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FACTORS ASSOCIATED WITH PULMONARY TUBERCULOSIS INCIDENCE IN THE WORKING AREA OF TAMBANG ULANG PUBLIC HEALTH CENTER

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ABSTRACT

Factors Associated With Pulmonary Tuberculosis Incidence In The Working Area Of Tambang Ulang Public Health Center. *Tuberculosis (TB) remains a significant public health concern in Indonesia and worldwide. It is caused by Mycobacterium tuberculosis, an acid-fast bacillus transmitted through airborne droplets. This study aimed to analyze the factors associated with the incidence of pulmonary TB in the working area of Puskesmas Tambang Ulang. An observational analytic study with a case-control design was conducted. A total of 45 respondents were selected using purposive sampling, consisting of 15 cases and 30 controls. Data were analyzed using the Chi-Square test and Odds Ratio (OR) calculations. The results showed significant associations between pulmonary TB incidence and several factors: ventilation (p = 0.002; OR = 9.333), occupancy density (p = 0.003; OR = 9.750), humidity (p = 0.003; OR = 8.000), temperature (p = 0.001; OR = 11.000), physical contact (p = 0.006; OR = 6.417), and smoking habits (p = 0.001; OR = 11.000). These findings indicate that both environmental conditions and personal behaviors contribute to the risk of TB transmission. It is recommended that communities adopt preventive behaviors such as regularly opening windows for ventilation, avoiding physical contact with TB patients, and reducing smoking habits. These efforts are expected to support health promotion strategies and serve as a basis for targeted TB prevention programs in the community.*

INTRODUCTION

Tuberculosis (TB) is a chronic infectious disease caused by infection with the bacterium Mycobacterium tuberculosis. This disease remains an unresolved global public health issue. According to the 2021 Global Tuberculosis Report by the WHO, there were approximately 9.9 million new TB cases worldwide [1,2], with Indonesia ranking third after India and China as the country with the highest number of TB cases [3–5]. At the national level, the 2018 Basic Health Research (Riskesdas) data recorded around 1,017,290 TB cases [6]. Meanwhile, data from the Indonesian Ministry of Health indicated that the number of TB cases in Indonesia increased from 351,936 cases in 2020 to 397,377 cases in 2021 [7]. These figures demonstrate that Indonesia continues to face a high epidemiological burden in controlling TB.

Tuberculosis is transmitted through droplets expelled by infected individuals when coughing, sneezing, or talking [8,9]. Mycobacterium tuberculosis is an acid-fast bacillus, either straight or slightly curved, with a microscopic size of 0.2–0.4 x 1.4 microns. The bacteria can survive in sputum droplets for 8–10 days and can be destroyed by direct sunlight within approximately 2 hours [10–15]. TB infection can affect anyone, regardless of age, gender, or socioeconomic

status, and can develop into a chronic disease with serious complications if not treated properly. Due to its rapid transmission, particularly in poorly ventilated environments, TB is heavily influenced by housing conditions and individual behavior.

Various studies have shown that TB incidence is influenced by a combination of individual and environmental factors. Individual factors include age, gender, nutritional status, education level, smoking habits, and physical contact history with TB patients [16–20]. Environmental factors include ventilation area, housing density, room temperature and humidity, lighting, and type of flooring or wall materials (Budi, Raharjo, et al., 2024; Jannah et al., 2023; Kapoor et al., 2016; Lestari Muslimah, 2019; Marni et al., 2024; Muhammad et al., 2020; Naolin et al., 2024; Pratiwi & Pramono, 2020; Sulidah et al., 2024; Wardani & Wahono, 2019; Zaenab et al., 2025). A study by Oktavia et al. (2016) found that non-standard ventilation increases the risk of TB by up to 27 times. Furthermore, close contact within the same household increases the risk of pulmonary TB transmission by 4.7 times, overcrowded housing by 4.3 times, flooring type by 16.7 times, nutritional status by 17.6 times, and age by 3.9 times, indicating that close household contact is strongly correlated with new TB infections among family members. Another study by Damayanti et al. (2018) revealed that high indoor humidity also contributes to an increased TB risk with an odds ratio (OR) greater than 5 [33].

