

How to Cite

Simanjuntak, S. P. P., & Saragih, J. R. P. (2024). The relationship between anemia and pneumonia severity in children aged 29 days to 5 years. *International Journal of Health & Medical Sciences*, 7(2), 30-34. <https://doi.org/10.21744/ijhms.v7n2.2276>

The Relationship between Anemia and Pneumonia Severity in Children Aged 29 Days to 5 Years

Stevan Pagar Pardamean Simanjuntak

General Practitioner, Waikabubak General Hospital, Indonesia

Corresponding author email: ipenpagar@gmail.com

Japendi Rizal Pavliando Saragih

Pediatric Department, Waikabubak General Hospital, Indonesia

Abstract---*Background: Pneumonia is an acute infection of the lung parenchyma and is a leading cause of death among children under five worldwide. The World Health Organization (WHO) notes that 15% of all under-five deaths are due to pneumonia, with a prevalence of 3.55% in Indonesia. Anemia, especially iron deficiency anemia, is also a common health issue among children and is associated with increased morbidity and mortality. Anemia is believed to increase the risk and worsen the severity of pneumonia due to hypoxia and impaired immune function. Methods: This cross-sectional study was conducted at Waikabubak General Hospital, West Sumba, on children aged 29 days to 5 years who were hospitalized with pneumonia from January 2022 to December 2023. Pneumonia was defined based on WHO criteria. Anemia was defined as blood hemoglobin levels <11 mg/dL. Exclusion criteria included other conditions that might affect the study results. Data analysis was performed using the Chi-square test to assess the relationship between anemia and pneumonia severity. Results: Of the 399 subjects meeting the criteria, 57.9% were male and 42.1% female. A total of 61.9% were diagnosed with mild to moderate pneumonia, and 38.1% were diagnosed with severe pneumonia. Most subjects (55.8%) had anemia. The analysis showed a significant correlation between hemoglobin levels and pneumonia severity ($p=0.0125$; $OR=2.0043$; $CI\ 95\%= 1.1542 - 3.4805$). Conclusion: This study reveals a significant relationship between anemia and pneumonia severity in children. Early detection and management of anemia can be important interventions to reduce the incidence and severity of pneumonia, thus improving clinical outcomes in the pediatric population.*

Keywords---*anemia, children, hypoxia, immune function, pneumonia severity.*

Introduction

Pneumonia is an acute infection of the lung parenchyma, involving the alveoli and interstitial tissue, characterized by symptoms such as cough, shortness of breath, fever, wet rales, and infiltrates on chest X-rays. Pneumonia is the leading cause of infectious death in children and remains a global health issue, especially among children under five. According to the World Health Organization (WHO, 2022), 15% of all deaths in children under five are caused by pneumonia.

Acute lower respiratory tract infections, including pneumonia in children under five, are the leading cause of childhood illness and death globally, accounting for nearly 60% of hospitalizations due to infectious diseases in infants. The Indonesian Health Profile 2019 reports that pneumonia is one of the causes of under-five mortality, with 277 cases or 9.5% of total under-five deaths in Indonesia. The prevalence of pneumonia in children under five in Indonesia is 3.55% (Ministry of Health of the Republic of Indonesia, 2019).

Anemia is the most common hematologic disorder found in infants and children. About a quarter of the world's population suffers from anemia. Recent findings from the World Health Organization (WHO) in 2019 show that the overall prevalence of anemia is 39.8% among children globally. This condition is most prevalent in developing countries such as those in Africa and Asia, particularly Southeast Asia, where anemia affects a significant portion of individuals (Msinde, 2023; Islam et al., 2022). In Indonesia, according to the Basic Health Research (RISKESDAS)

survey, more than 50% of Indonesian children and adolescents are anemic, including 28% of children under five and 26% of children aged 5–14 years (Juffrie et al., 2020). Microcytic, hypochromic anemia, as the name suggests, is a type of anemia where circulating red blood cells are smaller than normal (microcytic) and have reduced red color (hypochromic). The most common cause of this type of anemia is decreased iron reserves in the body (Chaudhry & Kasarla, 2017). Anemia, especially iron deficiency anemia, is associated with increased morbidity and mortality rates in children, especially in preschool children (Gallagher, 2022; Jayamanna & Jayaweera, 2023).

The interaction between these two conditions is very complex and varied, affecting morbidity and mortality rates in the pediatric population. Children under five are particularly vulnerable to anemia (Jayamanna & Jayaweera, 2023). Anemia is known to be a risk factor and an aggravating factor for pneumonia, especially in under-five population (Oktafia et al., 2021; Chisti et al., 2022). This may be because anemia creates a hypoxic environment in the respiratory circulation, which can be a major contributor to lower respiratory tract infections (Gobinaath, 2020).

