Relationship Between Risk Factors and The Incidence of Primary and Post Primary Tuberculosis

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Abstract.

Tuberculosis (TB) remains a significant global health problem, with Indonesia ranking second in the world for the highest number of cases. This study aims to analyze the relationship between various risk factors and the incidence of primary and post-primary tuberculosis in the Merdeka Public Health Center working area in 2025.Based on preliminary data, there are 122 TB patients in the region diagnosed using the Molecular Rapid Test (TCM). Identified risk factors include host factors such as male gender, productive age (15–64 years), low education, and low economic status. Additionally, home environmental factors play a crucial role in increasing transmission risk, including inadequate residential density (<9m²/person), poor ventilation, lack of natural lighting, and suboptimal air humidity. Negative preventive behaviors and exposure to cigarette smoke are also significant contributors to the incidence of the disease.Mitigation efforts require comprehensive interventions. These must focus not only on medical treatment but also on improving residential environmental conditions and educating the community on healthy behaviors.

Keywords: *Pulmonary Tuberculosis; Environmental Risk Factors; Residential Density; Merdeka Public Health Center and Mycobacterium tuberculosis.*

I. INTRODUCTION

Tuberculosis (TB) remains a significant global health challenge characterized by high morbidity and mortality rates. This infectious disease, caused by the bacterium Mycobacterium tuberculosis, primarily spreads through the air when an active patient expels droplet nuclei. These bacilli not only attack the lung parenchyma but can also spread hematogenously or through the lymphatic system to various other organs. According to the World Health Organization (WHO) 2023 report, there were approximately 8.2 million newly diagnosed TB cases worldwide, with an incidence rate of 134 cases per 100,000 population. Currently, Indonesia ranks second globally in TB burden, trailing only India. Data indicates a concerning upward trend in Indonesia, with an estimated 1,060,000 new cases and an annual mortality rate of 134,000 deaths.Similar challenges are observed at the local level in regions such as Bogor City. The Bogor City Health Office recorded a prevalence of 11,772 TB cases in 2024. While case detection rates are relatively high, they are not yet aligned with treatment success, which reached only 80 percent in 2023. This figure remains below the national target of 90 percent. Furthermore, the emergence of Drug-Resistant Tuberculosis (DR-TB) and a high number of pediatric infections complicate disease management efforts. In 2025, the Merdeka Public Health Center recorded 122 pulmonary TB patients, underscoring the urgent need for serious management. To improve diagnostic accuracy, advanced tools such as the Xpert MTB/RIF Molecular Rapid Test have been implemented to simultaneously detect the presence of M. tuberculosis and resistance to rifampicin.

The incidence of pulmonary TB is influenced by a complex interaction between agent, host, and environmental factors. Regarding host factors, the productive age group (15 to 64 years) and males show a higher proportion of cases due to high mobility and increased environmental exposure. Socioeconomic factors, including low education levels and poor economic status, further limit access to health information and medical services. Additionally, the residential environment plays a vital role in disease transmission. High residential density, suboptimal indoor temperatures, and a lack of natural lighting create micro-

environments that support the survival of TB bacilli.Previous multivariate analyses indicate that inadequate indoor humidity can increase the risk of infection by 2.89 times. Furthermore, insufficient natural lighting shows a very strong correlation with disease incidence, increasing the risk dozens of times over. Beyond physical housing conditions, negative preventive behaviors and poor nutritional status weaken the host's immune system, facilitating the progression from latent infection to active disease. Comorbidities such as Diabetes Mellitus and HIV further exacerbate the pathophysiology by impairing macrophage function. Therefore, a deep understanding of environmental determinants and patient demographic characteristics is essential for designing effective intervention strategies. This study aims to analyze the dominant variables contributing to pulmonary TB incidence to systematically reduce transmission rates and improve therapeutic success.

II. METHODS

This study utilizes an observational analytic design with a cross-sectional approach to identify risk factors for primary and secondary TB at the Merdeka Community Health Center (Puskesmas Merdeka), Bogor City. The study was conducted over two months, from December 2025 to January 2026. The research population includes all TB patients who have undergone treatment at this location, totaling 50 individuals. Sampling was conducted using total sampling, involving 50 respondents who met the inclusion and exclusion criteria. Inclusion criteria consist of primary or secondary TB patients willing to participate as respondents. Conversely, patients categorized with MDR-TB, XDR-TB, and extrapulmonary TB were excluded from the study sample. The research instrument used is a digital questionnaire via Google Forms.

This instrument includes an informed consent form, personal data, and a list of questions regarding risk factors. Data collected consist of primary data through questionnaires and secondary data obtained from medical records or the health center’s website. The research workflow began with faculty supervision, instrument design, and validity and reliability testing. The researcher then identified respondents, established initial contact, and sought informed consent before data collection. Collected data were processed through editing, coding, scoring, entry, and cleaning stages. Statistical data analysis was performed using SPSS version 24.0 software. Univariate analysis was used to describe the frequency distribution of each variable, while bivariate analysis was applied to test the relationship between risk factors and the incidence of primary and secondary TB in the region.

