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THE PHYSICAL ENVIRONMENTAL CONDITION OF THE HOUSEHOLD AND ITS RELATIONSHIP WITH PULMONARY TUBERCULOSIS (TB) CASES

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ABSTRACT
A house that does not meet health requirements is one of the risk factors for pulmonary tuberculosis (TB). This study aimed to determine the relationship between the physical environmental condition of the household and pulmonary TB cases in Rantau Alai District, Ogan Ilir Regency, in 2023. This was a quantitative analytic study involving a case-control approach, conducted over one month in Rantau Alai sub-district. A total of 108 participants were enrolled consisiting of 36 cases and 72 control, and data were collected through interviews, observations, and direct measurements of various aspects of the physical environmental condition of the household using a roll meter, lux meter, and thermo-hygrometer. The data was analyzed with chi-square test and multiple logistic regression. The primary outcome with bivariate analyzed of the study is the relationship between ventilation (p-value = 0.025), lighting (p-value = 0.005), humidity (p-value = 0.008), temperature (p-value = 0.048), wall type (p-value = 0.048), floor type (p-value = 0.048), and residential density (p-value = 0.012) with pulmonary TB cases in Rantau Alai District. Multivariate analyzed show the most dominant factor affecting TB cases was residential density (OR 3.10 CI 1.07-8.97). It is important for adequate physical environmental condition, especially if there are active TB cases in the home environment with unqualified residential density to prevent the spread of TB cases among household contacts.

Keywords: case control; physical environmental condition; pulmonary TB; the household

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INTRODUCTION

Health is a very important issue that should be a global focus. Tuberculosis (TB) is a serious health problem and remains one of the most dangerous infectious diseases in the world (Monintja et al., 2020). In 2022, there were approximately 10.6 million people suffering from tuberculosis globally, where we can see an increase when compared to 10.3 million in 2021 and 10 million in 2020. In 2022, nearly 1.3 million people died from tuberculosis. According to the Global TB Report 2023, Indonesia was the second country in the world with the highest number of tuberculosis cases in 2022, after India and China. The Ministry of Health of the Republic of Indonesia reported 724,309 TB cases in 2022, with 16,528 mortality.Tuberculosis is caused by Mycobacterium tuberculosis bacteria that spread through the air, such as through droplets, sneezing, and coughing by a person who suffers from TB with acid resistant bacteria (Mushidah et al., 2022). The household environment is one of the factors that plays a role in the spread of tuberculosis bacteria. These bacteria can survive for an extended period, depending on the physical condition of the house. Transmission is more likely in indoor environment with poor ventilation and high humidity (Hanifah et al., 2024; Sari, 2018).

Previous studies have established a link between the physical environment condition of the household and smoking habits with tuberculosis incidence in Banjarejo Public Health Center area. The research found a significant association between ventilation, lighting, and residential density with the occurrence of pulmonary TB in this region (Rosyid et al., 2023).

Another study that examined the relationship between physical environmental factors in the house and health behaviors with the incidence of lung tuberculosis in South Purwokerto, Banyumas, revealed an association between temperature, humidity, and the occurrence of lung tuberculosis in the respective area (Nuraini et al., 2022). Additionally, research on home environmental health and tuberculosis cases in Tanjung Seteko Village, Indralaya District, Ogan Ilir Regency, identified a significant relationship between the type of wall and floor with pulmonary TB incidence in the village in 2021 (Oktriyedi et al., 2021). This study aims to determine the relationship between the physical environment condition of the house and pulmonary TB cases in Rantau Alai District, Ogan Ilir Regency, in 2023. In the initial survey, researchers found that many community houses did not meet health standards, such as houses with unplastered walls and floors, inadequate ventilation, and insufficient lighting, which also affected the temperature and humidity inside the house. The high number of tuberculosis cases in Rantau Alai District makes it an interesting phenomenon this study to determine the relationship between the physical condition of the household and the incidence of tuberculosis.

