Risk Factors for the Home Physical Environment and the Incidence of Childhood Tuberculosis

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Abstract

Risk factors for tuberculosis in children include lack of nutrition, HIV infection, poverty, cigarette smoke exposure, and close contact with infected individuals. Children's immune systems are less developed, making them more susceptible and causing severe complications. This study uses cross-sectional research to analyze secondary data from Indonesia's 2018 Basic Health Research study. The sample consisted of 110.465 children aged 0–14, selected randomly or based on criteria. The study used univariate analysis and chi-square bivariate analysis to determine the relationship between variables and the incidence of tuberculosis in children. Further analyses were conducted in May–June 2024 using JASP version 16.The study revealed a significant association between lighting conditions and TB incidence, with 119 cases in well-lit master bedrooms and 51 in poorly lit bedrooms. Kitchen windows also played a role. However, the study concluded that the association could be due to chance, with no strong association between adequate living room lighting and TB incidence.The study found no significant association between lighting or ventilation conditions in different house areas and tuberculosis (TB) incidence. Although slight variations were observed, these were likely due to chance. The prevalence ratios also showed no strong association between adequate lighting or ventilation and TB incidence. Public health initiatives should focus on improving housing infrastructure, ventilation, and hygiene to mitigate environmental risk factors. Further research is recommended to explore socioeconomic and geographical variations influencing TB incidence in children.

Keyword: Children, Environment, Home, Tubeculosis

INTRODUCTION

The list of the 20 leading causes of death worldwide includes TB as the second-leading cause of death after HIV/AIDS. Indonesia has the world's third-highest number of TB patients. In 2020, an estimated 9.9 million people were affected by TB globally (World Health Organization, 2020). In 2021, an estimated 10.6 million (95% confidence interval 9.9–11 million) people had TB worldwide, of whom 6.0 million were men, 3.4 million were women, and 1.2 million were children (World Health Organization, 2022). In 2021, the number of tuberculosis cases found was 19,147, an increase compared to the number of tuberculosis cases found in 2020, which was 17,303. The age group of 45–54 years had the highest number of TB cases, accounting for 17.5% of the total. Meanwhile, TB in children accounted for 9.7% of cases (World Health Organization, 2022).

Risk factors for tuberculosis (TB) in children include several things, such as lack of nutritional intake, HIV infection, living in poverty, exposure to cigarette smoke, and having close contact with people infected with TB (Pangaribuan et al., 2020); (Alene, 2020). Children who live in areas with a high prevalence of TB, have a history of TB infection and have weakened immune systems are also at higher risk of developing TB (Lestari et al., 2021); (Jain, 2020). However, having TB-infected adults around them, especially in the family environment, is the leading risk factor (Mone et al., 2023).

The bacterium Mycobacterium tuberculosis causes the infectious disease tuberculosis (TB). The disease commonly affects the lungs but can also affect other body parts, such as the kidneys, bones and brain. TB can infect anyone, although it mostly affects people with weakened immune systems (Zimmer, 2022); (Ramadhan, 2021). However, it's important to note that children, with their developing immune systems, are particularly vulnerable to TB disease. When infected with TB bacteria, children can experience symptoms such as prolonged coughing, loss of appetite, and weight loss. However, TB symptoms in children are often difficult to detect because they are similar to those of other diseases (CDC, 2021); (Nezenega, 2020).

The problem of TB in children is more prominent than TB in adults because TB in children can cause more severe complications and is more difficult to diagnose compared to adults. Furthermore, children are susceptible to TB infection because their immune systems are still developing and less powerful to fight off infection. If children do not receive prompt diagnosis and treatment for TB, it can result in permanent damage to organs like the lungs, brain, and spine (Sherman, 2023). Although adults are more likely to suffer from TB than children, childhood TB remains a significant problem because it can affect a child's quality of life and future (WHO, 2022).

Based on the explanation above, it is crucial to continue investigating the determinants of tuberculosis incidence in Indonesian children. We aim to prevent and overcome these factors. This study examined the following risk factors: age, gender, a history of asthma, nutritional status, exposure to cigarette smoke, living environment, ventilation, windows, and lighting. Further research in these areas is essential to develop effective prevention and treatment strategies.

