



The Relationship Between Parents' Education Level and Contact History with the Incidence of Pulmonary Tuberculosis in Children in Medan City

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Abstract

Pulmonary tuberculosis (TB) in children remains a significant public health issue in Indonesia. Transmission generally occurs through direct exposure to adult TB patients, particularly via close contact within the household, and is influenced by family-related factors. This study aimed to evaluate the relationship between parental education level and contact history with the incidence of pulmonary TB in children. A

case-control design was employed, involving a total of 93 children as respondents—31 cases and 62 controls—selected from the working areas of 12 Community Health Centers (Puskesmas) in Medan City. Sampling was conducted using a total sampling method, and data were collected through a structured questionnaire. Bivariate analysis was performed using the Chi-square test. The results showed that a history of contact with pulmonary TB patients was the most influential factor associated with the incidence of TB in children. An odds ratio (OR) of 209.1 with a p-value of 0.001 indicates that children with a contact history had a 209-fold greater risk of developing pulmonary TB compared to those without such a history. These findings highlight the critical importance of strengthening contact tracing efforts and implementing TB Preventive Therapy (TPT) at the household level as strategic measures to reduce TB transmission among children.

keywords: Childhood tuberculosis, contact history, parental education, family characteristics

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Introduction

Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*, which spreads through the air—especially when someone with active TB coughs or sneezes. TB primarily affects the lungs (pulmonary TB), but it can also infect other organs or tissues (extrapulmonary TB). This disease can affect individuals of all ages, including both adults and children (Irianto, 2018).

Children—especially infants and toddlers—are among the most vulnerable groups to TB infection due to their underdeveloped immune systems. Key risk factors in children include a history of close contact with individuals with active TB (particularly within the household), weakened immunity (e.g., due to HIV/AIDS or malnutrition), densely populated living conditions, exposure to cigarette smoke, and limited access to health care services. TB in children can cause serious complications such as stunted growth from malnutrition, permanent organ damage, and even death if left untreated. Therefore, early detection and appropriate treatment are crucial to prevent long-term consequences (WHO, 2024).

Globally, TB remains one of the deadliest infectious diseases, with an estimated 10.8 million new cases annually. The majority of cases occur in men (55%), followed by women (33%) and children/adolescents (12%). The five countries with the highest TB burden are India (26%), Indonesia (10%), China and the Philippines (6.8% each), and Pakistan (6.3%). Children under the age of 15 account for approximately 11% of total cases, with over 1.15 million infected. The global TB mortality rate in children remains high, reaching 209,000 deaths—of which approximately 80% occur in children under five. Alarmingly, 96% of children who die from TB have not received any treatment, highlighting significant barriers to accessing health services (WHO, 2024).

In Indonesia, the number of deaths due to TB reached 87,531, with 361 new cases per 100,000 population reported in 2022—an increase from 354 cases in 2021 and 301 cases in 2020. The provinces with the highest number of cases include West Java (156,977 cases), East Java (130,683 cases), and Central Java (118,184 cases). By age group, the highest TB incidence is seen in those aged 25–34, followed by those aged 15–24, and children aged 5–14 years (Ministry of Health, Republic of Indonesia, 2024). These data indicate that TB remains a serious public health concern, particularly in densely populated areas and among the productive age group, and requires comprehensive, sustainable intervention.

In North Sumatra Province, 34,714 TB cases were reported in 2022—an increase from 19,147 cases in the previous year. Males (64.69%) were more affected than females (35.31%). Medan City had the highest number of cases (10,050), followed by Deli Serdang Regency (4,170) and Langkat Regency (1,927). Meanwhile, the lowest numbers were reported in Pakpak Bharat (117), West Nias (119), and North Nias (163) (North Sumatra Provincial Health Office, 2023).



The preliminary survey conducted in three sub-districts (Medan Deli, Medan Denai, and Medan Helvetia) showed that out of 30 respondents, 20% had not provided BCG immunization, 43.3% had incomes below the minimum wage, and 56.6% had a history of living in the same household with a person with TB. Based on these findings, this study was conducted to further examine the influence of family characteristics and contact history on the incidence of pulmonary TB in children in Medan City.