We hypothesize that anemia not only increases children's susceptibility to pneumonia but can also worsen the severity of the condition (Wahyuni & Widyaningsih, 2021). This hypothesis is based on the physiological impacts of anemia, which disrupts oxygen delivery to tissues and impairs immune function, potentially leading to increased susceptibility to infections such as pneumonia (Morey et al., 2015; Yung, 2000). By exploring this relationship, this study aims to uncover potential intervention pathways that could reduce the burden of this condition on child health. The importance of this research is underscored by its potential to improve clinical outcomes through early identification and treatment of anemia, ultimately reducing the incidence and severity of pneumonia in children (Suci, 2020).

Methods

A cross-sectional study was conducted in the pediatric ward of Waikabubak General Hospital, West Sumba. The study subjects were children aged 29 days to 5 years who were hospitalized with pneumonia from January 2022 to December 2023. Pneumonia was defined based on WHO criteria: a respiratory rate of at least 50 breaths per minute in children aged 2-11 months and at least 40 breaths per minute in children aged 1-5 years, along with chest wall indrawing. Pneumonia severity was assessed based on WHO criteria: cough or difficulty breathing with oxygen saturation below 90% or severe respiratory distress or the presence of danger signs (inability to drink, altered consciousness, seizures). Anemia was defined as blood hemoglobin levels <11 mg/dL, with MCV <80 fl, MCH <27 pg, and MCHC <32 g/dL.

Exclusion criteria included subjects with a history of malignancy, undergoing antineoplastic therapy, a history of thalassemia, malnutrition, other systemic conditions, and incomplete medical records. Eligible samples were taken from hospital medical records using consecutive sampling methods and analyzed using SPSS version 27 with univariate and bivariate Chi-square tests between anemia ($hb < 11.0$) and severe pneumonia. We recorded sample characteristics such as patient gender, pneumonia severity, and hemoglobin levels.

Results

Secondary data were obtained from patients admitted to Waikabubak General Hospital, West Sumba, from January 2022 to December 2023, recorded in the hospital medical records. A total of 399 samples met the inclusion and exclusion criteria. The characteristics of the subjects included in this study are shown in Table 1.

Table 1
Study subject characteristics

Characteristics	Frequency
Gender	
Male	231 (57.9%)
Female	168 (42.1%)
Diagnosis	
Mild-moderate Pneumonia	247 (61.9%)
Severe Pneumonia	152 (38.1%)
Hemoglobin level (mg/dL)	
> 11 (non-anemia)	184 (46.1%)
< 11 (anemia)	215 (53.8 %)

This study had nearly equal numbers of male and female subjects (57.9% and 42.1%, respectively). The majority of subjects were diagnosed with mild to moderate pneumonia (61.9%), while the remaining 38.1% were diagnosed with severe pneumonia. Almost half of the subjects were anemic (55.8%), while the other half were not (46.1%). Our data analysis revealed a significant correlation between hemoglobin levels and pneumonia severity ($p=0.0125$; $OR=2.0043$; $CI\ 95\%= 1.1542 - 3.4805$), as shown in Table 2.

Table 2
Correlation between hemoglobin levels and pneumonia severity

Status Hb	Severe pneumonia	Mild-moderate pneumonia	Total	P	OR	95% CI
Anemia	46 (67,6%)	169 (51%)	215 (53,8%)	0.012	2.004	1.1542 - 3.4805
Non-anemia	22 (32,3%)	162 (49%)	184 (46,1%)			

p significant if <0.05

Discussion

Anemia and pneumonia are two of the most common pathological conditions in the young population, and they often occur simultaneously. Children under five and pregnant women are highly susceptible to anemia, especially in low-income countries (Aksu & Ünal, 2023). In Indonesia, more than 50% of children and adolescents are anemic, including 28% of children under five and 26% of children aged 5–14 years (Juffrie et al., 2020). Various conditions can cause anemia, such as micronutrient deficiencies, acute or chronic infections, low socioeconomic status, demographics, genetics, and immunohematologic diseases (Michiels, 2004; Zhou et al., 2006). Microcytic, hypochromic anemia, as the name suggests, is a type of anemia where circulating red blood cells are smaller than normal (microcytic) and have reduced red color (hypochromic) (Solaini et al., 2010). The most common cause of this type of anemia is decreased iron reserves in the body (Chaudhry & Kasarla, 2017). Our study did not investigate the type of anemia, so the specific effects of anemia on pneumonia severity cannot be explained (Ito et al., 2020). However, based on the data, iron deficiency is the most common cause of anemia (Gallagher, 2022; Juffrie et al., 2020). Anemia, especially iron deficiency anemia, is known to be a risk factor and increase susceptibility to lower respiratory tract infections, including pneumonia (Behairy et al., 2018; Saputra et al., 2022).

