

Literature Review: Leukocyte, Neutrophil, and Neutrophil-Lymphocyte Ratio Levels Based on Chest X-Ray Images of Pneumonia Patients

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Abstract. *Pneumonia is an infectious disease associated with substantial morbidity and mortality. Inflammatory biomarkers, including leukocyte count, neutrophil count, and the neutrophil-to-lymphocyte ratio (NLR), may support the assessment of inflammatory severity when interpreted alongside chest radiographic findings. This study aimed to review leukocyte, neutrophil, and NLR levels based on chest X-ray findings in patients with pneumonia. A systematic literature review was conducted using the PICOS framework and PRISMA 2020 selection process. Relevant studies published in English between 2020 and 2026 were identified through PubMed, Scopus, ScienceDirect, and Google Scholar. Full-text original research articles examining leukocyte, neutrophil, or NLR levels in pneumonia patients with radiological evaluation were included. Of 7,203 initially identified records, 15 studies met the eligibility criteria and were included in the review. The synthesis showed that patients with more severe pneumonia generally had higher leukocyte counts, neutrophil levels, and NLR values. Increased inflammatory markers were also associated with bacterial pneumonia, extensive pulmonary involvement, lung consolidation, intensive care requirements, prolonged hospitalization, and an increased risk of mortality. Among the evaluated parameters, NLR was the most consistently associated with pneumonia severity and clinical outcomes. However, the reviewed studies used different NLR cut-off values, populations, and study designs, contributing to heterogeneity across findings. In conclusion, leukocyte count, neutrophil count, and particularly NLR are simple and accessible laboratory parameters that may complement chest X-ray findings in evaluating inflammation and pneumonia severity. Further studies are required to establish standardized NLR thresholds for clinical application.*

Keywords: *Chest X-Ray, Leukocytes, Neutrophils, Neutrophil-To-Lymphocyte Ratio, Pneumonia*

Received: July 16, 2026

Received in Revised: August 20,
2026

Accepted: September 25, 2026

INTRODUCTION

Pneumonia is a major health problem with a high morbidity rate and is associated with increased mortality in both the short and long term. It is also one of the leading infectious causes of death across all age groups worldwide (Cillóniz et al., 2021). Based on data from the 2023 Indonesian Health Survey, the prevalence of pneumonia across all age groups in Indonesia reached 10.8% of the total population. The provinces with the highest prevalence were Highlands Papua (36.6%), Central Papua (25.8%), and East Nusa Tenggara (22.1%). The increase in pneumonia incidence is particularly evident in certain age groups, namely children under 4 years of age and individuals aged 65 years and older. In the United States, an estimated 2.2 to 8 million

cases of pneumonia require hospitalization each year, while other reports indicate the annual number of cases exceeds 5 million (Sattar et al., 2024).

Pneumonia is an infectious disease that can be caused by various microorganisms, such as bacteria, viruses, and fungi. Medically, pneumonia is defined as inflammation of one or both lung parenchyma (Ibrahim et al., 2024; Zambare & Thalkari, 2019; Anwar et al., 2024; Zar et al., 2024). This inflammatory process affects the body's immune response, particularly neutrophils and lymphocytes. Neutrophils are the first type of leukocyte to respond to bacterial infection, while lymphocytes play a role in the long-term immune response to infection. In pneumonia, the inflammatory process can increase the number of neutrophils and lymphocytes in the blood, so the Neutrophil-Lymphocyte Ratio (NLR) can be used as an indicator to assess the immune response and disease severity (Luo et al., 2022; Buonacera et al., 2022; Zahorec, 2021; Cataudella et al., 2017; Pantzaris et al., 2018; Kuikel et al., 2022; Curbelo et al., 2019).

Leukocytes and neutrophils are key components of the immune system, playing a role in the initial response to bacterial infections in the lungs. Neutrophils can migrate to the site of infection through leukocyte extravasation, then undergo phagocytosis to destroy pathogens. (Zhang et al., 2021). However, an excessive or prolonged neutrophil response can cause lung tissue damage, increase edema, and worsen respiratory function (Korkmaz & Traber, 2023). In pneumonia, which is generally caused by bacterial or viral infections, the NLR test can provide insight into the body's inflammatory response to pathogens. An increased NLR value is also often associated with a worse prognosis because it reflects a more severe inflammatory process and a higher risk of complications (Lee et al., 2021).

In addition to blood tests to calculate the NLR, the diagnosis of pneumonia is generally confirmed using a chest x-ray. A chest x-ray is an X-ray imaging test used to view the structure of organs within the chest cavity (Konietzke et al., 2020). In patients with pneumonia, this examination can reveal characteristic changes in the lungs that indicate infection, such as fluid or mucus buildup. Chest x-rays also play an important role in monitoring disease progression and evaluating the patient's response to therapy (Janizek et al., 2020; Baratella et al., 2020; Elsharkawy et al., 2021; Cellina et al., 2020; Jiao et al., 2021; Irede et al., 2026).

However, although most studies demonstrate an association, the amount of literature evaluating leukocyte, neutrophil, and neutrophil-lymphocyte ratio levels based on chest x-rays in pneumonia patients is still limited. Therefore, a comprehensive literature review is needed to summarize the findings from various studies to provide a more comprehensive picture of leukocyte, neutrophil, and neutrophil-lymphocyte ratio levels based on chest x-rays in pneumonia patients.

