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Analysis of factors influencing the incidence of tuberculosis in children under five years of age in Karang Tengah district, Tangerang city

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ABSTRACT

Background: Tuberculosis (TB) in children under five years remains a public health concern in Karang Tengah District, Tangerang City. This study aimed to identify factors associated with TB among children under five years. Methods: A quantitative cross-sectional study was conducted in Karang Tengah District, Tangerang City, from Mei to Juni 2026. A total of 94 children were selected using proportional stratified random sampling. TB status was determined based on documented TB diagnoses in health-center records and the Tuberculosis Information System (SITB). Information on other study variables was obtained through structured interviews with parents or guardians and supplemented by health-center records. The variables assessed included maternal education and knowledge, sex, nutritional status, household contact with a TB patient, cigarette-smoke exposure, BCG immunization status and healthcare service quality. Results: Good nutritional status was observed in 84.0% of participants, 29.8% had a history of household contact with a TB patient and 90.4% had received BCG immunization. TB was documented in 20.2% of children. Nutritional status and household contact history were significantly associated with TB in the bivariate analysis (both $p<0.001$). In the multivariable model, nutritional status remained significantly associated with TB (AOR 9.043; 95% CI: 1.656–49.376; $p=0.011$), while household contact history showed a strong adjusted association (AOR 20.828; 95% CI: 3.703–117.150; $p<0.001$). The wide confidence intervals indicate limited precision of the adjusted estimates. Conclusion: Nutritional status and household contact history were associated with TB among children under five years. Given the cross-sectional design, these findings should be interpreted as associations rather than causal relationships.

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INTRODUCTION

Tuberculosis (TB) remains a major public health concern, particularly among children under five years, who are more susceptible to progression from TB infection to disease and severe forms of childhood TB ((Marais & Schaaf, 2010). Early identification of children at risk is therefore an important component of TB prevention and control. Indonesia continues to face a considerable TB burden and remains among the countries with the highest numbers of TB cases globally (WHO, 2024). Population-based evidence from Indonesia also indicates that Mycobacterium tuberculosis infection remains present among children, highlighting the importance of continued attention to childhood TB (Nurjana et al., 2023). This situation underscores the need for comprehensive and sustainable TB control strategies, particularly for vulnerable populations such as young children.

Previous studies have identified several factors associated with TB among children, including nutritional status, household contact with TB patients, BCG immunization, cigarette-smoke exposure and parental characteristics. Nutritional status has been associated with TB among children in several studies ((Jahiroh & Prihartono, 2017). Household exposure to an infectious TB patient is also an important consideration in childhood TB, with studies reporting an association between household contact and TB among children (Setyoningrum et al., 2024). In addition, exposure to tobacco smoke has been investigated as a potential factor associated with TB in children (Altet et al., 2022), while BCG vaccination has been examined in relation to protection against TB infection among children exposed to infectious household contacts (Syggelou et al., 2020). Parental characteristics, including education and maternal nutrition-related knowledge, have also been considered in relation to child health and nutritional conditions (Simanjuntak et al., 2025).

Although these studies provide evidence regarding individual risk factors, the factors associated with childhood TB have not been examined consistently across populations and settings. Differences in study populations, geographical settings, study designs and variables included in the analyses may contribute to variation in findings. Furthermore, several studies have focused on specific factors, such as nutritional status or household contact, rather than examining individual, household, environmental and healthcare-related factors simultaneously (Baun et al., 2023). This indicates a need for further investigation using a broader set of factors within primary healthcare settings, particularly among children under five years.

The occurrence of TB among children may involve multiple interconnected domains, including individual characteristics, nutritional status, household exposure, environmental conditions and access to or quality of healthcare services. Therefore, examining nutritional status, household TB contact, BCG immunization, cigarette-smoke exposure, maternal education and knowledge and healthcare service quality within the same study may provide a more comprehensive assessment of factors associated with childhood TB. However, evidence examining these factors collectively among children under five years in primary healthcare settings in Indonesia remains limited. Addressing this gap may contribute additional evidence regarding the factors associated with childhood TB at the community and primary healthcare levels.

