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Original Article

Paediatrics Section

Association of Neutrophil-Lymphocyte Ratio and C-reactive Protein with Disease Severity in Infants with Acute Bronchiolitis: A Retrospective Study

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ABSTRACT

Introduction: Acute bronchiolitis is a leading cause of hospitalisation in children under two years of age. Its clinical severity assessment is largely clinical; easily available inflammatory markers that correlate with severity may assist early risk stratification. However, data regarding the utility of Neutrophil–Lymphocyte Ratio (NLR) as a severity marker in Indian paediatric populations remain limited.

Aim: To evaluate the relationship between NLR, C-Reactive Protein (CRP), and disease severity in children aged 0-24 months hospitalised with acute bronchiolitis.

Materials and Methods: This retrospective study was conducted at the Department of Paediatrics, Karwar Institute of Medical Sciences, KRIMS, Karwar, Karnataka, India over two years (Data were collected from April 2023 to April 2025 and analysis was done in the period of May 2025 to September 2025) with a sample size of 182 children the study included children between the age group of 0-24 months. Disease severity was categorised as mild, moderate, or severe using a standardised bronchiolitis severity classification based on respiratory rate, heart rate, oxygen saturation, retractions, apnoea/cyanosis, and FiO_2 requirement. Complete blood count and admission CRP were recorded; NLR was calculated from differential leukocyte counts. One-way Analysis of Variance (ANOVA) was used to compare means of continuous variables across the three severity groups (mild, moderate, severe). Chi-square test was applied to compare categorical variables between groups. Kruskal-Wallis test (non parametric) was used for comparison of skewed continuous variables (e.g., CRP and NLR across severity groups).

Results: Among 182 children, 70 (38.5%) had mild, 60 (33.0%) moderate, and 52 (28.5%) severe bronchiolitis. Age and sex distribution were comparable across severity groups (p-value =0.08 and p-value=0.41). Mean age in months was 5.1±4.3 for mild, severly affected with severe disease were predominantly males (57.7%) when compared to females (42.3%). Clinical parameters worsened significantly with increasing severity, including higher heart rate and respiratory rate and lower SpO_2 (all p-value<0.001). CRP and NLR increased significantly across severity categories (CRP p-value=0.01; NLR p-value=0.004). Post-hoc analysis showed significantly higher CRP and NLR in moderate/severe groups compared with mild disease. Disease severity correlated positively with CRP (r-value=0.17, p-value=0.03) and NLR (r-value=0.21, p-value=0.008).

Conclusion: The values of NLR and CRP at admission correlate significantly with the severity of acute bronchiolitis and may serve as a practical adjunct marker for severity assessment in hospitalised infants.

Keywords: Inflammatory markers, Mucosal oedema, Respiratory syncytial virus infections

INTRODUCTION

Acute bronchiolitis is the most common lower respiratory tract infection in infants and young children, and remains a leading cause of hospitalisation in children under two years of age worldwide [1]. It is typically caused by viral pathogens, most commonly Respiratory Syncytial Virus (RSV), and is characterised by airway inflammation, mucosal oedema, and increased mucus production leading to airflow obstruction and respiratory distress [1-3]. Despite being a generally self-limiting illness, bronchiolitis can follow a severe clinical course, particularly in young infants, necessitating oxygen therapy, intensive care admission, and prolonged hospitalisation [2,4].

Acute phase reactants such as white blood cell count, CRP, and procalcitonin are frequently measured in clinical practice, although their role in predicting disease severity remains inconsistent [5,6].

Inflammation plays a central role in the pathophysiology of bronchiolitis. Studies have demonstrated that neutrophil predominance is a key feature of the inflammatory response in viral bronchiolitis, particularly RSV infection, with elevated neutrophil counts detected in airway secretions and blood samples [7,8]. In recent years, the NLR has emerged as a simple, inexpensive, and reproducible marker of systemic inflammation and physiological stress [9,10]. NLR has been shown to correlate with disease severity and outcomes in a variety of infectious and inflammatory conditions, including pneumonia, sepsis, and critical illness [11,12].