METHODS

Research Sources and Methods

This study is a systematic literature review that systematically analyzes previous research using the PICOS Framework. Primary studies are represented by individual studies, while the literature review is included in secondary research. The approach applied combines quantitative and qualitative methods. The purpose of this review is to determine the levels of leukocytes, neutrophils, and the neutrophil-lymphocyte ratio based on chest radiographs in pneumonia patients. The search was conducted using electronic databases such as PubMed, Scopus, Science Direct, and Google Scholar. These electronic databases were assessed from 2020 to 2026. Additional studies were also identified by reviewing reference lists based on journal titles and individual keywords related to leukocyte, neutrophil, and neutrophil-lymphocyte ratio levels based on chest radiographs in pneumonia patients.

Research Time and Location

This research was conducted from June to July 2026. This research was conducted online on several scientific databases such as PubMed, Scopus, Science Direct, and Google Scholar.

Inclusion and Exclusion Criteria

The study's findings were limited to English-language scientific articles published between 2020 and 2026. Inclusion criteria included full-text research articles written in English that discussed leukocyte, neutrophil, and neutrophil-to-lymphocyte ratio levels based on chest radiographs in pneumonia patients. Exclusion criteria included publications that were not scientific research articles, such as review articles, news articles, opinion pieces, commentaries, or conference abstracts; articles identified as duplicate publications; and articles with titles or discussions irrelevant to the research focus.

Data Collection Techniques

Articles were thoroughly screened before being selected for this systematic review. First, any papers that did not meet the inclusion criteria in the title were excluded. Second, article abstracts were screened, and any articles that did not meet the inclusion criteria were excluded, and duplicate studies were removed. Finally, the remaining articles were reviewed, and any articles that did not meet the inclusion criteria were excluded. Data collection in this study was conducted through a systematic scientific literature search in electronic databases such as: (1) PubMed; (2) Scopus; (3) Science Direct; and (4) Google Scholar. The literature search used a combination of keywords designed based on the main research concepts, in English. Examples of keywords used include: "pneumonia" OR "community-acquired pneumonia," "leukocyte" OR "white blood cell" OR "WBC," "neutrophil" OR "neutrophilia," "neutrophil-to-lymphocyte ratio" OR "NLR" OR "neutrophil-lymphocyte ratio," "chest radiograph" OR "chest X-ray." Articles were screened based on criteria including articles published between 2020 and 2026, articles that were available for full-text download and had open access, and articles with qualitative and quantitative designs that discussed neutrophil-lymphocyte ratio levels in pneumonia patients.

Data Management

Data analysis in this study was conducted using the PICOS (Population, Intervention, Comparison, Outcome, Study Design) approach to ensure the literature synthesis process runs systematically and in a directed manner; (1) Population, namely the population and sample as the target research subjects; (2) Intervention, namely the influence or provision that is to be assessed on the group; (3) Comparative, namely the group with the application that is the comparison group for the intervention; (4) Outcome, namely the results of the analysis obtained; (6) Study Design, namely observational or analytical research designs such as cross-sectional, case-control, cohort, as well as descriptive studies and surveys.

Variable Identification

The independent variables in this study were leukocyte, neutrophil, and neutrophil-lymphocyte levels. The dependent variable was the chest radiograph of pneumonia patients.

Operational Definition

Table 1. Operational Definitions

No.	Variable Types	Definition	Measuring instrument	Measuring Scale	Objective Criteria
1.	Leukocyte Levels	The total number of white blood cells in one microliter of blood as detected by laboratory examination.	Complete Blood Count (CBC) was taken from data reported in primary studies.	Ordinal	Normal: 4,000-11,000/mm ³ Leukocytosis: >11,000/mm ³

2.	Neutrofil	Neutrophils are a fraction of white blood cells that are measured through a Complete Blood Count (CBC) examination with a leukocyte differential count, which describes the number of neutrophil cells in the patient's blood circulation during the examination.	Complete Blood Count (CBC) was taken from data reported in primary studies.	Ordinal	Normal: 40-70% Neutrofilia: >70% Neutropenia: <40%
3.	Neutrophil Lymphocyte Ratio	The ratio between the absolute neutrophil count and the absolute lymphocyte count is a parameter that is an indicator of bloodstream infection in patients.	Complete Blood Count (CBC) was taken from data reported in primary studies.	Ordinal	Normal: < 3.5 - Increase: 3.5
4.	Chest X-ray of Pneumonia	The picture of lobar pneumonia is characterized by consolidation and homogeneous opacity in one or more lobes spread over both lungs.	Clinical diagnosis and/or radiological confirmation (chest x-ray) listed in the primary study	Nominal	- Unilateral - Bilateral

