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Susceptibility to Tuberculosis in Children Aged 1–5 Years with Growth Disorders in Jember Regency, Indonesia

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Abstract

Background: Tuberculosis (TB) in children remains a major public health problem, particularly among vulnerable age groups such as children under five years old. Poor nutritional status is considered one of the important host factors that may increase susceptibility to TB infection. This study aimed to determine the relationship between nutritional status and the incidence of tuberculosis among children aged 1–5 years in Jember Regency, Indonesia.

Materials and Methods: This analytical observational study employed a retrospective case-control design, adhering to STROBE guidelines. Data were obtained from 16 Primary Health Centers (Puskesmas) in Jember Regency in 2025. The sample (n=214) included 107 children aged 1–5 years diagnosed with TB and 107 age-and sex-matched controls. Anthropometric status was assessed using WHO Z-score standards for weight-for-height (WHZ), weight-for-age (WAZ), and height-for-age (HAZ). Potential confounders, including feeding history (breastfeeding vs. formula), pre-existing anemia (Hb <11 g/dL), and secondary comorbidities, were analyzed. Data were analyzed using Chi-Square and binary logistic regression to adjust for expression bias and isolate the effect of nutritional status.

Results: The results showed a significant relationship between nutritional status and tuberculosis incidence among children. Based on the BB/TB indicator, children with poor nutritional status had a 2.68 times higher risk of developing tuberculosis compared to children with normal nutritional status ($\chi^2 = 9.054$; $p = 0.003$; OR = 2.684; 95% CI: 1.934–5.169). Significant associations were also found for BB/U ($p = 0.001$) and TB/U ($p = 0.002$).

Conclusion: Nutritional status is significantly associated with the incidence of tuberculosis in children aged 1–5 years. Improving nutritional status should be integrated into tuberculosis prevention and control programs to reduce TB risk among young children.

Key Words: Tuberculosis, Nutritional status, Under-five children.

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1- INTRODUCTION

Tuberculosis (TB) in infants remains a significant public health problem, both globally and nationally. The disease is caused by Mycobacterium tuberculosis and is transmitted through droplets from people with active TB (1). Infants are a group that is highly susceptible to TB due to their immature immune systems, making it easier for the infection to develop into active disease and posing a risk of serious complications, including extrapulmonary TB and death (2). The World Health Organization (WHO) reports that childhood TB still accounts for a large proportion of total global TB cases, particularly in developing countries with a high TB burden (3).

Indonesia ranks second as the country with the highest number of TB cases in the world. Based on reports from the WHO and the Indonesian Ministry of Health, TB cases in children, including toddlers aged 1-5 years, are still found in significant numbers each year (4). This condition shows that TB control in the pediatric age group is not yet optimal. At the regional level, Jember Regency is one of the areas with a high TB burden, including in the toddler group, thus requiring special attention in efforts to prevent and control childhood TB.

In addition to exposure to TB bacteria, nutritional status is an important determinant that affects the susceptibility of toddlers to TB infection (5). Suboptimal nutritional status, both malnutrition and chronic growth disorders, can reduce the function of the immune system, particularly cellular immunity, which plays a major role in fighting Mycobacterium tuberculosis (2). Deficiencies in energy, protein, and essential micronutrients can cause a decrease in the number and function of immune cells, making it easier for latent TB infection to develop into active TB (6). Therefore, infants with abnormal nutritional status have a higher risk of developing TB compared to infants with good nutritional status (7).

Children's nutritional status is defined by anthropometric Z-scores: WHZ (acute status), WAZ (general status), and HAZ (chronic growth disorders). Recent evidence suggests that factors such as early infancy feeding patterns, pre-existing anemia, and underlying chronic diseases significantly influence cellular immune resilience against Mycobacterium tuberculosis. Nutritional status assessment of toddlers can be done through several anthropometric indicators, namely weight for height (WHZ), weight for age (WAZ), and height for age (HAZ). The WHZ indicator describes acute nutritional status, while WAZ and HAZ reflect more chronic nutritional status. Chronic growth disorders indicated by the H/A indicator often reflect long-term nutritional problems that can affect a child's immune system over a long period of time (8). Therefore, the H/A indicator is thought to have a stronger correlation with TB incidence in toddlers than other nutritional indicators.

Jember Regency in Indonesia also faces a high rate of malnutrition among toddlers, both in terms of undernourishment and growth disorders. The overlap between malnutrition and TB in toddlers has the potential to worsen children's health and increase the risk of severe TB. Although most toddlers have received the BCG vaccination, the protection provided by the vaccine does not completely prevent TB, especially in toddlers with compromised immunity due to malnutrition (9). Therefore, a more comprehensive approach is needed by integrating TB prevention efforts and improving nutritional status. This study is important to analyze the relationship between nutritional status and tuberculosis incidence in infants aged 1–5 years in Jember District. The results of this study are expected to provide a scientific basis

for strengthening TB prevention and control programs for infants through continuous growth monitoring and nutritional status improvement at the primary health care and community levels.

