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Regional Case Study

Environmental Factors Associated with Pulmonary Tuberculosis in Martapura's Primary Health Center

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Abstract

Pulmonary TB continues to be a health problem as it is the leading cause of death and ranks 10th in the world. The number of TB cases in South Kalimantan Province reached 5,636. Based on district/city, the highest number of TB cases was in Banjarmasin City with 868 cases, followed by Banjar Regency with 817 cases and Banjarbaru City with 483 cases, while the lowest number was in Balangan Regency with 187 cases. The purpose of this study was to analyse the relationship between ventilation, floor type and lighting with the incidence of pulmonary tuberculosis in the working area of Martapura 1 primary health center, Banjar Regency. This study was an observational analytical study with a case-control design approach. The study population consisted of 90 respondents, 30 people as cases and 60 people as controls. There was an association between ventilation (p-value = 0.03, OR 95% CI 4.5) and the incidence of pulmonary TB. Floor type (p-value = 0.211) and lighting (p-value = 0.577) were not associated with the incidence of pulmonary TB in Martapura 1 Health Centre.

Keywords: Pulmonary Tuberculosis; Air Holes; floor type; lighting

1. Introduction

Tuberculosis (TB) is an infectious disease caused by Mycobacterium Tuberculosis, an acid-fast bacterium (BTA) (Mertaniasih et al., 2013). According to the World Health Organization (WHO) report (Ermalena, 2017), pulmonary TB remains a significant global health issue and was the 10th leading cause of death worldwide in 2016. Pulmonary tuberculosis is one of the targets of the Sustainable Development Goals (SDGs), specifically Goal 3, which aims to end the tuberculosis epidemic by 2030 (Widiyanto, 2016). The primary symptom experienced by patients with pulmonary TB is coughing up phlegm for a duration of two weeks or more. This may be accompanied by additional symptoms, such as phlegm mixed with blood, coughing up blood, shortness of breath, weakness, decreased appetite, weight loss, night sweats without physical activity, and chills lasting for more than one month (Kemenkes RI, 2018; Dotulong et al., 2015). The incidence of pulmonary TB in the world in 2016 was 10.4. This number represents 0.14% of the world's population in the same year. Countries contributing the highest number of cases of pulmonary tuberculosis include India, Indonesia, China, the Philippines, and Pakistan. The estimated incidence of

pulmonary TB in 2016 mostly occurred in the Southeast Asia region (45%) followed by South Africa (25%) (Ermalena, 2017). In 2017 there were 1.4 million (0.019%) deaths plus 0.4 million (0.005%) deaths from TB in HIV-positive people worldwide. According to the 2018 TB case notification, the number of patients with TB disease was 316 cases per 100,000 population, with 88% of cases confirmed. Of these cases, 37% were women, 52% were men, and 11% were children aged 0-14 years. Bacteriological confirmation was 50% per 100,000 inhabitants (WHO, 2018).

Tuberculosis occurs in all countries and all age groups, including children. Based on data from the *Global Tuberculosis Report* (2023), the incidence of TB increased by 3.9% between 2020 and 2022, reaching 10.6 million people in 2022, with 5.8 million men, 3.5 million women, and 1.3 million of them being children. Globally, the TB death rate will be 1.3 million (12%) in 2022. According to the WHO (2022), in 2021 Southeast Asia became the number one contributor to TB cases with a prevalence of 45%. Indonesia will be the second largest contributor to TB cases in the world after India with a proportion of 1,060,000 cases (10%) globally in 2022 (WHO, 2023). The number of TB cases in Indonesia that have been reported is 724,309, with 110,881 TB cases in children under 15 years of age (15.3% of all TB cases) and 40,976 cases in children aged 15-19 years (Health Ministry of Indonesia of, 2023)

