

# Assesment risk factor for tuberculosis transmission among children: Case study in Medan



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**Abstract** Tuberculosis (TB) is a contagious illness caused by *Mycobacterium tuberculosis* and can affect individuals of all age groups. According to the Global Tuberculosis Report in 2022, approximately 1.2 million children and adolescents under the age of 15 were diagnosed with TB. Additionally, a significant increase in TB incidence among children in Indonesia was observed, rising from 42,187 cases in 2021 to 100,726 new cases in 2022. Based on RISKESDAS data from 2018, North Sumatra ranks second among provinces with the highest incidence of tuberculosis cases. The aim of this study was to identify the risk variables associated with the occurrence of pulmonary tuberculosis in children residing in Medan. An analytical observational study with a case-control study design was employed. The results indicated that TB cases were present in 21 out of 42 community health centers in Medan city. Participants included children aged 5-14 years and parents with incomes below the Minimum Wage. The majority of the participants had parents who smoked, were exposed to contact transmission, and lived in inadequate housing conditions. The findings also revealed that transmission through direct contact was the primary and most significant risk factor for TB among the children. The risk factors for tuberculosis transmission among children were identified as gender, number of persons living per room, and a history of contact with TB sufferers. It is recommended that efforts be made to prioritize contact tracing, community education, family intervention, and continuous surveillance to strengthen contact tracing programs.

**Keywords:** tuberculosis, children, risk factor, Medan

## 1. Introduction

Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, is a significant health issue worldwide, particularly in underdeveloped countries (WHO, 2023). It is a major contributor to illness and death globally, particularly in children. Globally, tuberculosis continues to be a significant and difficult public health problem (Dodd et al., 2014). According to the World Health Organization (WHO; Bagcchi, S, 2022), tuberculosis (TB) is among the top 10 causes of death worldwide according to the World Health Organization (Bagcchi, S, 2022). It is also the primary cause of mortality due to a single infectious agent, surpassing HIV/AIDS. Tuberculosis (TB) poses unique obstacles in children, such as the complexity of diagnosing the disease due to vague symptoms and difficulty in collecting sputum samples, resulting in cases being either missed or misidentified (Safiri et al., 2023). Additionally, children are more susceptible to severe forms of TB, such as miliary TB or TB meningitis, which can have long-lasting health effects.

Indonesia ranks among the countries with the third highest TB burden worldwide, with significant public health implications. The city of Medan, the third most populous city in Indonesia, provides a unique context for studying TB due to its high population density, diverse socioeconomic composition, and specific living conditions. Factors such as overcrowding, limited healthcare access, and varying levels of public health awareness significantly influence TB transmission and persistence in this region.

This study focused on the role of contact transmission of TB, particularly among children in Medan. Contact transmission involves the spread of TB from an infected person to others through close respiratory interactions. Understanding this transmission pathway is crucial for developing targeted interventions, especially since the nuances of contact transmission in children have not been thoroughly explored in Medan (Wikurendra et al., 2021).

Our research aimed to fill this gap by investigating contact transmission as a key risk factor for TB among children in Medan city. Using a case-control study design, we will examine the extent of contact transmission among children diagnosed with TB compared to a control group without the disease. This study sought to identify specific patterns and risk factors associated with contact transmission in this demographic population, which could inform TB control strategies. The likelihood of TB spreading through close contact is increased by the commonality of extended families living in close quarters. By



measuring this risk and identifying trends, our research aims to provide valuable insights into the dynamics of TB transmission among children. These findings could lead to more effective public health interventions and policies, contributing to the global fight against tuberculosis, particularly in vulnerable populations such as children in urban settings such as Medan.

## 2. Materials and Methods

This type of research was analytic observational with a case–control research design to explain the risk factors for TB. Risk factors are independent variables that are statistically related to the dependent variable. This study aimed to explain the characteristics of populations with different frequencies of health problems in the same time period. This study was conducted at the Medan City Health Center. The research lasted for one year, starting in June, when the proposal was submitted.

### 2.1. Population and sample collection

The subjects of this study were divided into case and control groups. The study population included all patients with pulmonary TB and not pulmonary TB. The research sample for risk factors was taken by total sampling, which included 62 cases of pulmonary TB in all children's health centers in Medan. The research locations were 21 subdistricts with TB in children according to the Tuberculosis Recording System (SITT), and 62 cases of TB in children were found in the city of Medan. However, at the time of data collection, 52 pulmonary TB patients were found in 16 subdistricts due to differences in patient records and patient unwillingness. Individual variables included child characteristics (age, sex, and economic status), environmental factors (house density, habit of opening windows, history of smoking exposure, and patient contact history), BCG immunization status, and nutritional status.

The inclusion criteria for this study were as follows: 1) clear address data, age <15 years, and willingness to be research respondents. The exclusion criteria were case data with untraceable addresses, a person who was not a patient with pulmonary TB or who had never had pulmonary TB, who was >15 years old, who had the same sex as the patient, who lived close to the patient, and who was willing to be research respondents. The number of cases and controls was set at 1:1.