2- MATERIALS AND METHODS

This retrospective case-control study was conducted at 16 Primary Health Centers in Jember Regency, Indonesia, during 2025. Participants included children aged 1–5 years. The study used secondary data obtained from health care facilities in in Jember Regency in 2025. The population in this study consisted of all children aged 1–5 years registered in Jember Regency. The study sample consisted of two groups: children with tuberculosis as the case group and children without tuberculosis as the control group. Sampling was performed using total sampling in accordance with predetermined inclusion and exclusion criteria. Eligible participants were children aged 1–5 years with complete medical documentation. Children were excluded if they had missing anthropometric records or incomplete data regarding feeding history and co-morbidities. A total of 214 children were analyzed, consisting of 198 children with tuberculosis and 16 children in the control group (Figure 1).

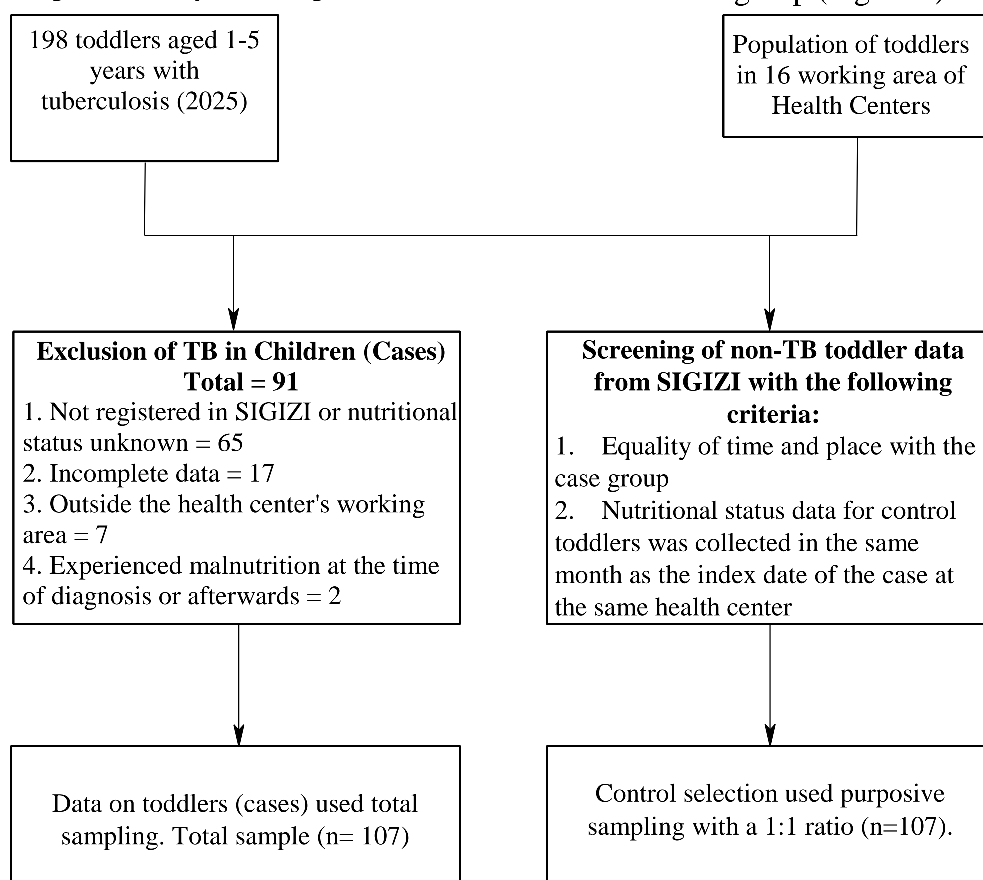

Figure-1: Data screening process.

The independent variable was nutritional status (WHZ, WAZ, HAZ). To remove expression bias, we adjusted for confounding variables, including infant feeding modes, history of anemia, and the presence of secondary chronic co-morbidities. The independent variable in this study was the nutritional status of children, while the dependent variable was the incidence of tuberculosis. Nutritional status was assessed based on anthropometric indicators of weight for height (WHZ), weight for age (WFA), and height for age (HFA) according to World

Health Organization (WHO) standards. Nutritional status was assessed using measurement data taken three months before the infants were diagnosed with tuberculosis, taking into account the incubation period of TB. This research underwent ethical review through the Health Research Ethics Committee (KEPK) of the Faculty of Nursing, University of Jember, with No. 434/UN25.1.14/KEPK/2025.

