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Original Research Article

Clinical, Immunological, and Microbiological Factors of Allergic Rhinitis across ARIA Severity Groups

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Abstract

Introduction: Allergic rhinitis is a common IgE-mediated inflammatory disorder of the nasal mucosa characterized by sneezing, rhinorrhea, nasal obstruction, and itching. The relationship between disease severity, immunological markers, and nasal bacterial colonization remains inadequately explored. This study evaluated these parameters in relation to ARIA-based severity classification.

Methods: A hospital-based cross-sectional study was conducted on 247 patients with allergic rhinitis fulfilling ARIA diagnostic criteria. Clinical evaluation, ARIA classification, absolute eosinophil count, serum IgE estimation, and nasal bacterial culture were performed. Data were analyzed using appropriate statistical tests, and $p<0.05$ was considered significant.

Results: Moderate-severe persistent allergic rhinitis was the most common ARIA category (38.9%). Elevated eosinophil counts and serum IgE levels were observed in most patients. Staphylococcus aureus was the predominant isolate (29.6%). Serum IgE levels and bacterial colonization showed significant association with ARIA severity ($p<0.001$).

Conclusion: The present study demonstrated that allergic rhinitis severity is associated with objective immunological and microbiological parameters. Serum IgE levels increased significantly with increasing ARIA severity and may serve as a useful marker of disease burden. Nasal bacterial colonization was significantly more common in patients with severe disease, suggesting a possible role in persistence and amplification of airway inflammation. However, the type of bacterial isolate did not independently influence disease severity. These findings support an integrated approach combining clinical assessment, laboratory markers, and microbiological evaluation for better understanding, stratification, and management of allergic rhinitis patients.

Keywords: AR (Allergic rhinitis), ARIA (Allergic rhinitis and its impact on Asthma), Eosinophills, IgE, intermittent AR, persistent Allergic Rhinitis.

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Introduction

Allergic rhinitis (AR) is a chronic inflammatory disorder of the nasal mucosa following exposure to inhaled allergens. It is characterized by symptoms such as nasal obstruction, nasal discharge, sneezing, and itching. Althoughit is not commonly life-threatening, but it may affect the quality of life, sleep, cognitive performance, and

work productivity. In the whole world, the burden of allergic rhinitis is very high. [1] A lot of epidemiological studies andthe World Allergy Organization estimate that allergic rhinitis affects approximately 10–30% of the adult population and up to 40% of children worldwide. Several studies have demonstrated a rising trend in prevalence over recent decades, particularly in urban populations. [2]

In India, the prevalence of allergic rhinitis varies across the geographical regions, but available data suggest a high burden. The ISAAC Phase III study reported the prevalence of allergic rhinitis symptoms in Indian children to be approximately 11–15%, while other hospital- and community-based studies indicate higher prevalence rates in urban populations. An Indian investigator reported that allergic rhinitis constitutes a significant proportion of ENT outpatient visits, emphasizing its clinical relevance in routine practice. Varshney and Saxena (2015) et al [3,4]

The ARIA (Allergic rhinitis and its impact on Asthma) classification is a standardized classification based on duration and severity of symptojms. This classification is clinically useful; however, it is primarily based on symptom.

The pathophysiology of allergic rhinitis primarily involves a type I hypersensitivity reaction mediated by immunoglobulin E (IgE). After exposure to allergens such as dust mites, pollen, smoke, or fungal spores, antigen-presenting cells stimulate T-helper 2 (Th2) lymphocytes. [3]

These Th2 cells release cytokines such as interleukin-4 (IL-4), IL-5, and IL-13, which promote IgE production by B lymphocytes and recruitment of eosinophils into the nasal mucosa.

IgE binds to mast cells and basophils, and subsequent allergen exposure triggers release of inflammatory mediators, including histamine, leukotrienes, and prostaglandins. This inflammatory cascade results in mucosal edema, glandular hypersecretion, and nasal obstruction. [5]

In allergic rhinitis high Eosinophill count is an indicator of inflammation, and high Serum IgE is widely used as a marker of allergic sensitization. However, the relationship between these laboratory parameters and the clinical severity of allergic rhinitis has been inconsistent across studies. Some investigators like Ciprandi et al., have reported a positive correlation between serum IgE levels and symptom severity.

