

Characteristics of Patients with Severe Uncontrolled Asthma in Saudi Arabia: A Cross-Sectional Study

Riyad O Al-Lehebi^{1,2}, Rana A Saleh³, Abdalla M Alasiri⁴, Bader J Alghamdi^{5,6},
Hajer Y Almudaiheem^{7,8}, Ahmed H Al-jedai^{8,9}, Eid A Almutairi³, Haifa Aldakhil¹⁰,
Khaulah A Alokili⁷, Fahad Zuriqan⁷, Adeeb A Bulkhi¹¹

¹Pulmonary Department, King Fahad Medical City, Riyadh, Saudi Arabia; ²Internal Medicine Department, College of Medicine, Alfaisal University, Riyadh, Saudi Arabia; ³Lung Health Centre Department, Organ Transplant Centre of Excellence, King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia; ⁴Pulmonary Department, Aseer Central Hospital, Abha, Saudi Arabia; ⁵College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia; ⁶Pulmonary Department, King Abdulaziz Medical City, National Guard Ministry, Jeddah, Saudi Arabia; ⁷Drug Policy and Regulations Unit, Ministry of Health, Riyadh, Saudi Arabia; ⁸The Saudi Society of Clinical Pharmacy, Riyadh, Saudi Arabia; ⁹Colleges of Medicine and Pharmacy, Alfaisal University, Riyadh, Saudi Arabia; ¹⁰Biostatistics, Epidemiology and Scientific Computing Department, King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia; ¹¹Internal Medicine Department, College of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia

Correspondence: Adeeb A Bulkhi, Internal Medicine Department, College of Medicine, Umm Al-Qura University, 3135 Abdulaziz Kurdi St, Makkah, 24372, Saudi Arabia, Tel +966554533650, Email aabulkhi@uqu.edu.sa

Background: Severe asthma poses significant morbidity and healthcare burden, with the eosinophilic phenotype being particularly prevalent. This study aims to characterize the demographic and clinical profiles of severe eosinophilic asthma patients in a Saudi Arabian cohort involving multiple centers in the country.

Methods: A cross-sectional analysis of a prospective cohort of 268 patients with severe eosinophilic asthma, eligible for benralizumab treatment, was analyzed from the Saudi Arabian Ministry of Health database. Demographic data, biomarker profiles, and historic disease and medication burden were examined and stratified by various parameters including city/region, eosinophil count, and type 2 inflammatory comorbidities.

Results: Patients were predominantly female (66.4%), with an average age of 45.3 years, and had a median BMI of 27.7 kg/m². The majority were never smokers, and about one-third had type 2 inflammatory comorbidities. High exacerbation rates (median of 5 exacerbations per year) and frequent healthcare utilization were noted despite high-dose inhaled corticosteroid/long-acting beta-agonist (ICS/LABA) treatment. Nearly 20% of patients were on maintenance oral corticosteroids. The median blood eosinophil count was 656 cells/ μ L, indicating a high prevalence of severe eosinophilic asthma (defined as a blood eosinophil count $\geq$ 150 cells/ μ L).

Conclusion: This study confirms the substantial burden of severe eosinophilic asthma in the Saudi population, with significant exacerbation rates and healthcare resource use despite conventional therapy. The data suggest a potential role for benralizumab in improving disease outcomes for severe eosinophilic asthma. Further research is needed to evaluate the efficacy and cost-effectiveness of benralizumab in these patients.

Keywords: severe asthma, eosinophilic asthma, benralizumab, Saudi Arabia, asthma exacerbations, biological therapy, healthcare utilization

Introduction

Asthma is a common respiratory disease characterized by airway inflammation and expiratory airflow limitation that leads to debilitating symptoms of wheeze, cough, shortness of breath, and chest pain.¹ An estimated 262 million people suffer from asthma worldwide.² A recent multi-regional survey of Saudi adults in 2019 reported a prevalence of self-reported current wheeze of 14.2%.³ Several Saudi Arabian studies suggested a rise in asthma prevalence that has

plateaued since 2010–2016.^{4,5} Although asthma-related mortality has decreased over time, disability due to asthma has seen little change in the last 25 years.⁶

Severe asthma is defined per ATS/ERS guidelines⁷ as “asthma which requires treatment with high-dose inhaled corticosteroids (ICS) and with a second controller (and/or systemic corticosteroids) to prevent it from becoming uncontrolled or which remains uncontrolled despite this therapy”. International figures report the prevalence of severe asthma as 3–10% of individuals with asthma.^{7,8} On the other hand, a study in Saudi Arabia reported that 38.1% of patients experienced severe asthma symptoms.³ This subtype of asthma is associated with increased mortality, worse quality of life and increased health care costs.⁹ The eosinophilic asthma phenotype is one of the most common subtypes of severe asthma accounting for more than half of all asthmatics even in the primary health care setting.¹⁰ This number is similar in Saudi Arabia as shown in one cross-sectional study.¹¹

