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Study of Iron Profile, Neutrophil Count and Eosinophil Count as Risk Factors in Egyptian Children with Bronchial Asthma

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Abstract:

Background: Bronchial asthma (BA) is a chronic pediatric airway disease frequently associated with immune dysregulation and micronutrient deficiencies, particularly iron. Increasing evidence suggests that iron metabolism and eosinophilic inflammation may influence asthma onset and severity. This study aims to evaluate of iron profile, eosinophil count, and neutrophil count roles as potential risk factors and predictors of asthma severity in Egyptian children. **Methods:** This case-control study was conducted on 100 children aged 2–18 years, including 50 asthmatic patients and 50 age- and sex-matched healthy controls. All subjects underwent clinical assessment and laboratory evaluation of CBC, serum iron (SI), ferritin, total iron-binding capacity (TIBC), transferrin saturation (TS), and differential leukocyte counts. **Results:** Asthmatic children showed significantly lower SI (32.7 vs. 72 µg/dL, P = 0.001), ferritin (34 vs. 65 ng/mL, P < 0.001), and TS, with elevated eosinophil counts (2.2 vs. 0.9, P < 0.001) and TIBC (P = 0.015). Eosinophil count had highest diagnostic accuracy (AUC = 0.939), followed by ferritin (AUC = 0.744) and iron (AUC = 0.686). Logistic regression identified low iron, low ferritin, and high eosinophil count as significant asthma predictors (P < 0.001), while neutrophil count was not. **Conclusion:** Iron deficiency and elevated eosinophil levels are reliable predictors of asthma occurrence and severity in children, offering potential utility for early risk stratification and personalized management.

Keywords: Bronchial Asthma, Iron Deficiency, Serum Ferritin, Eosinophils.

Introduction

Bronchial asthma (BA) is a chronic, heterogeneous respiratory disease characterized by airway inflammation and variable airflow limitation, presenting with symptoms such as wheezing, shortness of breath, and coughing [(1)]. Globally, asthma affects approximately 300 million individuals and causes around 250,000 deaths annually [(2)]. In Egypt, the prevalence of asthma among children ranges from 6% to 8.7% in various regions [(3)].

Iron deficiency anemia (IDA) is commonly encountered in pediatric practice. Low Hb levels may impair oxygen delivery and respiratory function [(4)]. Studies have observed reduced serum iron (SI) levels in asthmatic cases, although exact role of iron in asthma remains unclear. Some experimental data suggest iron supplementation may reduce airway inflammation [(5, 6)]. Others report conflicting findings, including altered iron distribution and increased oxidative stress in asthmatic children [(7, 8)], highlighting a complex relationship between iron metabolism and airway inflammation.

Eosinophils and neutrophils are major immune cells implicated in asthma pathogenesis and exacerbations. Elevated eosinophil counts are strongly linked with allergic inflammation and asthma severity, and are used clinically to guide targeted therapies such as anti-IL-5 treatments [(9-11)]. Neutrophilic inflammation, often associated with more severe and steroid-resistant asthma phenotypes, may also contribute to airway remodeling and persistent symptoms. Studies show that combined eosinophilic and neutrophilic patterns are associated with more active and uncontrolled disease [(12)].

Despite growing interest, combined evaluation of iron profile, eosinophil count, and neutrophil count as potential risk factors in pediatric asthma remains underexplored, particularly in Egyptian populations. Understanding their contribution may help identify biomarkers for asthma severity and control. Therefore, this study aims to evaluate their roles as possible risk factors in Egyptian children with BA.

Patients and methods:

This case-control study was conducted at Chest and Allergy Clinic, Pediatric Department, and Clinical Pathology Departments of Benha University Hospital and Benha Children's Hospital. The study spanned a period of 12 months, from May 2023 to April 2024, and included a total of 100 children.

The study was done after being approved by Research Ethics Committee, Faculty of Medicine, Benha University (Approval no: MS 16-5-2023). Informed consent was obtained from all parents of participants.

Inclusion criteria were children aged 2–18 years of both sexes with confirmed BA based on clinical diagnosis per Kamal et al. [(13)], which includes typical symptoms (recurrent wheeze, cough), auscultatory findings (wheezing), and exclusion of alternative diagnoses. While exclusion criteria were children receiving systemic corticosteroids, those with parasitic infections, other causes of anemia apart from IDA, or those who had received iron supplementation within last three months.

