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ORIGINAL ARTICLE

THE INFLUENCE OF LIGHTING, FLOOR TYPE AND WALL TYPE ON THE PULMONARY TUBERCULOSIS IN FARMERS

Pengaruh Pencahayaan, Jenis Lantai dan Jenis Dinding terhadap Kejadian TBC Paru pada Petani

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ABSTRACT

Background: *Mycobacterium tuberculosis* is the bacterium responsible for tuberculosis (TB), a disease primarily spread through droplets from infected individuals. Ponorogo Regency ranks eighth in TB-related mortality in East Java, with Kauman Health Center recording the highest number of TB cases, most of which involve individuals working as farmers. This study aims to investigate how environmental factors such as lighting, floor type, and wall type contribute to the occurrence of pulmonary TB among farmers in the Kauman Health Center area. **Methods:** This research employed an analytical observational design with a case-control approach. A total of 78 who worked as farmers were included, consisting of 39 cases and 39 controls, selected through simple random sampling. Both primary and secondary data were collected using measurement and observation techniques. The study focused on pulmonary TB incidence as the dependent variable, while the independent variables included lighting, floor type, and wall type. Data analysis involved univariate and bivariate methods using logistic regression. **Results:** Findings showed that the majority of respondents lived in homes with inadequate lighting (72%), proper floor types (79%), and acceptable wall types (69%). A significant association was identified between poor lighting and TB incidence among farmers, OR = 3.659 (95% CI: 1.422–9.417). However, no significant relationship was found between TB incidence and either floor type (p=0.366) or wall type (p=0.113). **Conclusion:** Inadequate lighting is significantly associated with pulmonary TB in farmers. In contrast, the type of floor and wall materials did not significantly influence this study.

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ABSTRAK

Latar belakang: *Mycobacterium tuberculosis merupakan bakteri penyebab penyakit Tuberkulosis (TBC), yang umumnya menyebar melalui droplet dari penderita yang terinfeksi. Kabupaten Ponorogo menempati peringkat ke-8 angka kematian TBC di Jawa Timur, dengan jumlah kasus terbanyak berada di wilayah kerja Puskesmas Kauman. Mayoritas penderita TBC Paru di wilayah ini berprofesi sebagai petani. Tujuan penelitian untuk menganalisis pengaruh pencahayaan, jenis lantai dan jenis dinding terhadap kejadian TBC paru pada petani di wilayah kerja Puskesmas Kauman Kabupaten Ponorogo.* ***Metode:*** *Desain penelitian merupakan obeservasional analitik dengan pendekatan case control. Jumlah sampel sebanyak 78 orang, terdiri dari 39 kasus dan 39 kontrol yang dipilih melalui simple random sampling. Data penelitian diperoleh dari data primer dan data sekunder dengan teknik pengukuran dan observasi. Variabel dependen pada penelitian ini adalah kejadian TBC paru pada petani. Sedangkan variabel independen adalah pencahayaan, jenis lantai dan jenis dinding. Analisis data menggunakan analisis univariate dan bivariate dengan menggunakan uji regresi logistik.* ***Hasil:*** *Sebagian besar responden tinggal dirumah dengan tingkat pencahayaan yang tidak memenuhi syarat (72%), jenis lantai yang memenuhi syarat (79%), dan jenis dinding yang memenuhi syarat (69%). Terdapat pengaruh yang bermakna antara pencahayaan (p value 0,007; OR=3,659) terhadap kejadian TBC paru pada petani. Tidak terdapat pengaruh yang signifikan antara jenis lantai (p value 0,366) maupun jenis dinding (p value 0,113) terhadap kejadian TBC paru pada petani.* ***Simpulan:*** *Pencahayaan yang tidak memenuhi syarat memiliki pengaruh yang signifikan dengan kejadian TBC paru pada petani, sedangkan variabel jenis lantai dan jenis dinding tidak memiliki pengaruh pada penelitian ini.*

INTRODUCTION

Pulmonary tuberculosis (TB) is still a global public health problem and is the 3rd goal in the SDGs on healthy and prosperous living, one of which is combating infectious diseases. Pulmonary tuberculosis is one of the 20 leading causes of death and is the leading cause of death after HIV/AIDS (1). Tuberculosis is a contagious disease caused by infection with the bacterium Mycobacterium tuberculosis. The disease is spread through droplet nuclei of people infected with tuberculosis bacilli. Transmission occurs when other people inhale the air when TB patients cough or sneeze (airborne disease) (2).

In 2022, it was estimated that 10.6 million people worldwide were affected by tuberculosis, with 1.1 million deaths attributed to the disease. Indonesia ranks second globally, following India, contributing 13% of new TB cases. According to the 2023 Indonesian Health Profile, there were 724,309 recorded TB cases (2). East Java Province accounted for 78,334 (10.90%) cases, placing it second among all provinces (3).