Research Flow

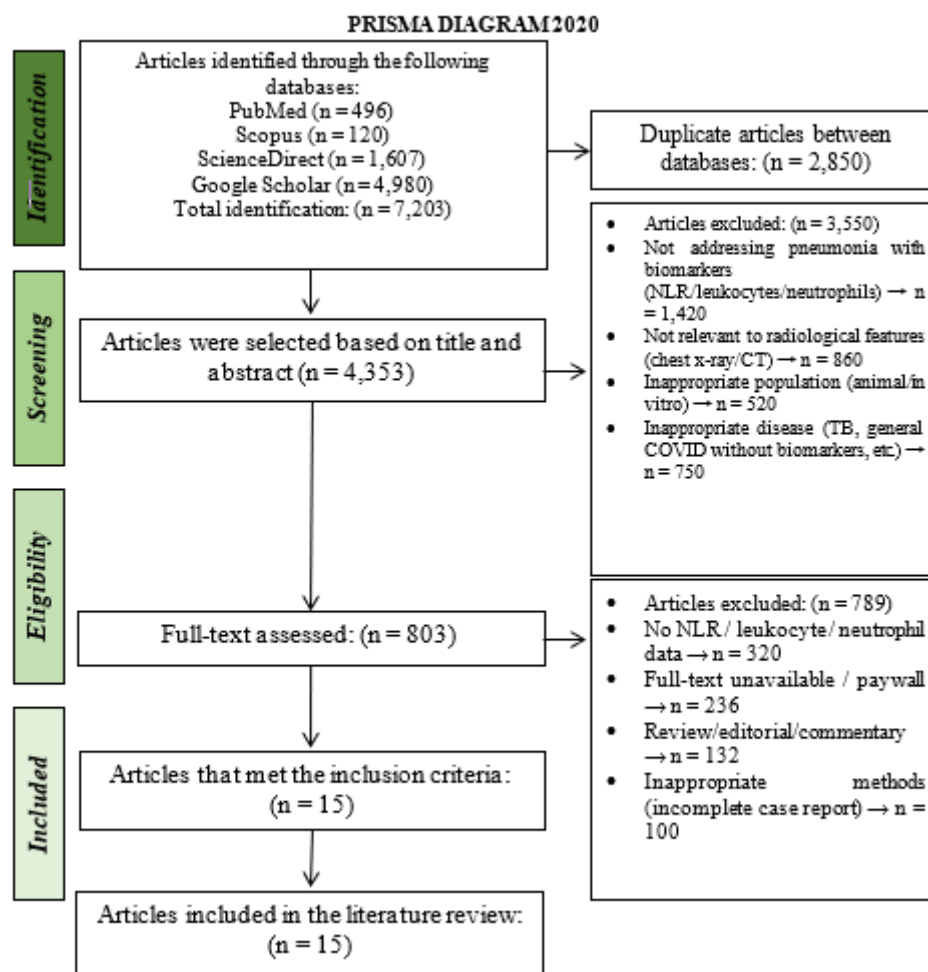


Figure 1. Research Flow

RESULT AND DISCUSSION

Literature Selection Results

The literature search for this study was conducted by searching several scientific databases, including PubMed, Scopus, ScienceDirect, and Google Scholar. Selected articles were limited to publications within a year range that aligns with the development of research on inflammatory biomarkers in pneumonia, namely, 2020-2026. The article selection process followed the PRISMA 2020 process to ensure clarity and retrieval of each step.

The initial search resulted in 7,203 articles from all databases. After checking for duplication, 2,850 articles had to be removed due to multiple occurrences. This left 4,353 articles to be screened based on their titles and abstracts. At this stage, the majority of articles did not meet the research requirements. 3,550 articles were excluded because they did not discuss pneumonia, did not assess blood biomarkers such as leukocytes, neutrophils, or NLR, or were not related to chest radiography. After this process, 803 articles remained, which were then read in full. When entering the full-text assessment stage, a more rigorous screening process was conducted. A total of 790 articles were excluded because they did not contain required data, such as NLR or leukocyte parameters, were review articles without research data, or were not fully accessible. In the final step, only 15 articles fully met the criteria and were used in this review.

Article Description

Table 2. Article Description

Author	Year	Source
Dyaneshwar Nirgude et al.	2021	Google Scholar
Jie Liu et al.	2025	Scopus
Jinghua Wu et al.	2021	PubMed
Dan Li et al.	2023	Scopus
Yue Meng et al.	2023	ScienceDirect
E Çil et al.	2022	Google Scholar
Tord A Florin et al.	2020	Google Scholar
Abhisek Ghosh et al.	2025	Scopus
Aliye Gamze Calis et al.	2025	PubMed
Maya Lakshmanan et al.	2025	ScienceDirect
Ahmed Omran et al.	2022	PubMed
Junlin Zhao et al.	2026	Scopus
Sai Luo et al.	2022	Google Scholar
Aida Mujaković et al.	2022	PubMed
Zakir Hossion et al.	2026	Scopus

Research Result

After several screening processes based on inclusion and exclusion criteria, the articles selected for review are summarized in Table 3.