In Karang Tengah District, Tangerang City, childhood TB remains a local public health concern. Data from the Tuberculosis Information System recorded 87 TB cases among children under five years in 2024 and 113 cases in 2025 (SITB, 2025). The 2025 SITB data were used to describe the most recent complete annual TB situation available before the study was conducted in Mei-Juni 2026. Although these surveillance data demonstrate the local burden of childhood TB, they do not explain which individual, household, environmental, or healthcare-related factors are associated with TB among children under five years in this setting. Therefore, the local evidence gap, together with the limited evidence examining multiple domains of factors simultaneously, provides a rationale for the present study.

Therefore, this study aimed to identify factors associated with TB among children under five years in the working area of community health centers in Karang Tengah District, Tangerang

City. By examining factors across individual, household, environmental and healthcare-related domains, this study seeks to contribute locally relevant evidence to the broader understanding of factors associated with childhood TB in primary healthcare settings.

RESEARCH METHOD

A quantitative analytical study with a cross-sectional design was conducted in the working area of community health centers in Karang Tengah District, Tangerang City, Indonesia, from Mei to Juni 2026. The source population consisted of 113 children aged 0–59 months. The sample size was calculated using the Lemeshow formula, resulting in 94 children. Participants were selected using proportional stratified random sampling from Puskesmas Pedurenan, Puskesmas Karang Tengah, and Puskesmas Pondok Bahar.

TB status was the dependent variable and was determined from documented TB diagnoses in health-center medical records and the Tuberculosis Information System (SITB). The explanatory variables were maternal education and knowledge, child sex, nutritional status, household TB contact, cigarette-smoke exposure, BCG immunization, and healthcare service quality. Nutritional status was assessed using the weight-for-length (BB/PB) or weight-for-height (BB/TB) index and expressed as a Z-score based on the WHO Child Growth Standards. Maternal knowledge was assessed using a questionnaire adapted from Rahman et al. (2017), with item validity of $r>0.30$ and Cronbach's alpha of 0.70–0.80. Household TB contact and cigarette-smoke exposure were assessed through structured interviews with parents or guardians, while BCG status, nutritional status, and TB diagnosis were verified using health records. Healthcare service quality was assessed using SERVQUAL.

Descriptive statistics were used to summarize participant characteristics. Bivariate associations were assessed using the chi-square or Fisher's exact test. Multivariable binary logistic regression was used to estimate adjusted odds ratios (AORs) with 95% confidence intervals. Variable selection was guided by the conceptual framework and epidemiological considerations regarding potential confounding, with $p<0.25$ used only as an additional screening criterion. Multicollinearity was assessed using VIF/tolerance and model fit was assessed using the Hosmer–Lemeshow test, Omnibus test and Nagelkerke R^2.

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Public Health, Universitas Muhammadiyah Jakarta (No.10.017.B/KEPK-FKMUMJ/V/2026). Written informed consent was obtained from parents or legal guardians and participant confidentiality was maintained throughout the study.

RESULTS AND DISCUSSIONS

Table 1 summarizes the distribution of the study variables, covering child characteristics and the maternal, nutritional, household, environmental, and healthcare-related factors assessed in relation to TB occurrence.

Univariate Analysis

Table 1. Characteristics of the study participants

Characteristics	Frequency (n)	Percentage (%)
Sex		
Male	48	51,1
Female	46	48,9
Maternal Education Level		
Elementary School	4	4,3
Junior High School	16	17,0
Senior High School	42	44,7
Higher Education	32	34,0
Maternal Knowledge Level		

Characteristics	Frequency (n)	Percentage (%)
Low Knowledge	8	8,5
High Knowledge	86	91,5
Nutritional Status		
Good Nutritional Status	79	84,0
Undernutrition/Malnutrition	15	16,0
History of Contact with TB Patients		
No	66	70,2
Yes	28	29,8
BCG Immunization Status		
Never Immunized	9	9,6
Immunized	85	90,4
Exposure to Cigarette Smoke		
Not Exposed	56	59,6
Exposed	38	40,4
Healthcare Service Role		
Poor Healthcare Services	19	20,2
Good Healthcare Services	75	79,8
TB Occurrence		
No TB	75	79,8
TB	19	20,2
Total	94	100,0

