



The Relationship Between Increased Neutrophils and Length of Hospitalization in Pediatric Pneumonia Patients

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Abstract

Pneumonia remains one of the major respiratory infections affecting children and is often associated with increased morbidity, prolonged hospitalization, and higher healthcare burden. Neutrophils play an important role in the inflammatory response to infection and may serve as a useful laboratory indicator for evaluating disease severity and clinical outcomes in pediatric pneumonia. This study aimed to determine the relationship between increased neutrophil levels and length of hospitalization among pediatric pneumonia patients at Ibnu Sina Hospital Makassar during January to December 2025. This research used an observational analytic design with a cross sectional approach based on secondary data from medical records. The study population consisted of pediatric patients aged 0 to 18 years diagnosed with pneumonia, with complete blood count data available. Data were analyzed using univariate and bivariate analysis, with the Chi Square test applied to determine statistical significance. The results showed that most pediatric pneumonia patients were aged 1 to 10 years, were slightly more likely to be male, and were predominantly treated as inpatients. Most patients had a length of hospitalization of more than 4 days. Neutrophil examination showed that 50 patients had increased neutrophil levels, 38 had normal levels, and 9 had decreased levels. The analysis demonstrated a significant relationship between neutrophil levels and the incidence of pneumonia with a p value of 0.046. Furthermore, increased neutrophil levels were significantly associated with length of hospitalization, with a p value of 0.001. These findings indicate that increased neutrophil levels may reflect the severity of inflammatory response in pediatric pneumonia and may be useful as a clinical indicator for predicting longer hospitalization.

Introduction

Pneumonia is a bacterial lung inflammation characterized by high fever, coughing up phlegm, rapid breathing, shortness of breath, and other symptoms (headache, restlessness, and decreased appetite). Pneumonia is a global health problem due to its high mortality rate, not only in developing countries but also in developed countries such as the United States, Canada, and other European countries (Natasya, 2022; Sotianingsih et al., 2019). Community-acquired pneumonia is an acute inflammation of the lung parenchyma acquired in the community. Community-acquired pneumonia is a common, serious disease associated with high morbidity and mortality. It is a leading cause of death among infectious diseases (Irawan et al., 2019; Anderson & Feldman, 2023; Liu et al., 2023).

There are various factors that can cause death from pneumonia, which are multifactorial in nature, including excessive inflammation, both systemic and local, in the lungs. Other causes include coagulopathy, acute lung injury, and vascular endothelial dysfunction. The inflammatory process occurs when bacteria enter the body. This triggers a response from the body's immune system to fight the bacterial invasion. The inflammatory process resolves when the bacteria are successfully eliminated from the body. However, if bacteria cannot be eradicated, they will continue to grow and spread, damaging body tissue (Julianti et al., 2024; Palma & Qi, 2024). Therefore, markers are needed that can be used to predict inflammation in cases of pneumonia infection (Jain, 2023). More specifically, they are used to estimate the level of morbidity and clinical outcomes of patients. Currently used parameters, such as the leukocyte count, absolute neutrophil count, C-reactive protein (CRP), and neutrophil-lymphocyte ratio (NLR), can reflect the level of inflammation that occurs in the acute phase. (Putri & Subawa, 2025; Maysanjaya, 2020; Malaha et al., 2023; Sinurat et al., 2022; Jannah et al., 2025; Almira et a., 2025)

Elevated NLR is a biomarker of the systemic inflammatory response that is easily measured, inexpensive, and easy to interpret because it can be calculated from a complete blood count. Furthermore, NLR can also be a predictor of prognosis in pneumonia patients, associated with length of hospital stay. However, recent research is limited and its application in daily practice is still limited. Therefore, it is necessary to evaluate the use of NLR biomarkers in pneumonia patient outcomes through assessment of length of hospital stay (Julianti et al., 2023; Ziko e al., 2022; Cillóniz et al., 2021).

Based on this description, research is essential to investigate the relationship between elevated neutrophil counts and pneumonia in children. The results of this study are expected to contribute to increasing understanding of the role of neutrophils as a laboratory parameter, as well as assisting health workers in establishing diagnoses, determining therapy, and monitoring the condition of children with pneumonias.

Methods

This is an observational analytical study with a cross-sectional design using secondary data. This study aims to determine the relationship between increased neutrophil counts and the clinical condition of pneumonia in children (Suci, 2020). Measurements of the independent and dependent variables were conducted simultaneously using medical records of pediatric patients with pneumonia. This study was conducted at Ibnu Sina Hospital, Makassar, which has medical records of pediatric patients diagnosed with pneumonia. The study was conducted in March 2026. The dependent variable in this study was pediatric pneumonia patients. The independent variable in this study was increased neutrophil counts in children with pneumonia, as measured by a complete blood count (CBC) laboratory examination..