The findings of this study highlight a significant correlation between anemia and pneumonia severity in children ($p=0.0125$; $OR=2.0043$; $CI\ 95\%= 1.1542 - 3.4805$), consistent with the initial hypothesis and previous research (Chisti et al., 2022; Cao et al., 2023). Oktafia et al. (2021), stated that anemia is associated with an increased risk of complications in pneumonia. Children with anemia experience reduced hemoglobin capacity to carry oxygen, exacerbating the abnormal ventilation-perfusion ratio, thereby increasing the risk of respiratory failure in children with severe pneumonia. Therefore, anemia can significantly increase morbidity and mortality rates in children with pneumonia (Cao et al., 2023; Reade et al., 2010). Low hemoglobin levels are known to cause hypoxemia, thus alveolar macrophages have a lower capacity to acquire iron from red blood cells. This immune system imbalance leads to worsened lung infections and triggers increased pneumonia severity (Wahyudi et al., 2020; Satici et al., 2020).

The increased risk of pneumonia observed in anemic children indicates that anemia is not just a comorbid condition but may contribute to the development of pneumonia. There are several limitations to this study. It did not analyze the relationship of other variables with severe pneumonia occurrence. We also did not analyze the specific causes of hypochromic, microcytic anemia. Measuring ferritin levels could confirm the specific cause of microcytic hypochromic anemia (Shah et al., 2010; Accinelli & Leon-Abarca, 2017; Brabin et al., 2001).

Conclusion

There is a significant relationship between hemoglobin levels and the occurrence of severe pneumonia in children aged 29 days to 5 years.

