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Association of CBC Laboratory Parameters with Respiratory Infection in Asthmatic Children

Mustafa Qahtan Hashim Al-Moussawi[1], Sawsan M. Jabbar AL-Hasnawi[1 *], Ashwaq Ali Hussein Ammar[2]
[1]College of medicine, University of Kerbala, Karbala, Iraq
[2]Imam Al Hassan Al Mujtaba Teaching Hospital, Karbala, Iraq

***Corresponding Author:**
Sawsan Mohammed Jabbar: sawsan.m@uokerbala.edu.iq

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Abstract

Background: This study investigates the sociodemographic factors influencing the severity of asthma among patients attending a hospital outpatient clinic. Asthma, a chronic respiratory condition, affects individuals globally and has varying degrees of severity based on numerous factors.
Patients and methods: This cross-sectional study analyzed data from 100 patients, focusing on demographics, clinical characteristics, drug consumption, and bacterial culture
Results: The results revealed that 64% of patients had uncontrolled asthma, with a higher prevalence among females and older adults. Most patients reported experiencing asthma symptoms for over 5 years, with frequent exacerbations observed in those with a history of respiratory infections. Additionally, bacterial cultures indicated a significant association between respiratory infections and the severity of asthma.
Conclusion: Effective asthma management was found to be influenced by several factors, including patient education, treatment adherence, and socioeconomic conditions. This study highlights the importance of comprehensive care strategies tailored to individual patient needs to improve asthma control and reduce exacerbations.

العلاقة بين معايير تعداد الدم الكامل والعدوى التنفسية لدى الأطفال المصابين بالربو

مصطفى قحطان هاشم الموسوي، سوسن محمد جبار الحسناوي، اشواق علي حسين عمار

الخلاصة

المقدمة: التأثير على شدة الربو بين المرضى الذين يرتادون العيادات الخارجية في المستشفى. الربو، وهو حالة تنفسية مزمنة، يؤثر على الأفراد على مستوى العالم وله درجات متفاوتة من الشدة بناءً على عوامل عديدة.

المرضى وطرق العمل: قامت هذه الدراسة المقطعية بتحليل بيانات من 100 مريض، مع التركيز على التركيبة السكانية والخصائص السريرية واستهلاك الأدوية وزراعة البكتيريا.

النتائج: وكشفت النتائج أن 64% من المرضى يعانون من الربو غير المنضبط، مع انتشار أعلى بين الإناث وكبار السن. وأفاد معظم المرضى بمعاناتهم من أعراض الربو لأكثر من 5 سنوات، مع تفاقم الأعراض بشكل متكرر لدى أولئك الذين لديهم تاريخ من التهابات الجهاز التنفسي. بالإضافة إلى ذلك، أشارت الثقافات البكتيرية إلى وجود ارتباط كبير بين التهابات الجهاز التنفسي وشدة الربو.

الاستنتاج: وُجِد أن إدارة الربو الفعّالة تتأثر بعدة عوامل، بما في ذلك تثقيف المريض، والالتزام بالعلاج، والظروف الاجتماعية والاقتصادية. وتسلط هذه الدراسة الضوء على أهمية استراتيجيات الرعاية الشاملة المصممة خصيصًا لتلبية احتياجات المريض الفردية لتحسين السيطرة على الربو والحد من تفاقمه.

1. Introduction

Asthma is a chronic inflammatory disorder of the airways characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, the condition is particularly prevalent in children, posing significant challenges in terms of management and quality of life (Lötvall et al., 2011). One of the critical aspects of asthma management is understanding the various laboratory markers that can influence disease severity and control. Among these markers, the total Immunoglobulin E (t.IgE), lymphocytes, and eosinophils have been extensively studied for their roles in the pathophysiology of asthma (Carolan and Sutherland, 2013; "Clinical phenotypes of chronic obstructive pulmonary disease and asthma: Recent advances," 2013; Lötvall et al., 2011) Children with asthma have airways that are hyperreactive and more prone to inflammation and obstruction. When infected by viruses such as respiratory syncytial virus (RSV), rhinovirus, or influenza, these children experience a greater burden of illness compared to their non-asthmatic peers (Gern, 2019; Mthembu et al., 2021). Immunoglobulin E (IgE) is a type of antibody that plays a crucial role in the body's allergic response. Elevated levels of t.IgE are often associated with allergic asthma, and its measurement can provide insights into the severity and control of the disease (Gevaert et al., 2022). Lymphocytes, a subtype of white blood cells, are essential for the body's immune response, and their levels can indicate the state of immune activation in asthmatic patients. Eosinophils, another type of white blood cells, are involved in combating parasitic infections and play a significant role in allergic reactions and asthma (Valent et al., 2021, 2012). This study aims to explore the association of these laboratory markers with respiratory infections in asthmatic children. Specifically, we seek to examine the differences in these markers based on gender, age, and body mass index (BMI) categories. Additionally, we investigate the bacterial cultures obtained from these patients to understand the potential impact of bacterial infections on the laboratory parameters.