Table 3. Literature Review

No	Research Title	Population (P)	Intervention (I)	Comparative ©	Outcome (O)	Study Design (S)
1	Dyaneshwar Nirgude et al. (2021) - <i>Study of Absolute Neutrophil Absolute Lymphocyte count ratio in Community Acquired Pneumonia patients as a prognostic indicator at a tertiary care centre</i>	Adult patients aged ≥18 years with a diagnosis of Community-Acquired Pneumonia (CAP) who were hospitalized in Bangalore, India. The total study sample was 100 patients.	Measurement of Absolute Neutrophil Count (ANC), Absolute Lymphocyte Count (ALC), and Neutrophil-Lymphocyte Count Ratio (NLCR/NLR) on days 1, 3, and 7 of treatment to assess their prognostic value in CAP patients	Comparison of NLCR values based on ICU care requirements, as well as between patients who died and survived during treatment.	The results showed that leukocyte, neutrophil, and NLR levels gradually decreased during the first, third, and seventh days of treatment in pneumonia patients. The decrease in these three parameters indicates that the systemic inflammatory response gradually diminished as therapy was successful and the patient's clinical condition improved.	Prospective Study
2	Jie Liu et al. (2025) - <i>Comparative analysis of the clinical characteristics of severe Mycoplasma pneumoniae pneumonia and severe bacterial pneumonia in children</i>	316 children were treated with severe pneumonia at Henan Children's Hospital, China. The patients were divided into three groups based on etiology: 130 cases of	Examination of clinical characteristics, laboratory parameters (including leukocytes/WBC, neutrophil percentage, lymphocyte percentage, CRP, ESR, PCT, IL-6, ALT, AST, CK,	Comparisons were made between three patient groups, namely SMPP vs SPP, SMPP vs SHIP, and SPP vs SHIP, to determine differences in clinical characteristics, laboratory	The results showed that leukocyte levels differed significantly among the three patient groups (p <0.001). The SHIP group had the highest median leukocyte count, followed by the SPP group, while the SMPP group had the lowest value. Further analysis showed a significant difference between the SMPP and	Studi Observasional retrospektif

		severe Mycoplasma pneumoniae pneumonia (SMPP), 81 cases of severe Streptococcus pneumoniae pneumonia (SPP), and 105 cases of severe Haemophilus influenzae pneumonia (SHIP) in children.	CK-MB, LDH, and D-dimer), as well as imaging examinations (thoracic CT) and fiberoptic bronchoscopy	results, and imaging features..	SPP groups ($P_1 = 0.007$) and SMPP and SHIP ($P_2 < 0.001$), while SPP and SHIP did not differ significantly ($P_3 = 0.634$). The percentage of neutrophils also showed a significant difference ($p = 0.008$). The SPP group had the highest neutrophil percentage, higher than both SMPP and SHIP, indicating a stronger acute inflammatory response in that group.	
3	Jinghua Wu et al (2021) - <i>The value of lymphocyte-to-monocyte ratio and neutrophil-to-lymphocyte ratio in differentiating pneumonia from upper respiratory tract infection (URTI) in children: a cross-sectional study</i>	Children diagnosed with pneumonia who received inpatient and outpatient treatment at Zhejiang Provincial People's Hospital, China. A total of 5,211 children were enrolled in the retrospective cohort, and 2,548 children were diagnosed with pneumonia.	Blood biomarker tests include the Neutrophil-to-Lymphocyte Ratio (NLR) and Lymphocyte-to-Monocyte Ratio (LMR), which are calculated from routine blood tests. The blood parameters assessed include white blood cell count (WBC), neutrophil cell count (NC), lymphocyte cell count (LC), monocyte cell count (MC), and CRP.	Comparing pneumonia subgroups: viral pneumonia and bacterial pneumonia based on clinical symptoms, laboratory results, and chest X-ray images.	The WBC (leukocyte) count in pneumonia patients is within the normal range. Meanwhile, the Neutrophil (NC) count reflects the neutrophil inflammatory response to infection. An NLR of 0.87 indicates the ratio of neutrophils to lymphocytes; a higher NLR typically indicates a more dominant inflammatory response (e.g., in severe infections or systemic inflammation).	Retrospective Cohort Study
4	Dan Li et al (2023) - <i>Neutrophil-to-lymphocyte ratio as a predictor of poor outcomes of Mycoplasma pneumoniae pneumonia</i>	Patients with Mycoplasma pneumoniae pneumonia (MPP). A total of 1,401 subjects were included. Patients were then classified based on the presence or absence of necrotizing pneumonia (NP). The NP group comprised 30 patients, while the non-NP	Examination and evaluation of inflammatory parameters and blood laboratory in MPP patients, especially White blood cell (WBC/leukocyte), Neutrophil-Lymphocyte Ratio (NLR), CRP (C-reactive protein), LDH, ALT, D-dimer, and other blood parameters. In addition, radiological findings such as	Comparison between MPP with necrotizing pneumonia (NP) and MPP non-necrotizing pneumonia (Non-NP)	Leukocytes (WBC) in the NP (necrotizing pneumonia) group were higher than those in the non-NP group, while the RMPP (Refractory Mycoplasma Pneumoniae Pneumonia) group showed a stronger inflammatory response in necrotic pneumonia. NLR was also higher in the NP and RMPP groups compared to the non-NP and non-RMPP groups. This indicates a predominance of neutrophils and a relative decrease in lymphocytes in more	Desain penelitian ini adalah studi prospektif