Table 1. Operational Definition

Research Variables	Operational Definition	Measuring instrument	Measurement Results	Measuring Scale
Pneumonia	Inflammatory infection of the lung parenchyma caused by various microorganisms such as bacteria, viruses, parasites, fungi, exposure to chemicals, or	Doctor's Diagnosis + History Notes	- Yes (Diagnosis of Pneumonia) - No (Non-Pneumonia)	Categorical

	physical damage to the lungs.			
Neutrophils	The first immune system functions to fight pathogens that enter the body	Hematology Laboratory Results (CBC)	Normal : 50-70 %	Numeric
Length of Hospitalization	Length of hospitalization is the time that indicates the number of days a patient is hospitalized during one treatment period, which is assessed by calculating the difference between the discharge date and the hospital admission date.	Calculator	1. > 4 days 2. ≤ 4 days	Nominal

The population of this study was all pediatric patients aged 0-18 years diagnosed with pneumonia and undergoing treatment at Ibnu Sina Hospital Makassar during the period January - December 2025. The sample was representative of the population with characteristics that describe and represent the population studied. The sample in this study was the results of blood tests of children aged 0-18 years in the work area of Ibnu Sina Hospital Makassar. The sample was taken using the total sampling method. In this way, all populations in the medical record that met the inclusion and exclusion criteria were taken as research samples. The following is the minimum sample required in this study using the Slovin formula used in the population known as follows:

$$n = \frac{N}{1 + N(e)^2}$$

Information :

n : Number of samples

N : Population Size

e: Margin of error

$$n = \frac{97}{1 + 97(0,05^2)}$$

$$n = \frac{97}{1 + 97(0,0025)}$$

$$n = \frac{97}{1 + 0,2425}$$

$$n = \frac{97}{1,2425}$$

$$n = 78,06$$

Based on these calculations, the sample size used in this study was 78 respondents.

Inclusion Criteria: (1) Pediatric patients aged 0–18 years diagnosed with pneumonia at Ibnu Sina Hospital, Makassar; (2) Pediatric patients undergoing outpatient or inpatient care with a

diagnosis of pneumonia at Ibnu Sina Hospital, Makassar, between January and December 2025; (3) Pediatric patients with complete medical records, particularly regarding neutrophil counts.

Exclusion Criteria: (1) Pediatric patients with pneumonia who have a history of immunodeficiency disease or use of immunosuppressive therapy that can affect neutrophil counts; (2) Pediatric patients with pneumonia who have immunodeficiency diseases that can cause a significant increase in neutrophil counts, thus affecting the study results.

Data collection was conducted using secondary data obtained from the medical records of pediatric patients diagnosed with pneumonia at Ibnu Sina Hospital, Makassar, between January and December 2025. Data collected included patient identification and neutrophil counts.

The research material consisted of secondary data from medical records of inpatient pediatric patients at Ibnu Sina Hospital, Makassar, for the period January - December 2025 who met the inclusion criteria: children aged 0-18 years with a diagnosis of pneumonia and complete blood count (CBC) results. Data were extracted from the Hospital Information System (SIRH), pediatric ward inpatient registers, patient medical record cards, and hematology laboratory reports.

Several tools were used in this study; (1) Structured data abstraction form (Google Form/Excel) with variables: Neutrophil percentage (%), pneumonia diagnosis, hospital admission date, age, gender, and radiology; (2) Laptop computer with minimum specifications Intel i5, 8GB RAM with Microsoft Excel 2021 and SPSS version 26 for statistical analysis; (3) Access to the SIMRS KHANZA database at Ibnu Sina Hospital, Makassar through the official researcher account; (4) Printer and A4 paper for printing reports; (5) The hospital used a hematology analyzer (Sysmex XN/Mindray BC-6800) for CBC, with the results recorded by researchers without primary measurements.

All instruments were calibrated to hospital standards, with double data entry by two independent enumerators for 95% validity. These materials and instruments were adequate for a retrospective, analytical cross-sectional study calculating the Odds Ratio (ODR) of the relationship between neutrophils and the incidence of pneumonia in children.

The collected data will be edited, coded, and tabulated, then analyzed statistically. Data analysis includes: (1) Univariate analysis to determine the frequency distribution of each variable; (2) Bivariate analysis to determine the relationship between increased neutrophils and the clinical condition of pneumonia in children using appropriate statistical tests, such as the Chi-Square test or the Fisher Exact test, with a statistical significance level ($p < 0.05$).

Research Flow

Before conducting the research, the researcher will first register with the Research Ethics Commission at Menara Universitas Muslim Indonesia to obtain ethical clearance as well as permission to access patients' medical records at Ibnu Sina Hospital Makassar. Ethical approval is required to ensure that the study is conducted in accordance with research ethics principles, including respect for participants' rights, confidentiality, and the responsible use of research data. After obtaining ethical clearance, the researcher will submit a research permission letter to Ibnu Sina Hospital Makassar. Upon receiving approval from the hospital, the researcher will proceed with data collection according to the approved research protocol.

During the research process, the confidentiality of all patients' personal information contained in the medical records will be strictly maintained. Patients' identities will not be disclosed in any form, and all data collected will be used solely for research purposes. The researcher will ensure that all information is securely managed and reported only in aggregate form, thereby protecting participants' privacy and ensuring that no individual or institution is harmed or disadvantaged as a result of the research.