METHOD

This study used a quantitative approach with an analytic observational research design, specifically a case-control design. The population in this study were all residents in Rantau Alai District. The sampling technique used was purposive sampling based on inclusion criteria. A total of 108 samples were used, divided into two groups, i.e., 36 respondents in the case group and 72 respondents in the control group. The study was conducted in Rantau Alai District, Ogan Ilir Regency. The available health facilities in Rantau Alai District are two public health centers without inpatient care, i.e., Lebung Bandung Publich Health Center and Mekar Sari Public Health Center.The data collection instruments used in this study included questionnaires, observation, and direct measurement. A roll meter, a lux meter, and a thermo-hygrometer were used for direct measurement of ventilation, lighting, and room temperature and humidity variables, respectively. Observations were made to get information regarding the type of floors and walls. The data analysis included the chi-square test and multiple logistic regression analysis using the SPSS software.This study was approved by the Health Research Ethics Committee of the Faculty of Public Health, Sriwijaya University (Approval Number: 027/UN9.FKM/TU.KKE/2024). All participants signed informed consent form before participating in the study, and their confidentiality was strictly maintained throughout the research process. The instrument was tested for validity and reliability, which shows valid results for each measurement of the variables study.

RESULT

A total of 108 respondents were included in the study, where 47.2% had unqualified house ventilation, 51.9% had unqualified house lighting, 52.8% had unqualified house humidity, 51.9% had unqualified house temperature, 49.1% had unqualified wall type, 46.3% had unqualified floor type, and 53.7% had unqualified residential density.

A total of 7 variables were entered into the model, the results are shown in Table 2. The findings show that residential density is the most dominant factor affecting the case of pulmonary TB. This suggests that the denser the residence, the easier and the faster the disease is transmitted.

Table 1.
Bivariate Analysis the Physical Environmental Condition of the Household and its Relationship with Pulmonary Tuberculosis (TB) Cases

Variable	Pulmonary TB				P-Value	OR
	Case		Control			
	f	%	f	%		
Ventilation						
Unqualified	23	63.9	28	38.9	0.025	2.78 (1.21-6.36)
Qualified	13	36.1	44	61.1		
Lighting						
Unqualified	26	72.2	30	41.7	0.005	3.64 (1.53-8.66)
Qualified	10	27.8	42	58.3		
Humidity						
Unqualified	26	72.2	31	43.1	0.008	3.43 (1.44-8.17)
Qualified	10	27.8	41	56.9		
Temperature						
Unqualified	24	66.7	32	44.4	0.048	2.50 (1.08-5.75)
Qualified	12	33.3	40	55.6		
Wall type						
Unqualified	23	63.9	30	41.7	0.048	2.47 (1.08-5.65)
Qualified	13	36.1	42	58.3		
Floor type						
Unqualified	22	61.1	28	38.9	0.048	2.46 (1.08-5.61)
Qualified	14	38.9	44	61.1		
Residential density						
Unqualified	26	72.2	32	44.4	0.012	3.25 (1.36-7.71)
Qualified	10	27.8	40	55.6		

Table 2.
Multivariate Analysis of Logistic Regression Test

Variable	OR Crude	95% CI	OR Adjust	95% CI
Residential density	3.25	(1.36-7.71)	3.10*	(1.073-8.972)
Wall Type	2.47	(1.08-5.65)	0.79	(0.05-11.67)
Lighting	3.64	(1.53-8.66)	1.22	(0.28-5.29)
Temperature	2.50	(1.08-5.75)	0.39	(0.04-3.73)
Humidity	3.43	(1.44-8.17)	2.43	(0.49-11.98)
Ventilation	2.78	(1.21-6.36)	2.06	(0.56-7.51)
Floor Type	2.46	(1.08-5.61)	4.49	(0.31-63.78)

