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Original article

Neutrophils to Lymphocytes Ratio as a Biomarker in Pediatric Asthma Severity and Control

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Abstract

Background: Asthma is a chronic inflammatory condition affects all age groups, but it peaks in pediatrics. T2-mediated immunity has long been thought to be the pathophysiological mechanism of asthma. Also, the disease is associated with inflammatory mechanism, so the identification of a reliable inflammatory biomarker for diagnosing asthma and assessment of the disease severity is a great importance. **Aim of the Study:** Evaluate the role of neutrophils to lymphocytes ratio as a biomarker in asthma severity and control. **Methods:** This case control study was carried out on 44 asthmatic children and 44 healthy controls. The children who were included underwent a comprehensive evaluation that included obtaining a thorough clinical history, conducting a full clinical examination to determine the severity of their asthma, and looking for any atopic diseases. Assessment of the different laboratory parameters was conducted with determination of the neutrophil lymphocyte ratio. **Results:** The neutrophil/lymphocytes ratio was statistically significantly higher in the asthmatic cases as compared to the controls ($P < 0.001$). The best cutoff point of Neutrophil/lymphocytes ratio to identify cases with asthma from control was > 1.75 with 79.5% sensitivity and 75.9 specificity. The AUC was 0.826 and the value was statistically significant. Cases with severe asthma and cases with severely uncontrolled disease showed higher level of NLR compared to the cases with mild and moderate asthma and compared to cases with controlled asthma respectively. **Conclusions:** Neutrophil/lymphocytes ratio could be used as non-invasive diagnostic biomarker for diagnosing asthma and is strongly correlated with degree of disease severity.

Keywords: Asthma, Pediatrics, NLR, Biomarker.

Introduction:

Asthma is a chronic condition, mainly characterized by airway inflammation and hyper responsiveness [1]. The global prevalence of asthma is estimated to range between 1 to 18% [2].

According to reports, the prevalence of asthma in Egyptian newborns and children under four years old, across five governorates, was 4.8% [3]. Also, another study in Cairo, the prevalence of asthma is was 9.4% in 11– 15-year-old [4].

Patients with asthma describe breathing difficulties in addition to other manifestations as coughing, wheezing, dyspnea, and/or tightness in the chest. As the disease progresses, these symptoms become more frequent and intense and are accompanied by a reduction in expiratory airflow and a general deterioration in lung function [5].

There is still lack of exact knowledge around the actual mechanisms that cause asthma, but it was suggested that environmental and genetic factors interact in complicated ways, leading to a wide range of symptoms, inflammation, and even airway remodeling [6].

Due to the complexity of the disease's pathophysiology, more precise diagnostic tools are required for asthma since the disease's heterogeneity poses numerous problems in diagnosis, prognosis, therapy, and management [7, 8].

In order to enhance the dependable rate of asthma detection and patient outcomes, it would be highly beneficial to have accessible, easy-to-obtain, low-risk, clinically useful, and, ideally, inexpensive biomarkers [9, 10].

Asthma pathogenesis involves inflammation as a key component. Eosinophils, T lymphocytes, macrophages, and neutrophils are among the immune cells brought into play by asthma [11].

The current study was conducted to evaluate the role of neutrophils to lymphocytes ratio as a biomarker in asthma severity and control.

Patients and Methods

Study design:

This case control study was carried out on 44 asthmatic children aged less than 16 years old, with typical asthma symptoms and 44 healthy age and sex matched controls. They were recruited from Pediatric Department in the Faculty of Medicine of Benha University, Egypt., throughout the period from April 2023 till April 2024. The study was presented to the research Ethics Committee of Faculty of Medicine- Benha University and approved with approval code MS 39-4-2023). Informed consent was obtained from the patients before participating in this study.

The cases with the following criteria were excluded, Children with chronic diseases (as chronic kidney disease, diabetes, hypertension, chronic heart disease, chronic liver disease, iron deficiency anaemia, obesity, thalassemia, etc….), children with

severe infection (sepsis, meningitis, pneumonia, peritonitis, etc….), immunocompromised cases and refusal to participate.

