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ORIGINAL ARTICLE

The Relationship between Household Environmental Health and the Incidence of Pulmonary Tuberculosis Community Health Center in Jambi City

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ABSTRACT

Background: Pulmonary tuberculosis is a preventable infectious disease, but according to 2022 data, pulmonary TB ranks second in causing deaths worldwide after the coronavirus (COVID-19). Household environmental conditions are thought to play a role in its transmission. This study aims to determine the relationship between lighting, humidity, and ventilation in homes and the incidence of pulmonary TB at the Pakuan Baru Community Health Center, Simpang Kawat Community Health Center, and Paal X Community Health Center in 2024.

Method: This research uses a case-control design with a sample of 104 respondents (26 cases, 78 controls) in three community health center areas. Lighting and humidity measurements were taken using a lux meter and hygrometer, while windows were measured using observation sheets. Data were analyzed univariately and bivariately using the Chi-Square test with Odds Ratio (OR).

Results: Most homes of TB patients have inadequate environmental conditions. Analysis shows a significant relationship between inadequate humidity (OR=54.86; 95% CI:11.60-259.52; p<0.001), inadequate lighting (OR=13.83; 95% CI: 4.61-41.52; p<0.001), and lack of windows (OR=4.29; 95% CI: 1.62-11.35; p=0.002) with TB incidence.

Conclusion: Poor household environmental conditions, such as humidity, lighting, and window conditions, are risk factors for TB. It is recommended that TB prevention programs integrate the promotion of household environmental improvements.

Keywords : *Pulmonary tuberculosis, household environment, lighting, humidity, window conditions*

INTRODUCTION

Tuberculosis infection is a major health problem because pulmonary tuberculosis is one of the most deadly infectious diseases in the world.1–3 Indonesia has the second-highest number of pulmonary TB cases in the world after India.(1–4)

Tuberculosis is initially transmitted through the air by the bacterium Mycobacterium tuberculosis. Clinically, tuberculosis can manifest in two forms: pulmonary tuberculosis, which affects the lungs, and extrapulmonary tuberculosis, which spreads to other organs outside the lungs. The main source of transmission is adults with sputum that is BTA-positive.(5–8)

The risk factors for pulmonary TB can be divided into host, agent, and environment. Host factors originate from humans and include gender, age, educational history, and immunization status. Meanwhile, the agent causing pulmonary TB is the bacterium Mycobacterium tuberculosis. Environmental factors include household health, proximity to patients, and socioeconomic status.(9–13)

Household environmental health is divided into several risk factors that affect it through water, air, soil, food, building facilities, vectors, and disease-carrying animals. Risk factors such as lighting, humidity, and windows are very important in the prevention of pulmonary TB. Natural light, especially sunlight entering through windows, contains ultraviolet (UV) rays that can destroy harmful germs such as Mycobacterium TB. Good ventilation, which can be achieved by regularly opening windows, will improve air circulation, reduce exposure to air pollution, and minimize excessive humidity in the home. Inappropriate humidity, defined as below 40% or above 60%, has been linked to an increased risk of pulmonary tuberculosis infection, as these conditions promote the growth and spread of bacteria.(14–18)

Previous studies have shown that lighting, humidity, and windows affect the prevalence of pulmonary tuberculosis. Homes with little natural lighting due to a lack of windows or poor location prevent sunlight from entering, thereby limiting the natural antibacterial effects of UV radiation. Uncontrolled humidity, whether too low below 40% or too high above 60%, provides an ideal habitat for the growth of bacteria and other diseases. Additionally, poor ventilation caused by infrequent or inadequate window openings reduces air circulation, increasing the concentration of pollutants and pathogens indoors. All these environmental factors are interrelated and play a crucial role in determining disease incidence rates in a given area. Further research and environmental improvement efforts are urgently needed to curb the spread of pulmonary tuberculosis.(19–22)

METHOD

This study is an analytical observational study with a case-control study design matched by age and gender. Data

collection was conducted retrospectively by identifying factors associated with household environmental health (lighting, humidity, and windows) and the incidence of pulmonary tuberculosis at the Pakuan Baru, Simpang Kawat, and Paal X Community Health Centers in 2024. The study was conducted from July to October 2024.

The case population in this study consisted of adult pulmonary TB patients treated for the first 3 months based on bacteriological and clinical findings at the Pakuan Baru, Simpang Kawat, and Paal X Community Health Centers, with a total population of 26 people. The control population consisted of respondents who did not have pulmonary TB and who were matched for age, gender, and population with the case population, with a case-control ratio of 1:3.

The inclusion criteria for the case population were pulmonary TB patients undergoing their first 3 months of treatment, aged > 18 years, residing in the working areas of the Pakuan Baru, Simpang Kawat, and Paal X Community Health Centers. Meanwhile, the control population consisted of individuals who did not have pulmonary TB and were of the same gender, age, and housing type as the cases. The exclusion criteria were unwillingness to participate and inability to communicate well. Sample collection for this study used consentative sampling, which is selecting samples based on the inclusion and exclusion criteria set by the researcher.

RESULT AND DISCUSSION

This study involved 104 respondents consisting of 26 tuberculosis cases and 78 non-tuberculosis controls with a ratio of 1:3. Respondents were matched based on age and gender to control for the influence of these confounding variables.

Based on the Table 1, the distribution of characteristics of the 104 research respondents shows that most respondents are male (65.4%). In terms of age, the 40-59 age group constitutes the largest proportion (42.3%), followed by the elderly ≥60 years (30.8%) and young adults 18-39 years (26.9%).