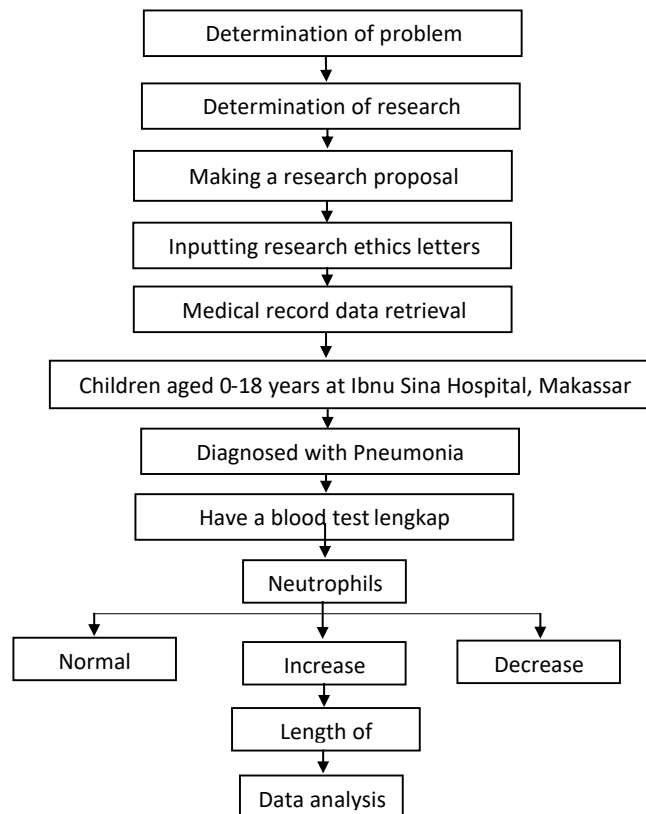


Figure 1. Research flow

Result and Discussion

Research result

This is an observational analytical study with a cross-sectional design. It used secondary data in the form of medical records of pediatric patients with pneumonia at Ibnu Sina Hospital, Makassar, from January to December 2025. The study aimed to determine the relationship between increased neutrophil counts and pneumonia in children. Measurements of the independent and dependent variables were conducted simultaneously based on data available in the patient's medical records.

The study was conducted at Ibnu Sina Hospital, Makassar, in March 2026. The dependent variable was the incidence of pneumonia in children, while the independent variable was the increased neutrophil count obtained from a complete blood count (CBC) laboratory test. The data analyzed included pediatric patients who met the study criteria from January to December 2025.

Characteristics of Childhood Pneumonia Patients Based on Age at Ibnu Sina Hospital Makassar for the Period January–December 2025

Table 2. Characteristics of Childhood Pneumonia Patients Based on Age at Ibnu Sina Hospital Makassar for the Period January–December 2025

Age	Frequency (n)	Percentage (%)
1 – 10 Years	91	93,8
11 – 20 Years	6	6,2
Total	97	100

Source: Secondary data, 2026

Table 2 shows that the age distribution of pediatric pneumonia patients at Ibnu Sina Hospital, Makassar, from January to December 2025 was dominated by the 1–10 age group. This age group accounted for 91 patients (93.8%), while the 11–20 age group accounted for only 6 patients (6.2%). This indicates that pneumonia is more common in younger children than in older children.

Characteristics of Pediatric Pneumonia Patients by Gender at Ibnu Sina Hospital, Makassar, January–December 2025

Table 3. Characteristics of Childhood Pneumonia Patients Based on Gender at Ibnu Sina Hospital, Makassar, January–December 2025

Sex	Frequency (n)	Persentase (%)
Male	50	51,1
Female	47	48,5
Total	97	100

Source: Secondary data, 2026

Table 3 shows that the gender distribution of patients was nearly balanced at Ibnu Sina Hospital Makassar from January to December 2025. Fifty (51.5%) were male, while 47 (48.5%) were female. This indicates that the incidence of disease during this period was slightly higher among male patients than female patients, although the difference was not significant.

Percentage of Pediatric Pneumonia Patients by Treatment Status at Ibnu Sina Hospital Makassar from January to December 2025

Table 4. Percentage of Childhood Pneumonia Patients Based on Treatment Status at Ibnu Sina Hospital Makassar for the Period January–December 2025

Status	Frequency (n)	Percentage (%)
Outpatient	40	41,2
Inpatient	57	58,8
Total	97	100

Source: Secondary data, 2026

Table 4 shows that the distribution of pediatric pneumonia patients at Ibnu Sina Hospital Makassar from January to December 2025 was dominated by inpatients. There were 57 inpatients (58.8%), while 40 outpatients (41.2%). This indicates that the majority of pediatric pneumonia patients required further hospitalization.

Percentage of Pediatric Pneumonia Patients by Length of Hospitalization at Ibnu Sina Hospital Makassar from January to December 2025

Table 5. Percentage of Childhood Pneumonia Patients Based on Length of Hospitalization at Ibnu Sina Hospital Makassar for the Period January–December 2025

Length of Hospitalization	Frequency (n)	Percentage (%)
≤ 4 days	8	10,3
> 4 days	70	89,7
Total	78	100

Source: Secondary data, 2026

Table 5 shows that the length of stay for pneumonia patients indicates that the majority of patients were treated for >4 days, amounting to 70 patients (89.7%), while only 8 patients (10.3%) had a length of stay of ≤4 days. These results indicate that the majority of pediatric pneumonia patients require relatively longer hospitalization. Longer hospitalization lengths can be influenced by the severity of the infection, the body's inflammatory response, the patient's

clinical condition, and an increase in neutrophils, an indicator of bacterial infection and acute inflammation.

