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EVALUATION OF PULMONARY FUNCTION TEST USING SPIROMETRY IN NON-ASTHMATIC PATIENTS WITH ALLERGIC RHINITIS AND THE EFFECT OF ALLERGIC RHINITIS MANAGEMENT ON SPIROMETRIC PARAMETERS

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ABSTRACT **Background** Allergic rhinitis (AR) is one of the most common chronic inflammatory disorders of the upper airway and affects approximately 10–40% of the global population. It is characterized by sneezing, rhinorrhoea, nasal obstruction and nasal itching following exposure to allergens. Increasing evidence supports the concept of the "united airway disease," which recognizes that inflammation involving the upper airway frequently extends to the lower respiratory tract. Consequently, patients with allergic rhinitis, even in the absence of clinically diagnosed asthma, may exhibit subclinical bronchial involvement detectable by pulmonary function testing. Spirometry is a simple, inexpensive and non-invasive investigation capable of identifying early airway obstruction before clinical manifestations of asthma become apparent. **Aim** To evaluate pulmonary function using spirometry in non-asthmatic patients with allergic rhinitis and determine the effect of allergic rhinitis management on spirometric parameters. **Materials and Methods** A prospective observational longitudinal study was conducted in the Department of Otorhinolaryngology at Sri Venkateshwaraa Medical College Hospital and Research Centre between February 2024 and July 2025. Two hundred clinically diagnosed non-asthmatic allergic rhinitis patients fulfilling the ARIA criteria were included. Baseline clinical assessment, spirometry, bronchodilator reversibility testing and Mini Rhinoconjunctivitis Quality of Life Questionnaire (Mini-RQLQ) scoring were performed. Patients received standard medical treatment according to ARIA guidelines. Mini-RQLQ assessment was repeated after two weeks and spirometry after four weeks. Statistical analysis was performed using IBM SPSS version 29.0. **Results** Among the 200 study participants, females constituted the majority (61%), while the highest prevalence was observed in the 31–40-year age group. Sneezing was the commonest presenting complaint. Mild intermittent allergic rhinitis represented the largest clinical subgroup. Baseline spirometry demonstrated reduced pulmonary function across all categories of allergic rhinitis. Significant improvement in FVC, FEV_1, FEV_1/FVC ratio and FEF25–75% was observed following treatment. Mini-RQLQ scores also showed statistically significant improvement after therapy ($p<0.05$). **Conclusion** Pulmonary function abnormalities are frequently present among non-asthmatic patients with allergic rhinitis. Appropriate treatment of allergic rhinitis significantly improves spirometric parameters and patient quality of life. Routine spirometric evaluation should therefore be considered in allergic rhinitis patients for early identification of lower airway involvement and prevention of progression to overt asthma.

KEYWORDS : Allergic rhinitis, Spirometry, Pulmonary function test, FEV_1, FVC, Bronchodilator reversibility, Mini-RQLQ.

INTRODUCTION

Allergic rhinitis (AR) is an immunoglobulin E (IgE)-mediated inflammatory disorder of the nasal mucosa characterized by sneezing, rhinorrhoea, nasal obstruction, and nasal itching following exposure to allergens. It is increasingly recognized as a systemic airway disease rather than an isolated nasal disorder due to the close anatomical and immunological relationship between the upper and lower respiratory tract, commonly referred to as the "united airway disease" concept (Bousquet et al., 2020).

The Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines classify AR based on symptom duration and severity into mild intermittent, mild persistent, moderate-to-severe intermittent, and moderate-to-severe persistent forms, providing a standardized approach to diagnosis and management (Brożek et al., 2017). Allergic rhinitis affects approximately 10–40% of the global population, with an increasing prevalence attributed to urbanization, environmental pollution, and lifestyle changes. In India, the prevalence among adults is estimated to be around 9.8%, significantly affecting quality of life, sleep, and daily productivity (Moitra et al., 2023).

