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Evaluation of Clinical Chemistry Biomarkers as Predictors of Asthma Severity

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Abstract

Background: To assess the clinical chemistry biomarkers linked to asthma severity and ascertain their potential utility in forecasting bronchial asthma patients' illness severity.

Materials and Methods: One hundred people with asthma diagnoses from doctors participated in a cross-sectional study. Standard clinical chemistry laboratory techniques were used to determine total IgE, C-reactive protein (CRP), and eosinophil count from blood samples. Additionally evaluated were pulmonary function tests, such as FEV1 and the FEV1/FVC ratio. Laboratory results were statistically compared after patients were divided into groups with mild, moderate, and severe asthma.

Results: The most common severity category was moderate asthma (47%), which was followed by mild asthma (36%) and severe asthma (17%). As asthma severity increased, laboratory analysis showed gradually higher mean serum total IgE and CRP values. As the severity of the disease worsened, FEV1 and the FEV1/FVC ratio decreased, indicating deteriorating pulmonary function. Severe asthma patients had an increasing trend in eosinophil levels, but there was no statistically significant difference between the severity categories.

Conclusions: Pulmonary function measures and clinical chemistry biomarkers, especially blood total IgE and CRP, are useful markers of the severity of asthma. Their combined evaluation could enhance the assessment of inflammatory activity, make it easier to classify diseases, and help asthma patients receive better clinical care.

تقييم المؤشرات الحيوية للكيمياء السريرية كمتنبئات لشدة الربو

حنين سعيد محسن

الخلاصة

المقدمة: تهدف هذه الدراسة إلى تقييم المؤشرات الحيوية الكيميائية السريرية المرتبطة بشدة الربو، وتحديد مدى فائدتها المحتملة في التنبؤ بشدة مرض الربو القصبي.

المواد وطرق العمل: شارك في هذه الدراسة المقطعية مئة شخص تم تشخيص إصابتهم بالربو من قبل أطباء. استُخدمت تقنيات المختبر الكيميائية السريرية القياسية لتحديد مستوى الغلوبولين المناعي E الكلي(IgE) ، والبروتين المتفاعل C (CRP)، وعدد الحمضات في عينات الدم. كما تم تقييم اختبارات وظائف الرئة، مثل حجم الزفير القسري في الثانية الأولى (FEV1) ونسبة .FEV1/FVC تمت مقارنة نتائج المختبر إحصائيًا بعد تقسيم المرضى إلى مجموعات حسب شدة الربو: خفيف، متوسط، وشديد.

النتائج: كانت فئة الربو الأكثر شيوعًا هي الربو المتوسط (47%)، تليها الربو الخفيف (36%) ثم الربو الشديد (17%). مع ازدياد شدة الربو، أظهر التحليل المختبري ارتفاعًا تدريجيًا في متوسط قيم الغلوبولين المناعي E الكلي (IgE) والبروتين المتفاعل C (CRP) في مصل الدم. ومع تفاقم شدة المرض، انخفض كل من حجم الزفير القسري في الثانية الأولى (FEV1) ونسبةFEV1/FVC ، مما يشير إلى تدهور وظائف الرئة .لوحظ ارتفاع في مستويات الحمضات لدى مرضى الربو الحاد، ولكن لم يكن هناك فرق ذو دلالة إحصائية بين فئات شدة المرض.

الخلاصة: تُعدّ قياسات وظائف الرئة والمؤشرات الحيوية الكيميائية السريرية، وخاصةً مستوى الغلوبولين المناعي E الكلي في الدم وبروتين سي التفاعلي، مؤشرات مفيدة لشدة الربو. ويمكن لتقييمها مجتمعةً أن يُحسّن من تقييم النشاط الالتهابي، ويُسهّل تصنيف الأمراض، ويُساعد مرضى الربو على تلقّي رعاية سريرية أفضل.

