JPH RECODE October 2024; 8 (1): 71-77
http://e-journal.unair.ac.id/JPHRECODE
http://dx.doi.org/10.20473/jphrecode.v8i1.41268

THE INFLUENCE OF HUMIDITY, TEMPERATURE, AND VENTILATION AREA ON THE INCIDENCE OF TUBERCULOSIS AMONG FARMERS IN INDONESIA: A CASE CONTROL STUDY

Aziza Zahrotul Adha, Citra Anggun Kinanthi*
Faculty of Public Health, Universitas Jember, Indonesia
Corresponding Author: citraanggun@unej.ac.id

ARTICLE INFO

Article History:
Received: 06th, December 2022

Review:
From 07th, February 2023

Accepted: 17th, May 2023

ABSTRACT

Background: Tuberculosis is transmitted through infected droplets. Ponorogo Regency is ranked 8th in TB mortality rates in East Java. The highest TB cases in Ponorogo Regency are in the Kauman Community Health Center and most people with pulmonary TB work as farmers. **Purpose:** The aim of the research was to analyze the effect of humidity, temperature, and ventilation area on the incidence of pulmonary TB in farmers in the working area of Kauman Health Center, Ponorogo Regency. **Methods:** The research design is analytical observational with a case control approach. The number of research samples was 39 cases and 39 controls. The sampling technique uses simple random sampling. The research data sources are primary data and secondary data with measurement techniques. The dependent variable in this study is the incidence of pulmonary TB in farmers. Meanwhile, the independent variables are humidity, temperature, and ventilation area. Data analysis uses univariate and bivariate analysis using logistic regression tests. **Results:** Most respondents have houses with humidity levels that do not meet the requirements (59%), room temperatures that do not meet the requirements (79.5%), and ventilation areas that do not meet the requirements (73.5%). There is a significant influence between humidity (p value 0.007; OR=3.753), temperature (p value 0.032; OR=3.889), and ventilation area (p value 0.025; OR=3.437) on the incidence of pulmonary TB in farmers. **Conclusion:** There is a significant influence between humidity, temperature, and ventilation area on the incidence of pulmonary TB in farmers.

Keywords: tuberculosis, humidity, temperature, ventilation area, farmers

Cite this as: Adha, A. Z., & Kinanthi, C. A. 2024. The Influence of Humidity, Temperature, and Ventilation Area on The Incidence of Tuberculosis among Farmers in Indonesia: A Case Control Study. *Journal of Public Health Research and Community Health Development*. 8(1), 71-77. http://dx.doi.org/10.20473/jphrecode.v8i1.41268

INTRODUCTION

Pulmonary tuberculosis is one of the 20 causes of death. Tuberculosis occurs due to infection with the bacteria Mycobacterium tuberculosis. Tuberculosis (TB) is transmitted through droplets from people infected with TB. Transmission occurs if droplets released when coughing or sneezing from someone infected with TB are inhaled by another person (Kemenkes RI, 2020).

Globally, in 2020, it is estimated that 9.9 million people will suffer from TB and 1.3 million of them will die (Kemenkes RI, 2021). The number of TB cases in Indonesia are ranked third in the world after India and China (Kemenkes RI, 2022). Data from the Indonesian Health Profile in 2021 shows that the number of TB cases was 397,377 cases (Kemenkes RI, 2021). East Java Province is in second place with a total of 43,247 (10.9%) TB cases (Dinas Kesehatan Provinsi Jawa Timur, 2022). Ponorogo Regency is one of the areas with the 8th highest TB mortality rate in East Java at 5.3%. The highest number of TB cases in Ponorogo Regency in 2020 was in the Kauman Community Health Center working area with 40 cases. Based on TB data from the Kauman Community Health Center from 2020 to May 2022, there were 64 TB cases reported. Of this number, 65% of TB sufferers work as farmers (Dinas Kesehatan Kabupaten Ponorogo, 2021).

Based on H.L. Blum's theory, the biggest risk factor that affects people's health is environmental factors, including social, economic, political and cultural aspects (Priyoto, 2014). TB is a disease that commonly occurs in low socio-economic groups. According to Dr. Imam Pambudi in Rokom (2023) stated that the highest number of drug-sensitive tuberculosis cases occurred in workers and farmers, up to 54,800 people and 51,900 people respectively (Rokom, 2023). The high number of TB cases among farmers is closely related to the farmers' economic status. Farming is a field of work with a low income category. Low income causes farmers to be among the poor. In 2013, more than 50% of the 28 million poor people in rural areas worked in the agricultural sector (BPS, 2014). Even though farmers have side jobs, the average income of farmer households is still below a decent living standard (Astuti, 2022). Income is closely related to the incidence of pulmonary TB since it influences the ability to provide healthy housing, especially living conditions (Rianto, 2018).