Grouping: This study included 100 children divided into two groups: **Group I (Patients group):** Included 50 children diagnosed with BA. **Group II (Control group):** Included 50 age- and sex-matched healthy children with no history of asthma or chronic respiratory illness.

Methods:

Clinical Evaluation:

All participants underwent thorough medical history taking including personal, family, and environmental history, symptom analysis (frequency, triggers, diurnal/seasonal variation), and past allergic or asthmatic conditions. Full physical and systemic examinations were performed. Asthma exacerbations were classified (mild to life-threatening) based

on GINA (2017) and National Asthma Education and Prevention Program [14].

Laboratory Investigations:

Venous blood samples (5 ml) were collected under aseptic conditions and analyzed as follows: CBC: Included Hb level, red blood cell indices MCV, MCH, MCHC, RDW, total leukocyte count, eosinophil and neutrophil counts. Anemia was defined as Hb <11 g/dL [15], with confirmation based on WHO guidelines [16]. Iron Profile: Included SI, ferritin measured by ELISA, TIBC, and calculated TS (iron/TIBC × 100).

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics, version 28 (Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation or median with interquartile range, depending on results of Shapiro-Wilk normality test. Categorical variables were summarized as frequencies and percentages. Group comparisons were conducted using either independent samples t-test or Mann–Whitney U test for continuous data, and Chi-square or Fisher's exact test for categorical variables, as appropriate. ROC curve analysis was employed to evaluate diagnostic utility of iron parameters and leukocyte subsets. Associations between variables were assessed using Pearson or Spearman correlation coefficients, depending on data distribution. Logistic regression models were constructed to identify independent predictors of asthma diagnosis, disease control, and severity. A two-tailed p-value below 0.05 was considered indicative of statistical significance.

Results:

The studied groups were comparable regarding age (P = 0.177), sex (P = 0.422), and consanguinity (P = 0.509).

In this study, 22% of the cases had a personal history of atopy, and 62% reported a family history. The median duration of asthma was 5 years, with a range of 1 to 12 years. Diurnal and seasonal symptom variations were observed in 60% and 58% of cases, respectively. Viral infections were most common trigger (26%), followed by exposure to odors (34%), insect bites (16%), food (8%), emotional factors (8%), and unknown causes (8%). Asthma was well-controlled in 46% of cases, while 54% had uncontrolled disease. The median number of weekly asthma attacks was 2 for both day (range 1–5) and night (range 1–7) episodes. In terms of severity, 44% of cases had mild asthma, 34% moderate, and 22% severe. **Table 1**

Patients showed markedly lower Hb (P = 0.008), MCV (P = 0.035), and MCH (P < 0.001) compared to controls. SI (P = 0.001), ferritin (P < 0.001), and TS (P < 0.001) were also substantially reduced, while TIBC was higher (P = 0.015). IDA was more prevalent in patients (P = 0.003). Inflammatory markers were elevated, including TLC (P = 0.002), eosinophils (P < 0.001), and platelets (P < 0.001). Neutrophil and lymphocyte counts showed no notable variations. **Table 2**

SI levels were significantly inversely correlated with disease severity (r = -0.381, P = 0.006). Other variables, including age, disease duration, and frequency of attacks were not significantly correlated with SI. **Table 3**

Serum ferritin (SF) levels were significantly inversely correlated with disease severity (r = -0.368, P = 0.009). Other variables, including age, disease duration, frequency of attacks, TLC, eosinophils, and platelets, were not significantly correlated. **Table 3**

Neutrophil count showed a significant inverse correlation with Hb (r = -0.428, P = 0.002) and MCV (r = -0.321, P = 0.023), and a strong positive correlation with total leukocyte count (r = 0.773, P < 0.001). Other variables, including age, disease duration, attack frequency and disease severity were not significantly correlated with neutrophil count. **Table 3**

Eosinophil count was significantly positively correlated with age (r = 0.385, P = 0.006), disease duration (r = 0.353, P = 0.012), and number of day attacks per week (r = 0.299, P = 0.035). Other variables including night attacks, disease severity were not significantly correlated. **Table 3**

ROC analysis was done to predict asthma from SI, SF, TS, total iron binding capacity, eosinophilic count, and neutrophil count. For SI, AUC was 0.686, with a 95% CI of 0.580 – 0.793 (P = 0.001). Best cutoff point was ≤46.1, at which sensitivity, specificity, PPV, and NPV were 64%, 76%, 72.7%, and 67.9%, respectively. **Figure 1-A**

