

# Correlation Between The Number Of Leucocytes And Neutrophil To Lymphocytes Count Ratio In Children With Pneumonia At Rsud Koja Jakarta

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## ABSTRACT

Pneumonia is an acute lower respiratory tract infection that affects the lungs. This disease is one of infant and toddlers' biggest causes of death. Immature immunity, poor air quality, poor sanitation and nutrition, and incomplete immunization make children vulnerable to this disease. This study used an analytic observational method with a cross-sectional research design. The research subjects used as many as 30 respondents with pneumonia in children with an age range of 1 year -17 years who were in the pediatric ward at Koja Hospital. The study was conducted at the Koja Hospital laboratory from February to June 2022. The sample in this study was the result of a complete blood count, namely the examination of the leukocyte count and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia. The data was collected by performing a complete blood count using the Sysmex XN 1000 Hematology Analyzer. Data analysis in this study used the Pearson product-moment correlation test with a 95% confidence level. Using the Statistical product and service solution version 23 program. The results showed a significance value ( $p$ ) of  $0.05 > 0.03$ . This study concludes that there is a correlation between the number of leukocytes and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia at Koja Hospital, Jakarta.

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## 1. Introduction

Pneumonia is an acute lower respiratory tract infection that affects the lungs. The lungs are made up of small sacs called alveoli. These alveoli are filled with air when a healthy person breathes. But when a person has pneumonia, these alveoli are filled with fluid or pus which makes it difficult for the patient to breathe thereby limiting the intake of oxygen that enters. Pneumonia can be spread in various ways, including when coughing and sneezing (WHO, 2014). The causes can vary, most are caused by microorganisms (viruses or bacteria) and a small part is caused by other things (aspiration or radiation.) (Said M, 2015). In patients with pneumonia, there is a build-up of sputum in the respiratory tract, the patient can produce a lot of mucus and thicken the alveolar fluid. This increase in sputum production will cause impaired airway hygiene. If the cleanliness of the airway is disturbed, it will hinder the fulfillment of oxygen supply to the brain and cells throughout the body, if left for a long time will cause hypoxemia and then develop into severe hypoxia and decreased consciousness. (Sari, 2016) because of this pneumonia sufferers can die (Misnadiarly, 2008).

Pneumonia is a health problem in the world because it is one of the biggest causes of death in infants and toddlers, not only in developing countries but also in developed countries such as America, Canada, and other European countries. Based on data from the World Health Organization and the Ministry of Health of the Republic of Indonesia (2018), the incidence of pneumonia is more common in developing countries. Pneumonia attacks about 450 million people every year, the

number of pneumonia sufferers in Indonesia in 2019 based on the Indonesian Health Profile of the Ministry of Health is more than 400 thousand cases. The Jakarta Capital Special Region Health Office estimates 43,309 cases of pneumonia or pneumonia in children during 2019 (IDI, 2020). And in North Jakarta alone there were 7,687 cases of pneumonia in children (P2P Jakarta Health Office, 2019). This is because the immune system in children is still weak and immature, making them susceptible to disease (Aryani et al., 2018). Due to the high cases of pneumonia in children that occur in Jakarta, especially in North Jakarta, it is necessary to conduct research related to establishing a fast and inexpensive diagnosis of pneumonia.

One of the most common blood tests to diagnose pneumonia is a complete blood count. A white blood cell count is a complete blood count. If the result is an increase in the number, it is confirmed that infection or inflammation accompanies it. It's just that this examination is not specifically a diagnosis of pneumonia. Other supporting examinations such as chest X-rays (Thorax) are required. The role of inflammatory markers is quite large in assessing the course of pneumonia, one of which is the Neutrophil Lymphocyte Ratio (NLR) which combines neutrophils as an active inflammatory component and lymphocytes as regulators and protective components in a single parameter. This research is needed as an evaluation of the role of NLR as a biomarker for the diagnosis of pneumonia. Based on research on previous journal studies that discussed NLR as a risk factor for bacterial infection in children, it was concluded that the NLR Ratio of 4.67 was a risk factor for bacteremia. This cut-off value can be used to initiate antibiotic therapy to prevent a worse prognosis (Yullyantara et al., 2019). In another journal, it was also found that at the cut-off limit of 6.4 the NLR can be relied upon as a marker of bacterial sepsis (Luhulima et al., 2018). Thus, this study is considered necessary as an initial diagnosis of pneumonia considering the increasing cases of pneumonia in children in North Jakarta, especially in Koja Hospital.