2. Material and Methods

The sample size was (100) participants as a group of patients with asthma. According to the patient's ability, sputum or cough swab samples were collected from each patient to bacterial culture. Also, 3 ml of whole blood was collected (2) ml in an EDTA tube to count the number of neutrophils, eosinophils, and lymphocytes, and 1ml of blood was placed in an gel tube to measure the total serum IgE. Samples were taken from both sexes (69) males and (31) females, aged between (5-16) years, at teaching children hospital in Karbala, And AI- Ammam AL-Hussein Medical City. from October (2023) to May (2024).

2.1. Sample Collection

2.1.1. Sputum was collected from a patient with exacerbation asthma, in the morning in a sterile container after rinsing the mouth of a patient with saline or water before expectoration with

attempts to minimize contamination by saliva, then the specimens were transported immediately to the laboratory.

2.1.2. Cough swab (oropharyngeal swab) (OP): For children cannot produce a sputum sample, a cough swab was used. It is a swab placed on a stick that is placed. For children who cannot cough on demand, rub the swab on the back of the throat. After gently opening the mouth (with the aid of a tongue depressor in uncooperative children), a cotton-tipped swab was passed to sample the posterior pharynx or induce a cough. Once the sample (sputum or cough swab) is collected, it is sent to the microbiology laboratory.

2.1.3. Blood sample: Approximately 3 ml of venous blood was drawn from each participant which was obtained by disinfecting the anticup puncture with 70% ethanol and then making a venous puncture via disposal syringes after applying a tourniquet. 2 ml of blood was dispensed into an EDTA tube (to perform a five-differentiated blood cell count). Also, 1 ml of blood was dispensed into a gel tube and left to clot, then the serum was separated by centrifugation at 3000 rpm for 15 minutes. The serum was then transferred to a new striated tube and stored in deep freeze (−20°C) for use in immunoassays. (total IgE)

2.2. Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics were performed on patient data, with means and standard deviations for continuous variables and frequencies for qualitative data. Means of biomarkers were compared using t-tests; chi-square analysis was used for comparing percentages. Differences among groups were analyzed with one-way ANOVA, and Pearson correlation coefficients checked relationships between markers. Hypothesis tests with p-values <0.05 were considered statistically significant.

3. Results

3.1. Assessment of laboratory Markers in Patients According to Sex

Table1 displays the assessment of Lab. Markers in Asthma patient according to sex, the statistical analysis revealed that t .IgE significantly ($p=0.004$) increased in male (557.2923±52.41625) compared with female patients (305.9336±52.28526), while the other markers showed non-significant ($p>0.05$) differences in the distribution of laboratory markers.

Table1: Assessment of Lab. Markers in Patients According to Gender

Lab. parameters	Concentration (10^3\µL) Mean ± Std. Deviation		P value
	Male	Female	
Lymph	4.5672 ± 0.32215	4.2797 ± 0.52921	0.630^{NS}
Neu.	6.85807± 2.42306	6.3200 ± 0.43519	0.343^{NS}
Eosin	0.7529 ±0 .10731	0.6848 ±0.08183	0.689^{NS}
t .IGE	557.2923 ± 52.41625 *	305.9336 ± 52.28526	0.004*
*Significant difference under p ≤ 0.05 by T-test, NS: Non-significant difference			

3.2. Assessment of Laboratory Markers in Patients According to Age Categories

Table2 illustrates impact of age on the levels of Lab. Markers in Asthma patient. Current study recorded that only Lymph. showed significant (p=0.000) differences, their levels were decreasing by age; where it increased in 5-9 y age category and significantly decreased in 10-14 y and 15-16 y age categories. On the other hand, the remaining markers showed in-significant (p>0.05) differences.

Table2: Assessment of Laboratory Markers in Patients According to Age Categories

Lab. parameters	Age group Mean ± Std. Deviation (10^3\µL)			P value
	5-9 y	10-14 y	15-16 y	
Lymph	5.6491 ±0.39157 a	3.0259 ± 1.00749 b	2.721 ± 0.3817 b	0.000 *
Neu.	6.5033 ± 2.376	18.7070 ± 9.303	5.680 ± 1.659	0.064
Eosin	0.7793 ±0.12274	0.7304 ± 0.09951	0.5650 ± 0.140	0.629
t .IGE	470.1934 ± 55.3823	589.4426 ± 78.68812	326.321± 89.931	0.124
Total No.	57	27	16	
Different small letters refer to significant between-groups comparison, *Significant difference under p ≤ 0.05 by One way – ANOVA.				