Several studies have demonstrated a strong association between allergic rhinitis and bronchial asthma, with approximately 80% of asthmatic patients having coexisting allergic rhinitis and 20–40% of allergic rhinitis patients eventually developing asthma (Bousquet et al., 2020). Lower airway involvement may remain clinically silent for years, making early detection essential. Spirometry is a simple, reliable, and non-invasive investigation that evaluates pulmonary function through parameters such as Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), FEV_1/FVC ratio, and Forced Expiratory Flow between 25% and 75% of expiration ($FEF_{25–75}$), which is particularly sensitive for detecting early small airway dysfunction (Pellegrino et al., 2005).

Previous studies have reported subclinical pulmonary function impairment in non-asthmatic patients with allergic rhinitis, with improvement following appropriate treatment (Ciprandi et al., 2011). However, evidence from South India remains limited. Therefore, the present study was undertaken to evaluate pulmonary function using spirometry in non-asthmatic patients with allergic rhinitis and to assess the effect of standard allergic rhinitis management on spirometric parameters and quality of life.

AIM

To evaluate pulmonary function using spirometry in non-asthmatic patients with allergic rhinitis and assess the effect of standard treatment on pulmonary function and quality of life.

Objectives

1. To assess baseline pulmonary function using spirometry in non-asthmatic patients with allergic rhinitis.
2. To compare spirometric parameters across different ARIA classifications.
3. To evaluate changes in spirometric parameters and bronchodilator reversibility following treatment.
4. To assess changes in quality of life using the Mini Rhinoconjunctivitis Quality of Life Questionnaire (Mini-RQLQ).
5. To determine the association between allergic rhinitis severity and pulmonary function abnormalities.

MATERIALS AND METHODS

A prospective observational longitudinal study was conducted in the Department of Otorhinolaryngology, in collaboration with the Department of Respiratory Medicine, Sri Venkateshwaraa Medical College Hospital and Research Centre, Puducherry, from February 2024 to July 2025, after obtaining Institutional Ethics Committee

approval and written informed consent from all participants. A total of 200 non-asthmatic patients aged 18–60 years with clinically diagnosed allergic rhinitis based on ARIA guidelines were consecutively enrolled. Patients with bronchial asthma, chronic obstructive pulmonary disease, pulmonary tuberculosis, acute respiratory infections, chronic rhinosinusitis with nasal polyposis, previous nasal or thoracic surgery, pregnancy, smoking history, or inability to perform acceptable spirometry were excluded.

A detailed clinical history and otorhinolaryngological examination were performed. Allergic rhinitis was classified according to the ARIA criteria into mild intermittent, mild persistent, moderate-to-severe intermittent, and moderate-to-severe persistent. Baseline pulmonary function was assessed using computerized spirometry following ATS/ERS guidelines, recording Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), FEV_1/FVC ratio, and Forced Expiratory Flow between 25% and 75% of expiration ($FEF_{25–75}$). Bronchodilator reversibility testing was performed in patients with abnormal spirometric findings.

Quality of life was evaluated using the Mini Rhinoconjunctivitis Quality of Life Questionnaire (Mini-RQLQ). All participants received standard ARIA-based treatment, including intranasal corticosteroids, oral antihistamines, saline nasal irrigation, and allergen avoidance advice. Mini-RQLQ assessment was repeated after two weeks, while spirometry was repeated after four weeks.

Data were analysed using IBM SPSS version 29.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Statistical analysis was performed using the paired Student's *t*-test, Chi-square test, or Fisher's exact test, with a p-value <0.05 considered statistically significant.

All participants underwent detailed history taking and clinical examination, including otorhinolaryngological evaluation. Allergic rhinitis was classified according to the ARIA guidelines into mild intermittent, mild persistent, moderate-to-severe intermittent, and moderate-to-severe persistent disease.

Baseline pulmonary function was assessed using a calibrated computerized spirometer following ATS/ERS guidelines. Spirometric parameters recorded included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), FEV_1/FVC ratio, and Forced Expiratory Flow between 25% and 75% ($FEF_{25–75}$). Patients with abnormal spirometry underwent bronchodilator reversibility testing using 400 µg inhaled salbutamol, with repeat spirometry performed after 15–20 minutes. A significant bronchodilator response was defined as an increase in FEV_1 of ≥12% and ≥200 mL.