Based on the epidemiological triangle theory approach, there are three factors that influence the incidence of a disease, including environmental factors. Environmental factors that influence the incidence of pulmonary TB include humidity, temperature and ventilation area (Oktriyedi *et al*., 2021). Humidity that does not meet the requirements has a risk of 3.397 times greater of pulmonary TB incidence risk. Room humidity affects the growth of bacteria (Kusumawardani, 2021). High humidity increases the risk of bacterial microorganisms multiplying indoors. Mycobacterium tuberculosis survives in the environment for months in a dark and damp environment. The bacterial cell volume is mostly formed from water (80%), M. Tuberculosis grows well in high air humidity (Pradita *et al*., 2018).

A house temperature that does not meet the requirements has an 88.2% chance of being infected with pulmonary TB. Temperature plays an important role in the growth rate of M. Tuberculosis bacteria. A house temperature that does not meet the requirements is a good place for bacteria to live. M. Tuberculosis bacteria grow optimally at temperatures of 310C-370C (Lestari Muslimah, 2019). Ventilation is a place for air exchange. Ventilation that does not meet the requirements has a 6 times greater risk of pulmonary TB compared to ventilation that meets the requirements (Damayati *et al*., 2018). Air flow in the house will be disrupted if the ventilation area of the house does not meet the requirements and this will result in bacteria in the house trapped and unable to escape with the air flow (Gulo *et al*., 2021).

Based on data collected by the Ministry of Health Republic Indonesia in 2022 that as many as 51,900 farmers contract TB. Therefore, farmers occupy among the top ranking of professions most vulnerable to the transmission of TB. However, TB studies specifically on farmers is scarce. The aim of this research is to analyze the influence of humidity, temperature and ventilation area in the working area of Kauman Health Center, Ponorogo Regency in 2022 on the incidence of pulmonary TB in farmers.

METHOD

Research design

The research method used an analytical observational design with a case control study approach. The study case population was all pulmonary TB sufferers from January 2019 to May 2022 who worked as farmers and lived in the working area of Kauman Health Center, Ponorogo Regency.

Population and sample

The number of population was 58 sufferers based on medical record data on pulmonary TB incidents and data on types of work at Kauman Health Center from 2019 to 2022. The study's control group consisted of 3,352 non-pulmonary tuberculosis patients who were employed as farmers and resided in the Kauman Health Center's working district in Ponorogo Regency. Using P1 and P2 values from earlier study variables that yielded the largest samples, the lemeshow formula was used to determine the sample. There were 39 cases and 39 control samples in the 1:1 research sample. The sampling technique used was simple random sampling.

Data collection

The research in this article used primary and secondary data. Data collection methods included observation, measurement, and interviewing. Questionnaires and observation sheets were used in both observations and interviews. Using observation sheets and measuring tools, measurements were made on a single day (24 hours) in rooms generally utilized by the respondents for their activities. Between 09.00 and 14.00 WIB, a thermohygrometer was used to measure the temperature and humidity. After the values on the thermohygrometer stabilize, it was left on the ground for one to three minutes. By calculating the ratio between the ventilation area and the room's floor area, a roll meter might be used to measure the ventilation area.

Data analysis

The dependent variable was the incidence of pulmonary TB in farmers. The independent variable was humidity, grouped into two categories that met the humidity requirements of 40%-60% and did not meet the requirements of <40% or >60%. The temperature of the house was divided into two groups: eligible temperatures fall between 180 and 3000C, and ineligible temperatures fall between 180 and 3000C. According to the Ministry of Health of the Republic of Indonesia (2011), the ventilation area variable was divided into two groups: eligible if it made up ≥10% of the floor area and not eligible if it made up less than 10% of the floor area. Using logistic regression tests, data analysis was applied both univariate and bivariate.

Ethical clearance

An ethical review was carried out based on the decision of the Health Research Ethics Commission, Faculty of Dentistry, Jember University number: 1582/UN25.8/KEPK/DL/2022 on July 15 2022. Informed consent was taken from each respondent in written form.

RESULT

Kauman Community Health Center was one of 31 community health centers in the Ponorogo Regency area. Northern working area boundaries were Sukorejo District; Eastern working area boundaries were Ponorogo District; Southern working area boundaries were Balong District; and Western working area boundaries were Jambon District. Kauman Community Health Center consists of 11 village areas. Most of the people work as farmers with agricultural products including rice, corn, shallots, ginger, etc (BPS Kabupaten Ponorogo, 2021).