3.3. Assessment of Laboratory Markers in Patients According to BMI Categories

Table3 summarizes the effects of BMI on the Lab. markers in Asthma patients. The statistical analysis revealed a significant (p=0.000) increase in the concentration of lymphocytes in Underweight category compared with others BMI categories. Also, the concentrations of Eosin significantly (p=0.031) increased in Underweight category versus to other categories. Neutrophils and t .IgE showed non-significant differences, despite a trend toward significant differences (p=0.055) were recorded in distribution of neutrophils.

Table3: Assessment of Lab. Markers in Patients According to BMI Categories

Lab. Markers	BMI Mean ± Std. Deviation (10^3\µL)				P value
	Underweight	Normal	Overweight	Obesity	
Lymph	7.1641± 2.694 a	3.6182 ± 1.268 b	4.4692 ± 1.6436 b	3.2133 ± 0 .394 b	0.000*
Neu.	6.5659 ±2 .555	6.048 ± 1.319	6.5659 ± 2.659	5.1256 ± 1.106	0.055
Eosin	1.1545 ± 0.2854a	0.6113 ±0.069 b	0.7062 ± 0.096 b	0.4856 ± 0.132 b	0.031*
t .IGE	627.486± 89.017	399.614 ± 54.31	578.73 ± 97.487	470.05 ± 148.529	0.125
Total No.	22	56	13	9	

Different small letters refer to significant between-groups comparison**,** *Significant difference under $p \leq 0.05$ by One way – ANOVA**.**

3.4. Percentage of Bacterial Growth According to Bacterial Gram Stain

Fig.1 displays that bacterial Gram-positive percent was 16%, while the percent of Gram negative was 25%.

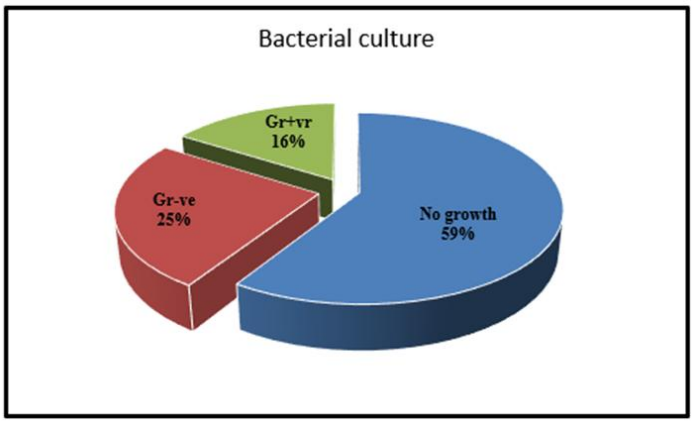

Figure1: Distribution of bacterial culture results among the studied samples. The pie chart illustrates the proportion of culture outcomes, showing that **59%** of samples demonstrated **no bacterial growth**, while **25%** yielded **Gram-negative (Gr-ve)** bacteria and **16%** yielded **Gram-positive (Gr+ve)** bacteria. These findings highlight that the majority of cultures were negative, with Gram-negative isolates being more common than Gram-positive ones among positive cultures.

Table4 shows the evaluation of Lab. markers in Asthma patients according to Bacterial Gram stain. The results of statistical analysis using one-way – ANOVA, revealed that only Lymphocytes and Eosin showed significant differences (p=0.000 and 0.001, respectively). Both levels of Lymphocytes and Eosin showed a significant decrease in gram-negative bacteria. Neutrophils and t.IGE also decreased in gram-negative bacteria, but the differences were insignificant.