Study tools:

All patients were subjected to full clinical history and clinical examination. Pulmonary function testing was done for all cases and controls using a Spirometer device [12].

The cases were classified as mild, moderate, or severe according to daytime symptoms, night-time symptoms, and pulmonary function tests. Asthma exacerbation severity is classified by the Global Initiative for Asthma (GINA) as worsening symptoms (shortness of breath, cough, increased chest activity, wheezing) and increased use of relief medications (e.g., inhaled short-acting β2 agonists). Please ensure to include the date of the GINA guidelines (year .....?) in the references section.

In order to administer the asthma control test (ACT), researchers had patients fill out a series of five questions pertaining to their asthma symptoms, medication usage, and overall impact on daily life. There is a scale from 5 to 25. A score of 25 indicates good control, a level of 20–24 indicates partial control, and a score of 19 or lower indicates inadequate control [13].

Complete blood count (CBC) with differential white blood cells counts, Erythrocyte sedimentation rate (ESR), CRP, measurement of total serum IgE concentration and analysis of arterial blood gases. Neutrophil to lymphocyte ratio were calculated by dividing the percentage of neutrophils and lymphocytes in complete blood count analysis.

Sample Size Calculation:

The required sample size was calculated using the IBM[a] SPSS[a] Sample Power[a] version 3.0.1 (IBM[a] Corp., Armonk, NY, USA).

Based on an intensive literature review, the mean value of NLR in the asthmatic cases was 2.77 (SD: 1.87) in the study conducted by Hendy et al. (2019) versus 1.40 (SD: 0.52) in the control group [14]. This difference between the groups was taken for calculating the sample size. At a 95% level of significance and a power of 80%, the minimal required sample size calculated was 44 in each group.

Approval Code : MS 39-4-2023

Statistical analysis

Statistical analysis was done by SPSS v25 (IBM Inc., Chicago, IL, USA). Shapiro-Wilks test was used to evaluate the normality of the distribution of data. Quantitative parametric data were presented as mean and standard deviation (SD) and were analyzed by independent samples t-test (Two groups) and ANOVA (F) test with post hoc test (Tukey) (Three or more groups). Quantitative non-parametric data were presented as median and range and were analyzed by Mann Whitney-test to compare two groups. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test. The receiver operator

characteristic (ROC) curve was used to determine the optimal cutoff value of quantitative variable to distinguish between groups in terms of sensitivity and specificity followed by determining accuracy. A two tailed P value < 0.05 was considered statistically significant.

Results:

The current study included 44 children with asthma (the cases group) in addition to 44 healthy children as a control group. As shown in table (1), there was no statistically significant difference between the cases and the control groups regarding the age (p= 0.382), the sex distribution (p= 0.669) and the positive family history of asthma (p= 0.089). The history of previous artificial feeding and mixed feeding were statistically significantly higher in the asthmatic cases 38.6% and 27.3% respectively in the cases group versus 20.5% and 15.9% respectively in the control group). The prevalence of parenteral smoking was statistically significantly higher in the asthmatic cases (65.9%) as compared to the control group (36.4%). The prevalence of exposure to other triggers was statistically significantly higher in the asthmatic cases (59.5%) as compared to the control group (34.1%).

According to table (1), the serum eosinophilic percentage, total IgE, WBCs count, neutrophil percentage and neutrophil/lymphocytes ratio were statistically significantly higher in the asthmatic cases as compared to the control group (p < 0.001).

On the other hand, the percentage of lymphocytes was statistically significantly higher in the asthmatic cases as compared to the control group (p = 0.014).

The clinical manifestations in the cases group included shortness of breathing in 33 cases (75%), wheezes in 25 cases (56.8%), cough in 18 cases (40.9%), fatigue in 16 cases (36.4%), seasonal variations in 14 cases (31.8%) and increased sensitivity to cold in 26 cases (59.1%). (Table 2).