References

- Accinelli, R. A., & Leon-Abarca, J. A. (2017). Solid fuel use is associated with anemia in children. *Environmental research*, 158, 431-435. <https://doi.org/10.1016/j.envres.2017.06.032>
- Aksu, T., & Ünal, Ş. (2023). Iron deficiency anemia in infancy, childhood, and adolescence. *Turkish Archives of Pediatrics*, 58(4), 358.
- Behairy, O. G., Mohammad, O. I., & Elshaer, O. S. (2018). Iron-deficiency anemia as a risk factor for acute lower respiratory tract infections in children younger than 5 years. *Egyptian Journal of Bronchology*, 12, 352-357.
- Brabin, B. J., Premji, Z., & Verhoeff, F. (2001). An analysis of anemia and child mortality. *The Journal of nutrition*, 131(2), 636S-648S. <https://doi.org/10.1093/jn/131.2.636S>
- Cao, L., Ji, Z., Zhang, P., & Wang, J. (2023). Epidemiology and mortality predictors for severe childhood community-acquired pneumonia in ICUs: A retrospective observational study. *Frontiers in Pediatrics*, 11, 1031423.
- Chaudhry, H. S., & Kasarla, M. R. (2017). Microcytic hypochromic anemia.
- Chisti, M. J., Kawser, C. A., Rahman, A. S. M. M. H., Shahid, A. S. M. S. B., Afroze, F., Shahunja, K. M., ... & Ahmed, T. (2022). Prevalence and outcome of anemia among children hospitalized for pneumonia and their risk of mortality in a developing country. *Scientific Reports*, 12(1), 10741.
- Gallagher, P. G. (2022). Anemia in the pediatric patient. *Blood, The Journal of the American Society of Hematology*, 140(6), 571-593.
- Gobinaath, J. A. D. (2020). Association between anemia and acute lower respiratory tract infection in under-five children at Puducherry, India: a case control study. *Int J Contemp Pediatr*, 7(3): 679.
- Islam, M. A., Afroja, S., Khan, M. S., Alauddin, S., Nahar, M., & Talukder, A. (2022). Prevalence and triggering factors of childhood anemia: An application of ordinal logistic regression model. *International Journal of Clinical Practice*, 2022.
- Ito, A., Ishida, T., Tokumasu, H., Yamazaki, A., & Washio, Y. (2020). Evaluation of pneumonia severity scoring systems in nursing and healthcare-associated pneumonia for predicting prognosis: a prospective, cohort study. *Journal of infection and chemotherapy*, 26(4), 372-378. <https://doi.org/10.1016/j.jiac.2019.11.001>
- Jayamanna, U., & Jayaweera, J. S. (2023). Childhood Anemia and Risk for Acute Respiratory Infection, Gastroenteritis, and Urinary Tract Infection: A Systematic Review. *Journal of Pediatric Infectious Diseases*, 18(02), 061-070.
- Juffrie, M., Helmyati, S., & Hakimi, M. (2020). Nutritional anemia in Indonesia children and adolescents: Diagnostic reliability for appropriate management. *Asia Pacific Journal of Clinical Nutrition*, 29.
- Kementrian Kesehatan Republik Indonesia. (2019). Profil kesehatan Indonesia 2019 [Internet]. Kementrian Kesehatan Republik Indonesia. p. 487
- Michiels, C. (2004). Physiological and pathological responses to hypoxia. *The American journal of pathology*, 164(6), 1875-1882. [https://doi.org/10.1016/S0002-9440\(10\)63747-9](https://doi.org/10.1016/S0002-9440(10)63747-9)
- Msinde, P. S. (2023). The Prevalence, Etiology, And Outcome Of Anemia In Children Under Five On Admission In Three Hospitals Of Dar-Es-Salaam. *medRxiv*, 2023-12.
- Morey, J. N., Boggero, I. A., Scott, A. B., & Segerstrom, S. C. (2015). Current directions in stress and human immune function. *Current opinion in psychology*, 5, 13-17. <https://doi.org/10.1016/j.copsyc.2015.03.007>
- Oktafia, P., Airlangga, P. S., Dharmawati, I., & Setyoningrum, R. A. (2021). Risk factors of complicated pneumonia in children. *Journal Of The Indonesian Medical Association*, 71(3), 135-140.
- Reade, M. C., Weissfeld, L., Angus, D. C., Kellum, J. A., & Milbrandt, E. B. (2010). The prevalence of anemia and its association with 90-day mortality in hospitalized community-acquired pneumonia. *BMC pulmonary medicine*, 10, 1-10.
- Saputra, N. W., Kusumawardani, T., & Muryawan, M. H. (2022). Hubungan Anemia Defisiensi Besi dengan Pneumonia pada Anak Usia 6 Bulan–5 Tahun. *Medica Hospitalia: Journal of Clinical Medicine*, 9(1), 75-80.
- Satici, C., Demirkol, M. A., Altunok, E. S., Gursoy, B., Alkan, M., Kamat, S., ... & Esatoglu, S. N. (2020). Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19. *International Journal of Infectious Diseases*, 98, 84-89. <https://doi.org/10.1016/j.ijid.2020.06.038>
- Shah, F., Kazi, T. G., Afridi, H. I., Baig, J. A., Khan, S., Kolachi, N. F., ... & Shah, A. Q. (2010). Environmental exposure of lead and iron deficit anemia in children age ranged 1–5 years: a cross sectional study. *Science of the total environment*, 408(22), 5325-5330. <https://doi.org/10.1016/j.scitotenv.2010.07.091>
- Solaini, G., Baracca, A., Lenaz, G., & Sgarbi, G. (2010). Hypoxia and mitochondrial oxidative metabolism. *Biochimica et Biophysica Acta (BBA)-Bioenergetics*, 1797(6-7), 1171-1177. <https://doi.org/10.1016/j.bbabi.2010.02.011>
- Suci, L. N. (2020). Pendekatan Diagnosis dan Tata Laksana Pneumonia pada Anak. *Jurnal Kedokteran Nanggroe*

Medika, 3(1), 30-38.

World Health Organization. (2022). Pneumonia in Children [Internet].

Wahyudi, E., Handayani, T., & Setyoningrum, R. A. (2020). Risk factors of hypoxemia in children with pneumonia. *Indian Journal of public health research and development*, 11(6), 1226-1230.

Wahyuni, I. S., & Widyaningsih, E. B. (2021). Intervention with Fe supplementations and IEC about anemia against hemoglobin levels in female teenagers in state senior high school. *International Journal of Health & Medical Sciences*, 4(1), 38-43. <https://doi.org/10.31295/ijhms.v4n1.500>

Yung, R. L. (2000). Changes in immune function with age. *Rheumatic disease clinics of North America*, 26(3), 455-473. [https://doi.org/10.1016/S0889-857X\(05\)70151-4](https://doi.org/10.1016/S0889-857X(05)70151-4)

Zhou, J., Schmid, T., Schnitzer, S., & Brüne, B. (2006). Tumor hypoxia and cancer progression. *Cancer letters*, 237(1), 10-21. <https://doi.org/10.1016/j.canlet.2005.05.028>