RESEARCH ARTICLE

pISSN: 0126-074X | eISSN: 2338-6223
https://doi.org/10.15395/mkb.v58.4467
Majalah Kedokteran Bandung. 2026;58(2):132–137

Majalah Kedokteran Bandung (MKB)

Received: July 9, 2025
Accepted: February 11, 2026
Available online: June 30, 2026

Tuberculosis Risk Factors in Children Aged 0–5 Years in an Indonesian Hospital

Jasmine Drias Sugito,[1] Defa Rahmatun Nisaa,[2] Niklah Zaidah,[3] Dedi Rachmadi Sambas[4]
[1]Faculty of Medicine, Swadaya Gunung Jati University, Cirebon, Indonesia
[2]Department of Child Health, Swadaya Gunung Jati University, Cirebon, Indonesia
[3]Department of Basic Medical Sciences, Swadaya Gunung Jati University, Cirebon, Indonesia
[4]Department of Child Health, Faculty of Medicine Universitas Padjadjaran, Indonesia

Abstract

Tuberculosis (TB) is an infectious disease that poses a substantial public health challenge in developing countries, including Indonesia. Children under five years of age show increased susceptibility to the infection due to incompletely developed immune systems. Therefore, this study aimed to determine the relationship between TB risk factors and pulmonary TB incidence among children aged 0–5 years seen at Panti Abdi Dharma Hospital, Cirebon, Indonesia. A cross-sectional design was used with a sample of 196 children visiting the pediatric outpatient clinic at Panti Abdi Dharma Hospital from February to April 2025. Data were collected using a stuctured questionnaire that includes variables of age, gender, nutritional status, BCG vaccination history, exclusive breastfeeding history, birth weight, history of contact with TB patients, parents' education and occupation, family smoking behavior, and housing density. Univariate analysis results showed that most respondents were >2–5 years old (50.5%) and predominantly male (53.6%). Chi-square tests showed significant associations between age, nutritional status, and a history of contact with adult TB patients and pulmonary TB incidence ($p < 0.05$). Multivariate logistic regression showed that nutritional status and history of contact with adult TB patients were significant predictors of pulmonary TB. Good nutritional status was identified as a protective factor (OR=0.276; $p<0.001$), with children with poor or inadequate nutritional status had approximately 3.62-fold higher odds of developing TB compared with those with good nutritional status. In conclusion, poor or inadequate nutritional status and a history of contact with adult TB patients are the most influential risk factors for pulmonary TB among children aged 0–5 years at Panti Abdi Dharma Hospital, Cirebon, Indonesia.

Keywords: Nutritional status, preschool children, risk factors, tuberculosis, tuberculosis contact

Introduction

Tuberculosis (TB) is an infectious disease that continues to pose a substantial public health challenge, particularly in developing countries such as Indonesia. This infectious disease is caused by the bacterium *Mycobacterium tuberculosis*, which primarily affect the lungs and is transmitted through airborne droplets expelled when an infected person coughs or sneezes. Failure to receive appropriate treatment can lead to severe complications, including mortality.[1] Globally, the prevalence of the infection continues to increase. According to data from the World Health Organization (WHO), 10.3 million cases of TB were documented in 2021, with the total increasing to 10.6 million by 2022.[2] Children account for approximately 1.2 million of the total cases.[3] Indonesia is ranked second worldwide for TB incidence, surpassing only India with an estimated 969,000 and 724,309 cases in 2021 and 2022, respectively.[4]

Tuberculosis presents a particular challenge in the pediatric population. In 2021, approximately 1.15 million children younger than 15 years were estimated to have developed TB worldwide, representing an increase of 3.6% during the COVID-19 pandemic.[3] Among pediatric TB cases, a substantial proportion occurred in children younger than five years. In Indonesia, 80,829 TB cases were reported among children younger than 15 years in 2022. Data from the Cirebon City Health Office also showed an increase in TB

