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Relationship Between Nutritional Status and Severity of Pneumonia among Children Under Five

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Abstract

Background: Pneumonia is known as a forgotten pandemic, leading to high morbidity and mortality, especially among children under five years, with nutritional status identified as a risk factor for the disease's incidence. **Objective:** This study aimed to determine the relationship between nutritional status and pneumonia severity in children under five. **Methods**: An analytical observational study with a cross-sectional design was conducted among 122 children aged 2-59 months diagnosed with pneumonia based on medical record data from January 2022 to January 2024. The data were obtained with consecutive sampling. Data were analyzed through univariate and bivariate analyses using the chi-square test with SPSS software version 27. **Results**: Of 122 patients, the majority of patients were aged 12-59 months (64.8%), male (56.6%), had good nutritional status (63.1%), had a high level of life outcomes (98.4%), and had pneumonia (71.4%). Bivariate analysis showed a significant relationship between nutritional status and pneumonia severity (p < 0,001); PR = 4,3023; CI = 3,449 – 20,338). But there was no relationship between age (p = 0,081; PR = 1,740; CI = 0,989 – 4,963) and gender (p = 1,000; PR = 1,02; CI = 0,468 – 2,283) with severity of pneumonia. **Conclusion:** This study found that age and gender were not associated with the severity of pneumonia in children under five years, but nutritional status was significantly associated with the severity of pneumonia in children under five years of age, where malnutrition has a 4 times higher risk of experiencing severe pneumonia. It is important to enhance interventions to improve the nutritional status of children to reduce the incidence, severity, and mortality of pneumonia in children.

Keywords: Children, Nutritional status, Pneumonia, Severe pneumonia

Original Research Article

INTRODUCTION

Pneumonia is recognized as a significant contributor to elevated morbidity and mortality rates in children, affecting both developing and developed nations. Every year, there are approximately 120 million pneumonia cases in children globally, which leads to an estimated mortality of 1.3 million cases (Tramper-Stranders, 2018). In 2019, this disease claimed the lives of 740,180 children under 5 years old and contributed to 14% of all deaths (Troeger et al., 2020).

Pneumonia affects people of all ages, but in Indonesia—a developing country—children aged one to four experience the highest incidence (Sutriana et al., 2021). Surveillance data show that pneumonia is the leading cause of child mortality, with most cases occurring in toddlers. Between 2017 and 2020, 1,802,213 pneumonia cases were reported in toddlers across Indonesia (Kemenkes, 2023). Due to weak immune systems, infections occur more frequently in infants (Afriani & Oktavia, 2021).

Several factors influence the occurrence of pneumonia. These factors are nutritional status in children, LBW (<2,500 grams at birth), indoor air pollution, densely populated area, zinc deficiency, maternal educational level, maternal parenting in previous children, comorbidities, daycare, weather, vitamin A deficiency, and birth order of babies (Sutriana et al., 2021). Children with good nutrition have a lower risk of pneumonia than those with malnutrition because nutritional status and immunity are interrelated. In children with malnutrition, immunity will decrease, causing them to be susceptible to infection (Ngaisyah & Avianty, 2020).

Malnutrition, besides affecting children more susceptible to infectious diseases, also makes children more susceptible to more serious conditions (Walson & Berkley, 2018). Previous studies suggest that mortality from pneumonia is significantly higher in severe conditions (Xie et al., 2024). The latest data from *Survei Status Gizi Indonesia* (SSGI) 2022 showed that 21.6% of children under 5 years old experienced stunting and 7.7% were underweight. Compared to 2021, the stunting rate reached 24.4%. Although experiencing a decrease, according to the WHO, the number above 20% is still considered high (Kemenkes RI, 2022). The prior research indicates a correlation between nutritional status and pneumonia severity in pediatric patients (Artawan et al., 2016). This study focuses on defining pneumonia severity criteria by referring to the WHO 2014 revision, given the differences in the definition of this disease among several previous studies.

Based on the previous background, considering the high number of pneumonia cases and the nutritional problems still a significant concern in Indonesia, researchers are interested in conducting a study that aims to determine the relationship between nutritional status and the severity of pneumonia among children under five. Severe pneumonia is known to lead to a prolonged length of hospitalization, high cost of treatment, and worsen the prognosis (Sultana et al., 2021; Xie et al., 2024; Yamananda et al., 2019). It is important to understand the factors that may worsen the severity of pneumonia, such as nutritional status. It can help reduce morbidity and mortality rates from pneumonia, especially in children under five years old, through proper management and education for the public.