For SF, AUC was 0.744, with a 95% CI of 0.645 – 0.842 (P < 0.001). Best cutoff point was ≤ 58, at which sensitivity, specificity, PPV, and NPV were 78%, 66%, 69.6%, and 75%, respectively. **Figure 1-B**

For TS, AUC was 0.716, with a 95% CI of 0.617 – 0.816 (P < 0.001). Best cutoff point was ≤ 23, at which sensitivity, specificity, PPV, and NPV were 68%, 66%, 66.7%, and 67.3%, respectively. **Figure 1-C**

For TIBC, AUC was 0.656, with a 95% CI of 0.547 – 0.765 (P = 0.007). Best cutoff point was > 379, at which sensitivity, specificity, PPV, and NPV were 62%, 66%, 64.6%, and 63.5%, respectively. **Figure 1-D**

For eosinophilic count, AUC was 0.939, with a 95% CI 0.886 – 0.992 (P < 0.001). Best cutoff point was > 1.3, at which sensitivity, specificity, PPV, and NPV were 80%, 98%, 97.6%, and 83.1%, respectively. **Figure 1-E**

For neutrophilic count, AUC was insignificant (P = 0.168). It was 0.580, with a 95% CI of 0.467 – 0.693 (P = 0.168). Best cutoff point was > 5, at which sensitivity, specificity, PPV, and NPV were 42%, 78%, 65.5%, and 57.4%, respectively. **Figure 1-F**

Multivariate logistic regression analysis revealed that controlling for age, sex, and consanguinity, lower SI levels were significantly associated with increased odds of asthma (OR = 0.978, 95% CI: 0.965 - 0.992, P = 0.001) as were lower SF levels (OR = 0.958, 95% CI: 0.938 - 0.978, P < 0.001) and lower TS (OR = 0.902, 95% CI: 0.852 - 0.954, P < 0.001). Total iron-binding capacity (TIBC) showed a modest but significant positive association (OR = 1.005, 95% CI: 1 - 1.01, P = 0.032). A higher eosinophil count was also significantly associated with increased odds of asthma (OR = 1.718, 95% CI: 1.336 - 2.21, P < 0.001). Neutrophil count (P = 0.169) was not significantly associated with the outcome. **Table 4**

The comparison between controlled and uncontrolled asthma cases revealed significant differences in SI levels, with lower values observed in the uncontrolled group (21 vs. 56 µg/dl, P = 0.003). TIBC was notably higher in uncontrolled asthma cases (440 ± 72 vs. 375 ± 68 µg/dl, P = 0.002), and SF levels were significantly lower in uncontrolled group (21 vs. 50 ng/ml, P = 0.002). Eosinophil count (P = 0.240), neutrophil count (P = 0.423), and TS (P = 0.242) did not show notable variations between the two groups. **Table 5**

The comparison between cases with severe asthma and those without revealed notable variations in eosinophil count (3.1 ± 1.3 vs. 2 ± 0.9, P = 0.003), SI levels (17 vs. 45 µg/dl, P = 0.003), total iron-binding capacity (TIBC) (464 ± 59 vs. 395 ± 75 µg/dl, P = 0.008), SF levels (19 vs. 40 ng/ml, P = 0.015), and TS (15 vs. 21, P = 0.049). Neutrophil count (P = 0.082) did not show a notable change between the two groups. **Table 5**

ROC analysis was done to predict uncontrolled asthma from SI and SF. For SI, AUC was 0.748, with a 95% CI 0.609 – 0.887 (P = 0.003). Best cutoff point was ≤ 24, at which sensitivity, specificity, PPV, and NPV were 66.7%, 82.6%, 81.8%, and 67.9%, respectively. For SF, AUC was 0.755, with a 95% CI 0.619 – 0.892 (P = 0.002). Best cutoff point was ≤

28, at which sensitivity, specificity, PPV, and NPV were 66.7%, 87%, 85.7%, and 69%, respectively. **Table 6**

ROC analysis was done to predict severe asthma from SI and SF. For SI, AUC was 0.793, with a 95% CI 0.617 – 0.968 (P = 0.003). Best cutoff point was ≤20, at which sensitivity, specificity, PPV, and NPV were 81.4%, 82.1%, 56.2%, and 94.1%, respectively. For SF, AUC was 0.742, with a 95% CI 0.570 – 0.915 (P = 0.015). Best cutoff point was ≤22, at which sensitivity, specificity, PPV, and NPV were 81.8%, 76.8%, 50%, and 93.7%, respectively. **Table 6**