Corresponding Author:
Defa Rahmatun Nisaa
Department of Child Health, Swadaya Gunung Jati University, Cirebon, Indonesia
Email: defa.suwarto@gmail.com

cases from 1,064 in 2022 to 1,352 in 2023 among children aged 0–14 years.[4]

Children under the age of five are particularly susceptible to TB infection because their immune systems are not yet fully developed. Transmission commonly occurs through close contact with adults who have active pulmonary TB, particularly household contacts such as parents or other family members. The diagnosis of TB in children is often challenging because clinical manifestations may be nonspecific. Common symptoms include prolonged fever, night sweats, weight loss, persistent cough, and fatigue.[5]

Different studies have shown that many factors influence the occurrence of TB in children, including the individual aspects of the child, parents, environmental conditions, and socio-economics. These factors include a history of contact with TB patients, exposure to smokers, lighting and humidity of the residence, parental knowledge, nutritional status, BCG immunization, and the socio-economic status of the family.[6]

Given the high burden of childhood TB and the multiple factors influencing disease transmission, further investigation of risk factors among young children is warranted. Panti Abdi Dharma Hospital, Cirebon, represents an appropriate setting for this study due to the substantial number of pediatric TB cases managed at the institution. Therefore, this study aimed to determine the relationship between potential risk factors and the incidence of pulmonary TB among children aged 0–5 years at Panti Abdi Dharma Hospital, Cirebon.

Methods

This analytical observational study employed a cross-sectional design to examine the relationship between various risk factors and the incidence of pulmonary tuberculosis (TB) among children aged 0–5 years. The study was conducted at the pediatric outpatient clinic of Panti Abdi Dharma Hospital, Cirebon, from February to April 2025. The source population comprised all children aged 0–5 years attending the clinic during the study period, while the accessible population included children whose parents or caregivers agreed to participate and provided written informed consent.

The inclusion criteria were children aged 0–5 years who attended the pediatric outpatient clinic during the study period and whose parents or caregivers completed the study questionnaire. Children with incomplete medical records or questionnaires that were not fully completed were excluded from the study.

The minimum sample size was calculated using Slovin's formula: $n = N / (1 + N \cdot e^2)$, where n is the minimum sample size, N is the population size, and e is the margin of error. Using a population size of 382 and a margin of error of 5%, the minimum sample size was calculated as follows: $n=382/(1+382\times0.0025)= 382/1.955 = 195.4$. The required sample size was rounded up to 196 participants. Consecutive sampling was employed by recruiting all eligible children aged 0–5 years attending the pediatric outpatient clinic during the study period until the required sample size was achieved.

Data were collected using a structured closed-ended questionnaire developed according to the operational definitions of the study variables. The independent variables included child-related factors (age, sex, nutritional status, BCG immunization history, exclusive breastfeeding history, birth weight, and history of contact with TB patients' parent- or household-related factors (parental education, parental occupation, socioeconomic status, household smoking behavior, and residential density). The dependent variable was the incidence of pulmonary TB, determined by a medical professional using the pediatric TB scoring system.

Prior to the data collection, the questionnaire underwent content review by three experts to evaluate the relevance, appropriateness, and clarity of each item. A pilot test was subsequently conducted among 30 parents or caregivers to assess face validity and clarity of the items. Feedback from the pre-test was used to revise ambiguous wording, improve item comprehension, and finalize the questionnaire before field implementation. The measurement indicators adhered to clinical and public health standards.

Nutritional status was classified according to the World Health Organization growth standards as: severe undernutrition (<-3 SD), undernutrition (-3 SD to < -2 SD), normal nutrition (-2 SD to +1 SD), and at risk of overnutrition (> +1 SD to +2 SD). Residential density was classified as adequate (≥9 m^2/person) and inadequate (<9 m^2/person). Socioeconomic status was defined by a monthly income threshold of IDR 2.5 million (equivalent to the 2023 UMR of Cirebon City).