Pulmonary TB cases in Indonesia are ranked third in the world. In 2017 the death rate from pulmonary tuberculosis reached 40 per 100,000 population (excluding TB-HIV) and 3.6 per 100,000 population (including TB-HIV), becoming the third highest cause of death. Furthermore, as per the Global TB Report in 2018, the death rate from pulmonary tuberculosis increased to 44 per 100,000 population (both without TB-HIV and with TB-HIV) (Kemenkes RI, 2019). The total number of TB cases in South Kalimantan Province in 2020 show that the total number of TB cases in South Kalimantan Province reached 5,636 cases. By district/city, the highest number of TB cases was in Banjarmasin City with 868 cases, followed by Banjar Regency with 817 cases, and Banjarbaru City with 483 cases while the lowest was in Balangan Regency with 187 cases (Dinas Kesehatan Provinsi Kalimantan Selatan, 2020). The Case Notification Rate (CNR) for all TB cases in Banjar Regency from 2013 to 2017 was 136.21 per 100,000 population (729 cases), 160.07 per 100,000 population (888 cases), 166.47 per 100,000 population (923 cases), and 191.81 per 100,000 population (1080 cases) and 2017 in 186.15 per 100,000 population (1064 cases). The CNR of all TB cases are still above the district strategic plan target, namely CNR 160-180 per 100,000 population (Dinas Kesehatan Kabupaten Banjar, 2017; Dinas Kesehatan Kabupaten Banjar, 2020).

The epidemiological perspective views the occurrence of TB as the outcome of interactions between the three elements of the host, the cause (agent), and the environment (environment) with risk factors being analyzed from these nodes. On the host side, susceptibility to Mycobacterium tuberculosis infection is significantly influenced by a person's immune system at that point in time. In epidemiology, factors that may trigger health problems are human factors, place and time. The human factor is a characteristic of the individual that affects susceptibility to disease. Human characteristics can be genetic factors, age, gender, occupation, habits and socioeconomic status. The magnitude of other health problems that can significantly affect the risk of TB includes HIV, malnutrition, diabetes mellitus, smoking, and other conditions that cause a decrease in bodily resistance. TB germ infection will occur when other people breathe air that contains sputum splashes of people infected with TB. Some factors that affect TB transmission in general include the proximity of contact with the source of transmission, the length of contact time with the source of transmission and the concentration of germs in the air. Ventilation is a place for air exchange, which can bring bacteria into the room. In addition, if the ventilation area does not meet the criteria for a healthy home, it will result in obstruction of the air circulation process and minimal light entering the home, so the tuberculosis bacteria in the home will remain and can be inhaled by other family members through the respiratory system (Pangaribuan et al, 2020).

This research analyses the relationship between ventilation area, floor type and lighting on the incidence of pulmonary tuberculosis in the working area of Martapura 1 Health Centre, Banjar Regency. The lack of coverage of the cure rate has a negative impact on public health and the success of the

programme, as it still provides opportunities for transmission of pulmonary TB disease to family members and the surrounding community. In addition, it allows the resistance of pulmonary TB germs to Anti-Tuberculosis Drugs (OAT), thereby increasing the spread of Pulmonary TB disease, increasing by 8 morbidity and death due to TB. TB patients can be cured by taking medicine completely and regularly. Medicines have been provided free of charge at Fasyankes that have implemented the DOTS strategy, so it is necessary to monitor and evaluate the programme with organised information system that can be well operationalised and can answer the needs of TB eradication programmes (Suryo, 2010).

Pulmonary tuberculosis is part of the effort towards achieving the third goal of the *Sustainable Development Goals* (SDGs), which is to end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases by 2030, and to combat hepatitis, waterborne diseases, and other infectious diseases. This study aims to provide recommendations for the prevention of pulmonary tuberculosis, which is also one of the central issues in the SDGs.