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

Variable	Case		Control	
	n	%	n	%
Age				
Unproductive Age (<15 and ≥ 65 years)	11	28	14	36
Productive Age (15-64 years)	28	72	25	64
Total	39	100	39	100

Continuation of Table 1. Distribution of respondent characteristics in the Kauman Community Health Center Working Area, Ponorogo Regency, 2019-2022

Variable	Case		Control	
	n	%	n	%
Sex				
Female	11	28	15	38
Male	28	72	24	62
Total	39	100	39	100
Education				
High (graduate SHS/University)	10	25	9	23
Middle (graduate Primary School/JHS)	12	31	22	56
Primary (uneducated/graduate primary school)	17	44	8	21
Total	39	100	39	100
Income				
High if ≥ Minimal Wage of Ponorogo (≥ Rp. 1.913.321)	5	13	10	26
Low if < Minimal Wage of Ponorogo (<Rp. 1.913.321)	34	87	29	74
Total	39	100	39	100

According to Table 1, the majority of pulmonary TB sufferers among farmers were of productive age with an age range of 15-64 years amounting to 28 (72%) people. Based on the gender variable, most pulmonary TB sufferers were male which was 28 (72%) people. Regarding the education variable, the majority of pulmonary TB patients—17 (44%), have only completed elementary school, and the majority of pulmonary TB patients—34 (87%)—have low incomes.

Table 2. Effect of humidity, house temperature, and ventilation area on the incidence of pulmonary TB among farmers in the Kauman Health Center Working Area, Ponorogo Regency

Variable	Case		Control		p-value ($\alpha < 0,05$)	OR	95% CI
	n	%	n	%			
Humidity							
Unqualified (<40% and >60%)	29	74	17	44			
Qualified (40% - 60%)	10	26	22	56	0,007	3,753	1,440-9,779
House Temperature							
Unqualified (<18°C and >30°C)	35	90	27	69			
Qualified (18°C - 30°C)	4	10	12	31	0,032	3,889	1,128-13,411
Ventilation Area							
Unqualified (<10% floor area)	33	85	24	62			
Qualified (≥10% floor area)	6	15	15	38	0,025	3,437	1,164-10,152

Based on Table 2, the humidity variable showed that the majority of TB sufferers have house humidity that did not meet the requirements of 29 (74%). Bivariate analysis resulted in a p-value of 0.007, which means that the humidity variable has an association with the occurrence of pulmonary TB in farmers. The OR value was 3.753, which means that house humidity that did not meet the requirements increases the chance of experiencing pulmonary TB 3.753 times compared to a house with humidity that meets the requirements.

In the variable of house temperature obtained results, most of the houses of TB

patients with temperatures did not meet the requirements of 35 (90%). The results of the bivariate test obtained a p value of 0.032, meaning that house temperature has a relationship with the occurrence of pulmonary TB in farmers. The OR value was 3.889, which means that unqualified home temperature conditions increase the chance of 3.889 times to experience pulmonary TB compared to qualifying home temperatures.

The variable of ventilation area obtained the results of the ventilation area of the respondent's house in the case group in the unqualified category of 33 (85%). The results of the bivariate analysis of the ventilation area variable obtained a p-value of 0.025 <0.05 and OR = 3.437, which means that the ventilation area in the unqualified category increases the chance of 3.437 times more infected with pulmonary TB than homes with ventilation area meeting the healthy home requirements.

DISCUSSION

House humidity conditions play a role in the occurrence of pulmonary TB in farmers in the Kauman Health Centre working area, Ponorogo Regency. The results of research conducted by Miharti (2022), found that humidity has a relationship with the incidence of pulmonary TB. Research by Kenedyanti and Sulistyorini (2017) stated the same thing that living in a house where humidity conditions do not meet health requirements will increase the risk of pulmonary TB. The proliferation of bacterial microorganisms is influenced by the humidity conditions of the house. M.TB bacteria can survive for months if the room conditions are dark and humid. High air humidity becomes a growth medium, because most bacterial cells are formed from water (Pradita *et al*., 2018). Most of the respondents' houses did not have a ventilation area that met the requirements, causing a lack of air exchange and increased air humidity.

House temperature is one of the risk factors for pulmonary TB in farmers in the Kauman Health Centre working area, Ponorogo Regency. Research by Maulinda *et al*. (2021) found that room temperature conditions were associated with the occurrence of pulmonary TB with a p-value of 0.001. Similar research, namely research by Mardianti *et al*. (2020) with the results of house temperature with unqualified conditions has a risk of 11,200 times being infected with pulmonary TB.

