Jurnal Kesehatan
Manarang

Jurnal Kesehatan Manarang, 11(1), April 2025, pp. 21 – 33
ISSN 2528-5602 (Online), ISSN 2443-3861 (Print)
doi: https://doi.org/10.33490/jkm.v11i1.1561

ENVIRONMENTAL SANITATION AND PATIENT BEHAVIOR IN TUBERCULOSIS CONTROL: A CASE-CONTROL STUDY IN TALISE HEALTH CENTER, PALU CITY

Mustafa[1]✉, **Hanum Sasmita**[1], **Rizkaningsih**[2]
[1]Department of Environmental Health, Poltekkes Kemenkes Palu, Palu, Indonesia
[2]Department of Nursing, Poltekkes Kemenkes Palu, Palu, Indonesia

ARTICLE INFO

Article history

Submitted : 2024-08-20
Revised : 2025-04-23
Accepted : 2025-04-24

Keywords:

Tuberculosis;
Sanitation;
Behaviour

ABSTRACT

There has been an increase of tuberculosis cases in the Talise Health Centre working area from 2022 to 2023. Sanitation-based interventions and efforts to modify patient behavior in Talise remain limited. Environmental and behavioral factors are known to contribute to the rise in tuberculosis cases. This study was aimed to determine the relationship between environmental sanitation and patient behavior with the incidence of tuberculosis. This research used an analytical survey with a case-control design, conducted in the working area of Talise Health Centre, Palu City. The study sample comprised 40 recorded tuberculosis cases, with a 1:1 case-to-control ratio, resulting in a total of 80 respondents. Controls were selected from nearby neighbors matched by age and sex to the case group. Data were analyzed using univariate and bivariate analyses, with the Chi-Square test applied to describe each variable and assess the relationship between them. The results showed that environmental sanitation significantly influenced the incidence of tuberculosis. Poor environmental sanitation was associated with a 5.476-fold higher risk of developing TB compared to adequate sanitation (p = 0.001, OR = 5.476 [2.099–14.284]). Environmental sanitation factors that showed significant associations included ventilation (p = 0.002), occupancy density (p = 0.004), temperature (p = 0.004), and lighting (p = 0.004). In terms of patient behavior, both attitude and actions were significantly associated with TB incidence. Negative attitudes were linked to a 4.394-fold higher risk of TB (p = 0.003, OR = 4.394 [1.709–11.295]), while poor actions increased the risk by 3.857 times (p = 0.003, OR = 3.857 [1.526–9.750]). This study highlights the critical role of environmental sanitation and patient behavior in the incidence of tuberculosis.

Kata Kunci:

Tuberkulosis;
Sanitasi;
Perilaku

ABSTRAK

Terjadi peningkatan kasus Tuberkulosis di wilayah kerja Puskesmas Talise sejak tahun 2022 – 2023. Intervensi berbasis sanitasi dan upaya mengubah perilaku pasien di Talise masih terbatas. Faktor lingkungan dan prilaku dapat menyebabkan meningkatnya kasus Tuberkulosis. Tujuan penelitian adalah untuk mengetahui hubungan sanitasi lingkungan dan perilaku penderita dengan kejadian Tuberkulosis. Jenis penelitian adalah survey analitik dengan metode *case control*. Penelitian dilakukan di Wilayah Kerja Puskesmas Talise Kota Palu. Sampel penelitian adalah seluruh kasus Tuberculosis yang tercatat pada Puskesmas Talise sebanyak 40 kasus. Perbandingan kasus dengan kontrol yaitu 1:1, sehingga total sampel sebanyak 80 responden.Kontrol berasal dari tetangga terdekat yang memiliki kesamaan umur dan jenis kelamin dengan kelompok kasus. Analisis data yang digunakan yaitu univariate dan bivariate dengan uji Chi-Square yang digunakan untuk mendeskripsikan masing-masing variable dan untuk melihat hubungan antara dua varibel. Hasil penelitian menunjukkan bahwa sanitasi lingkungan meberikan pengaruh terhadap kejadian Tuberkulosis, sanitasi lingkungan yang tidak memenuhi syarat memiliki risiko 5,476 kali lebih besar terkena TB dibandingkan yang memenuhi syarat (p = 0,001, OR = 5,476 [2,099-14,284]). Sanitasi lingkungan yang memiliki hubungan signifikan yaitu ventilasi (0,002), kepadatan hunian (0,004), suhu (0,004) dan pencahayaan (0,004). Untuk perilaku penderita yang mencakup sikap dan tindakan memberikan pengaruh terhadap kejadian Tuberkulosis, Sikap yang negatif memiliki risiko 4,394 kali lebih besar terkena TB dibandingkan yang memiliki sikap positif (p = 0,003, OR = 4,394 [1,709-11,295]). Sedangkan tindakan yang buruk memiliki risiko 3,857 kali lebih besar terkena TB dibandingkan yang memiliki tindakan baik (p = 0,003, OR = 3,857 [1,526-9,750]). Kesimuplan dari penelitian ini yaitu sanitasi lingkungan dan perilaku penderita TB memberikan pengaruh terhadap kejadian TB.

✉ ***Corresponding Author:***
Mustafa
Telp. 082187252696
Email: mtata48@gmail.com

INTRODUCTION

Before the COVID-19 pandemic, tuberculosis (TB) was the leading cause of death from a single infectious agent, surpassing HIV/AIDS. TB remains a major public health concern and one of the leading causes of mortality worldwide. (Bloom et al., 2017; Goletti & Martineau, 2021; Migliori et al., 2019; WHO, 2022a).

In 2021, TB caused approximately 1.6 million deaths and was the 13th leading cause of death globally. It ranked second among infectious diseases after COVID-19. An estimated 10.6 million people were infected, comprising 6 million men, 3.4 million women, and 1.2 million children. The Southeast Asia Region accounted for 46% of new cases, followed by Africa (23%) and the Western Pacific (18%). Around 87% of new cases occurred in 30 high-burden countries, with India, Indonesia, China, the Philippines, Pakistan, Nigeria, Bangladesh, and the Democratic Republic of Congo accounting for more than two-thirds of the global total (Quaife et al., 2020; WHO, 2022b).

The According to the Ministry of Health of Indonesia, 717,941 TB cases were reported in 2022, reflecting a 61.98% increase compared to the 443,235 cases reported in the previous year. Four provinces—West Java, Banten, Gorontalo, and Jakarta—met the TB case notification target by exceeding 90% coverage in 2022. However, 30 other provinces failed to meet the target, including Central Sulawesi Province (Kementerian Kesehatan RI, 2023).

