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The Influence of Home Environment and Habits on Pulmonary Tuberculosis Transmission in Teminabuan South Sorong District

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ABSTRACT

Introduction: The 2023 report from the Tuberculosis Working Group of the Directorate for Prevention and Control of Communicable Diseases, Ministry of Health of the Republic of Indonesia, showed an increase in detected pulmonary TB cases from 724,309 cases in 2022 to 821,200 cases in 2023. This increase aligns with the coverage rate of pulmonary TB rising from 68% in 2022 to 77% in 2023. The estimated detection of pulmonary TB cases in Indonesia from 2023-2024 is around 1,060,000 cases. At the provincial level, the case notification achievements showed that West Papua Province had a notification coverage of 112%, while West Papua Province had only 66%.

Objective: The aim of this research is to examine the influence of physical environmental factors at home and the habits of pulmonary TB sufferers on the incidence of pulmonary TB as a factor in the transmission of pulmonary TB in South Sorong Regency.

Method: The method used in this research is quantitative analysis with a cross sectional approach by carrying out logistic regression analysis.

Result: The results of the study showed that the type of floor, humidity, the habit of opening and closing windows, cough etiquette and the habit of expelling phlegm were related to the incidence of pulmonary TB. There is no relationship between lighting levels, residential density, ventilation area, temperature and smoking habits on the incidence of pulmonary TB. The habit of expelling phlegm is the variable that has the most influence on the incidence of pulmonary TB (aPR 7.630 95%CI 1.991-29.242)..

Conclusion: This research recommends promotion of stone ethics and monitoring of the housing conditions of pulmonary TB sufferers. Evaluation of programs and infrastructure improvements by the South Sorong District Health Service.

Keywords: Tuberculosis; Physical Environment; Habits; Risk Factors

INTRODUCTION

Data from the Global Report Tuberculosis published in 2021 show that geographically, the highest incidence of tuberculosis (pulmonary TB) occurs in Southeast Asia (45.6%), followed by Africa (23.3%) and the Western Pacific (17.8%). Meanwhile, the lowest incidence occurs in the Middle East (8.1%), the Americas (2.9%), and Europe (2.2%). Ten countries account for two-thirds of the total pulmonary TB cases globally, with India at the top (27.9%), followed by Indonesia (9.2%), and China (7.4%). According to this report, Indonesia ranks third in the incidence of pulmonary TB, with an estimated incidence rate of 8.4%, following India (26%) and China (8.5%). The highest number of pulmonary TB cases was found in adult men, accounting for 56% of the total cases in 2020 (1).

The United Nations (UN) has agreed upon the Sustainable Development Goals (SDGs), one of which includes a strategy to end pulmonary tuberculosis (TB) with a target of reducing TB cases by 80% and TB-related deaths by 90% by 2030. The commitment to diagnose and treat 40 million people with pulmonary TB was established in September 2018. As one of the countries committed to the SDGs, Indonesia pays significant attention to pulmonary TB cases (2).

Indonesia, as the country with the second highest number of pulmonary TB cases after India, had an estimated incidence of 969,000 cases in 2021, equivalent to 354 cases per 100,000 population. Additionally, there were 22,000 cases of TB-HIV per year, or 8.1 per 100,000 population. Although there was a decrease in the incidence and mortality rate of pulmonary TB during the period 2000-2020, an increase in cases was recorded in 2020-2021. It is estimated that there were 144,000 deaths due to pulmonary TB, or 52 deaths per 100,000 population, and 6,500 deaths due to TB-HIV, equivalent to 2.4 per 100,000 population (4).

The 2023 report from the Tuberculosis Working Group of the Directorate for Prevention and Control of Communicable Diseases, Ministry of Health of the Republic of Indonesia, showed an increase in detected pulmonary TB cases from 724,309 cases in 2022 to 821,200 cases in 2023. This increase aligns with the coverage rate of pulmonary TB rising from 68% in 2022 to 77% in 2023. The estimated detection of pulmonary TB cases in Indonesia from 2023-2024 is around 1,060,000 cases. At the provincial level, the case notification achievements showed that West Papua Province had a notification coverage of 112%, while West Papua Province had only 66% (4).

The study of risk factors for tuberculosis (TB) infection has garnered significant attention from experts. In 2013, a theory was developed that influences the progression from TB bacteria exposure to the infection stage and eventually to the final stage of TB disease. There are two major components affecting the progression from exposure to infection and from infection to disease. The host-related risk factors include proximity and duration of close contact, which affect the progression from exposure to infection. Host factors that influence the progression from infection to disease include age, gender, immunity, nutritional status, and comorbid conditions. The second set of factors involves environmental and social components, where housing density, unhealthy homes, alcohol consumption, smoking, cough etiquette, expectoration practices, and window ventilation impact both stages: from exposure to infection and from infection to TB disease (5).