MATERIALS AND METHODS

Design

This research is a quantitative study. This study used a cross-sectional study and analytical observational methods.

Population and Sample

Data were derived from the medical records of children aged 2 to 59 months diagnosed with pneumonia who were hospitalized or treated as outpatients at Prof. Dr. Charuddin Panusunan Lubis Hospital in Medan from January 2022 to January 2024. The inclusion criteria consisted of children aged 2 to 59 months diagnosed with pneumonia, having complete medical records that included age, sex, weight, height, and pneumonia severity. Exclusion criteria included patients with other pulmonary diseases, hydrocephalus, a history of congenital heart disease, and immunodeficiency disorders.

Sampling

The data were selected using a consecutive sampling method. After being calculated using two unpaired categorical formulas, a minimum sample of 118 people was required. One hundred twenty-two patients were obtained according to the inclusion and exclusion criteria.

Variable

The variables in this study were age (2–11 months, 12–59 months), gender (male, female), nutritional status (malnutrition, good nutrition), outcome (survival, death), and severity of pneumonia (pneumonia, severe pneumonia).

Instrument

The evaluation of nutritional status was conducted using WHO criteria based on body weight and height for children <5 years old (IDAI, 2018). The assessment of severity was guided by the WHO revised guidelines, which classify pneumonia in children as either pneumonia or severe pneumonia, based on the child's clinical presentation upon arrival at the hospital. Children are diagnosed with pneumonia if they exhibit rapid breathing (greater than 50 breaths per minute for ages 2-11 months and greater than 40 breaths per minute for ages 12-59 months) accompanied by retraction of the lower chest wall. Severe pneumonia is defined by symptoms including cough and dyspnea, accompanied by oxygen saturation levels below 90% or the occurrence of central cyanosis. Additional symptoms encompass acute respiratory distress, potentially presenting as grunting or significant chest wall retraction, alongside typical indicators of severe pneumonia, such as an inability to breastfeed or drink, lethargy or diminished consciousness, and seizures such as an inability to breastfeed or drink, lethargy or diminished consciousness, and seizures (WHO, 2014).

Analysis

Data analysis was conducted utilizing SPSS software version 27, employing univariate and bivariate analytical methods. Univariate analysis was used to examine the frequency of the variables. The bivariate analysis employed the chi-square test to examine the relationship between the variables. The findings were considered significant when the p-*value* was less than 0.05. The prevalence ratio is used to compare the prevalence of a disease between two distinct groups. Specifically, to calculate the PR, divide the prevalence in the test group by the prevalence in the control group.

Ethical Approval

The study was carried out with the approval of the Health Research Ethics Committee at Universitas Sumatera Utara, reference number 751/KEPK/USU/2024.

RESULTS

The frequency distribution of the characteristics is shown in Table 1. Most children were 12-59 months old (64.8%), males (56.6%), with good nutritional status (63.1%), life outcomes (98.4%), and had pneumonia (71.3%).

Table 1. Patients Characteristics Distribution

Characteristics	n (%)
Age (months)	
- 2 – 11	43 (35,2)
- 12 – 59	79 (64,8)
Gender	
- Male	69 (56,6)
- Female	53 (43.4)
Nutritional Status	
- Severely wasted	18 (14,8)
- Wasted	22 (18,0)
- Good	77 (63,1)
- Overweight	5 (4,1)
Outcome	
- Survived	120 (98,4)
- Died	2 (1,6)
Severity of Pneumonia	
- Severe pneumonia	35 (28,7)
- Pneumonia	87 (71,3)

The analysis of the relationship between the age and gender of pneumonia patients with the severity of pneumonia is shown in Table 2.

Table 2. Bivariate Analysis of Age and Gender in Relationship to Pneumonia Severity

Characteristic	Severity of Pneumonia		Total (n = 122)	p-*value**	PR (95% CI)
	Severe Pneumonia	Pneumonia			
	n(%)	n(%)			
Age (months)					1,740
2 - 11	17 (39,5)	26 (60,5)	43	0,081	(0,989 – 4,963)
12 – 59	18 (22,8)	61 (77,2)	79		
Gender					1,02
Male	20 (29,0)	49 (71,0)	69	1,000	(0,468 –2,283)
Female	15 (28,3)	38 (71,7)	53		

**chi-square test*

For research purposes, cell merging was carried out by simplifying the characteristics of nutritional status in children. Cell merging simplifies nutritional status into malnutrition, which consists of severely wasted, wasted, and overweight. The analysis is shown in Table 3.