ROC analysis was done to predict severe asthma from eosinophilic count. AUC was 0.721, with a 95% CI 0.566 – 0.877 (P = 0.026). Best cutoff point was > 1.9, at which sensitivity, specificity, PPV, and NPV were 90.9%, 64.1%, 41.7%, and 96.2%, respectively. **Table 6**

Multivariate logistic regression analysis identified that controlling for age, sex, and consanguinity, lower SI levels were significantly associated with an increased likelihood of uncontrolled asthma (OR = 0.965, 95% CI: 0.941 - 0.989, P = 0.005). Similarly, lower SF levels were also significantly associated with uncontrolled asthma (OR = 0.957, 95% CI: 0.928 - 0.987, P = 0.005).

Multivariate logistic regression analysis revealed that controlling for age, sex, and consanguinity, lower SI levels (OR = 0.964, 95% CI: 0.931 - 1, P = 0.047) and lower SF levels (OR = 0.954, 95% CI: 0.912 - 0.999, P = 0.043) were significant predictors of severe asthma. Additionally, higher eosinophil count was significantly associated with severe asthma (OR = 2.677, 95% CI: 1.023 - 7.006, P = 0.045).

Table 1: Clinical findings of the patients' group.

Clinical characteristics		
History of atopy	n (%)	11 (22)
Family history	n (%)	31 (62)
Duration of disease (years)	Median (range)	5 (1 - 12)
Diurnal variation	n (%)	30 (60)
Seasonal variation	n (%)	29 (58)
Main exacerbating factor		
Viral infection	n (%)	13 (26)
Food	n (%)	4 (8)
Insect bite	n (%)	8 (16)
Odor	n (%)	17 (34)
Emotional	n (%)	4 (8)
Unknown	n (%)	4 (8)
Asthma control		
Controlled	n (%)	23 (46)
Uncontrolled	n (%)	27 (54)
Number of day attacks/week	Median (range)	2 (1 - 5)
Number of night attacks/week	Median (range)	2 (1 - 7)
Severity		
Mild	n (%)	22 (44)
Moderate	n (%)	17 (34)
Severe	n (%)	11 (22)

Table 2: Laboratory findings in the studied groups.

		Patients (n = 50)	Controls (n = 50)	P-value
Hb (g/dl)	Mean ±SD	11.01 ±1.35	11.63 ±0.87	**0.008***
MCV	Mean ±SD	71.97 ±8.74	75.2 ±6.17	**0.035***
MCH	Mean ±SD	24.7 ±3.6	26.9 ±0.9	**<0.001***
TLC	Mean ±SD	10.87 ±3.08	9.13 ±2.36	**0.002***
Eosinophil count	Mean ±SD	2.2 ±1.1	0.9 ±0.3	**<0.001***
Neutrophil count	Median (range)	4.8 (1.5 - 8.1)	4 (1.5 - 9)	0.164
Lymphocyte count	Median (range)	3 (0.9 - 6)	3.5 (1.3 - 6)	0.264
Platelets	Mean ±SD	426 ±129	344 ±102	**<0.001***
Serum iron (ug/dl)	Median (range)	32.7 (14.3 - 145)	72 (11 - 145)	**0.001***
Total iron binding capacity (ug/dl)	Mean ±SD	410 ±77	366 ±98	**0.015***
Serum ferritin (ng/ml)	Median (range)	34 (10 - 90)	65 (13 - 90)	**<0.001***
Transferrin saturation	Median (range)	19.5 (10 - 38)	28.5 (13 - 41)	**<0.001***
Iron deficiency anemia	n (%)	20 (40)	7 (14)	**0.003***

*Significant P-value; n: Number; %: Percentage; Hb: Hemoglobin; g/dl: Grams per deciliter; SD: Standard deviation; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; TLC: Total leukocyte count; ug/dl: Micrograms per deciliter; ng/ml: Nanograms per milliliter

Table 3: Correlation between serum iron, serum ferritin, neutrophilic count, and eosinophilic count and other parameters in asthma patients.

