

Unveiling the Role of Malnutrition in Pediatric Tuberculosis: A Study at Al Ihsan Hospital, West Java, Indonesia

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Abstract. Tuberculosis (TB) and undernutrition are significant health challenges, particularly in children. Pediatric TB remains a significant public health challenge, particularly in developing countries where malnutrition is prevalent. This study aims to shed light on the role of malnutrition in pediatric TB and identify associated factors. This study employed an observational analytic design with a case-control approach, focusing on the retrospective analysis of secondary data obtained from medical records at Al Ihsan Hospital in Bandung. The study aimed to investigate the role of undernourished in pediatric TB among pediatric TB between with bacteriology confirmed January 2018 to December 2022. Out of a total of 1,423 children, 1,153 were in the confirmed TB group and 270 in the unconfirmed group. Among the Undernourished, 9.97% (n=115) of children were confirmed TB cases, while only 2.22% (n=6) had unconfirmed TB cases. In contrast, in the non-Undernourished, 90.03% (n=1.038) were confirmed TB case and 97.78% (n=264) were unconfirmed TB case. Statistical analysis revealed a significant association between malnutrition and TB case, with a p-value of 0.001. The odds ratio (OR) of 4.87 indicates that children with malnutrition were 4.87 times more likely to be diagnosed with TB compared to those with adequate nutrition. The findings of this study demonstrate a statistically significant association between malnutrition and the incidence of pediatric tuberculosis (TB) at Al Ihsan Regional Hospital in 2020. Children with malnutrition were found to be 4.87 times more likely to have confirmed TB compared to those with adequate nutritional status, with a p-value of 0.001, indicating strong evidence of a relationship. However, this study has limitations. Being a retrospective case-control design, it cannot establish causality. Nutritional status was assessed at the time of diagnosis, which may not reflect long-term nutritional history. Additionally, other confounding factors such as socioeconomic status, comorbidities, and environmental exposures were not controlled in this analysis.

Keywords: *Pediatric Tuberculosis, Malnutrition, Risk Factors.*

A. Introduction

Malnutrition in children remains a major public health burden in developing countries, contributing substantially to childhood morbidity and mortality. Beyond malnutrition due to food insecurity, disease-related malnutrition (DRM)—malnutrition triggered or exacerbated by chronic diseases—represents a distinct and complex challenge due to its multifactorial pathophysiology and difficulties in assessment (1). Malnutrition and infection interact in a vicious cycle: malnutrition impairs immune function—particularly cell-mediated immunity—thereby increasing susceptibility to and severity of infections such as tuberculosis and malaria, while severe infections further deteriorate nutritional status. Studies across various pediatric populations have demonstrated a strong association between malnutrition and the severity of infectious diseases (2,3).

Severe acute malnutrition (SAM) remains a major cause of morbidity and mortality among children in low-resource settings. A study in Ethiopia reported a low recovery rate of 58.4% among hospitalized children with SAM, with better outcomes associated with female sex, vaccination, higher MUAC, longer hospital stays, and vitamin A supplementation, while HIV, tuberculosis, and other comorbidities reduced recovery likelihood. Similarly, research from Zambia found that 1.6% of children with SAM had

tuberculosis, and those co-infected with TB and HIV faced markedly higher mortality. Both studies highlight that malnutrition, infection, and HIV interact synergistically, emphasizing the need for integrated nutrition, infection control, and child health programs to improve survival outcomes in high-burden regions (4,5).

The intersection of pediatric TB and malnutrition presents significant challenges but also opportunities for improving child health through integrated management approaches. Continued research and implementation of comprehensive care strategies are crucial for addressing this dual burden effectively.(2,4,6) More research is needed to understand the epidemiological links between TB and malnutrition in children (7,8).

In the reported year of Badan Pusat Statistik Provinsi Jawa barat, West Java recorded a total of 224,798 tuberculosis (TB) cases, representing the highest incidence among all provinces in Indonesia. Al Ihsan Regional Hospital, as a referral hospital in West Java Province, was selected as the study site due to its central role in managing TB cases in the region (9). This study aims to shed light on the role of malnutrition in pediatric TB and identify associated factors.

B. Method

This study was approved by the Health Research Ethics Committee of Universitas Islam Bandung (KEPK Unisba) under ethical clearance number 093/KEPK-Unisba/X/2020. This study employed an observational analytic design with a case-control approach, focusing on the retrospective analysis of secondary data obtained from medical records at Al Ihsan Hospital in Bandung, Indonesia. The study aimed to investigate the role of malnutrition in pediatric TB among children diagnosed of TB confirmed bacteriology between January 2018 and December 2022.