The nasal cavity is colonized by a diverse group of microorganisms, and in recent studies have suggested the role of the nasal microbial organism in modulating airway inflammation. Colonization with organisms such as Staphylococcus aureus has been implicated in enhancing Th2-mediated immune responses through superantigen production, potentially exacerbating allergic inflammation. There is a relative very limited studies are from this geographical region that report these domains to provide a comprehensive understanding of allergic rhinitis severity, particularly in the Indian context.

Methodology

Study Design: This is a hospital-based cross-sectional study conducted in the Department of ENT of Sudha Medical College Kota.

Study Duration: One year.

Sample Size: 247 patients were included in the study. Sample was calculated according to prevalence. (P =18 %) [2]

Inclusion criteria: Patients were included in the study if they fulfilled the ARIA classification diagnostic criteria for allergic rhinitis. Diagnosis was based on the presence of two or more characteristic symptoms, including sneezing, rhinorrhea, nasal obstruction, or nasal itching, occurring for at least one hour per day on most days. Patients were further classified

according to ARIA duration and recurrence criteria into:

- Intermittent allergic rhinitis: symptoms occurring for less than 4 days per week or for less than 4 consecutive weeks.
- Persistent allergic rhinitis: symptoms occurring for more than 4 days per week and for more than 4 consecutive weeks.

Severity was categorized as:

- Mild: symptoms not affecting sleep, daily activities, work, school performance, or quality of life.
- Moderate-severe: symptoms associated with sleep disturbance, impairment of daily activities, troublesome symptoms, or reduced quality of life. [5]

Exclusion criteria: Conditions affecting the diagnosis of Acute or chronic Respiratory Tract Infection (infective rhinitis), and nasal polyposis, vasomotor rhinitis, recent use of systemic corticosteroids (within 2 weeks), recent antibiotic therapy (within 2 weeks), hematological disorders affecting eosinophils or immunocompromised patients, or patient unwilling to give consent.

Patients presenting to the ENT outpatient department were screened according to inclusion criteria and obtained consent. The blood for laboratory test and sterile nasal swab for culture samples were collected from the patient and sent to the laboratory. Clinical data were recorded using a structured case record proforma, including demographic details, relevant history, duration of symptoms, frequency, seasonal variation, trigger factors, family history, associated atopic conditions, and smoking exposure. Patients were categorized according to the ARIA classification into intermittent or persistent, and mild or moderate–severe disease. Bacterial isolates were identified using microscopy and biochemical reactions.

Data collection: Data was entered into SPSS, analyzed using appropriate statistical tests, and a p-value <0.05 will be considered significant.

Result

A total of 247 patients with allergic rhinitis were included in the present study. Among them, 184 (74.49%) were males and 63 (25.51%) were females. The most common age group was 30–44 years, comprising 73 (29.55%) patients, followed by patients aged more than 60 years (25.51%).

Most participants belonged to urban areas (73.68%), most of them belongs to service workers, followed by students (24.7%) and labourers (19.4%).

Table 1: Socio-demographic characteristics of the study participants

Parameter	Category	Frequency (n)	Percentage (%)
Gender	Male	184	74.49%
	Female	63	25.51%
Age Group (Years)	15–29	59	23.89%
	30–44	75	30%
	45–59	50	20.24%
	More than 60	63	25.51%
Area of Residence	Urban	182	73.68%
	Rural	65	26.32%
Occupation	Student	61	24.7
	Service	72	29.1
	Labourer	48	19.4
	Others	66	26.7

Table 2: Distribution of Patients According to ARIA Classification (n = 247)

ARIA classification	Frequency	Percentage
Mild intermittent	52	21
Moderate–Severe Intermittent	38	15.4
Mild persistent	61	24.7
Moderate-severe persistent	96	38.9

According to the ARIA classification, moderate-severe persistent allergic rhinitis was the most common category, seen in 96 (38.9%) patients, followed by mild persistent disease in 61 (24.7%) patients. Mild intermittent and moderate-severe intermittent disease were observed in 21% and 15.4% of patients, respectively.