Univariate analysis was performed to describe participant characteristics using frequency distributions and percentages. Bivariate analysis

Table 1 Distribution of Respondent Characteristics

Category	Frequency (n)	Percentage (%)
Age (years)		
0–1	32	16.3
>1–2	65	33.2
>2–5	99	50.5
Nutritional Status		
Severe undernutrition (<−3 SD)	53	27.0
Undernutrition (−3 SD to <−2 SD)	45	23.00
Good nutrition (−2 SD to +1 SD)	93	47.4
At risk of overnutrition (> +1 SD to +2 SD)	5	2.6
History of TB Contact		
Yes	143	73.0
No	53	27.0
Family Smoking Status		
No smokers	46	23.5
Smokers	150	76.5

was performed using the Chi-square test with significance set at $p<0.05$. Variables with $p<0.25$ were included in multivariate analysis using logistic regression to determine the most influential factors on the incidence of pulmonary TB.

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Swadaya Gunung Jati, Cirebon (No. 01/EC/FKUGJ/I1/2025). Written informed consent was obtained from all parents or caregivers before participation. The study was conducted in accordance with ethical principles governing human subject research, including confidentiality, voluntary participation, and respect for participant rights.

Results

A total of 196 children aged 0–5 years were included in this study. The largest proportion of participants were aged >2–5 years (50.5%) and male (53.6%). Regarding nutritional status, 27.0% of children were classified as severely undernourished, 23.0% as undernourished, 47.4% had good nutritional status, and 2.6% were at risk of overnutrition. Most children had a history of contact with adult TB patients (73.0%) and lived in households with at least one smoker (76.5%) (Table 1).

Bivariate analysis using the Chi-square test demonstrated significant associations between age and pulmonary TB status ($p=0.010$), nutritional status and pulmonary TB status ($p<0.05$), and history of contact with adult TB patients and pulmonary TB status ($p<0.001$). No significant associations were observed for sex, BCG immunization history, or family smoking behavior (all $p>0.05$).Multivariate logistic regression analysis identified nutritional status and history of contact with adult TB patients as significant predictors of pulmonary TB (Table 2). Good nutritional status was associated with lower odds of pulmonary TB (OR=0.276, $p<0.001$). In contrast, a history of contact with adult TB patients was associated with approximately five-fold higher odds of pulmonary TB (OR=4.986, $p=0.001$). Age was not independently associated with pulmonary TB after adjustment for other variables (OR=1.040, $p=0.866$).

Discussion

This study identified nutritional status and history of contact with adult TB as significant factors associated with pulmonary TB among children aged 0–5 years at Panti Abdi Dharma

Table 2 Multivariate Logistic Regression Results

Variables	p-value	Odds Ratio	Decision
Age	0.866	1.040	Not significant
Child Nutritional Status	<0.001	0.276	Significant
TB Contact History	0.001	4.986	Significant

Hospital, Cirebon. Although age was significantly associated with pulmonary TB in the bivariate analysis, this association was no longer significant after adjustment in the multivariate model. These findings suggests that the apparent effect of age may have been influenced by other factors, particularly nutritional status and exposure to infectious TB contacts. Overall, these findings support existing evidence that childhood TB is strongly influenced by both host susceptibility and exposure to infectious sources.[8]

Nutritional status was a significant predictor of pulmonary TB. Children with poor or inadequate nutritional status had substantially higher odds of pulmonary TB, while good nutritional status appeared protective. This finding is biologically plausible because adequate nutrition is essential for maintaining immune competence, particularly cell-mediated immunity, which plays a central role in controlling Mycobacterium tuberculosis infection. Malnutrition impairs T-lymphocyte proliferation, macrophage activation, and cytokine production, including interferon-gamma and tumor necrosis factor-alpha, which are required for the formation and maintenance of granulomas that contain TB infection. Consequently, malnourished children are more susceptible to primary infection, disease progression, and severe manifestations of TB.[11]