Descriptive statistics and Chi-Square tests were applied. Binary logistic regression was performed to calculate Adjusted Odds Ratios (AOR) to determine the independent risk of nutritional status on TB incidence, controlling for co-morbidities. Tuberculosis incidence data were obtained from medical records and TB program records at health care facilities. The Chi-Square (χ^2) test was used to analyze the data, while the risk was expressed in Odds Ratio (OR) with a 95% confidence interval (95% CI). After adjusting for anemia and feeding history, the logistic regression model demonstrated a significant association: children with chronic growth disorders (HAZ) remained at a 3.530 times higher risk of TB (AOR = 3.530; 95% CI: 1.706–7.306; $p < 0.001$).

3- RESULT

A total of 214 infants aged 1-5 years were analyzed in this study, consisting of 198 infants with tuberculosis as the case group and 16 infants without tuberculosis as the control group. The median age of infants in the case group was 2 years, with the majority being male (56.1%). Most of the infants in the case group had received BCG immunization (97.5%). Based on clinical classification, almost all infants in the case group were diagnosed with clinical TB (99.5%), with the main location being pulmonary TB (96.0%). The characteristics of the toddler respondents are presented in Table 1.

Table-1. Distribution of characteristics of data on tuberculosis in infants.

Characteristics of Toddlers	Cases	Controls	Total
Age (Years)			
Median (P_{25} - P_{75})	2 (1-3)	3 (2-4)	2 (1-4)
Sex f (%)			
Male	60 (56.1)	53 (49.5)	113 (52.8)
Female	47 (43.9)	54 (50.5)	101 (47.2)
TB type f (%)			
Bacteriological	1 (0.9)	0 (0)	1 (0.5)
Clinical	106 (99.1)	0 (0)	106 (49.5)
Non-TB	0 (0.0)	107 (100.0)	107 (50.0)
TBC location f (%)			
Lung	105 (98.1)	0 (0.0)	105 (49.1)
Ekstra-pulmonary	2 (1.9)	0 (0.0)	2 (0.9)
Non-TB	0 (0.0)	107 (100.0)	107 (50.0)
BCG Immunization (%)			
Yes	4 (3.7)	107 (100.0)	210 (98.1)
No	103 (96.3)	0 (0.0)	4 (1.9)
History of Contact f (%)			
Yes	25 (23.4)	0 (0.0)	82 (38.3)
No	82 (76.6)	107 (100.0)	132 (61.7)

Note: f(%) : number (percentage); **Md (P_25 - P_75) :** median (25th-75th percentile);

Source: Data on nutrition and tuberculosis among toddlers at community health centers in Jember Regency, 2025.

The distribution of nutritional status, as shown in Table 2, indicates that toddlers in the tuberculosis group had a higher proportion of abnormal nutritional status compared to the control group. Based on the weight-for-height indicator, 33.6% of toddlers in the case group had malnutrition, while in the control group, the figure was 15.9%. Based on the BB/U indicator, 42.1% of toddlers in the case group had abnormal nutritional status, which was higher than the 21.5% in the control group. Meanwhile, based on the TB/U indicator, 30.8% of toddlers in the case group had growth disorders (short and very short), while in the control group, the figure was 11.2%.

The relationship between nutritional status and tuberculosis incidence in toddlers was analyzed using bivariate analysis and is presented in Table 3. There was a significant relationship between nutritional status and the incidence of tuberculosis in toddlers ($p < 0.05$).

Infants with poor nutritional status based on the BB/TB indicator had a 2.684 times greater risk of tuberculosis than infants with good nutritional status (OR = 2.684; 95% CI: 1.394–5.169). Based on the BB/U indicator, toddlers with abnormal nutritional status had a 2.651 times higher risk of tuberculosis (OR = 2.651; 95% CI: 1.455–4.830).

Table-2. Redistribution of toddler nutritional status.

Indicator	Cases	Controls	Total
Nutritional status according to weight/height f (%)			
Good nutrition	71 (66.4)	90 (84.1)	161 (75.2)
Poor nutrition	36 (33.6)	17 (15.9)	53 (24.8)
Nutritional status according to weight/age f (%)			
Normal	62 (57.9)	84 (78.5)	146 (68.2)
Abnormal	45 (42.1)	23 (21.5)	68 (31.8)
Nutritional status according to height/age f (%)			
Normal	74 (69.2)	95 (88.8)	169 (79.0)
Abnormal	33 (30.8)	12 (11.2)	45 (21.0)

Note: f(5): amount of data (percentage)
Source: Nutrition Data at Jember District Health Center 2025 (taken in December 2025))

Table-2. Analysis of the relationship between nutritional status based on weight-for-height, weight-for-age, height for age, and the incidence of tuberculosis in children aged 1-5 years in Jember district (n=214).