1. Introduction

Over 260 million people worldwide suffer from asthma, which is one of the most common chronic inflammatory airway illnesses and a significant global health burden. Chronic airway inflammation, reversible airflow restriction, bronchial hyperresponsiveness, and recurring respiratory symptoms are its defining characteristics. Biochemical and immunological biomarkers have become useful tools for illness phenotyping, prognosis, and therapy monitoring, even if clinical symptoms and spirometry are still the primary means of diagnosis (Sim et al., 2024). Instead of being a singular disease, asthma is now understood to be a diverse disorder. Inflammatory processes, disease severity, response to treatment and longterm prognosis vary greatly among patients. As a result, precision medicine—which combines test biomarkers with clinical data to categorize patients based on their inflammatory phenotype and direct customized treatment plans has become the new standard for managing asthma.(Sim et al., 2024). By evaluating circulating biomarkers that indicate immune activation and systemic inflammation, clinical chemistry labs are essential to the assessment of asthma. These laboratory indicators help physicians track disease activity, anticipate exacerbations, and assess treatment response by offering objective information beyond clinical symptoms alone. Because of this, biochemical testing is becoming a crucial part of a thorough evaluation of asthma(Fouka et al., 2022). Total immunoglobulin E Ig-E is still one of the most significant markers of allergic asthma among the often studied biomarkers. Mast cell activation and persistent airway inflammation are caused by elevated serum IgE, which is a sign of type 2 immune response activation and allergen sensitization. Higher IgE concentrations are now crucial when choosing patients for anti-IgE biological therapy since they are often linked to more severe asthma.(Lavere et al., 2025). Another clinically significant biomarker that is tested in clinical chemistry labs is C-reactive protein (CRP). Elevated CRP concentrations have been linked to poor asthma control, frequent exacerbations, and decreased lung function, despite the fact that CRP is a nonspecific acute-phase protein produced by the liver. CRP measurement offers more details about inflammatory burden, especially in individuals with moderate to severe asthma (Fonseca et al., 2019). It is generally acknowledged that the peripheral blood eosinophil count is a useful surrogate indicator of eosinophilic airway irritation. Type-2 asthma, increased disease activity, and better sensitivity to inhaled corticosteroids and biological treatments that target eosinophilic inflammation are all linked to elevated eosinophil levels. Eosinophil testing has become a crucial laboratory parameter in asthma phenotyping due to its regular availability and low cost.(Nizam et al., 2026). When determining the severity of asthma, pulmonary function evaluation is still essential. The FEV1/FVC ratio and forced expiratory volume in one second (FEV1) are objective physiological markers of airway blockage and disease development. Reduced values are typically associated with poor asthma management and worsening airflow restriction. Measurements of pulmonary function combined with biochemical indicators improve clinical decision-making and the overall assessment of disease severity(Sim et al., 2024). No single laboratory measure offers comprehensive diagnostic or prognostic information, even with the availability of many biomarkers. In comparison to assessing each measure separately, recent research has highlighted that combining serum IgE, blood eosinophils, inflammatory markers including CRP, and pulmonary function metrics offers greater predictive performance.

This integrated method facilitates more precise illness phenotyping and individualized treatment plans(He et al., 2024). Interest in finding new inflammatory biomarkers that can distinguish asthma subtypes and forecast treatment response has increased due to developments in molecular medicine and laboratory diagnostics. It is

anticipated that new biomarkers will enhance customized treatment selection and supplement traditional laboratory testing, particularly for individuals with severe or treatment-resistant asthma(He et al., 2024).