Employment characteristics show that entrepreneurs constitute the largest group (33.7%), followed by farmers/laborers (19.2%), and housewives (23.1%). Only 1% of respondents are civil servants/military/police officers.

The educational level of respondents was dominated by high school/equivalent graduates (44.2%), followed by elementary school/equivalent (26.9%) and junior high school/equivalent (17.3%). Higher education (D3 to bachelor's degree) reached 10.6% of the total respondents.

Table 1. Respondent Characteristic

Variable	Respondents (n)	Percentage (%)
Gender		
Male	68	65.4
Female	36	34.6
Age		
18–39 years	28	26.9
40–59 years	44	42.3
≥ 60 years	32	30.8
Occupation		
Housewife (Homemaker)	24	23.1
Civil servant / Military / Police	1	1.0
Private employee	11	10.6
Self-employed	35	33.7
Farmer/Laborer	20	19.2
Unemployed	13	12.5
Education Level		
No formal education	1	1.0
Elementary school/equivalent	28	26.9
Junior high school/equivalent	18	17.3
Senior high school/equivalent	46	44.2
Diploma (D3)	2	1.9
Bachelor's degree or higher	9	8.7

In general, most of the respondents' homes meet environmental health requirements. Lighting is the aspect with the best conditions, with 78.8% of homes having adequate natural light intensity. However, there are still 21.2% of homes with poor lighting, which has the potential to create an environment that is less than optimal for the health of its occupants.

In terms of humidity, 63.5% of homes are dry (not humid), while 36.5% of homes are humid. High humidity can support the growth of microorganisms, including Mycobacterium tuberculosis.

Table 2. Environmental Variable

Environmental Variable	Category	n (104)	%
Lighting	Meets the standard	82	78.8
	Does not meet the standard	22	21.2
Humidity	Meets the standard	66	63.5
	Does not meet the standard	38	36.5
Windows	Meets the standard	79	76.0
	Does not meet the standard	25	24.0

Regarding windows, 76% of respondents have the habit of opening windows every day, while 24% of homes still do not meet the requirements in terms of window opening habits or lack windows. The lack of window opening habits or the absence of windows can affect ventilation, leading to stagnant air and increasing the risk of respiratory disease transmission.

Table 3. Bivariate Analysis

Environmental Factors	Case (n=26)	Control (n=78)	OR (95% CI)	p-value
Lighting				
Does not meet the standard	15 (57.7%)	7 (9.0%)	13.83 (4.61–41.52)	<0.001
Meets the standard	11 (42.3%)	71 (91.0%)	1	
Humidity				
Does not meet the standard	24 (92.3%)	14 (17.9%)	54.86 (11.60–259.52)	<0.001
Meets the standard	2 (7.7%)	64 (82.1%)	1	
Windows				
Does not meet the standard	12 (46.2%)	13 (16.7%)	4.29 (1.62–11.35)	0.002
Meets the standard	14 (53.8%)	65 (83.3%)	1	

DISCUSSION

This study revealed that nearly 60% of TB cases lived in homes with substandard lighting, while in the control group the proportion was only 9%. The Odds Ratio value of 13.83 (95% CI: 4.61–41.52) is not only statistically significant ($p < 0.001$), but also indicates a much stronger association than previous meta-analysis estimates. This large difference suggests that the lighting factor may be operating in an environmental context that amplifies its impact, such as high humidity and limited ventilation commonly found in tropical regions. (23,24)

The odds ratio value for humidity of 54.86 (95% CI: 11.60–259.52) was the most striking finding in this study, indicating that individuals living in damp homes had a 54.86 times higher risk of developing TB than those living in homes with optimal humidity. Only 7.7% of TB patients in this study lived in homes with acceptable humidity levels, while 92.3% of cases were concentrated in homes with humidity levels outside the healthy range (40–60%).(24)

The window variable showed a significant association with tuberculosis cases, with an odds ratio of 4.29 (95% CI: 1.62–11.35) and a p-value of 0.002. A total of 46.2% of TB cases lived in houses with windows that did not meet the requirements, while in the control group the proportion was only 16.7%. Although the strength of the association was lower than that of humidity (OR=54.86) and lighting (OR=13.83), these findings confirm that the habit of opening windows every day is an important component of a healthy home environment.(24,25)

CONCLUSION

Respondent characteristics show that most respondents are male (65.4%) with the largest age group being 40-59 years old (42.3%), the educational level is dominated by high school/equivalent graduates (44.2%), and the largest occupational group is self-employed (33.7%).

There is a relationship between lighting and the incidence of pulmonary tuberculosis at the Pakuan Baru, Simpang Kawat, and Paal X Community Health Centers in 2024. Respondents living in homes with inadequate lighting had a 13.83 times greater risk (OR=13.83; 95% CI: 4.61-41.52) of suffering from TB compared to respondents in homes with adequate lighting ($p < 0.001$).

There is a relationship between humidity and the incidence of pulmonary TB at the Pakuan Baru, Simpang Kawat, and Paal X Community Health Centers in 2024. Respondents living in homes with inadequate humidity had a 54.86 times greater risk (OR=54.86; 95% CI: 11.60-259.52) of developing TB compared to respondents in homes with adequate humidity ($p < 0.001$).

There is a relationship between conditions and the incidence of pulmonary TB at the Pakuan Baru Community Health Center, Simpang Kawat Community Health Center, and Paal X Community Health Center in 2024. Respondents who lived in homes with the habit of not opening windows daily had a 4.29 times higher risk (OR=54.86; 95% CI: 11.60-259.52) of developing TB compared to respondents in homes with the habit of opening windows daily ($p = 0.002$).

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