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# Factors Associated with Pneumonia Diagnosis among Children Aged 1–60 Months at Hospital, Palembang: A Cross-Sectional Study Using 2024 Medical Records

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## ABSTRACT

**Background:** National surveillance provides an overview of the overall burden of childhood pneumonia but offers limited insight into factors associated with pneumonia among children treated at individual healthcare facilities. Dr. Mohammad Hoesin General Hospital is a tertiary referral hospital in South Sumatra and therefore provides clinically relevant, although not population-representative, hospital-based evidence to complement national and provincial surveillance. This study aimed to examine factors associated with pneumonia diagnosis among children aged 1–60 months treated at Dr. Mohammad Hoesin General Hospital, Palembang, using 2024 medical record data.

**Methods:** This analytical cross-sectional study included 123 children aged 1–60 months, using medical records from 2024, comprising 91 with pneumonia and 32 without. Descriptive statistics were used to summarize participant characteristics. Bivariate analyses were performed using Pearson's chi-square test or Fisher's exact test, as appropriate. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated using binary logistic regression.

**Results:** Among the 123 children included in this hospital-based sample, 91 (74.0%) were classified as having pneumonia. Incomplete immunization was associated with higher odds of pneumonia (crude OR=7.82; 95% CI: 2.42–25.22; Fisher's exact  $p<0.001$ ). Age  $\leq 12$  months, male sex, malnutrition, and absence of exclusive breastfeeding showed positive but statistically non-significant crude associations, with wide confidence intervals.

**Conclusion:** Incomplete immunization was associated with higher odds of pneumonia in the bivariate analysis of this hospital-based sample. Because the estimate was unadjusted and the study was cross-sectional, hospital-based, and based on secondary records, adjusted studies with broader environmental and socioeconomic variables are required to confirm an independent association.



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## INTRODUCTION

Pneumonia is an acute infection of the lung parenchyma in which inflammation and fluid or pus within the alveoli impair gas exchange. Clinical manifestations include cough or difficulty breathing, fever, and age-specific tachypnea; severe disease may be accompanied by chest indrawing, hypoxemia, or danger signs. Pneumonia may be classified by place of acquisition,

including community-acquired and hospital-acquired pneumonia, and by clinical severity. In the present study, the outcome was pneumonia status documented in the medical record rather than population incidence (World Health Organization, 2022).

According to UNICEF (2025), pneumonia remains the leading infectious cause of death among children under five years of age, claiming the lives of over 700,000 children annually, or approximately 2,000 children each day, including around 190,000 newborns. Almost all of these deaths are preventable through proven interventions such as routine immunization, exclusive breastfeeding, early diagnosis, and timely treatment. Globally, pneumonia affects more than 1,400 per 100,000 children each year (approximately one case per 71 children), with the highest incidence reported in South Asia (2,500 cases per 100,000 children) and West and Central Africa (1,620 cases per 100,000 children) (UNICEF, 2025).

In Indonesia, pneumonia remains a major infectious cause of morbidity and mortality among children under five. The Indonesian Health Profile 2024 reported that pneumonia accounted for 1.6% of all under-five deaths, although this proportion is based on deaths from all causes. Case-detection coverage declined from 65.3% in 2016 to 36.95% in 2023 (Kemenkes RI, 2024). In South Sumatra, 6,663 childhood pneumonia cases and five deaths were reported, with more than half of the cases occurring in Palembang City.

Established determinants of childhood pneumonia include young age, undernutrition, incomplete immunization, absence of exclusive breastfeeding, low birth weight, prematurity, household crowding, indoor air pollution, parental smoking, daycare exposure, maternal education, and socioeconomic conditions (Afriani & Oktavia, 2021; Caniago et al., 2022; Sutriana et al., 2021; Tangdilian et al., 2025). Immunization against pneumococcus, Haemophilus influenzae type b, measles, influenza, and pertussis is an important preventive strategy, while adequate nutrition and exclusive breastfeeding support children's natural defenses (World Health Organization, 2022). Only age, sex, nutritional status, immunization status, and exclusive breastfeeding were available consistently in the medical records used for this study; the remaining determinants were treated as unmeasured potential confounders. However, evidence from Indonesian tertiary referral hospitals using routinely collected medical records remains limited, particularly studies that compare children with pneumonia and a clearly defined non-pneumonia group. In addition, few hospital-based studies have evaluated age-appropriate immunization status together with nutritional status and exclusive breastfeeding as factors associated with childhood pneumonia using standardized medical-record data.

