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Original Research Article

Comparison of Pulmonary Function Tests and Hematological Parameters between Patients of Allergic Rhinitis and Healthy Adolescents

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Abstract:

Background: Allergic rhinitis is an IgE-mediated inflammatory disorder of the nasal mucosa, but increasing evidence supports lower airway and systemic inflammatory involvement. Adolescence is a relevant period for identifying early functional changes before clinically overt asthma develops.

Objective: To compare pulmonary function tests and selected hematological/immunological parameters between adolescents with allergic rhinitis and healthy adolescents.

Methods: This observational comparative cross-sectional study included 30 adolescents with allergic rhinitis and 30 age-matched healthy controls aged 10-18 years. Spirometry was performed using a computerized spirometer, and FEV1, FVC, FEV1/FVC ratio, PEFR and FEF25-75% were recorded. Hemoglobin, total leukocyte count, platelet count, eosinophil percentage, absolute eosinophil count, neutrophil-lymphocyte ratio, platelet-lymphocyte ratio and serum IgE were assessed. Between-group comparisons were performed and $p < 0.05$ was considered statistically significant.

Results: Cases and controls were matched for age, sex, weight, height and BMI. FEV1, FVC, FEV1/FVC ratio and FEF25-75% were significantly lower in allergic rhinitis cases than healthy controls, while PEFR did not differ significantly. TLC, platelet count, eosinophil percentage, AEC, NLR, PLR and serum IgE were significantly higher in cases, whereas hemoglobin was comparable.

Conclusion: Adolescents with allergic rhinitis showed evidence of subclinical lower airway impairment along with systemic inflammatory activation. Routine physiological and hematological assessment may help in early identification of adolescents at risk of progression along the allergic airway disease spectrum.

Keywords: Allergic rhinitis; Adolescents; Spirometry; FEF25-75%; Eosinophils; Serum IgE; Neutrophil-lymphocyte ratio; Absoute eosinophil count, Platelet-lymphocyte ratio.

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Introduction

Allergic rhinitis is a chronic IgE-mediated inflammatory disorder characterized by sneezing, rhinorrhoea, nasal obstruction and nasal itching. Although it primarily presents with upper airway symptoms, it is now recognized as part of a systemic allergic airway disease rather than a purely localized nasal condition. [1,2]

The unified airway concept emphasizes anatomical and immunological continuity between the upper and lower respiratory tract. Allergic inflammation in the nasal mucosa may influence bronchial function through systemic inflammatory mediators, neural reflexes and direct airway interaction. Therefore, adolescents with allergic rhinitis may demonstrate lower airway changes even without a formal diagnosis of asthma. [3-6]

Pulmonary function tests are non-invasive tools for detecting airflow limitation. Parameters such as FEV1, FVC, FEV1/FVC ratio, PEFR and FEF25-75% provide information on large and small airway function. FEF25-75 is particularly relevant because small airway dysfunction may precede conventional spirometry abnormalities. [7-10]

Allergic rhinitis is also associated with systemic inflammatory and immunological changes. Eosinophils, total IgE, total leukocyte count, platelet count and derived ratios such as NLR and PLR may reflect the inflammatory burden. The present study compared pulmonary function and selected hematological markers between adolescents with allergic rhinitis and healthy controls. [11-18]

Materials and Methods

Study design and setting: This was an observational, comparative cross-sectional study conducted in the Upgraded Department of Physiology and the Allergy Clinic of Sawai Man Singh Hospital/SMS Medical College, Jaipur. [1,2]

Study participants: The study included 30 adolescents diagnosed with allergic rhinitis and 30 healthy adolescents aged 10-18 years. Cases were recruited from the allergy clinic, while healthy controls were selected from staff families of SMS Medical College. Written informed consent from parents/guardians and assent from adolescents were obtained. The study was conducted after obtaining institutional Ethical and Scientific committee clearance.

Eligibility criteria: Cases were adolescents already diagnosed with allergic rhinitis and cooperative for spirometry. Controls were healthy adolescents without allergic rhinitis or respiratory disease. Subjects with acute or chronic systemic illnesses, smoking/tobacco exposure, alcohol use or intake of medicines affecting pulmonary function or hematological parameters were excluded.

Pulmonary function testing: Spirometry was performed using a computerized Helios 401 spirometer with Spiro Excel software. Height and weight were entered for predicted values. After demonstration and practice, at least three acceptable and reproducible maneuvers were recorded in the sitting position with a nose clip; the best technically acceptable reading was used for analysis.9,10

Hematological and immunological assessment: Venous blood samples were collected under aseptic precautions. Complete blood count was used to derive hemoglobin, TLC, platelet count, eosinophil percentage and AEC. NLR and PLR were calculated from differential leukocyte and platelet counts. Total serum IgE was estimated by an immunoassay-based method in the central laboratory.

Statistical analysis: Data were entered in Microsoft Excel and analyzed using SPSS version 27.0. Continuous variables were expressed as mean ± SD. Independent group comparisons were performed using unpaired Student's t-test, while categorical variables were compared using Pearson chi-square test. A p value <0.05 was considered statistically significant.