The Central Sulawesi Provincial Health Office reported that the total number of TB cases in the past three years reached 10,207. As of September 2022, Palu City recorded the highest number of cases with 718, followed by Banggai Regency with 579 cases, and Parigi Moutong Regency with 421 cases (Dinas Kesehatan Provinsi Sulawesi Tengah, 2022). In the Talise Health Center working area, 273 suspected TB cases were identified from January to May 2023. This figure represents a substantial increase compared to 343 cases in 2022, 124 in 2021, and even fewer in 2020 (Puskesmas Talise, 2023).

This upward trend highlights Talise as a critical focus area for TB intervention. Despite the increasing burden of TB, sanitation-based interventions and patient behavior modification efforts in Talise remain limited. The combination of high case prevalence and inadequate targeted interventions underscores the urgency of this study, which aims to address gaps in environmental sanitation and behavioral practices that exacerbate TB transmission and adverse outcomes in this region. This research is essential to inform more effective, evidence-based interventions tailored to the specific needs of the Talise community.

TB is transmitted through the air when an infected person coughs, sneezes, or spits. Inhaled TB bacteria can infect others. Approximately 25% of the global population has latent TB infection, in which individuals are exposed to TB bacteria but do not exhibit symptoms and are not contagious. The lifetime risk of developing active TB disease among those with latent infection is estimated at 5–10%. Individuals with weakened immune systems are at greater risk of developing pulmonary TB (Nortajulu et al., 2022; Nur Hasina et al., 2020; Pang et al., 2019).

The onset of pulmonary TB disease is influenced by various factors, including individual, microbial, and environmental factors (Feng et al., 2019; Izzati et al., 2015; Mulu et al., 2015). Individual factors that weaken the immune system such as HIV/AIDS, malnutrition, Diabetes Mellitus (DM), and the use of immunosuppressive drugs can increase vulnerability to TB. Microbial factors include the bacterial load and the duration of exposure to an infected individual. Environmental factors that contribute to TB transmission include poor ventilation, overcrowding, and inadequate lighting (Hansson et al., 2022; Hsu et al., 2021; Mirahmadizadeh et al., 2022). The purpose of this study is to determine the relationship between environmental sanitation and patient behavior with the incidence of tuberculosis.

METHOD

Type of Research

This study used an analytical survey with a case-control design.

Place and Time of Research

The research was conducted in the Working Area of the Talise Health Center, Palu City from February to July 2024.

Population and Sample

The study population comprised all tuberculosis patients in the Talise Health Center working area. The sample consisted of 40 TB cases who received treatment at the Talise health center between January and May 2023. The ratio of case-to-control was 1:1, resulting in a total of 80 respondents. Control were selected from nearby neighbors matched by age and gender to the case group.

The selection of controls from the nearest neighbors was based on logistical efficiency and the similarity of physical environmental conditions, ensuring comparable exposure to relevant environmental factors. To minimize the risk of selection bias, potential controls were interviewed to confirm they had no history of active TB treatment or previous TB diagnosis.

Data Collection

The researchers visited the study site according to the agreed schedule. To obtain approval from the study participants, they met directly with respondents at their homes. The researchers explained the purpose and benefits of the study and ensured that the respondents understood the research process. Afterward, respondents were asked to sign an informed consent form if they agreed to participate. The questionnaire used in this study consisted of two main sections:

1. Environmental Sanitation Indicators which included House ventilation: The area and number of available vents. Housing density: The number of residents in a house relative to the floor area. Room temperature: Measured using a thermometer. Natural lighting: The intensity of sunlight entering the house.
2. Patient Behavior which included Attitude towards treatment: awareness and compliance with TB treatment. Personal hygiene practices: Habits such as covering the mouth when coughing and washing hands.

Respondents were given one day to complete the questionnaire at the study location. The researchers provided instructions on how to fill out the questionnaire and ensured that all items were completed upon return. Validation was conducted by re-checking the questionnaires to ensure the accuracy and relevance of the collected data.

Data Analysis and Processing

Data analysis in this study consisted of univariate and bivariate analyses. The Chi-Square test was used to describe each variable and to assess the relationship between two variables. The data were analyzed using the SPSS version 26 software. Variables with a significance value of $p < 0.05$ were considered statistically significant and were further analyzed using logistic regression to determine whether the variables collectively influenced the incidence of tuberculosis (TB).

For univariate analysis, each variable was categorized as follows:

1. Improper Ventilation: Refers to ventilation types considered inadequate, such as closed or limited vents that restrict healthy air circulation.
2. Non-Waterproof Floors: Homes with floors that absorb water easily (e.g., dirt or poorly maintained floors).
3. Unhealthy House Density: A house is considered overcrowded if there are more than two people per bedroom.
4. Good Lighting: Indicates homes with sufficient natural light, such as those with adequately sized windows that are not obstructed.
5. Good Humidity: Defined as maintaining indoor relative humidity levels between 30% and 60%.
6. Good Wall Type: Refers to wall materials such as concrete or brick that are resistant to damage and can block moisture and contaminated air.

7. Bad Behavior: Includes health-compromising behaviors such as smoking or poor personal hygiene, based on individual responses.

Furthermore, the relationships between these variables and TB incidence were analyzed using the Chi-Square test to determine whether any significant associations existed.

RESULT

Table 1. Characteristics of Respondents

Variabel	TB Disease			
	Case		Control	
	n	%	n	%
Gender				
Male	21	52.2	21	52.2
Female	19	47.5	19	47.5
Age				
<20	1	2.5	1	2.5
21-30	10	25.0	10	25.0
31-40	1	2.5	1	2.5
41-50	7	17.5	7	17.5
>51	21	52.5	21	52.5
Education				
Primary School	13	32.5	16	40.0
Junior high school	13	32.5	14	35.0
Senior high school	11	27.5	9	22.5
College	3	7.5	1	2.5
Occupation				
Civil Servant	1	2.5	5	12.5
Self-employed	10	25.0	6	15.0
Farmer	1	2.5	9	22.5
Trader	7	17.5	7	17.5
Retired	1	2.5	13	32.5
Student	6	15.0	5	12.5
Unemployed	14	35.0	6	15.0

Table 1 shows the characteristics of the study respondents who were divided into two groups, namely the case group (tuberculosis patients) and the control group (healthy individuals).

The majority of respondents in both groups were male (52.2%). In terms of age, most participants were over 51 years old (52.5%). Regarding educational background, the largest proportion of respondents had completed education at the elementary to junior high school level (32.5%), while the proportion of those with higher education was the lowest (7.5%). In terms of occupation, the majority of respondents in the case group were unemployed (35.0%).