Percentage Increase in Pediatric Pneumonia Patients by Period at Ibnu Sina Hospital Makassar, January–December 2025

Table 6. Percentage Increase in Pediatric Pneumonia Patients by Period at Ibnu Sina Hospital Makassar, January–December 2025

Period	Frequency (n)	Percentage (%)
January	4	4,1
February	12	12,4
March	20	20,6
April	10	10,3
May	0	0
June	5	5,2
July	2	2,1
August	8	8,2
September	10	10,3
October	6	6,2
November	15	15,5
December	5	5,2
Total	97	100

Source: Secondary data, 2026

Table 6 shows that the distribution of pediatric pneumonia patients at Ibnu Sina Hospital, Makassar, from January to December 2025 varied each month. The highest number of cases occurred in March, with 20 cases (20.6%), followed by November with 15 cases (15.5%), and February with 12 cases (12.4%). Meanwhile, April and September each recorded 10 cases (10.3%), and August with 8 cases (8.2%). Conversely, the lowest number of cases was found in July with 2 cases (2.1%), and no cases were found in May (0%). Other months, such as January, June, October, and December, showed relatively lower numbers of cases.

Description of Characteristics of Pediatric Pneumonia Patients Based on Neutrophil Examination at Ibnu Sina Hospital, Makassar, January–December 2025

Table 7. Characteristics of Childhood Pneumonia Patients Based on Neutrophil Examination at Ibnu Sina Hospital, Makassar, January–December 2025

Neutrophils	Frequency (n)	Percentage (%)
Increased	50	51,5
Normal	38	39,2
Decreased	9	9,3
Total	97	100

Source: Secondary data, 2026

Table 7 shows that the distribution of pediatric pneumonia patients at Ibnu Sina Hospital, Makassar, from January to December 2025, based on neutrophil examination, was dominated by patients with elevated neutrophil counts. Fifty patients (51.5%) had elevated neutrophil counts, while 38 patients (39.2%) had normal neutrophil counts, and nine patients (9.3%) had decreased neutrophil counts. This indicates that the majority of patients experienced elevated neutrophil counts.

Relationship of Elevated Neutrophil Counts to Childhood Pneumonia at Ibnu Sina Hospital, Makassar, January to December 2025

Table 8. Relationship of Elevated Neutrophil Counts to Childhood Pneumonia at Ibnu Sina Hospital, Makassar, January to December 2025

Neutrophils	Pneumonia				Total		P Value
	Yes		No				
	n	%	n	%	n	%	0,046
Increase	45	46,4	5	5,2	50	51,5	
Normal	20	20,6	18	18,6	38	39,2	
Decrease	3	3,1	6	6,2	9	9,3	
Total	68	70.1	29	29.9	97	100.0	

Source: SPSS, 2026

Table 8 shows a relationship between neutrophil levels and the incidence of pneumonia in children at Ibnu Sina Hospital Makassar from January to December 2025. 45 (46.4%) patients with elevated neutrophil levels experienced pneumonia, while 5 (5.2%) did not experience pneumonia, for a total of 50 (51.5%). Meanwhile, in patients with normal neutrophil levels, 20 (20.6%) had pneumonia and 18 (18.6%) did not experience pneumonia, for a total of 38 (39.2%). In patients with decreased neutrophil levels, 3 (3.1%) had pneumonia and 6 (6.2%) did not experience pneumonia, for a total of 9 (9.3%). Overall, 68 (70.1%) patients experienced pneumonia and 29 (29.9%) did not experience pneumonia, for a total of 97 (100%). A p-value of 0.046 indicates a significant association between neutrophil levels and the incidence of pneumonia in children. This indicates that neutrophil levels can be an important indicator in detecting infection, particularly pneumonia. Increased neutrophil levels are generally associated with the body's response to bacterial infection, so changes in neutrophil levels can reflect the extent of the infection.

The Relationship Between Increased Neutrophils and Length of Hospitalization in Pediatric Pneumonia Patients at Ibnu Sina Hospital Makassar in the Period January-December 2025

Table 9. Relationship between Increased Neutrophils and Length of Hospitalization in Pediatric Pneumonia Patients at Ibnu Sina Hospital, Makassar, January – December 2025

Neutrophils	Length of Hospitalization				Total		P Value
	≤4 Days		>4 Days				
	n	%	n	%	n	%	0,001
Increase	0	0,0	24	100	24	30,8	
Normal	8	21,1	30	78,9	38	48,7	
Decrease	0	0,0	16	100	16	20,5	
Total	8	10.3	70	89.7	78	100.0	

Table 9 shows that the analysis of the relationship between increased neutrophil counts and length of hospitalization in pneumonia patients shows that the majority of patients had a length of stay of >4 days (70 patients (89.7%)), while only 8 patients (10.3%) had a length of stay of ≤4 days. In the increased neutrophil count group, all 24 patients (100%) had a length of stay of >4 days. Similarly, in the decreased neutrophil count group, all 16 patients (100%) were also hospitalized for >4 days. Meanwhile, in the normal neutrophil count group, 30 patients (78.9%) had a length of stay of >4 days and 8 patients (21.1%) had a length of stay of ≤4 days.