Dr. Mohammad Hoesin General Hospital was selected because it is a major tertiary referral center in South Sumatra and maintains medical records from children referred from Palembang and surrounding districts. Hospital-based evidence from this setting may identify documentation and prevention priorities among children receiving tertiary care, particularly age-appropriate immunization. However, the referral pattern may enrich the sample with severe or complicated cases and limits generalization to the community. This study therefore aimed to examine factors associated with pneumonia diagnosis among children aged 1–60 months treated at the hospital in 2024.

## METHODS

This analytical cross-sectional study was conducted at Dr. Mohammad Hoesin General Hospital, Palembang, from May to June 2025 using secondary medical-record data from pediatric patients attending the Pediatric Pulmonology Clinic between January and December 2024. The source population consisted of 1,906 medical records of children attending the clinic during the study period. Purposive sampling was used according to predefined eligibility criteria. 85 Medical records were screened sequentially. Children aged 1–60 months were first identified ( $n = 758$ ). Records of children diagnosed with pulmonary tuberculosis were excluded, leaving 557 potentially eligible records. Subsequently, only hospitalized children residing in Palembang with complete documentation of pneumonia status and all study variables were included, resulting in a final analytical sample of 123 children, comprising 91 children with pneumonia and 32 children without pneumonia. Because this was a cross-sectional study, the eligibility criteria were applied

uniformly to all participants. Additional exclusion criteria for non-pulmonary conditions were unnecessary because the source population was restricted to patients attending the Pediatric Pulmonology Clinic. No missing data were identified for the study variables among the included medical records. Records with incomplete or inaccessible information were excluded before analysis; therefore, complete-case analysis was performed. Children were included in the pneumonia group if they: (1) were aged 1–60 months; (2) were hospitalized and evaluated through the Pediatric Pulmonology Clinic at Dr. Mohammad Hoesin General Hospital, Palembang, between January and December 2024; (3) were residents of Palembang; (4) had a physician-recorded final diagnosis of pneumonia in the medical record; and (5) had complete and accessible information on age, sex, nutritional status, immunization status, and exclusive breastfeeding history. Records were excluded if the child had pulmonary tuberculosis, fell outside the specified age range, was not hospitalized, resided outside Palembang, or had incomplete or inaccessible information for any study variable.

The minimum sample size was determined using the Lemeshow formula for comparing two proportions, with a 95% confidence level, 80% statistical power, and an anticipated exposure difference based on previous evidence. The required minimum sample size was smaller than the final analytical sample of 123 children, indicating that the study achieved the planned sample size. A post hoc power analysis was performed to evaluate whether the study sample was sufficient to detect the observed difference in pneumonia occurrence according to immunization status. Using Kelsey's formula for comparing two proportions with a two-sided significance level of 0.05, the observed proportion of pneumonia was 94.5% among children with incomplete immunization and 5.5% among those with complete immunization. Based on the total sample of 123 participants and a control-to-case ratio of 0.35, the calculated  $Z\beta$  was 8.11, corresponding to an estimated statistical power approaching 100%. This finding indicates that the available sample size was more than adequate to detect the observed association between immunization status and pneumonia. Consequently, the probability of a Type II error ( $\beta$ ) was very low, suggesting that the statistically significant association observed in this study is unlikely to be attributable to insufficient sample size. Nevertheless, because this was a post hoc power analysis derived from the observed data, the high statistical power primarily reflects the large observed effect size rather than serving as an independent validation of the sample size determination.

Pneumonia status was determined from physician-recorded diagnoses supported by clinical assessment and/or radiological findings documented in the medical records. Medical records were eligible if the child's pneumonia status and all study variables were available. Records with incomplete or inaccessible information were excluded before analysis. No missing data were identified among the included records; therefore, complete-case analysis was performed.

The dependent variable was pneumonia status, categorized as pneumonia or non-pneumonia. The independent variables were age ( $\leq 12$  months and  $>12$ –60 months), sex, nutritional status, immunization status, and exclusive breastfeeding. Nutritional status was assessed using weight-for-length/height z-scores based on the WHO Child Growth Standards and the classification stipulated in Indonesian Ministry of Health Regulation No. 2 of 2020. Children with a z-score below  $-2$  SD were classified as malnourished, whereas those with a z-score from  $-2$  SD to  $+1$  SD were classified as having good nutritional status.