	Serum iron (ug/dl)		Serum ferritin (ng/ml)		Neutrophilic count		Eosinophil count	
	r	**P**	**r**	**r**	**r**	**P**	**r**	**P**
Age (years)	-0.037	0.797	-0.076	0.602	0.185	0.198	0.385	**0.006***
Duration of disease (years)	0.087	0.546	-0.01	0.946	0.216	0.131	0.353	**0.012***
Number of day attacks/week	-0.266	0.062	-0.257	0.071	0.104	0.471	0.299	**0.035***
Number of night attacks/week	-0.236	0.1	-0.211	0.141	0.259	0.069	0.165	0.252
Severity	-0.381	**0.006***	-.368	**0.009***	0.155	0.282	0.177	0.219

*Significant P-value; ROC: Receiver Operating Characteristic; AUC: Area Under the Curve; CI: Confidence Interval; PPV: Positive Predicti Value; NPV: Negative Predictive Value; TIBC: Total iron binding capacity

Table 4: Multivariate logistic regression analysis to predict asthma

	OR (95% CI)†	P-value
Serum iron (ug/dl)	0.978 (0.965 - 0.992)	**0.001***
Serum ferritin (ng/ml)	0.958 (0.938 - 0.978)	**<0.001***
Total iron binding capacity (ug/dl)	1.005 (1 - 1.01)	**0.032***
Transferrin saturation	0.902 (0.852 - 0.954)	**<0.001***
Eosinophilic count	1.718 (1.336 - 2.21)	**<0.001***
Neutrophil count	1.212 (0.921 - 1.593)	0.169

*Significant P-value; †: Adjusted for age, sex, and consanguinity; OR: Odds ratio; CI: Confidence interval; P: P-value; ug/dl: Micrograms per deciliter; ng/ml: Nanograms per milliliter

Table 5: Iron profile, eosinophilic count, and neutrophilic count according to asthma control and severity.

	Asthma control			Severe asthma		
	Uncontrolled	**Controlled**	**P**	**Yes**	**No**	**P**
Eosinophil count	2.4 ±1.1	2 ±1	0.24	3.1 ±1.3	2 ±0.9	**0.003***
Neutrophil count	5.2 (2 - 8.1)	4 (1.5 - 7.8)	0.423	5.3 (3.1 - 8.1)	4 (1.5 - 7.8)	0.082
Serum iron (ug/dl)	21 (14.3 - 90)	56 (15.4 - 145)	**0.003***	17 (14.3 - 79)	45 (15.4 - 145)	**0.003***
TIBC (ug/dl)	440 ±72	375 ±68	**0.002***	464 ±59	395 ±75	**0.008***
Serum ferritin (ng/ml)	21 (10 - 90)	50 (16 - 87)	**0.002***	19 (12 - 70)	40 (10 - 90)	**0.015***
Transferrin saturation	19 (10 - 38)	22 (11 - 34)	0.242	15 (11 - 35)	21 (10 - 38)	**0.049***

*Significant P-value; SD: Standard deviation; n: Number; %: Percentage; P: P-value; ug/dl: Micrograms per deciliter; ng/ml: Nanograms per milliliter

Table 6: ROC analysis of serum iron and ferritin to predict uncontrolled asthma

	Uncontrolled asthma		Severe asthma		
ROC characteristics	**Serum iron**	**Serum ferritin**	**Serum iron**	**Serum ferritin**	**Eosinophilic count**
AUC	0.748	0.755	0.793	0.742	0.721
95% CI	0.609 – 0.887	0.619 – 0.892	0.617 – 0.968	0.570 – 0.915	0.566 – 0.877
Best cutoff	≤24	≤28	≤20	≤22	> 1.9
Sensitivity	66.70%	66.70%	81.80%	81.80%	90.90%
Specificity	82.60%	87%	82.10%	76.80%	64.10%
PPV	81.80%	85.70%	56.20%	50%	41.70%
NPV	67.90%	69%	94.10%	93.70%	96.20%
P-value	**0.003***	**0.002***	**0.003***	**0.015***	**0.026***

*Significant P-value; ROC: Receiver Operating Characteristic; AUC: Area Under the Curve; CI: Confidence Interval; PPV: Positive Predictive Value; NPV: Negative Predictive Value.