Statistical analysis revealed a significant association between home ventilation and the incidence of tuberculosis (TB) in the working area of the Talise Health Center, with a p-value of 0.002 ($p < 0.05$). Individuals living in homes with inadequate ventilation had a 4.90 times higher risk of developing TB, as indicated by an odds ratio (OR) of 4.90 (95% CI: 1.892–12.669). In contrast, floor type was not significantly associated with TB incidence ($p = 0.819$; OR = 1.23; 95% CI: 0.503–3.018).

Occupancy density showed a significant association with TB (p = 0.004; OR = 4.31; 95% CI: 1.692–10.995), indicating that overcrowded housing increased the risk of TB. A similar association was observed for lighting conditions (p = 0.004; OR = 4.31), suggesting that insufficient natural lighting also contributed to higher TB risk. Humidity did not show a significant association (p = 0.654; OR = 1.35), while inadequate indoor temperature conditions were significantly associated with TB (p = 0.004; OR = 4.33). The type of wall material also did not show a statistically significant relationship with TB incidence (p = 0.500; OR = 1.50).

Table 2. Bivariate Test Results on the Incidence of TB

Variabel	Penyakit TB				*p*	OR (95%CI)
	Case		Control			
	n	%	n	%		
Ventilation						
Uneligible	26	65	11	27,5	0,002	4,90 (1,892-12,669)
Meets Requirements	14	35	29	72,5		
Floor Type						
Unwatertight	17	42,5	15	37,5	0,819	1,23 (0,503-3,018)
Watertight	23	57,5	25	62,5		
Residential Density						
Uneligible	27	67,5	13	32,5	0,004	4,31 (1,692-10,995)
Meets Requirements	13	32.5	27	67,5		
Lighting						
Uneligible	27	67,5	13	32,5	0,004	4,31 (1,692-10,995)
Eligible	13	32,5	27	67,5		
Humidity	1	2.5	9	22.5		
Unqualified	23	57,5	20	50	0,654	1,35 (0,560-3,267)
Eligible	17	42,5	20	50		
Wall Type	14	35.0	6	15.0		
Unwatertight	20	50	16	40	0,500	1,50 (0,619-3,637)
Watertight	20	50	24	60		
Temperature						
Uneligible	26	65	12	30	0,004	4,33 (1,696-11,069)
Eligible	14	35	28	70		
Environmental Sanitation						
Uneligible	25	18,5	12	18,5	0,001	5,48 (2,099 – 14,284)
Eligible	15	21,5	28	21,5		
Knowledge						
Low	24	60	12	30	0,013	3,50 (1,386-8,835)
High	16	40	28	70		
Attitude						
Negative	25	62,5	11	27,5	0,003	4,39 (1,709-11,295)
Positive	15	37,5	29	72,5		
Action						
Less	26	65	13	32,5	0,007	3,86 (1,526-9,750)
Good	14	35	27	67,5		
Total	**40**	**100**	**40**	**100**		

Environmental sanitation as a composite variable demonstrated a strong association with TB risk (p = 0.001; OR = 5.48; 95% CI: 2.099–14.284), with poor sanitation increasing the likelihood of infection more than fivefold. In addition, behavioral variables were significantly associated with TB incidence. Respondents with low knowledge had a 3.50 times greater risk (p = 0.013; 95% CI: 1.386–8.835), those with negative attitudes had a 4.39-fold higher risk (p = 0.003; 95% CI: 1.709–11.295), and individuals who practiced poor preventive actions had a 3.86 times greater risk of developing TB (p = 0.007; 95% CI: 1.526–9.750).

Based on the results of multivariate analysis, this study identified significant associations between several factors and the incidence of tuberculosis (TB), including occupancy density, lighting, temperature, knowledge, attitudes, actions, and environmental sanitation. Among these variables, lighting emerged as the most influential factor, with the highest Exp(B) value of 10.115. This indicates that respondents living in poorly lit homes had a 10.115 times greater risk of developing TB compared to those living in well-lit homes.

Table 3. Multivariate Analysis Results

Variabel independent	B	Sig	Exp(B)	95% CI
Residential Density	2,220	0,009	9,206	1,732 – 48,942
Lighting	2,314	0,008	10,115	1,808 – 56,602
Temperature	2,184	0,012	8,884	1,615 – 48,881
Knowledge	1,654	0,039	5,228	1,090 – 25,079
Attitude	2,036	0,022	7,660	1,342 – 43,720
Action	1,862	0,030	6,435	1,202 – 34,451
Environmental Sanitation	1,538	0,045	4,655	1,038 – 20,878
Constant	-7,249	0,000	0,001	

DISCUSSION

Relationship between Environmental Sanitation and TB Incidence

Environmental sanitation encompasses more than just basic components such as latrines, clean water, waste disposal, and sewage systems. It also includes aspects of the physical environment, such as ventilation, humidity levels, temperature, and occupancy density. Maintaining proper sanitary conditions in public areas—particularly within the home—can help prevent the transmission of various diseases (Zahratul Jannah et al., 2023). In this study, environmental sanitation was found to be significantly associated with the incidence of tuberculosis (p = 0.001), based on the results of the bivariate analysis. These findings align with previous studies conducted in Jember and Situbondo, which reported that most TB patients lived in environments with poor hygiene and inadequate sanitation, and that environmental sanitation was strongly related to the occurrence of TB (Cardoso et al., 2017; Fitri et al., 2021; Ma'rufi et al., 2018). Conversely, a study conducted in the working area of the Kesamben Health Center in Blitar Regency reported no significant association between environmental sanitation and TB incidence indicating that contextual and regional differences may influence outcomes (Ali Widyantara & Wardani, 2024).

A well-maintained home environment can contribute significantly to an improved quality of life in terms of health, comfort, and a sense of safety. Poor physical sanitation in the household can cause discomfort and increase susceptibility to illness due to stale air, high humidity, or fluctuating indoor temperatures. These conditions can affect how individuals dress and behave indoors—for example, wearing thick clothes too often due to cold conditions or removing clothes due to heat—which, over time, may negatively impact family health and well-being (Singh, 2023). Sanitation is essentially a health-promoting effort that ensures environmental cleanliness across various settings, including homes, offices, and public spaces. One of the key contributors to disease transmission is environmental hygiene. Cleaner home environments are associated with reduced disease transmission, while poor hygiene can exacerbate it (Celesta & Fitriyah, 2019). In this study, the environmental sanitation indicators assessed included ventilation, occupancy density, temperature, humidity, lighting, and wall type. Overall, environmental health can be defined as the presence of optimal environmental conditions that contribute positively to achieving a good health status. These conditions include adequate lighting, suitable floor types, spacious rooms, sufficient ventilation, and appropriate residential density (Sartiwi & Sandra, 2021).