DISCUSSION

Bivariate Analysis

Relationship Between Ventilation and Pulmonary Tuberculosis

Based on the results of the study, it was found that there is a relationship between ventilation and pulmonary TB cases in Rantau Alai District, with a p-value of 0.025 and an odds ratio (OR) of 2.780. This indicates that respondents with unqualified house ventilation have a 2.7 times higher risk of developing pulmonary TB compared to those with qualified house ventilation. The results of this study are consistent with previous research, which found an association between the ventilation area of houses in South Purwokerto, Banyumas and pulmonary TB cases, with a p-value of 0.002 (Nuraini et al., 2022). The findings are also aligned with research conducted by Saqib and Ahmad (2019) in Khyber Pakhtunkhwa province, Pakistan. According to their study, most of the population in the region lives in poorly constructed houses that lack proper ventilation. This issue is largely due to the extreme poverty experienced by many people in Pakistan (Saqib & Ahmad, 2019). According to the Regulation of the Minister of Health of the Republic of Indonesia No. 1077 of 2011, house ventilation must meet the requirement of having a ventilation area greater than 10% of the

floor area. Ventilation that does not meet health standards can contribute to the occurrence of pulmonary TB. In addition, the presence of ventilation impacts other factors that can trigger the proliferation of TB germs. Continuous airflow helps remove bacteria from the air, especially bacteria that cause diseases such as tuberculosis (Sumarmi, 2014). Ventilation also ensures smooth air circulation, preventing stuffiness, and maintaining the oxygen balance that is required by the residents (Anggraeni & Rahayu, 2018). Proper ventilation allows natural light to enter the house, enabling ultraviolet (UV) rays to kill tuberculosis bacteria, which are particularly sensitive to direct sunlight (Pratama et al., 2024).

Relationship Between Lighting and Pulmonary Tuberculosis

Based on the results of the study, it was found that there is a relationship between lighting and the pulmonary TB cases in Rantau Alai District, with a p-value of 0.005 and an odds ratio (OR) of 3.640. This indicates that respondents with unqualified house lighting have a 3.6 times higher risk of developing pulmonary TB compared to those with qualified house lighting.The results of this study is aligned with previous research, which found a relationship between lighting and tuberculosis cases in Kedaton Public Health Center working area of Bandar Lampung, with a p-value of 0.000 (Safitri et al., 2024). The respective study showed that it happened because respondents rarely opened windows and doors, and even though the windows were opened there were still curtains that blocked sunlight from entering the house properly. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 1077 of 2011, lighting should be at least 60 lux. Tuberculosis bacteria die quickly when exposed to morning sunlight because it contains high levels of ultraviolet rays. Therefore, natural lighting, such as sunlight, is very important as it can kill tuberculosis bacteria in the house. The more sunlight that enters a room, the lower the risk of tuberculosis (Safitri et al., 2024). Based on the measurements taken, some respondents' houses had insufficient lighting. This is because some respondents lacked proper ventilation and did not regularly open their windows, preventing the sunlight, an essential source of natural lighting, from entering the house. One way to allow sunlight into the house is to keep the windows open every morning. Increasing indoor lighting can also be achieved by adding artificial light sources, such as light bulbs. Proper lighting will reduce humidity in the house and help kill other disease-causing germs (Siregar & Lubis, 2022).

Relationship Between Humidity and Pulmonary Tuberculosis

Based on the results of the study, a relationship was found between ventilation and pulmonary TB cases in Rantau Alai District, with a p-value of 0.008 and an odds ratio (OR) of 3.439. This indicates that respondents with unqualified house humidity have a 3.4 times higher risk of developing pulmonary TB compared to those with qualified house humidity.The findings of this study are consistent with previous research, which found a relationship between house humidity and tuberculosis cases in Putri Ayu Public Health Center working area in 2022, with a p-value of 0.03 (Rini et al., 2023). According to this study, the humidity levels in community houses are influenced by the location of the settlements. For example, in Legok Village, the community's houses are very humid and prone to flooding during the rainy season.According to the Regulation of the Minister of Health of the Republic of Indonesia No. 1077 of 2011, qualified house humidity should range from 40% RH to 60% RH. Based on the measurements taken, most respondents had unqualified house humidity due to insufficient ventilation and infrequent opening of windows, which resulted in poor air exchange and uneven sunlight penetration into the house. This condition was further exacerbated by the fact that most respondents' houses had non-permeable wall and floor types, such as wooden planks, which contributed to the house being dark and humid. High humidity levels can promote the growth of disease-causing bacteria, including *Mycobacterium tuberculosis* (Hasan & Nurmaladewi, 2023).

