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Original Research Article

ASSESSMENT OF HEARING IMPAIRMENT IN PATIENTS WITH ALLERGIC RHINITIS THROUGH AUDIOLOGICAL PROFILE

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ABSTRACT

Background: Allergic rhinitis (AR) is a common chronic inflammatory disorder affecting the upper respiratory tract, which may also impair auditory function through Eustachian tube dysfunction and middle ear involvement. Despite increasing awareness, its impact on hearing remains under-recognized. To assess the audiological profile of patients with allergic rhinitis using tympanometry and pure tone audiometry, and to explore the correlation between hearing thresholds and duration of AR symptoms.

Materials and Methods: This cross-sectional, hospital-based study included 150 patients with clinically diagnosed allergic rhinitis and 150 age-matched controls. Audiological evaluation was conducted using the Titan Interacoustic Tympanometer and standard pure tone audiometry. Tympanogram types, air conduction thresholds, and degrees of hearing loss were compared. Pearson correlation was used to analyze the relationship between symptom duration and hearing thresholds.

Results: AR patients had significantly more abnormal tympanograms (Type B: 20.7%, Type C: 10%) compared to controls (Type B: 3.3%, Type C: 4.7%) ($p < 0.001$). Air conduction thresholds were elevated across all frequencies in the AR group ($p < 0.001$), with a mean threshold of 30.5 ± 8.2 dB at 8000 Hz. Hearing loss was detected in 32% of AR patients—predominantly mild (22.7%) and moderate (6.7%). A moderate positive correlation ($r = 0.41$, $p < 0.001$) was found between duration of AR and hearing loss severity.

Conclusion: Allergic rhinitis is significantly associated with subclinical conductive hearing loss and abnormal middle ear function, which worsen with prolonged symptom duration. Early audiological screening in AR patients is essential to prevent long-term auditory complications.

Keywords: Allergic Rhinitis, tympanograms, audiometry.

INTRODUCTION

Allergic rhinitis (AR) is a prevalent chronic inflammatory condition of the nasal mucosa, triggered by an immunoglobulin E (IgE)-mediated hypersensitivity response to environmental allergens. It manifests clinically with symptoms such as sneezing, nasal congestion, rhinorrhoea, and pruritus involving the nose, eyes, and throat.[1] With an estimated global prevalence of 15–20%, allergic rhinitis represents a significant public health burden due to its impact on productivity, sleep quality, and overall quality of life.[2] Emerging evidence suggests that allergic rhinitis may be associated with a range of otological manifestations, including hearing impairment. The underlying mechanism is thought to involve eustachian tube dysfunction secondary to nasal congestion and mucosal inflammation, which can result in negative middle ear pressure and conductive hearing loss.[3] Additionally, the inflammatory cascade seen in allergic responses, including the release of histamine, leukotrienes, and other mediators, may adversely affect the auditory system either directly or through their impact on middle and inner ear structures.[2]

Research has also pointed towards a possible role of allergic reactions in altering inner ear function. For instance, the endolymphatic sac, which plays a crucial role in maintaining inner ear homeostasis, may be affected by allergic responses, thereby contributing to auditory symptoms in patients with allergic rhinitis.[4] A study by Radman et al. further emphasized the immunological aspect, showing that Toll-like receptor 4 (TLR4) may have a significant role in the pathogenesis of allergic rhinitis, suggesting a broader systemic involvement.[5] Despite the potential for auditory complications, studies specifically examining the audiological profile of allergic rhinitis patients remain limited. Recent investigations, such as the hospital-based study by Prabakaran et al. (2024), demonstrated a correlation between the severity of hearing loss and the duration of allergic rhinitis, highlighting the importance of early audiological assessment in such patients.[6] Advanced diagnostic tools have improved the ability to detect subclinical or mild hearing impairment in AR patients. The Titan Interacoustic Tympanometer is one such instrument, capable of performing detailed middle ear assessments through tympanometry and wideband acoustic immittance. It provides objective measurements of tympanic membrane compliance, middle ear pressure, and acoustic reflexes, thereby offering valuable insights into auditory function.[5,7,8] Given the potential impact of allergic rhinitis on hearing and the paucity of literature exploring this association with comprehensive audiological tools, the present study was undertaken to assess hearing impairment in patients diagnosed with allergic rhinitis using the Titan Interacoustic Tympanometer.