Table 3: Distribution of Absolute Eosinophil Count (AEC) (n = 247)

Eosinophil count	frequency	percentage
< 500 cells /mm3	89	36
500-1000	96	38.9
More than 1000	62	25

Table 4: Distribution of Serum IgE Levels (n = 247)

Serum Ig E level	Frequency	Percentage
Less than 100	58	23.5
100-300	92	37.5
More than 300	97	39.3

Absolute eosinophil count (AEC) was elevated in a majority of patients, with 96 (38.9%) having counts between 500–1000 cells/mm³ and 62 (25%) having counts greater than 1000 cells/mm³. Serum IgE levels above 300 IU/mL were observed in 97 (39.3%) patients, while 92 (37.5%) had levels between 100–300 IU/mL.

Table 5: Distribution of Nasal Bacterial Isolates (n = 247)

Organism isolated	Frequency	Percentage
Streptococci sp	54	22
Staphylococcus aureus	73	29.6
Gram-positive bacilli	41	16.6
Mixed flora	32	13
No growth	47	19

Table 6: Growth Density of Nasal Bacterial Colonization (n = 247)

Growth pattern	Frequency	Percentage
No growth	47	19
Scanty growth	68	27.5
Moderate	79	32
Heavy growth	53	21.5
total	247	

Among nasal bacterial isolates, Staphylococcus aureus was the most common organism isolated in 73 (29.6%) patients, followed by streptococci species in 54 (22%) patients. Moderate bacterial growth was the most common growth pattern (32%).

Table 7: Serum IgE vs ARIA Classification

ARIA classification	Mean serum I gE	SD
Mild intermittent	142.5	60
Moderate-severe intermittent	238.7	85.2
Mild persistent	265.4	92.1
Moderate-severe persistent	412.6	110.5

P value is less than 0.001

Table 8: Chi-Square Table: Bacterial Colonization vs ARIA Severity

ARIA classification	Growth present	No growth	total	Percentage
Mild intermittent	28	24	52	21
Moderate-severe intermittent	29	9	38	15.4
Mild persistent	45	16	61	24.7
Moderate-severe persistent	94	2	96	38.9

P value is less than 0.001 so it is significant

Table 9: Chi-Square Table: Type of Organism vs ARIA Severity

	Mild	Moderate sever	
Staphylococcus	25	48	73
Streptococcus	21	33	54
Gram-positive bacilli	18	23	41
Mixed	10	22	32
No growth	39	8	47
Total	113	134	247

P value more than 0.001 not significant

Mean serum IgE levels increased significantly with increasing ARIA severity, from 142.5 IU/mL in mild intermittent disease to 412.6 IU/mL in moderate-severe persistent disease ($p<0.001$). A significant association was also observed between bacterial colonization and ARIA severity ($p<0.001$), whereas the type of organism isolated did not show a statistically significant association with disease severity.

Discussion

A total of 247 patients were studied with a comprehensive dataset integrating demographic, clinical, immunological, and microbiological parameters. 74 % patient were male this male predominance was an important observation in this study. Similar findings have been reported in hospital-based studies by Varshney and Saxena (2015) et al. they reported a higher proportion of males presented with allergic rhinitis. [4] However, a multicenter large-scale epidemiological studies (Asher et al., 2006) have demonstrated a balanced gender distribution, suggesting that the observed male predominance may be influenced by more healthcare access, occupational exposure of male, rather than a true biological difference in prevalence. [3]

The present study showed that the majority of patients belonged to the 30–44 years age group, which is similar with the known natural history of allergic rhinitis. The high presence of patients above 60 years in this study suggests long-standing disease and cumulative allergen exposure, which has also been noted in chronic airway disease literature.