The Saudi Arabian Ministry of Health (MOH) provides free healthcare coverage to all Saudi Arabia citizens that extends to biological therapies for severe asthma according to predefined criteria. Current 2025 Global Initiative for Asthma (GINA) guidelines emphasize the importance of phenotyping severe asthma to guide add-on biologic therapies.¹ Benralizumab, an anti-IL-5R antibody, was added to the MOH’s formulary in 2019. Incorporating a value-based approach, the MOH has established a prospective database to monitor the efficacy and cost-effectiveness of benralizumab within the Saudi governmental health system. Currently, 22 tertiary centers across 18 regions participate in this database, reporting the baseline and follow-up data of patients eligible for benralizumab as a prerequisite for state provision of treatment. Without a confirmation of eosinophil counts, a standard definition of eosinophilic asthma remains elusive; however, clinical trials and practice guidelines frequently utilize peripheral blood eosinophil counts of ≥ 150 cells/ μ L, ≥ 300 cells/ μ L, or ≥ 400 cells/ μ L to define the eosinophilic phenotype.

We herein describe a nationally representative cohort of patients with severe eosinophilic asthma eligible for treatment with benralizumab with aim to describe this group’s demographic characteristics, biomarker profiles, and historic disease and medication burden.

Materials and Methods

We describe a cross-sectional analysis of a prospective cohort of adult patients referred from 22 designated severe asthma centers in MOH hospitals eligible for benralizumab between 2019–2024. Inclusion criteria comprised adult patients diagnosed with severe uncontrolled asthma per ATS/ERS guidelines, demonstrating an eosinophilic phenotype, and meeting local MOH eligibility criteria for benralizumab, which includes a history of 2 or more exacerbations despite high-dose ICS/LABA therapy and elevated peripheral blood eosinophils. Pulmonologists initiated the referrals. We examined all patients referred for treatment with benralizumab for the first time, including those who had been receiving other biological therapies at the time of referral. The study received ethical approval from Ministry of Health Institutional Research Board.

The study variables were extracted from the MOH monitoring registry. All physician referrals for benralizumab mandate completion of a standardized form that captures demographic variables, biomarker measurements, current medication, and asthma outcomes such as asthma exacerbations, hospitalizations, emergency visits and asthma control history in the year prior to referral (reported by recall).

The baseline characteristics of the registry patients were summarized using descriptive statistics. Categorical variables were presented as counts and percentages. Continuous variables were assessed for normality using Shapiro–Wilk test. Normally distributed variables were presented as means and standard deviations, while non-normally distributed variables were presented as medians and interquartile ranges. The distribution of severe asthma cases across different regions in Saudi Arabia was visualized using a heatmap. Additionally, the distribution of blood eosinophil counts across different regions was displayed in a strip chart.

Negative binomial regression was used to assess the association between blood eosinophil levels and exacerbation frequency in patients with severe asthma. Two models were employed: Model 1: examined the unadjusted association between different eosinophil cutoffs and exacerbation count. The cutoffs used were 150, 200, 300, 400, 500 and 1000 cells/ μ L to reflect standard clinical trial thresholds and examine extreme eosinophilia phenotypes. Model 2: examined the unadjusted association between categorical eosinophil levels (using less than 150 cells/ μ L as the reference group) and

exacerbation count. Confounding variables for the sensitivity analysis were carefully selected based on clinical relevance, previous literature, and their known impact on asthma outcomes (eg., age, BMI, smoking status, and comorbidities). In both models, the dependent variable was the number of exacerbations each patient experienced. The independent variable was either the eosinophil cutoff category (Model 1) or the categorical eosinophil levels (Model 2). Two sensitivity analysis were done to examine the adjusted association between different eosinophil cutoffs and exacerbation count using different confounders. All statistical analyses were performed using R version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at a p-value of < 0.05.

Results

The severe asthma cohort included 268 enrolled patients at the time of reporting. The majority of cases originated from Makkah (35.45%), Asir (23.88%), and the Eastern Region (18.66%). Figure 1 shows a heat map of the cases by regions in Saudi Arabia. Table 1 shows the baseline characteristics of the patients in the cohort. Most patients were females (66.4%) with a mean age of 45.3 ± 12.4 years and a median BMI of 27.7 kg/m². The vast majority of patients were never smokers (91%), and only three patients (1.1%) were current smokers. The median age of asthma diagnosis was 30 years, with an interquartile range (IQR) between 20 and 36 years, indicating adult-onset asthma for all patients. Nearly half of the patients (46.6%) reported a family history of asthma, and approximately 33% of them presented with type 2 inflammatory comorbidities, specifically allergic rhinitis (16.4%), nasal polyps (14.9%) and chronic rhinosinusitis (8.2%), noting that while nasal polyps and chronic rhinosinusitis frequently indicate type 2 inflammation in this specific phenotype, they may not exclusively reflect a type 2 endotype in all populations. Regarding asthma outcomes, almost all