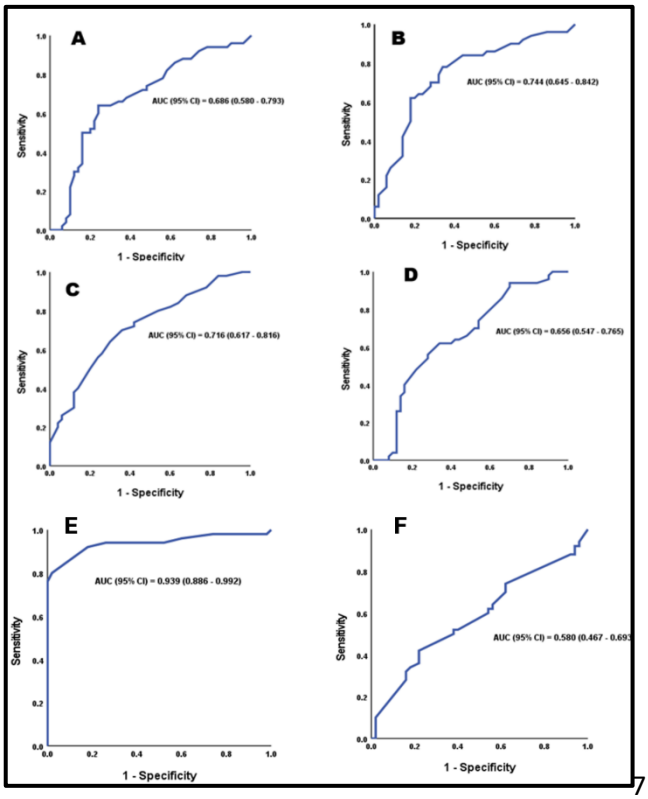

Figure 1: ROC analysis for A) serum iron; B) serum ferritin; C) transferrin saturation; D) TIBC, E) eosinophilic count, and F) neutrophilic count to predict asthma.

Discussion:

BA involves complex immune and inflammatory processes. Emerging evidence links iron deficiency and altered eosinophil and neutrophil counts to asthma severity, yet their combined role in children remains unclear [17]. So, we aim to evaluate their roles as possible risk factors in Egyptian children with BA.

In the present study, groups were similar in baseline characteristics. A history of atopy and family history were common among cases. Most had long-standing asthma with frequent diurnal and seasonal variation. Viral infections and odors were common triggers. Over half of cases had uncontrolled asthma, with varying severity from mild to severe. In close proximity, Xu et al.[18] reported an asthma prevalence of 4.8% among 2438 children in Hangzhou. Similarly, Zedan et al.[19], in a study on 602 Egyptian children, found a significantly higher asthma prevalence in males than females (26.5% vs. 16.1%, P = 0.002), with no significant association with age, residence, or family history.

In the current study, cases had lower Hb, MCV, and MCH levels, indicating microcytic hypochromic anemia. Additionally, elevated total leukocyte and eosinophil counts suggest an underlying inflammatory or allergic response, while higher platelet counts may reflect a reactive thrombocytosis associated with chronic inflammation. Parallel to our findings, Elsayed et al. [20] reported that asthmatic children had markedly lower Hb, hematocrit, and RBC levels (P = 0.001, 0.008, 0.004, respectively), along with substantially higher ESR (P = 0.000), while no significant differences were observed in WBCs and platelets (P = 0.069, 0.829). Similarly, Metbulut et al. [21] compared 54 asthmatic children to 162 non-asthmatic peers and found that although asthma cases had slightly lower WBCs, higher Hb, eosinophils, platelets, neutrophils, and lymphocytes, none of these differences reached statistical significance (P > 0.05 for all).

In our study, cases exhibited lower SI, ferritin, and TS levels, along with higher TIBC, indicating iron deficiency. IDA was more prevalent among cases, while neutrophil and lymphocyte counts showed no significant differences between groups. Supporting our results, Elsayed and Essa [22] found that IDA and elevated TIBC were significantly more common in asthmatic children compared to healthy controls (P = 0.000), while SI and ferritin levels were significantly lower (P = 0.000). This aligns with evidence that chronic inflammation in asthma increases pro-inflammatory cytokines and hepcidin, which impairs iron absorption and mobilization, leading to iron deficiency and contributing to worsened respiratory function [23-26].