2. Methods

2.1. Research design

This is an observational analytical study with a case-control design approach. Case control studies are observational studies that assess the relationship between disease exposure by determining a group of people with the disease (cases) and a group of people without the disease (controls) (Murti, 2016). This study aims to analyze environmental factors related to the incidence of pulmonary tuberculosis. The environmental factors studied included ventilation, floor type, and lighting in the incidence of pulmonary tuberculosis. The study population includes all pulmonary TB patients and non-TB patients who were in the Work Area of the Martapura 1 Health Centre, Banjar Regency in 2021. This study employed a sample ratio of 1:2, as studies with two controls can offer more information for analysing risk factors and save time statistically. Therefore, the total number of participants was 90. The sample calculation was determined based on the minimum statistical limit, with a sample of 30 respondents for the case group and a control sample of 60 respondents in Banjar Regency in 2021. The sample met the inclusion criteria as it contained complete and traceable address data for the research team (Figure 1).

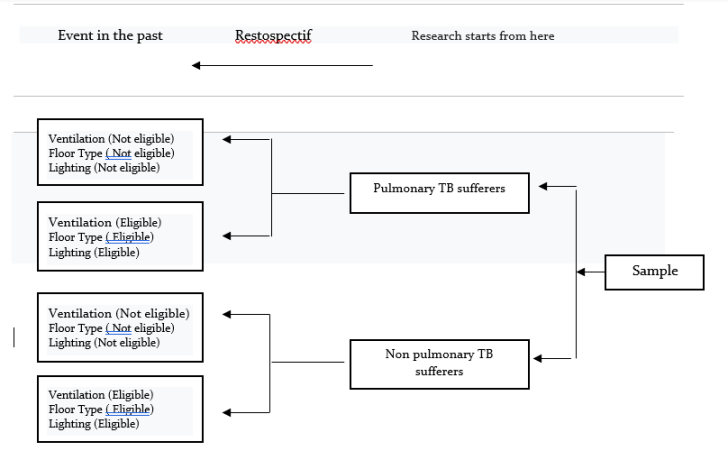

Figure 1. Case control study

2.2. Population and Sample

The analysis of the relationship/correlation consists of a sample of cases and controls. The sampling technique used was exhaustive sampling. The sample of cases that met the inclusion criteria in this study were pulmonary TB patients with a clear address, while the control sample consisted of non-pulmonary TB sufferers or those who had never had pulmonary TB. They had the same sex as the cases, lived close by and were willing to be participate in the study.

2.3. Data Collection Tools

The primary data used in this study are risk factor data obtained from questionnaire interviews with cases and controls. Correlation analysis was carried out using the chi-square test to determine the relationship between environmental risk factors and the incidence of pulmonary TB. Bivariate analysis was carried out as an analytical observational study to answer the research hypothesis for each variable to determine the relationship between the variables studied and the incidence of pulmonary TB.

3. Result and Discussion

The study was conducted at the Martapura 1 Health Centre and obtained 60 respondents consisting of 30 case group respondents (pulmonary TB sufferers) and 30 control group respondents, namely the non-pulmonary TB patient group and the control group selected based on the location adjacent to the case and having the same sex and the same case. The purpose of the univariate analysis is to provide an overview of the frequency distribution of data related to the characteristics of the respondents, the independent variable, and the dependent variable. The description of these variables has shown in Table 1.

Table 1. Distribution and frequency of respondent characteristics

No	Respondent Characteristics	Case (n=30)		Control (n=60)	
		n	%	n	%
1.	Gender				
	Male	15	50	15	50
	Female	15	50	15	50
2.	Age				
	< 50 years	22	73.3	21	70
	> 50 years	8	26.7	9	30
3.	Education				
	Never went to school	1	3.4	1	3.4
	Elementary School	10	33.3	7	23.3
	Junior High School	10	33.3	7	23.3
	Senior High School	6	20	9	30
	College	3	10	6	20
4.	Work				
	Working	16	53.3	19	63.3
	Not Working	14	46.7	11	36.7
5.	Income				
	Less than 1.500.000	20	66.7	16	53.3
	More than 1.500.000	10	33.3	14	46.7