The increase in pulmonary TB cases is closely related to the physical environmental conditions of housing, such as ventilation, temperature, humidity, occupancy density, lighting, flooring, and walls (1). Dense and squalid housing environments with poor air circulation and lack of sunlight can prolong the survival of TB-causing bacteria. Therefore, constructing health-compliant housing is crucial, including ensuring each room has adequate clean airflow and sufficient sunlight to reduce the risk of diseases caused by poor air quality (6).

Research in various locations shows a relationship between housing conditions and community habits with the incidence of pulmonary TB. In Mamasa District, West Sulawesi, smoking habits and poor cough etiquette in homes with high occupancy density are associated with the incidence of pulmonary TB (7)]. In the working area of Puuwatu Community Health Center, Kendari, inadequate ventilation and the habit of not opening house windows were also associated with the incidence of pulmonary TB (2). In Jayapura District, the habit of indiscriminately spitting among the Papuan ethnic community showed a correlation with the incidence of pulmonary TB (7).

Understanding the risk factors for pulmonary TB in specific areas, such as South Sorong District, can help local governments develop effective mitigation strategies. This study aims to increase government attention to pulmonary TB cases and encourage preventive measures by mitigating existing risk factors.

METHOD

This study uses an observational analytical design with a cross-sectional approach to explore how physical home environment factors and patient habits affect pulmonary tuberculosis (TB) transmission. Conducted from May to June 2024 in the Teminabuan Health Center area, South Sorong District, it involves 97 families selected from a population of 2,621 families using Slovin's formula.

Data were collected via home visits, with respondents completing questionnaires and environmental assessments performed by health experts. Key steps included identifying TB patients, gathering case data, developing the questionnaire, mapping TB case distribution, conducting environmental surveys, and training field staff. Data

processing involved editing, coding, entry, and cleaning. Analysis included univariate, bivariate (using chi-square or Fisher's exact test), and multivariate (logistic regression) techniques, with results presented in tables and narratives.

RESULTS

The characteristics of respondents in this study are explained based on the univariate table as follows:

Tabel 1. Demographic Characteristic Respondents

No	Characteristic	Total (n=97)	%
1.	**Age**		
	Productive (19-59 tahun)	78	80,41
	Unproductive (<19 dan >59 tahun)	19	19,59
2.	**Gender**		
	Male	50	51,55
	Female	47	48,45
3.	**Working Status**		
	Work	41	42,27
	Doesn't work	56	57,73
4.	**Home ownership**		
	Ride	20	20,62
	One's own	51	52,58
	Rent	19	19,59
	Heritage	7	7,22
5.	**Ethnic**		
	Native Papua	74	76,29
	No Papua	23	23,71
6.	**Floor Type**		
	Not eligible	53	54,64
	Qualify	44	45,36
7.	**Lighting Level**		
	Below 60 lux	5	5,15
	Qualify	92	94,85
8.	**Residential Density**		
	Congested	5	5,15
	Not solid	92	94,85
9.	**Ventilation area**		
	< 10 % Floor Area	48	49,48
	≥ 10 % Floor Area	49	50,52
10.	**Humidity**		
	Not eligible	92	94,85
	Qualify	5	5,15
11.	**Temperature**		
	Not eligible	5	5,15
	Qualify	92	94,85
12.	**Habit of Opening and Closing Windows**		
	Not eligible	39	40,21
	Qualify	58	59,79
13.	**Cough Ethics**		
	Any cough	63	64,95
	Practice cough etiquette	34	35,05
14.	**Habit of Getting Rid of Phlegm**		
	Get rid of any phlegm	78	80,41
	Get rid of phlegm properly	19	19,59
15.	**Smoking habit**		
	Active smoker	50	51,55
	Not a smoker	47	48,45

The majority of respondents in this study are in the productive age category (19-59 years), with 78 individuals (80.41%). Male respondents (51.55%) outnumber female respondents, although the difference is not substantial. Most respondents are married (80.41%). The highest level of education among the respondents is primary school and junior high school completion (21.65%). A significant portion of the respondents, 56 individuals (57.73%), are unemployed. More than half of the respondents own their homes (52.58%). The majority of the respondents are indigenous Papuans (76.29%).