Results

Table 1: Baseline characteristics of study participants

Variable	Cases (n=30)	Controls (n=30)	p value
Age (years)	16.03 ± 1.68	16.57 ± 0.78	0.11
Female/Male	17/13	11/19	0.196
Weight (kg)	49.75 ± 8.15	52.20 ± 3.26	0.132
Height (cm)	150.50 ± 7.92	152.73 ± 2.99	0.174
BMI (kg/m²)	21.92 ± 3.45	22.49 ± 1.27	0.403

The two groups were comparable with respect to age, sex and anthropometric variables, reducing the likelihood of demographic and body-size related confounding effects.

Table 2: Comparison of pulmonary function parameters between cases and controls

Parameter	Cases (n=30)	Controls (n=30)	p value
FEV_1 (L)	2.41 ± 0.32	2.93 ± 0.93	0.003
FVC (L)	2.90 ± 0.34	3.43 ± 0.98	0.005
FEV_1/FVC (%)	83.64 ± 6.12	92.64 ± 6.45	<0.001
PEFR (L/min)	350.7 ± 61.09	375.9 ± 115.80	0.310
FEF25-75% (L/s)	2.76 ± 0.58	3.98 ± 1.31	<0.001

FEV1, FVC, FEV1/FVC ratio and FEF25-75% were significantly lower among allergic rhinitis cases than controls. PEFR was lower in cases but the difference was not statistically significant.

Table 3: Comparison of hematological and immunological parameters between cases and controls

Parameter	Cases (n=30)	Controls (n=30)	p value
Hemoglobin (g/dL)	13.37 ± 1.01	13.83 ± 1.32	0.130
TLC (/µL)	8469 ± 1656	6448 ± 1507	<0.001
Platelets (×10³/µL)	308.71 ± 23.41	281.97 ± 39.78	0.003
Eosinophils (%)	8.29 ± 1.74	2.94 ± 1.21	<0.001
AEC (cells/µL)	722.94 ± 252.63	205.89 ± 92.47	<0.001
NLR	1.69 ± 0.39	1.48 ± 0.25	0.016
PLR	115.13 ± 39.6	95.03 ± 20.8	0.01
Serum IgE (IU/mL)	635.52 ± 342.91	129.93 ± 43.08	<0.001

TLC, platelet count, eosinophil percentage, AEC, NLR, PLR and serum IgE were significantly elevated in allergic rhinitis cases. Hemoglobin levels were not significantly different between groups.

Discussion

The present study demonstrates that adolescents with allergic rhinitis have significantly reduced pulmonary function tests parameters along with increased systemic inflammatory and atopic markers. The groups were comparable for age, sex and anthropometric parameters; therefore, the observed differences are more likely related to allergic rhinitis and associated airway inflammation.

The significant reduction in FEV1, FVC, FEV1/FVC ratio and FEF25-75% suggests functional lower airway involvement in allergic rhinitis. The reduction in FEF25-75 is physiologically important because this parameter reflects mid-expiratory flow and is considered sensitive to small airway dysfunction. The absence of a significant PEFR difference indicates that large airway or effort-dependent peak flow may remain preserved despite small airway impairment. [5-10]

These findings are consistent with the unified airway concept, in which upper and lower airway disease share inflammatory mechanisms. Allergic inflammation may extend beyond the nasal mucosa through circulating mediators, eosinophilic activation and bronchial hyperresponsiveness. Thus, spirometric evaluation in allergic rhinitis may identify subclinical involvement before overt asthma becomes clinically apparent. [3-6]

The hematological findings support systemic inflammatory activation. Allergic rhinitis cases showed significantly higher TLC, platelet count, eosinophil percentage and AEC. Eosinophils are central effector cells in type I hypersensitivity and contribute to epithelial injury, cytokine release and airway hyperresponsiveness. Elevated serum IgE further confirms the atopic and IgE-mediated nature of disease in the case group. [11-18]

NLR and PLR were also significantly higher among cases, suggesting that these hematological ratios may provide low-cost indicators of systemic inflammatory status. However, these indices should be interpreted as supportive markers rather than stand-alone diagnostic tests. [12-16]

Overall, the findings support comprehensive assessment of allergic rhinitis in adolescents. A combined evaluation of spirometry and hematological markers may provide better insight into lower airway and inflammatory involvement than symptom assessment alone.

Conclusion

Adolescents with allergic rhinitis showed significantly reduced FEV1, FVC, FEV1/FVC and FEF25-75% values, along with significantly increased TLC, platelet count, eosinophil percentage, AEC, NLR, PLR and serum IgE compared with healthy controls. These findings suggest that allergic rhinitis in adolescents is associated with subclinical lower airway impairment and systemic inflammatory activation.

Limitations

The sample size was modest and derived from a single tertiary care setting.

The cross-sectional design does not establish longitudinal progression to asthma.

Bronchial provocation testing and post-bronchodilator reversibility assessment were not included.

Allergen-specific IgE was not evaluated.

Declarations

Ethics approval: The study was conducted after approval from the Institutional Research Review Board and Institutional Ethics Committee, SMS Medical College, Jaipur. IEC approval number and date should be inserted before submission.

Consent to participate: Written informed consent was obtained from parents/guardians, and assent was obtained from adolescent participants.

Funding: No external funding was received for this study.

Conflict of interest: The authors declare no conflict of interest.

Data availability: Data are available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

Author contributions: Dr. Manindra Singh: concept execution, data collection, analysis, manuscript drafting. **Dr. Kapil Gupta:** supervision, conceptual guidance, critical revision. **Dr. Manoj Kumar Gupta**: helped in devising research protocol and statistical analysis of data. All authors approved the final manuscript draft.

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