Limited paediatric studies have evaluated the role of NLR in bronchiolitis [13]. Previous reports suggest that higher NLR values are associated with more severe disease, reflecting an imbalance between innate and adaptive immune responses [13]. A study by Güneş Ö et al., demonstrated a significant association between increasing bronchiolitis severity and elevated NLR and CRP levels in hospitalised infants, highlighting the potential utility of these markers in clinical assessment [14]. However, Indian data on this association remain scarce, and there is a need for locally relevant evidence to support the use of NLR as a severity indicator in routine paediatric practice.

The present study was therefore undertaken to evaluate the relationship between NLR, CRP, and disease severity in children aged 0-24 months hospitalised with acute bronchiolitis, and to assess the potential role of these inflammatory markers as adjuncts to clinical severity assessment.

MATERIALS AND METHODS

This retrospective study was conducted in the Department of Paediatrics, Karwar Institute of Medical Sciences (KRIMS), Karwar, Karnataka, India over a period of two years. Data was collected of duration from April 2023 to April 2025 and analysis was done in the period of May 2025 to September 2025. The study population comprised children aged 0-24 months admitted with a clinical diagnosis of acute bronchiolitis. As acute bronchiolitis is more prevalent in this age group. Ethical approval was obtained from the Institutional Ethics Committee (approval number - IEC/KRIMS/O/53/2025-26), and the study adhered to the principles of the Declaration of Helsinki 2013.

Inclusion criteria: Children aged 0-24 months hospitalised for bronchiolitis with complete clinical and laboratory records were included. The diagnosis of bronchiolitis was based on clinical features such as tachypnoea, chest retractions, wheezing, prolonged expiration, and a preceding history of upper respiratory tract infection. Radiological findings, when available, included hyperinflation, peribronchial infiltrates, or atelectasis.

Exclusion criteria: Children with severe immunodeficiency, chronic neurological or cardiac disease, or incomplete records were excluded from the study.

Sample size: The sample size was calculated based on the expected correlation between disease severity and NLR. Assuming a correlation coefficient (r) of 0.206, with 80% power and a 5% level of significance, the required sample size was 182 patients, all of whom were included in the final analysis [15].

r = 0.206, the expected correlation coefficient between NLR and disease severity

Sample size: $r= (Z \text{ alpha}/2+Z \text{ beta})^2 \div (C)^2 + 3$

Where C =: C=0.5×ln{(1+r)/(1-r)}

C=0.5 *ln {1.206}/ln {0.794}

C=0.5×0.42

=0.2094

n=(1.96+0.84)^2/(0.2094) ^2+3

(13.34) ^2+3

=181.72……Approximately, =182.

Z alpha /2=1.96 -> standard normal variable at 5% level of significance.

Z beta =0.84->standard normal variable at 80% power.

Data collection: Disease severity was assessed at admission using the Wang Clinical Severity Score, a validated clinical scoring system for acute bronchiolitis based on respiratory rate, wheezing/respiratory distress, retractions, and general condition, with additional consideration of oxygen saturation and apnoea. Patients were categorised into mild, moderate, and severe bronchiolitis according to total score [16]. Laboratory parameters were retrieved from medical records. For complete blood count, 1-2 mL of blood was taken into an EDTA tube and studied in an ERBA H560 automated haemanalyser coulter machine, and the NLR of the patients was calculated. CRP of the patient was also obtained [17]. Complete blood count was analysed using an automated haematology analyser, and the NLR was calculated from differential counts. Serum CRP levels were measured at admission.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 27.0. Continuous variables were assessed for normality using the Shapiro-Wilk test and summarised as mean±standard deviation or median (interquartile range), as appropriate. Comparisons among the three severity groups were performed using One-way ANOVA for normally distributed variables and the Kruskal-Wallis test for non normally distributed variables. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Correlation between bronchiolitis severity score and inflammatory markers was assessed using Pearson correlation coefficient. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline demographic characteristics were comparable across bronchiolitis severity groups. Mean age did not differ significantly (ANOVA, p-value=0.08), and sex distribution was also similar (χ^2, p-value=0.41). These findings indicate that age and sex were evenly distributed across severity groups, suggesting that subsequent differences observed in clinical parameters and inflammatory markers are unlikely to be confounded by baseline demographic factors [Table/Fig-1].