The limitation of the problem in this study is the correlation between the number of leukocytes and the NLR value in pediatric pneumonia patients with an age range of 1 year-17 year in the pediatric ward of Koja Hospital. With the criteria of moderate to severe pneumonia. Based on the description of the background, the formulation of the problem is "How is the correlation between the number of leukocytes and NLR in pediatric patients with moderate to severe pneumonia in the inpatient ward of the pediatric section of Koja Hospital, North Jakarta."

Literature review, pneumonia is an acute lower respiratory tract infection that affects the lungs. The lungs are made up of small sacs called alveoli. These alveoli are filled with air when a healthy person breathes. But when a person has pneumonia, these alveoli are filled with fluid or pus which makes it difficult for the patient to breathe thereby limiting the intake of oxygen that enters. Pneumonia can be spread in various ways, including when coughing and sneezing (WHO, 2014). The causes can vary, with the main sources being bacteria, viruses, fungi, various chemical compounds, and other particles (Sukandar et al., 2013). In patients with pneumonia, there is a buildup of sputum in the respiratory tract, the patient can produce a lot of mucus and thicken the alveolar fluid. This increase in sputum production will cause impaired airway hygiene. If the cleanliness of the airway is disturbed, it will hinder the fulfillment of oxygen supply to the brain and cells throughout the body, if left for a long time it will cause hypoxemia and then develop into severe hypoxia and decreased consciousness (Sari, 2016), because of this pneumonia sufferers can die (Misnadiarly, 2008).

Patients infected with pneumonia will experience various signs and symptoms. These signs and symptoms vary according to the classification and cause of pneumonia. The following signs and symptoms are usually experienced by someone infected with pneumonia: Based on the classification, the signs and symptoms of pneumonia can be grouped into: Mild Pneumonia. Mild pneumonia is characterized by coughing followed by difficulty breathing (rapid breathing). Severe Pneumonia is characterized by symptoms of severe shortness of breath until the lower chest wall pulls in, there is nostril breathing, and the head is nodding due to shortness of breath. This can be confirmed by several physical examinations and photographs (Misnadiarly Prihatiningtyas R.A, 2014).

According to (Udin, 2019), based on the cause, signs, and symptoms of pneumonia can be grouped into. Bacterial Pneumonia, this type of pneumonia is usually caused by the pneumococcus bacteria and other types of bacteria. Bacterial pneumonia is usually experienced by all ages, but most often occurs in children under the age of 6 years. Symptoms experienced by patients with this type of pneumonia are sudden onset of high fever, moderate to severe pain, abdominal or chest

pain, and local infiltrate on chest x-ray. (Udin, 2019)

Infancy Atypical Pneumonia Chlamydia Trachomatis it is the cause of this type of pneumonia. Infancy anti-pneumonia usually occurs in children under 3 months of age. Symptoms that arise in the form of tachypnea, mild hypoxemia, rarely accompanied by fever, wheezing, and there is an interstitial infiltrate on chest x-ray (Udin, 2019). The cause of atypical pneumonia in children is usually due to mycoplasma which usually affects children under the age of 5 years, the symptoms are slow onset, low-grade fever, and there is a uniform infiltrate on the x-ray (Udin, 2019).

Viral Pneumonia, Viral pneumonia attacks at all ages and is most common in children aged 3 months to 5 years. Symptoms that arise in viral pneumonia include the appearance of symptoms of acute respiratory infection (ARI), mild fever or no fever, experiencing wheezing, and there is a diffuse infiltrate on x-ray (Udin, 2019).

Leukocytes, leukocytes are nucleated cells in the blood that can be divided into 5 types. Each cell can be calculated the percentage in the blood by doing a type count and can be distinguished based on the size of the shape of the nucleus, the color of the cytoplasm, and the granules in it. Leukocytes function as the body's defense against foreign objects, microorganisms, and foreign tissues. Type count is carried out to determine the type of leukocyte in an inflammatory condition (Hardjoeno, 2003). The normal values for leukocytes are as follows (Kemenkes RI, 2011): Adult : 3200-10,000/mm<sup>3</sup>, Infant/child : 9000-12000/mm<sup>3</sup>, Newborn : 9000-30.000/mm<sup>3</sup>. Leukocytes are the body's defense system, come in several shapes and sizes, and have different functions. The characteristics of leukocytes (Sutedjo, 2008)) are each has a nucleus, which is the inside of a cell that contains materials for growth, nutrition, and reproduction, each serves a specific immune function. All leukocytes come from the same parent, called Stem cells, which are present in the bone marrow. Stem cells give birth to approximately five immature blood cells, which then develop until they reach "maturity". This phase of development occurs in different parts of the body, depending on the type of blood cell.