		group comprised 1,371 patients.	pleural effusion and consolidation/at electasis are assessed.		severe infection conditions.	
5	Yue Meng et al. (2023) - <i>Blood heparin-binding protein and neutrophil-to-lymphocyte ratio as indicators of the severity and prognosis of community-acquired pneumonia</i>	A total of 206 adult patients with community-acquired pneumonia (CAP) were treated at the First Affiliated Hospital of Anhui Medical University, China. Patients were divided into 126 with common pneumonia and 80 with severe CAP (SCAP) based on disease severity.	Heparin-Binding Protein (HBP) and Neutrophil-to-Lymphocyte Ratio (NLR) examinations upon patient admission to the hospital, accompanied by examinations of other inflammatory biomarkers such as WBC, neutrophils, CRP, PCT, lactate	Comparisons were made between the common pneumonia and severe pneumonia (SCAP) groups.	Patients with severe pneumonia had higher levels of leukocytes, neutrophils, and NLR compared to patients with common pneumonia. Similarly, the median neutrophil count increased, indicating a stronger inflammatory response in patients with more severe disease. Furthermore, the NLR also increased significantly, from 6.74 in the common pneumonia group to 12.23 in the severe pneumonia group ($p = 0.001$). The increased NLR reflects an imbalance in the immune response due to increased neutrophil counts and decreased lymphocyte counts during severe inflammation.	Studi observational retrospektif
6	E Çil et al (2022) - <i>Evaluation of the relationships between procalcitonin and neutrophil/lymphocyte ratio and platelet/lymphocyte ratio in patients with pneumonia</i>	Patients diagnosed with pneumonia and treated at the Respiratory Unit, Adıyaman University Faculty of Medicine Hospital, Türkiye. A total of 54 patients were treated during the study period. January 2018–July 2019. The diagnosis of pneumonia was made based on chest X-ray images	Examination of blood inflammation parameters, namely: White Blood Cell (WBC/leukocytes), Neutrophils (neutrophils), Neutrophil-Lymphocyte Ratio (NLR), Platelet-Lymphocyte Ratio (PLR), Procalcitonin, CRP (C-reactive protein), Erythrocyte sedimentation rate (ESR).	Pneumonia patients were compared based on normal versus elevated procalcitonin levels. WBC, neutrophil, NLR, PLR, and CRP levels were then compared between the two groups.	Leukocyte, neutrophil, NLR, and CRP values were significantly higher in patients with elevated procalcitonin levels. The NLR value in the normal procalcitonin group was 3.97, while in the high procalcitonin group it was 7.21 ($p=0.012$). NLR is associated with inflammatory parameters and can be used as an additional indicator in assessing pneumonia, particularly in predicting elevated procalcitonin.	Retrospective Observational Study
7	Tord A Florin et al. (2020) - <i>Biomarkers and Disease Severity in Children With</i>	Children aged 3 months–18 years with signs and symptoms of	Blood biomarker examination as a predictor of disease severity, namely: white	Comparison of disease severity: mild vs mild-moderate vs	Assessing the ability of biomarkers to predict pneumonia severity. Results showed that WBC, ANC, CRP, and	Prospective cohort study

	<i>Community-Acquired Pneumonia</i>	lower respiratory tract infection (LRTI) who presented to the Emergency Department (ED) and were suspected of having community-acquired pneumonia (CAP). A total of 477 children were analyzed.	blood cell (WBC) count, absolute neutrophil count (ANC), C-reactive protein (CRP), and procalcitonin	moderate-severe vs severe, and nonsevere vs severe analysis	procalcitonin did not have sufficient discriminatory ability to differentiate severe from non-severe CAP overall.	
8	Abhisek Ghosh et al. (2025) - <i>Neutrophil-to-Lymphocyte Ratio as a Prognostic Marker of Disease Severity in Community-Acquired Pneumonia</i>	A total of 162 adult patients (≥18 years) diagnosed with community-acquired pneumonia (CAP) were admitted to Silchar Medical College and Hospital, Assam, Northeast India. Patients were recruited by consecutive sampling during October 2023–November 2024.	Neutrophil-to-Lymphocyte Ratio (NLR) measurement obtained from a complete blood count when the patient is admitted.	Comparisons were made based on the groups of patients who died and survived. Additionally, patients with an NLR ≥9.5, an NLR ≥16, and a lower NLR were compared.	An NLR ≥9.5 predicts ICU need, while an NLR ≥16 is associated with higher mortality. Patients with severe CAP also have higher total leukocytes, absolute neutrophils, and NLR..	Prospective observational study
9	Aliye Gamze Calis et al. (2025) - <i>Correlation of Pneumonia Severity Index and CURB-65 Score with Neutrophil/Lymphocyte Ratio, Platelet/Lymphocyte Ratio, and Monocyte/Lymphocyte Ratio in Predicting In-Hospital Mortality for Community-Acquired Pneumonia:</i>	Adult patients hospitalized with a diagnosis of community-acquired pneumonia (CAP). A total of 343 patients from three hospitals in Antalya, Turkey, were admitted between January 2020 and September 2023.	Measurement of hematological parameters in the form of Neutrophil-to-Lymphocyte Ratio (NLR), Monocyte-to-Lymphocyte Ratio (MLR), and Platelet-to-Lymphocyte Ratio (PLR)	The group of patients who died during hospitalization and the group of patients who survived. Furthermore, the predictive abilities of NLR, MLR, and PLR were compared.	Leukocyte levels in patients who died were higher than in patients who survived. Similarly, neutrophil counts in patients who died were higher than in patients who survived, but these differences were also not significant. Conversely, the NLR values showed a significant difference between the two groups, indicating that a higher NLR was associated with an increased risk of mortality in pneumonia patients.	Retrospective observational study