The Chi-Square statistical test yielded a p-value of 0.001 ($p < 0.05$), indicating a significant relationship between increased neutrophil counts and length of hospitalization in pneumonia patients. This suggests that changes in neutrophil levels, particularly increased neutrophils, are

associated with the inflammatory process and the severity of infection, which can result in patients requiring longer hospitalization.

Characteristics of Childhood Pneumonia Patients by Age at Ibnu Sina Hospital, Makassar, January–December 2025

The age distribution of childhood pneumonia patients at Ibnu Sina Hospital, Makassar, during the January–December 2025 period was dominated by the 1–10 age group, with 91 (93.8%) and only 6 (6.2%) in the 11–20 age group. This indicates that pneumonia is more common in younger children than in older children, possibly related to an underdeveloped immune system.

Pneumonia is a respiratory infection that most commonly affects children under five (toddlers), especially those under two years of age. This vulnerability is related to the immaturity of the immune system, respiratory tract anatomy, various environmental risk factors, and nutritional status. After two years of age, most children no longer receive breast milk as their primary source of nutrition and immunological protection, increasing their risk of infection. Toddlers who are not exclusively breastfed during the first six months of life have a higher risk of developing pneumonia. This is because breast milk contains important immunological components such as secretory immunoglobulin A (sIgA), immunoglobulin G (IgG), lactoferrin, and lysozyme, which function to protect the respiratory tract mucosa from pathogenic infections (Hidaya & Fortuna, 2025).

In children who are fed formula milk (formula/sufor) from birth, the risk of pneumonia may be higher compared to children who are exclusively breastfed. This is because formula milk does not contain live antibodies such as sIgA, IgG, or other protective immune factors found in breast milk. Although formula milk is fortified with various nutrients, such as vitamins and minerals, these components cannot completely replace the immunological function of breast milk. Furthermore, in some circumstances, formula milk can also increase the risk of contamination if preparation and hygiene are not optimal, potentially increasing exposure to pathogens that cause respiratory infections (Hidaya & Fortuna, 2025).

In addition to breastfeeding, nutritional status also plays a significant role in determining a child's susceptibility to pneumonia. Toddlers with malnutrition or severe malnutrition have weaker immune systems, making them more susceptible to infection and experiencing more severe complications. Micronutrient deficiencies such as vitamin A, zinc, and iron are also known to contribute to reduced resistance to respiratory infections (Hidaya & Fortuna).

Environmental factors also significantly influence the incidence of pneumonia in toddlers. Exposure to household air pollution, such as cigarette smoke, smoke from cooking fuels (wood, charcoal), and poor home ventilation can increase the risk of respiratory tract irritation and infection. Furthermore, high residential density facilitates the transmission of infectious agents, especially bacteria and viruses that cause pneumonia (Hidaya & Fortuna, 2025).

Another equally important factor is immunization status. Children who have not received complete immunizations, especially vaccines such as DPT, measles, and pneumococcus, have a higher risk of respiratory tract infections, including pneumonia. Immunization plays a role in developing specific immunity against certain pathogens, thereby reducing the incidence and severity of disease (Hidaya & Fortuna, 2025).

Anatomically and physiologically, infants and young children have relatively narrow airways, and defense mechanisms such as the cough reflex and ciliary function are not yet optimal. This condition makes it more difficult for children to clear the airways of mucus and microorganisms, thus increasing the risk of obstruction and shortness of breath when infection occurs (Hidaya & Fortuna, 2025). Research conducted by Radjivshah et al. (2024) found that the age group of 1 to 3 years/toddlers had the highest prevalence (66.1%), followed by the age group of 3 to 5 years/toddlers.

Characteristics of Childhood Pneumonia Patients Based on Gender at Ibnu Sina Hospital Makassar for the Period January–December 2025

The gender distribution of patients at Ibnu Sina Hospital Makassar from January to December 2025 showed a preponderance of male patients, at 50 (51.5%), while female patients accounted for 47 (48.5%). The difference in proportion between male and female patients during this period was relatively small, but still indicated a tendency toward male dominance. This difference is not simply coincidental but may be influenced by various interrelated factors. Biologically, men and women differ in their immune systems and inflammatory responses, with men tending to be more susceptible to infection or exhibiting different immune responses than women in some situations. Hormonal factors, such as testosterone and estrogen, can also influence immunity and susceptibility to certain diseases (Radjivshah et al., 2024).

Furthermore, behavioral factors contribute significantly. Men generally have a higher tendency toward risky behaviors, such as smoking, alcohol consumption, and exposure to hazardous work environments (e.g., dust, chemicals, or pollution). Adherence to a healthy lifestyle and disease prevention efforts is also often lower in men than in women. On the other hand, women tend to be more concerned about their health and seek medical care more quickly when experiencing symptoms (Radjivshah et al., 2024).

Social and cultural factors also play a significant role in shaping patterns of healthcare utilization. In some societal contexts, men are more frequently exposed to activities outside the home, increasing their risk of exposure to disease agents. Meanwhile, women may have limited access to healthcare services due to domestic roles, cultural norms, or economic factors. Furthermore, education levels and health literacy can influence individuals' awareness of symptoms and decision-making regarding treatment (Radjivshah et al., 2024).