An increase in the number of leukocytes or called leukocytosis indicates an acute infectious or inflammatory processes, such as pneumonia, meningitis, appendicitis, tuberculosis, tonsillitis, and others. It can also occur in myocardial infarction, liver cirrhosis, burns, cancer, leukemia, parasitic diseases, and stress due to surgery or emotional disturbances. A decrease in the number of leukocytes or leukopenia can occur in patients with certain infections, especially viruses, malaria, alcoholism, SLE, rheumatoid arthritis, and hemopoietic diseases (aplastic anemia, pernicious anemia) (Sutedjo, 2008).

Counting the type of leukocyte is the calculation of the type of leukocyte present in the blood based on the proportion (%) of each type of leukocyte from the total number of leukocytes. The results of this examination can describe specifically the incidence and process of disease in the body, especially infectious diseases. There are 5 types of leukocytes, namely neutrophils, eosinophils, basophils, monocytes, and lymphocytes. One type of leukocyte is quite large, which is 2 times the size of erythrocytes (red blood cells) and is able to move actively in blood vessels and outside blood vessels. Neutrophils react the fastest to inflammation and injury when compared to other leukocytes and are a defense during the acute infection phase (Sutedjo, 2008).

Functions of Leukocytes Leukocytes consist of several series, and each series has a different function (Sutedjo, 2008), namely: Neutrophils, leukocytes are granular whose nucleus has many lobes so it is called polymorphonuclear. Consists of 60-70% of the total number of leukocytes. These leukocytes are quite large, which is 2x the size of erythrocytes, and are able to move actively in blood vessels and outside blood vessels. Neutrophils react most rapidly to inflammation and injury than other types of leukocytes and are the front line of defense during the acute phase of infection.

Eosinophils, granular leukocytes, having 2 lobes in their nucleus, constitute 1-2% of the total leukocyte count. These leukocytes will increase in number in the blood in the event of allergies and infections (especially worms) in the body. With the administration of steroids, the number of eosinophils will decrease.

Basophils, leukocytes, which contain large granules, have the letter S, making up 0.5-1% of the total number of leukocytes. Basophils are present in the inflammatory process, leukemia, and the healing phase of infection. Lymphocytes leukocytes are not granular with large nuclei, slightly larger in size than erythrocytes, produced by lymphatic tissue, and play an important role in the

process of immunity and antibody formation.

Monocytes, leukocytes with non-granulated cytoplasm, large nuclei with a size twice as large as erythrocytes, the largest in circulating blood, and are made in lymphatic tissue. Is a calculation of the type of leukocytes in the blood based on the proportion (%) of each type of leukocyte from the total number of leukocytes. The results of this examination can describe the incidence and process of disease in the body, especially infectious diseases. The five white blood cells counted were neutrophils, eosinophils, basophils, monocytes, and lymphocytes, accounting for 80-90% of the total leukocytes. The results of the leukocyte type count provide specific information related to infection and the disease process (Sutedjo, 2008). See attachment 1 Types of Leukocytes

Neutrophil Lymphocyte Ratio (NLR) can be calculated from the number of neutrophils divided by the number of lymphocytes. Normally  $<5$  and a result  $>6$  generally indicates a severe infection. The neutrophil-lymphocyte ratio is a parameter that has the potential to predict bacteremia and has been proposed as an indicator of the systemic inflammatory response in several studies that have been carried out in recent years (Jensen et al., 2011). The same thing was also stated in Turkey in 2015 where the neutrophil-lymphocyte ratio can be used as a biomarker of inflammation in acute exacerbation of bronchiectasis in children due to the physiological response of circulating leukocytes in the human body due to an increase in neutrophils and a decrease in lymphocytes (Nacaroglu et al., 2017). A retrospective study in Korea from 2010 to 2014 in 298 children with urinary tract infections found that NLR can be used as a marker of acute pyelonephritis in children compared to CRP, leukocytes, and erythrocytes and NLR examination is simple, inexpensive, and easy to use as a parameter for inflammation because it can be measured in almost all laboratory (Han et al., 2016).