Variable	Mild (n=70)	Moderate (n=60)	Severe (n=52)	p-value
Age (months), Mean±SD	5.1±4.3	6.9±5.8	6.2±5.1	0.08[a]
Sex, n (%)				0.41[b]
Male	41 (58.6)	36 (60.0)	30 (57.7)	
Female	29 (41.4)	24 (40.0)	22 (42.3)	

[Table/Fig-1]: Baseline demographic characteristics according to bronchiolitis severity (n=182).
*Statistical tests: [a]One-way ANOVA; [b]Chi-square test

Clinical parameters at admission demonstrated a clear and progressive worsening with increasing bronchiolitis severity. Heart rate and respiratory rate increased significantly with bronchiolitis severity, indicating rising physiological and respiratory distress (p-value<0.001). Oxygen saturation decreased progressively, with the lowest values in severe cases, while higher FiO_2 requirement (>0.4) was significantly more common in the severe group (p-value<0.001). These findings reflect worsening clinical status with increasing severity [Table/Fig-2].

Parameter	Mild (n=70)	Moderate (n=60)	Severe (n=52)	p-value
Heart rate (bpm), Mean±SD	132±12	148±15	162±18	<0.001[a]
Respiratory rate (cpm), Mean±SD	44±5	58±6	74±8	<0.001[a]
SpO_2 at admission (%), Mean±SD	95.2±1.8	89.6±2.4	82.4±3.1	<0.001[a]
FiO_2 > 0.4, n (%)	6 (8.6%)	21 (35.0%)	38 (73.1%)	<0.001[b]

[Table/Fig-2]: Clinical severity parameters at admission.
*Statistical tests: [a]One-way ANOVA; [b]Chi-square test

Collectively, these findings validate the clinical severity classification used in the study and confirm that increasing bronchiolitis severity is associated with significant deterioration in cardiorespiratory parameters at presentation.

In present study, serum CRP concentrations showed a progressive increase from mild to severe disease, with children in the severe group exhibiting the highest mean and median values. CRP levels differed significantly across severity groups, indicating increasing systemic inflammation with worsening disease (Kruskal–Wallis, p-value=0.01). The NLR also showed a significant stepwise rise from mild to severe bronchiolitis (p-value=0.004), supporting its association with disease severity. The consistent increase in both CRP and NLR with worsening clinical severity underscores their association with the inflammatory burden in acute bronchiolitis and supports their potential utility as accessible biomarkers for assessing disease severity at presentation [Table/Fig-3].

Post-hoc pairwise analysis using Dunn's test showed that both CRP and NLR were significantly higher in children with moderate and severe bronchiolitis compared with mild disease. Significant

differences were observed for CRP between mild vs moderate (p-value=0.03) and mild vs severe groups (p-value=0.001), while no difference was seen between moderate vs severe groups (p-value=0.12). Similarly, NLR was higher in moderate and severe cases than mild disease (p-value=0.002 and p-value=0.004, respectively), with no significant difference between moderate and severe groups (p-value=0.29). These findings indicate that CRP and NLR are useful in distinguishing mild from more severe bronchiolitis, but have limited ability to separate moderate from severe disease [Table/Fig-4].

Variable	Mild (n=70)	Moderate (n=60)	Severe (n=52)	p-value
CRP (mg/L)				
Mean±SD	11.8±28.6	26.4±44.9	35.7±51.2	0.01[c]
Median (IQR)	4.1 (1.3-11.9)	12.2 (4.0-24.8)	18.6 (6.1-39.4)	
NLR				
Mean±SD	0.72±0.54	1.58±1.83	1.89±1.67	0.004[c]
Median (IQR)	0.56 (0.32-0.91)	0.92 (0.48-2.21)	1.24 (0.62-2.43)	

[Table/Fig-3]: Association between inflammatory markers and disease severity.
*Statistical test:[c]Kruskal-Wallis test