Among the 94 children included in the study, 48 (51.1%) were male and 46 (48.9%) were female. The most common maternal education level was senior high school (44.7%), followed by higher education (34.0%), junior high school (17.0%), and elementary school (4.3%). Most mothers had a high level of TB-related knowledge (91.5%), while 8.5% had low knowledge. Most children had good nutritional status (84.0%), whereas 16.0% were classified as undernourished or malnourished. A history of household contact with a person with TB was reported for 29.8% of children. Most children had received BCG immunization (90.4%), while 9.6% had not. Exposure to cigarette smoke inside the home was reported for 40.4% of children. Healthcare service quality was rated as good by 79.8% of respondents. Overall, 19 children (20.2%) were classified as having TB, while 75 (79.8%) did not.

Bivariate Analysis

Each study factor was compared with TB occurrence using the chi-square test (Table 2). Significant relationships were found for nutritional status and household contact history, both with $p<0.001$. No statistically significant relationship was detected for maternal knowledge, BCG immunization, cigarette-smoke exposure, or healthcare service quality, for which p-values were above 0.05.

Table 2. Bivariate associations between study factors and TB occurrence

Variable	No TB n (%)	TB n (%)	OR	95% CI	p-value
Maternal Knowledge Level					
Low Knowledge (Reference)	7 (87.5)	1 (12.5)	1.000	Reference	
High Knowledge	68 (79.1)	18 (20.9)	1.853	0.214–16.047	1.000
Nutritional Status					
Good Nutritional Status	72 (91.1)	7 (8.9)	0.024	0.006–0.107	<0.001
Undernutrition/Malnutrition (Reference)	3 (20.0)	12 (80.0)	1.000	Reference	
History of Household Contact with TB Patients					
No (Reference)	64 (97.0)	2 (3.0)	1.000	Reference	<0.001
Yes	11 (39.3)	17 (60.7)	49.455	9.997–244.640	
BCG Immunization Status					
Never Immunized (Reference)	7 (77.8)	2 (22.2)	1.000	Reference	1.000
Immunized	68 (80.0)	17 (20.0)	0.875	0.167–4.597	
Exposure to Cigarette Smoke					
Not Exposed (Reference)	46 (82.1)	10 (17.9)	1.000	Reference	0.602
Exposed	29 (76.3)	9 (23.7)	1.428	0.518–3.933	

Variable	No TB n (%)	TB n (%)	OR	95% CI	p-value
Healthcare Service Quality					
Poor (Reference)	17 (89.5)	2 (10.5)	1.000	Reference	0.344
Good	58 (77.3)	17 (22.7)	2.491	0.523–11.876	

The present study identified nutritional status and household contact history as factors significantly associated with TB occurrence among children under five years of age. Children with good nutritional status had substantially lower odds of TB compared with those with undernutrition or malnutrition (OR=0.024; 95% CI: 0.006–0.107; p<0.001). This finding is biologically plausible because inadequate nutritional status may impair immune function and reduce the ability of children to control Mycobacterium tuberculosis infection. Previous studies have also reported an association between undernutrition and childhood TB, supporting the role of nutritional vulnerability in TB susceptibility. However, the relationship between nutritional status and TB may be bidirectional, because TB infection can also result in reduced appetite, increased metabolic demands, and subsequent deterioration of nutritional status. Therefore, the association observed in this cross-sectional study should not be interpreted as evidence of a causal relationship.

Household contact history was also significantly associated with TB occurrence. Children who had a history of household contact with a TB patient had higher odds of TB than those without such contact (OR=49.455; 95% CI: 9.997–244.640; p<0.001). This finding is consistent with previous evidence showing that children exposed to infectious TB patients within the household have a greater risk of TB infection and disease. The association can be explained by repeated and prolonged exposure to infectious respiratory droplets in a shared living environment. The particularly large OR observed in this study should, however, be interpreted with caution because only 19 children had TB and the confidence interval was wide. The magnitude of the association therefore indicates a strong statistical association in this study population but should not be interpreted as evidence that household contact causes TB in an individual child.