Smoking behavior has also been identified as a significant risk factor. According to the Indonesian Ministry of Health Regulation (Permenkes) of 2016, smoking increases the risk of developing pulmonary TB by 2.4 times compared to non-smokers [34]. Smoking not only weakens the respiratory immune system but also slows recovery and increases the risk of relapse. A study by Bay et al. (2022) even reported that TB patients who smoke have a lower recovery rate than non-smokers [35].

At the local level, Tanah Laut Regency in South Kalimantan, including the Tambang Ulang Health Center service area, continues to report a significant number of TB cases annually. However, there is still a lack of systematic data analyzing environmental and behavioral determinants contributing to TB incidence in the region. Yet, assessing local risk factors is essential for designing evidence-based, context-specific, and targeted interventions.

Most residents in this area live in housing conditions that do not meet environmental health standards, such as narrow ventilation, high humidity, and high occupancy density. Moreover, smoking indoors is still common, further deteriorating indoor air quality. The persistent stigma and limited public knowledge about TB also result in low awareness to avoid direct contact with infected individuals. These conditions form a combination of reinforcing risk factors, facilitating both latent and active TB transmission.

Therefore, this study is deemed important. By applying a case-control study design, this research aims to analyze the relationship between various risk factors—from housing environmental conditions to individual behaviors—and the incidence of pulmonary TB in the Tambang Ulang Health Center service area. The results are expected to provide a scientific basis for developing more effective, locally tailored intervention strategies, including health promotion, housing improvement, and advocacy for behavior change related to smoking and close contact with TB patients.

MATERIALS AND RESEARCH METHODS

This study is a quantitative research with an analytical observational approach, aiming to examine the relationship between environmental and behavioral factors and the incidence of pulmonary tuberculosis. The study design used was a case-control approach with a retrospective method, comparing the case group (respondents with pulmonary TB) and the control group (respondents without TB) to examine their exposure history to certain factors.

The study was conducted in the Tambang Ulang Health Center area, Tanah Laut Regency, South Kalimantan Province, with data collection carried out in 2023. The population consisted of all residents living in the health center's service area. A total of 45 respondents were selected, comprising 15 cases and 30 controls. The purposive sampling technique was employed, with inclusion criteria as follows: (1) living in the study area for at least one year, (2) willing to participate, and (3) able to be interviewed directly. Exclusion criteria included: respondents with communication difficulties or unwillingness to participate in the interview process.

The independent variables in this study were home ventilation, housing density, humidity, room temperature, history of physical contact with TB patients, and smoking habits, while the dependent variable was the incidence of pulmonary tuberculosis.

Data were collected using a structured questionnaire, direct observation of housing conditions, and documentation of health records from the local health center. Primary data were obtained through interviews and observations, while secondary data were retrieved from medical records and TB reports from the Tambang Ulang Health Center.

Data analysis was performed using univariate and bivariate techniques. Univariate analysis was used to describe respondent characteristics, while bivariate analysis utilized the Chi-Square test to examine relationships between independent and dependent variables. Risk interpretation used Odds Ratio (OR) values, with a significance level of $\alpha = 0.05$. Data processing was conducted using appropriate statistical software.

RESEARCH RESULTS AND DISCUSSION

This study analyzed six factors suspected to be associated with pulmonary tuberculosis incidence, namely: home ventilation, housing density, indoor humidity, room temperature, physical contact history with TB patients, and smoking habits. The bivariate statistical analysis using the Chi-Square test indicated that all variables had a statistically significant relationship with the incidence of pulmonary TB ($p < 0.05$). The Odds Ratio (OR) values also confirmed that each of these factors significantly increased the risk of TB incidence.

Home Ventilation

The relationship between home ventilation area and the incidence of pulmonary tuberculosis can be analyzed based on Table 1 below.