The floor type of respondents in this study did not meet the requirements (54.64%). The majority of lighting levels in the respondents' homes at the time the measurements were carried out met the requirements of above 60 lux (94.85%). The majority of residential density conditions in the homes of respondents in this study are in the not dense category (94.85%). The ventilation area in this study was divided into two, namely <10% of the floor area (49.48%) which was not much different from ≥10% of the floor area (50.52%). The humidity level in the respondent's house in this study did not meet the requirements (94.85%).

More than half of the respondents in this study had the habit of opening and closing windows in the eligible category (59.79%). The majority of respondents in this study had the habit of coughing randomly (64.95%). Respondents in this study had the habit of throwing up phlegm carelessly (80.41%). Respondents in this study had excessive cigarette consumption (51.55%) To determine the relationship between variables in this study, a bivariate test was carried out as follows:

Tabel 2. Bivariate Analysis

No.	Variabel	PR	95% CI	*p-value*
1.	**Floor Type** Not eligible Qualify	5,476	2,030 – 14,770	0,0001
2.	**Lighting Level** Below 60 lux Qualify	0,758	0,131- 4,398	0,756
3.	**Residential Density** Congested Not solid	1,576	0,168 - 14,769	0,688
4.	**Ventilation area** < 10 % Floor Area ≥ 10 % Floor Area	2,019	0,811 - 5,024	0,128
5.	**Humidity** Not eligible Qualify	12,000	1,276 -112,894	0,008
6.	**Temperature** Not eligible Qualify	0,707	0,619 -0,806	0,154
7.	**Habit of Opening and Closing Windows** Not eligible Qualify	4,156	1,414 - 12,215	0,007
8.	**Cough Ethics** Any cough Practice cough etiquette	5,300	2,043 - 13,748	0,0001
9.	**Habit of Getting Rid of Phlegm** Get rid of any phlegm Get rid of phlegm properly	9,905	3,209 - 30,570	0,0001
10.	**Smoking habit** Active smoker Not a smoker	0,950	0,358 - 2,519	0,918

The results of the bivariate analysis showed that the independent variables that had a significant relationship with the transmission of pulmonary TB (pvalue < 0.05) were the type of floor, humidity, the habit of opening and closing windows, cough etiquette and the habit of expelling phlegm. There is no relationship between the variables of lighting level, residential density, ventilation area, temperature and smoking habits on the transmission of pulmonary TB.

There is a relationship between the type of floor and transmission of pulmonary TB where people who have a type of floor that does not meet the requirements have a 5.5 times higher chance of transmitting pulmonary TB compared to people who have a type of floor that meets the requirements (PR 5.476 95%CI 2.030-14.770) .

There is a relationship between humidity and transmission of pulmonary TB where people who have housing conditions with humidity levels that do not meet the requirements have a 12 times higher chance of transmitting pulmonary TB compared to people who have humidity levels that meet the requirements (PR 12,000 95%CI 1.276 – 112.894).

There is a relationship between humidity and transmission of pulmonary TB where people who have housing conditions with humidity levels that do not meet the requirements have a 12 times higher chance of transmitting pulmonary TB compared to people who have humidity levels that meet the requirements (PR 12,000 95%CI 1.276 – 112.894).

There is a relationship between the habit of opening and closing windows and the transmission of pulmonary TB where people who never open and close windows have a 4.2 times higher chance of transmitting pulmonary TB compared to people who open and close windows (PR 4.156 95%CI 1.414-12.215) .

There is a relationship between cough etiquette and the transmission of pulmonary TB, where people who cough carelessly have a 5.3 times higher chance of transmitting pulmonary TB compared to people who cough using cough etiquette (PR 5,300 95%CI 2,043 – 13,748).

There is a relationship between expelling phlegm and transmission of pulmonary TB, where people who expel phlegm carelessly have a 9.9 times higher chance of transmitting pulmonary TB compared to people who open and close windows (PR 9.905 95% CI 3.209-30.570).

Multivariate analysis was used to determine the physical environmental factors at home and the habits of pulmonary TB sufferers that had the most influence after adjustment. The multivariate test used is logistic regression with the results presented in table 3 as follows:

Tabel 3. Analysis Multivariate

No.	Variabel	PR	aPR	95% CI	*p-value*
1.	**Floor Type** Not eligible Qualify	5,476	3,806	1,181 - 12,268	0,025
2.	**Humidity** Not eligible Qualify	12,000	7,970	0,576 – 110,240	0,121
3.	**Habit of Opening and Closing Windows** Not eligible Qualify	4,156	1,979	0,536 – 7,303	0,305
4.	**Cough Ethics** Any cough Practice cough etiquette	5,300	0,962	0,252 -3,681	0,955
5.	**Habit of Getting Rid of Phlegm** Get rid of any phlegm Get rid of phlegm properly	9,905	7,630	1,991 – 29,242	0,003