Table4: Evaluation of Lab. Parameters in Patients According to Bacterial Gram Stain

Gram stain bacteria	Lab. parameters Mean ± Std. Deviation (10^3\µL)			
	Lymphocytes	Neutrophils.	Eosin	t .IGE
No growth	5.244±0 .362 [a]	10.84 ±4.0733	0.949 ± 0.117 [a]	507.476± 53.633
Gr.-ve B.	2.513 ±0.210 [b]	7.626 ±.57365	0.280 ±0.062 [c]	348.202± 78.817
Gr.+ve B.	4.686 ±0.728 [a]	8.512 ±.62901	0.635 ±0.021 [b]	580.685± 103.542
Total	4.4725 ± 0.2725	9.666 ±3.378	0.731 ±0.028	479.371±41.17581
P value	0.000*	0.674NS	0.001*	0.151
Different small letters refer to significant between-groups comparison, *Significant difference under p ≤ 0.05 by One way – ANOVA				

3.5. Evaluation of Lab. Markers in Asthma Patients According to Bacterial Growth

Table5 displays the evaluation of Lab. markers in Asthma patients according to Bacterial growth. According to the results of statistical analysis using one way – ANOVA, only Lymphocyte and t .IgE showed a significant differences (p=0.002 and 0.048, respectively); The highest concentration of lymphocytes was found in patients from whom *Staphylococcus aureus* were isolated as compared with remaining bacterial isolates. Regarding to (t .IgE), the highest concentration was recorded in patients from whom *Staphylococcus aureus* and *Enterobacter cloacae* complex were isolated, as compared with remaining bacterial isolates.

Table5: Evaluation of Lab. Markers in Patients According to Bacterial Growth

Bacterial growth	Lab. markers Mean ± Std. Deviation (10^3\µL)			
	Lymph	Neu.	Eosin	t .IGE
No growth	5.244 ± 2.783 b	10.84 ±4.0733	0.949 ±0 .117	507.476 ± 53.633 c
Klebsiella pneumoniae	2.135 ± 1.016 c	8.103 ± 0.823	0.358 ± 0.168	414.925 ± 186.021c
Streptococcus pneumoniae	4.285 ± 2.574 b	7.745 ± 0.255	0.664 ±0.117	426.8155 ± 97.509 c
Pseudomonas aeruginosa	2.766 ± 1.31 c	9.146 ±0.396	0.363 ±0.191	460.2717 ± 198.363 c
Streptococcus pyogens	2.97 ± 1.5108 c	10.546 ± 3.320	0.316 ±0.226	731.9967 ± 268.003 b
pseudomonas stutzeri	3.26 ± 1.327 c	7.3467 ±0.426	0.106 ± 0.013	123.1767 ± 41.286 d
Proteus spp	3.63 ± 0.102 c	6.88 ±0.0125	0.09 ±0.102	89.4500 ±2.102 d
Escherichia coli	2.90 ±0 .011 c	11.50 ± 0.024	0.20 ±0.028	241.5400 ±3.002 d
Enterobacter cloacae complex	1.63 ± 0.622 c	4.875 ± 3.205	0.28 ±0.0050	1000.0 ± 32.0010 a
staph aureus	9.48 ±2 .0123 a	9.68 ± 0.123	0.96 ±0.101	1200.0±1.01 a
Klebsiella oxytoca	1.83 ± 1.021 c	8.31 ±0.033	0.51 ± 0.015	79.09 ±2 .121 d
Acinetobacter baumannii complex	1.83 ±0.1402 c	0.99±0.1002	0.090 ± 0.0325	132.1±12 .024 d
Total	4.47 ± 2.783	13.062 ± 8.032	0.7318 ±0.078	479.3711± 41.175
P value	0.002*	1.000NS	0.186NS	0.048*
Different small letters refer to significant between-groups comparison, *Significant difference under p ≤ 0.05 by One way – ANOVA				

Correlation analysis using Pearson's correlation coefficients was applied among the lab. markers; the results are illustrated in Table6. t .IgE showed a significant positive correlation with Lymphocyte (p=0.045) and Eosin (p=0.014). Lymphocyte had a significant positive correlation with Eosin (p=0.015).

Table6: Correlation Between Lab. Markers in Patients

Lab. markers		**t .IGE**	**Lymphocyte**	**Neutrophil**	**Eosin**
t .IgE	Pearson Correlation	1	0.201	0.189	0.246
	Sig. (2-tailed)		0.045*	0.060	0.014*
	N		100	100	100
Lymphocyte	Pearson Correlation		1	-0.079-	0.244
	Sig. (2-tailed)			0.432	0.015*
	N			100	100
Neutrophil	Pearson Correlation			1	-0.051-
	Sig. (2-tailed)				0.617
	N				100
Eosin	Pearson Correlation				1
	Sig. (2-tailed)				
	N				100
*. Correlation is significant at the 0.05 level (2-tailed).					