	<i>Observational Study</i>					
10	Maya Lakshmanan et al (2025) - <i>Neutrophil-lymphocyte ratio as a point-of-care marker for predicting bacterial etiology in pediatric community-acquired Pneumonia: A comparative analysis with C - reactive protein</i>	Children aged 1 month–5 years diagnosed with community-acquired pneumonia (CAP) and requiring hospitalization at a tertiary hospital in South India during the period January 2023– December 2024. Of the 514 children with CAP, 398 were included in the study..	A blood biomarker test, the Neutrophil-Lymphocyte Ratio (NLR), is used as a marker to predict the bacterial etiology of pneumonia. In addition to the NLR, other laboratory parameters are also examined, including Total Leukocyte Count (TLC), Absolute Neutrophil Count (ANC), Absolute Lymphocyte Count (ALC), and C-reactive protein (CRP)..	Comparing two groups of patients with bacterial pneumonia and non-bacterial pneumonia	The bacterial group had higher leukocyte levels than the non-bacterial group, indicating that bacterial infections more often cause an increase in leukocyte counts due to the body's inflammatory response to bacteria. The bacterial group showed higher neutrophil levels than the non-bacterial group. The increase in neutrophils indicates activation of the innate immune system, particularly in response to bacterial infection. The NLR value in the bacterial group was higher than in the non-bacterial group. This indicates that in bacterial infections there is an increase in neutrophil dominance accompanied by a relative decrease in lymphocytes, so the NLR can be one parameter to differentiate bacterial and non-bacterial infections.	Retrospective analytical study
11	Ahmed Omran et al. (2022) – <i>Lung Ultrasound and Neutrophil Lymphocyte Ratio in Early Diagnosis and Differentiation between Viral and Bacterial Pneumonia in Young Children</i>	Children aged 2 months–2 years admitted to the pediatric emergency department with symptoms and signs suggestive of community-acquired pneumonia (CAP) were evaluated. A total of 60 children were evaluated, with 52 included in the analysis (34 with bacterial pneumonia and 18 with viral pneumonia).	Neutrophil Lymphocyte Ratio (NLR) examination as an inflammatory biomarker and Lung Ultrasound (LUS) examination to detect and differentiate bacterial and viral pneumonia in children.	Comparison of bacterial pneumonia vs. viral pneumonia based on sputum culture results, viral PCR, laboratory examinations, and radiological images.	Bacterial pneumonia indicates leukocytosis, which is common in bacterial infections due to increased white blood cell production in response to inflammation. Viral pneumonia, on the other hand, remains within the normal range. A higher NLR in bacterial pneumonia indicates a predominance of neutrophils over lymphocytes as an immune response to bacterial infection.	Prospective observational study

12	Junlin Zhao et al. (2026) - <i>Neutrophil-to-lymphocyte ratio mediates pulmonary consolidation through oxidative stress in children with Mycoplasma pneumoniae pneumonia</i>	The study population consisted of 81 children aged 1–18 years with acute phase Mycoplasma pneumoniae pneumonia (MPP) (≤ 2 weeks since onset) who were admitted to the Department of Pediatrics, The First Affiliated Hospital of Xinjiang Medical University, China, from May 6, 2023, to November 5, 2025.	The primary variable evaluated was the Neutrophil-to-Lymphocyte Ratio (NLR) as a biomarker of inflammation. The study also measured biomarkers of oxidative stress in bronchoalveolar lavage fluid (BALF).	Patients were divided into groups with and without lung consolidation based on chest X-ray or CT scan results. All clinical parameters, laboratory parameters, BALF biomarkers, and clinical outcomes were compared between the two groups.	Leukocyte levels in the consolidation group were slightly higher than in the non-consolidation group. The percentage of neutrophils in the consolidation group was higher than in the non-consolidation group. The NLR value in the consolidation group was higher than in the non-consolidation group. These results indicate that an increase in NLR is associated with the occurrence of lung consolidation in children with Mycoplasma pneumoniae pneumonia, so NLR has the potential to be used as a simple biomarker to assess the degree of inflammation and disease severity.	Studi Case Control Retrospektif
13	Sai Luo et al. (2022) - <i>The clinical value of neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and D-dimer-to-brinogen ratio for predicting pneumonia and poor outcomes in patients with acute intracerebral hemorrhage</i>	The study population was 329 adult patients with acute intracerebral hemorrhage (ICH) who were treated at the ICU of the Fourth Clinical Faculty of Xinxiang Medical University in the period May 2018–July 2020.	<i>Neutrophil-to-Lymphocyte Ratio (NLR), Platelet-to-Lymphocyte Ratio (PLR), and D-dimer-to-Fibrinogen Ratio (DFR) were measured from blood tests upon hospital admission. These three inflammatory biomarkers are considered predictors of pneumonia and poor clinical outcomes after ICH.</i>	Comparisons were made between the group of patients with pneumonia and the group without pneumonia. Patients were also compared based on 90-day clinical outcomes.	Leukocyte levels showed that patients with pneumonia had significantly higher leukocyte counts than patients without pneumonia. Neutrophil levels were also statistically significant. High neutrophil levels in pneumonia patients indicate activation of the innate immune system in response to infection, as neutrophils are the first line of defense cells involved in the acute inflammatory process. The Neutrophil-to-Lymphocyte Ratio (NLR) value in the pneumonia group was <0.05 , while in the non-pneumonia group <0.05 . The higher NLR value in the pneumonia group indicates an increased systemic inflammatory response due to neutrophil dominance accompanied by a relative decrease in lymphocytes.	Retrospektive Observational Study