The results of multivariate analysis show two variables that are related to the incidence of pulmonary TB. The variables that have a relationship are the type of floor (p value < 0.025 aPR 3.806 95%CI 1.181-12.268) and the habit of expelling phlegm (p value <0.003 aPR 7.630 95%CI 1.991-29.242). After adjusting the multivariate test, the habit variable was obtained. expelling phlegm is the variable that has the most influence on the transmission of pulmonary TB (aPR 7.630 95%CI 1.991-29.242). People who throw phlegm carelessly can cause pulmonary TB 7.6 times compared to people who do not throw phlegm carelessly.

DISCUSSION

The habit of indiscriminate sputum disposal involves the act of expelling sputum or saliva from the mouth without proper disposal. The expelled sputum or saliva serves as a medium for Mycobacterium tuberculosis to spread to different human hosts. Mycobacterium tuberculosis can survive in the air for 20-30 hours if not exposed to ultraviolet light from the sun. Bacteria contained in indiscriminately discarded sputum can survive and infect new hosts if supported by suitable temperature and humidity conditions, thus increasing the risk of transmission (19).

The habit of indiscriminate sputum disposal is common among some individuals. Research conducted in Depok City found that TB patients still disposed of sputum indiscriminately in healthcare facilities (14).

Indiscriminate sputum disposal can increase the transmission of pulmonary TB, as each cough can release approximately 3,000 bacterial particles that can persist under certain conditions. If a pulmonary TB patient disposes of sputum indiscriminately near healthy individuals, it can increase the risk of transmission. Close contact with a pulmonary TB patient who indiscriminately disposes of sputum can transmit the disease to 2-3 people in close proximity (9).

In the working area of Teminabuan Health Center, the habit of indiscriminate sputum disposal is linked to the consumption of betel nut, as evidenced by the presence of betel nut saliva stains in respondents' homes. This indicates a low level of proper sputum disposal practices. The community does not consider TB transmission prevention when disposing of betel nut saliva, as most of them do not dispose of it in sun-exposed locations.

The consumption of betel nut, combined with the habit of indiscriminate sputum disposal by pulmonary TB patients, makes indiscriminate sputum disposal a significant factor in TB transmission in the working area of Teminabuan Health Center. Nearly half of the respondents in the study showed that the distance at which betel nut consumers disposed of their saliva was less than 1 meter from others. This indicates a high potential for rapid bacterial transmission, as droplets from pulmonary TB patients can easily be inhaled by healthy individuals nearby.

The houses in this study were dirty, reflecting low levels of clean and healthy living practices. This is influenced by the community's lack of knowledge regarding cleanliness and health. This is evident in the hand-washing habits of the community, where the majority only wash their hands with water. Understanding and applying knowledge related to cleanliness and health still requires further study and improvement efforts.

The most common house types found in this study were concrete houses and traditional houses. Research conducted in Jayawijaya District showed a relationship between traditional honai houses and TB transmission. The home environment affects TB transmission, with factors such as adequate lighting, good ventilation for air circulation, and sunlight exposure to avoid excessive humidity being influential (19).

This study found no effect of lighting levels, occupancy density, ventilation area, and temperature on TB transmission. This is because the majority of respondents already had adequate lighting, utilizing both natural sunlight during the day and artificial light at night. Lighting levels above 60 lux meant that lighting had no significant relationship with TB transmission. The community in the working area of Teminabuan Health Center had a high number of family members per house. Most of the community had an occupancy density of less than 8m² per person (94.85%). This statistical condition means that occupancy density was not related to TB transmission. Ventilation area did not relate to TB transmission due to the insignificant difference between qualified and unqualified ventilation, with only a one-respondent difference affecting the test results. The majority of the room temperature conditions (94.85%) were categorized as good, thus statistically showing no relationship with TB transmission.

Floor type and humidity showed a relationship with TB transmission. The most common floor types used by the community were wood and ceramic. Research in the working area of Kertapati Health Center, Palembang City, indicated that non-waterproof and dirty floor types were related to TB transmission, compounded by inadequate ventilation health standards. This was exacerbated by the large number of people living in one house, making TB transmission among family members very easy (7). Floor type was a significant environmental factor, with research in the working area of Pekalongan Health Center, East Lampung, showing a strong relationship between house type and TB transmission (12).