Health-related quality of life was assessed using the Mini Rhinoconjunctivitis Quality of Life Questionnaire (Mini-RQLQ) at baseline and two weeks after treatment. All patients received standard ARIA-based management, including intranasal corticosteroids, second-generation antihistamines, saline nasal irrigation, and allergen avoidance advice. Spirometry was repeated after four weeks to assess treatment response.

The primary outcome was improvement in spirometric parameters (FVC, FEV_1, FEV_1/FVC, and $FEF_{25–75}$), while secondary outcomes included bronchodilator reversibility, Mini-RQLQ scores, and their association with allergic rhinitis severity.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS version 29.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Baseline and post-treatment spirometric parameters were compared using the paired Student's *t*-test, and categorical variables were analysed using the Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULT

A total of 200 patients with clinically diagnosed non-asthmatic allergic rhinitis were included in the study. The majority of participants were 31–40 years old (33.5%), followed by 41–50 years (22.5%), 51–60 years (19.5%), 18–30 years (15%), and >60 years (9.5%). Females constituted 61% of the study population, while males accounted for 39%. Most participants belonged to Class V socioeconomic status (34.5%), and 67.5% were from urban areas.

Sneezing (83%) was the most common presenting symptom, followed by anterior rhinorrhoea (78%), post-nasal drip (51%), nasal obstruction (44%), headache (38.5%), and allergic conjunctivitis (22%). The duration of symptoms was less than six months in 44% of patients, while 62% had no associated comorbidities. Smoking and alcohol consumption were reported by 37% and 40% of participants, respectively.

Based on the ARIA classification, 36% of patients had mild intermittent allergic rhinitis, 27.5% had mild persistent disease, 23% had moderate-to-severe intermittent disease, and 13.5% had moderate-to-severe persistent allergic rhinitis. Baseline spirometry demonstrated impaired pulmonary function across all categories of allergic rhinitis. Following treatment, a significant improvement was observed in all spirometric parameters (Table 1). Mean FVC increased from 79.39±2.23% to 85.01±2.15% in mild intermittent AR (p=0.034), 78.22±2.06% to 85.85±2.16% in mild persistent AR (p=0.012), 76.24±2.12% to 83.50±1.72% in moderate-to-severe intermittent AR (p=0.009), and 72.52±1.36% to 81.44±2.41% in moderate-to-severe persistent AR (p=0.002). Similarly, mean FEV_1 improved significantly following treatment in all groups. Values increased from 76.58±2.23% to 83.46±2.07% in mild intermittent AR, 76.96±1.95% to 84.53±2.21% in mild persistent AR, 75.13±2.57% to 83.91±1.59% in moderate-to-severe intermittent AR, and 71.44±1.15% to 81.96±1.69% in moderate-to-severe persistent AR (all p<0.05).

Assessment of small airway function using $FEF_{25–75}$ also showed improvement after treatment. Significant improvement was observed in mild intermittent (p=0.035), moderate-to-severe intermittent (p=0.009), and moderate-to-severe persistent disease (p=0.001), whereas improvement in the mild persistent group did not reach statistical significance (p=0.058).

The FEV_1/FVC ratio increased significantly in all categories of allergic rhinitis following treatment. Mean values improved from 69.03±1.48% to 73.96±1.72% in mild intermittent AR, 69.15±1.97% to 74.33±1.62% in mild persistent AR, 66.78±1.26% to 72.85±2.29% in moderate-to-severe intermittent AR, and 64.26±1.23% to 69.00±1.49% in moderate-to-severe persistent AR (all p<0.05).

Bronchodilator reversibility improved significantly following treatment across all ARIA categories. The proportion of patients demonstrating reversibility increased from 15% to 32.5% in mild intermittent AR, 7.5% to 25% in mild persistent AR, 8% to 20% in moderate-to-severe intermittent AR, and 3.5% to 11% in moderate-to-severe persistent AR. These improvements were statistically significant (χ^2, p<0.001).