As shown in table (2), the median duration of illness was 6 years with range between 5 and 12 years. The median number of diurnal exacerbation was 2/week with range between 1 and 7 / week. The median number of nocturnal attacks was zero/month with range between 0 and 5 / month. Atopic dermatitis was detected in 14 cases (31.8%) and allergic rhinitis was detected in 16 cases (36.4%).

This table also shows that regarding the degree of severity of asthma, mild degree was reported in 24 cases (54.5%), moderate degree in 14 cases and severe degree in 6 cases (13.6%). The controller medications included ICS in 15 cases (34.1%), Leukotriene modifier in 3 cases (6.8%), ICS & Leukotriene modifier in 5 cases (11.4%), ICS & LABA in 5 cases (11.4%) and ICS & Leukotriene modifier & LABA in 7 cases (15.9%). Regarding the level of asthma control, there were 26 controlled cases, 11 cases (25%) partially controlled and 7 cases (15.9%) were severely uncontrolled.

Table (3) shows that the best cutoff point of Neutrophil/lymphocytes ratio to identify cases with asthma from control was > 1.75 with 79.5% sensitivity and 75.9 specificity. The AUC was 0.826 and the value was statistically significant ($p < 0.001$).

Table (4) shows that NLR was statistically significantly higher in the cases with severe asthma compared to the cases with mild and moderate asthma. Also, the NLR was statistically significantly higher in the cases with moderate asthma compared to the cases with mild asthma.

This table also shows that NLR was statistically significantly higher in the cases with severely uncontrolled asthma compared to the cases with controlled asthma. Also, the NLR was statistically significantly higher in the cases with Partially controlled asthma compared to the cases with controlled asthma.

Table (1): Demographic data, and Laboratory findings of the studied groups

Demographic data			
Variables	Cases group (n=44)	Control group (n=44)	Test of significance
Age (years) Mean ± SD	10.89 ± 3.57	10.31 ± 2.53	t= 0.879 P= 0.382
Gender			χ^2 =0.183
Male	23 (52.3%)	25 (56.8%)	P=0.669
Female	21 (47.7%)	19 (43.2%)	
Residence			χ^2 =0.046
Urban	19 (43.2%)	20 (45.5%)	P=0.830
Rural	25 (56.8%)	24 (54.5%)	
Nutritional history			χ^2 = 7.708
Breast feeding	15 (34.1%)	28 (63.6%)	P= **0.021***
Artificial feeding	17 (38.6%)	9 (20.5%)	
Mixed	12 (27.3%)	7 (15.9%)	
Paternal Smoking			χ^2 = 7.686
Negative	15 (34.1%)	28 (63.6%)	P= **0.006***
Positive	29 (65.9%)	16 (36.4%)	
Exposure to other triggers			
Negative	18 (40.9%)	29 (65.9%)	χ^2 = 5.526
Positive	26 (59.1%)	15 (34.1%)	P= **0.019***
Family history			χ^2 = 2.884
Negative	29 (65.9%)	36 (81.8%)	P = 0.089
Positive	15 (34.1%)	8 (18.2%)	
t: Independent samples t-test	**χ^2: Chi-square test**		
***: Statistically significant ($p < 0.05$)**			
Laboratory findings			
Variables	Cases group (n=44)	Control group (n=44)	Test of significance
Serum eosinophilic percentage Median (Min-Max)	8.87 (0.7 – 14.9)	5.46 (0.43 – 9.82)	Z= - 4.184 **P < 0.001***

Total IgE (IU/ml) **Median (Min-Max)**	208 (22 - 675)	29.35 (4.80 -57.9)	Z= - 7.215 **P < 0.001***
WBCs (10^3/µL) **Mean ± SD**	8.04 ± 0.93	6.74 ± 1.12	t= 5.879 **P < 0.001***
Neutrophil (%) **Mean ± SD**	62.23 ± 6.27	50.82 ± 7.73	t= 7.603 **P < 0.001***
Lymphocytes (%) **Mean ± SD**	28.89 ± 5.54	31.89 ± 5.71	t= -2.502 **P = 0.014***
Neutrophil/lymphocytes ratio **Mean ± SD**	2.23 ± 0.48	1.64 ± 0.38	t= 6.371 **P < 0.001***

t: Independent samples t-test **z: Mann-Whitney u-test**
***: Statistically significant (p < 0.05)**