House temperature in the unqualified category has the potential to become a breeding ground for bacteria and increase the transmission of pulmonary TB. Mycobacterium tuberculosis bacteria grow optimally at temperatures of 310C-370C (Lestari Muslimah, 2019). The temperature conditions of the research respondents' homes were included in the unqualified category because there were still houses of patients with pulmonary TB that did not have ventilation and the bedroom space was only limited by wooden walls, causing minimal air circulation and air temperatures tended to be high.

Ventilation area is a risk for pulmonary TB in farmers in the Kauman Health Centre working area, Ponorogo Regency. Research conducted by Oktavia *et al*. (2016) stated that ventilation affects the occurrence of pulmonary TB (p value = 0.02). Research by Prihartanti *et al*. (2017) stated the same thing that the ventilation area of the house correlated with the occurrence of pulmonary TB with a risk of 7.429 times greater.

Ventilation area <10% floor area included in the category not eligible (Kemenkes RI, 2011). The condition affects a decrease in the oxygen concentration in the room and increases the concentration of carbon dioxide, thereby increasing the humidity. The pathogenic bacteria grow well in conditions of high humidity, one of which is M. TB. There is ventilation and ventilation use aimed at making the air of the room free of pathogen bacteria by diluting the concentration of M. tuberculosis bacteria. Bacteria brought out through ventilation will die after exposure to ultraviolet rays (Purnama, 2016).

Respondents in this study mostly had extensive ventilation conditions that were not eligible, and respondents who had sufficient ventilation in the study respondents did not use ventilation properly so that air circulation was not smooth and caused high humidity.

CONCLUSION

There is a meaningful influence between room humidity, temperature, and ventilation with the occurrence of pulmonary tuberculosis in farmers in the area of work of Kauman Community Health Center , Ponorogo District.

SUGGESTION

The suggestion in this study is that there is cross-sector cooperation between the government of the village, the Community Health Center, or the private to plan home improvement activities that fit the conditions of the healthy home. In addition, the community is expected to be able to modify the home environment so that the intensity of air exchange is sufficient so that temperature and humidity in the room is good.

ACKNOWLEDGMENT

We would like to express our gratitude to all those involved and to help carry out the research.

CONFLICT OF INTEREST

The authors have no conflict of interest with any party.

FUNDING SOURCE

The authors received no specific funding for this work.

AUTHOR CONTRIBUTION

Author Aziza Zahrotul Adha is responsible for Data Collection, Data Analysis, Script Writing, Literature Search and Library Listing. Author Citra Anggun Kinanthi is in charge of Research Design, data collection supervisor, literature and library search, script editor.

REFERENCES

Astuti, N. F. W. 2022. The Socio Demographic of Farmers' Household Food Security in Indonesia: A Literature Review. *Jurnal Kesehatan Masyarakat Mulawarman, 4*(2), 96-110.

BPS. 2014. Analisis Sosial Ekonomi Petani Di Indonesia. Jakarta: Badan Pusat Statistik.

BPS Kabupaten Ponorogo. 2021. Kecamatan Kauman Dalam Angka. Ponorogo: BPS Kabupaten Ponorogo.

Damayati, D. S., A., Susilawaty., & Maqfirah. 2018. Risiko kejadian tb paru di wilayah kerja puskesmas liukang tupabbiring kabupaten pangkep. *Higiene*, *4*(2), pp. 121-130.

Dinas Kesehatan Kabupaten Ponorogo. 2021. Profil Kesehatan Kabupaten Ponorogo Tahun 2020. Ponorogo: Dinas Kesehatan Kabupaten Ponorogo.

Dinas Kesehatan Provinsi Jawa Timur. 2022. Profil Kesehatan Provinsi Jawa Timur 2021. Surabaya: Dinas Kesehatan Provinsi Jawa Timur.

Gulo, A., Warouw, S. P., & Brahmana, N. E. B. 2021. Paru di wilayah kerja upt puskesmas padang bulan kota medan tahun 2020. *Journal Of Healthcare Technology and Medicine, 7*(1), 128-137.

Juniyarti., & Dewi, R. R. K. 2021. Faktor risiko kejadian tuberkulosis paru pada usia produktif di wilayah kerja puskesmas sungai durian. *Media Publikasi Promosi Kesehatan Indonesia (MPPKI), 4*(4), 517–523. https://doi.org/10.56338/mppki.v4i4.1741

Kemenkes RI. 2011. Peraturan Menteri Kesehatan Republik Indonesia Nomor 1077 Tahun 2011 Tentang Pedoman Penyehatan Udara Dalam Ruang Rumah. 2011. Jakarta: Kemenkes RI.