4. Discussion

The present study evaluates the association of CBC laboratory parameters with respiratory infection in asthmatic children, highlighting variations based on gender, age, BMI, and bacterial growth. The findings align with and diverge from various other studies in notable ways. In our study, total IgE (t.IgE) levels were significantly higher in male patients compared to females, whereas other parameters like lymphocytes, neutrophils, and eosinophils did not show significant gender differences. This finding is consistent with the study by (Brakhas et al., 2016; Journal, 2016), which also reported there is a significant elevate in mean serum t-IgE in patients through gender groups compared to the control group, the mean of serum t-IgE levels increased in asthmatic males 506.025 ± 138.7 IU/ml compared to asthmatic females. At the same time, contrast with the same study found a significant difference in the percentage count of eosinophils in (cases) allergic asthma. As well as, this study in line with (Dogru and Yesiltepe Mutlu, 2016; Pekgör et al., 2020)found there was no difference between the groups with regard to gender, the mean neutrophil-lymphocyte ratio (NLR) was 2.07 in the case group and 1.77 in the control

group. Our results showed a significant decrease in lymphocyte levels with increasing age, particularly marked in the 10-14- and 15-19-years categories. This trend aligns with the findings of (Weerkamp et al., 2005), who demonstrate that distribution of thymocyte subsets changes with age and correlates with age-related fluctuations of T-lymphocyte counts in peripheral blood.

Significant differences in lymphocyte and eosinophil levels were observed across different BMI categories, with underweight children showing higher levels of these markers. This is in agreement with the study which reported blood neutrophil count was significantly correlated with BMI but not with symptom and severity of asthma, possibly due to underlying nutritional deficiencies or different immune response patterns (Rhee et al., 2018). The analysis of bacterial growth revealed that lymphocyte and eosinophil levels were significantly lower in patients with gram-negative bacterial infections compared to those with gram-positive or no bacterial growth. However, this finding contrasting evidence from (Sumardi et al., 2021) suggests that lymphocyte counts in patients infected with gram-positive bacteria was significantly lower (239–742/mm3) versus (573–1,138/mm3) in those infected with gram-negative bacteria with the significant association at p-value > 0.007, and absolute neutrophil count was higher in gram-positive bacterial infection (11,409–24,080 mm3) versus gram-negative bacterial infection (10,102–20,394 mm3). In our study, lymphocyte levels were significantly different across bacterial groups, with the highest levels observed in children with no bacterial growth (5.244 ± 2.783) and the lowest in those with Enterobacter cloacae complex (1.63 ± 0.622) and Klebsiella oxytoca (1.83 ± 1.021). These findings are consistent with (Cheng et al., 2020), who found that gram-negative bacterial infections, such as those caused by Enterobacter are associated with lower lymphocyte levels due to immune suppression. The study showed no significant differences in neutrophil levels across bacterial groups ($p = 1.000$), which aligns with the findings of (Crisford et al., 2021),who also reported non-significant differences in neutrophil levels among different bacterial infections in asthmatic patient. This indicates that neutrophil response might not be significantly influenced by the type of bacterial infection in asthma. Eosinophil levels did not show significant differences across bacterial groups ($p = 0.186$), which contrasts with (Park et al., 2020; Son et al., 2020) who found significant variations in eosinophil counts among different bacterial infections, particularly noting higher levels in children with gram-positive bacterial infections. Our findings suggest that eosinophil response might be more variable and influenced by other factors such as underlying atopic conditions. Total IgE levels varied significantly across bacterial groups ($p = 0.048$), with the highest levels in children with Staphylococcus aureus (1200.0 ± 1.01) and the lowest in those with Klebsiella oxytoca (79.09 ± 2.121). This is in agreement with (Chiu et al., 2021), who reported elevated IgE levels in children with gram-positive bacterial infections like Staphylococcus aureus.

Correlation analysis showed significant positive correlations between t.IgE and both lymphocytes and eosinophils, as well as between lymphocytes and eosinophils themselves. These correlations are in line with the findings of Ahmed & Hussein, (2023) which also reported similar relationships, suggesting that positive correlations between t.IgE and lymphocytes. While (Jassim and Al-Kazaz, 2023) found association between t.IgE with eosinophile.

Conclusion

The findings demonstrate that a significant proportion of patients experience uncontrolled asthma, with respiratory infections playing a crucial role in exacerbating the condition. Female patients and older adults were found to be more susceptible to severe asthma symptoms, which emphasizes the need for targeted interventions in these groups. Improving patient education on disease management, adherence to prescribed medications, and addressing underlying socioeconomic issues are pivotal in achieving better asthma control. Future research should further explore the role of bacterial infections in asthma exacerbations and develop more effective preventive and therapeutic strategies to enhance patient outcomes.

Ethical Approval

Ethics approval was obtained from Kerbala Health Directorate. Verbal consent was taken from patients and/or their parents. Health and safety measures were followed during sampling.

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