Table (2): Clinical criteria in the asthmatic cases

	Cases group (n=44)
Clinical manifestations	
Shortness of breathing	33 (75%)
Wheezes	25 (56.8%)
Cough	18 (40.9%)
Fatigue	16 (36.4%)
Seasonal variations	14 (31.8%)
Increased sensitivity to cold	26 (59.1%)
Duration of illness (years) **Median (Min-Max)**	6 (5 -12)
Number of diurnal exacerbation (/week) **Median (Min-Max)**	2 (1 - 7)
Number of nocturnal attacks (/Months) **Median (Min-Max)**	0 (0 - 5)
Degree of asthma severity	
Mild	24 (54.5%)
Moderate	14 (31.8%)
Severe	6 (13.6%)
Atopic dermatitis	
Negative	30 (68.2%)
Positive	14 (31.8%)
Allergic rhinitis	
Negative	28 (63.6%)
Positive	16 (36.4%)
History of controller medications	
No	9 (20.5%)
ICS	15 (34.1%)
Leukotriene modifier	3 (6.8%)
ICS & Leukotriene modifier	5 (11.4%)
ICS & LABA	5 (11.4%)
ICS & Leukotriene modifier & LABA	7 (15.9%)
Level of asthma control	
Controlled	26 (59.1%)
Partially controlled	11 (25%)
Severely uncontrolled	7 (15.9%)

Table (3): Diagnostic value of Neutrophil/lymphocytes ratio to differentiate asthmatic cases from controls

Diagnostic criteria	**Neutrophil/lymphocytes ratio**
AUC	0.826
Cut off point	> 1.75
Sensitivity	79.5 %
Specificity	75.9 %
NPV	76.3 %
PPV	80.4 %
Accuracy	78.6 %
P	**< 0.001***

AUC: area under the curve. **NPV: Negative predictive value**
PPV: Positive predictive value **P: probability.**
***: significant p value (< 0.05).**

Table (4): Comparison of neutrophil lymphocyte ratio, and Comparison of neutrophil lymphocyte ratio according to asthma severity

Comparison of neutrophil lymphocyte ratio

Variables	Cases group (n=44)	Neutrophil lymphocyte ratio	Test of significance
Level of asthma severity			
Mild	24	1.83 ± 0.39	F= 6.485
Moderate	14	2.17 ± 0.41	**P< 0.001***
Severe	6	2.59 ± 0.60	
			P1 = 0.002*
			P2 < 0.001*
			P3 < 0.001*

F: One Way ANOVA test *: significant p value (< 0.05).
P1: Significance between mild and moderate cases.
P2: Significance between mild and severe cases
P3: Significance between moderate and severe cases

Comparison of neutrophil lymphocyte ratio

Variables	Cases group (n=44)	Neutrophil lymphocyte ratio	Test of significance
Level of asthma control			
Controlled	26	1.92 ± 0.48	F= 4.159
Partially controlled	11	2.20 ± 0.50	**P= 0.005***
Severely uncontrolled	7	2.46 ± 0.53	
			P1 = 0.036*
			P2 < 0.001*
			P3 = 0.059

F: One Way ANOVA test *: significant p value (< 0.05).
P1: Significance between controlled and partially controlled cases.
P2: Significance between controlled and severely uncontrolled cases
P3: Significance between partially controlled and severely uncontrolled cases