Based on the type of work, farm laborers are one of the occupations that are vulnerable to TB. Farm labor is a job with a low-income level. Low income causes farm laborers to be included among people with low incomes. In 2021, 36.11% of the poor aged 15 years and over worked in the agricultural sector (4). Although farm laborers have a side job, the average household income is still below the standard of living (5). Low-income individuals are less likely to participate in maintaining environmental health, thus affecting the availability of healthy housing (6).

Based on environmental factors, the components of healthy housing include occupancy density, ventilation area, temperature, humidity, lighting, type of floor, and type of wall that meet the requirements. These conditions affect the growth of agents in the environment, especially the agent that causes TB (7). In addition to income factors, exposure to unhealthy working environments also

makes farmers vulnerable to tuberculosis infection. Farmers are often exposed to chemicals (such as pesticides) and dust, especially when tilling the soil or storing crops. This dust can damage the lungs and weaken the respiratory system, making farmers more susceptible to TB infection (8).

Based on the epidemiological triangle theory approach, the occurrence of a disease is influenced by environmental factors. Environmental factors include occupancy density, ventilation area, temperature, humidity, lighting, floor, and wall type. Among these, lighting, floor, and wall types have been identified as significant contributors to pulmonary TB incidence (9). Inadequate lighting levels (<60 lux) are associated with a 6.226 times higher risk of developing pulmonary TB compared to lighting conditions that meet the standard (≥60 lux). Natural lighting in the form of sunlight contains much ultraviolet, which can kill TBC bacteria, thus minimizing the occurrence of infection (10).

Floors that do not comply with health standards carry a 5.431 times higher risk of pulmonary TB infection than floors that meet the criteria (11). Floors that meet health standards are waterproof and easy to maintain, whereas non-compliant floors typically lack water resistance (12). Similarly, walls that fail to meet the required standards pose a 6.527 times higher risk of pulmonary TB than those that do (13). The type of wall that meets the requirements is made of non-flammable, waterproof, and easy-to-clean materials.

Ponorogo Regency is among the regions in East Java with a high TB mortality rate, ranking 8th at 5.30%. In 2020, the Kauman Health Center service area reported the highest number of TB cases in Ponorogo Regency, totaling 40 cases. According to TB records from Kauman Health Center between 2020 and May 2022, 64 TB cases were reported. Of these, approximately 65% of the patients were farmers. This study examines the influence of environmental factors, including lighting, floor type, and wall type, on the incidence of pulmonary TB among farmers in the working area of Kauman Health Center, Ponorogo Regency.

METHODS

This study employed an analytical observational method using a case-control design. The case population consisted of 58 individuals diagnosed with pulmonary TB between January 2019 and May 2022 who worked as farmers and lived in the working area of the Kauman Health Center, Ponorogo Regency, as recorded in the health center's medical records and occupational data. The control population included individuals without pulmonary TB who worked as farmers and lived in the same area. The sample size was calculated using the Lemeshow formula, based on P1 and P2 values taken from previous studies, with the largest variable outcome used to determine the sample. This study used a ratio of 1:1, with a sample size of 39 cases and 39 control samples.

The sampling technique used was simple random sampling. The outcome variable was the occurrence of pulmonary TB among farmers. In contrast, the independent variable examined was lighting, which was categorized into groups: qualified if the lighting was ≥60 lux and unqualified if <60 lux (14). The house's floor type variable was grouped into two categories: eligible if the floor was made of ceramic or cement, and ineligible if the floor was made of bamboo/soil/ wooden boards/or similar (15). The variable type of wall is grouped into two eligible categories if the type of wall is watertight (wall/brick/brick or the like) and no mold/mildew or similar biological indicators are found. Walls are not eligible if they are made of woven bamboo/wood planks/etc, and mold/mildew or similar biological indicators are found (16).

The research data sources used primary and secondary data, with data collection techniques through interviews, measurements, and observations. Interviews and observations using questionnaires and observation sheets. Lighting measurements were carried out at 09.00-14.00 WIB in rooms that were often used for respondents' activities in one day (24 hours) using a lux meter, while floor type and wall type are determined by direct observation The data were analyzed using logistic regression applied for statistical testing. To minimize bias due to confounding variables (e.g., income, smoking, and house density), researchers collected and controlled these data using logistic regression analysis. Ethical approval for the study was granted by the Health Research Ethics Committee of the Faculty of Dentistry, University of Jember, under decision number: 1582/UN25.8/KEPK/DL/2022 on July 15, 2022.