Essential elements of a healthy home include waterproof floors, which help maintain good humidity levels. According to the Indonesian Ministry of Health Decree No. 829/MENKES/SK/IIV/1999, floors in permanent homes must be waterproof and easy to clean. For homes with wooden floors or elevated homes, according to the healthy home module published by the Ministry of Public Works in 2011, the floor height must be at least 75 cm above ground level (13). Wooden floors, the most common type found in this study, indicate that the floors used in the Teminabuan Health Center working area are water-absorbing, affecting home humidity.

High-humidity homes can adversely affect residents' health. Humid environments support the growth of microorganisms such as bacteria, spirochetes, rickettsiae, and viruses. These microorganisms can be airborne and infect house residents. Bacteria thrive in high humidity because water constitutes more than 80% of bacterial cell volume, crucial for their growth and survival (5). The wide confidence interval indicates that humidity alone is not a standalone factor influencing TB transmission. The effect of floor type on humidity shows the potential for confounding factors from this variable.

Efforts to maintain cleanliness and health, such as covering the mouth when coughing, opening windows daily, sun-drying mattresses, eating nutritious food, and keeping the home environment healthy, are crucial for creating a clean and hygienic environment. The habit of opening and closing windows is one hygiene practice that is often overlooked (15).

Dark and humid rooms result from the habit of not opening windows, leading to insufficient light and poor air exchange. Such conditions create an ideal environment for bacteria to thrive. Not opening windows daily increases the risk of pulmonary TB because poor air circulation and the lack of sunlight hinder bacterial eradication. This habit

impedes proper air exchange, making the room humid. A room is considered to have good humidity if it ranges between 40-70%. Humidity beyond this range can potentially increase the growth of disease-causing bacteria (2).

Cough etiquette is one of WHO's key guidelines to prevent TB transmission. WHO recommends seven steps to reduce TB spread: screening patients based on symptoms, isolating severe coughers, starting treatment as soon as possible, practicing good coughing habits, using ultraviolet light in upper rooms, ensuring good ventilation, and using masks (16).

Research on the implementation of cough etiquette among pulmonary TB patients and TB transmission to partners found that poor coughing habits by patients did not increase TB risk to those around them. This could be due to other well-implemented infection prevention efforts, such as managing the environment well. A healthy environment, such as a house with good ventilation or the use of ultraviolet light, is crucial for preventing Mycobacterium tuberculosis transmission (3).

Smoking habits in this study showed no relationship, as the distribution of active smokers and non-smokers was not significantly different. This statistical condition, with 50 active smokers and 47 non-smokers, resulted in no relationship between smoking habits and TB transmission in South Sorong District.

CONCLUSION

The study “Impact of Home Physical Environmental Factors and Patient Habits on Pulmonary TB Incidence at Teminabuan Health Center, South Sorong District” provides critical insights into the relationship between environmental and behavioral factors and the transmission of pulmonary TB. This research addresses the initial questions by identifying key factors that influence TB transmission and their broader implications for public health practices. The study reveals that significant physical environmental factors associated with TB transmission include floor type and humidity levels, where homes with non-waterproof and dirty floors, combined with high humidity, create conducive conditions for the survival and spread of Mycobacterium tuberculosis. Additionally, patient habits such as indiscriminate disposal of sputum, improper cough etiquette, and inadequate window opening practices are crucial in reducing the transmission risk. These findings underscore the importance of targeted interventions in both home environment improvements and patient behavior modifications to effectively combat TB transmission. The study's strengths lie in its comprehensive approach, examining both environmental and behavioral factors, which provides a holistic understanding of TB transmission dynamics. However, the study is geographically limited to the Teminabuan Health Center's working area, potentially affecting the generalizability of the results. Additionally, reliance on self-reported behaviors and conditions may introduce reporting biases.

SUGGESTION

Based on the findings of this study, several actionable recommendations are proposed to mitigate the risk of pulmonary TB transmission. It is essential to regularly clean floors and use easy-to-clean flooring materials to reduce the risk of TB transmission. Additionally, improving home ventilation to reduce humidity and prevent the growth of TB bacteria is crucial. For patient habits, educating the community on proper sputum disposal and providing designated places for sputum disposal are necessary steps. Promoting health education on proper cough etiquette, such as covering the mouth with tissue or the arm when coughing, and encouraging regular window opening to improve air circulation inside homes are also vital. Future research should expand the geographical scope to include diverse settings, enhancing the generalizability of the findings, and employ longitudinal designs to observe the impact of interventions over time. Investigating additional environmental factors such as air quality and socioeconomic conditions can also provide further insights. These recommendations, rooted in the conclusions drawn from the research, offer concrete steps for future exploration and practical applications, contributing meaningfully to advancing knowledge and informing decision-making within the field of TB prevention and control.

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