Relationship Between Temperature and Pulmonary Tuberculosis

Based on the results of the study, a relationship was found between temperature and pulmonary TB cases in Rantau Alai District, with a p-value of 0.048 and an odds ratio (OR) of 2.500. This indicates that respondents with unqualified house temperatures have a 2.5 times higher risk of developing pulmonary TB compared to those with qualified house temperatures.The findings of this study are consistent with previous research, which showed a relationship between house temperature in South Purwokerto, Banyumas, and pulmonary TB cases, with a p-value of 0.005 (Nuraini et al., 2022). Onozuka and Hagihara's (2015) study in Japan also found a significant increase in TB cases in extreme hot and cold temperatures (Onozuka & Hagihara, 2015). In addition, a study conducted by Khalid et al. (2015), which compared the tuberculosis cases in the Northern and Southern regions of Azad Jammu and Kashmir (AJK) State, supports these findings. Their study revealed that tuberculosis was more common in the northern region, due to the cold, snowy, and mountainous terrain with prolonged winters. The winter season leads to increased indoor temperatures, and most family members spend time in heated rooms. This creates an environment where the risk of contracting pulmonary TB is higher (Khalid et al., 2013).

From the measurements taken, it was found that the respondents' houses had varying temperatures, which were influenced by indoor humidity levels and a lack of proper ventilation, resulting in poor air exchange. Most of the respondents lived in high-density housing. The unbalanced ratio between the number of people and the size of the house contributes to the increase in temperature. Room temperature is closely related to ventilation or air circulation within the house. Insufficient ventilation leads to poor air exchange, making the room stuffy, increasing the room temperature, and raising the humidity. A humid environment is ideal for the development of *Mycobacterium tuberculosis* bacteria, which increases the transmission of pulmonary TB. Proper air circulation helps regulate room temperature and reduces the transmission of pulmonary TB (Mahawati et al., 2023).

Relationship Between Wall Type and Pulmonary Tuberculosis

Based on the results of the study, a relationship was found between the type of wall and pulmonary TB cases in Rantau Alai District, with a p-value of 0.048 and an odds ratio (OR) of 2.477. This indicates that respondents with unqualified house walls have a 2.4 times higher risk of developing pulmonary TB compared to those with qualified house walls The findings of this study are consistent with previous research, which identified a relationship between the type of wall and TB cases in the Bandar Khalifah Public Health Center working area in 2021, with a p-value of 0.038 (Tajung & Tanjung, 2021). The study found that most respondents had houses with wooden plank walls, which was a result of the community's economic limitations, preventing them from affording the cost of plastering the walls.According to the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023, the type of house wall that meets health requirements is an impermeable (plastered) wall. Observations in this study revealed that some respondents' houses had walls made of planks or wood, which were not watertight. Several respondents' houses also had fragile walls, with rainwater seeping through the outer walls. This condition was attributed to the respondents' poor economic situation, which prevented them from repairing or plastering the walls of their houses. The type of wall can contribute to the transmission of pulmonary TB. Walls that are not waterproof can affect the humidity inside the house and support the growth of *Mycobacterium tuberculosis*, the bacterium responsible for pulmonary TB (Budi et al., 2024).

Relationship Between Floor Type and The Case of Pulmonary Tuberculosis

Based on the results of the study, a relationship was found between the type of floor and pulmonary TB cases in Rantau Alai District, with a p-value of 0.048 and an odds ratio (OR) of 2.469. This indicates that respondents with unqualified house floor types have a 2.4 times