According to research Pangaribuan et al., (2020), the incidence of TB in participants aged 15 years and above is influenced by various factors such as age, gender, region of residence, education, and region, in addition to other factors, such as smoking habits. Tuberculosis incidence is also influenced by income level, occupancy density, and the type of floor of the

patient's house. the type of floor of the house is not at risk, namely the type of floor of the house that meets the requirements of a healthy house (Harahap et al., 2017).

Homes that are unable to defend their occupants from air humidity increase the chances of suffering from various diseases including infectious diseases, as do crowded and isolated home environments. Homes that are not in crowded or isolated environments are more likely to be protected from diseases such as mental disorders, recovery from wheziing within three months, recovery from influenza, and coughing with phlegm in the morning, especially in adults (WHO, 2018).

METHODS

This study is a quantitative analytical study employing a cross-sectional design. Cross-sectional research is a type of observational study that collects data at a single point in time to determine the relationship between the independent and dependent variables. The study was conducted in Indonesia using data from the 2018 Basic Health Research (Riskesdas), a comprehensive national survey conducted across all provinces. Further data analysis and refinement were carried out from May to June 2024. The purpose of this article is to explore and identify the most dominant risk factors for tuberculosis (TB) incidence in children based on previously collected Riskesdas data. The population for this study included all children aged 0–14 years who participated in the 2018 Riskesdas survey, totaling 303,507 individuals. The sample used in this study consisted of all respondents who met the inclusion and exclusion criteria. The inclusion criteria included children aged 0–14 years whose households participated in the Riskesdas survey and who had complete data for the variables analyzed. Exclusion criteria involved missing or incomplete data and respondents outside the specified age group. After data cleaning, the final sample consisted of 110,465 children.

The study used secondary data from the 2018 Riskesdas survey, which has undergone prior ethical approval. Ethical clearance for the use of Riskesdas data was obtained through the Ethics Commission of the Ministry of Health, providing assurance of the research's compliance with ethical standards. The data analysis procedures included univariate analysis to determine the frequency distribution of variables, bivariate chi-square analysis to identify significant relationships between variables.

All data processing and analysis were conducted using JASP version 16. The research adhered to strict ethical protocols, including obtaining informed consent from participants during the Riskesdas survey. The study instruments included standardized and validated questionnaires used in Riskesdas, which ensured the reliability and accuracy of the collected

data. Data were presented in tables and descriptive summaries, highlighting key findings and their relevance to TB prevention and control strategies.

RESULTS

Table 1 Distribution of Tuberculosis Incidence Based on Home Physical Environment

Variable	Incidence of TB				Total	
	Yes		No			
	n	%	n	%	N	%
Lighting in Bedroom						
Enough	119	0,1	82170	74,4	82289	74,5
Not enough	51	0,1	28125	25,5	28176	25,5
Total	**170**	**0,2**	**110.295**	**99,9**	**110.465**	**100**
Cook/kitchen/Windows						
Yes, opened every day	74	0,1	55643	50,4	55717	50,4
Existing, rarely opened	45	0,0	20331	18,4	20376	18.4
None	51	0,0	34321	31,1	34372	31,1
Total	**170**	**0,1**	**110.295**	**99,9**	**110.465**	**100**
Cook/kitchen/Ventilation						
Existing, area >=10% of floor area	77	0,1	50817	46.0	50894	46.0
Existing, area <10% of floor area	65	0,1	36906	33.4	36971	33.5
None	28	0,0	22572	20.4	22600	20.5
Total	**170**	**0,2**	**110.295**	**99,8**	**110.465**	**100.0**
Cooking/Kitchen/Lighting						
Enough	119	0,1	78774	71.3	78893	71.4
Not Enough	51	0,0	31521	28.5	31572	28.6
Total	**170**	**0,1**	**110.295**	**99,9**	**110.465**	**100**
Living Room/Windows						
Yes, opened every day	92	0,1	64879	58.7	64971	58.8
Existing, rarely opened	62	0,1	28649	25.9	28711	26.0
Not available	16	0,0	16767	15.2	16783	15.2
Total	**170**	**0,2**	**110.295**	**99,8**	**110.465**	**100.0**
Living Room/Ventilation						
Existing, area >=10% of floor area	103	0,1	61931	56.1	62034	56.2
Existing, area <10% of floor area	51	0,0	32525	29.4	32576	29.5
Not available	16	0,0	15839	14.3	15855	14.4
Total	**170**	**0,1**	**110.295**	**99,8**	**110.465**	**100.0**
Living room Lighting						
Enough	138	0,1	86882	78.7	87020	78.8
Not enough	32	0,0	23413	21.2	23445	21.2
Total	**170**	**0,1**	**110.295**	**99,9**	**110.465**	**100**