Furthermore, a history of household contact with a TB patient has been shown to significantly influence transmission in children. A study by Siregar, Andayani, and Sinaga (2019) revealed that 39.5% of children with a household contact history had positive tuberculin test results—compared to only 5.4% among those without such contact. This highlights the importance of early identification of at-risk children and the need for more proactive TB control programs.

Efforts to prevent TB in children can include BCG immunization, maintaining proper nutrition, avoiding exposure to TB patients, providing Tuberculosis Preventive Therapy (TPT) for children with known contact history, and maintaining a clean home environment with good ventilation and adequate sunlight (Ministry of Health, Republic of Indonesia, 2023). These strategies align with the third Sustainable Development Goal (SDG 3), which aims to ensure healthy lives and promote well-being for all ages, including reducing TB mortality and ending the global TB epidemic.

Methods

This study is a primary health care-based case-control study conducted in 12 community health centers in Medan City, namely: Amplas, Belawan, Bromo, Glugur Darat, Helvetia, Medan Area Selatan, Padang Bulan Selayang II, Sentosa Baru, Sering, Simalingkar, Simpang Limun, and Teladan. The selection of these locations was based on data from the Tuberculosis Information System (SITB), which showed that these centers are actively involved in recording and reporting cases of pulmonary tuberculosis in children. The study is scheduled to run from January 2025 until completion.

The study population comprised all children aged 0–14 years residing in Medan City who received treatment at the 12 designated community health centers. The case population included children diagnosed with pulmonary TB between January and April 2025, while the control population included children who were not diagnosed with pulmonary TB but received outpatient treatment at the same health centers during the same period.

The study sample included children who met the inclusion and exclusion criteria. The case group consisted of children aged 0–14 years diagnosed with pulmonary TB and treated at the selected community health centers between January and April 2025. The control group consisted



of children in the same age range who received outpatient care at the same centers but were not diagnosed with pulmonary TB during the study period.

Based on the sample size calculation, the control-to-case ratio was 2:1. Thus, the number of control subjects was $2 \times 31 = 62$, making the total number of study participants 93 children. Control subjects were selected using the consecutive sampling technique, whereby all eligible individuals were included sequentially during the data collection period until the required sample size was achieved. The sampling method used was non-probability sampling, incorporating both purposive and consecutive sampling techniques.

This study involved two types of variables. The independent variables were the parents' or caregivers' level of education and the child's history of contact with TB patients. The dependent variable was the incidence of pulmonary TB in children aged 0–14 years. Data were collected through interviews using a structured questionnaire that gathered information on parental education and contact history. Data analysis was conducted using bivariate analysis with the Chi-square test to assess the relationship between the independent and dependent variables.

Results

Univariate Analysis

Univariate analysis aims to provide an initial overview of the sample characteristics, including age distribution, gender, parental/caregiver education level, and contact history.

Table 1. Distribution of Case and Control Sample Characteristics in Childhood Pulmonary TB Incidence

Sample Characteristics	Case		Control	
	n=31	%	n=62	%
Age				
0 - ≤ 5 years	13	41.9%	32	51.6%
6 - ≤ 14 years	18	58.1%	30	48.4%
Gender				
Man	15	48.4%	32	51.6%
Woman	16	51.6%	30	48.4%
Contact History				
No	8	25.8%	61	98.4%
Yes	23	74.2%	1	1.6%



This study involved 93 respondents, consisting of 31 children with pulmonary TB (cases) and 62 children without pulmonary TB (controls). Based on age distribution, the majority of children in the case group were aged 6–14 years, accounting for 18 children (58.1%), while in the control group, most children were aged 0–5 years, totaling 32 children (51.6%).