Relationship of Lighting with TB incidence

The results of the chi-square test showed a significant association between lighting and the incidence of pulmonary tuberculosis (TB), with a p-value of 0.004 ($p < 0.05$). This indicates a relationship between lighting conditions and TB incidence. A comparison of the case and control groups in the Talise Health Center working area revealed that homes in the control group were more likely to have adequate natural lighting, while a higher proportion of homes in the case group lacked sufficient lighting. The lack of lighting in the homes of TB patients was often due to several conditions, including inadequate ventilation (such as a lack of windows, vents, or doors) and the close proximity of neighboring houses, which limited sunlight entry. Natural lighting—defined as sunlight entering the home through windows, glass tiles, or other openings—is an important factor in indoor environmental health (Muhammad et al., 2020).

Sunlight plays a crucial role in killing pathogenic bacteria, including *Mycobacterium tuberculosis*. This bacterium can survive in the air for 1–2 hours, especially in areas with high humidity and poor lighting (Madhona et al., 2017). A study conducted in Eastern Perak found that homes lacking natural sunlight showed a higher presence of *Mycobacterium tuberculosis* (Dwi Lestari Muslimah, 2019). Similarly, research in Denpasar reported that poor natural lighting was commonly observed in the homes of pulmonary TB patients (Dewi et al., 2017).

This finding aligns with a study conducted in Sembung Hamlet, Margopatut Village, Sawahan District, Nganjuk Regency, which concluded that poor lighting was a significant risk factor for TB. Inadequate lighting reduces the effectiveness of natural UV light in killing TB bacteria, thus increasing the risk of transmission. Good lighting can help prevent the spread and reproduction of TB-causing germs (Mayasari et al., 2022). Furthermore, the multivariate analysis in the present study confirmed that lighting had the strongest influence on TB incidence, with the highest Exp(B) value of 10.115. This means that respondents living in poorly lit homes were 10.115 times more likely to contract TB compared to those living in well-lit homes.

Several other studies support the relationship between lighting and TB risk. For example, Wanti et al. (2022) found that many homes in Kupang City did not meet the Ministry of Health's standard of 60 Lux for minimum lighting, a condition that facilitates TB transmission. These poorly lit environments often coincided with poor ventilation and high humidity, exacerbating TB risk (Wanti et al., 2022). Similarly, Yuniar et al. (2021) reported a statistically significant relationship between home lighting and TB incidence ($p = 0.036$), suggesting that improved lighting could serve as a modifiable risk factor in TB prevention (Yuniar et al., 2021).

However, not all studies reported consistent findings. Farsida (2023) found no significant association between lighting and TB incidence among children ($p = 0.200$), possibly due to different study populations or confounding factors such as ventilation or overall housing conditions (Farsida, 2023). In another study, Shabrina et al. (2015) noted that although lighting was related to TB incidence, other environmental factors such as nutritional status and ventilation also played significant roles, indicating that lighting may not be the sole determinant of TB risk (Shabrina et al., 2015).

The role of physical environmental factors—including lighting—in TB transmission is further emphasized by Windarti (2024), who found that poor air circulation and insufficient lighting were significantly associated with TB incidence. These findings highlight the importance of physical housing conditions in controlling the spread of TB (Windarti, 2024).

The relationship between lighting and TB incidence is complex and influenced by multiple environmental factors. While inadequate lighting appears to be a contributing risk factor, it is likely that its impact is compounded by other conditions such as poor ventilation and overcrowding. Nevertheless, improving natural lighting in residential settings—particularly in high-burden areas—may be an effective strategy for reducing the transmission of tuberculosis.

Relationship between Ventilation and Tuberculosis incidence

The results of the chi-square test showed a significant association between ventilation and the incidence of tuberculosis (TB), with a *p*-value of 0.002 ($p < 0.05$). The odds ratio (OR) was 4.896, indicating that individuals living in homes with inadequate ventilation were 4.896 times more likely to develop TB than those with adequate ventilation.

These findings are consistent with previous studies. Wulandari et al. (2023) reported a significant relationship between ventilation and the prevalence of pulmonary TB among individuals of productive age (Wulandari et al., 2023). Similarly, Windarti et al. (2024) found that home air circulation was significantly associated with TB incidence (Windarti et al., 2024). A study conducted in the Aceh Besar Health Center working area also supported this finding, confirming that poor ventilation was a contributing factor to TB transmission (Ajrina et al., 2024).

Observations of respondents' homes revealed that many did not meet the ventilation standards outlined in the Indonesian Ministry of Health Regulation No. 2 of 2023, which recommends a ventilation area of at least 10–20% of the floor area (Kemenkes, 2023). Additionally, many residents were found to rarely open their windows in the morning and evening, leading to increased indoor humidity and reduced air circulation. Furthermore, high residential density may exacerbate the spread of TB in poorly ventilated homes. A study in Tiga Panah District, Karo Regency, found a significant association between

ventilation area and TB case frequency (p = 0.006) (Samuel Marganda Halomoan Manalu et al., 2022). Likewise, Aryani et al. (2022) found a similar relationship in Kebasen District, Banyumas Regency, with a p-value of 0.0001 (Aryani et al., 2022). Conversely, some studies reported different results. For instance, research conducted in Palembang City and in the Rasimah Ahmad Health Center working area in Bukittinggi City found that ventilation was not a significant factor in the incidence of pulmonary TB (Sulung & Amalia, 2018; Suswita et al., 2022)**.**

The Relationship between Housing Density and the Incidence of Tuberculosis

Housing density is one of the key physical environmental factors associated with the risk of tuberculosis (TB). The chi-square test results in this study showed a significant association between housing density and TB incidence, with a p-value of 0.004 ($p < 0.05$). The odds ratio (OR) was 4.314, indicating that individuals living in overcrowded homes were 4.314 times more likely to develop TB compared to those living in homes with adequate occupancy.

High residential density can negatively affect indoor air temperature and quality. It also facilitates the transmission of TB through close contact between infected individuals and others in the household, thereby increasing the risk of disease spread (Suswita et al., 2022). These findings are consistent with research conducted in Tangerang City in 2022, which also reported a significant association between housing density and TB incidence (p = 0.001) (Nurany et al., 2023). Similar results were found in studies carried out in the working areas of the Tawaeli Health Center, the Banjarejo Health Center in Madiun City, and in Central Buton, all of which confirmed that housing density was significantly associated with TB occurrence (Muchammad Rosyid, 2023; Rizkaningsih & Mustafa, 2023; Sukmawati et al., 2023). Housing density is closely related to the quality of indoor air circulation. Higher numbers of residents in a confined space reduce airflow and increase humidity, as human sweat and exhaled water vapor accumulate in the room (Kenedyanti & Sulistyorini, 2017). Crowded living conditions also lead to more frequent contact between individuals with pulmonary TB and their family members, thus accelerating disease transmission (Lolan et al., 2022). To reduce TB transmission risks related to housing density, it is recommended to limit the number of occupants per room and to improve air circulation by regularly opening windows and doors (Monintja et al., 2020).