Other factors that could potentially influence this include differences in access to and utilization of healthcare services, economic status, and family support. Individuals with better access to healthcare services tend to be diagnosed more quickly, which is why they are recorded in healthcare data. Furthermore, differences in the types of diseases that predominate among the sexes can also influence the distribution of patients visiting healthcare facilities (Radjivshah et al., 2024).

Gender is a risk factor for pneumonia in children, which is more common in boys than in girls. This is because boys have a greater potential to develop lower respiratory tract infections because their immune systems are relatively weaker than those of girls. It has been reported that the T helper 1 (Th1) immune response in boys tends to be less effective than in girls. In addition, boys generally have a smaller airway diameter, making them more susceptible to lower respiratory tract infections, including pneumonia. Radjivshah et al. (2024) reported that male children represented the largest proportion of pneumonia cases, accounting for 30 patients (50.8%).

Percentage of Childhood Pneumonia Patients Based on Hospitalization Status at Ibnu Sina Hospital, Makassar, January–December 2025

The status of pediatric pneumonia patients shows that the majority were hospitalized, amounting to 57 (58.8%), while 40 (41.2%) were outpatients. This indicates that the majority of pneumonia cases in children require more intensive hospitalization, both for monitoring and further therapy, depending on the severity of the disease.

Children with mild pneumonia generally do not require hospitalization, and outpatient treatment is considered sufficient. The recommended antibiotics for outpatient pneumonia include oral amoxicillin or co-trimoxazole. However, hospitalization is indicated when children present with respiratory distress (retractions or nasal flaring), age-specific tachypnea,

oxygen saturation below 92%, refusal to eat or drink, or signs of dehydration (Aprilia et al., 2024).

Based on the study by Hidayat and Fortuna (2025), the majority of pediatric patients diagnosed with pneumonia had a length of stay of 3–5 days (88.18%). The duration of hospitalization is determined by the interval between the admission and discharge dates (Hidayat & Fortuna, 2025).

Percentage of Pediatric Pneumonia Patients Based on Length of Stay at Ibnu Sina Hospital Makassar, January–December 2025

Based on research conducted at Ibnu Sina Hospital Makassar during January–December 2025, the majority of pediatric pneumonia patients experienced hospitalization for more than four days. This finding indicates that pneumonia remains one of the leading causes of prolonged inpatient care among children, particularly in patients with moderate to severe clinical manifestations. The duration of hospitalization is influenced by several factors, including disease severity, nutritional status, the presence of complications, and the patient's response to antibiotic therapy.

The findings of this study are consistent with those reported by Gong et al. (2025), who found that 67.9% of children with pneumonia were hospitalized for five days or longer at Surya Husadha General Hospital, Denpasar. Their study demonstrated that most pediatric pneumonia patients require relatively prolonged hospitalization because recovery from pulmonary infection requires continuous clinical monitoring. Furthermore, they reported that the median length of hospital stay among children with severe community-acquired pneumonia was five days, with 28.93% of patients experiencing prolonged hospitalization (Gong et al., 2025).

Similarly, Dinku et al. (2023) reported a median hospital stay of five days among pediatric pneumonia patients, with 28.93% experiencing prolonged hospitalization. The study identified anemia, malnutrition, pulmonary complications, and delayed hospital admission as significant predictors of prolonged hospitalization (Dinku et al., 2023).

Another study conducted by Radjivshah et al. (2024) found that most children under five years of age with pneumonia were hospitalized for one to seven days. The authors suggested that the length of hospital stay can serve as an important indicator of treatment effectiveness and hospital service efficiency. Therefore, the findings of the present study are in agreement with previous studies demonstrating that pediatric pneumonia generally requires hospitalization lasting several days, depending on disease severity and the patient's response to treatment (Radjivshah et al. (2024).

Percentage Increase in Childhood Pneumonia Patients by Period at Ibnu Sina Hospital Makassar, January–December 2025

The distribution of childhood pneumonia cases during January–December 2025 shows variations in the number of cases each month. The highest number of cases occurred in March, with 20 cases (20.6%), followed by November with 15 cases (15.5%), and February with 12 cases (12.4%). Meanwhile, April and September each recorded 10 cases (10.3%), and August with 8 cases (8.2%). The lowest number of cases was found in July with 2 cases (2.1%), and there were no cases in May (0%), while other months showed relatively lower numbers. This indicates fluctuations in incidence, likely influenced by seasonal and environmental factors. In Indonesia, pneumonia is among the top causes of hospitalization, accounting for a substantial proportion of inpatient cases and contributing to a high case fatality rate (CFR) (Irawan et al., 2019). Meanwhile, according to the 2018 Basic Health Research (Riskesdas), South Sulawesi ranks among the provinces with the highest incidence and prevalence of pneumonia (Huang et al., 2025).

Data from the 2017 Indonesian Health Profile show that the estimated percentage of pneumonia cases among children under five years of age in South Sulawesi Province reached 3.79%, which is higher than the national estimate of 3.55%. Furthermore, according to the 2016 Makassar City Health Profile, bronchopneumonia ranked as one of the leading causes of death in Makassar (Huang et al., 2025).