Regarding gender, the distribution between boys and girls was relatively balanced in both groups. In the case group, there were 15 boys (48.4%) and 16 girls (51.6%), while the control group consisted of 32 boys (51.6%) and 30 girls (48.4%).

Table 2. Frequency Distribution of Contact History with TB Patients

Interaction Frequency	f	%
Every day	22	91.7%
Several times/week	2	8.3%
Total	24	100%

Based on the table above, 22 children (91.7%) were reported to have daily contact with TB patients. Additionally, 2 children (8.3%) reported having contact 1–3 times per week.

Family Characteristics of Case and Control Groups. The characteristics of the case and control families include the parental level of education.

Table 3. Distribution of Parental Education in the Incidence of Pulmonary Tuberculosis in Children

Variables	Case		Control		Total	
	N	%	n	%	n	%
Parental Education						
High	6	19.4%	24	38.7%	30	32.3%
Low	25	80.6%	38	61.3%	63	67.7%

A total of 25 children (80.6%) in the case group came from parents with low educational backgrounds, while 6 children (19.4%) came from parents with higher education. In the control group, 24 children (38.7%) had parents with higher education, and 38 children (61.3%) had parents with low educational backgrounds. Overall, 30 children (32.3%) had parents with higher education, while 63 children (67.7%) had parents with low education. This comparison indicates that children whose parents have low educational attainment are more commonly found in the case group.



Bivariate Analysis

Bivariate analysis in this study was conducted using the Chi-square test to examine the relationship between the independent variables (parental education and contact history) and the dependent variable (incidence of pulmonary TB in children).

Table 4. Relationship Between Parental Education and the Incidence of Pulmonary Tuberculosis in Children

Variables	Case		Control		<i>p-value</i>	OR	95% CI	
	n=31	%	n=62	%			Lower	Upper
Parental Education								
High	6	20.0%	24	80.0%	0.060	2,632	0.942	7,350
Low	25	39.7%	38	60.3%				

The cross-tabulation results showed that out of 63 children with parents who had a low level of education, 25 were pulmonary TB cases and 38 were controls. Meanwhile, among the 30 children with parents who had a higher level of education, only 6 were TB cases and 24 were controls. The chi-square test yielded a *p*-value of 0.060 (> 0.05), indicating that the result is not statistically significant. Nevertheless, children of parents with low educational backgrounds had a 2.63 times greater risk of developing pulmonary TB compared to those with highly educated parents (OR = 2.632; 95% CI = 0.942–7.350).

Table 5. Relationship Between Contact History and the Incidence of Pulmonary Tuberculosis in Children

Contact History	Case		Control		<i>p-value</i>	OR	95% CI	
	n=31	%	n=62	%			Lower	Upper
No	8	25,8	61	98,4	0.001	175,375	20,769	1480,867
Yes	23	74,2	1	1,6				

The bivariate analysis of contact history and the incidence of pulmonary TB in children showed that out of 24 children with a history of contact with a TB patient, 23 (74.2%) were TB cases, and only 1 child (1.6%) was a control. In contrast, among the 69 children with no history of contact, only 8 (25.8%) were cases and 61 (98.4%) were controls. The chi-square test produced a *p*-value of < 0.001 , indicating a highly significant association between contact history and the occurrence of pulmonary TB in children. Children with a history of contact with a pulmonary TB patient had a 175 times greater risk of developing TB compared to those without such contact (OR = 175.375; 95% CI = 20.769–1480.867).



Discussion

The Relationship Between Parental Education and the Incidence of Pulmonary TB in Children

Low parental education was associated with an odds ratio (OR) of 2.63 and a p-value of 0.060 based on bivariate analysis. Children of parents with low educational attainment had approximately 2.6 times higher risk of developing pulmonary tuberculosis compared to children of highly educated parents. However, this result was not statistically significant, as the p-value was greater than 0.05, although there was a trend suggesting an increased risk.

