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Original Research Article

Pediatric asthma and eosinophilia: insights from nasal and blood smear analyses

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ABSTRACT

Background: Allergic respiratory maladies, particularly pediatric asthma, pose substantial challenges in public health. This cross-sectional investigation endeavours to unravel the eosinophilic landscape within nasal cytological specimens and peripheral blood samples of pediatric asthma cohorts, with a keen focus on discerning the correlation between nasal and systemic eosinophilia.
Methods: Sixty-six pediatric asthma subjects, aged 6 to 18, under the care of Cheluvamba hospital in Mysuru, were meticulously recruited over an extensive 18-month period.
Results: Analysis unveiled a conspicuous preponderance of male participants, with a mean age range spanning 9 to 13 years. Intriguingly, the presence of allergic rhinitis (AR) exhibited no discernible statistically significant nexus with either asthma severity or eosinophilic markers. Noteworthy findings include peripheral eosinophilia detected in 56% of subjects, juxtaposed against nasal eosinophilia observed in 20%; however, no statistically meaningful correlation emerged between nasal and peripheral eosinophilia.
Conclusions: The inquiry culminated in a robust affirmation that mean nasal eosinophil count and blood absolute eosinophil count (AEC) exhibit a salient association with asthma severity and control in pediatric cohorts, irrespective of AR presence. Particularly, a discernible augmentation in mean AEC and nasal eosinophil count was discerned concomitant with exacerbating asthma severity and in cases of partial/ uncontrolled asthma.

Keywords: Pediatric asthma, AR, Eosinophilia, Nasal cytological analysis, Hematological assessment, Asthma severity, Pediatric respiratory diseases

INTRODUCTION

Asthma, according to the 2022 guidelines from the global initiative for asthma (GINA), is characterized by a history of respiratory symptoms influenced by various factors such as allergen exposure, physical activity, irritants, weather changes, and viral respiratory infections.[1] In India, where an estimated 35 million individuals among a population of 1.36 billion contend with asthma, the condition represents a significant public health challenge.[2] Immune responses triggered by common airway irritants like aeroallergens, tobacco smoke, pollutants, or respiratory viruses can precipitate prolonged airway inflammation and disrupt healing processes in susceptible individuals, particularly impacting lung development and differentiation.[1]

The understanding of the upper and lower respiratory passages as forming a unified airway continuum has evolved notably in recent years, spurred by initiatives like the AR and its impact on asthma (ARIA) world health organization workshop.[3,5] Despite conventional clinical practice of treating nose and lungs as separate entities, significant anatomical and histological similarities exist between upper and lower respiratory tracts, including shared features like basement membrane, lamina propria, ciliary epithelium, glands, and goblet cells.[6,7]

Research, exemplified by the national institutes of health-sponsored severe asthma research program (SARP), has examined eosinophilic and other cellular markers in relation to asthma outcomes. Individuals exhibiting significant sputum eosinophilia, often alongside sputum neutrophilia, tend to experience more severe asthma, necessitating heightened medication use, systemic corticosteroid interventions, and hospitalizations.[8,9] Diminished eosinophil levels in blood and sputum are associated with fewer exacerbations and reduced healthcare utilization for asthma.[10,11] However, the labour-intensive and non-routine nature of induced sputum collection and measurement poses challenges in clinical practice. Therefore, this study aims to explore the correlation between nasal and blood eosinophilia and asthma severity and control.

METHODS

This cross-sectional study spanned 18 months from May 2021 to November 2023 and was conducted at Cheluvamba hospital in Mysore, affiliated with the Mysore medical college and research institute. Ethical clearance was obtained from institutional ethics committee. A minimum sample size of 66 asthmatic children was determined based on an estimated prevalence rate of 4.5% among children attending the hospital, with a significance level of 0.05. Purposive sampling was employed to select participants meeting specific criteria. Inclusion criteria comprised children aged 6 to 18 diagnosed with asthma as per the GINA guidelines 2020.[12] Exclusion criteria encompassed children using nasal steroid spray, with a history of parasitic infestation, recent oral steroid use, coexisting conditions (e.g., deviated nasal septum, chronic sinusitis), or medication history predisposing to eosinophilia. Asthma severity was stratified into four grades: mild persistent, moderate persistent, severe persistent, and intermittent, while AR classification followed the ARIA guidelines.[5] Statistical analyses utilized SPSS 22 and Microsoft excel, incorporating correlation and regression analyses to elucidate the relationship between nasal and blood eosinophilia and assess the impact of independent variables on the dependent variable.

RESULTS

The investigation revealed a conspicuous male preponderance, comprising 76% of the cohort, while the remaining 24% constituted female participants, thus underscoring a palpable gender asymmetry skewed towards males. Within the cohort of 66 subjects, 19% were classified as underweight, 33% as overweight, and a mere 1.5% as obese based on their BMI categorization. A detailed distribution of subjects according to their BMI classification is delineated in Table 1. Notably, the highest mean value of 1.64 was recorded for the blood eosinophil percentage on the differential count, highlighting a significant proportion of eosinophils in the blood. Additionally, the highest standard deviation of 0.554 was observed for the steroid dose variable, suggesting considerable variability in the doses administered among the subjects.