The increase in the number of neutrophils is due to IL-6 produced by macrophages. Sepsis will stimulate the production of IL-6 so that neutrophilia occurs (Okashah et al., 2014). The decrease in the number of lymphocytes in bacterial sepsis is caused by the increased secretion of glucocorticoid hormones and suppresses the production of lymphocytes in the lymph nodes, resulting in lymphocytopenia (Nugroho et al., 2013). Another theory says that the mechanism responsible for the process of lymphocytopenia in sepsis involves the process of marginalization and redistribution of lymphocytes in the lymphatic system and the acceleration of the process of apoptosis (de Jager et al., 2010). The apoptotic process has occurred early in sepsis when bacteria or their products stimulate macrophages to release proapoptotic substances, such as TNF-, NO (nitrite oxide), and glucocorticoids. This situation will suppress the production of lymphocytes. As the disease progresses in sepsis, there will be an accumulation of apoptotic lymphocyte products that act as an anti-inflammatory stimulus (Parrino et al., 2007).

Patients with pneumonia will cause changes in laboratory results, namely an increase in the number of leukocytes or leukocytosis ( $\geq 10,000/\text{mm}^3$ ). In the study of adult community pneumonia patients, leukocytosis was found, with an average leukocyte count of  $16,870/\text{mm}^3 \pm 5,600/\text{mm}^3$  (Sutedjo, 2008). In patients with pneumonia, macrophages are activated in the alveoli to produce chemokines, including LTB-4, IL-8, GRO- $\alpha$ , MCP-1, IP-10, and I-TAC, these chemokines attract neutrophils, monocytes, and T cells. Lymphocytes to inflamed tissue, resulting in leukocytosis. Leukocytes build the body's main mechanism in fighting infection through the process of phagocytosis, where leukocytes will envelop foreign organisms and then destroy them. Leukocytes also produce, transport, and distribute antibodies as part of an immune response to an antigen (Sacher et al., 2004). Leukocyte cells that play a role in the non-specific immune system are mononuclear phagocytes consisting of monocytes-macrophages and polymorphonuclear consisting of eosinophils, basophils, neutrophils and NK cells, and mediator cells. Leukocyte cells that play a role in the specific immune system are T lymphocytes and B lymphocytes (Baratawidjaja K, 2009)

Although most of the leukocytes that play a role in the phagocytosis process are neutrophils and monocytes, neutrophils are more involved in an inflammatory response unless the foreign particles are large. In patients with pneumonia, cytokines are released, including TNF-, IL-1, and IL-6, thereby stimulating the bone marrow to accelerate the differentiation, proliferation, and maturation of granulocyte cells resulting in neutrophilia. Neutrophils play a role in the general phagocytic activity, especially in the respiratory system, gastrointestinal system, and urinary system (Lisyani & Indranila, 2008).

The main function of lymphocytes is to produce antibodies as a specific immune response or as special effector cells in response to antigens attached to macrophages. In patients with

pneumonia, there is an increase in glucocorticoid hormones so that it suppresses the production of lymphocytes in the lymph nodes, resulting in lymphocytopenia. Lymphocytes consist of T lymphocytes and B lymphocytes. B lymphocytes are fewer in number than T lymphocytes, only about 10-12% and play a role in humoral immune reactions which will grow into plasma cells to form antibodies (de Jager et al., 2010). T lymphocytes generally play a role in inflammation, macrophage activation in phagocytosis, activation, and proliferation of B cells in antibody production. T cells also play a role in the recognition and destruction of infected cells (Turgeon, 2017).

## 2. Method

This type of research uses the Analytical Observational method with a cross-sectional design. The object of this research is the number of leukocytes and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia with an age range of 1 year – 17 years who are in the pediatric ward of Koja Hospital. The sampling technique is EDTA blood, namely by using a purposive sampling technique, namely a sampling technique that considers certain characteristics and specifications. (Masturoh, 2018).

Analysis of the data used in this study is as follows:

### 2.1 Normality Test

The normality test aims to test the variables in the regression model of the dependent variable, independent variable, or normal distribution or not (Suardi, 2019). The normality test used in this study is the Kolmogorov Smirnov test which is a classic test to determine the distribution of random data from small or large samples. One of the conditions for the Kolmogorov Smirnov test is interval or ratio scale data and the data comes from a random sample. The data is said to be normal if the significant value ( $p$ ) is 0.05 and said to be abnormal if the significant value ( $p$ )  $< 0.05$ .