	TB	Non-TB	χ2	p	OR	95% CI
	f (%)	f (%)				Min-Max
Nutritional Status According to Weight/Height						
Good Nutrition	71 (44.1)	90 (55.9)	9.054[a]	< 0.05	2.684	1.394-5.169
Poor Nutrition	36 (67.9)	17 (32.1)				
Nutritional Status According to Weight/Age						
Normal	62 (42.5)	84 (57.5)	10.433[a]	< 0.05	2.651	1.455-4.830
Abnormal	45 (66.2)	23 (33.8)				
Nutritional Status According to TB/U						
Normal	74 (43.8)	95 (56.2)	12.409[a]	< 0.05	3.530	1.706-7.306
Abnormal	33 (73.3)	12 (26.7)				

Note: f (%): data amount (percentage), **χ2:** Pearson Chi-Square, **p:** p-value, **OR:** Odds Ratio, **CI:** Confidence Interval, **Min-Max:** Upper and Lower Limits, **[a]:** Meets Expected Count Requirements.
Source: Nutrition Data at the Jember District Health Center 2025 (taken in December 2025)

The highest risk was found in the TB/U indicator, where toddlers with chronic growth disorders had a 3.530 times higher risk of tuberculosis compared to toddlers with normal height (OR = 3.530; 95% CI: 1.706–7.306).

4- DISCUSSION

The stronger association observed with HAZ versus WHZ indicates that chronic malnutrition, compounded by early-life feeding practices and comorbid anemia, provides a superior predictor of long-term cellular immunity suppression in toddlers. The results of this study indicate that nutritional status is significantly associated with the incidence of tuberculosis in children aged 1–5 years in Jember District. Children with poor and abnormal nutritional status have a higher risk of developing TB than children with good nutritional status. These findings reinforce the concept that nutritional status is an important determinant of children's susceptibility to chronic infectious diseases, particularly tuberculosis.

Based on anthropometric indicators, the highest risk of TB was found in toddlers with chronic growth disorders, according to the TB/U indicator, with an OR value of 3.530. This finding shows that chronic malnutrition has a stronger association with TB than acute malnutrition. The TB/U indicator reflects long-term malnutrition that persists over a long period of time, thereby having a greater impact on the decline in the immune system function of infants. Chronic malnutrition can cause a decline in cellular immunity, particularly T cell and macrophage function, which play an important role in controlling Mycobacterium tuberculosis infection.

Meanwhile, the BB/TB indicator, which describes acute nutritional status, also shows a significant association with TB incidence but with a lower OR value compared to TB/U. This can be explained because acute malnutrition is temporary and can be influenced by short-term conditions such as illness or recent food intake. Conversely, chronic growth disorders reflected in TB/U indicate that toddlers have experienced nutritional deficits over a longer period of time, thereby increasing their effects on the immune system and susceptibility to TB.

The findings of this study are in line with various previous studies stating that children with poor nutritional status and growth disorders have a higher risk of developing TB. Research by Manillaturrochmah et al. (2023) and Putri et al. (2025) reported a significant association between nutritional status and TB incidence in children under five years of age (10,11). An international study by Vonasek et al. (2022) also showed that children with malnutrition, especially chronic malnutrition, had a higher prevalence of TB compared to children with good nutritional status (5).

Although most of the toddlers in this study had received BCG immunization, TB cases were still found in the case group. This shows that BCG immunization does not completely prevent TB infection, especially in toddlers with compromised immunity due to nutritional disorders. Poor nutritional status can reduce the effectiveness of the post-immunization immune response, so that toddlers remain at risk of TB infection even after receiving the BCG vaccine. Research by Susanto et al. (2022) shows a significant relationship between family functioning and the nutritional status of toddlers, whereby families with good functioning are 2.217 times more likely to have toddlers with good nutritional status. This condition indicates that families play an important role in ensuring adequate nutritional intake and monitoring the growth of toddlers, which in turn can affect their susceptibility to infectious diseases such as tuberculosis (12). Based on these results and

discussion, it can be concluded that chronic malnutrition is a strong contributing factor to TB incidence in toddlers. Therefore, TB prevention and control efforts in toddlers should not only focus on treatment and immunization but also integrate continuous growth monitoring and nutritional status improvement interventions, especially to prevent long-term growth disorders (13,14).

5- CONCLUSION

This study shows that nutritional status is significantly associated with the incidence of tuberculosis in children aged 1-5 years in Jember District. These findings confirm that nutritional status is an important determinant in the prevention and control of tuberculosis in toddlers. These findings demonstrate the need for integration between childhood TB control programs and nutrition improvement programs, particularly at the community health center (Puskesmas) and integrated health post (Posyandu) levels. Promotive and preventive efforts through nutritional status monitoring, family education, and strengthening the role of community health workers are expected to contribute to reducing the risk of TB in toddlers in Jember Regency, in line with the community nursing approach and community-based TB control.

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