III. RESULT AND DISCUSSION

Overview of Primary and Secondary TB Patients

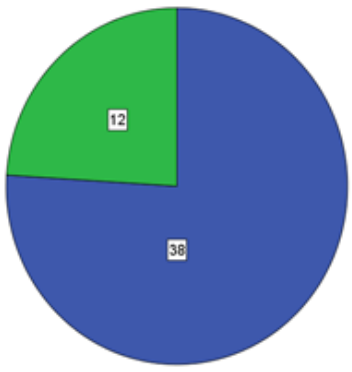

Fig 1. Primary and Secondary TB Patients

Patient Age

Table 2. Patient Age

TB	Total	Percentage
< 25 years old	13	26%
25-50 years old	26	52%
Total	50	100%

Research findings show that most TB patients fall within the 25–50 year age group (52%). This indicates that the productive age group is at the highest risk for TB incidence in the Merdeka Community Health Center work area. These findings align with research by Manullang et al. (2025), which states that the productive age group has a higher risk of exposure to Mycobacterium tuberculosis due to high mobility and social interaction. WHO also reports that the global TB incidence is most frequently found in the productive age group because of high outdoor activity levels and repeated environmental exposure.

Gender

Table 3. Gender

Gender	Frequency (n)	Percentage (%)
Male	27	54%
Female	23	46%
Total	50	100%

Research findings indicate that TB patients are predominantly male (54%) compared to females, with a statistically significant relationship (p = 0.000). This result aligns with a study by Haddase et al. (2024), which states that men have a higher risk of suffering from pulmonary TB than women. This difference is attributed to behavioral factors such as smoking habits, outdoor activities, and exposure to unhealthy work environments, which are more frequently found in men.

IMT

Tabel 4. IMT

BMI Category	Primary TB n (%)	Secondary TB n (%)	Total n
Underweight	7 (14%)	4 (8%)	11
Normal	31 (62%)	8 (16%)	39
Total	38 (76%)	12 (24%)	50

Based on the research results, most TB patient respondents have a normal BMI, indicating that TB incidence is not only found in individuals with poor nutritional status. Nevertheless, statistical analysis shows no significant relationship between BMI and TB incidence (p > 0.05).This finding is consistent with research by Pralambang and Setiawan (2021), which states that TB can occur in individuals with normal nutritional status because other factors, such as germ exposure, environmental conditions, and comorbidities, play a more significant role. A study by Akbar et al. (2022) also explains that while nutritional status affects the immune system, a normal BMI does not fully protect someone from the risk of Mycobacterium tuberculosis infection.

Educational Background

Table 5. Educational Background

Educational Background	TB	(%)	*p-value*
Did not graduate High School	14	28%	
High School Graduate	25	50%	**0,000**
Bachelor's Degree	11	22%	
Total	50	100%	

The results show that the largest group of TB patients did not graduate from high school (28%), and there is a significant relationship between education level and TB incidence (p = 0.000).This result is in line with research by Darmin et al. (2018), which shows that low education levels are significantly associated with the incidence of pulmonary TB. Low education is linked to limited knowledge regarding TB prevention, low awareness of clean and healthy living behaviors, and delays in seeking healthcare services.

Diabetes Mellitus

Tabel 6. Diabetes Melitus

DM	TBC		Total	*p-value*	95% CI	PR
	Primary TB	Secondary TB				
Yes	34	4	38	**0,014**	**1,294-28,494**	**6,071**
No	7	5	12			
Total	41	9	50			

Bivariate analysis shows that respondents with diabetes mellitus have a 6.071 times greater risk of experiencing TB compared to respondents without diabetes, with a statistically significant relationship (p = 0.014).Diabetes mellitus is known to impair immune system function, specifically macrophage and lymphocyte activity, thereby increasing the risk of developing active TB. This aligns with a study by Suwirda et al. (2025), stating that diabetes mellitus patients have a higher susceptibility to pulmonary TB infection compared to individuals without diabetes.

Active and Passive Smokers

Table 7. Active and Passive Smokers

Active Smoker	TBC		Total	*p-value*	95% CI	PR
	Primary TB	Secondary TB				
Ya	26(68,4%)	4(33,3%)	30	**0,031**	**1,089-17,250**	**4,333**
Tidak	12(31,6%)	8(66,7%)	20			
Total	38	12	50			

Passive Smoker	TBC		Total	*p-value*	95% CI	PR
	Primary TB	Secondary TB				
Yes	28	4	32	**0,011**	**1,380-22,724**	**5,6**
No	10	8	18			
Total	38	12	50			

The research shows that active smokers have a 4.333 times greater risk of experiencing TB (p = 0.031), while passive smokers have a 5.6 times greater risk (p = 0.011).These findings align with research by Tandang et al. (2018), which states that there is a significant relationship between smoking habits and the incidence of pulmonary TB. Exposure to cigarette smoke can damage respiratory defense mechanisms and lower local lung immunity, facilitating Mycobacterium tuberculosis infection.