### 2.2. Data analysis

Data analysis was performed using SPSS, which consists of univariate and bivariate analyses. Univariate analysis was performed to describe the characteristics of the respondents, and bivariate analysis was carried out to determine the relationship and magnitude of the risk of each independent variable on the incidence of TB. Risk can be assessed using odds ratio (OR) analysis.

## 3. Results

The results of this study are described using univariate and bivariate analyses. Table 1 and Table 2 show the univariate analysis, and Tables 3, 4, and 5 show the bivariate analysis.

### 3.1. Characteristics of the subjects

**Table 1** Health Factors.

Variable	Amount	Percentage
BCG Immunization Status		
No	20	19.6
Yes	82	80.4
Smoking History		
Yes	74	72.5
No	28	27.5
Contact History		
Yes	54	52.9
No	48	47.1
Contact History Specifics		
Parent	18	17.6
Caregiver	1	1.0
Grandma/Grandpa/Uncle/Aunt	8	7.8
Schoolmate	5	4.9
Other	22	21.6

**Table 2** Housing Factors.

Variable	Amount	Percentage
Room Size		
< 8 meters	7	6.9
≥ 8 meters	95	93.1
Number of People Per room		
≥3 Orang	59	57.8
1-2 People/3 People with 1 including children under 5 year	43	42.2
House Density		
Not eligible	61	59.8
Eligible	41	40.2
Home Humidity		
< 40%	58	56.9
40-70%	44	43.1
House Temperature		
>30°C	47	46.1
≤30°C	55	53.9
Home Lighting		
< 60 lux	43	42.2
≥ 60 lux	59	57.8
Types of House Floors		
Made entirely of earth	1	1.0
Made from cement, ceramics, boards	101	99.0
Habit of Opening Windows		
No	10	9.8
Yes	92	90.2

Of the respondents, 52.9% had a history of contact with patients with TB, 72.5% had families with a history of smoking, 80.4% had received BCG immunization, and 59.8% had dense housing. Do not meet the requirements for a healthy house, 57.8% of the people per room do not meet the requirements, 93.1% have a room area that meets the requirements, 90.2% have a habit of opening windows, 56.9% have humidity that does not meet the requirements, 53.9% have a house temperature that meets the requirements, 57.8% have house lighting that meets the requirements, 99.0% have the type of floor according to the requirements, 60.8% have parents whose income is below the minimum wage, and 66.7% have a place to live close to a health facility.

Following univariate analysis, bivariate analysis using the chi-square test was performed. The main goal of this analysis was to determine the correlation of each independent variable with the dependent variables. The p value, which is always directly proportional to the 95% confidence interval limit, indicates the outcome of the statistical test. The 95% CI does not reach 1 if the p value is less than 0.05, indicating that the data are significant, relevant, and meaningful.

**Table 3** Analysis Bivariat of Housing Factors.

Variabel	P	OR	95% CI
House Occupancy Density			
Not Eligible	0.545	1.278	0.578-2.824
Eligible			
Number of people per room			
Not Eligible	0.001	4.176	1.801-9.684
Eligible			
Room Size			
Not Eligible	0.240	0.376	0.069-2.032
Eligible			
Humidity			
Not eligible	0.110	0.524	0.237-1.161
Eligible			
Room temperature			
Not eligible	0.321	1.486	0.679-3.249
Eligible			
Lighting			
Not eligible	0.841	0.923	0.420-2.025
Eligible			



Housing floor			
Partly or wholly earthen	0.315	2.020	1.659-2.460
Made of cement, ceramic, board			
Habbits of opening window			
Yes	0.505	1.567	0.415-5.921
No			

**Table 4** Bivariate analysis of sociodemographic status.

Variabel	P	OR	95% CI
Sex			
Male	0.015	0.364	0.160-0.830
Female			
Age			
0-14 Years	1.000	1.000	0.444-2.253
5-14 Years			
Housing income			
Under UMR	1.000	1.000	0.452-2.214
Above UMR			
Distance to Healthcare			
Far	0.401	1.425	0.623-3.260
Closed			

**Table 5** Analysis Bivariat of Health Factors.

Variabel	P	OR	95% CI
Contact Transmission			
With Contact transmission	0.000	5.286	2.266-12.328
Without Contact transmission			
BCG Immunization			
No	1.000	1.000	0.376-2.658
Yes			
Family habits of smoking			
Yes	0.183	0.550	0.227-1.333
No			

According to the table above, sex, contact transmission, and the number of people in the room are risk factors for TB in children.

**4. Discussion**

This study examined three major risk factors: health, sociodemographic factors, and housing. Regarding sociodemographic factors, sex was a significant contributing factor to the risk of TB ( $p < 0,05$ ). Mixed findings have been found in research on sex variations in the outcomes of childhood TB. Male sex was linked to poor treatment outcomes in children aged 0–4 years, according to Ogbudebe et al. (2018), but Stival et al. (2014) found the opposite. These results imply that although sex may not directly affect the incidence of TB in children, it may affect treatment outcomes and the spread of the disease.