MATERIALS AND METHODS

This prospective, cross-sectional, hospital-based observational study was conducted in the Department of ENT at a tertiary care hospital affiliated with the Deccan College of Medical Sciences. The primary aim was to assess hearing impairment in patients diagnosed with allergic rhinitis using the Rapid Allergy Prediction Questionnaire (RAPQ) for screening and the Titan Interacoustic Tympanometer for audiological evaluation. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants prior to their inclusion in the study.

A total of approximately 300 participants, both male and female, aged between 10 and 80 years, were enrolled. Among these, 150 subjects were diagnosed as allergic rhinitis-positive based on their clinical presentation and positive RAPQ screening. An equal number of age-matched healthy control subjects without any history of cold, allergy, or upper respiratory tract infections in the previous 6 to 7 months were also included. Inclusion criteria comprised individuals aged 10 to 80 years with clinical symptoms consistent with allergic rhinitis confirmed through the RAPQ. Subjects were excluded if they had a history of otological disorders, previous ear surgeries, exposure to ototoxic drugs, hearing loss due to systemic or metabolic diseases, otoscopic evidence of tympanic membrane perforation, or unwillingness to undergo a full otological assessment. Allergic rhinitis-positive participants underwent detailed audiological testing using the Titan Interacoustic Tympanometer. Air conduction thresholds were assessed across frequencies ranging from 125 Hz to 8000 Hz, and bone conduction thresholds were evaluated from 250 Hz to 8000 Hz. Tympanometric measurements were also recorded to evaluate middle ear compliance and acoustic reflexes, enabling a comprehensive analysis of auditory function. Data were analyzed using appropriate statistical tools. Continuous variables were presented as mean ± standard deviation, while categorical variables were summarized as frequencies and percentages. The Chi-square (χ^2) test was applied to compare categorical variables between groups. Pearson correlation analysis was used to determine associations between variables. A p-value of less than 0.05 was considered statistically significant for all comparisons.

RESULTS

The demographic distribution of participants was comparable between the allergic rhinitis and control groups. The mean age was 35.8 ± 14.2 years in the allergic rhinitis group and 36.5 ± 13.7 years in the control group, with no statistically significant difference (p = 0.612). Gender distribution was also balanced, with males comprising 54.7% in the allergic rhinitis group and 50.7% in the control group (p = 0.429), indicating no significant demographic bias between groups (Table 1).

Table 1: Demographic Profile of Study Participants (N = 300)

Variable		Allergic Rhinitis Group (n = 150)	Control Group (n = 150)	Total (n = 300)	p-value
Age (years)	(Mean ± SD)	35.8 ± 14.2	36.5 ± 13.7	36.1 ± 13.9	0.612
Gender	Male	82 (54.7%)	76 (50.7%)	158 (52.7%)	0.429
	Female	68 (45.3%)	74 (49.3%)	142 (47.3%)	

Assessment of Tympanometric findings revealed a higher prevalence of abnormal middle ear function among allergic rhinitis patients. While 92.0% of the control group exhibited normal Type A tympanograms, only 69.3% of the allergic rhinitis group showed similar results. Notably, 20.7% of

allergic rhinitis patients had Type B tympanograms suggestive of middle ear effusion, compared to just 3.3% in controls. Type C patterns indicating eustachian tube dysfunction were also more frequent in the allergic rhinitis group (10.0% vs 4.7%), and these differences were statistically significant ($p < 0.001$) (Table 2).