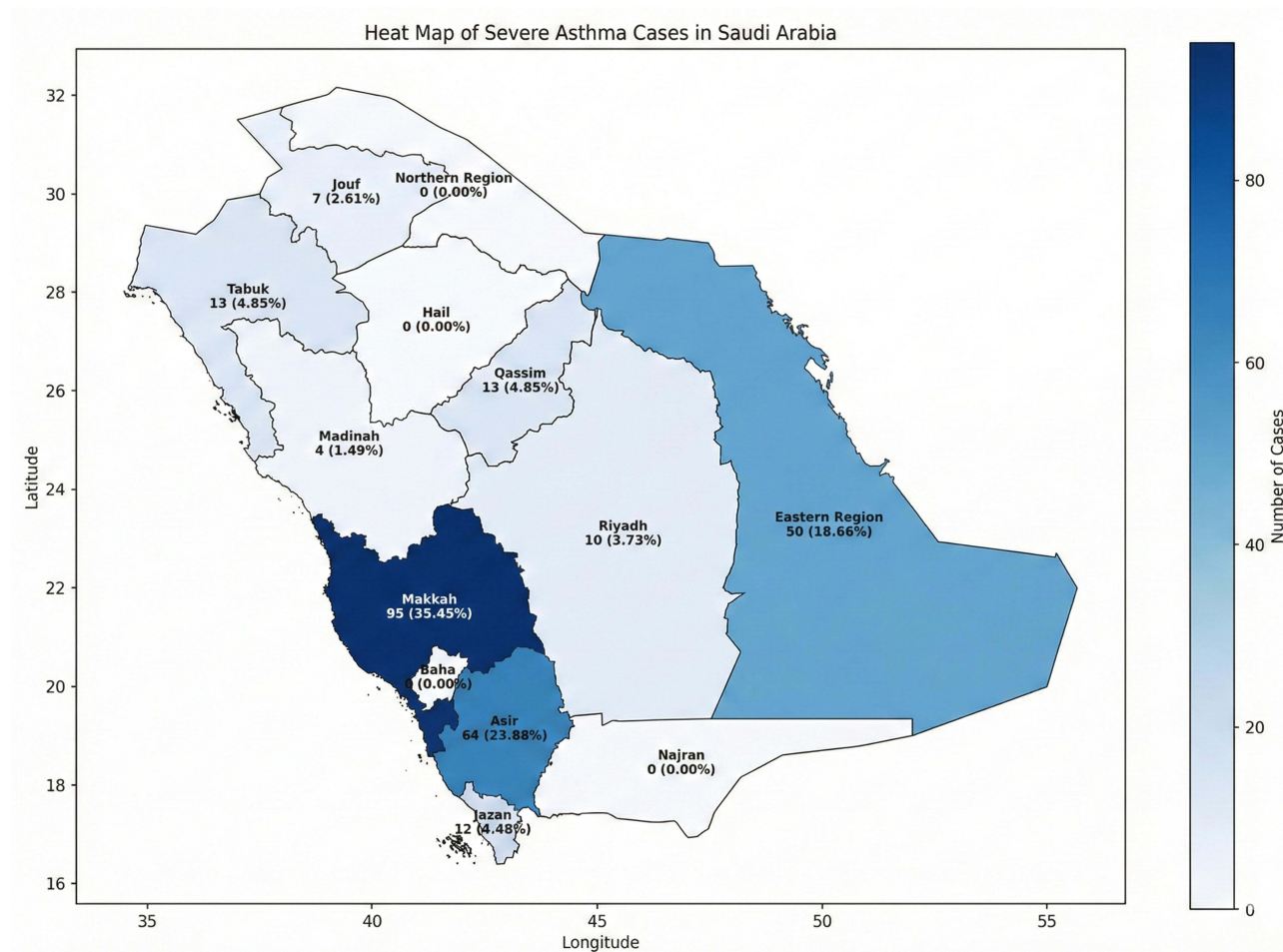


Figure 1 Heat map showing the geographic distribution of severe eosinophilic asthma cases across regions in Saudi Arabia.