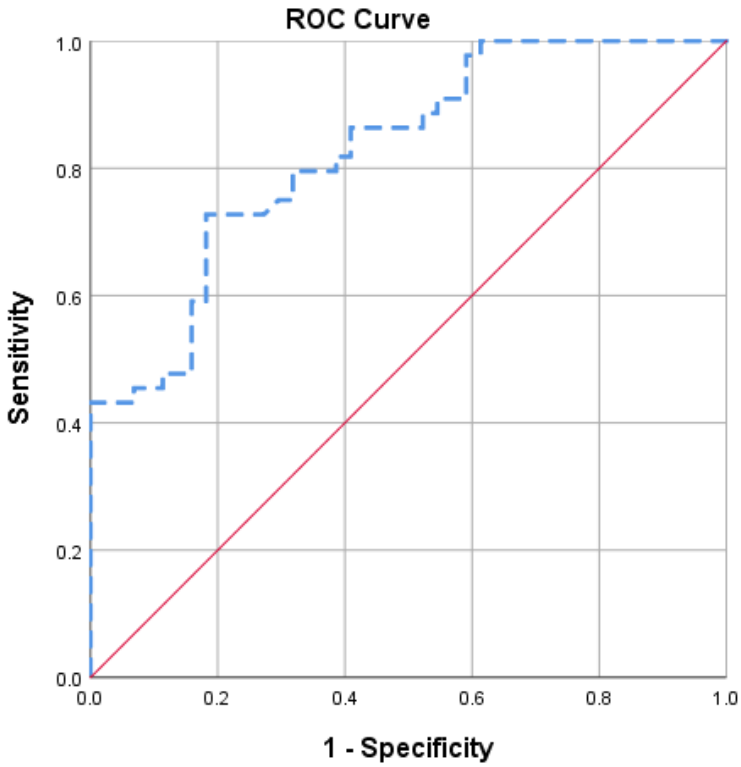

Figure (1): ROC curve of Neutrophil/lymphocytes ratio to differentiate asthmatic cases from controls

Discussion

The current study was conducted to evaluate the role of neutrophils to lymphocytes ratio as a biomarker in asthma severity and control. The current study included 44 children with asthma in addition to 44 apparently healthy children as a control group.

In the current study, the mean age among patients' group was 10.89 ± 3.57 as compared to 10.31 ± 2.53 among control group with no statistically significant difference.

According to Dogru and Mutlu[15], asthmatic cases and controls had mean ages of 8.58±3.25 years and 8.71±3.03 years respectively, with no significant difference. [15], which copes with the current study.

In a recent study [16], which included 25 asthmatic children and 25 healthy youngsters the results were contradictory. The study found that the control group had a higher mean age than the case group, with a significant difference.

The discrepancy can be elucidated by noting that the average age in this study was lower in both study groups as compared to our present investigation.

In the present study, the proportion of males compared to females was 52.3% versus 47.7% in the cases group and 56.8% versus 43.2% in the control group. The asthma group exhibited a greater proportion of males.

The current results resembled those of Archea et al [17], who studied 140 asthma patients in Cairo and found that 55% of male patients had asthma, higher than female patients.

In children under 14, male sex is a risk factor for asthma, explaining gender variations in asthma prevalence. The gap narrows as children grow, and by adulthood, women have more asthma than males. The causes of these gender variances are unclear [18].

More than half of the asthma cases in this research came from rural regions (56.8%). Consistent with this finding, a cross-sectional research in El-Minofiya found that 14.1% of the population had asthma, compared to 7.1% in urban areas [19].

On the other hand, in a Bolivian standardized questionnaire that was complemented to 2584 children revealed a higher prevalence of symptoms of asthma in urban area compared to rural area [20]. Distinct environmental conditions and geographical features may account for the observed variation.

Compared to the healthy control groups, the asthmatic cases in this study used artificial and mixed feedings more frequently.

This was consistent with Wilson et al[21], who found that any breastfeeding duration had a protective linear trend with ever asthma and that exclusive breastfeeding was duration-dependently protective of child asthma outcomes [21].

Human milk contains many bioactive elements that nourish gut bacteria and support lung growth, preventing wheezing and promoting healthy lung development [22, 23].

In the current study, the prevalence of parenteral smoking was statistically significantly higher in the asthmatic cases (65.9%) as compared to the control group (36.4%).

The current findings agreed with El-Mashad et al. [24] who reported that exposure to smoke had a highly significant effect as arisk factor for asthma [24].

This hypothesis proposes that post-natal tobacco smoke exposure can skew pulmonary immune responses toward Th2 pathways, raising inflammation, allergic disease risk, and infection susceptibility, which increases asthma risk [25].