Wong-Chew et al. (2026), in their study entitled "*Changes in the Epidemiology of Pneumonia in Children Younger than 14 Years Old During and After the COVID-19 Pandemic in Mexico: A National Multicenter Study*," reported that the incidence of childhood pneumonia exhibited a distinct seasonal pattern, with the highest number of cases occurring during winter, particularly between December and February (Wong-Chew et al., 2026).

Seasonal factors have a substantial influence on the distribution of pneumonia cases among children. Winter is associated with environmental conditions such as lower temperatures, increased humidity, and a higher prevalence of respiratory infections, all of which may increase the risk of pneumonia. Therefore, the period from the end of the year to the beginning of the following year should be regarded as a high-risk season for childhood pneumonia due to the increased likelihood of disease transmission (Wong-Chew et al., 2026).

Characteristics of Pediatric Pneumonia Patients Based on Neutrophil Examination at Ibnu Sina Hospital, Makassar, January–December 2025

Neutrophil examination showed that most patients had elevated neutrophil counts, amounting to 50 (51.5%), while 38 (39.2%) had normal neutrophil levels, and 9 (9.3%) had decreased neutrophil levels. These findings indicate that elevated neutrophil counts are common among pediatric pneumonia patients and may reflect an active inflammatory response or bacterial infection.

Neutrophil counts in Gram-stained sputum specimens are useful for assessing the host inflammatory response and identifying the morphology of microorganisms causing pneumonia. According to Bartlett's criteria, polymorphonuclear neutrophils (PMNs) are categorized as <10, 10–25, or >25 cells per low-power field and serve as indicators of the intensity of infectious inflammation. Acute inflammation induced by the host immune response promotes infiltration of inflammatory cells into the alveolar space, resulting in pulmonary consolidation visible on chest radiographs. The predominant inflammatory cell type often reflects the underlying pathogen, with neutrophils predominating in bacterial infections, lymphocytes in viral infections, and granulomatous inflammation in mycobacterial or fungal infections (Hubatullah et al., 2024).

Huang et al. (2025), in their study entitled "*Neutrophils are Involved in the Development and Outcomes of Plastic Bronchitis Associated with *Mycoplasma pneumoniae* Pneumonia*," demonstrated that neutrophils play a central role in the pathogenesis and clinical outcomes of pediatric pneumonia, particularly cases caused by *Mycoplasma pneumoniae*. Their findings showed that elevated neutrophil counts were a characteristic feature of affected children and were associated with more severe clinical manifestations, including the development of plastic bronchitis. Moreover, neutrophil activation, particularly through the formation of neutrophil extracellular traps (NETs), contributed to excessive inflammatory responses and pulmonary tissue injury (Huang et al., 2025).

Furthermore, Huang et al. (2025) confirmed that elevated neutrophil counts have strong predictive value for identifying plastic bronchitis in children with *Mycoplasma pneumoniae* pneumonia. Increased neutrophil counts and excessive NET formation were both associated with poorer clinical outcomes and greater disease severity. These findings suggest that neutrophil assessment is valuable not only as an indicator of bacterial infection but also as a useful biomarker for evaluating disease severity and the risk of complications in pediatric pneumonia patients (Huang et al., 2025).

The Relationship Between Elevated Neutrophil Levels and the Occurrence of Pneumonia in Children at Ibnu Sina Hospital, Makassar, January–December 2025

Analysis of the relationship between neutrophil levels and the incidence of pneumonia showed that 45 patients with elevated neutrophil levels (46.4%) developed pneumonia, while 5 patients (5.2%) did not. Among patients with normal neutrophil levels, 20 (20.6%) developed pneumonia and 18 (18.6%) did not. Meanwhile, among patients with decreased neutrophil levels, 3 (3.1%) developed pneumonia and 6 (6.2%) did not.

The p-value of 0.046 indicates a statistically significant association between neutrophil levels and the incidence of pneumonia in children. These findings suggest that neutrophil levels may serve as an important laboratory indicator for identifying bacterial infections, and alterations in neutrophil counts are associated with an increased likelihood of pneumonia.

Putri and Subawa (2025) concluded that the neutrophil-to-lymphocyte ratio (NLR) is significantly correlated with the severity of pneumonia in children and represents an important biomarker for assessing disease risk and prognosis. During systemic inflammation, peripheral blood typically shows neutrophilia accompanied by lymphocytopenia, resulting in an increased NLR (Putri & Subawa, 2025).

Elevated neutrophil levels in children with pneumonia demonstrate a significant association with the occurrence of the disease. Children with abnormal neutrophil counts are more likely to develop pneumonia than those with normal neutrophil levels. These findings are consistent with those reported by Jiang and Liu (2026), whose systematic review and meta-analysis demonstrated that an elevated neutrophil-to-lymphocyte ratio is strongly associated with disease severity and adverse clinical outcomes in children with *Mycoplasma pneumoniae* pneumonia. Increased neutrophil counts reflect activation of the innate immune response to bacterial infection; therefore, higher neutrophil levels are associated with an increased risk of severe pneumonia (Jiang & Liu, 2026).

Furthermore, elevated neutrophil levels may serve as an important predictor of clinical progression. Children presenting with marked neutrophilia are at greater risk of severe disease, prolonged hospitalization, and the development of complications or refractory pneumonia. These findings emphasize that routine laboratory parameters, such as neutrophil counts, not only facilitate the diagnosis of pneumonia but also provide valuable prognostic information for clinical decision-making and patient management. Consequently, regular monitoring of neutrophil levels should be considered an integral component of the evaluation and management of pediatric pneumonia patients (Jiang & Liu, 2026).