Table 1 Baseline Characteristics of Patients in the Severe Asthma Registry

Characteristics	Total (N=268)
Age, mean $\pm$ SD	45.29 $\pm$ 12.36
BMI*, median (IQR)	27.7 (25.1–31.2)
Gender, n (%)	
Male	90 (33.58%)
Female	178 (66.42%)
Age at diagnosis *, median (IQR)	30.0 (20.0–36.0)
Smoking status*, n (%)	
Never	244 (91.04%)
Current	3 (1.12%)
Former	11 (4.10%)
Family history of Asthma*, n (%)	
Yes	125 (46.64%)
No	91 (33.96%)
Type 2 comorbidities	
Presence of type 2 comorbidities*, n (%)	
Yes	89 (33.21%)
No	160 (59.70%)
Type 2 comorbidities count*, median (IQR)	0.00 (0.00–1.00)
Allergic Rhinitis*, n (%)	44 (16.42%)
Nasal Polyps*, n (%)	40 (14.93%)
Chronic Rhinosinusitis*, n (%)	22 (8.21%)
Eczema*, n (%)	1 (0.37%)
Atopic Disease*, n (%)	4 (1.49%)
Asthma Medications	
High dose ICS/LABA, n (%)	268 (100%)
LAMA, n (%)	173 (64.6%)
Daily OCS, n (%)	51 (19%)
Dose of daily OCS (mg), mean (SD)	19.7 $\pm$ 13.2
Median (IQR)	20 (5–40)
Days on steroids, mean (SD)	342.6 $\pm$ 445.4
Median (IQR)	155 (1–1806)
Switched from other biologics, n (%)	80 (29.9%)
Mepolizumab, n (%)	9 (11.25%)
Dupilumab, n (%)	21 (25.25%)
Omalizumab, n (%)	50 (62.5%)
Asthma Outcomes	
Exacerbations, n (%)	
Yes	241 (89.93%)
No	27 (10.07%)
Exacerbations count ^a , median (IQR)	5.0 (3.0–6.0)
≥ 1 exacerbations ^a , n (%)	241 (100.00%)
≥ 2 exacerbations ^a , n (%)	203 (84.23%)
≥ 3 exacerbations ^a , n (%)	203 (84.23%)
≥ 4 exacerbations ^a , n (%)	175 (72.61%)
≥ 5 exacerbations ^a , n (%)	137 (56.85%)
Hospitalization count ^a , median (IQR)	1.0 (0.0–2.0)
ER visit count ^a , median (IQR)	3.0 (1.0–5.0)
Short courses of steroids ^a , median (IQR)	4.0 (2.0–5.0)

(Continued)

Table 1 (Continued).

Characteristics	Total (N=268)
Asthma biomarkers	
Actual FEV1 [L]*, median (IQR)	1.75 (1.25–2.31)
% on Predicted FEV1 [%]*, median (IQR)	66.67 (50.00–81.84)
Patients with FEV1 $\geq$ 70%, n (%)	98 (44.3%)
Patients with FEV1 50–70%, n (%)	78 (35%)
Patients with FEV1 <50%, n (%)	45 (20.3%)
Actual FVC [L]*, median (IQR)	2.58 (1.90–3.27)
% on Predicted FVC [%]*, median (IQR)	80.17 (67.46–95.80)
FEV1/FVC ratio*, median (IQR)	0.86 (0.72–0.96)
Peak flow [L/min]*, median (IQR)	4.73 (2.12–11.48)
Blood eosinophil count [cells/ μ L]*, median (IQR)	656.00 (402.75–1000.00)
Eosinophil < 150, n (%)	25 (9.33%)
Eosinophil 150–299, n (%)	16 (5.97%)
Eosinophils 300–449, n (%)	27 (10.07%)
Eosinophils $\geq$ 450, n (%)	174 (64.93%)
Serum IgE level [UI/mL]*, median (IQR)	238.50 (87.50–529.50)
FeNO [ppb]*, median (IQR)	15.50 (0.00–31.75)

Notes: *Missing data, ^a Among individuals with comorbidities.

patients experienced at least one exacerbation in the 12 months preceding registry enrollment, with over half of the patients (56%) reporting at least five exacerbations annually. Patients made a median of 3 (range 1–5) visits to the emergency department, had a median of 1 hospitalization, and received a median of 4 short courses of steroids in the year prior to registry enrollment.

A total of 51 patients (19%) were on daily maintenance oral steroids, with a mean dose of 19.7 mg. They had been on daily steroids for an average of 342 days (median 155 days) before enrollment. Nearly all patients were on high-dose inhaled corticosteroids with long-acting beta agonist (LABA). Approximately 64.4% of patients were on daily long-acting muscarinic antagonists (LAMA). Almost 30% of patients had been receiving other biological therapies, including omalizumab (50 patients), dupilumab (21 patients), and mepolizumab (9 patients).

The average FEV1 was 2.8 liters (66.7% predicted). The median blood eosinophil count was 656 cells/ μ L, with most patients (64.9%) exhibiting a blood eosinophil count of 450 cells/ μ L or higher. A significant majority of the patient cohort (90%) exhibited eosinophilic asthma, defined by a blood eosinophil count greater than or equal to 150 cells/ μ L. [Figure 2](#) displays the distribution of blood eosinophil counts across different regions in the country. The median IgE count was 238 UI/mL.