Table 2: Distribution of Tympanometric Findings

Tympanogram Type	Allergic Rhinitis Group(n = 150)	Control Group(n = 150)	p-value
Type A (Normal)	104 (69.3%)	138 (92.0%)	<0.001
Type B (effusion/OME)	31 (20.7%)	5 (3.3%)	
Type C (eustachian tube dysfunction)	15 (10.0%)	7 (4.7%)	

Air conduction thresholds measured through pure tone audiometry were consistently higher across all frequencies in the allergic rhinitis group compared to controls. The most notable threshold elevations were observed at 8000 Hz (30.5 ± 8.2 dB in allergic rhinitis vs 17.4 ± 5.6 dB in controls) and 4000 Hz (27.1 ± 7.6 dB vs 16.3 ± 5.2 dB), reflecting high-frequency hearing impairment in the affected population. All frequency comparisons between groups were statistically significant ($p < 0.001$), indicating a clear audiological impact of allergic rhinitis (Table 3).

Table 3: Pure Tone Audiometry Results – Air Conduction Thresholds (in dB HL)

Frequency (Hz)	Allergic Rhinitis Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
125 Hz	20.4 ± 6.5	13.1 ± 4.8	<0.001
500 Hz	21.2 ± 7.3	13.6 ± 4.6	<0.001
1000 Hz	23.8 ± 6.9	14.2 ± 5.1	<0.001
2000 Hz	25.5 ± 7.0	15.8 ± 4.9	<0.001
4000 Hz	27.1 ± 7.6	16.3 ± 5.2	<0.001
8000 Hz	30.5 ± 8.2	17.4 ± 5.6	<0.001

Among allergic rhinitis patients, hearing status varied widely. While 68.0% maintained normal hearing (≤25 dB HL), nearly one-third exhibited some degree of hearing loss. Mild hearing loss was most prevalent (22.7%), followed by moderate (6.7%) and moderately severe loss (2.6%). No cases of severe hearing loss (>70 dB HL) were recorded. These findings emphasize the subclinical yet measurable auditory involvement in allergic rhinitis (Table 4).

Table 4: Hearing Loss Grading Among Allergic Rhinitis Patients (n = 150)

Degree of Hearing Loss	Number of Patients	Percentage (%)
Normal Hearing (≤25 dB)	102	68.0%
Mild (26–40 dB)	34	22.7%
Moderate (41–55 dB)	10	6.7%
Moderately Severe (56–70)	4	2.6%
Severe (>70 dB)	0	0.0%

The relationship between the duration of allergic rhinitis symptoms and hearing threshold revealed a positive correlation. Patients with symptom duration of less than 6 months had a mean hearing threshold of 20.8 ± 5.9 dB HL, whereas those with symptoms persisting for more than 12 months exhibited significantly elevated thresholds (28.3 ± 7.2 dB HL). The Pearson correlation coefficient was 0.41, indicating a moderate positive correlation, which was statistically significant ($p < 0.001$), suggesting that prolonged allergic rhinitis may contribute to progressive hearing impairment (Table 5).

Table 5: Correlation between Duration of Allergic Rhinitis and Hearing Loss (n = 150)

Duration of AR Symptoms	Mean Hearing Threshold (dB HL)	Pearsons's correlation (r)	p-value
<6 months	20.8 ± 5.9	0.41	<0.001
6–12 months	24.6 ± 6.4		
>12 months	28.3 ± 7.2		