There is a substantial relationship between the number of people per room and the incidence of TB. According to the WHO (2018), the standard per person room is 1-2 people/3 people with 1 child under 5 years old. In this study, most respondents did not fulfill the requirement of more than three people per room. Living in overcrowded housing can increase their risk of infection when a young person comes into contact with a TB patient. (Patterson and Wood,2019). When close family members cough, sneeze, or talk, there is a chance that the person will be exposed to more infectious droplet nuclei (Rezaei,2023). Consequently, the closeness brought about by overcrowding increases the risk of tuberculosis infection in vulnerable populations, including young children who interact with family members (WHO,2018). This study showed that respondents who slept in the same room with more than three people had a 4.157 greater risk of developing TB than those who slept with 1-2 people/3 people. This finding is in line with a study (Siregar, 2019) showing that the risk of TB was 5.73 times greater for children living in crowded homes than for those who did not. Research conducted in Uganda and Brazil also revealed that households with more crowded conditions (more than three people per room) experienced an increase in individual-level risk factors for TB transmission in children (Sousa et al., 2019). Prevalent TB infection has been associated with other proxies of household transmission by having another child (5-15 years of age) in a house with TB infection (Marquez et al., 2020).



Based on this study, there is a substantial relationship between the occurrence of tuberculosis in children and their contact transmission. Children with previous contact transmission had a 5.286 greater risk of developing tuberculosis than did those with no transmission. Pulmonary TB occurs in children when they are in contact with adult pulmonary TB patients (Laghari,2019). Adult TB patients are the primary source of childhood TB because children come in contact with adult patients with TB (Asyari et al., 2017). The risk of transmission increases when children live in the same house as TB patients. (Roy et al., 2019). This study is in line with a study showing that having a household member who had TB was shown to increase the risk of developing TB threefold (AOR = 3.00; 95% CI: 1.60, 5.62). (Shimeles et al., 2019). Research has shown that having a family member who experiences TB increases the risk 5.18 times that of someone with TB infection. (Sulistiyawati and Ramadhan, 2021). A study in Sumedang, West Java, also revealed that there was a significant correlation between contact history and the incidence of TB in children. Children with a previous contact history had an 11,793 greater risk of developing tuberculosis than those who had no previous exposure (Nurjaman et al., 2019).

Children can contract tuberculosis from adults with acid-fast bacilli (AFB) (+), which is the general source of transmission in tuberculosis patients (WHO,2023). The patient's sputum contains a large number of tuberculosis germs, specifically, acid-fast bacilli (AFB) (+). An estimated 3000 germ cells, known as droplet nuclei, are released into the air when a tuberculosis patient coughs or sneezes (Patterson and Wood, 2019). Children and those nearby are exposed to this contagious splash as tiny spit lingers in the air (Siregar, 2019). Frail children are particularly susceptible to developing tuberculosis. The risk of infection is greatest if the contact is close and prolonged, such as between an infant or toddler and a mother or other caregivers in the household. In this study, parents and grandparents had the most previous contact history. Moreover, the risk of developing disease after infection is much greater for infants and young children aged <5 years than for children aged ≥5 years. (WHO, 2021).

The majority of cases in this study were located in Medan's metropolitan areas. A comparative analysis comparing the incidence patterns of tuberculosis in Bangladesh, Indonesia, and the Philippines revealed a common pattern of illness. The distribution of tuberculosis (TB) in the general population was similar in all three countries with respect to age, sex, place of residence, and the impact of certain biological and social risk factors. The typical pattern of TB incidence rates was significantly greater in males, older age groups, and metropolitan regions in all three nations. (Kak et al., 2020).

The findings of this study may have enormous implications for defined strategies to prevent TB in children in Medan. In this study, contact transmission had the largest odds ratio as a risk factor for TB. Moreover, combating contact transmission in households is suggested to prevent TB in children. The main purposes of screening for TB are to identify symptomatic children (i.e., children of any age with undiagnosed TB disease) and provide preventive therapy for susceptible individuals (i.e., asymptomatic children aged <5 years who are in close contact with TB-positive individuals).

This study had several limitations. As a case-control study, this study is limited by the possibility of recall bias when defining disease exposure (Elwood,2019). Thus, there is the possibility of bias information from measuring housing aspects such as humidity, temperature, and lighting, which use Android applications. The absence of respondents (due to the difficulty in finding the addresses of respondents) might have affected the results of the study. Further research is required to investigate the mechanism of TB transmission in childhood.

## 5. Conclusions

TB is a major problem in Medan. Contact transmission is the most influential risk factor for tuberculosis. Strengthening contact-tracing programs by prioritizing contact tracing, community education, household intervention, and continuous surveillance should be considered to overcome childhood TB in Medan.

## Acknowledgments

The author thanks The Health Office of Medan City as a partner of this research, who assisted with the research process.

## Ethical considerations

This research was approved by the Research Ethics Committees of the Universitas Prima Indonesia (number 022/KEPK/UNPRI/IX/2022).

## Conflict of interest

The authors declare no conflicts of interest.

## Funding

The author thanks Universitas Sumatera Utara for providing research funding under Talenta research grant number 1705/UN5 1. R/RPM/2022.

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