Maternal knowledge was not statistically associated with TB occurrence (p=1.000). Children of mothers with high knowledge had an OR of 1.853 (95% CI: 0.214–16.047) compared with those whose mothers had low knowledge. The wide confidence interval indicates limited precision of the estimate. This finding may partly be explained by the very small number of mothers classified as having low knowledge. In addition, knowledge alone may not necessarily result in preventive behaviour because TB prevention is also influenced by household exposure, socioeconomic circumstances, housing conditions, access to healthcare, and the ability to implement recommended preventive practices.

BCG immunization status was not statistically associated with TB occurrence (p=1.000). Immunized children had an OR of 0.875 (95% CI: 0.167–4.597) compared with children who had never been immunized. The absence of a statistically significant association in this study should be interpreted cautiously because 90.4% of the children had received BCG immunization, leaving only a small proportion in the non-immunized category. This limited variation may have reduced the statistical power to detect an association. Therefore, the non-significant finding in the present study should not be interpreted as evidence that BCG vaccination has no protective effect against TB.

Cigarette-smoke exposure was not significantly associated with TB occurrence (p=0.602). Although exposed children had higher odds of TB than non-exposed children (OR=1.428; 95% CI: 0.518–3.933), the confidence interval included 1. Previous studies have reported an association between second-hand smoke exposure and TB among children. The discrepancy may be related to differences in exposure measurement. In the present study, cigarette-smoke exposure was categorized as exposed or not exposed and may not have captured the intensity, frequency, duration, or proximity of exposure. Differences in household conditions and other potential confounding factors may also contribute to the different findings.

Healthcare service quality was not significantly associated with TB occurrence (p=0.344). Children categorized as receiving good healthcare service quality had higher odds of TB than those in the poor-quality category (OR=2.491; 95% CI: 0.523–11.876); however, the confidence interval included 1. Most respondents in this study rated healthcare services as good, resulting in limited variation between the categories. In addition, perceived healthcare service quality may not fully represent TB-specific service performance, including early case detection, contact investigation, diagnostic capacity, screening procedures, and timely referral. Therefore, the absence of a statistically significant association should not be interpreted as indicating that healthcare services have no role in TB prevention.

From a public health perspective, the findings emphasize the importance of strengthening household contact investigation and early assessment of children exposed to TB patients. Nutritional assessment and monitoring should also be integrated into childhood TB prevention and control activities, particularly among children with household exposure. Nevertheless, the findings should be interpreted within the context of the study design and sample characteristics. The adjusted odds ratios and their confidence intervals represent statistical associations within the study population and should not be interpreted as causal effects.

Multivariate Analysis

Multivariable logistic regression was used to examine whether the factors identified during the bivariate screening remained associated with TB after adjustment. Nutritional status and household contact history were entered together because both satisfied the p<0.25 criterion. Their independent associations were evaluated using adjusted odds ratios, 95% confidence intervals, and p-values, as shown in Table 3.

Table 3. Multivariable logistic regression results for TB occurrence

Variable	B	p-value	Adjusted OR	95% CI Lower	95% CI Upper
Nutritional status	2,202	0,011	9,043	1,656	49,376
Kontak Erat	3,036	<0,001	20,828	3,703	117,150
Constant	-3,561	<0,001	0,028		
Nilai p-value Omnibus tes <0,001			Nagelkerke R square=0,615		

In the multivariable analysis, nutritional status and household contact history remained significantly associated with TB occurrence after adjustment for the other variable in the final model. Children with unfavorable nutritional status had higher adjusted odds of TB occurrence (AOR=9.043; 95% CI: 1.656–49.376; p=0.011). This finding is consistent with the biological relationship between nutritional status and host immunity. Undernutrition may impair immune responses and increase susceptibility to Mycobacterium tuberculosis infection. However, the cross-sectional design prevents determination of the temporal direction of this association, and TB infection may itself contribute to deterioration in nutritional status. Therefore, the adjusted association should not be interpreted as evidence of a causal relationship.