DISCUSSION

The present study comprehensively evaluated the impact of allergic rhinitis (AR) on middle and inner ear function, using tympanometry, pure tone audiometry (PTA), and correlation with symptom duration. Importantly, demographic comparability between groups strengthened the reliability of the findings. The mean age and gender distribution were statistically similar between allergic rhinitis and control groups, ruling out demographic bias. These results are in concordance with Kaur S et al. (2018),[9] who emphasized the importance of demographic matching to ensure the validity of auditory assessments in comparative studies. The present study demonstrated a significantly higher incidence of abnormal tympanograms in allergic rhinitis patients, with only 69.3% showing normal Type A curves compared to 92.0% in controls ($p < 0.001$). Type B and C tympanograms, indicating middle ear

effusion and Eustachian tube dysfunction respectively, were more frequent in the allergic group (20.7% and 10.0%) than controls (3.3% and 4.7%). These findings are consistent with Mahajan et al. (2022)[3] and Dwarakanath et al. (2019),[1] who also reported increased Type B and C patterns in allergic rhinitis due to mucosal edema and poor tube function. Similar trends were noted by Kaur et al.[9] (2025), Kumar et al. (2018),[10] and Sahni et al. (2020),[4] reinforcing the association between allergic rhinitis and subclinical middle ear involvement.

Air conduction thresholds assessed via PTA were showed significantly elevated air conduction thresholds at all tested frequencies—from 125 Hz (20.4 ± 6.5 dB) to 8000 Hz (30.5 ± 8.2 dB)—compared to controls (13.1 ± 4.8 dB to 17.4 ± 5.6 dB), with $p < 0.001$ throughout. These results indicate mild to moderate conductive hearing loss in the allergic group. Similar findings were reported by Mahajan et al. (2022),[3] who observed higher thresholds in 30% of AR patients. Dwarakanath et al. (2019) reported 52.5% with hearing loss, while Sahni et al. (2020).[4] found mild loss in 78% of bilateral OME cases. Kaur et al. (2025).[9] and Kumar et al. (2018),[10] also highlighted a strong association between AR-related OME and hearing impairment. Clinically, this highlights the importance of routine audiological screening in allergic rhinitis patients to prevent long-term auditory complications. Grading of hearing loss revealed that 32% of allergic rhinitis patients had hearing loss: 22.7% had mild (26–40 dB), 6.7% moderate (41–55 dB), and 2.6% moderately severe loss (56–70 dB); no cases of severe loss were noted. These findings align with Mahajan et al. (2022).[3] and Kaur et al. (2025),[9] who reported predominantly mild to moderate conductive hearing loss in AR patients. Dwarakanath et al. (2019).[1] and Sahni et al. (2020)[4] similarly found no cases exceeding mild impairment. This emphasizes the need for early audiological monitoring in allergic rhinitis to prevent progression and ensure timely intervention. A key strength of the present study, a significant positive correlation ($r = 0.41$, $p < 0.001$) was observed between the duration of allergic rhinitis and mean hearing thresholds, which increased from 20.8 dB (<6 months) to 28.3 dB (>12 months). This trend mirrors findings by Mahajan et al. (2022),[3] Kaur et al. (2025),[9] and Dwarakanath et al. (2019),[1] who also noted worsening hearing with prolonged AR duration due to prolonged allergic inflammation may result in progressive damage to the middle and inner ear structures, likely through repeated episodes of Eustachian tube dysfunction and immune-mediated cochlear injury. Clinically, this emphasizes the importance of early identification and sustained management of allergic rhinitis to prevent cumulative auditory damage and long-term conductive hearing loss. The study underscores the significant impact of allergic rhinitis on both middle and inner ear function. The consistency of findings with multiple previous studies reinforces the need for routine and early audio logical screening in allergic rhinitis patients, particularly those with chronic or poorly controlled symptoms. Early identification and management of auditory dysfunction in this population can prevent progression to more severe impairment and improve overall quality of life.

CONCLUSION

The present study establishes a significant association between allergic rhinitis and subclinical middle ear dysfunction, as evidenced by abnormal tympanometric patterns, elevated hearing thresholds, and varying degrees of conductive hearing loss. A clear trend of worsening auditory function with increasing duration of allergic symptoms further underscores the progressive nature of this complication. These findings highlight the importance of routine otological evaluation and timely intervention in patients with allergic rhinitis, particularly in pediatric populations, to prevent long-term auditory sequelae and improve quality of life.

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