Thus, the current study sought to assess the association between asthma severity and commonly detected biochemical indicators, such as total serum IgE, C-reactive protein, peripheral blood eosinophil count, FEV1, and the FEV1/FVC ratio. By analyzing these laboratory parameters in relation to clinical severity and identifying their relevance as predictive biomarkers for illness evaluation, this study seeks to support the expanding importance of clinical chemistry in precision medicine for asthma management(He et al., 2024). The significance of integrating traditional biochemical indicators with immunological and physiological characteristics to enhance the precision of asthma severity evaluation has been brought to light by recent developments in clinical chemistry. Clinicians can identify patients at higher risk of exacerbations, differentiate between various inflammatory endotypes, and optimize tailored therapy interventions using multi-biomarker methods. When combined with pulmonary function testing, serum biomarkers have proven to be more predictive than depending just on(Lupu et al., 2023). Growing research suggests that systemic inflammatory mediators, in addition to conventional laboratory indicators, play a major role in airway remodeling and the gradual deterioration of lung function. Chronic inflammation causes structural alterations in the bronchial wall, such as subepithelial fibrosis, smooth muscle hypertrophy, and epithelial damage, all of which are linked to severe asthma and unfavorable clinical consequences. Therefore, early detection of inflammatory activity by laboratory biomarkers may enable prompt treatment intervention and slow the progression of long-term disease.(Holguin et al., 2021). Furthermore, laboratory biomarkers have become increasingly valuable for monitoring treatment efficacy during long-term asthma management. Serial measurements of serum IgE, blood eosinophils, and inflammatory markers provide objective evidence of disease control and therapeutic response, particularly in patients receiving biologic agents targeting type-2 inflammation. Continuous biochemical monitoring assists clinicians in modifying treatment plans according to changes in inflammatory status, thereby improving disease control and reducing healthcare burden(Menzies-Gow et al., 2020). The goal of the current study was to assess the clinical importance of a few biochemical and inflammatory biomarkers as indicators of the severity of asthma, such as total immunoglobulin E Ig-E , C-reactive protein (CRP), and eosinophil count. The study also aimed to determine how these biomarkers relate to pulmonary function metrics (FEV1 and FEV1/FVC ratio) and to evaluate their potential utility in enhancing the classification of illness severity and aiding in the therapeutic management of asthmatic patients.

2. Materials Subjects and Methods

2.1. Design of the Study

The purpose of this cross-sectional observational study was to assess the relationship between specific biochemical indicators and the severity of asthma in patients with bronchial asthma. The study looked into the possibility of using routinely measured laboratory biomarkers to support clinical assessment and forecast the severity of an illness. Study Population: One hundred patients with bronchial asthma who had been diagnosed by a doctor were included in the study. During the study period, participants were chosen from the outpatient internal medicine and respiratory clinics. Based on clinical symptoms and spirometry results, the diagnosis of asthma was made in accordance with the Global Initiative for Asthma (GINA) guidelines.

2.2. Inclusion Criteria

Adult patients who are at least eighteen years old. Diagnosis of bronchial asthma verified by a doctor. Stable clinical state when the blood sample was taken. The capacity and readiness to give informed consent.

2.3. Exclusion Standards

Individuals suffering from COPD, or chronic obstructive lung disease. Acute infection of the respiratory system During the preceding four weeks. Inflammatory or autoimmune diseases. Cancer. Being pregnant. Individuals undergoing systemic immunosuppressive treatment for conditions other than asthma.

2.4. Data Collection

Direct interviews and medical records were used to gather clinical and demographic data. Among the variables gathered were: Gender and Age, Status of smoking, Prior hospitalization for asthma, Nocturnal symptoms (night awakenings) frequency, Classification of asthma severity, based on GINA clinical criteria, patients were categorized as having mild, moderate, or severe asthma.

2.5. Blood Sample Collection

Each participant had about 5 milliliters of venous blood drawn under aseptic circumstances. To extract serum, samples were centrifuged for ten minutes at 3000 rpm after being allowed to clot. Serum samples were either examined right away or kept at -20°C until they were examined in a lab.

2.6. Measurements in the Lab

The biochemical markers listed below were measured: IgE (total immunoglobulin E). A commercially available ELISA kit was used to measure serum total IgE concentrations in accordance with the manufacturer's instructions. In the Clinical Chemistry Laboratory, all laboratory analyses were carried out using defined quality-control protocols.

Total Immunoglobulin E (IgE): Serum total immunoglobulin E (IgE) levels were measured using a commercially available enzyme-linked immunosorbent assay (ELISA) kit, following the manufacturer's protocol. Briefly, serum samples, calibration standards, and quality-control samples were added to antibody-coated microplate wells and incubated to allow IgE binding. After incubation, the wells were washed to remove unbound components, and an enzyme-conjugated anti-human IgE antibody was added. Following a second incubation and washing step, tetramethylbenzidine (TMB) substrate solution was added to initiate the colorimetric reaction. The reaction was terminated by adding the stop solution, and the absorbance was measured at 450 nm using a microplate reader. Serum IgE concentrations were determined from a standard calibration curve and expressed as international units per milliliter (IU/mL). All analyses were performed in accordance with the manufacturer's instructions and standard laboratory quality-control procedures.