RESULTS

The number of respondents in this study was 78, consisting of 39 case and 39 control respondents. Based on Table 1, the age category shows that of the total 39 respondents, 28 (72%) respondents in the case group and 25 (64%) respondents in the control group were of productive age. The majority of respondents were male gender in both the case

and control groups, with 28 (72%) respondents and 24 (62%) respondents, respectively. Regarding education, the case group mostly had low education, with 17 (44%) respondents, while in the control group, most had secondary education, with 22 (56%) respondents. Compared to the control group, most TB patients had a low level of education (21% vs. 44%). The interview results showed that most case and control group respondents had low income, with 34 (87%) respondents and 29 (74%) respondents.

From Table 2, the lighting variable obtained the results that most TB patients had unqualified house lighting, 28 (72%), whereas in the control group, as many as 23 (59%) respondents had qualified lighting. The bivariate analysis yielded a p-value of 0.007, indicating a significant association between lighting and the occurrence of pulmonary TB among farmers. The odds ratio (OR) value is 3.659, which means that unqualified house lighting has a risk of 3.659 times of experiencing pulmonary TB compared to houses with qualified lighting. In the variable type of floor, the results obtained by 31 (79%) respondents in the case group and 34 (87%) respondents in the control group had a type of floor that met the requirements. The bivariate test results obtained a p-value of 0.366> 0.05, meaning there is no significant influence of the type of floor on the incidence of pulmonary TB in farmers.

The wall type variable also shows the same thing; in most cases, the case and control group respondents have a type of wall that meets the requirements of 27 (69%) respondents and 33 (85%) respondents, respectively. The results of the statistical test analysis obtained a *p-value of* 0.113 > 0.05, which means there is no significant influence of the type of wall on the incidence of pulmonary TB in farmers. Compared to controls, TB patients more frequently lived in homes with inadequate lighting (72% vs. 41%) and unqualified wall types (31% vs. 15%). While the majority had qualified floors, the proportion was slightly lower in the TB group (79%) compared to controls (87%). These comparisons highlight lighting as this population's most distinguishable environmental factor associated with TB.

Table 1
Distribution of respondent characteristics in the Kauman Health Center Work Area, Ponorogo Regency, 2019-2022

Variables	Case		Control		Total	
	n	%	n	%	n	%
Age						
Non-productive age (< 15 and ≥ 65 years)	11	28	14	36	25	32
Productive age (15-64 years)	28	72	25	64	53	68
Gender						
Female	11	28	15	38	26	33
Male	28	72	24	62	52	67
Education						
High (graduated from high school or university)	10	25	9	23	19	24
Intermediate (Elementary/senior high school graduate)	12	31	22	56	34	44
Elementary (not in school or graduated from elementary school)	17	44	8	21	25	32
Revenue						
High (≥ minimum wage Rp. 1,913,321)	5	13	10	26	15	19
Low (< minimum wage Rp. 1,913,321)	34	87	29	74	63	81

Table 2
Influence of lighting, floor type, and wall type on the incidence of Pulmonary TB among Farmers in the Kauman Health Center Working Area, Ponorogo Regency

Variables	Case		Control		*p*	OR (95% CI)
	n	%	n	%		
Lighting						
Unqualified (if <60 lux)	28	72	16	41	0.007*	3,659
Qualified (if ≥60 lux)	11	28	23	59		1.422<OR<9.417
Floor type						
Not eligible (if the floor is made of bamboo/soil/wood planks/etc.)	8	21	5	13	0.366	1,755
Qualified (if the floor is ceramic/tile/cement)	31	79	34	87		0.519<OR<5.937
Wall type						
Not eligible (if the wall type is not watertight)	12	31	6	85	0.113	2,444
Qualified (if impermeable wall type)	27	69	33	15		0.810<OR<7.374

Source: Primary Data Processed, 2022
* The results are significant (≤0.05)

DISCUSSION

Lighting

The statistical test results obtained that house lighting affects the occurrence of pulmonary tuberculosis among farmers in the Kauman Health Center service area, Ponorogo Regency. This study's results align with the results of research conducted by Siregar and Lubis (17), which states that lighting has a relationship with the incidence of pulmonary tuberculosis with a p-value of 0.030. Other research conducted by Alkatiri et.al (18) stated that there was a significant relationship between lighting and the occurrence of pulmonary TB. Another study conducted by Prakosa (19) also showed similar results, that there was a relationship between lighting and the incidence of pulmonary TB in the Pegirian Surabaya Health Center Working Area, with a p-value of 0.015 (<0.05).

Besides being useful as lighting, lighting is also needed so that the house is not humid and inhibits the growth of Mycobacterium tuberculosis bacteria. Sunlight is more effective than artificial lighting from lamps because sunlight contains ultraviolet (UV), which can kill bacteria. Sunlight can enter the house through windows, glass roof tiles, or glass walls. Lighting in a room is adjusted to the need to see objects around and read. Insufficient lighting can make the room dark, increasing humidity. Bacteria very favor these conditions to multiply (20).