A The results of the study revealed the distribution of tuberculosis (TB) incidence based on physical environmental factors in the house. In bedroom lighting conditions, the majority of cases occurred in bedrooms with adequate lighting, with 119 cases (0.1%) out of a total of 82,289 individuals (74.5%). Bedrooms with inadequate lighting had 51 cases (0.1%) out of a

total of 28,176 individuals (25.5%). A P value greater than 0.001 indicated that this difference was not statistically significant.

Kitchen window conditions show that homes where kitchen windows were opened daily had the highest number of TB cases, with 74 cases (0.1%) out of 55,717 individuals (50.4%). Homes with no windows recorded 51 cases (0.0%) out of 34,372 individuals (31.1%). A P value of less than 0.001 indicates that this difference is statistically significant.

Ventilation in the kitchen revealed that homes with ventilation occupying at least 10% of the floor area had the highest proportion of TB cases, with 77 cases (0.1%) out of 50,894 individuals (46.0%). Homes with no ventilation reported the fewest cases, with 28 cases (0.0%) out of 22.600 individuals (20.5%). A P value greater than 0.001 indicates that the difference in TB incidence based on kitchen ventilation conditions was not statistically significant.

Kitchen lighting conditions demonstrated that homes with sufficient lighting had the highest TB cases, with 119 cases (0.1%) out of 78,893 individuals (71.4%). Insufficient lighting in kitchens was associated with 51 cases (0.0%) out of 31,572 individuals (28.6%). A P value greater than 0.001 indicates that the difference in TB incidence based on kitchen lighting conditions was not statistically significant. The prevalence ratio (PR) 934 with a 95% confidence interval (CI) between 673 and 1,296 indicates no strong association between adequate kitchen lighting and TB incidence.

Living room window conditions indicated that homes with windows opened daily had the most TB cases, with 92 cases (0.1%) out of 64,971 individuals (58.8%). Homes without windows in the living room had the fewest cases, with 16 cases (0.0%) out of 16,783 individuals (15.2%). A P value greater than 0.001 indicates that the difference in TB incidence based on the presence and frequency of window openings in living rooms was not statistically significant.

Ventilation in living rooms showed that homes with ventilation covering at least 10% of the floor area had the highest number of TB cases, with 103 cases (0.1%) out of 62,034 individuals (56.2%). Homes without ventilation had the lowest, with 16 cases (0.0%) out of 15,855 individuals (14.4%). Value P greater than 0.001 indicates that the difference in TB incidence based on ventilation conditions in living rooms was not statistically significant.

Living room lighting conditions demonstrated that homes with sufficient lighting recorded the highest number of TB cases, with 138 cases (0.1%) out of 87,020 individuals (78.8%). Insufficient lighting in living rooms was associated with 32 cases (0.0%) out of 23,445 individuals (21.2%). The prevalence ratio (PR) of 1.162 with a 95% confidence interval (CI) between 791 and 1.706 indicates no strong association between adequate living room

lighting and TB incidence. A PR of 1 would indicate no association, while a PR greater than 1 would indicate a positive association.

DISCUSSION

Pulmonary tuberculosis (TB) is a serious public health issue, particularly in developing countries, with children being a vulnerable group. Home physical environmental conditions, such as ventilation, lighting, occupancy density, humidity, and temperature, can affect children's health and their risk of developing TB (Siregar, 2018). Studies have shown that several home physical environmental factors are associated with an increased incidence of pulmonary TB in children.