In the current study, the prevalence of Atopic dermatitis was 31.8% and the prevalence of allergic rhinitis was 36.4%.

In agreement with Takejima et al. [26], allergic asthmatics exhibited more atopic dermatitis and rhinoconjunctivitis and, interestingly, increased disease severity than non-allergic asthmatics [26].

The atopic march describes the evolution of atopic illnesses from infantile atopic dermatitis (AD) to allergic rhinitis and asthma in children [27].

In the current study, regarding the level of asthma control, there were 26 controlled cases, 11 cases (25%) partially controlled and 7 cases (15.9%) were severely uncontrolled.

Gungen and Aydemir identified 51.4% controlled and partially controlled patients and 48.95% uncontrolled [28]. GINA revealed between 28.7 and 45% of asthmatic patients in a multicenter study of 10 significant Chinese cities obtained full and partial control [29].

Based on ACT sores, Yan et al. [30] identified good asthma control in 31.61% of moderate or severe asthmatics, partial asthma control with 40.27%, and poor asthma control in 28.12% [30].

It is reasonable to show these variations in the asthmatic cases between different studies and communities due to variations in the adherence to treatment.

In the current study, the eosinophilic percentage and total IgE were statistically significantly higher in the asthmatic cases as compared to the control group ($p < 0.001$).

This agreed with Zedan et al. [31] who reported the same finding that total serum IgE was significantly higher in asthmatic cases [31].

The results support Sykes et al**.** [32] and Uller et al. [33]. findings showing Asthmatic children had considerably lower IFN-β levels than controls. Previous research indicates IFN-β deficiency in asthmatic individuals [32, 33].

Reduction of IFN-β was previously tested in the asthmatic bronchial epithelium and showed that these cells failed to mount an effective innate immune response involving IFN-β [34]

In the current study, the WBCs count, neutrophil percentage and neutrophil/lymphocytes ratio were statistically significantly higher in the asthmatic cases as compared to the control group ($p < 0.001$). On the other hand, the percentage of lymphocytes was statistically significantly higher in the asthmatic cases as compared to the control group ($p = 0.014$).

According to Pan et al. [11] the case group had significantly greater white blood cells, neutrophils, and NLR ($p < 0.001$) and decreased lymphocytes ($p = 0.001$) compared to the control group [11].

The same meta-analysis by Huang et al. found that 743 stable asthma patients had substantially higher NLR values ($p = 0.002$) than 439 healthy controls [35].

Also, in accordance to the current results, the study by Elshony et al. [36] showed that NLR was statistically significantly higher in asthmatic patients ($p<0.001$) [36].

Darwesh and colleagues found that asthmatic patients had a mean WBC count of 8.3, compared to 7.3 for controls ($p=0.03$). High neutrophil/lymphocyte ratio significantly correlated with asthmatic cases ($p<0.001$), with 8% of asthmatic cases having low NLR and 24% having high NLR, compared to 2% of controls with high NLR [37]. This copes with the current results.

Among 482 pediatric patients, Wawryk-Gawda et al. [38] chose 107 without allergic illness symptoms for the control group. The asthma patients had a mean NLR of 3.42 ± 4.05, while the control group had 1.94 ± 1.91. Allergic asthma and control groups had statistically significant differences in NLR [38].

Neutrophils in asthmatic sputum and BL are related with increased IL-5, IL-8, and proinflammatory mediators. Active macrophages or epithelial cells produce IL-8, which recruits neutrophils and causes diffuse bronchial inflammation in severe acute asthma [39]. Patients with asthma have Th1/Th2 and Treg/Th17 imbalances, suggesting that activated T cells in the lungs are linked to asthma [40].

However, Bedolla-Barajas et al. found no NLR difference between adult asthmatics and controls. Patients in the research and control groups averaged 33 years old.

Asthmatics showed greater eosinophil and basophil counts, while neutrophil counts were similar to the control group. However, the authors believe that inflammatory cell count ratios are becoming more important asthma markers [41].