Table 1. Distribution of Ventilation Area in Case and Control Houses Related to the Incidence of Pulmonary Tuberculosis in the Working Area of Tambang Ulang Public Health Center

No	Ventilation Area	Pulmonary Tuberculosis Incidence	
		CAses	Control
1	Non-compliant	12	9
		80%	30%
2	Compliant	3	21
		20%	70%
	Total	100	100
	P= 0,002 < α = 0,05 OR= 9,333		

Source: Processed Primary Data

A total of 80% of individuals with pulmonary tuberculosis (TB) lived in homes with inadequate ventilation, while 70% of individuals without TB lived in homes with adequate ventilation. Based on the analysis, the p-value was found to be 0.002 and the odds ratio (OR) was 9.333, indicating that individuals living in poorly ventilated homes had a 9 times greater risk of developing pulmonary TB compared to those living in homes with adequate ventilation.

Inadequate ventilation can lead to the accumulation of droplet particles containing Mycobacterium tuberculosis in indoor air, thereby increasing the likelihood of transmission. This condition is particularly risky in homes with high occupancy density and the habit of

keeping windows closed throughout the day. These findings are consistent with the theory that environments with limited air circulation are significant risk factors in the transmission of respiratory infectious diseases [22,23,26,29,30].

Residential Density

The association between residential density and the incidence of pulmonary tuberculosis (TB) can be analyzed based on Table 2 below.

Table 2. Distribution of Residential Density in Case and Control Households in Relation to Pulmonary TB Incidence in the Working Area of Tambang Ulang Public Health Center

No	Ventilation area	Pulmonary Tuberculosis Incidence	
		Cases	Control
1	Non-compliant	13	12
		86,7%	40%
2	compliant	2	18
		13,3%	60%
	Total	100	100
	P= 0,003 < α = 0,05 OR= 9,750		

Source: Processed Primary Data

The analysis of occupancy density shows that 86.7% of pulmonary TB patients live in homes with overcrowded conditions that do not meet health standards. A p-value of 0.003 and an odds ratio (OR) of 9.750 support the conclusion that residential crowding is a significant risk factor. Individuals living in densely populated homes are 9 times more likely to develop pulmonary TB compared to those residing in adequately spaced housing.

Living with many individuals in a confined space facilitates close, frequent contact, which increases the potential for TB transmission. Furthermore, overcrowding contributes to elevated indoor temperature and humidity, ultimately affecting overall air quality [22,24,26,28–30].

Air Humidity

The study also found that indoor air humidity is associated with pulmonary TB incidence, as presented in Table 3.

Table 3. Distribution of Indoor Humidity in Case and Control Houses in Relation to Pulmonary TB Incidence in the Working Area of Tambang Ulang Health Center

No	Housing Density	Pulmonary Tuberculosis Incidence	
		Cases	Control
1	Non-compliant	12	10
		80%	33,3%
2	compliant	3	20
		20%	66,7%
	Total	100	100
	P= 0,003 < α = 0,05 OR= 8,000		

Source: Processed Primary Data

A total of 80% of individuals with TB lived in homes with inadequate humidity levels. Statistical analysis showed a p-value of 0.003 and an odds ratio (OR) of 8.000. Humid homes tend to be less healthy as they promote the growth of microorganisms, including pathogens that affect the respiratory system.

High air humidity also reduces the respiratory tract's resistance to infection and can facilitate the persistence of droplets in enclosed environments. The link between humidity and TB has been widely discussed in previous literature, which states that such conditions prolong the survival of TB bacilli in the air or on surfaces [25–27,29–31,33].

Room Temperature

Similar to air humidity, room temperature is also associated with the incidence of pulmonary tuberculosis, as shown in Table 4.