Relationship Between Neutrophil Elevation and Length of Hospitalization in Pediatric Pneumonia Patients at Ibnu Sina Hospital, Makassar, January–December 2025

Based on research conducted at Ibnu Sina Hospital, Makassar, during January–December 2025, a significant relationship was found between elevated neutrophil counts and the length of hospitalization among pediatric pneumonia patients. These findings indicate that children with elevated neutrophil levels tend to experience longer hospital stays than those with normal neutrophil counts. This association may be explained by the role of neutrophils as a key component of the body's inflammatory response to bacterial infection within the lung tissue.

In pneumonia, microbial invasion activates the innate immune system, stimulating the bone marrow to increase neutrophil production to eliminate invading pathogens. Elevated neutrophil counts therefore reflect acute inflammation and greater infection severity. As the inflammatory response intensifies, lung tissue damage becomes more extensive, delaying clinical recovery and consequently prolonging hospitalization.

The findings of the present study are consistent with those reported by Julianti et al. (2024), who demonstrated a significant association between the neutrophil-to-lymphocyte ratio (NLR)

and the length of hospital stay among pneumonia patients ($p < 0.05$). Their study showed that most patients with elevated NLR values required hospitalization for more than four days. The authors concluded that increased neutrophil counts reflect a systemic inflammatory response to pulmonary infection and are associated with disease prognosis as well as the duration of hospitalization (Julianti et al., 2024).

Furthermore, Julianti et al. (2024) reported that neutrophilia commonly occurs in pneumonia patients as part of the body's defense mechanism against infection. Increased neutrophil production facilitates bacterial phagocytosis; however, excessive inflammation may increase oxygen demand, impair pulmonary function, and necessitate prolonged observation and treatment (Julianti et al., 2024).

The present findings are further supported by Ayu et al. (2024), who reported a significant positive correlation between the neutrophil-to-lymphocyte ratio and the length of hospitalization ($p = 0.008$). Their study suggested that neutrophilia is closely associated with inflammatory responses and tissue injury, both of which contribute to prolonged hospital stays. A greater inflammatory response generally reflects more severe clinical conditions and a longer recovery period (Ayu et al., n.d.).

Similarly, Dinku et al. (2023) found that pediatric pneumonia patients presenting with severe clinical manifestations and disease complications were more likely to experience prolonged hospitalization. Their findings indicate that severe inflammatory responses in childhood pneumonia are associated with delayed clinical recovery and extended hospital stays (Dinku et al., 2023).

Physiologically, elevated neutrophil counts during pneumonia result from the release of inflammatory mediators, including interleukins and tumor necrosis factor (TNF), which stimulate neutrophil production in the bone marrow. Activated neutrophils subsequently migrate to infected pulmonary tissue to eliminate invading bacteria. However, an excessive inflammatory response may also cause alveolar injury and impaired gas exchange, leading to worsening clinical conditions and the need for prolonged antibiotic therapy, oxygen supplementation, and continuous clinical monitoring (Akram, 2025).

Overall, the findings of this study indicate that elevated neutrophil counts are associated with greater inflammatory severity in pediatric pneumonia and contribute to prolonged hospitalization. Higher neutrophil counts reflect a more intense inflammatory response, increasing the likelihood of delayed recovery and extended inpatient care. These findings are consistent with previous studies demonstrating that neutrophil counts and the neutrophil-to-lymphocyte ratio are valuable inflammatory biomarkers and prognostic indicators in patients with pneumonia (Julianti et al., 2024; Hibatullah et al., 2024; Dinku et al., 2023).

Conclusion

Based on the results of the research analysis on pediatric pneumonia patients at Ibnu Sina Hospital Makassar for the period January–December 2025, the following conclusions were obtained; (1) Characteristics of pediatric pneumonia patients based on age at Ibnu Sina Hospital Makassar for the period January–December 2025 showed that the majority of patients were in the 1–10 year age group; (2) Characteristics of pediatric pneumonia patients based on gender at Ibnu Sina Hospital Makassar for the period January–December 2025 showed that the majority of patients were male; (3) The percentage of pediatric pneumonia patients based on treatment status at Ibnu Sina Hospital Makassar for the period January–December 2025 showed that the majority of patients were hospitalized; (4) The percentage of increased neutrophils in pneumonia patients based on length of stay at Ibnu Sina Hospital Makassar for the period January–December showed that the majority of patients underwent treatment for > 4 days; (5) The percentage of pediatric pneumonia patients based on the period at Ibnu Sina Hospital Makassar for the period January–December 2025 shows that the majority of patients increased

in the March period; (6) Characteristics of pediatric pneumonia patients based on neutrophil examination at Ibnu Sina Hospital Makassar for the period January–December 2025 show that 50 people increased, 9 people decreased, and 38 people were normal; (7) There is a relationship between increased neutrophils and the incidence of pneumonia in children at Ibnu Sina Hospital Makassar for the period January–December 2025; (8) There is a relationship between increased neutrophils and the length of hospitalization in pediatric pneumonia patients at Ibnu Sina Hospital Makassar for the period January–December 2025.

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