Table 1 shows that there was a total of 60 respondents, with 30 cases and 30 controls. The gender distribution was equal in both groups, with 15 female (50%) and 15 male respondents (50%) in each. Table 1 shows that the age group <50 years old has a higher number of respondents compared to the group >50 years old. Specifically, there were 43 respondents (71.7%) <50 years old and 17 respondents (28.3%) >50 years old. In the case group, 22 respondents (73.3%) <50 years old and 8 (26.7%) >50 years old, while in the control group, 21 respondents (70%) >50 years old and 9 people (30%) <50 years old. Based on table 1, it can be seen that the most recent education of the respondents was elementary and junior high school, namely 17 respondents (28,3%) each, in the case group. Respondents with the last elementary and junior high school education respectively were 10 respondents (33,3%) while in the control group, respondents

with the last elementary and junior high school education respectively were 7 respondents (33,3%). Furthermore, when considering the grouping of respondents in the case and control groups, the most common level of education in the case group was the year of primary and secondary school. Specifically, there were 10 respondents (33,3%) with only a primary school education and 10 respondents (33,3%) with only a secondary school education. However, in the control group, the most recent level of education was high school, with 9 respondents (30%).

Table 1 shows that 35 respondents (58.3%) work, while 25 respondents (41.7%) do not. Furthermore, based on the grouping of respondents in the case and control groups, 16 respondents (53.3%) worked in the case group, while in the control group, 19 respondents (63.3%) worked.

Based on table 1, it can be seen that the income of the respondents is less than Rp. 1.500.000 more than the income of the respondents of more than Rp. 1.500.000, namely 36 respondents (60%) with an income of less than Rp. 1.500.000 and 24 respondents (40%) with an income more than Rp. 1.500.000. Furthermore, when viewed based on the grouping of respondents in the case and control groups, 20 respondents had an income of less than Rp. 1.500.000 more than those who had an income of more than Rp. 1.500.000 in the case group, namely 20 respondents (66,7%), and so did the control group. Respondents who had an income of less than 1,500,000 were more than those who had an income of more than Rp. 1.500.000 in the control group, namely 16 respondents (33,3%). It can be concluded that the respondents, male and female, were divided into 2 with a total of 15 respondents, with more ages <50 years, the last education for cases was primary school and secondary school, while for controls more education was in high school, and they had more jobs and an income of less than 1,500,000.

3.1. The Relationship between Ventilation and the Incidence of Pulmonary TB in the Work Are of the Martapura's Health Center 1

3.1.1. Ventilation

Table 2 shows that 18 cases (60%) of respondents who had pulmonary TB with extensive ventilation conditions did not meet the requirements and 12 cases (40%) met the requirements. Meanwhile, 15 respondents (25%) in the control group with extensive ventilation conditions did not meet the requirements, and 45 respondents (75%) met the requirements. The results of the Chi-square statistical analysis obtained a p-value of 0,03 (<0,05), which means that there is a relationship between the ventilation area and the incidence of pulmonary TB in the working area of the Martapura's Health Centre 1. Odds ratio of 4,500 indicated that respondents who had ventilation conditions did not meet the requirements were at risk of 4,500 times infected with pulmonary TB than respondents who had good ventilation conditions.

Table 2. Relationship between Ventilation and the incidence of pulmonary tb in the work area of the Martapura's Health Center 1

Ventilation	Pulmonary TB				OR 95% CI	*p-value*
	Case		Control			
	n	%	n	%		
Not eligible	18	60	15	25	4.500	0.03
Eligible	12	40	45	75	(1.766-11.467)	
Total	30	100	60	100		

Ventilation is a primary factor in a healthy home, as it provides a place for indoor air exchange. Proper ventilation improves indoor air quality and helps maintain a comfortable room temperature between 18°C and 30°C with a relative humidity of 40% to 70%. According to the study, 60% of the total cases (18 respondents) had houses with inadequate ventilation areas that did not meet the requirements. The bivariate test results indicate a significant relationship between the ventilation area and the incidence

of pulmonary TB at the Maratapura 1 Health Centre. Houses with ventilation areas of less than 10% of the floor area did not meet the requirements. Ventilation is one of the supporting factors for a healthy home as a place for indoor air exchange.