14	Aida Mujaković et al. (2021) - <i>neutrophil-to-lymphocyte ratio and proatherogenic risk factors improve the accuracy of pneumonia severity index in the prediction of community acquired pneumonia outcome in healthy individuals</i>	A total of 83 adult patients diagnosed with Community-Acquired Pneumonia (CAP) and treated at the Clinic for Pulmonary Diseases and Tuberculosis "Podhrastovi", University Clinical Centre Sarajevo, Bosnia and Herzegovina, during the period March 2019–March 2021.	The study evaluated the Neutrophil-to-Lymphocyte Ratio (NLR) along with proatherogenic risk factors (age, systolic blood pressure, leukocytes, CRP, PLR, and other hematological parameters) to assess its association with the severity and outcome of CAP patients.	Comparisons were made between patients with low CAP risk (PSI <90) and patients with high CAP risk (PSI >90) based on PSI scores, then compared the NLR, leukocyte, CRP, PLR, and other clinical parameters in both groups.	Leukocyte levels in the high-risk group were higher than in the low-risk group, indicating that the higher the PSI score, the higher the leukocyte count. Neutrophil percentages were also higher in the high-risk group compared to the low-risk group. However, the Neutrophil-to-Lymphocyte Ratio (NLR) values were statistically significant ($p = 0.020$), indicating that patients with higher PSI scores had a more severe systemic inflammatory response.	Retrospective observational cross-sectional study
15	Zakir Hossion et al. (2026) - <i>Predictive value of neutrophil-to-lymphocyte ratio on hospital outcomes of patients with community-acquired pneumonia</i>	A total of 100 adult patients (≥ 18 years) with Community-Acquired Pneumonia (CAP) who were treated at the Department of Medicine, Dhaka Medical College Hospital, Bangladesh, during July 2023–June 2024	The main variable studied was the Neutrophil-to-Lymphocyte Ratio (NLR), calculated from a complete blood count upon admission. In addition to the NLR, the CURB-65 score was assessed, as were leukocytes, neutrophils, lymphocytes, and the patient's clinical characteristics.	Comparisons were made between patients with $NLR \geq 7.12$ and $NLR < 7.12$ to evaluate differences in clinical outcomes during treatment, including the need for oxygen therapy, ICU care, length of hospital stay, and mortality.	Leukocyte levels indicate leukocytosis, or an increase in the number of leukocytes above normal values. This condition reflects an inflammatory response and acute infection in patients with community-acquired pneumonia (CAP). Neutrophils are higher than the normal range (around 40–70%). An increase in neutrophils indicates activation of the innate immune system in response to infection, particularly bacterial infections, which are a common cause of CAP. The NLR value is considered elevated. This value indicates an imbalance between the increase in neutrophils and the relative decrease in lymphocytes due to the systemic inflammatory process.	Retrospective Observational Study

Leukocyte Counts in Relation to Chest X-Ray Findings in Pneumonia

The results of the 15 articles reviewed showed a nearly identical pattern. In pneumonia patients, an increase in inflammatory markers in the blood, such as leukocytes, neutrophils, and the neutrophil-lymphocyte ratio (NLR), is generally found. A chest X-ray reveals the severity of the pneumonia, whether it affects only one lung or both, and often correlates with an increase in

these inflammatory markers. The Neutrophil-Lymphocyte Ratio is a marker of inflammation that can be calculated from a complete blood count. The neutrophil count alone indicates the inflammatory status. The lymphocyte count, on the other hand, reflects an individual's immune status and generally decreases as inflammatory disease progresses. However, this decreased response is seen in the late stages and is insufficient to detect disease progression. An elevated Neutrophil-Lymphocyte Ratio in CAP patients may indicate several adverse pathophysiological processes: (1) excessive systemic inflammatory response syndrome (SIRS), (2) relative immunosuppression with increased susceptibility to secondary infections, (3) endothelial dysfunction and microvascular compromise, and (4) an increased risk of septic shock and multiorgan failure (Ahmad et al., 2025).

A study by Wu et al. (2021) showed that patients with more extensive pulmonary infiltrates on chest radiographs had higher leukocyte, neutrophil, and NLR values than patients with mild infiltrates. The larger the area of pulmonary consolidation or infiltration, the greater the inflammatory process, resulting in a higher systemic response in the form of increased neutrophils and NLR. This situation supports the importance of laboratory tests and chest radiographs as complementary tools in assessing the severity of pneumonia. A study by Lakshmanan et al. (2025) also reported that combining laboratory test results and radiological imaging can improve the accuracy of risk stratification in pneumonia patients compared to using either parameter alone. This approach helps clinicians make more precise decisions about therapy, the need for hospitalization, and patient monitoring.