In the current study, NLR was statistically significantly higher in the cases with severe asthma compared to the cases with mild and moderate asthma. Also, the NLR was statistically significantly higher in the cases with moderate asthma compared to the cases with mild asthma.

This matched Pan and colleagues' study of 89 asthmatic children separated into acute asthma exacerbation and clinical remission groups. In the acute asthma exacerbation group, 54 individuals had mild asthma, 17 had moderate, and 10 had severe. The severe asthma exacerbation subgroup had the highest NLR levels [11].

Esmaeilzadeh and colleagues studied 211 children with mild to severe asthma exacerbation. The mean NLR differed considerably between hospitalized and non-hospitalized patients [42].

In addition, 402 individuals with asthma exacerbation had considerably higher NLR levels than 1063 patients with stable asthma, according to research by Huang et al. [35].

Patients with a higher neutrophil count in their sputum were more likely to visit the emergency room, according to Furukawa et al. This finding could indicate that neutrophils have a role in airway inflammation and the rapid worsening of patients' conditions [43].

Zhu also found that CRP elevates the NLR index, notably in asthma exacerbations. The study included 86 asthmatics, including 15 severe, 17 intermediate, and 54 mild asthmatics. Patients with moderate forms had an NLR value of 2.64, whereas those with severe forms had approximately three times that value [39].

Another Chinese group discovered that profoundly aggravated illness patients had a considerably greater NLR than stable and control patients [44].

Chinese Liu et al. found that severe asthma increases NLR [45]. The Japanese study by Mochimaru et al. found that acute asthma exacerbations in adults raise NLR levels [46].

Consequently, keeping a careful eye on this metric might help with managing the progression of the identified illness and gauging the body's reaction to treatment.

In the current study, the best cutoff point of Neutrophil/lymphocytes ratio to identify cases with asthma from control was > 1.75 with 79.5% sensitivity and 75.9 specificity. The AUC was 0.826 and the value was statistically significant ($p < 0.001$).

To differentiate between asthma sufferers and healthy individuals, Pan et al. employed ROC curve in their investigation. In terms of sensitivity (0.73) and specificity (0.906), the sweet spot for NLR cutoff levels was 1.723 [11].

With a sensitivity of 92.5%, specificity of 93.8%, PPV of 93.7%, and NPV of 92.6% (AUC = 0.97) NLR was demonstrated to be an effective predictor of asthma control at a threshold level > 1.32 in a study conducted by Elshony et al. [36]

Wawryk-Gawda et al. [38] reported that ROC analysis showed a suggested cutoff of 0.53 (using Younden's approach) for distinguishing between asthmatic and non-asthmatic individuals, with a sensitivity of 93% and a specificity of 24% [38].

The current results showed that NLR was statistically significantly higher in the cases with severely uncontrolled asthma compared to the cases with controlled asthma. Also, the NLR was statistically significantly higher in the cases with Partially controlled asthma compared to the cases with controlled asthma.

This was in accordance with Elshony et al. [36] who showed a statistically significant increased NLR in uncontrolled patients when compared to partially controlled patients and well controlled patients [36].

In a study conducted by Pang et al. [47] in Egypt, it was found that NLR accurately predicts poorly managed asthma in bronchial asthma patients based on their ACT classes [47].

Rather, the current study contradicts Imtiaz et al., [48] who failed to find a significant correlation between neutrophil/lymphocyte percentage and asthma control. However, this study relied on self-reporting to identify asthma cases, and it did not compare neutrophil/lymphocyte percentage with controls [48].

Although this study did find some results, there are a few caveats that could make the findings less convincing. Two major drawbacks include the study's single-center design and its small sample size. To address these limitations, we recommend conducting multi-center studies with larger sample sizes to enhance the generalizability and robustness of the findings. Furthermore, longitudinal study designs could provide more insight into causal relationships.

Conclusions:

Bronchial asthma is a common condition with a great impact in the health system and quality of life. Neutrophil/lymphocytes ratio could be used as non-invasive diagnostic biomarker for diagnosing asthma and is strongly correlated with degree of disease severity.

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