Quality of life assessed using the Mini Rhinoconjunctivitis Quality of Life Questionnaire (Mini-RQLQ) showed marked improvement following treatment. Significant reductions were observed in activity limitation, practical problems, nasal symptoms, eye symptoms, and other symptom domains across all disease categories. Patients with moderate-to-severe persistent allergic rhinitis had the highest baseline scores and demonstrated the greatest improvement after treatment. Improvement was statistically significant in most domains (p<0.05), although nasal symptoms in the mild intermittent group (p=0.285), eye symptoms in the mild persistent (p=0.174) and moderate-to-severe persistent groups (p=0.053), and other symptoms in the mild intermittent group (p=0.051) did not achieve statistical significance.

Overall, spirometric parameters, bronchodilator reversibility, and Mini-RQLQ scores improved significantly following standard ARIA-based management, indicating beneficial effects of treatment on pulmonary function and health-related quality of life in non-asthmatic patients with allergic rhinitis.

DISCUSSION

Allergic rhinitis (AR) is a chronic inflammatory disorder of the upper airway that significantly affects quality of life and has a well-established association with lower airway diseases. The concept of "one airway, one disease" emphasizes the anatomical and immunological continuity between the upper and lower respiratory tract, explaining why patients with allergic rhinitis may exhibit

bronchial inflammation even in the absence of clinically diagnosed asthma (Bousquet et al., 2020). The present study evaluated pulmonary function in non-asthmatic patients with allergic rhinitis using spirometry and assessed the effect of standard medical management on spirometric parameters and quality of life.

In the present study, the majority of patients belonged to the 31–40 years age group, with a female predominance. Similar demographic findings have been reported by Ciprandi et al. (2011) and Kumar et al. (2018), who observed that allergic rhinitis is more frequently diagnosed among young and middle-aged adults. The higher prevalence among females observed in the present study may be attributed to increased healthcare-seeking behaviour, hormonal influences, and environmental exposure, although gender distribution varies across different populations.

Sneezing, rhinorrhoea, nasal obstruction, and nasal itching were the most common presenting symptoms in this study, with sneezing being the predominant complaint. These findings are consistent with the classical clinical manifestations described in the ARIA guidelines and are comparable to observations reported by Brożek et al. (2017). The predominance of these symptoms reflects IgE-mediated inflammation of the nasal mucosa following allergen exposure.

According to the ARIA classification, mild intermittent allergic rhinitis constituted the largest subgroup in the present study. This observation is similar to the findings of Bousquet et al. (2020), who reported that intermittent disease is more frequently encountered in outpatient settings. The ARIA classification provides a better assessment of disease burden than the traditional seasonal and perennial classification by incorporating both symptom duration and severity.

One of the important findings of the present study was the presence of spirometric abnormalities among patients without clinically diagnosed asthma. Baseline spirometry demonstrated reduced values of FVC, FEV_1, FEV_1/FVC ratio, and FEF25–75% in a considerable proportion of patients. Among these parameters, FEF25–75% appeared to be the earliest indicator of lower airway involvement, suggesting the presence of small airway dysfunction before clinically apparent airflow limitation. Similar findings have been reported by Ciprandi et al. (2011) and Guerra et al. (2019), who demonstrated that patients with allergic rhinitis frequently exhibit subclinical bronchial impairment despite the absence of overt asthma.

The reduction in spirometric indices observed in the present study supports the concept that allergic inflammation is not confined to the nasal mucosa but extends throughout the respiratory tract. Shared inflammatory mediators, including eosinophils, mast cells, interleukin-4, interleukin-5, and interleukin-13, contribute to airway inflammation in both allergic rhinitis and asthma. Persistent inflammation may eventually lead to bronchial hyperresponsiveness and structural airway remodeling if left untreated (Bousquet et al., 2020).