Correlation analysis demonstrated no significant association between disease severity score and age of the children (Pearson's r-value=0.09, p-value=0.27), indicating that age did not influence the clinical severity of bronchiolitis in the study population. In contrast, serum CRP levels showed a weak but statistically significant positive correlation with disease severity (r-value=0.17, p-value=0.03), suggesting increasing systemic inflammation with worsening clinical status. Notably, the NLR exhibited the strongest positive correlation with disease severity, with a statistically significant association (r-value=0.21, p-value=0.008). These findings indicate that NLR correlates more closely with clinical severity than CRP, supporting its potential role as a simple and reliable inflammatory marker for assessing disease severity in children with acute bronchiolitis [Table/Fig-5-7].

Comparison	CRP (p)	NLR (p)
Mild vs Moderate	0.03	0.002
Mild vs Severe	0.001	0.004
Moderate vs Severe	0.12	0.29

[Table/Fig-4]: Pairwise comparison of CRP and NLR between severity groups.
Statistical test: Dunn's post-hoc multiple comparison test. CRP expressed in mg/L; NLR expressed as ratio (unitless).

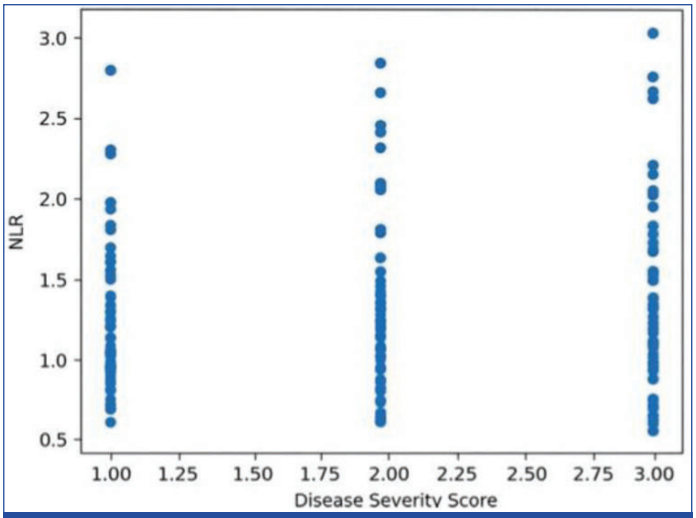
Variable	Correlation coefficient (r)	p-value
Age (months)	0.09	0.27
CRP (mg/L)	0.17	0.03
NLR	0.21	0.008

[Table/Fig-5]: Correlation of disease severity score with age and inflammatory markers.
Statistical test: Pearson correlation

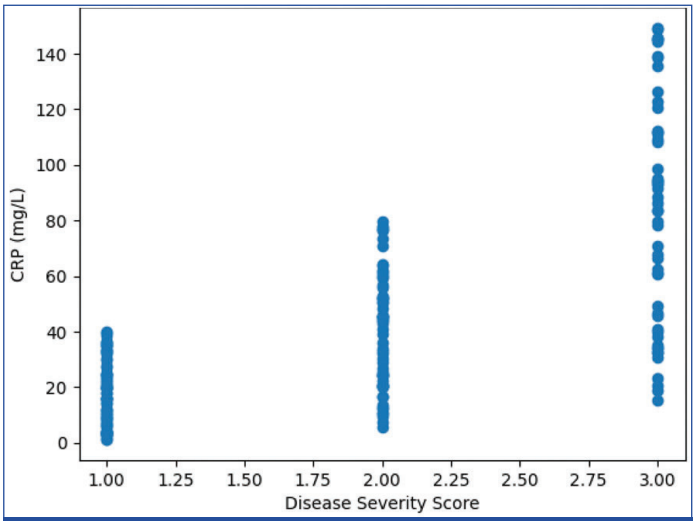
DISCUSSION

Acute bronchiolitis remains a major cause of hospitalisation in infants and young children, particularly in those under two years of age, with disease severity ranging from mild, self-limiting illness to severe respiratory failure requiring intensive support [1]. The present study evaluated the relationship between NLR, CRP, and clinical disease severity in hospitalised children with acute bronchiolitis, and demonstrated a significant association between increasing severity and elevated inflammatory markers.