Using a negative regression binomial model, when compared to patients with an eosinophil count of less than 300 cells/ μ L, those with higher blood eosinophil counts exhibited a higher rate ratio of asthma exacerbation at 1.3 (95% CI 1.06, 1.61) as shown in [Figure 3](#). Moreover, a separate negative binomial regression model compared the association between categorical eosinophil levels and exacerbation rate. While higher eosinophil groups (eg., above 300 cells/ μ L) demonstrated a positive association with a higher exacerbation rate compared to the reference group (less than 150 cells/ μ L), the 150–299 group displayed a different pattern, likely reflecting a distinct intermediate inflammatory phenotype or the effects of prior steroid therapies suppressing eosinophil counts. However, none of them reached statistical significance, as demonstrated in [Table 2](#). These associations remained consistent in sensitivity analyses using an adjusted Negative Binomial Regression Model, as demonstrated in [Table 3](#) and [Figure 4](#).

Discussion

This cross-sectional study comprehensively examines the characteristics and asthma-related outcomes of 268 individuals with severe asthma. It provides valuable insights into the demographic features, comorbidities, exacerbation frequency,

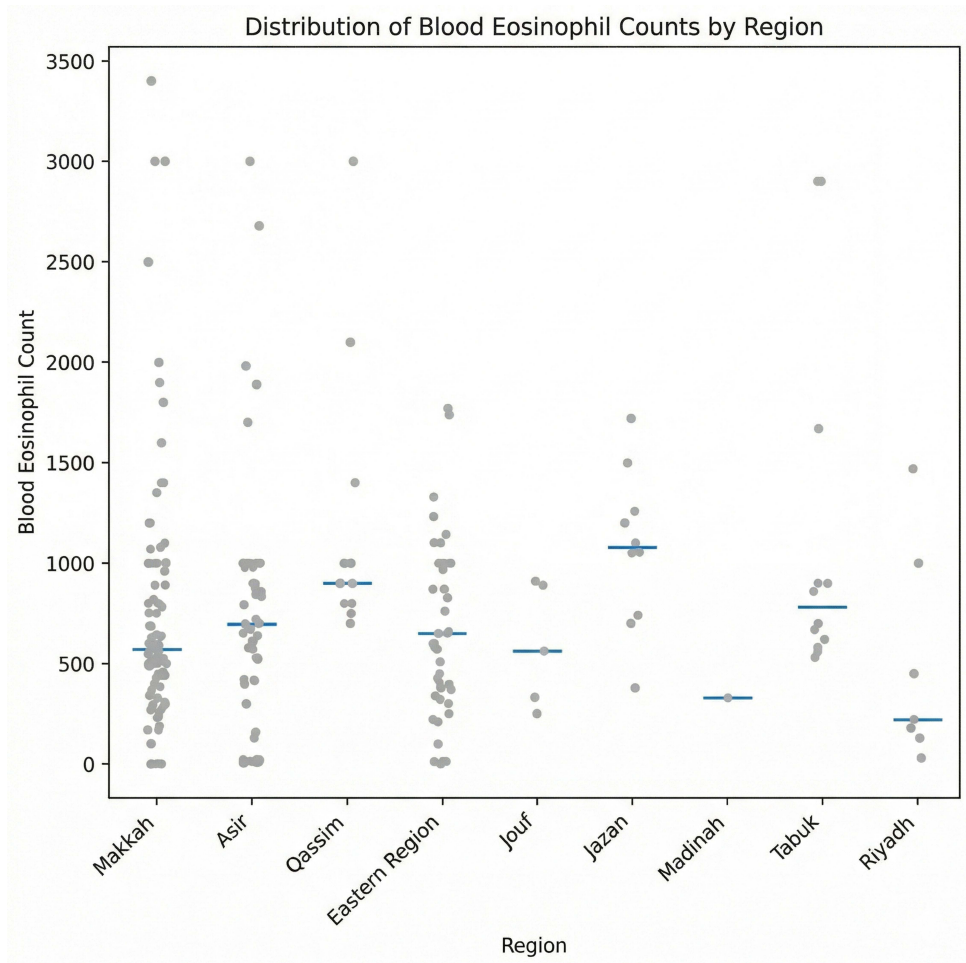


Figure 2 Distribution of blood eosinophil counts across different regions in Saudi Arabia.

Unadjusted rate ratio for asthma exacerbations (N=242)

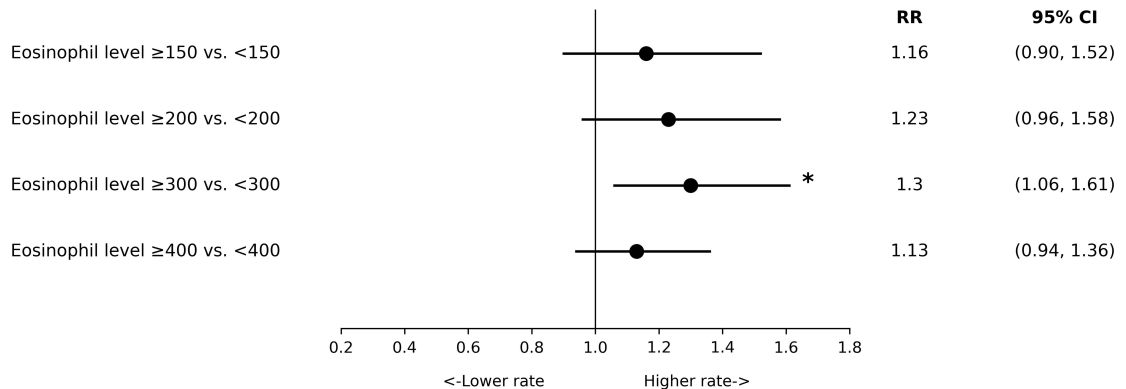


Figure 3 Unadjusted negative binomial regression model illustrating the association between different eosinophil cutoffs and exacerbation counts.

and biomarkers associated with eosinophilic asthma in patients recruited from a wide geographic range across Saudi Arabia.