These findings are consistent with previous studies reporting that undernutrition is an important risk factor for childhood TB and contributes substantially to disease burden.8,11 Several studies have demonstrated that malnourished children experience impaired immune responses and are less capable of limiting bacterial replication after exposure to M. tuberculosis. Furthermore, the relationship between TB and malnutrition is bidirectional. While malnutrition increases susceptibility to TB, active TB infection can also worsen nutritional status through reduced appetite, increased metabolic demands, and nutrient malabsorption. This interaction may create a cycle that further increases disease severity and adversely affects child growth and development.[11] Therefore, nutritional interventions should be considered an important component of childhood TB prevention and control programs.

History of contact with adult TB patients was also significantly associated with pulmonary TB in children. This finding is epidemiologically important because children commonly acquire TB infection from infectious adults living in the same household. Young children spend considerable time in close proximity to caregivers and family members, resulting in prolonged exposure to airborne droplets containing *M. tuberculosis*. The risk of transmission is particularly high when household contacts have untreated or inadequately treated pulmonary TB.[11]

The present findings are in agreement with previous studies demonstrating that household exposure is a major determinants of childhood TB.[11] Contact with infectious adults not only increases the likelihood of infection but also contributes to delayed diagnosis among children because TB symptoms in young children are often nonspecific and difficult to recognize. Consequently, active case finding and systematic contact tracing are critical components of TB control programs. Early identification and screening of household contacts can facilitate prompt diagnosis, preventive therapy, and timely treatment, thereby reducing disease transmission and progression among children.[11]

Several variables assessed in this study, including BCG vaccination history and family smoking behavior, were not significantly associated with pulmonary TB. Although these findings differ from some previous reports, several explanations are possible. The study population may have been relatively homogeneous with respect to environmental and socioeconomic characteristics, reducing the ability to detect meaningful differences between groups. In addition, some exposure variables relied on parental self-reporting and may have been affected by recall bias or misclassification. Furthermore, BCG vaccination is known to provide greater protection against severe forms of childhood TB, such as miliary TB and TB meningitis, than against infection itself, particularly in settings with ongoing community transmission.[12,13]

The absence of a significant associations for several environmental and behavioral factors should beinterpreted cautiously. Previous studies have consistently reported that poverty, overcrowding, poor housing conditions, and limited access to healthcare contribute to increased TB transmission and delayed treatment.[14] The lack of association observed in this study may reflect local contextual factors, sample size limitations, or insufficient variability among participants. Similarly, parental education and smoking behavior may influence TB risk indirectly through their effects on health-seeking behavior, environmental quality, and child health status rather than through direct biological pathways.[14]

Age was significantly associated with pulmonary TB in the bivariate analysis, with the highest proportion of cases observed among children aged >2–5 years. However, this association was no longer significant after adjustment for other variables. This finding suggests that age itself may not independently influence TB risk but rather acts through factors such as cumulative exposure to infectious contacts and nutritional status.15 As children grow older, opportunities for social interaction and exposure to infectious individuals may increase, potentially explaining the initial association observed in the unadjusted analysis.[15]

Several limitations should be considered when interpreting the findings. First, the study was conducted in a single hospital with a relatively limited sample size, which may restrict the generalizability of the results to other settings. Second, the cross-sectional design prevents determination of temporal relationships and causal inference between risk factors and TB occurrence. Third, information regarding contact history and some socioeconomic variables was obtained through parental reporting and may be subject to recall bias. Finally, the absence of longitudinal follow-up limited the ability to evaluate long-term outcomes and changes in risk factors over time.

Overall, the findings highlight the importance of nutritional status and household exposure to infectious TB cases in the occurrence of pulmonary TB among young children. Strengthening nutritional support programs, improving growth monitoring, enhancing household contact investigations, and expanding contact tracing activities may contribute to reducing the burden of childhood TB in similar settings. Future studies involving larger and more diverse populations are needed to further clarify the complex interactions between biological, environmental, and socioeconomic determinants of childhood TB.