2.7. C-Reactive Protein (CRP)

An automated clinical chemistry analyzer was used to measure serum CRP concentrations using an immunoturbidimetric technique. The results were given in mg/L. Eosinophil Count in Peripheral Blood

An automated hematology analyzer was used to perform a complete blood count, and the eosinophil count was expressed as cells/µL. Tests for Pulmonary Function the American Thoracic Society (ATS) recommendations were followed by trained people when doing spirometry.

The parameters listed below were noted: One-second forced expiratory volume (FEV1% anticipated)

FEV1/FVC ratio, for statistical analysis, the best value from each participant's minimum of three approved moves was selected, Evaluation of Asthma Severity, the severity of asthma was divided into: Moderate asthma
Asthma that is moderate, severe asthma, according to GINA guidelines, classification was based on lung, function measures, the frequency of symptoms, and the need for therapy.

2.8. Statistical Analysis

IBM SPSS Statistics version 26.0 was used to analyze the data. While categorical data were displayed as frequencies and percentages, continuous variables were portrayed as mean ± standard deviation (Mean ± SD). One-way Analysis of Variance (One-way ANOVA) was used to compare biomarker levels across the three asthma severity groups. Tukey's post hoc test was used for pairwise comparisons where significant differences were found. The Chi-square test was used to evaluate categorical variables; a P-value of less than 0.05 was deemed statistically significant.

2.9. Ethical Approval

The study protocol was reviewed and approved by the Research Ethics Committee of the College of Pharmacy, University of Kerbala, Karbala, Iraq. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment in the study. Participant confidentiality and privacy were strictly maintained throughout the study, and all collected data were anonymized and used solely for research purposes.

3. Results

Table1, Outlines the primary clinical traits of asthma sufferers. 54% of the participants had previously been hospitalized due to asthma. In terms of nocturnal symptoms, 30% reported problems regularly or every night, whereas 50% reported occasional night awakenings. Table2, demonstrates how the study participants' asthma severity is distributed. The most prevalent type of asthma was moderate (47%), followed by mild (36%) and severe (17%). Total IgE and CRP levels significantly increased with asthma severity ($P < 0.001$ for both). Although eosinophil counts were higher in patients with severe asthma, the difference was not statistically significant ($P = 0.073$). In contrast, pulmonary function declined significantly with increasing disease severity, as evidenced by progressive reductions in FEV_1 and the FEV_1/FVC ratio ($P < 0.001$ for both) Table3. The demographic characteristics of the participants. Females represented 62% of the study population, while 87% of participants were non-smokers as presented in Table4.

Table1: Clinical Profile of the Patients with Asthma

Clinical Feature	Category	Number (N)	Percentage (%)
History of asthma-related hospitalization	Yes	54	54%
	No	46	46%
Frequency of nocturnal symptoms (night awakening)	Never	20	20%
	Occasionally	50	50%
	Frequently	22	22%
	Every night	8	8%

Table2: Distribution of Asthma Severity Among the Studied Patients

Asthma Severity	Number (N)	Percentage (%)
Mild	36	36%
Moderate	47	47%
Severe	17	17%
Total	100	100%

Table 3: Levels of Biomarkers Across Different Asthma Severity Groups

Biomarker	Mild (Mean ± SD)	Moderate (Mean ± SD)	Severe (Mean ± SD)	P value
Total IgE (IU/mL)	158.6 ± 68.4	268.7 ± 96.3	403.2 ± 110.5	<0.001*
C-reactive Protein (mg/L)	3.20 ± 1.10	9.90 ± 2.60	17.40 ± 4.30	<0.001*
Eosinophil Count (cells/µL)	280 ± 190	420 ± 230	610 ± 280	0.073
FEV1 (%)	89.5 ± 14.2	72.1 ± 13.3	53.4 ± 12.6	<0.001*
FEV1/FVC Ratio	0.78 ± 0.07	0.70 ± 0.07	0.61 ± 0.06	<0.001*
Data are presented as mean ± standard deviation (SD). P values were obtained using one-way analysis of variance (ANOVA). $P < 0.05$ was considered statistically significant. Significant values are indicated by an asterisk ().*				