All patients met the ATS/ERS criteria for severe uncontrolled asthma,⁷ distinguished by high exacerbation rates and poor symptom control despite being on high doses of ICS/LABA. Patients’ characteristics aligned with the anticipated

Table 2 Unadjusted Negative Binomial Regression Model: Associations Between Eosinophil Levels and Exacerbation Count

(N=242)	Rate Ratio (95% CI)	P-value
Eosinophil<150	Reference	
Eosinophil 150–<300	0.80 (0.53–1.21)	0.29
Eosinophils 300–<500	1.30 (0.93–1.81)	0.11
Eosinophils 500–<1000	1.11 (0.85–1.46)	0.42
Eosinophils≥1000	1.27 (0.96–1.68)	0.08

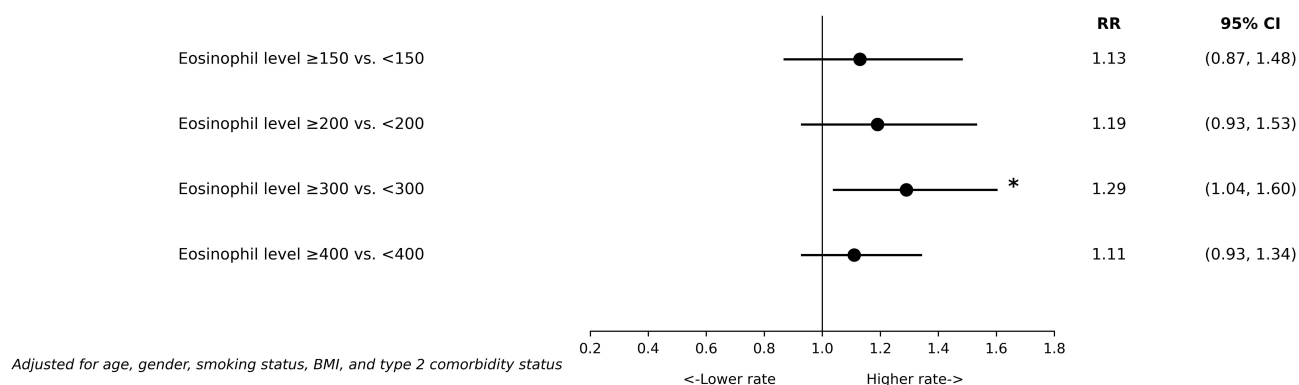
Table 3 Adjusted Negative Binomial Regression Model: Associations Between Eosinophil Levels and Exacerbation Count

(N=239)	Rate Ratio (95% CI)	P-value
Eosinophil<150	Reference	-
Eosinophil 150–299	0.80 (0.53–1.21)	0.292
Eosinophil 300–449	1.28 (0.92–1.79)	0.147
Eosinophil 450–999	1.10 (0.84–1.45)	0.496
Eosinophil≥1000	1.24 (0.94–1.65)	0.134
Age	1.00 (0.99–1.01)	0.891
Male (vs. Female)	1.01 (0.86–1.20)	0.894
Former smoker (vs. Never)	0.80 (0.52–1.22)	0.296
Current smoker (vs. Never)	0.76 (0.35–1.66)	0.492
BMI	1.00 (0.99–1.00)	0.756
Type 2 comorbidity (vs. No)	0.91 (0.77–1.07)	0.244

profile for eosinophilic asthma, typically characterized by adult-onset disease, frequent exacerbations, prominent fixed airflow obstruction, and common associations with nasal polyposis and chronic rhinosinusitis. Patients were mostly females, with adult-onset disease, not responding to high doses of ICS plus controller therapy, had a higher exacerbation rate. More than half of the patients had moderate to severe obstruction on spirometry.