higher risk of developing pulmonary TB compared to those with qualified house floor types. The findings of this study are consistent with previous research, which showed an association between the type of floor and tuberculosis cases in Banjarejo Public Health Center working area, Madiun City, with a p-value of 0.005 (Rosyid et al., 2023). The results are also supported by research by Singh et al. (2018) in India, which found that residents with floors made of earth or unplastered materials had a higher risk of developing tuberculosis. The study concluded that people living in poor-quality housing have an increased risk of developing tuberculosis (Singh et al., 2018). According to the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023, the type of floor that meets health requirements is a waterproof (plastered) floor. Observations in this study revealed that some respondents had wooden board floors. This was due to their poor economic conditions, which prevented them from affording the cost of plastering the floors. Wooden plank floors tend to promote high humidity and mold growth, which can increase the breeding grounds for *Mycobacterium tuberculosis* bacteria, potentially making it a source of pulmonary TB transmission. Additionally, during dry conditions in the summer, the floor can become dusty, which may harm the health of the house's residents (Muslimah, 2019).

Relationship Between Residential Density and The Case of Pulmonary Tuberculosis

Based on the results of the study, a relationship was found between residential density and pulmonary TB cases in Rantau Alai District, with a p-value of 0.012 and an odds ratio (OR) of 3.250. This indicates that respondents with unqualified residential density have a 3.2 times higher risk of developing pulmonary TB compared to those with qualified residential density. The findings of this study are consistent with previous research, which indicates a relationship between residential density and tuberculosis cases in Putri Ayu Public Health Center working area in 2022, with a p-value of 0.026 (Rini et al., 2023). According to the research, many respondents' houses were inhabited by more than one household head, with some married children still living with their parents. As a result, the number of people in the house increased, but the size of the house remains the same.Based on the measurements and observations, many respondents had high residential density, with one to two heads of households in a single home. Most respondents, especially those in the case group, did not have separate beds from family members who were not sick. Additionally, many respondents' bedrooms did not meet health standards, as they were smaller than 9 m² per room. Some case respondents did not have a designated bedroom at all and instead used the living room as their sleeping area. A higher number of residents increases the likelihood of frequent contact between individuals with pulmonary TB and other family members, thus accelerating the transmission of the disease (Romadhan et al., 2019). Therefore, residential density plays a significant role in disease transmission, i.e., the more residents in a housee, the easier it is for the disease to spread (Halim & Budi, 2017). Tuberculosis transmission can occur if a person interacts with someone who has pulmonary TB with acid resistant bacteria at home or cohabits with them for an extended period. Dense living conditions make contact between people with pulmonary TB and other family members more frequent (Kenedyanti & Sulistyorini, 2017).

Multivariate Analysis

Based on Table 2, the results of the final stage of multivariate analysis modeling were obtained. The analysis revealed that the most dominant variable influencing pulmonary TB cases in Rantau Alai District was residential density, with a p-value of 0.037 and OR = 3.103 (95% CI: 1.073-8.972). This means that respondents living in houses with unqualified residential density have a 3.103 times greater risk of developing pulmonary TB compared to those living in houses with qualified residential density. The confidence interval (95% CI: 1.073-8.972) indicates that we can be 95% confident that, in the general population,

respondents living in unqualified residential density conditions are 1 to 8 times more likely to experience pulmonary TB compared to those living in qualified residential density.Disease transmission is strongly influenced by housing density. The denser the housing, the easier and faster infectious diseases, particularly airborne diseases, can spread (Rini et al., 2023). High residential density can also cause the rooms to become stuffy, increase the temperature and humidity, and make unhealthy conditions in the house that are conducive for the growth of *Mycobacterium tuberculosis* bacteria. Therefore, it is essential that houses meet disease prevention standards, with a number of residents proportional to the size of the house (Fitri et al., 2022).

CONCLUSION

This study examined the relationship between the physical environment condition of the household and pulmonary TB incidence in Rantau Alai District, Ogan Ilir Regency, in 2023. The analysis focused on how various aspects of the household's physical environment condition, such as ventilation, lighting, humidity, temperature, wall type, floor type, and residential density, are linked to the occurrence of pulmonary TB. The results revealed that residential density was the most significant factor influencing the incidence of pulmonary TB in the district.It is important for adequate physical condition of the household, especially if there are active TB cases in the home environment with unqualified residential density to prevent the spread of TB cases among household contacts.

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