Table 1: Distribution study on different variables.

Variables	Variables sub group	N	Percentage (%)	Mean	Standard deviation
Age (in years)	6-11	33	50	1.5	0.504
	12-18	33	50		
Gender	Female	16	24	1.76	0.432
	Male	50	76		
BMI (kg/m^2)	Underweight	51	77	1.24	0.466
	Normal	14	21		
	Overweight	1	1		
Family history of atopy	No	41	62	1.38	0.489
	Yes	25	38		
Steroid dose	Low	41	62	1.41	0.554
	Medium	23	35		
	High	2	3		
Blood eosinophil percentage on differential count	<5%	24	36	1.64	0.485
	>5%	42	64		
Nasal eosinophil	≤10	53	80	1.2	0.401
	>10	13	20		
Blood AEC	≤440	28	43	1.58	0.498
	>440	38	58		

Table 2: Comparison of severity of AR with control of asthma.

Severity of AR asthma control	Asthma control			Total	Chi-square value	P value
	Well controlled	Partly controlled	Uncontrolled			
No AR	14	14	2	30	21.333	0.006
Mild intermittent AR	13	7	1	21		
Mild persistent AR	2	2	4	8		
Moderate to severe intermittent AR	1	4	0	5		
Moderate to severe persistent AR	0	2	0	2		
Total	30	29	7	66		

Table 2 delineates the comparative analysis between the severity of AR and the control of asthma within the cohort of study participants. AR severity was stratified into two categories: mild AR and moderate to severe AR. Among the 29 children classified with mild AR, 15 (52%) demonstrated well-controlled asthma, while 14 (48%) exhibited asthma categorized as not well-controlled. In contrast, among the 7 children diagnosed with moderate to severe AR, merely 1 (14.4%) achieved well-controlled asthma status, with the remaining 6 children (86.6%) displaying asthma categorized as not well-controlled. The derived chi-square value of 21.33 underscored the intensity of this comparison. Despite these observations, a statistically significant association between the severity of AR and the control of asthma among the study participants was not established (p=0.006).

Within the cohort of sixty-six asthmatic children, twenty-eight manifested blood eosinophilia without nasal eosinophilia, three exhibited nasal eosinophilia without blood eosinophilia, and twenty-five presented neither nasal nor peripheral eosinophilia. Noteworthy is the observation that the correlation between nasal and blood eosinophilia failed to attain statistical significance. Furthermore, among asthmatic children, both mean AEC and mean Nasal Smear Eosinophil (NSE) values exhibited a notable escalation in tandem with increasing asthma severity and the level of asthma control (p<0.05).

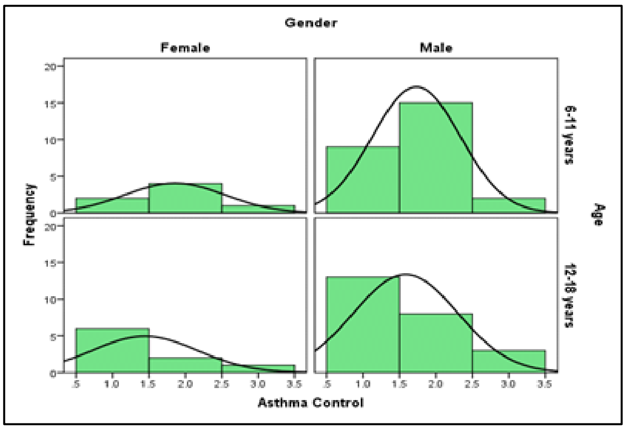

Figure 1: Asthma control versus gender and age.

Upon scrutinizing the data, a notable trend emerges: asthma control appears to be more effective among male subjects compared to females, as visually evident from the graph.

The investigation encompassed an array of factors as independent variables, including blood AEC, gender, BMI, family history of atopy, nasal eosinophil count, age, steroid dose, and blood eosinophil percentage on differential count. Notably, the analysis reveals a coefficient of determination (R square) of 0.514 for asthma control, suggesting that these independent variables collectively account for 51.4% of the variability observed in asthma control. The regression equation for asthma control provides insight into the relationship between these independent variables and asthma control: Y (Asthma control)=-0.727 + 0.052 (Age) + 0.086 (Gender) + 0.091 (BMI)-0.24 (Family history of atopy) + 0.372 (Steroid Dose) + 0.044 (Blood eosinophil) + 0.524 (Nasal Eosinophil). The F value obtained is 2.608, with a significance value of 0.000, indicating a statistically significant relationship between the independent variables and asthma control.