Table4: Demographic Characteristics of the Study Participants

Airable	Category	Number (N)	Percentage (%)
Sex	**Female**	62	62%
	Male	38	38%
Smoking Status	**Non-smoker**	87	87%
	Current smoker	13	13%

4. Discussion

The current investigation showed a strong correlation between biochemical indicators and the severity of asthma. As the severity of the disease increased, there were progressive increases in blood total IgE and CRP concentrations, while lung function indices (FEV_1 and FEV_1/FVC ratio) considerably decreased. These results provide credence to the idea that type-2 immune activation and chronic systemic inflammation play a significant role in the development of asthma and airway dysfunction (Talib & Shaheed, 2026). The stability and consistency of high sensitivity assays, as well as its crucial function as an IL6-driven acute-phase reactant, reinforce the pathobiological plausibility of hs-CRP as a risk marker. Causality is still unclear, though. Mendelian randomization experiments have shown conflicting results about the direct causative involvement of circulating

CRP in asthma severity or susceptibility, suggesting that hs-CRP is more likely a downstream integrator of inflammatory burden than a driver (Ko et al., 2016). Patients with severe asthma had considerably greater serum total IgE values than those with mild asthma. This finding aligns with the pathophysiology of allergic asthma, in which bronchial hyperresponsiveness and airway inflammation are triggered by IgE-mediated activation of mast cells and basophils. The current results support the clinical use of measuring IgE in identifying individuals who may benefit from targeted biological therapy and those who exhibit allergy symptoms (Asthma, 2025). As asthma severity rose, pulmonary function testing showed a gradual fall in FEV_1 and the FEV_1/FVC ratio. The biochemical indicators of inflammation and allergy activation found in this study closely match these physiological alterations.Compared to either method alone, the combination of spirometric measures with laboratory biomarkers offers a thorough assessment of disease activity and supports more accurate clinical classification(Gao et al., 2025). Eosinophil counts did not reach statistical significance, despite an increasing trend with disease severity. This finding could be explained by variations in corticosteroid exposure, biological variability, or the many inflammatory phenotypes of asthma. Therefore, rather than being used as a stand-alone signal, the eosinophil count should be interpreted in combination with other inflammatory indicators (D'Aiuto et al., 2025). Asthma treatments have traditionally focused on reducing airway inflammation, but there is growing recognition that structural airway remodeling plays a significant role in determining the etiology, severity, and course of the disease. The term "airway remodeling" describes structural alterations brought on by abnormal inflammatory and repair processes, which eventually result in permanent obstruction, recurrent inflammation, and damage to the airway epithelium. The thickening of the reticular basement membrane due to collagen deposition, hyperplasia of the airway smooth muscle (ASM), hyperplasia of goblet cells and mucus secretion, remodeling of the extracellular matrix, and angiogenesis are examples of hallmark pathological alterations. In addition to increasing symptom load, poor management, and an increased risk of exacerbation, these alterations may result in airway narrowing, permanent airflow limitation, rapid lung function decline, and resistance to bronchodilators and steroids (Quek et al., 2025). The results of this study highlight the importance of interpreting biochemical markers as part of an integrated laboratory profile rather than as separate entities. In clinical chemistry, a more thorough evaluation of asthma activity can be obtained by integrating serum total IgE, CRP, eosinophil count, and pulmonary function data rather than depending just on one laboratory parameter. Because asthma is a diverse inflammatory disease, each biomarker represents a distinct facet of the underlying pathophysiology. As a result, concurrent assessment of immunological and inflammatory biomarkers enhances illness phenotyping and helps predict disease progression and treatment response more accurately. In contemporary clinical chemistry labs, where several indicators are examined collectively to support evidence based clinical decision-making, this integrated laboratory approach is becoming more and more crucial (Yadav et al., 2025). Another significant finding is that lung function declined as asthma severity increased, demonstrating the intimate connection between physiological impairment and biochemical anomalies. Through epithelium destruction, subepithelial fibrosis, smooth muscle hypertrophy, and mucus hypersecretion, chronic airway inflammation encourages structural airway remodeling, all of which lead to irreversible airflow limitation in advanced disease. As a result, laboratory biomarkers are not only markers of inflammation but also serve as an indirect indicator of the degree of pathological alterations taking place in the respiratory system. Therefore, from a clinical chemistry standpoint, periodic evaluation of inflammatory biomarkers may help physicians identify individuals who are more likely to experience progressive airway remodeling before significant functional impairment becomes apparent (Sim et al., 2024). Clinical chemistry's

