those presenting with both BA and AR (8.60%), suggesting a stronger IgG-mediated response in this subgroup.

These results are in agreement with Prasanna Raut et al., who reported that *A. fumigatus*-specific IgE exhibited a sensitivity of 100% and specificity of 70% in diagnosing ABPA. Their pooled sensitivity for IgE was 0.83 (95% CI: 0.76–0.89), which they attributed to variability in baseline total IgE levels across populations. Importantly, their study highlighted the under-recognized diagnostic potential of specific IgG, which showed a sensitivity of 89% and specificity of 100% in ABPA. Our findings support these conclusions, with a pooled IgG sensitivity of 0.93 (95% CI: 0.87–0.97) and specificity of 0.73 (95% CI: 0.61–0.82).

Differences in assay methodologies may account for discrepancies across studies. For instance, Raut et al. noted that double gel diffusion methods yielded low sensitivity (27%), whereas enzyme immunoassays demonstrated sensitivities exceeding 90% for ABPA detection. These observations underscore the importance of appropriate immunoassay selection to ensure diagnostic accuracy in identifying fungal-associated allergic conditions.

Elevated total IgE levels were found in 19.35% of our patients, with the highest prevalence among those with BA (10.75%), followed by AR (6.45%), and patients with both conditions (2.15%). These findings are consistent with those reported by Sovio et al., who observed that total serum IgE typically exceeds 1000 IU/mL in ABPA and ranges between 400–700 IU/mL in general asthma cases. Their recommendation of using >500 IU/mL as a diagnostic threshold for ABPA further supports

the potential utility of total IgE as a screening tool.

Although absolute IgE values were not quantified beyond a defined range in our study, the observed prevalence trends align with previous research, suggesting that elevated total IgE can serve as an adjunctive diagnostic indicator. Furthermore, the predominance of males among IgE-positive individuals mirrors the overall gender distribution of our cohort and may reflect underlying gender-specific immunologic or environmental factors.

5. CONCLUSION

The present study reveals key demographic and immunological patterns in patients with bronchial asthma and allergic rhinitis. A higher disease prevalence was noted among adults aged 21–40 years, males, and individuals from rural areas, suggesting occupational exposure, environmental factors, and disparities in healthcare access as contributing factors. Immunological profiling demonstrated that *Aspergillus fumigatus*-specific IgE remains a valuable marker of sensitization, while specific IgG showed greater relevance in patients with overlapping clinical presentations. Total IgE levels were notably elevated in ABPA cases, supporting its role in preliminary screening. However, variability in total IgE among non-ABPA patients underscores the need for adjunctive diagnostic markers. The stronger association of total IgE with specific IgE than with specific IgG supports the predominance of IgE-mediated hypersensitivity in disease pathogenesis, with specific IgG likely reflecting previous antigen exposure rather than active sensitization. These findings highlight the importance of targeted public health interventions, particularly in rural populations, and call for age- and gender-specific awareness and diagnostic strategies to reduce the burden of allergic airway diseases.

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