In the present study, no notable variations were in neutrophil count between asthma vs. controls. Neutrophils did not predict asthma. In accordance with our findings, Bedolla-Barajas et al. [27] observed no significant difference in neutrophil counts between asthmatic adults and healthy controls (P = 0.585). In contrast, Goyal et al. [28] reported significantly higher neutrophil counts in children with partly/uncontrolled asthma compared to well-controlled cases (P = 0.02). Similarly, Zhu et al. [29] found that NLR was significantly higher in children with exacerbated asthma compared to healthy controls (P < 0.001), suggesting its potential as a diagnostic marker. Supporting this, Huang et al. [30] conducted a meta-analysis and confirmed elevated NLR in asthmatic children (SMD 1.335, 95% CI 0.429–2.241; P < 0.001). These discrepancies across studies may reflect differences in sample size or methodology. Also, our cohort likely represents Th2-high eosinophilic asthma, explaining strong link between eosinophil levels and disease severity. In contrast, neutrophil involvement may vary by population due to environmental exposures, which may

account for limited neutrophilic response seen in our study.

Correlation analysis revealed that lower SI levels were significantly associated with increased disease severity. SI also showed strong positive correlations with Hb, MCV, MCH, and lymphocyte count, while other clinical and hematological variables showed no significant correlation. More severe asthma is associated with greater iron depletion, likely due to inflammation-induced alterations in iron metabolism. Higher iron levels correlate with increased Hb, as iron is vital for its synthesis [(31)]. Likewise, better iron status is reflected in higher MCV and MCH values, indicating larger, more Hb-rich red blood cells that enhance oxygen delivery [(32)].

Concerning correlation of SI and lymphocytes, our study found positive correlation with SI. AlRajeh et al.[(33)] investigated iron deficiency impact on immunity in 64 iron-deficient cases and 19 healthy controls, revealing that anemic cases (Hb ≤11 g/dL) had significantly lower absolute lymphocyte counts (P = 0.013), highlighting a potential link between IDA and impaired immune function.

In the current study, SF levels showed a significant inverse correlation with disease severity and a strong positive correlation with Hb, MCV, and MCH, indicating its link to anemia status. Neutrophil count was negatively correlated, while lymphocyte count was positively correlated with ferritin. Other clinical and hematological parameters showed no significant association. Similarly, Ali et al.[(34)] examined 50 asthmatic children divided into groups with and without IDA and found significant negative correlations between asthma severity (measured by reduced FEV1/FVC ratio) and both Hb and ferritin levels, indicating that lower iron status is associated with poorer lung function and more severe asthma. As disease severity increases, inflammation elevates hepcidin levels, reducing iron absorption and release, thereby depleting ferritin and impairing Hb synthesis [(31)]. Higher ferritin levels support better MCV and MCH values, reflecting improved oxygen-carrying capacity. Additionally, elevated neutrophils signal inflammation-driven iron sequestration, while adequate iron supports stronger immune responses, evidenced by higher lymphocyte counts [(35)].

This study found that eosinophil count was positively correlated with age, disease duration, and frequency of day attacks, and inversely correlated with Hb levels, indicating its association with chronicity and anemia. It also showed a strong positive correlation with total leukocyte count, while other variables showed no significant correlations. Similarly, Reyad et al. [(36)] studied 60 asthmatic children and found a significant moderate positive correlation between eosinophil count and number of asthma exacerbations (R = 0.58, P < 0.001), highlighting eosinophils as a predictor of acute attacks. Supporting this, Koshak and Alamoudi [(37)] reported a strong positive correlation between total peripheral eosinophil count and asthma severity assessed by symptoms alone (R = 0.460, P = 0.001) and a moderate correlation when severity was assessed by both symptoms and PFR (R = 0.328, P < 0.05).

In the current study, ROC and logistic regression analyses revealed that lower SI, ferritin, and TS levels, along with higher eosinophil counts, were significantly associated with asthma risk, with eosinophils showing highest predictive accuracy. Total iron-binding capacity had a modest association, while neutrophil count was not significantly linked. These findings suggest that iron deficiency and eosinophilia are reliable indicators of asthma occurrence and severity, and their monitoring may support better assessment and management strategies in pediatric asthma.

This study's limitations include a relatively small sample size, single-center setting, and cross-sectional design, which may

restrict generalizability of findings and prevent conclusions about long-term effects or causality.

Conclusion:

Our study identified lower serum iron and ferritin levels, along with higher eosinophil counts, as significant predictors of asthma occurrence and severity in Egyptian children. Lower iron and ferritin were linked to more severe asthma, while elevated eosinophil counts indicated a greater likelihood of uncontrolled asthma. Proper treatment of iron deficiency anaemia reveals good control of asthmatic patients.

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Author contribution

The authors contributed equally to the study.

Conflicts of interest

No conflicts of interest

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