Bronchodilator reversibility testing was performed in patients with abnormal spirometry. A proportion of patients demonstrated significant reversibility, indicating reversible lower airway obstruction despite the absence of a clinical diagnosis of asthma. Similar observations have been reported in previous studies, suggesting that bronchial hyperresponsiveness may precede clinically evident asthma and can be detected through pulmonary function testing (Pellegrino et al., 2005). Early identification of these patients allows timely intervention and may reduce progression to chronic airway disease.

Following standard ARIA-based treatment, significant improvement was observed in all spirometric parameters. Improvement in FVC, FEV_1, FEV_1/FVC ratio, and FEF25–75% indicates that effective treatment of upper airway inflammation has a beneficial effect on lower airway function. These findings support the united airway concept and are in agreement with studies by Ciprandi et al. (2011), who demonstrated improved pulmonary function following intranasal corticosteroid therapy and antihistamine treatment.

Assessment of quality of life using the Mini Rhinoconjunctivitis Quality of Life Questionnaire (Mini-RQLQ) also revealed significant improvement following treatment. Patients reported reduced nasal symptoms, fewer practical limitations, improved daily activities, and better overall well-being. Allergic rhinitis has a considerable impact on sleep quality, work productivity, and psychological health; therefore, improvement in quality-of-life scores highlights the importance of early diagnosis and appropriate management. Similar improvements have been reported by Juniper et al. (2000), who validated the Mini-RQLQ as a reliable instrument for assessing treatment outcomes in allergic rhinitis.

The findings of the present study reinforce the importance of spirometry as an adjunctive investigation in patients with allergic rhinitis. Although spirometry is routinely recommended for patients with suspected asthma, it is not commonly performed in patients presenting solely with allergic rhinitis. The present study demonstrates that pulmonary function abnormalities may be detected even in asymptomatic individuals without clinical evidence of asthma. Routine spirometric evaluation may therefore facilitate early identification of lower airway involvement and prompt initiation of appropriate therapy.

CONCLUSION

The present study demonstrated that pulmonary function abnormalities are frequently present in non-asthmatic patients with allergic rhinitis, supporting the concept of the united airway disease. Baseline spirometry revealed significant reductions in pulmonary function parameters, including Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), FEV_1/FVC ratio, and Forced Expiratory Flow between 25% and 75% of expiration (FEF25–75%), despite the absence of clinically diagnosed bronchial asthma.

The study further established that standard ARIA-based management of allergic rhinitis resulted in significant improvement in pulmonary function as well as health-related quality of life. Improvement in spirometric parameters following treatment suggests that effective control of upper airway inflammation positively influences lower airway function. These findings reinforce the concept that allergic rhinitis should be regarded as a systemic airway disease rather than an isolated nasal disorder.

Routine spirometric evaluation in patients with allergic rhinitis may facilitate early identification of subclinical bronchial involvement, allowing timely intervention before progression to clinically overt asthma. Therefore, spirometry should be considered an important adjunctive investigation, particularly in patients with persistent or moderate-to-severe allergic rhinitis.

Early diagnosis, appropriate pharmacological management, patient education, and regular follow-up are essential for improving respiratory outcomes and overall quality of life in patients with allergic rhinitis.

LIMITATIONS OF THE STUDY

The study was conducted at a single tertiary care institution, limiting the generalizability of the findings. The follow-up duration was relatively short and therefore could not assess long-term progression to bronchial asthma. Immunological markers such as serum IgE levels, blood eosinophil count, skin prick testing, or fractional exhaled nitric oxide (FeNO) were not evaluated. Environmental allergen exposure and seasonal variation were not analysed separately. Pulmonary function was assessed only using spirometry without advanced pulmonary function tests.

DECLARATIONS

Ethical Approval

The study was approved by the Institutional Ethics Committee of Sri Venkateshwaraa Medical College Hospital and Research Centre, Puducherry, prior to commencement of the study. Written informed consent was obtained from all participants before enrolment.

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Conflict of interest:

The authors declare that there is no conflict of interest regarding the publication of this study.

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