Household contact history was also independently associated with TB occurrence (AOR=20.828; 95% CI: 3.703–117.150; p<0.001). Children with a history of household contact had substantially higher adjusted odds of TB than those without such contact. This finding is epidemiologically plausible because children living in close contact with an infectious TB patient may experience repeated exposure to infectious respiratory particles within the household environment. Nevertheless, the wide confidence interval indicates substantial uncertainty in the magnitude of the estimated association. The relatively small sample size and the limited number of TB cases may have contributed to this imprecision. Therefore, the AOR of 20.828 should be interpreted as an estimate of the strength of association in this study population rather than as evidence of a causal effect.

The Nagelkerke R^2 of 0.615 indicates the relative explanatory performance of the final logistic regression model compared with the null model. Because Nagelkerke R^2 is a pseudo-R^2

measure, it should not be interpreted in the same manner as R^2 in linear regression or as meaning that 61.5% of TB occurrence was caused by or directly explained by nutritional status and household contact. Other factors that were not included in the final model may also contribute to childhood TB occurrence. These may include household crowding, ventilation, socioeconomic conditions, intensity of TB exposure, previous exposure outside the household, and other individual or environmental factors.

The findings have important implications for childhood TB prevention. The persistence of household contact history as a significant factor after adjustment highlights the importance of systematic household contact investigation and early assessment of children exposed to TB patients. Nutritional screening and monitoring should also be integrated into TB prevention and control activities, particularly among children with increased vulnerability. However, these implications should be interpreted cautiously in light of the study design, sample size, and precision of the estimated associations. Several limitations of the present study should therefore be considered when interpreting these findings.

This study has several limitations. First, the cross-sectional design limits the ability to establish temporality between the measured exposures and TB occurrence. This is particularly relevant to nutritional status because TB may contribute to deterioration in nutritional status, making the direction of the observed association difficult to establish. Second, the sample size was relatively small, comprising 94 children, including only 19 children with TB. The small number of outcome events may have reduced statistical power and contributed to the wide confidence intervals observed for several odds ratios, indicating limited precision of the effect estimates. Third, several exposure categories were highly imbalanced, particularly maternal knowledge, BCG immunization status, and healthcare service quality. Such imbalance may have limited the ability to detect statistically significant associations.

Fourth, some variables, particularly household contact history and cigarette-smoke exposure, relied on reported information and may therefore be subject to recall or reporting bias. The measurement of cigarette-smoke exposure was relatively broad and may not have captured important characteristics such as the number of smokers in the household, frequency and duration of exposure, or proximity of the child to smokers. Similarly, perceived healthcare service quality may not fully represent objective TB program performance, including the effectiveness of contact investigation, screening, diagnostic capacity, and referral procedures. Fifth, categorizing several variables into binary groups may have reduced variability and resulted in loss of potentially relevant information. Sixth, residual confounding cannot be excluded. Factors such as household crowding, ventilation, socioeconomic conditions, indoor air quality, previous TB exposure outside the household, and other underlying health conditions were not comprehensively assessed or may not have been retained in the final multivariable model. Finally, because the study was conducted in Karang Tengah District, Tangerang City, the findings may not be directly generalizable to populations with different demographic characteristics, household conditions, healthcare systems, and TB epidemiology. Therefore, the findings should be interpreted cautiously and confirmed through larger prospective studies using more comprehensive measurements of potential confounding factors and more precise assessment of relevant exposures.estimated associations.

CONCLUSION

The analysis identified significant associations between TB and nutritional status and household contact history among children under five years in Karang Tengah District, Tangerang City. These findings indicate that children with unfavorable nutritional status and a history of household TB contact may warrant greater attention in the context of TB prevention and early assessment. Maternal knowledge, BCG immunization, cigarette-smoke exposure, and healthcare service quality were not significantly associated with TB in this study. Given the cross-sectional design, the

observed associations should not be interpreted as causal relationships. Further research is needed to confirm these associations and assess their temporal relationships.

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