Table 3. Bivariate Analysis of Nutritional Status and Pneumonia Severity

Characteristic	Severity of Pneumonia		Total (n = 122)	p-*value**	PR (95% CI)
	Severe Pneumonia	Pneumonia			
	n(%)	n(%)			
Nutritional Status					4,3023 (3,449 – 20,338
Malnutrition	25 (55,6)	20 (44,4)	45	<0,001	
Good nutrition	10 (13,0)	67 (87,0)	77		

**chi-square test*

DISCUSSION

According to Saha et al. (2016), younger age increases the risk of pneumonia, especially severe cases. As children age within this range, their risk decreases. This is because younger children have lower immunity and smaller airway diameters (Kristya et al., 2023). Our finding shows that the highest age of children experiencing pneumonia in this study was 12 – 59 months old, which was 79 children (64.8%) and 43 children (35.2%) aged 2 – 11 months. This finding contradicts prior studies, which indicated that the majority of patients were under 12 months, consisting of 63 children (54.8%) (Kifle et al., 2023). The incidence may be higher in children aged 12-59 months because they become more active outdoors, leading to greater exposure to pathogens and higher levels of pollution (Ostrzy et al., 2023; Zhou et al., 2022). In addition, symptoms in infants can be more difficult to detect in the early stages, making it challenging to record cases and potentially leading to more severe outcomes (Chen et al., 2021).

However, the findings in this study indicate no relationship between age and pneumonia severity in children under five, with a p-value of 0.081 (p-value > 0.05). The prevalence ratio in this study was 1.740 (95% CI: 0.989 – 4.963). This is consistent with previous research with a p-value = 0.085 (Al-Dalfi et al., 2023). Although theoretically age is recognized as a risk factor for pneumonia, it is not the only factor influencing the severity of pneumonia in children, as other risk factors can also contribute to its severity.

The findings indicate that based on the characteristics of gender, pneumonia cases were higher in males of 69 children (56.6%) than females of 53 children (43.4%). This aligns with the study by Setyoningrum and Mustiko (2020), which found that pneumonia was more prevalent in males, with 141 cases (56.7%), compared to females, with 112 cases (44.3%). Previous analyses show the same result, where more cases occurred in males of 63 children (68.5%) (Fadmi et al., 2023). The findings in this study showed that there is no relationship between gender and the severity of pneumonia in children, with a p-*value* = 1.000 (p-*value* > 0.05), with a prevalence ratio of 1.02 (95% CI: 0.468 – 2.283).

This aligns with the previous research, which apprises a similar result with a p-*value* of 0.775 (Arista et al., 2022).

The incidence of infectious diseases is typically higher in males than in females, due to anatomical defenses and innate and adaptive immune systems (Whitsett, 2014). The innate and adaptive immune system is more robust against infection in females than in males (Whitsett, 2014). Sex hormones affect immunity, such as testosterone in males, which can suppress the body's immune response, while estrogen in females increases the body's immune response (A'yuni et al., 2022). Anatomically, boys have narrower respiratory tracts than girls, which makes them more susceptible to pneumonia (Hoffstein, 1986). Other factors that also have an effect include males tend to be more active and, therefore, more often exposed to risk factors related to the external environment (Ulfa, 2020). Previous research indicated that parents and relatives were more likely to bring boys to the physician for pneumonia than girls (Naheed et al., 2019). This led to the recording of more cases in males than females (Corica et al., 2022).

Out of 122 pediatric pneumonia patients, only 2 children died (1.6%). Meanwhile, the other 120 children had a survival/recovery outcome (98.4%). Previous study shows the same result, where more pneumonia patients had survival/recovery outcomes of 47 children (51.6%), and 44 children passed away (48.4%) (Adilla & Lubis, 2022). Another study is also in line with this study, where the most patient outcomes were alive in 183 children (81.33%), and 42 children died (18.67%) (Latumahina et al., 2016). Based on previous studies, mortality is higher in severe pneumonia (Marangu & Zar, 2019). However, this study's results exhibit a notable percentage difference when compared to the prior study. The survival rate of patients in this study was greater compared to those who passed away. This difference is related to the treatment administered by the hospital for each patient (Tsegaw et al., 2021). Furthermore, it can also be influenced by other factors, such as severe pneumonia, decreased consciousness, incomplete immunization, and malnutrition (Adbela et al., 2024).