function in managing asthma has been significantly altered by the growing use of precision medicine. Biomarkers are increasingly used to identify particular inflammatory endotypes and to direct focused biological therapy instead of relying just on laboratory examinations for diagnosis. While eosinophil counts and other inflammatory biomarkers help identify individuals who might benefit from anti-IL-5 or anti-IL-4/IL-13 medications, serum IgE is still crucial for choosing anti-IgE therapy. As a result, clinical chemistry labs are essential to personalized medicine because they offer unbiased laboratory data to support treatment selection and monitoring (Lavere et al., 2025). The current results further imply that, despite its nonspecificity, CRP might be a valuable supplementary biomarker. While CRP is raised in many inflammatory conditions, prolonged elevations in asthmatic patients may be a sign of unchecked systemic inflammation, especially in cases of severe illness. In addition to improving laboratory interpretation, measuring CRP in conjunction with asthma specific biomarkers may help distinguish between stable and poorly managed illness. Additionally, repeated CRP readings during follow-up may offer important insights into the efficacy of treatment and the remission of inflammation. These findings support the growing significance of frequent biochemical testing in the long-term treatment of respiratory conditions (Lavere et al., 2025). Notwithstanding the noteworthy correlations found in this study, a number of restrictions should be taken into account. Age, smoking status, obesity, concurrent infections, corticosteroid medication, and environmental exposures can all affect biomarker concentrations. Furthermore, patients with various asthma phenotypes exhibit significant biological variability. As a result, laboratory results should always be evaluated in conjunction with pulmonary function testing and clinical evaluation. In order to enhance diagnosis accuracy and enable customized treatment approaches, future clinical chemistry research should examine novel biomarkers, such as cytokines, metabolomic profiles, proteomic signatures, and genetic markers (Hanania & Diamant, 2018).

Study Limitations

This study has several limitations. First, the cross-sectional design does not permit causal inferences regarding the relationships between the investigated biomarkers and asthma severity. Second, the study was conducted at a single center and included a relatively small sample, which may limit the generalizability of the findings to broader populations. Third, biomarker levels were measured at only one time point and may therefore not reflect changes in disease activity or treatment response over time. In addition, several potential confounding factors, including corticosteroid and other asthma medication use, environmental exposures, and comorbid conditions, were not assessed and may have influenced biomarker concentrations. Larger prospective, multicenter studies incorporating repeated biomarker measurements are therefore needed to confirm these findings and better define the clinical value of these biomarkers in asthma management.

Conclusions

The results of this study show that while pulmonary function measurements continue to be crucial indicators of the course of the disease, serum total IgE and CRP are useful biochemical markers linked to the severity of asthma. Combining spirometry evaluation with biochemical markers may enhance illness stratification and facilitate individualized therapeutic care. However, more extensive multicenter prospective studies are necessary to confirm these results and assess other indicators that could improve asthma precision therapy.The clinical results also showed that individuals with moderate and severe asthma were more likely to experience nocturnal symptoms and hospitalization linked to asthma. These findings imply that poor symptom management and higher healthcare utilization are caused by chronic airway inflammation. Thus, integrating clinical evaluation with test biomarkers may enhance the precision of classifying asthma severity and enable tailored patient care.

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