Tuberculosis transmission is influenced by the presence of ventilation. Ventilation functions as a place for air exchange to free air in the room from bacteria, especially pathogenic bacteria that cause tuberculosis (Tanjung et al, 2021). Lack of ventilation causes a lack of oxygen levels, increased CO_2 gas levels, increased air humidity, the temperature in the room rises, and odors appear in the room. This is a risk factor for increasing the occurrence of pulmonary tuberculosis because tuberculosis bacteria can develop and survive for a long time in a damp and dark place. This research aligns with Rahmawati (2021) and Kusuma (2015) said that ventilation is a risk factor for the incidence of tuberculosis, because the ventilation hole area is less than 10% of the floor area so it does not meet the requirements. (Rahmawati, 2021). According to Fatimah's research, ventilation is also a risk factor for tuberculosis (Kanchan et al, 2015; Muchsin et al, 2019).

3.1.2. Floor type

Based on table 3, it shows that there were 6 cases (20%) of respondents who had pulmonary TB with floor type conditions that did not meet the requirements and 24 cases (80%) met the requirements. Meanwhile, there were 5 respondents (8,3%) in the control group who did not meet the requirements and 55 respondents (91,7%) who met the requirements. The results of the Chi-square statistical analysis obtained a p-value of 0,211 (> 0,05), which means that there is no relationship between the type of floor and the incidence of pulmonary TB in the working area of the Martapura's Health Centre 1.

Table 3. Relationship between floor type and the incidence of pulmonary tb in the work area of the Martapura's Health Center 1

Floor Type	Pulmonary TB				OR 95% CI	*p-value*
	Case		Control			
	n	%	n	%		
Not eligible	6	20	5	8,.3	2.750	0.211
Eligible	24	80	55	91.7	(0.765-9.891)	
Total	30	100	60	100		

Kepmenkes number 829/Menkes/SK/VII/1999 on health requirements for housing states that the requirements for housing components require floors that are waterproof and easy to clean. Examples of waterproof floors include ceramics, tiles, and plaster, while non-waterproof floors include soil or damaged plaster. Based on the study results, it was found that 6 respondents (20%) had a floor area that met the requirements. However, the bivariate test did not identify a significant correlation between the type of floor and the incidence of pulmonary TB at the Martapura 1 Health Centre. This may be due to other factors not considered in the study.

The transmission of pulmonary TB through floors is possible if a patient's sputum is spat on the floor, causing TB germs to become airborne and infect those nearby. Moisture on the ground floor can also support the breeding of germs. However, most of the respondents' floors met the necessary requirements and were clean. According to Notoatmodjo, the socio-economic status can affect the condition of the house, including the floor. It was found that most of the respondents' floors did not meet the requirements. It is important to maintain a clean-living environment to prevent the spread of disease. However, it should be noted that some respondents did not regularly sweep their floors. Additionally, the type of dirt floor can contribute to the development of pulmonary TB through indoor humidity. Dirt floors can generate moisture, which can affect the viability of TB germs in the environment. Therefore, the type of floor that meets the requirements can regulate the humidity in the room, potentially

preventing the spread of germs. This study aligns with previous research conducted by Rahmawati (2021) and Kusuma (2015), which found no correlation between the type of flooring and the incidence of tuberculosis. The respondents' houses met the necessary requirements (Rahmawati, 2021). Other researchers Aditama (2019) is a significant correlation between floor type conditions and the incidence of pulmonary tuberculosis in respondents who have poor floor types but there is the same risk as those who have good floor types of being infected with pulmonary TB.