Relationship of Knowledge with TB incidence

The chi-square analysis revealed a significant relationship between knowledge and the incidence of tuberculosis (TB), with a p-value of 0.013 ($p < 0.05$). These findings are consistent with a study by Andriani et al. (2020), which also showed a significant relationship (p = 0.021) (Andriani et al., 2020). However, contrasting results were found by Yulianita et al. (p = 0.678), suggesting no significant association between knowledge and TB incidence (Nita et al., 2023). Knowledge about tuberculosis is fundamental for effective prevention and treatment. Lack of public awareness often hinders TB control efforts. With adequate knowledge, individuals are more likely to understand the importance of early detection, appropriate treatment, and the necessary preventive behaviors to reduce TB transmission. Increased awareness leads to informed behavior, which plays a crucial role in reducing disease spread. For instance, understanding how TB is transmitted encourages people to adopt practices that prevent exposure and infection (Hidayat et al., 2020).

Tuberculosis is primarily transmitted through the air via droplet nuclei released when an infected person coughs or sneezes. These airborne particles, depending on factors such as ultraviolet exposure, ventilation, and humidity, can remain suspended in the air for 1–2 hours. TB bacteria can survive for extended periods in dark and humid environments, and particles smaller than 5 micrometers can enter the lungs when inhaled by a healthy individual (Christof et al., 2020; Makalew et al., 2019).

Based on the results of the multivariate analysis, knowledge was among the key behavioral factors associated with TB risk, with an Exp(B) value of 5.228. When comparing risk factors from highest to lowest, lighting had the strongest influence (Exp(B) = 10.115), followed by occupancy density (9.206), temperature (8.884), attitude (7.660), knowledge (5.228), action (6.435), and environmental sanitation (4.665). To reduce TB risk, several interventions can be implemented. Improving lighting at home by opening doors and windows in the morning, installing glass tiles, and ensuring adequate ventilation are essential. Reducing occupancy density can also help improve air quality and reduce humidity, limiting TB transmission. In terms of behavioral interventions, health promotion efforts

should focus on increasing public awareness through various media, such as social media campaigns, printed materials, and community outreach. Given that environmental quality is closely linked to socioeconomic factors, improving household income through skills training and support for local entrepreneurship may indirectly contribute to reducing TB risk by enabling better housing and access to health services.

Relationship between Behavior and TB incidence

Health-related behavior in individuals and communities is influenced by various factors, including education level, knowledge, attitudes, and cultural values. Additionally, the availability of healthcare facilities and the behavior of health professionals can play a supporting role in shaping health behavior (Khamai et al., 2024). The behavior of individuals with tuberculosis (TB) is particularly crucial in determining both the incidence and transmission of the disease. Failure to adhere to recommended health protocols may prolong recovery and increase the risk of transmission to others (Australian Commission for Safety and Quality in Healthcare, 2019). One key behavioral factor that can be related to TB include poor levels of knowledge.

Poor knowledge of TB often results in inappropriate behaviors that hinder prevention and treatment efforts. Therefore, public education and counseling are essential in improving awareness and reducing TB transmission (Zulaikhah et al., 2019). Another important behavioral component involves hygiene practices. Unhygienic habits—such as failing to cover the mouth when coughing or neglecting environmental cleanliness—can significantly accelerate TB spread. On the contrary, good hygiene practices and a clean living environment can reduce the risk of transmission (Tria Meriyanti & Sudiadnyana, 2018). In addition to knowledge and hygiene, lifestyle behaviors such as smoking, alcohol consumption, and poor nutrition can compromise the immune system, making individuals more susceptible to TB infection (Rangki & Sukmadi, 2021). Furthermore, treatment-seeking behavior also plays a significant role. Social stigma or financial constraints may cause some TB patients to delay seeking medical care, which contributes to disease progression and continued transmission (Sejati & Sofiana, 2015).

The results of this study showed significant associations between both attitudes ($p = 0.003$) and actions ($p = 0.007$) and the incidence of TB. These findings are supported by previous studies. For instance, Hutajulu (2019) found that TB patients with a positive attitude toward treatment demonstrated better adherence to medication and had a lower risk of relapse (hutajulu, 2019). A study conducted in Ethiopia reported that TB patients who practiced proper coughing etiquette, such as covering their mouth when coughing or sneezing, had a reduced risk of transmitting the disease (Eliso et al., 2015).

Overall, the evidence confirms that positive attitudes and preventive actions are associated with a lower risk of TB infection. These findings are in line with research by Onyango et al. (2021), which found a statistically significant relationship between patient behavior and TB incidence (Onyango et al., 2021). Moreover, knowledge and family involvement have been shown to positively influence self-care behaviors among TB patients (Parwati et al., 2021). A study in India found that most TB patients did not practice preventive behaviors and maintained close contact with family members, contributing to the continued spread of the disease. Therefore, enhancing preventive behaviors—including health education and behavior change communication—is necessary to reduce exposure and transmission risk (Huddart et al., 2018).

CONCLUSION AND SUGGESTION

This study indicates that ventilation, residential density, and lighting are significantly associated with the incidence of tuberculosis ($p < 0.005$). Improving environmental sanitation is essential for TB prevention, reducing transmission risk, and enhancing public health. Health interventions should prioritize clean, well-ventilated, and adequately lit living environments. To understand the long-term impact of changes in sanitation and individual behavior on TB incidence, longitudinal studies are highly recommended.

REFERENCES

Ajrina, A., Sofia, Nurjannah, Usman, S., & Maulana, T. (2024). The Relationship Of The Physical Quality Of Houses With The Incidence Of Pulmonary Tuberculosis In The Working Area Of The

Aceh Besar Health Center. *International Journal of Medical Science and Dental Health*, *10*(11), 21–42. https://doi.org/https://doi.org/10.55640/ijmsdh-10-11-03

Ali Widyantara, L., & Wardani, R. (2024). Hygiene and Environmental Sanitation Practices Againts The Incident of Tuberculosis In The Working Area of Kesamben Health Center Blitar District. *Indonesian Journal of Nutritional Epidemiology and Reproductive*, *7*(2 SE-Articles), 64–72. https://doi.org/10.30994/ijner.v7i2.314

Andriani, S., Andriani, R., & Hudayah, N. (2020). Hubungan Faktor Host dan Lingkungan dengan Kejadian TB Paru di Wilayah Kerja Puskesmas Betoambari. *Kampurui Jurnal Kesehatan Masyarakat (The Journal of Public Health)*, *2*(1), 7–14. https://doi.org/10.55340/kjkm.v2i1.136

Aryani, A. A., Lintang Kusuma Wardani, F., & Rahardjo, S. (2022). Lingkungan Fisik Rumah Sebagai Faktor Risiko Kejadian Tuberkulosis Paru di Kecamatan Kebasen, Kabupaten Banyumas. *Jurnal Ilmiah Kesehatan Masyarakat : Media Komunikasi Komunitas Kesehatan Masyarakat*, *14*(2), 56–62. https://doi.org/10.52022/JIKM.V14I2.333

Australian Commission for Safety and Quality in Healthcare. (2019). Australian Guidelines for the Prevention and Control of Infection in Healthcare. In *National Health Medical Research Council*. National Health and Medical Research Council.