### 2.2 Hypothesis Test

Hypothesis testing is carried out using a simple linear regression test with the help of the SPSS program, namely to test whether there is a relationship between the independent variable (free) and the dependent variable (bound) (Masturoh, 2018). Pearson correlation test is a simple correlation test technique that only involves one dependent variable (bound) and one independent variable (free). In this study, the Pearson product-moment correlation test was used to determine the correlation between the number of leukocytes and the NLR in pediatric patients with pneumonia. The research criteria for testing this hypothesis are:

### 2.3 Significant value ( $p$ ) less than 0.05 ( $p < 0.05$ ):

There is a relationship between the number of leukocytes and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia who are treated in the pediatric ward of Koja Hospital, North Jakarta.

### 2.4 Significant value ( $p$ ) greater than or equal to 0.05 ( $p \geq 0.05$ ):

There is no relationship between the number of leukocytes and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia in the pediatric ward of Koja Hospital, North Jakarta.

## 3. Result and Discussion

### 3.1 Research Results

Research on the correlation between the number of leukocytes and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia at Koja Hospital Jakarta from February to March 2022 was obtained from 30 respondents who met the research criteria and agreed to give informed consent. Samples were taken by purposive sampling with the following results:

**Table 1.**  
Correlation Between Leukocyte Count and Neutrophil Lymphocyte Ratio  
Value in Pediatric Pneumonia Patients at Koja Hospital

No	Age	Gender	Leukocyte Count	NLCR
1	2 Year	Female	8.300	1.65
2	1 Year	Female	13.800	1.68
3	2 Year	Male	8.400	1.16
4	1 Year	Male	11.400	0.38
5	4 Year	Female	7.700	2.40
6	6 Year	Female	18.800	14.85
7	1 Year	Female	12.700	2.19
8	3 Year	Male	16.500	1.70
9	2 Year	Male	12.600	8.33
10	1 Year	Male	23.100	2.72
11	1 Year	Female	8.800	1.54
12	1 Year	Male	4.300	3.61
13	2 Year	Male	12.600	8.33
14	6 Year	Female	9.300	2.10
15	10 Year	Male	15.900	5.11
16	5 Year	Male	3.800	2.17
17	1 Year	Male	11.400	2.57
18	6 Year	Male	14.800	5.06
19	1 Year	Male	7.600	4.04
20	3 Year	Male	8.900	3.64
21	15 Year	Female	13.500	4.18
22	8 Year	Female	15.100	13.68
23	5 Year	Female	16.100	6.76
24	2 Year	Female	12.600	1.40
25	3 Year	Female	5.700	2.21
26	3 Year	Male	16.600	4.91
27	3 Year	Male	25.200	5.69
28	1 Year	Female	14.400	1.16
29	5 Year	Male	8.100	1.81
30	4 Year	Female	14.100	8.56

(Source: Primary and Secondary Data, 2022)

### 3.2 Characteristics of Pediatric Pneumonia Patients in Koja Hospital

There are 30 patients with pneumonia in children, so the characteristics of 30 pediatric patients with pneumonia can be identified as follows:

a. Age

**Table 2.**  
Frequency Distribution of Child Pneumonia Patients

No	Age	Frequency	Percentage
1	Toddler (1 Year to 5 Years)	24	80.0 %
2	Childhood (6 Years to 11 Years)	5	16.67 %
3	Early teens (12 years to 16 years)	1	3.34 %
Total		30	100%

(Source: Primary and Secondary Data, 2022)

Based on table 2, it is known that the characteristics of pediatric pneumonia sufferers in Koja Hospital are the majority aged from the Toddler group (1 year to 5 Years) as many as 24 patients or 80.0%.

b. Gender

**Table 3.**  
Frequency Distribution of Sex of Children with Pneumonia

No	Age	Frequency	Percentage
1	Male	16	53.34%
2	Female	14	46.66%
Total		30	100%

(Source: Primary and Secondary Data, 2022)

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Based on table 3, it is known that the characteristics of pediatric Pneumonia sufferers in Koja Jakarta Hospital are the majority male, with as many as 16 patients or 53.34%..

### 3.3 Normality test

The normality test is used to determine whether the distribution of the leukocyte count and NLCR data is normally distributed or not so that it can determine the statistical test of the hypothesis to be used. The normality test method used in this study is the Kolmogorov Smirnov normality test with the following results:

**Table 4.**  
**Kolmogorov-Smirnov. Normality Test Results**

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		30
Normal Parameters <sup>a,b</sup>	Mean	,000000
	Std. Deviation	3,29728663
Most Extreme Differences	Absolute	,092
	Positive	,092
	Negative	-,067
Test Statistic		,092
Asymp. Sig. (2-tailed)		.200 <sup>c,d</sup>

a. Test distribution is Normal.  
b. Calculated from data.  
c. Lilliefors Significance Correction.  
d. This is a lower bound of the true significance.