References

1. Maelmakers K, Perdana J, Nopita E, Suryani L, Siringoringo HE, Binahusada SK, et al. Analisis kejadian tuberkulosis (TB) paru. J Ilm Kesehat. 2023;6(1):201–12.
2. World Health Organization. Global tuberculosis report 2023. Geneva: World Health Organization; 2023. p. 2–3.
3. Kementerian Kesehatan Republik Indonesia. Petunjuk teknis tata laksana tuberkulosis anak dan remaja Indonesia 2023. Jakarta: Kementerian Kesehatan Republik Indonesia; 2023. p. 4-5.
4. Almira FN, Rakhmawati W, Hendrawati S, Maryam NA. Pengetahuan orang tua dengan anak tuberkulosis di RSUD Dr. Soeselo Tegal. J Surya Med. 2023;9(2):161–7. doi: 10.33084/jsm.v9i2.5685
5. Wolde HF, Clements ACA, Gilmour B, Alene KA. Spatial co-distribution of tuberculosis prevalence and low BCG vaccination coverage in Ethiopia. Sci Rep. 2024;14:31561. doi:10.1038/s41598-024-68549-7
6. Wijaya MSD, Mantik MFJ, Rampengan NH. Faktor risiko tuberkulosis pada anak. e-CliniC. 2021;9(3):124–33. doi:10.35790/ecl.v9i1.32117
7. Baun HA, Picauly I, Paun R. Analisis faktor risiko kejadian tuberkulosis pada anak di wilayah Kota Kupang. Public Health Risk Assess J. 2023;1(1):56–73. doi:10.61511/phraj.v1i1.2023.66
8. Dhanny DR, Sefriantina S. Hubungan asupan energi, asupan protein, dan status gizi terhadap kejadian tuberkulosis pada anak. Muhammadiyah J Nutr Food Sci. 2022;2(2):58–68. doi:10.24853/mjnf.2.2.58-68
9. Kementerian Kesehatan Republik Indonesia. Pedoman nasional pelayanan kedokteran tata laksana tuberkulosis. Jakarta: Kementerian Kesehatan Republik Indonesia; 2020. p. 9–10.
10. Fitria PA, Ervina R. Karakteristik skrining yang berhubungan dengan kejadian tuberkulosis (TB) paru pada anak. J Keperawatan Muhammadiyah. 2021;4(2):85–92. doi:10.24853/ijnsp.v4i2.85-92
11. Ekawati D. Pengaruh faktor risiko, usia, jenis kelamin, dan status imunisasi pada kasus TB paru anak di Puskesmas Merdeka. Koloni. 2022;1(3):965–71.
12. Fatahillah H, Andarini I, Hidayah D. Hubungan imunisasi BCG dengan tuberkulosis paru pada anak balita di RSUD Dr. Moewardi. Plexus Med J. 2022;1(1):18–23.
13. Flores JA, Coit J, Mendoza M, Leon SR, Konda K, Lecca L, et al. Is exclusive breastfeeding for six months protective against pediatric tuberculosis?. Glob Health Action. 2021;14(1):1861922. doi:10.1080/16549716.2020.1861922
14. Iskandar D, Suwantika AA, Pradipta IS, Postma MJ, van Boven JFM. Clinical and economic burden of drug-susceptible tuberculosis

in Indonesia: national trends 2017-19. Lancet Glob Health. 2023;11:e117–e125. doi:10.1016/S2214-109X(22)00455-7
15. Setyoningrum RA, Maharani RA, Hapsari R, Chafid APP. Risk factors of tuberculosis in children with adult household tuberculosis contact. Paediatr Indones. 2024;64(4):287–92. doi:10.14238/pi64.4.2024.287-92