Bloom, B. R., Atun, R., Cohen, T., Dye, C., Fraser, H., Gomez, G. B., Knight, G., Murray, M., Nardell, E., Rubin, E., Salomon, J., Vassall, A., Volchenkov, G., White, R., Wilson, D., & Yadav, P. (2017). *Tuberculosis.* (K. K. Holmes, S. Bertozzi, B. R. Bloom, & P. Jha (eds.)). https://doi.org/10.1596/978-1-4648-0524-0_ch11

Cardoso, B. A., Fonseca, F. de O., Moraes, A. H. A. de N., Martins, A. C. G. S., Oliveira, N. V. da S., Lima, L. N. G. C., Dias, G. A. da S., & Saad, M. H. F. (2017). Environmental aspects related to tuberculosis and intestinal parasites in a low-income community of the Brazilian Amazon. *Revista Do Instituto de Medicina Tropical de Sao Paulo*, *59*, e57. https://doi.org/10.1590/S1678-9946201759057

Celesta, A. G., & Fitriyah, N. (2019). Overview Basic Sanitation In Payaman Village, Bojonegoro District 2016. *Jurnal Kesehatan Lingkungan*, *11*(2 SE-Articles), 83–90. https://doi.org/10.20473/jkl.v11i2.2019.83-90

Christof, C., Nußbaumer-Streit, B., & Gartlehner, G. (2020). [WHO Guidelines on Tuberculosis Infection Prevention and Control]. *Gesundheitswesen (Bundesverband der Arzte des Offentlichen Gesundheitsdienstes (Germany))*, *82*(11), 885–889. https://doi.org/10.1055/a-1241-4321

Dewi, D. P. R., Putra, I. W. G. A. E., Sawitri, A. A. S., & Duarsa, D. P. (2017). Risk factors of pulmonary tuberculosis among diabetes mellitus patients in Denpasar City. *Public Health and Preventive Medicine Archive*, *5*(1), 19–23. https://doi.org/10.53638/phpma.2017.v5.i1.p05

Dinas Kesehatan Provinsi Sulawesi Tengah. (2022). *Profil Kesehatan Provinsi Sulawesi Tengah*.

Dwi Lestari Muslimah, 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. https://doi.org/10.20473/jkl.v11i1.2019.26-34

Eliso, E., Medhin, G., & Belay, M. (2015). Prevalence of smear positive pulmonary tuberculosis among outpatients presenting with cough of any duration in Shashogo Woreda, Southern Ethiopia. *BMC Public Health*, *15*(1), 112. https://doi.org/10.1186/s12889-015-1411-4

Farsida, F. (2023). Relationship Between Nutritional Status and Living Conditions With the Risk of Tuberculosis in Children. *Jurnal Kesehatan Masyarakat*, *18*(3), 341–348. https://doi.org/10.15294/kemas.v18i3.35343

Feng, M., Xu, Y. G., Zhang, X. Y., Qiu, Q., Lei, S. G., Li, J. L., Yuan, W., Song, Q. F., & Xu, J. H. (2019). Risk factors of multidrug-resistant tuberculosis in China: A meta-analysis. *Public Health Nursing (Boston, Mass.)*, *36*(3), 257–269. https://doi.org/10.1111/PHN.12582

Fitri, N., Mufida, D. C., Hermasyah, B., Armiyanti, Y., Agustina, D., & Suswati, E. (2021). Environmental Sanitation, Personal Hygiene, STH Co-infection in TB Patients. *Jurnal Kesehatan Masyarakat*, *16*, 402–410. https://doi.org/10.15294/kemas.v16i3.23639

Goletti, D., & Martineau, A. R. (2021). Pathogenesis and Immunology of Tuberculosis. *Essential Tuberculosis*, 19–27. https://doi.org/10.1007/978-3-030-66703-0_3

Hansson, J., Nordenmark, M., Tjulin, Å., Landstad, B. J., & Vinberg, S. (2022). Socio-Ecological

Factors and Well-Being among Self-Employed in Europe during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*, *19*(13). https://doi.org/10.3390/IJERPH19137840

Hidayat, J., Lee, M.-C., Lee, M.-D., & Chen, C.-H. (2020). The Relationship between Knowledge and Medication Compliance Behavior among Patients with Tuberculosis. *South East Asia Nursing Research*, *2*(2), 46–54. https://doi.org/10.26714/SEANR.2.2.2020.1-9

Hsu, K. J., Carl, E., DiVita, A., Feldman, T., Foulser, A. A., Freihart, B., Madole, J., McNamara, M. E., Rubin, M., Stein, A. T., Tretyak, V., & Smits, J. A. J. (2021). Rising to the Occasion of This COVID-19-Impacted Nation: Development, Implementation, and Feasibility of the Brief Assessment-Informed Skills Intervention for COVID-19 (BASIC). *Cognitive and Behavioral Practice*, *28*(4), 468. https://doi.org/10.1016/J.CBPRA.2021.02.003

Huddart, S., Bossuroy, T., Pons, V., Baral, S., Pai, M., & Delavallade, C. (2018). Knowledge about tuberculosis and infection prevention behavior: A nine city longitudinal study from India. *PloS One*, *13*(10), e0206245. https://doi.org/10.1371/journal.pone.0206245

hutajulu, johansen. (2019). Hubungan Perilaku Dengan Kepatuhan Minum Obat Pada Penderita Tuberkulosis Paru Di Puskesmas Helvetia Tahun 2018. *JURNAL HEALTH REPRODUCTIVE*, *4*(2), 1–8.

Izzati, S., Basyar, M., & Nazar, J. (2015). Faktor Risiko yang Berhubungan dengan Kejadian Tuberkulosis Paru di Wilayah Kerja Puskesmas Andalas Tahun 2013. *Jurnal Kesehatan Andalas*, *4*(1). https://doi.org/10.25077/JKA.V4I1.232

Kemenkes. (2023). *Peraturan Menteri Kesehatan Nomor 2 Tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan*. Jakarta.