Neutrophil-to-Lymphocyte Ratio in Relation to Chest X-Ray Findings and Pneumonia Severity

Another literature study by Zhao et al. (2026) showed that the Neutrophil-to-Lymphocyte Ratio (NLR) is associated with the occurrence of lung consolidation in children with Mycoplasma pneumoniae pneumonia (MPP). An increased NLR reflects a more severe inflammatory response and plays a role through oxidative stress mechanisms, thereby increasing the risk of lung consolidation. These results suggest that the NLR can be used as a simple biomarker to help assess pneumonia severity and support the evaluation of radiological imaging in pneumonia patients. A study by Omran et al. (2022) explained that leukocytosis is a common manifestation of bacterial infection due to bone marrow stimulation by various pro-inflammatory cytokines, particularly interleukin-6 (IL-6), interleukin-1 β (IL-1 β), and tumor necrosis factor- α (TNF- α). These cytokines stimulate the release of both mature and immature neutrophils into the circulation, leading to an increase in the peripheral neutrophil count. Therefore, patients with bacterial pneumonia generally exhibit an increase in leukocytes accompanied by a predominance of neutrophils.

Furthermore, a study by Li et al. (2023) showed that a high NLR value is associated with a longer hospital stay, an increased need for mechanical ventilation, and a poorer prognosis.⁴⁵ A study by Nirgude et al. (2021) demonstrated that the Neutrophil-to-Lymphocyte Ratio (NLR) is a good prognostic indicator in patients with community-acquired pneumonia (CAP). Patients with higher NLR values tend to have more severe disease severity, require intensive care, and have a higher risk of mortality.

Hossion et al. (2026) showed that the Neutrophil-to-Lymphocyte Ratio (NLR) has good predictive value for the outcome of community-acquired pneumonia (CAP) patients during hospitalization. Patients with high NLR values tend to experience more severe disease severity, longer hospital stays, and a higher risk of mortality. A study by Luo et al. (2022) showed that a high Neutrophil-to-Lymphocyte Ratio (NLR) is associated with an increased risk of pneumonia and poor clinical outcomes in patients with acute intracerebral hemorrhage (ICH).

These findings align with the study by Liu et al. (2025), which reported that an increased NLR is associated with clinical deterioration and has good predictive ability for patient outcomes. Similarly, a study by Abhisek Ghosh et al. (2025) found that patients with high NLR values had a greater risk of complications and death than patients with low NLR values. A study by Mujaković

et al. (2021) showed that the Neutrophil-to-Lymphocyte Ratio (NLR) can improve the accuracy of the Pneumonia Severity Index (PSI) in predicting outcomes in community-acquired pneumonia (CAP) patients. Patients with higher NLR values have a higher risk of severity and worse clinical outcomes.

A study by Calis et al. (2025) showed that the Neutrophil-to-Lymphocyte Ratio (NLR) is significantly associated with the severity of community-acquired pneumonia (CAP) based on the Pneumonia Severity Index (PSI) and CURB-65 scores.⁵⁰ Similarly, a study by Yue Meng et al. (2023) showed that the Neutrophil-to-Lymphocyte Ratio (NLR) is associated with the severity and prognosis of community-acquired pneumonia (CAP). Patients with higher NLR values tend to experience more severe pneumonia and have a worse prognosis.

Çil et al. (2022) explained that leukocyte counts can be influenced by various other factors, such as age, chronic disease, corticosteroid use, and the patient's immune status. Therefore, some researchers recommend the use of combination biomarkers, particularly the NLR, as it reflects the balance between the innate and adaptive immune responses, thus offering better sensitivity and specificity in predicting disease progression.

Several advantages support the use of the NLR as a prognostic indicator in CAP. It is easy to measure, low cost, and has a strong correlation with established severity scores. All of these advantages make the NLR a practical tool for early triage, risk assessment, and clinical decision-making, particularly in settings with limited access to advanced diagnostics. The identified threshold values can also be used to provide region-specific reference points for clinicians.

This literature review has several limitations: the possibility of unmeasured confounding factors, such as the severity of comorbidities and variations in patient therapy, is present. There is no standard NLR cut-off value, while other studies have used different thresholds. This variation is thought to contribute to the high heterogeneity in study results.

CONCLUSION

Based on the results of a literature review of 15 research articles, it can be concluded that; (1) Leukocyte, neutrophil and neutrophil lymphocyte ratio (NLR) levels in pneumonia patients increase in response to the inflammatory process due to lung infection. An increase in these parameters indicates activation of the body's immune system against the infectious process that occurs in pneumonia; (2) Synthesis results show that levels of leukocytes, neutrophils, and neutrophil lymphocyte ratio (NLR) have a relationship with chest x-ray images in pneumonia patients. The more extensive the lung involvement on chest x-ray, the higher the systemic inflammatory response demonstrated through increased leukocytes, neutrophils, and especially NLR; (3) Based on scientific evidence that has been synthesized, leukocytes, neutrophils, and especially NLR are laboratory parameters that are simple, easy to obtain, and have clinical value in helping to assess the degree of inflammation and severity of pneumonia.

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