Similarly, for the severity of asthma, the coefficient of determination (R square) is 0.735, indicating that the independent variables collectively explain 73.5% of the variability observed in asthma severity. The regression equation for asthma severity is provided as Y (Asthma severity)=-0.322-0.036 (Age) + 0.106 (Gender)-0.091 (BMI) + 0.104 (Family history of atopy) + 0.587 (Steroid dose)-0.113 (Blood eosinophil) + 0.470 (Nasal eosinophil) + 0.572 (Blood absolute eosinophil). The F value obtained is 2.444, with a significance value of 0.024, indicating a statistically significant relationship between the independent variables and asthma severity.

For the severity of AR, the coefficient of determination (R square) is 0.505, suggesting that the independent variables collectively explain 50.5% of the variability observed in AR severity. The regression equation for AR severity is provided as Y (Asthma control)=0.185 + 0.611 (Age)-0.368 (Gender)-0.337 (BMI) + 0.517 (Family history of atopy) + 0.519 (Steroid dose) + 0.170 (Blood eosinophil)-0.011 (Nasal eosinophil) + 0.103 (Blood absolute eosinophil).

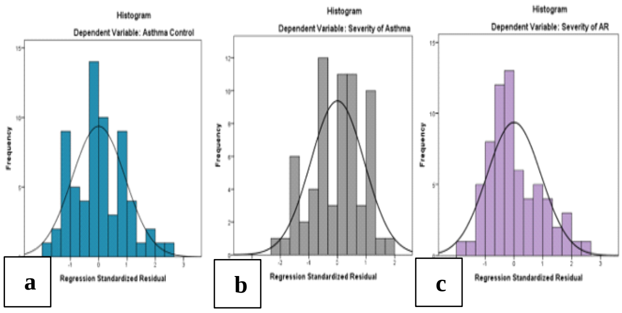

Figure 2 (a-c): Histogram for asthma control, severity of asthma, severity of AR.

DISCUSSION

Based on the results obtained from our study, several key findings emerge regarding the distribution of different variables among pediatric asthma patients and their implications for disease severity and control.

Our study confirms a notable male predominance in pediatric asthma incidence, consistent with established gender disparities observed in previous investigations and supported by existing literature.[13] Interestingly, this trend undergoes a transition in adulthood, with females demonstrating a higher prevalence, a phenomenon attributed to anatomical variances such as narrower airways in boys under ten, resulting in increased airway reactivity.[14,15] Our study cohort had a mean age of 11.35 (±3.12) years, mirroring age distribution trends seen in comparable studies, with 28.8%, 51.5%, and 19.7% falling within the 5-9 years, 10-14 years, and 15-18 years age brackets, respectively. These demographics are consistent with previous research, including studies by Devi et al and Kansal et al.[16,17] Notably, a significant portion of the children were categorized as overweight, indicating potential associations between BMI and asthma outcomes as supported by previous studies.[18]

Across various studies, the prevalence of nasal eosinophilia exhibited a wide range, spanning from 20 to 80%.[19-21] In our investigation, 20% of participants demonstrated nasal eosinophilia, a proportion consistent with findings observed by Choi et al and Crobach et al.[20,21] The investigation unveils a noteworthy disparity in mean AEC values between asthmatic children and their healthy counterparts, a discrepancy that holds statistical significance and echoes findings from earlier studies.[22,23] Noteworthy are findings from Nadif et al who noted a heightened risk of frequent asthmatic attacks among individuals with a blood eosinophil count surpassing 250 cells/mm^3.[24] Similarly, Mubarak et al observed a correlation between a blood eosinophil count exceeding 300 and recurrent asthma exacerbations in 32-40% of patients.[25]

Additionally, it identifies a positive blood eosinophil count in 56.9% of asthmatic children, aligning with previous research. Intriguingly, the study discerns heightened eosinophilia in severe asthma and poorly controlled asthma. However, contrary to expectations, the presence of AR did not significantly contribute to elevated eosinophil levels, challenging conventional associations between AR and asthma severity.

Moreover, the regression analyses elucidated significant relationships between various independent variables and asthma control, severity, and AR severity. Factors such as age, gender, BMI, family history of atopy, steroid dose, and eosinophil counts demonstrated notable impacts on asthma outcomes, underscoring the multifactorial nature of the disease.

Limitations

The present study is not a case control study as it is difficult to obtain controls for nasal smear study.

CONCLUSION

Our study underscores a robust correlation between mean nasal eosinophil count and blood AEC values with asthma severity and control in pediatric patients. Notably, as asthma severity escalated and in cases of partially or uncontrolled asthma, both mean AEC and mean nasal eosinophil count exhibited significant increases. These findings offer crucial insights into the distribution of variables among pediatric asthma patients and their implications for disease management. They emphasize the need for tailored, personalized approaches to asthma management based on individual patient characteristics. Further research is imperative to fully elucidate the underlying mechanisms driving these associations and to refine asthma management strategies accordingly.

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