One-third of our cohort had type 2 inflammatory comorbidities, particularly nasal polyps, and chronic rhinosinusitis, which are typically associated with worse asthma outcomes, as shown by Scelo and others.¹² Furthermore, it is important to acknowledge that the reporting of these historical comorbidities and exacerbations was obtained by patient recall,

Adjusted rate ratio for asthma exacerbations (N=242)

**Figure 4** Adjusted negative binomial regression model illustrating the association between eosinophil levels and exacerbation counts after adjusting for confounders.

introducing a potential source of recall bias. On the other hand, since this cohort enrolled patients who are candidates for biological therapies, these comorbidities are associated with better biological response and even clinical remission.¹³

Despite being treated with high-dose ICS/LABA, the disease burden remains substantial within this cohort, with a notable median exacerbation rate of five per year. In a separate cohort from Saudi Arabia examining both mild and severe asthmatics, Aljahdali et al documented an average exacerbation rate of 2.3 (3.7) annually despite 95% of their cohort being on medium-high fixed doses of ICS/LABA.¹⁴ Additionally, their findings revealed that 62.3% of the cohort experienced at least one severe exacerbation. This is in contrast with data from other Gulf Cooperation Council (GCC) countries, which reported that 49% of patients had experienced an exacerbation, with an overall annual exacerbation rate of only 0.9.¹⁵ This could be related to the fact that our cohort are patients who are referred to start Benralizumab and by default these patients are severe uncontrolled asthmatics.

Our study revealed that a significant proportion of patients (19%) were taking daily oral corticosteroids, with an average dose of 19.7 mg for approximately 342 days. Daily oral corticosteroid usage is prevalent in approximately 20% to 60% of severe asthmatics worldwide.¹⁶ The cumulative burden of oral corticosteroids is associated with adverse effects, including hypertension, diabetes, cataract, osteoporosis, and depression.¹⁷ In patients on daily oral steroids, we anticipate that starting benralizumab will result in significant improvement in their asthma outcomes, including a reduction in annual exacerbation rate and daily oral corticosteroids, and improvement in asthma symptoms as shown in both randomized controlled trials¹⁸ and real-world studies.¹⁹ At the time of this cross-sectional analysis, patients were eligible for, but not yet evaluated for the outcomes of, benralizumab treatment.

Serum eosinophil counts exceeded 150 cells/ μ L in over 90% of the cohort, confirming the predominance of eosinophilic asthma, which is congruent with the baseline characteristics described earlier. When applying the International Severe Asthma Registry Eosinophil Phenotype Algorithm,¹⁰ our cohorts showed that 77.9%, 10.4%, and 8.7% of patients were most likely (grade 3), likely (grade 2), and less likely (grade 1) to have eosinophilic asthma, respectively, and only 3% had noneosinophilic asthma. As shown by Kerkhof and others,¹⁰ patients with higher grade eosinophilic asthma are more likely to have difficult-to-control asthma require more healthcare resources use, and experience more asthma exacerbations. In our study, patients with higher eosinophil counts had a higher chance of exacerbation rates, especially when the blood eosinophil count was 300 cells/ μ L or higher. However, it is vital to note that prior treatments, including maintenance oral corticosteroids and other biologic therapies utilized by nearly 30% of our cohort, may confound the observed baseline association between eosinophil counts and exacerbation frequency by artificially suppressing peripheral eosinophilia.

The limitations of this study include potential selection bias, as the cohort consists of patients evaluated for benralizumab therapy who are presumably more likely to be eosinophilic. Medication history and asthma-related outcomes were reported by recall, which is a further source of bias. Nonetheless, the data still provide valuable insights into the burden of severe asthma, particularly regarding the most frequent phenotype, eosinophilic asthma.

Conclusion

In summary, this cohort study confirmed the heavy burden of severe, predominantly eosinophilic asthma among patients with uncontrolled asthma in Saudi Arabia. Despite high-dose treatment, exacerbations are frequent, and a significant proportion of patients depend on long-term oral corticosteroids, indicating the need for more effective management strategies. In daily clinical practice, these findings support a shift toward earlier phenotyping; specifically, clinicians should prioritize blood eosinophil screening in uncontrolled asthmatics to identify those with counts ≥ 300 cells/ μ L. Swiftly transitioning these high-risk patients to steroid-sparing biological therapies, such as benralizumab, is critical to mitigating the demonstrated high burden of systemic steroid toxicity and recurrent exacerbations in this population.

Data Sharing Statement

De-identified participant data (with data dictionary) underlying this article are available from the corresponding author upon reasonable request, subject to a data-sharing agreement and approval by the relevant ethics committee/IRB. Analysis code and materials will be shared on request.

Ethical Approval and Informed Consent

The study protocol was approved by the Ministry of Health Institutional Review Board on Jan 2025. All participants provided written informed consent prior to inclusion in the registry. The study was conducted in accordance with the principles of the Declaration of Helsinki. Patient confidentiality was maintained by using anonymized data.

Acknowledgment

The authors would like to thank the Research Center at King Fahd Medical City, Riyadh, for their valuable support of this study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

No grants, industry support, or in-kind external funding were received for this work.

Disclosure

The authors declare that they have no conflicts of interest related to this work.