The study population consisted of children aged 0 to 18 years who were diagnosed TB by WHO criteria and admitted to Al Ihsan Hospital during the specified period. The case group was diagnosed with TB in accordance with World Health Organization WHO criteria and was bacteriologically confirmed, whereas the control group were selected from the same population but no-bacteriological confirmation. Undernourished status as determined by WHO criteria for malnutrition based on weight-for-age and height-for-age z-scores. Secondary data were collected from the hospital's electronic medical records, including demographic information and diagnostic base on Internasional Classification of Disesase (ICD). Statistical analysis was conducted using a two-proportion z-test to evaluate the significance of differences between case and control study groups. Descriptive statistics were employed to summarize demographic and clinical characteristics.

C. Result and Discussion

Initial Findings

The results of the study using the Chi-square test showed a difference in the incidence of tuberculosis in children with Undernourished compared to those without Undernourished, with a p-value < 0.05, indicating a relationship between malnutrition and the incidence of tuberculosis in children at Al Ihsan Hospital in Bandung from 2017 to 2020. The odds ratio was 4.87 with a 95% confidence interval (2.122-11.200), meaning that the odds of developing tuberculosis in Undernourished children were 4.87 times greater than in children who were not Undernourished.

Table 1. The Incidence of Undernourished Among Pediatric Tuberculosis Patients at Al Ihsan Regional Hospital in 2020

	Pediatric Tuberculosis				p	OR
	Confirmation BTA		Unconfirmation BTA			
	N	%	N	%		
Undernourished	1038	90,03	264	97,78	0,001	4,87
Non-Undernourished	115	9,97	6	2,22		
Total	1153	100,00	270	100,00		

Analysis and Discussion

The present study identified a significant association between undernutrition and bacteriologically

confirmed *Mycobacterium(M) tuberculosis* infection among children, supporting earlier evidence that nutritional deficiency substantially increases the risk of tuberculosis (TB) infection and progression to active disease. This finding aligns with prior reports indicating that malnutrition impairs both innate and adaptive immune responses—particularly macrophage activation, cytokine signaling, and T-cell-mediated immunity—thereby weakening host defense against *M. tuberculosis* (10,11).

The immunological dysregulation associated with undernutrition, characterized by diminished Th1 responses, reduced IFN- γ production, and compromised macrophage bactericidal function, provides a mechanistic explanation for the increased susceptibility and bacteriologic confirmation observed in undernourished pediatric TB cases(10).

Comparable evidence from high-burden, resource-limited settings has demonstrated that the prevalence of active TB rises proportionally with the severity of malnutrition, reflecting a bidirectional and synergistic relationship in which nutritional deficiency both predisposes to infection and worsens disease outcomes(4). Malnutrition has further been associated with delayed sputum conversion, higher bacterial load, and increased mortality, underscoring its clinical and epidemiological significance in pediatric TB management (4,10).

The combination of malnutrition and TB can delay recovery and worsen clinical outcomes. Malnutrition exacerbates TB by increasing metabolic demands and reducing nutrient intake, which in turn depresses immune functions and delays recovery(12,13). The dual burden of malnutrition and TB significantly increases the risk of mortality. Malnourished children with TB are at higher risk of severe disease outcomes, including death, due to their compromised immune systems(14). From a translational perspective, these findings reaffirm the necessity of integrating nutritional screening and intervention into TB prevention and treatment programs. Nutritional rehabilitation may restore immunocompetence, enhance the efficacy of antimicrobial therapy, and mitigate relapse risk(4,10).

Undernourished leads to immunosuppression, making children more susceptible to infections, including TB. This is due to the compromised development and function of the immune system, particularly affecting cell-mediated immunity, which is crucial for fighting(15). Undernutrition affects cytokine production, which is vital for immune signaling. For instance, serum IL-10 levels, which are anti-inflammatory, were found to decrease with nutritional supplementation, although not significantly, indicating a potential but unclear impact on immune modulation(10).

From a clinical and public health perspective, these findings emphasize the importance of integrating nutritional assessment and intervention into pediatric TB control strategies, particularly in high endemic regions as Indonesia. Early identification and correction of undernutrition could enhance immune resilience, improve treatment outcomes, and reduce disease transmission.

Nonetheless, as the present analysis is limited by sample size and retrospective study design, further prospective studies with standardized bacteriologic confirmation and immunologic profiling are warranted to elucidate causal pathways and evaluate the efficacy of host-directed nutritional interventions in pediatric TB.

D. Conclusion

Malnutrition is significantly associated with pediatric tuberculosis . Undernourished children are nearly five times more likely to develop tuberculosis than non-Undernourished children (OR = 4.87). Strengthening nutritional support should be an integral part of pediatric TB prevention and management strategies.

Acknowledgement

Contains expressions of gratitude to relevant parties who assisted in the research, or to parties who provided grants or funding for research activities.

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