Immunization status was categorized as age-appropriate complete or incomplete according to documentation in the medical records. DPT immunization was defined as completion of the age-appropriate vaccination schedule against diphtheria, pertussis, and tetanus, whereas PCV immunization was defined as completion of the age-appropriate pneumococcal conjugate vaccine schedule. Children were classified as having complete immunization only when both age-appropriate DPT-containing and PCV vaccination schedules had been completed. Information on immunization status and all child characteristics was obtained exclusively from the medical records. Exclusive breastfeeding history was extracted from the infant feeding history documented in the hospital medical records during routine clinical assessment by healthcare professionals. Exclusive breastfeeding was defined as exclusive breast milk feeding during the first six months of life, as recorded in the medical records. Records with missing, undocumented,

or uncertain breastfeeding histories were excluded before analysis in accordance with the predefined complete-case approach.

Data were analyzed using SPSS. Frequencies and percentages were used to summarize participant characteristics. Pearson's chi-square test was applied for bivariate analyses when assumptions were satisfied, whereas Fisher's exact test was used for immunization status because one expected cell count was below five. Crude odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were calculated, with statistical significance defined as  $p < 0.05$ . Binary logistic regression was subsequently performed to estimate adjusted odds ratios. Model adequacy was evaluated using the omnibus likelihood-ratio test, Hosmer-Lemeshow goodness-of-fit test, Nagelkerke  $R^2$ , and the area under the receiver operating characteristic curve (AUC).

Ethical approval was obtained from the Health Research Ethics Committee of Dr. Mohammad Hoesin General Hospital, Palembang (Ethical Exemption No. DP.04.03/D.XVIII.6.8/ETIK/065/2025). Permission was granted to use secondary medical-record data for research purposes. All patient information was de-identified before analysis and handled confidentially throughout the study. Because this study used existing secondary medical-record data with no direct participant contact, the requirement for informed consent was waived by the Ethics Committee. All medical records were de-identified before analysis, and no personal identifiers were accessible to the researchers. Patient information was handled confidentially and used exclusively for the purposes of this study.

## RESULTS

The analysis examined crude associations of age, sex, immunization status, nutritional status, and exclusive breastfeeding with pneumonia status. The findings describe the 123 included hospital records and should not be interpreted as hospital or community prevalence. Table 2 presents the association between each risk factor and pneumonia status among children included in the study.

**Table 1. Frequency distribution of risk factors for pneumonia in children at RSUP Dr. Mohammad Hoesin Palembang (n=123)**

| Variables                      | n   | %    |
|--------------------------------|-----|------|
| <b>Pneumonia Occurrence</b>    |     |      |
| Pneumonia                      | 91  | 74.0 |
| No Pneumonia                   | 32  | 26.0 |
| <b>Age</b>                     |     |      |
| ≤12 months                     | 87  | 70.7 |
| >12 - <60 months               | 36  | 29.3 |
| <b>Gender</b>                  |     |      |
| Male                           | 66  | 53.7 |
| Female                         | 57  | 46.3 |
| <b>Nutritional status</b>      |     |      |
| Malnutrition                   | 43  | 35.0 |
| Good Nutrition                 | 80  | 65.0 |
| <b>Immunization Status</b>     |     |      |
| Incomplete Immunization        | 108 | 87.8 |
| Complete Immunization          | 15  | 12.2 |
| <b>Exclusive breastfeeding</b> |     |      |
| Not Exclusive                  | 103 | 83.7 |
| Exclusive                      | 20  | 16.3 |

Note: Nutritional status was assessed using weight-for-length/height z-scores based on the WHO Child Growth Standards and the classification stipulated in Indonesian Ministry of Health Regulation No. 2 of 2020. Children with a z-score below -2 SD were classified as Malnutrition, whereas those with a z-score from -2 SD to +1 SD were classified as having good nutritional status.

The study included 123 children treated at Dr. Mohammad Hoesin General Hospital in 2024; 91 (74.0%) were classified as having pneumonia and 32 (26.0%) had non-pneumonia diagnoses.

Most children were aged  $\leq 12$  months (70.7%), 53.7% were male, 65.0% had good nutritional status, 87.8% had incomplete immunization, and 83.7% had no documented history of exclusive breastfeeding. These percentages characterize only the selected hospital-based sample.