Household Density

Table 8. Household Density

Household Density	TBC		Total	*p-value*	95% CI	PR
	Primary TB	Secondary TB				
Crowded	31	5	36	**0,007**	**1,513-25,410**	**6,2**
Not Crowded	7	7	14			
Total	38	12	50			

The research results show a significant relationship between occupancy density and the incidence of pulmonary tuberculosis (p = 0.007). Respondents living in high-density houses have a greater risk of contracting TB. Housing conditions with many occupants in limited space increase the chances of close contact between infected individuals and healthy ones, facilitating the spread of Mycobacterium tuberculosis through airborne droplets.This finding is consistent with a recent study by Wahyuni et al. (2023), which found that high household density is significantly related to pulmonary TB incidence in Indonesian urban areas due to poor air exchange and more frequent interpersonal contact.

Ventilation Area

Table 9. Ventilation Area

Ventilation Size	TBC		Total	*p-value*	95% CI	PR
	Primary TB	Secondary TB				
<800 cm^2	31	6	37	**0,03**	**1,095-17,915**	**4,429**
>800 cm^2	7	6	13			
Total	38	12	50			

Analysis shows that house ventilation sizes that do not meet standards are significantly associated with the incidence of pulmonary TB (p = 0.03). Insufficient ventilation causes poor air exchange, increasing the concentration of airborne droplets containing TB germs and facilitating the transmission process.This finding aligns with a recent study by Ramadhan & Sari (2024), which states that good house ventilation significantly reduces the risk of pulmonary TB infection by ensuring smoother airflow and reducing the accumulation of TB droplets in closed spaces.

Window Area

Table 10. Window Area

Window Size	TBC		Total	*p-value*	95% CI	PR
	Primary TB	Secondary TB				
<5000 cm^2	23	3	26	**0,032**	**1,069-19,799**	**4,6**
>5000 cm^2	15	9	24			
Total	38	12	50			

Research results also indicate that substandard window sizes are related to TB incidence. Narrow windows inhibit the entry of air and sunlight, creating a damp environment that supports the survival of Mycobacterium tuberculosis bacteria.This is consistent with the latest research by Nugraha et al. (2023), which found that inadequate window size is associated with an increase in household pulmonary TB cases due to lack of air circulation and natural ultraviolet light exposure that helps inactivate the bacteria.

Lighting

Table 11. Lighting

Lighting Category	Primary TB	Secondary TB	Total
Poor	25	4	29
Good	13	8	21
Total	38	12	50

Research results show that poor lighting inside the house is associated with the incidence of pulmonary TB. Lack of sufficient sunlight exposure makes it easier for Mycobacterium tuberculosis bacteria to survive in the home environment because natural ultraviolet rays, which play a role in killing germs, are not optimal.This finding matches recent research by Prasetyo & Utami (2024), stating that houses with poor natural lighting have a higher risk of pulmonary TB incidence due to the minimal amount of sunlight entering the rooms.

IV. CONCLUSION

1. Characteristics of TB patients at the Merdeka Community Health Center in 2025 show that most patients are within the productive age group, are male, and have low education levels. They live in houses with substandard environmental conditions, are exposed to active or passive smoking at home, and some have diabetes mellitus as a comorbidity. Additionally, the majority maintain a normal nutritional status.
2. The distribution of TB cases at the Merdeka Community Health Center in 2025 includes both primary and secondary pulmonary TB cases, with primary pulmonary TB cases being more prevalent than secondary cases.
3. The education level of TB patients has a significant relationship with the incidence of pulmonary TB at the Merdeka Community Health Center in 2025, where lower education levels correlate with an increase in TB cases.
4. Household environmental conditions, including occupancy density, ventilation size, and window size, have a significant relationship with the incidence of pulmonary TB at the Merdeka Community Health Center in 2025.
5. Smoking status, including both active and passive smokers, has a significant relationship with the incidence of pulmonary TB at the Merdeka Community Health Center in 2025.
6. Diabetes mellitus has a significant relationship with the incidence of pulmonary TB at the Merdeka Community Health Center in 2025, with diabetes patients showing a higher risk of developing TB.
7. Nutritional status based on Body Mass Index (BMI) shows no significant relationship with the incidence of pulmonary TB at the Merdeka Community Health Center in 2025, as the majority of TB patients possess a normal nutritional status.

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