Table 4. Distribution of Room Temperature in Case and Control Households in Relation to Pulmonary TB Incidence in the Working Area of Tambang Ulang Public Health Center

No	Occupancy Density	Pulmonary Tuberculosis Incidence	
		CAses	Control
1	Non-compliant	12	8
		80%	26,7%
2	compliant	3	22
		20%	73,3%
	Total	100	100
	P= 0,001 < α = 0,05 OR= 11,000		

Source: Processed Primary Data

Based on the temperature measurements, 80% of TB patients were found to live in homes with temperatures that did not meet health standards. The significance value of p = 0.001 and an odds ratio (OR) of 11.000 confirm that inadequate indoor temperature is a strong risk factor for pulmonary TB incidence. Extremely low or high room temperatures can impair the immune system and reduce the effectiveness of mucosal defenses in the respiratory tract. Moreover, temperature plays a role in the efficiency of air circulation and is closely related to poor ventilation and humidity conditions [22,24,26,28–30].

Physical Contact with Pulmonary TB Patients

Physical contact with individuals diagnosed with pulmonary TB is also associated with the transmission of the disease, as illustrated in Table 5 below.

Table 5. Distribution of Physical Contact in Case and Control Households with Pulmonary TB Incidence in the Working Area of Tambang Ulang Public Health Center

No	Housing Density	Pulmonary Tuberculosis Incidence	
		Case	Control
1	Non-compliant	11	9
		73,3%	30%
2	compliant	4	21
		26,7%	70%
	Total	100	100
	P= 0,006 < α = 0,05 OR= 6,417		

Source: Primary Data (processed)

A total of 73.3% of respondents in the case group were found to have a history of physical contact with individuals diagnosed with pulmonary tuberculosis (TB). Statistical testing yielded a p-value of 0.006 and an odds ratio (OR) of 6.417. Physical contact, particularly within household settings, significantly increases the likelihood of repeated exposure to infectious droplets—even in the absence of initial symptoms.

This finding reinforces the evidence that TB transmission is closely associated with social interaction and physical proximity, especially in enclosed spaces. In such situations, the effectiveness of preventive measures—such as cough etiquette and proper ventilation—becomes critically important [18].

Smoking Habits

The final factor strongly suspected to be associated with the incidence of pulmonary TB is smoking behavior, as presented in Table 6 below.

Table 6. Association between Smoking Habits and Pulmonary TB Incidence in the Working Area of Tambang Ulang Health Center

No	Humidity	Pulmonary Tuberculosis Incidence	
		Cases	Control
1	Non-compliant	12	8
		80%	26,7%
2	compliant	3	22
		20%	73,3%
Total		100	100
P= 0,001 < α = 0,05 OR= 11,000			

Source: Processed Primary Data

The majority of TB patients (80%) had a history of active or passive smoking within the household. A p-value of 0.001 and an odds ratio (OR) of 11.000 indicate a very significant association between smoking habits and the incidence of pulmonary tuberculosis. Smoking damages the respiratory epithelium, impairs local immune function, and reduces the body's ability to clear foreign particles, including *Mycobacterium tuberculosis*. In addition, smoking increases the indoor particulate burden, which may exacerbate poor household ventilation conditions [20,36–39].

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that the incidence of pulmonary tuberculosis in the working area of Tambang Ulang Public Health Center is significantly associated with several risk factors, both in terms of physical housing conditions and individual behaviors. Inadequate ventilation, high occupancy density, non-optimal room temperature and humidity, as well as smoking habits were all found to significantly increase the risk of TB transmission. Moreover, a history of physical contact with TB patients emerged as a critical factor that requires special attention. These findings suggest that TB transmission is influenced not only by an individual's medical condition but also by their living environment and daily behavior.

Based on these findings, it is recommended that the Tambang Ulang Public Health Center utilize this research as a foundation for developing more targeted promotive and preventive health programs. Health education efforts should be intensified by involving community leaders and health volunteers, particularly in raising awareness on the importance of adequate ventilation, the dangers of smoking, and practical ways to prevent TB transmission at home. A community-based approach is considered effective in fostering behavioral changes toward a cleaner and healthier lifestyle.

Furthermore, the community is encouraged to actively maintain a healthy living environment by, for instance, opening windows daily to allow proper air circulation, limiting direct contact with TB patients, and quitting smoking to strengthen the immune system. To broaden understanding, future research is recommended to include additional variables such as nutritional status, quantitative measurements of household crowding, and access to healthcare services, in order to design more comprehensive and targeted interventions.

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