Poor ventilation, high housing density, and poor home hygiene are all factors that increase the risk of Mycobacterium tuberculosis transmission (Nurany, 2023). Research has shown that good ventilation can significantly reduce the risk of TB transmission. High housing density also increases the risk of TB transmission in children living in houses with many occupants in a small space (Honorio, 2023). Poor hygiene can increase children's exposure to various infections, including TB. Poor water quality and sanitation in the home can contribute to general poor health, which in turn can increase susceptibility to TB (Perez-Padilla, 2010). Limited access to clean water and adequate sanitation facilities can worsen children's health conditions, making them more susceptible to TB infection (Dewi et al., 2018).

The study reveals that lighting conditions in master bedrooms significantly influence the incidence of Tuberculosis (TB) in children. Well-lit master bedrooms have 119 TB cases, while poorly lit bedrooms have 51 TB cases. The prevalence ratio of TB incidence in houses with sufficient lighting was 799, with a P value greater than 0.001 indicating no statistically significant difference. Lighting conditions in master bedrooms, particularly from direct sunlight, can reduce the presence of Mycobacterium tuberculosis in the indoor environment due to its antibacterial and antiviral properties (Nurjana, 2019). Bright master bedrooms are generally associated with good ventilation, which can reduce humidity levels and help reduce the spread of airborne TB bacteria (Haryanik, 2023). Studies have shown that good ventilation can influence the risk of TB transmission indoors. Improving lighting conditions in master bedrooms not only improves the quality of the physical environment of the home but also potentially improves children's immune conditions, which can help in the prevention of pulmonary TB disease (Bhargava, 2023).

Tuberculosis remains a significant global health problem, especially in low- and middle-income countries. Environmental conditions within the home, including ventilation,

lighting, hygiene, and other household infrastructure, are closely linked to the spread of TB (Siregar, 2023); (Ekawati, 2022). Focusing on window conditions in the kitchen allows us to understand how this aspect affects the risk of pulmonary TB disease transmission and severity, particularly among children and other vulnerable populations (Noviansyah, 2021) .

Improving the physical environment of the home is an important step in preventing childhood pulmonary TB. Efforts to improve ventilation, reduce overcrowding, keep homes clean, and ensure access to clean water and proper sanitation can help reduce the risk of pulmonary TB in children (Siregar, 2021); (Chen, 2020). The distribution of Tuberculosis (TB) incidence in kitchens is influenced by the condition of windows. Homes with daily open windows have a lower incidence of TB, while homes with rarely opened windows have higher rates. Poor ventilation or closed windows are associated with higher TB transmission rates, especially in areas with high TB prevalence (Bunga, 2022).

Good ventilation and air circulation in kitchen spaces are crucial for reducing TB transmission. Regularly opened windows increase airflow, reduce humidity, and reduce the concentration of TB bacteria in indoor air (Zuidah, 2021). Poor hygiene also contributes to TB risk, as poor hygiene can create an ideal environment for pathogenic bacteria growth. Improving household infrastructure to ensure proper ventilation and adequate windows is essential for TB prevention strategies (Inayah, Samhatul, Wahyono, 2019).

Socioeconomic factors also play a role in the distribution of TB based on window conditions. Households with limited access to economic resources often face challenges in improving their household infrastructure, such as repairing broken windows or installing additional ventilation (Haryanik, 2023). From a public health perspective, adopting a holistic approach to TB prevention based on window conditions in kitchen homes is essential. Intervention measures should include community education on proper ventilation, regular window opening, and technical assistance to repair or replace damaged windows (Yang, 2020). Public policies that facilitate community access to resources and infrastructure are also necessary. Further research is needed to better understand the relationship between window conditions and TB incidence in different geographic and socioeconomic contexts.

CONCLUSIONS

There was no significant association between lighting or ventilation conditions in different areas of the house (bedroom, kitchen, and living room) and tuberculosis (TB) incidence. Although there were slight variations in the number of TB cases in houses with different lighting or ventilation, the statistical results (P value greater than 0.001) indicated that

these differences were not statistically significant, meaning that the observed variations were likely to have occurred by chance. In addition, the reported prevalence ratios (PRs) with wide confidence intervals support that there is no strong association between adequate lighting or ventilation and TB incidence. Lighting and ventilation factors in the home did not directly impact TB incidence in the population studied.

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