**Table 2. Relationship between risk factors and pneumonia status among children at RSUP Dr. Mohammad Hoesin Palembang (n = 123)**

| Variables                      | Pneumonia Occurrence |      |                   |      | Crude OR<br>(95 % CI) | p-value    |
|--------------------------------|----------------------|------|-------------------|------|-----------------------|------------|
|                                | Pneumonia<br>n       | %    | No pneumonia<br>n | %    |                       |            |
| <b>Gender</b>                  |                      |      |                   |      |                       |            |
| Male                           | 50                   | 75.8 | 16                | 24.2 | 1.22 (0.54 – 2.73)    | 0.629      |
| Female                         | 41                   | 71.9 | 16                | 28.1 | Reference             |            |
| <b>Age</b>                     |                      |      |                   |      |                       |            |
| $\leq 12$ months               | 68                   | 78.2 | 19                | 21.8 | 2.02 (0.87–4.73)      | 0.101      |
| $>12$ - $<60$ months           | 23                   | 63.9 | 13                | 36.1 | Reference             |            |
| <b>Nutritional status</b>      |                      |      |                   |      |                       |            |
| Malnutrition                   | 35                   | 81.4 | 8                 | 18.6 | 1.88 (0.76–4.63)      | 0.170      |
| Good Nutrition                 | 56                   | 70.0 | 24                | 30.0 | Reference             |            |
| <b>Immunization Status</b>     |                      |      |                   |      |                       |            |
| Incomplete Immunization        | 86                   | 79.6 | 22                | 20.4 | 7.82 (2.42–25.22)     | $<0.001^*$ |
| Complete Immunization          | 5                    | 33.3 | 10                | 66.7 | Reference             |            |
| <b>Exclusive breastfeeding</b> |                      |      |                   |      |                       |            |
| Not Exclusive                  | 78                   | 75.7 | 25                | 24.3 | 1.68 (0.60–4.67)      | 0.317      |
| Exclusive                      | 13                   | 65.0 | 7                 | 35.0 | Reference             |            |

\*Fisher's exact test was used because one expected cell count was  $<5$ ; other p-values are from Pearson's chi-square test. OR, odds ratio; CI, confidence interval. Crude OR from Binary Logistic Regression.

Based on Table 2, bivariate analysis showed that incomplete immunization was associated with higher odds of pneumonia (crude OR=7.82; 95% CI: 2.42–25.22; Fisher's exact  $p<0.001$ ). Because no multivariable model was performed, this estimate is unadjusted and should not be interpreted as an independent or causal effect.

Age  $\leq 12$  months (crude OR=2.02; 95% CI: 0.87–4.73), male sex (crude OR=1.22; 95% CI: 0.54–2.73), malnutrition (crude OR=1.88; 95% CI: 0.76–4.63), and absence of exclusive breastfeeding (crude OR=1.68; 95% CI: 0.60–4.67) showed positive but statistically non-significant associations with pneumonia. The wide CIs indicate limited precision; therefore, non-significance should not be interpreted as evidence that these factors are unimportant.

## DISCUSSION

The principal finding was a crude association between incomplete immunization and pneumonia status. Children with incomplete immunization had 7.82 times the odds of pneumonia compared with those whose immunization was complete, although the wide CI indicates imprecision, a pattern of substantial but imprecise unadjusted associations that is common in bivariate analyses of immunization and pneumonia outcomes reported elsewhere (Wilkes et al., 2023). This association may reflect vaccine protection but may also be influenced by age, socioeconomic conditions, healthcare access, nutrition, and other unmeasured factors, since studies that moved beyond simple bivariate comparison have shown that the protective association between complete immunization and reduced pneumonia deaths can weaken or disappear once age, malnutrition, and other clinical covariates are added to the model (Shahid et al., 2023). This finding is also consistent with evidence from Indonesia, where a case-control study in Makassar found that incomplete DPT-HB-Hib immunization was independently associated with pneumonia among children under five years, with an adjusted odds ratio of 9.68 after accounting for other relevant risk factors (Sidabutar et al., 2024). PCV directly protects against vaccine-type *Streptococcus pneumoniae*, an important bacterial cause of pneumonia, consistent with meta-analytic evidence that pneumococcal conjugate vaccination lowers the incidence of pneumonia in vaccinated children relative to placebo (Dai et al., 2025), whereas DPT-containing vaccines reduce

pertussis- and diphtheria-related respiratory illness, in line with real-world effectiveness studies showing that increasing numbers of acellular pertussis-containing doses substantially reduce the risk of pertussis-related illness in young children (Zhu et al., 2023). Because the analysis was bivariate, the finding cannot establish an independent effect, a limitation consistent with methodological guidance that crude odds ratios from bivariate screening require multivariable adjustment before determinants of incomplete immunization or pneumonia risk can be considered independent (Abegaz et al., 2023).