Consistent with previous literature, baseline demographic characteristics such as age and sex did not differ significantly across severity groups, suggesting that these factors did not influence disease severity [2,4]. Similar observations were reported by Güneş Ö et al., who found no association between age, gender,



[Table/Fig-6]: Scatter dot plot showing distribution of Neutrophil-Lymphocyte Ratio (NLR) across bronchiolitis disease severity categories, illustrating a positive association between bronchiolitis severity score and NLR levels, with higher NLR values observed as disease severity increases (Pearson correlation, r = 0.21, p-value = 0.008).



[Table/Fig-7]: Scatter dot plot showing distribution of CRP across bronchiolitis severity categories, illustrating a positive association between bronchiolitis severity score and CRP levels, with higher CRP values observed as disease severity increases (Pearson correlation, r=0.17, p=0.03).

and bronchiolitis severity in hospitalised infants [14]. These findings support the view that clinical severity is more closely related to inflammatory response than to demographic variables.

Clinical parameters at admission showed a clear stepwise deterioration with increasing severity, including higher heart and respiratory rates, lower oxygen saturation, and increased requirement for supplemental oxygen. This validates the severity classification used in the present study and aligns with established clinical scoring systems described in international guidelines [3,5]. Such findings reinforce that bronchiolitis severity reflects progressive respiratory compromise rather than isolated laboratory abnormalities.

The key finding of this study was the significant increase in NLR and CRP levels with worsening bronchiolitis severity. Serum CRP values were significantly higher in moderate and severe disease compared to mild disease, consistent with earlier studies demonstrating elevated CRP levels in severe lower respiratory tract infections [5,18]. However, as noted by Costa S et al., and others, CRP alone may not consistently distinguish between moderate and severe disease, which was also observed in the present study post-hoc analysis [6,7].

Notably, NLR demonstrated a stronger correlation with disease severity than CRP, showing a significant positive association and a clear stepwise increase across severity groups. This finding was in agreement with studies by Güzel EÇ et al., and Güneş Ö et

al., who reported higher NLR values in children with more severe bronchiolitis [14,16]. The biological plausibility of this association lies in the neutrophil-predominant inflammatory response characteristic of viral bronchiolitis, particularly RSV infection, along with relative lymphocyte suppression during systemic stress [7,8].

The NLR has been increasingly recognised as a valuable inflammatory marker in infectious and critical illnesses due to its simplicity, cost-effectiveness, and availability [9,10]. Studies in pneumonia and sepsis have demonstrated its prognostic significance, often outperforming conventional markers such as total leukocyte count or CRP [11,12]. The present study findings extend this evidence to acute bronchiolitis, supporting the role of NLR as a useful adjunct to clinical assessment. The relatively large sample size and standardised severity assessment strengthen the validity of the present study findings.

Limitation(s)

Being a single-centre study, the findings may have limited generalisability. Additionally, comparison with healthy controls was not performed. Longitudinal outcomes such as duration of hospitalisation, need for intensive care, or mechanical ventilation were not analysed in relation to inflammatory markers. Prospective multicentre studies are needed to further validate these findings.

CONCLUSION(S)

The present study demonstrated that NLR, in conjunction with CRP, correlates significantly with clinical severity in children with acute bronchiolitis. Recommendations for future studies include conducting larger multicentre prospective studies to validate the utility of NLR and CRP as severity biomarkers in acute bronchiolitis across diverse populations. Serial measurement of these markers during hospitalisation may help determine their prognostic value in predicting disease progression, need for intensive care, and duration of hospital stay. Further research comparing NLR and CRP with established clinical severity scores and other emerging biomarkers is also warranted.