Kemenkes RI. 2020. Pedoman Nasional Pelayanan Kedokteran Tata Laksana Tuberkulosis. Jakarta: Kementerian Kesehatan RI.

Kemenkes RI. 2021. Profil Kesehatan Indonesia Tahun 2020. Jakarta: Kementerian Kesehatan Republik Indonesia.

Kemenkes RI. 2022. Profil Kesehatan Indonesia Tahun 2021. Jakarta: Kementerian Kesehatan Republik Indonesia.

Kenedyanti, E., & Sulistyorini, L. 2017. Analysis of Mycobacterium tuberculosis and Physical Condition of The House with Incidence Pulmonary Tuberculosis. *Jurnal Berkala Epidemiologi, 5*(2), 152–162. https://doi.org/10.20473/jbe.V5I22017.152-162

Kusumawardani, A. 2021. Faktor-faktor yang berhubungan dengan kejadian tb paru di wilayah kerja puskesmas situ udik kabupaten bogor tahun 2020. *Promotor: Jurnal Mahasiswa Kesehatan Masyarakat, 4*(6), 556–568. https://doi.org/10.32832/pro.v4i6.5984

Mardianti, R., Muslim, C., & Setyowati, N. 2020. Hubungan faktor kesehatan

lingkungan rumah terhadap kejadian tuberkulosis paru. *Jurnal Penelitian Pengelolaan Sumberdaya Alam Dan Lingkungan*, *9*(2), 23–31. https://doi.org/10.31186/naturalis.9.2.13502

Maulinda, W. N., Hernawati, S., & Marchianti, A. C. N. 2021. Pengaruh kelembaban udara, suhu dan kepadatan hunian terhadap kejadian tb paru. *Jurnal MID-Z (Midwifery Zigot) Jurnal Ilmiah Kebidanan*, *4*(2), 38–40.

Miharti, I. 2022. Faktor-faktor yang mempengaruhi kejadian tb paru di wilayah kerja puskesmas pamenang tahun 2021. *Jurnal Ilmiah Kesehatan Masyarakat*, *1*(3), 301–308. https://doi.org/10.55123/sehatmas.v1i3.638

Lestari Muslimah, D. D. 2019. Physical Environmental Factors and Its Association with the Existence of Mycobacterium Tuberculosis: A Study in The Working Region of Perak Timur Public Health Center. *Jurnal Kesehatan Lingkungan*, *11*(1), 26–34. https://doi.org/10.20473/jkl.v11i1.2019.26-34

Oktavia, S., Mutahar, R., & Destriatania, S. 2016. Analisis faktor risiko kejadian tb paru di wilayah kerja puskesmas kertapati palembang. *Jurnal Ilmu Kesehatan Masyarakat*, *7*(2), 124–138.

Oktriyedi, F., Fauta, A., & Agustin, A. 2021. Analisis kesehatan lingkungan rumah dengan kejadian tuberkulosis di desa tanjung seteko kecamatan indralaya kabupaten ogan ilir. *Journal of Safety and Health*, *1*(2), 1–12.

Pradita, E. R., Suhartono., & Dewanti, N. A. Y. 2018. Kondisi faktor fisik rumah yang terkait dengan tuberkulosis paru di puskesmas bandarharjo kota semarang. *Jurnal Kesehatan Masyarakat*, *6*(6), 94–102.

Prihartanti, D., Subagyo, A., & Suparmin. 2017. Hubungan lingkungan fisik rumah dengan kejadian tb paru di wilayah kerja puskesmas mirit kabupaten kebumen tahun 2016. *Buletin Keslingmas*, *36*(4), 386–392. https://doi.org/10.31983/keslingmas.v36i4.3118

Priyoto. 2014. *Teori Sikap Dan Perilaku Dalam Kesehatan.* Yogyakarta: Nuha Medika.

Purnama, S. G. 2016. *Buku ajar penyakit berbasis lingkungan.* Jakarta: Ministry of Health of the Republic of Indonesia. 112.

Rianto, B. 2018. Hubungan sosial ekonomi dan kebiasaan merokok dengan kejadian tuberkulosis paru pada pasien rawat jalan. *Jurnal Kesehatan Budi Luhur : Jurnal Ilmu-Ilmu Kesehatan Masyarakat, Keperawatan, Dan Kebidanan*, *11*(2), 265–272. https://doi.org/10.62817/jkbl.v11i2.7

Rokom. 2023. *Pemerintah Fokuskan Penanganan TBC Pada Pekerja*. https://sehatnegeriku.kemkes.go.id/baca/rilis-media/20230317/1542598/pemerintah-fokuskan-penanganan-tbc-pada-pekerja/