The high proportion of incomplete immunization in this sample supports routine verification of age-appropriate vaccination status when children attend hospital services, a practice consistent with evidence that healthcare-seeking visits are a valuable point of contact for identifying missed doses that would otherwise go undetected until a formal coverage survey (Dadanova et al., 2025). Hospital-based screening may identify missed doses and facilitate referral for catch-up immunization, an approach that aligns with the "Big Catch-Up" strategy promoted globally to recover coverage lost among under-immunized children and to reintegrate missed-dose identification into routine health-system contacts (Jones et al., 2024). Explanations such as limited parental knowledge or barriers to access remain plausible but were not measured and should be examined rather than assumed, since prior Indonesian research has shown that parental knowledge and attitude together can account for a substantial share of variation in immunization completeness (Sriatmi et al., 2024), while broader regional evidence points to socioeconomic status, geographic access, and health-system capacity as additional intersecting barriers that require direct measurement rather than post hoc assumption (Nulong et al., 2025).

Age was not statistically significant, although infants aged  $\leq 12$  months had higher crude odds of pneumonia, consistent with findings that younger age is associated with elevated risk for severe community-acquired pneumonia even when several other predictors lose significance after adjustment (Chen et al., 2021). Biological susceptibility may contribute, but age also complicates the measurement of immunization because younger infants have not yet reached the scheduled age for every dose (Amalia, 2020). Age-appropriate assessment is therefore essential in vaccination research, since studies comparing vaccine receipt without accounting for a child's exact age relative to the recommended schedule risk conflating "not yet due" with "under-immunized" (Worku et al., 2024). Classification must therefore be age-appropriate; otherwise, infants may be misclassified as incompletely immunized, a bias that can distort estimates of the immunization–disease relationship in ways similar to how inadequate immunization and young age are commonly reported together as demographic risk correlates of pneumonia outcomes without clear separation of their independent effects (Wilkes et al., 2023). Such misclassification may occur when vaccination records do not fully capture delayed doses or vaccinations received outside the facility where records are assessed, potentially leading to inaccurate classification of children as under-immunized (Daley et al., 2017).

Malnutrition and absence of exclusive breastfeeding also showed non-significant positive associations. Undernutrition can impair immune defenses, while breast milk provides immunological protection against respiratory infection. This biological plausibility is supported by a recent umbrella review showing that non-exclusive breastfeeding was associated with a significantly increased risk of pneumonia among children under five years, with a pooled odds ratio of 2.34 (95% CI: 1.89–2.78) (Abate et al., 2025). Nevertheless, the small sample, broad nutritional categories, and possible misclassification of breastfeeding histories abstracted from medical records may have reduced statistical power and biased the estimates toward or away from an association (Fatimah et al., 2022; Karlinah, 2024; Wahyuni et al., 2019).

This study has several strengths. It uses real-world medical-record data from an important tertiary referral hospital and examines a preventable factor with direct clinical relevance. Its limitations are substantial: the cross-sectional design does not establish temporality or causality; the hospital-based comparison group may not represent the same source population as community cases; referral patterns may create selection bias; the small sample produced imprecise estimates; secondary records may contain incomplete or misclassified information; and no multivariable analysis was available. In addition, only variables that were consistently documented in the medical records were available for analysis. Clinical characteristics such as

pneumonia severity, microbiological findings, radiological severity, length of hospital stay, and oxygen requirement were not collected because they were unavailable or not consistently recorded across eligible medical records. Environmental tobacco smoke, indoor air pollution, crowding, prematurity, birth weight, comorbidities, maternal education, healthcare access, and socioeconomic status were not measured. Immunization may also be misclassified if age-appropriate schedules were not applied, and pneumonia definitions may vary across records. Accordingly, the observed associations should be regarded as exploratory and require confirmation in larger, prospectively designed studies with adjusted analyses.

## CONCLUSION

In this hospital-based sample, 91 of 123 children (74.0%) were classified as having pneumonia; this proportion is not an estimate of community prevalence or incidence. Incomplete immunization was the only factor significantly associated with pneumonia in bivariate analysis (crude OR=7.82; 95% CI: 2.42–25.22;  $p<0.001$ ). Age, sex, nutritional status, and exclusive breastfeeding were not statistically significant, although their wide CIs do not exclude potentially important associations. Because the study used cross-sectional secondary data and unadjusted analyses, further research is needed to confirm whether immunization is independently associated with pneumonia.

Hospitals should strengthen documentation and routine verification of age-appropriate DPT-containing and PCV immunization and facilitate referral for missed doses. Education on immunization, adequate nutrition, and exclusive breastfeeding remains appropriate, but these recommendations should be integrated with efforts to reduce household smoke exposure and other environmental risks. Future studies should use larger samples, clearly defined source populations and diagnostic criteria, separate vaccine measures where feasible, and multivariable models incorporating environmental and socioeconomic determinants.

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