References

- GINA. Global Strategy for Asthma Management and Prevention; 2025 [updated October 2025]. Available from: www.ginasthma.org. Accessed March 20, 2026.
- Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1204–1222.
- Alomary SA, Al Madani AJ, Althagafi WA, et al. Prevalence of asthma symptoms and associated risk factors among adults in Saudi Arabia: a national survey from Global Asthma Network Phase I. *World Allergy Organ J*. 2022;15(1):100623. doi:10.1016/j.waojou.2021.100623
- Frayh ASA. A 17 year trend for the prevalence of asthma and allergic diseases among children in Saudi Arabia. *J Allergy Clin Immunol*. 2005;115(2):S232. doi:10.1016/j.jaci.2004.12.938
- Mohamed Hussain S, Ayesha Farhana S, Mohammed Alnasser S. Time trends and regional variation in prevalence of asthma and associated factors in Saudi Arabia: a systematic review and meta-analysis. *Biomed Res Int*. 2018;2018:8102527. doi:10.1155/2018/8102527
- Mattiuzzi C, Lippi G. Worldwide asthma epidemiology: insights from the Global Health Data Exchange database. *Int Forum Allergy Rhinol*. 2020;10(1):75–80. doi:10.1002/alr.22464
- Chung KF, Wenzel SE, Brozek JL, et al. International ERS/ATS guidelines on definition, evaluation and treatment of severe asthma. *Eur Respir J*. 2014;43(2):343–373. doi:10.1183/09031936.00202013
- Hekking PW, Wener RR, Amelink M, Zwinderman AH, Bouvy ML, Bel EH. The prevalence of severe refractory asthma. *J Allergy Clin Immunol*. 2015;135(4):896–902. doi:10.1016/j.jaci.2014.08.042
- Dragonieri S, Carpagnano GE. Biological therapy for severe asthma. *Asthma Res Pract*. 2021;7(1):12. doi:10.1186/s40733-021-00078-w
- Kerkhof M, Tran TN, Allehebi R, et al. Asthma phenotyping in primary care: applying the International Severe Asthma Registry eosinophil phenotype algorithm across all asthma severities. *J Allergy Clin Immunol Pract*. 2021;9(12):4353–4370. doi:10.1016/j.jaip.2021.07.056
- Al-Jahdali H, Wali S, Albanna AS, et al. Prevalence of eosinophilic, atopic, and overlap phenotypes among patients with severe asthma in Saudi Arabia: a cross-sectional study. *BMC Pulm Med*. 2022;22(1):67. doi:10.1186/s12890-022-01856-9
- Scelo G, Torres-Duque CA, Maspero J, et al. Analysis of comorbidities and multimorbidity in adult patients in the International Severe Asthma Registry. *Ann Allergy Asthma Immunol*. 2024;132(1):42–53. doi:10.1016/j.anai.2023.08.021
- Wechsler ME, Scelo G, Larenas-Linnemann DES, et al. Association between T2-related comorbidities and effectiveness of biologics in severe asthma. *Am J Respir Crit Care Med*. 2024;209(3):262–272. doi:10.1164/rccm.202305-0808OC
- Al-Jahdali H, Wali S, Albanna AS, et al. Overprescription of short-acting beta(2)-agonists among patients with asthma in Saudi Arabia: results from the SABINA III cohort study. *Clin Respir J*. 2022;16(12):812–825. doi:10.1111/crj.13553
- Alzaabi A, Al Busaidi N, Pradhan R, et al. Over-prescription of short-acting beta(2)-agonists and asthma management in the Gulf region: a multicountry observational study. *Asthma Res Pract*. 2022;8(1):3. doi:10.1186/s40733-022-00085-5
- Wang E, Wechsler ME, Tran TN, et al. Characterization of severe asthma worldwide: data from the International Severe Asthma Registry. *Chest*. 2020;157(4):790–804. doi:10.1016/j.chest.2019.10.053
- Lefebvre P, Duh MS, Lafeuille MH, et al. Acute and chronic systemic corticosteroid-related complications in patients with severe asthma. *J Allergy Clin Immunol*. 2015;136(6):1488–1495. doi:10.1016/j.jaci.2015.07.046

18. Nair P, Wenzel S, Rabe KF, et al. Oral glucocorticoid-sparing effect of benralizumab in severe asthma. *N Engl J Med*. 2017;376(25):2448–2458. doi:10.1056/NEJMoa1703501
19. Chen W, Tran TN, Sadatsafavi M, et al. Impact of initiating biologics in patients with severe asthma on long-term oral corticosteroids or frequent rescue steroids (GLITTER): data from the International Severe Asthma Registry. *J Allergy Clin Immunol Pract*. 2023;11(9):2732–2747. doi:10.1016/j.jaip.2023.05.044

Journal of Asthma and Allergy

Publish your work in this journal

The Journal of Asthma and Allergy is an international, peer-reviewed open-access journal publishing original research, reports, editorials and commentaries on the following topics: Asthma; Pulmonary physiology; Asthma related clinical health; Clinical immunology and the immunological basis of disease; Pharmacological interventions and new therapies. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/journal-of-asthma-and-allergy-journal>

Dovepress

Taylor & Francis Group