An investigator Greiner et al. (2011), found out that Allergic rhinitis typically begins in childhood but often persists into adulthood, with peak clinical burden in

early to middle adulthood.An interesting finding in the current study was the predominance of patients from urban areas (73.68%). [6] However, more recent observations indicate a rising prevalence in rural populations, likely due to increased exposure to environmental pollutants, biomass fuel, and occupational allergens. According to the World Allergy Organization, allergic rhinitis is more prevalent in urban population. The present study demonstrated that the largest proportion of patients had moderate–severe persistent allergic rhinitis (38.9%), followed by mild persistent disease. [2] This pattern is consistent with another study by Bousquet et al 2008 where patients with more severe and persistent symptoms are more likely to seek medical attention. [5]

Absolute eosinophil count in the present study, was elevated (>500 cells/mm³) in approximately 64% of patients, reflecting the central role of eosinophils in allergic inflammation as eosinophils are key effector cells in IgE-mediated hypersensitivity reactions. However, when interpreted in the context of previous studies, including those by Ciprandi et al., the correlation between AEC and clinical severity is often moderate and inconsistent. The current study also supports this observation, as AEC, although elevated in a majority of patients, did not demonstrate as strong a relationship with ARIA severity as serum IgE. [6]

Serum IgE levels showed a strong and statistically significant association with disease severity ($p < 0.001$). Patients with moderate–severe persistent allergic rhinitis had markedly higher mean IgE levels than those with milder forms. This finding is consistent with the study by Ciprandi et al. (2005), which demonstrated a positive correlation between serum IgE levels and symptom severity. [6]

Similarly, Greiner et al. (2011) also reported that it has central role in mediating allergic inflammation. And it is a biomarker of disease activity. The results of the present study reinforce the concept that serum IgE can serve as a useful objective indicator of disease severity, although it should be interpreted in conjunction with clinical parameters due to inter-individual variability. [7]

The present study revealed that bacterial colonization was present in a majority of patients, with Staphylococcus aureus being the most common isolate (29.6%). This is consistent with findings from microbiological studies such as those by Brook et al (2006), who described S. aureus as a common colonizer of the upper respiratory tract. Other studies suggested that S. aureus is not merely a commensal organism but may play an active role in modulating airway inflammation. Another investigator Foreman et al. (2011) demonstrated that S. aureus can produce superantigens that stimulate T-cell activation and enhance Th2-mediated immune responses, thereby potentially exacerbating allergic inflammation. [8]

In the present study, bacterial colonization showed a statistically significant association with ARIA severity ($p < 0.001$). Patients with moderate–severe persistent disease had a higher prevalence of positive cultures compared to those with mild disease. This finding is similar to a study by Brook et al (2006) that microbial factors may contribute to the persistence and amplification of airway inflammation. Although most previous studies have focused on chronic rhinosinusitis, the current findings suggest that similar mechanisms may be operative in allergic rhinitis, particularly in more severe and persistent forms. [9]

However, when the type of organism isolated was analyzed in relation to disease severity, no statistically significant association was observed in this study. This suggests that the presence of bacterial colonization or broader microbial diversity per se is more relevant than the specific organism type. Similar to this study other

studies also found that alterations in microbial diversity and balance, rather than dominance of a single organism, may influence disease expression. [10]

The semi-quantitative assessment of bacterial growth in the present study further supports this interpretation, as higher growth density was more frequently observed in severe cases. Although this parameter has not been extensively evaluated in allergic rhinitis, it provides indirect evidence that microbial load may correlate with disease severity, possibly through sustained immune activation. [11]

When considered collectively, the findings of this study highlight the multifactorial nature of allergic rhinitis. While the ARIA classification provides a useful clinical framework, the addition of objective biomarkers such as serum IgE and AEC, along with microbiological assessment, offers a more comprehensive understanding of disease severity.

The strong association between serum IgE and ARIA severity supports its role as a key immunological marker, whereas the significant association between bacterial colonization and disease severity suggests that microbial factors may act as modifiers of disease expression.

In conclusion, the present study demonstrates that allergic rhinitis is a complex, multifactorial disease involving interactions between clinical severity, immunological markers, and microbial colonization.

Serum IgE emerged as a strong correlate of disease severity, while bacterial colonization was significantly associated with more severe disease, although the specific type of organism did not independently influence severity.

These findings support the need for an integrated approach to evaluation and management, combining clinical assessment with laboratory and microbiological parameters to better understand and stratify disease severity.

Limitation

It is a cross-sectional study limit the ability to establish actual causal relationship between allergic rhinitis and other factors. The study population was hospital-based, which may result in selection bias. Nasal swab identifies only colonization, not infection. Additionally, being a single-center study, the findings may not be generalizable to all populations.

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