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REFERENCES

[1] Florin TA, Plint AC, Zorc JJ. Viral bronchiolitis. Lancet. 2017;389(10065):211-24.
[2] Meissner HC. Viral bronchiolitis in children. N Engl J Med. 2016;374(1):62-72.
[3] Ralston SL, Lieberthal AS, Meissner HC, Alverson BK, Baley JE, Gadomski AM, et al. Clinical practice guideline: The diagnosis, management, and prevention of bronchiolitis. Pediatrics. 2014;134(5):e1474-e1502.
[4] Schroeder AR, Mansbach JM. Recent evidence on the management of bronchiolitis. Curr Opin Pediatr. 2014;26(3):328-33.
[5] Costa S, Rocha R, Tavares M, Bonito-Vítor A, Guedes-Vaz L, João HS. C-reactive protein and disease severity in bronchiolitis. Rev Port Pneumol. 2009;15(1):55-65.
[6] Ergül AB, Torun YA, Uytun S, Aslaner H, Kısaaslan AP, Şerbetçi MC. Reduction in mean platelet volume in children with acute bronchiolitis. Turk Pediatri Ars. 2016;51(1):40-45.
[7] Li YT, Liang Y, Ling YS, Duan MQ, Pan L, Chen ZG. The spectrum of viral pathogens in children with severe acute lower respiratory tract infection: A 3-year prospective study in the pediatric intensive care unit. J Med Virol. 2019;91(9):1633-42.
[8] Hopstaken RM, Muris JW, Knottnerus JA, Kester AD, Rinkens PE, Dinant GJ. Contributions of symptoms, signs, erythrocyte sedimentation rate, and C-reactive protein to a diagnosis of pneumonia in acute lower respiratory tract infection. Br J Gen Pract. 2003;53(490):358-64.
[9] Zahorec R. Neutrophil-to-lymphocyte ratio: Past, present and future perspectives. Bratisl Lek Listy. 2021;122(7):474-88.
[10] de Jager CPC, Wever PC, Gemen EFA, Kusters R, van Gageldonk-Lafeber AB, van der Poll T, et al. The neutrophil–lymphocyte count ratio in patients with community-acquired pneumonia. PLoS One. 2012;7(10):e46561.
[11] Hwang SY, Shin TG, Jo IJ, Jeon K, Suh GY, Lee TR, et al. Neutrophil-to-lymphocyte ratio as a prognostic marker in critically ill septic patients. Am J Emerg Med. 2017;35(2):234-39.
[12] Huang Y, Liu A, Liang L, Jiang J, Luo H, Deng W, et al. Blood parameters in pneumonia. Int Immunopharmacol. 2018;64:10-15.
[13] Güzel EÇ, Fidan Ç, Güzel S, Paketçi C, Çelikkol A. Bronşiolitli çocuklarda hastalık aktivitesinin değerlendirilmesinde nötrofil/lenfosit oranı yeni bir biyobelirteç olabilir mi? (Could the neutrophil/lymphocyte ratio be a novel biomarker for assessing disease activity in children with bronchiolitis?) Namik Kemal Med J. 2019;7(1):13-18.
[14] Güneş Ö, Erol M, Gayret ÖB, Özel A, Büke Ö. Evaluation of the relationship between the severity of the disease, the neutrophil/lymphocyte ratio and CRP in children with bronchiolitis. Bagcilar Med Bull. 2021;6(4):438-43.
[15] Suenera PV, Umapathy N, Janani MZ, Pradeep S. Association of neutrophil-lymphocyte ratio and C-reactive protein levels with disease severity in children with bronchiolitis: A prospective observational study. TPM [Internet]. 2025 [cited 2026 May 19];32(S1 (2025): Posted 12 May):1203-08.
[16] Wang EE, Milner RA, Allen U, Maj H. Bronchodilator therapy in acute bronchiolitis: A randomized trial. J Pediatr. 1992;121(4):633-37.
[17] Bain BJ, Bates I, Laffan MA. Dacie and Lewis Practical Haematology. 12th ed. Elsevier; 2017, 1001-56.
[18] Bircan A, Kaya O, Gökirmak M, Oztürk O, Sahin U, Akkaya A. C-reactive protein, leukocyte count and ESR in the assessment of severity of community-acquired pneumonia. Tuberk Toraks. 2006;54(1):22-29.

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