Kementerian Kesehatan RI. (2023). *Deteksi TBC Capai Rekor Tertinggi di Tahun 2022*.

Kenedyanti, E., & Sulistyorini, L. (2017). Analisis Mycobacterium Tuberculosis Dan Kondisi Fisik Rumah Dengan Kejadian Tuberkulosis Paru. *Jurnal Berkala Epidemiologi*, *5*(2), 152–162. https://doi.org/10.20473/jbe.v5i2.2017.152-162

Khamai, N., Seangpraw, K., & Ong-Artborirak, P. (2024). Using the health belief model to predict tuberculosis preventive behaviors among tuberculosis patients household contacts during the covid-19 pandemic in the border areas of northern Thailand. *Journal of Preventive Medicine and Public Health*, *57*(3), 223–233. https://doi.org/10.3961/JPMPH.23.453

Lolan, Y., Permana, I. S., & Akmal, D. (2022). Relationship of Environmental Factors with the Incidence of Tuberculosis. *Himalayan Journal of Community Medicine and Public Health*, *3*(3), 1–5. https://doi.org/10.47310/Hjcmph.2022.v03i03.001

Ma'rufi, I., Khorir, A., Ali, K., & Nugroho, H. (2018). The level of environmental Sanitation and the Incidence of Tuberculosis in Jember and Situbondo, Indonesia. *Indian Journal of Public Health Research & Development*, *9*, 330. https://doi.org/10.5958/0976-5506.2018.00308.X

Madhona, R., Ikhwan, Z., & Aminin, F. (2017). Physical Environment Home and Incidence of TB Disease in Tanjungpinang District. *Advances in Health Sciences Research*, *1*(PHICo 2016), 126–130. https://doi.org/10.2991/phico-16.2017.77

Makalew, L., Kuntoro, Otok, B., Soenarnatalina, M., & Dra, E. (2019). Spatio of Lungs Tuberculosis (Tb Lungs) in East Java Using Geographically Weighted Poisson Regression (GWPR). *Indian Journal of Public Health Research & Development*, *10*, 1830. https://doi.org/10.5958/0976-5506.2019.02115.6

Mayasari, E., Risnasari, D., & Chei, N. E. (2022). Analysis of Pulmonary Tuberculosis based on Home Sanitation in Sembung Hamlet, Margopatut East Java. *STRADA Jurnal Ilmiah Kesehatan*, *11*(1), 78–83. https://doi.org/10.30994/sjik.v11i1.894

Migliori, G. B., Nardell, E., Yedilbayev, A., D'Ambrosio, L., Centis, R., Tadolini, M., Van Den Boom, M., Ehsani, S., Sotgiu, G., & Dara, M. (2019). Reducing tuberculosis transmission: a consensus document from the World Health Organization Regional Office for Europe. *European Respiratory Journal*, *53*(6), 1900391. https://doi.org/10.1183/13993003.00391-2019

Mirahmadizadeh, A., Rezaei, F., Jokari, K., Moftakhar, L., Hemmati, A., Dehghani, S. S., Hassani, A. H., Lotfi, M., Jafari, A., & Ghelichi-Ghojogh, M. (2022). Correlation between environmental factors and COVID-19 indices: a global level ecological study. *Environmental Science and Pollution Research International*, *29*(11), 16667–16677. https://doi.org/10.1007/S11356-021-

16876-X

Monintja, N., Warouw, F., Roni, O., Program, P., Ilmu, S., Masyarakat, K., Kesehatan, F., Universitas, M., Ratulangi, S., & Belakang, A. L. (2020). Keadaan Fisik Rumah dengan Kejadian Tuberkulosis Paru. *Indonesian Journal of Public Health and Community Medicine*, *1*(3), 93–99. https://doi.org/10.35801/IJPHCM.1.3.2020.28991

Muchammad Rosyid, dan A. S. M. (2023). Hubungan Kondisi Fisik Rumah dan Kebiasaan Merokok Dengan Kejadian Tuberculosis di Wilayah Kerja Puskesmas Banjarejo Kota Madiun. *Jurnal Ilmu Kesehatan*, *11*(2), 76. https://doi.org/https://doi.org/10.32831/jik.v11i2.457

Muhammad, A., Lestari, P., & Widodo, A. (2020). The Ventilation-to-area Ratio and House Lighting Relate to the Incidence of Pulmonary Tuberculosis. *Althea Medical Journal*, *7*, 1–5. https://doi.org/10.15850/amj.v7n1.1821

Mulu, W., Mekonnen, D., Yimer, M., Admassu, A., & Abera, B. (2015). Risk factors for multidrug resistant tuberculosis patients in Amhara National Regional State. *African Health Sciences*, *15*(2), 368–377. https://doi.org/10.4314/AHS.V15I2.9

Nita, Y., Budiman, H., & Sari, E. (2023). Hubungan Pengetahuan, Kebiasaan Merokok Dan Riwayat Kontak Serumah Dengan Kejadian Tb Paru. *Human Care Journal*, *7*(3), 724. https://doi.org/10.32883/hcj.v7i3.2060

Nortajulu, B., Hermawan, D., Jl Ir Sumantri Brojonegoro No, L., Meneng, G., Rajabasa, K., Bandar Lampung, K., Ilmu Sosial dan Politik, F., & Lampung Jl Ir Sumantri Brojonegoro No, U. (2022). Faktor-faktor yang Berhubungan dengan Kesembuhan TB Paru. *Jurnal Penelitian Perawat Profesional*, *4*(4), 1207–1216. https://doi.org/10.37287/JPPP.V4I4.1215

Nur Hasina, S., Keperawatan dan Kebidanan, F., & Nahdlatul Ulama Surabaya, U. (2020). Pencegahan Penyebaran Tuberkulosis Paru Dengan (BEEB) Batuk Efektif Dan Etika Batuk Di Rw. VI Sambikerep Surabaya. *Community Development Journal : Jurnal Pengabdian Masyarakat*, *1*(3), 322–328. https://doi.org/10.31004/CDJ.V1I3.1019

Nurany, H., Raharjo, M., & Sakundarno, M. (2023). The Relationship between the Quality of the Physical Environment of the House and the Incidence of Pulmonary Tuberculosis in Tangerang City in 2022. *Contagion: Scientific Periodical Journal of Public Health and Coastal Health*, *5*(2), 514. https://doi.org/10.30829/contagion.v5i2.15157