Most respondents had house lighting that did not meet the requirements (<60 lux). Based on the results of measurements taken, it is found that the room lighting in this study that does not meet the requirements is in the range of 6-55 lux, with an average lighting of 28 lux, and those that meet the requirements are in the range of 61-127 lux, with an average lighting of 69 lux. As many as 8% of respondents still do not have windows, causing limited sunlight to enter, and the room is dark even during the day. Although some respondents already have windows, the windows are rarely opened, causing the room to become humid.

Floor Type

Floor type with the incidence of pulmonary TB in this study did not find a significant relationship among farmers in the Kauman Health Center working area, Ponorogo Regency. The results of this study are in line with Research Langkai dkk. (21) stated that floor type has no relationship with the occurrence of pulmonary TB. Similar research, namely by Widiati and Majdi (22), has found no relationship between the type of floor and the occurrence of pulmonary TB. Another study also showed similar results: there was no significant relationship between the type of floor and the incidence of pulmonary TB (p-value=0.671) (23).

The type of flooring plays a role in the occurrence of pulmonary TB because it affects the humidity in the room. Qualified floor types are water-resistant, non-moist, and easy to clean, such as cement, porcelain, ceramic, plaster, and tile. They are higher than the outside yard, with a minimum floor height of 10 cm from the yard and 25 cm from the road surface. Meanwhile, unqualified floor types include dirt, plank, and palm

flooring. Unqualified floor types will increase humidity, thus increasing bacterial growth (24).

Most of the floors in the respondents' houses are made of waterproof materials and are easy to clean, so that they do not get damp. The floors of the respondents' houses are made of ceramic tiles, tiles, or cement, which are qualified flooring materials. Qualified house floors will be more resistant to water seepage so that the humidity in the house can be controlled and bacterial growth can be prevented (25). The lack of significant association may be due to the high prevalence of qualified floors in both groups, reducing variability and statistical power.

Wall Type

Results of this study stated that wall type did not significantly affect the incidence of pulmonary TB among farmers in the Kauman Health Center working area, Ponorogo Regency. Research conducted by Sabila et al (26) stated that the type of wall does not affect the incidence of pulmonary TB. Research Rahmawati et al (27) stated that there was no relationship between the walls of the house and pulmonary TB disease. Another study that is in line with research by Monitja et al (28) which states that there is no relationship between the walls of the house and pulmonary tuberculosis ($p = 0.67$).

Although previous studies have suggested that the type of house wall has no significant association with tuberculosis incidence, these findings may not generally apply to all regions. Each region has its own environmental and socioeconomic characteristics that can influence the dynamics of TB transmission. In this context, a limited study focusing on farmers with agricultural exposure and rural environments, where physical housing characteristics, including wall type, may play a different role.

The wall protects against rain, wind, and heat. The type of wall that meets the requirements is made of non-flammable and waterproof materials so that it is easy to clean, such as bricks, walls, bricks, stones, or the like. The types of walls that do not meet the requirements are those made of woven bamboo, wooden boards, or the like (29).

Respondents in this study, patients with pulmonary TB and non-patients with pulmonary TB, mostly have a type of wall that meets the requirements in the form of bricks, both those that have not been plastered and those that are in the form of neatly painted walls. Qualified walls can reduce humidity and minimize the growth of bacteria (30). The lack of significance of wall type may be due to the uniformity of building materials among households, most of which have brick walls regardless of TB status. It is also possible that wall materials alone do not significantly affect transmission without considering other physical variables within the home.

These findings suggest that TB control programs should integrate environmental health interventions, particularly improving natural lighting in rural homes. Structural modifications such as enlarging windows or using transparent roofing materials could be included in community health outreach or supported through housing improvement subsidies. Moreover, health promotion should educate farmers on the importance of sunlight exposure and daily ventilation.

CONCLUSION

Inadequate home lighting is significantly associated with a higher risk of pulmonary TB among farmers, while floor and wall types did not show significant effects. Health workers are encouraged to routinely assess lighting levels using simple lux meters or standardized observation checklists and to provide tailored advice on improving natural light, such as adding or enlarging windows, installing transparent roofing panels, and ensuring daily ventilation. Collaboration with local authorities and community groups is recommended to support affordable home improvements that meet healthy housing standards.

CONFLICT OF INTEREST

The authors state that this study has no conflict of interest.

AUTHOR CONTRIBUTIONS

AZA developed the research concept, drafted the manuscript, collected and analyzed data, and wrote the introduction and methods section. CAK and SW were responsible for reviewing, revising, and providing feedback. WAKC contributed to data interpretation and provided critical input during manuscript revision.

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