Low educational attainment is assumed to have an indirect effect mediated by other variables, such as a history of contact with TB patients, family income, and parents' occupation. Limited knowledge about TB transmission, delays in recognizing symptoms, and inadequate access to healthcare services may increase the risk of TB infection in children from families with low educational backgrounds.

Research by Fadila (2022) in Bekasi City supports this conclusion. In a multivariate logistic regression model, caregiver education had an OR of 1.17 (95% CI: 0.17–7.99; $p = 0.869$) and was excluded from the final model due to lack of significance. Education was not found to be an independent predictor of childhood TB after controlling for variables such as age, immunization status, and contact history.

Similarly, research by Wardani and Wahono (2021) showed that low education was a significant risk factor in bivariate analysis. Mothers with low education had a 3.477 times greater risk of having a child with TB compared to those with higher education (OR = 3.477; 95% CI: 1.654–7.308; $p = 0.001$). These findings support the hypothesis that low education increases vulnerability to childhood TB, especially in low socioeconomic settings.

A study by Rukmini et al. (2025) further reinforces this pattern. Logistic regression analysis revealed that heads of households with high school, junior high school, and elementary education had a higher risk of having children with TB compared to those with university-level education (aOR = 1.871, 1.644, and 1.377, respectively). The risk increased with decreasing education level, suggesting a consistent relationship between parental education and childhood TB incidence.

Although not statistically significant in the final model of this study, parental education remains a critical social determinant in childhood TB control. Education is conceptually linked to health behavior, access to health information, and treatment adherence. Thus, targeted educational interventions and health promotion strategies remain essential, especially for families with lower levels of education.



The Relationship Between Contact History and the Incidence of Pulmonary TB in Children

The bivariate analysis showed that a history of contact with a pulmonary TB patient was the most significant and consistent factor in explaining the incidence of TB in children. The odds ratio (OR) was 209.1 ($p < 0.001$), indicating that children with a history of contact were 209 times more likely to develop pulmonary TB compared to those without such a history.

Epidemiologically, this finding is expected, as TB is transmitted through airborne droplets, and children are particularly vulnerable due to close, prolonged exposure—especially in crowded households with poor ventilation. Therefore, close household contact with a TB-positive individual is a key risk factor for childhood transmission.

This result aligns with previous studies. For example, Pasqualini et al. (2023) found that a history of close contact with a TB patient significantly increased the risk of active TB in children (aOR = 15.81; 95% CI: 5.29–47.22; $p < 0.001$). Similarly, Noor Atika Azit et al. (2021) in Malaysia reported that children with household exposure had very high odds of developing TB, particularly those under 5 years (aOR = 9.48; 95% CI: 3.41–26.36), with positive tuberculin tests (aOR = 395.73; 95% CI: 134.17–1167.13), and exposure duration exceeding 6 weeks (aOR = 7.48; 95% CI: 2.88–19.43).

In Finland, Kontturi et al. (2021) found that children born in TB-endemic countries had an elevated TB risk (aOR = 3.07; 95% CI: 1.10–8.57), and those with household contact with a smear-positive index case had a significantly increased risk (aOR = 2.96; 95% CI: 1.33–6.58). Likewise, Burusie et al. (2023) in Ethiopia reported that children living with a family member with TB had a markedly higher risk of developing the disease (mOR_{adj} = 4.28; 95% CI: 1.95–9.39). These findings, in agreement with the current study, confirm that contact history is the strongest determinant of childhood TB incidence and remains significant even after adjusting for other sociodemographic factors.

Conclusion

Based on the results of a study conducted on 93 children in the working areas of 12 Community Health Centers in Medan City, which examined the influence of family characteristics, BCG immunization, and contact history on the incidence of pulmonary tuberculosis in children, the following conclusions can be drawn: the analysis of child characteristics by age showed that the 6–14-year age group was more commonly found in the case group compared to the 0–5-year age group. Gender distribution was nearly equal between boys and girls in both the case and control groups. The results of the bivariate analysis revealed that a history of contact with TB patients had a significant relationship with the incidence of pulmonary tuberculosis in children.



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