The most common nutritional status among pediatric pneumonia patients is good nutritional status. The findings showed that children with good nutritional status are 77 (63.1%). Meanwhile, children with severely wasted are 18 (14.8%), wasted are 22 (18%), and overweight are 5 (4.1%). The prior research shows that most pediatric pneumonia patients have a good nutritional status of 83 children (81.4%), a poor nutritional status of 10 children (9.8%), and an overweight status of 9 children (8.8%) (Arista et al., 2022). Nutritional status is closely related to the immune system in children (Mirasa, 2024). Malnutrition affects the body's immune system in defending against infectious diseases and affects lung function (Tharumakunarajah et al., 2024). It can also predispose children to severe pneumonia (Walson & Berkley, 2018).

According to the severity criteria for pneumonia defined by WHO (2014), this study reports that pneumonia was observed in 87 children (71.3%), while severe pneumonia was identified in 35 children (28.7%). This finding aligns with the results of the earlier research in Central Java Province, which obtained the result that the most patients had pneumonia in 77 children (58.3%) and severe pneumonia in 55 children (41.7%) (Cahyani et al., 2024). The analysis results indicate a significant relationship between nutritional status and pneumonia severity in children, with a p-*value* < 0.001 (p-*value* < 0.05). This study found a prevalence ratio of 4.3023 (95% CI: 3.449 – 20.338), indicating that malnutrition is a significant risk factor for severe pneumonia. Toddlers experiencing malnutrition are 4.3023 times more likely to develop severe pneumonia compared to children with good nutrition.

This result aligns with the previous study, with p-*value* = 0.015 (p-*value* < 0.05) and prevalence ratio of 3.27 (95% CI: 1.247 – 8.590) (Susila et al., 2021). Children's immune system against infection is influenced by nutritional status. In children with malnutrition, the immune system decreases, causing them to be more susceptible to infections, such as pneumonia. Children with good nutritional status have a better ability to fight infections than children with malnutrition (Adriani & Simarmata, 2022). According to the WHO, malnutrition is not only a condition of nutritional deficiency but also a condition of overnutrition, which is overweight and obesity (Arifin et al., 2022).

Malnutrition increases the risk of numerous infectious diseases, contributes to the severity of illnesses, and increases mortality rates (Weckman et al., 2023). This is especially true in children under five with an immune system that is not yet fully formed (Ruwandasari, 2019). Nutritional status and

infection are complementary because malnutrition causes children to be susceptible to infection, while infection causes malnutrition through anorexia, malabsorption, and increased nutritional needs (Walson & Berkley, 2018). When a child has an infection, body protection mechanisms such as fever divert energy that should be used in growth and development. This condition causes the child's calorie needs to increase (Katona & Katona-Apte, 2008).

Children with malnutrition have lower immune mediator cells, a weak complement system, and less Ig A secreted. This leads to weakened humoral immunity (Wicaksono, 2016). Ig A, as an antimicrobial protein, protects the mucosal surface as the initial site of pathogen entry (Drummond et al., 2016). A decrease in Ig A affects pneumonia severity (Olofin et al., 2013). Impaired regeneration in respiratory tract epithelium, along with thymus and tonsil atrophy, leads to a gradual reduction in T lymphocyte numbers, resulting in decreased cellular immunity and increased susceptibility to infections in children (Wicaksono, 2016).

Nutritional intake increases the immune system through vitamins, minerals, and other bioactive compounds (Schwinger et al., 2019). Malnutrition as a protein deficiency can also be accompanied by the lack of intake of other vitamins and minerals (Gombart et al., 2020). Malnutrition, besides decreasing immunity, also decreases the function of respiratory muscles, which is related to the frequency, severity, and increasing mortality rate due to pneumonia (Gamal et al., 2023). Children with pneumonia require additional calories to increase breathing effort. If nutrition in children is inadequate, energy reserves tend to be lower, thus decreasing the recovery rate, making them susceptible to recurrence, and inhibiting children's growth and development generally (Katona & Katona-Appa, 2008).

CONCLUSION

This study shows that there is a significant relationship between nutritional status and the severity of pneumonia in children under five. If other researchers would like to conduct a study in a similar field, it is suggested to conduct a study by observing a relationship between other risk factor variables, such as breast milk, LBW, knowledge level, education level, domicile, and birth order, and the severity of pneumonia in children.

LIMITATION

Numerous limitations exist, particularly regarding research variables tied to external risk factors, owing to the use of medical records and the brief sample collection period. Furthermore, data collection was constrained by reliance on a single hospital center, a small sample size, and a two-year timeframe.

CONFLICT OF INTEREST

The authors state that they have no conflict of interest.

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