3.1.3. Lighting

Table 4 shows that respondents who experienced pulmonary TB with lighting conditions that did not meet the requirements were 22 cases (73.3%) 19 and as many as 8 cases (26.7%) fulfilled the requirements. Meanwhile, there were 39 respondents (65%) in the control group with lighting conditions that did not meet the requirements and 21 respondents (35%) who met the requirements. The results of the Chi-square statistical analysis obtained a p-value of 0,577 (> 0,05), which means that there is no relationship between lighting and the incidence of pulmonary TB in the working area of Martapura's Health Centre 1.

Table 4. Relationship between lighting and the incidence of pulmonary TB in the work area of the Martapura's Health Center 1

Lighting	**Pulmonary TB**				**OR 95% CI**	***p-value***
	Case		**Control**			
	n	%	**n**	%		
Not eligible	22	73.3	39	65	1.481	0.577
Eligible	8	26.7	21	35	(0.563-3.897)	
Total	30	100	60	100		

Lighting is a risk factor for pulmonary TB because it is related to the killing of bacteria or microorganisms. Lighting is divided into 2 namely natural and artificial lighting. Natural lighting in the form of sunlight is considered effective for killing germs, bacteria, or viruses. The number of disease-causing microorganisms can be further suppressed by the incoming light. The results of the analysis showed that the largest proportion of cases were in the non-eligible category, namely 22 respondents (73,3%). The results of the analysis showed that there was no significant relationship between lighting and the incidence of pulmonary tuberculosis p value 0,579, OR 95% 1,592; CI 0,531-4,775. Even though the results of the study showed that there was no significant relationship, the lighting requirements for healthy homes were 60 lux with conditions not dazzling, and with house conditions that met the standards, the risk factors for pulmonary TB disease could be suppressed properly. This research is in line with research by Vina D (2020) and Mariana (2017) which states that there is no relationship between lighting and the incidence of Tuberculosis (Pongkorung, V.D., 2021).

Mycobacterium tuberculosis bacteria are very sensitive to heat, sunlight, and ultraviolet rays. Direct exposure to ultraviolet rays will kill bacteria within a few minutes. Lighting can be associated with ventilation because ventilation as it can allow light, particularly sunlight, to enter. There needs to be proper ventilation to meet the requirements so that room lighting can also satisfy these requirements. Sunlight is one of the factors that can kill pulmonary tuberculosis bacteria. If the lighting is good in the house, the transmission and spread of tuberculosis germs can be prevented because the Mycobacterium tuberculosis bacteria cannot survive in a place exposed to ultraviolet light from sunlight entering the room (Honorio and Zavatela, 2023; Muhammad et al, 2020). A healthy home requires sufficient sunlight, not too little and not too much. Lack of sunlight entering the house, particularly sunlight, besides being uncomfortable can also be a good medium or place for Tuberculosis germs to live and breed. Lack of lighting can be a good medium for the growth of germs (Shimeles et al, 2019). Accordingly, a healthy house must possess ventilation of more than 10% of the floor area to enable sunlight to enter the house. The

research design used by researchers is a case-control design. This case-control design is prone to bias, namely recall bias and interviewer bias. Recall bias is an information bias that occurs when respondents forget about data related to exposure.

4. Conclusions

The study confirmed an association between ventilation and the incidence of pulmonary TB in the area of Martapura 1 Health Center. The results found that 60% of the total cases had homes with inadequate ventilation areas. The ventilation area in the respondents' homes that did not meet the standards was less than 10% of the floor area. However, no significant relationship was found between floor type or lighting and the incidence of pulmonary tuberculosis in the same area. Future researchers can use spatial analysis to determine the distribution of tuberculosis in the studied population. Martapura 1 Community Health Centre area, with a p-value of 0.03 and an OR of 4,500. However, no significant association was found between floor type or lighting and the incidence of pulmonary TB in the same area. Subsequent researchers could conduct a more in-depth study on the risk factors involved and use spatial analysis to determine the distribution of tuberculosis within the studied population. In addition to others related to the tuberculosis incidence such as window existence and the habit of opening windows

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