The results of the normality test using the Kolmogorov Smirnov method obtained a significant value for both variables, both Leukocytes, and NLCR, which were above 0.05. With the results of the Leukocyte normality test of  $0.200 > 0.05$ , it can be concluded that the two variables are normally distributed. Because the distribution of this data is normal, it can be continued to do the Pearson Product Moment parametric statistical test which serves to determine whether there is a relationship between the independent variable and the dependent variable which is shown in table 5 below:

**Table 5.**  
**Pearson Parametric Test Results Leukocyte Count and NLR in Pediatric Pneumonia Patients**

		Jumlah Leukosit	NLCR
Jumlah Leukosit	Pearson Correlation	1	.397*
	Sig. (2-tailed)		,030
	N	30	30
NLCR	Pearson Correlation	.397*	1
	Sig. (2-tailed)	,030	
	N	30	30

\*. Correlation is significant at the 0.05 level (2-tailed).

The results of the Pearson Product Moment parametric test contained in table 4-5 concluded that there was a relationship or correlation between the number of leukocytes and NLR in pediatric patients with pneumonia who were treated in the pediatric ward at Koja Hospital Jakarta. The results of the Pearson Product Moment parametric test are said to be significantly correlated if the significance value ( $p$ )  $< 0.05$ . Table 4-5 shows the significant value of the Pearson Product Moment parametric test of 0.03. Because the Pearson Correlation test is smaller than 0.05, the result is 0.03

< 0.05. So it can be concluded that there is a significant correlation or relationship between variables.

### 3.4 Discussion

The number of leukocytes in children with pneumonia at the Koja Hospital Jakarta showed that most of them were abnormal. The reference value for leukocytes based on the Ministry of Health of the Republic of Indonesia Year 2011 is 3200- 10,000/mm<sup>3</sup>. This indicates that children with pneumonia in Koja Hospital are dominated by the number of leukocytes in the blood > 10,000/mm<sup>3</sup>. Children with pneumonia in Koja Hospital related the results of the high number of leukocytes because Leukocytosis is a systemic inflammatory response to infection due to stimulation of proinflammatory cytokines and the presence of endotoxemia (de Jager et al., 2010). This study supports the research conducted by (Furer et al., 2011). Which mentions that leukocytosis is found in the majority of pneumonia patients. In terms of age, pneumonia sufferers are dominated by pediatric patients with an age range of 1 year - 5 years, which is 80.0%. This supports research conducted by (Nuraeni et al., 2019) which states that pneumonia sufferers mostly occur in toddlers. NLR shows a mean value of 4.186. The NLR value in this study ranged from 0.38 to 14.85. Neutrophils are a type of leukocyte whose number increases in patients with pneumonia. Neutrophils are released mainly to fight pathogens by means of phagocytosis at the site of inflammation (Kolling et al., 2001).

The results of the analysis showed that there was a correlation or relationship between the number of leukocytes and the value of the neutrophil-lymphocyte ratio in patients with pneumonia in children at Koja Hospital. The results of this study are in line with research conducted by (Yullyantara et al., 2015) which describes that the results of this study indicate that the NLR value of 4.67 is a risk factor for bacteremia. This cut-off value can be used to initiate antibiotic therapy to prevent a worse prognosis (sepsis, multiple organ failure, and death). But the results of this study are not in line with research conducted (Pramana et al., 2015) which illustrates that there is no relationship between the number of leukocytes and the severity of pneumonia in children.

Examination of the leukocyte count and NLR can be influenced by pre-analytical, analytical, and post-analytic factors. Pre-analytic factors include: sampling in children is quite difficult so that sometimes only a few blood samples are obtained, and incorrect labeling of samples. Analytical factors include the quality of the reagents which are sometimes close to the expiration date, the value of the instrument calibration factor, and the quality of the control of the hematology tool which is getting less and less in quality. Meanwhile, post-analytic factors include the calculation and reporting of results that sometimes do not match those listed on the hematology analyzer.

## 4. Conclusion

There is a correlation or relationship between the number of leukocytes and the value of the neutrophil-lymphocyte ratio in pediatric patients with pneumonia at Koja Hospital. This conclusion was obtained after performing the Pearson Product Moment parametric test with a value of 0.03 < 0.05.

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