Onyango, P. A., Ter Goon, D., & Rala, N. M. D. (2021). Knowledge, Attitudes and Health-seeking behaviour among Patients with Tuberculosis: A Cross-sectional Study. *The Open Public Health Journal*, *13*(1), 739–747. https://doi.org/10.2174/1874944502013010739

Pang, Y., An, J., Shu, W., Huo, F., Chu, N., Gao, M., Qin, S., Huang, H., Chen, X., & Xu, S. (2019). Epidemiology of Extrapulmonary Tuberculosis among Inpatients, China, 2008-2017. *Emerging Infectious Diseases*, *25*(3), 457–464. https://doi.org/10.3201/EID2503.180572

Parwati, N. M., Bakta, I. M., Januraga, P. P., & Wirawan, I. M. A. (2021). A Health Belief Model-Based Motivational Interviewing for Medication Adherence and Treatment Success in Pulmonary Tuberculosis Patients. *International Journal of Environmental Research and Public Health*, *18*(24). https://doi.org/10.3390/IJERPH182413238

Puskesmas Talise. (2023). *Laporan Puskesmas Talise*.

Quaife, M., Houben, R. M. G. J., Allwood, B., Cohen, T., Coussens, A. K., Harries, A. D., van Kampen, S., Marx, F. M., Sweeney, S., Wallis, R. S., & Menzies, N. A. (2020). Post-tuberculosis mortality and morbidity: valuing the hidden epidemic. *The Lancet Respiratory Medicine*, *8*(4), 332–333. https://doi.org/10.1016/S2213-2600(20)30039-4

Rangki, L., & Sukmadi, A. (2021). Hubungan Perilaku dengan Kejadian Tuberkulosis Paru di Kabupaten Muna. *Health Care : Jurnal Kesehatan*, *10*(2), 346–352. https://doi.org/10.36763/healthcare.v10i2.153

Rizkaningsih, R., & Mustafa, M. (2023). Hubungan Kondisi Fisik Lingkungan Rumah dengan Kejadian TBC (Tuberculosis). *Jurnal Promotif Preventif*, *6*(2 SE-Articles). https://doi.org/10.47650/jpp.v6i2.784

Samuel Marganda Halomoan Manalu, Deli Syaputri, Tisnawati Tanjung, & Theodorus Teddy Bambang Soedjadi. (2022). Faktor Risiko Kondisi Lingkungan Fisik Rumah Dengan Penderita Tb Paru. *Jurnal Ilmiah PANNMED (Pharmacist, Analyst, Nurse, Nutrition, Midwivery, Environment, Dentist)*, *17*(1), 63–70. https://doi.org/10.36911/pannmed.v17i1.1264

Sartiwi, W., & Sandra, R. (2021). Relationship Environmental Sanitation With The Incident Of Pulmonary Tuberculosisin Public Health Center Sikakap Mentawai Islands. *International Journal of Advanced Research*, *9*(5), 1213–1218. https://doi.org/10.21474/IJAR01/12958

Sejati, A., & Sofiana, L. (2015). Faktor-Faktor Terjadinya Tuberkulosis. *Jurnal Kesehatan Masyarakat*, *10*(2), 122. https://doi.org/10.15294/kemas.v10i2.3372

Shabrina, I., Basyar, M., & Nazar, J. (2015). Faktor Risiko Yang Berhubungan Dengan Kejadian Tuberkulosis Paru Di Wilayah Kerja Puskesmas Andalas Tahun 2013. *Jurnal Kesehatan Andalas*, *4*(1). https://doi.org/10.25077/jka.v4i1.232

Singh, A. (2023). Design &Amp; Development of a Air Pollution Monitoring Using Smartphone. *International Journal of Engineering Technology and Management Sciences*, *7*(3), 489–493. https://doi.org/10.46647/ijetms.2023.v07i03.68

Sukmawati, Amiruddin, E., & Meilani, N. (2023). Analysis of the Relationship between the Physical Conditions of the House, Smoking and the Incidence of Pulmonary Tuberculosis in Central Buton. *International Journal of Scientific Multidisciplinary Research*, *1*(5), 361–374. https://doi.org/10.55927/ijsmr.v1i5.4373

Sulung, N., & Amalia, N. G. (2018). Status Gizi, Ventilasi, Kebiasaan Merokok Dan Peran Tenaga Kesehatan Dengan Kejadian TB Paru. *Jurnal Pembangunan Nagari*, *3*(2), 65. https://doi.org/10.30559/jpn.v3i2.107

Suswita, E., Hasyim, H., & Windusari, Y. (2022). Analisis Hubungan Kondisi Lingkungan Dan Perilaku Pasien Dengan Kejadian TB Paru. *Jurnal Kesehatan*, *13*(2), 104–114. https://doi.org/10.35730/jk.v13i0.864

Tria Meriyanti, N. K. A., & Sudiadnyana, I. W. (2018). Hubungan Sanitasi Rumah Dengan Kejadian Tuberkulosis Paru Di Wilayah Kerja Puskesmas Ii Denpasar Barat. *Jurnal Kesehatan Lingkungan (JKL)*, *8*(1), 9–12. https://doi.org/10.33992/jkl.v8i1.342

Wanti, W., Agustina, A., Singga, S., & Respati, T. (2022). Physical Environmental Conditions and Germ Number in Bedroom of Tuberculosis Patients in Kupang City, East Nusa Tenggara Province. *Global Medical and Health Communication*, *10*(2), 122–127. https://doi.org/10.29313/GMHC.V10I2.10144

WHO. (2022a). *Global Tuberculosis Report 2022*.

WHO. (2022b). *Laporan Kasus Tuberkulosis (TBC) Global dan Indonesia 2022* .

Windarti. (2024). The Relationship Between the Physical Condition of the Home Environment and History of Disease With the Incidence of Tuberculosis in the Working Area of the Rangkasbitung Health Center in 2023. *Ijamesc*, *2*(2), 606–618. https://doi.org/10.61990/ijamesc.v2i2.218

Windarti, Ismarina, & Ikhlasiah, M. (2024). The Relationship Between The Physical Condition Of The Home Environment And History Of Disease With The Incidence Of Tuberculosis In The Working Area Of The Rangkasbitung Health Center In 2023. *International Journal of Accounting, Management, Economics and Social Sciences (IJAMESC)*, *2*(2), 606–618. https://doi.org/10.61990/IJAMESC.V2I2.218

Wulandari, R., Budiyono, B., Sulistiyani, S., & Wahyuningsih, E. (2023). The Relationship between Ventilation and Physical Quality of Houses with Pulmonary Tuberculosis Cases in the Working Area of Sragen Primary Healthcare Center, Sragen Regency. *JURNAL KESEHATAN LINGKUNGAN* , *15*(1), 76–83. https://doi.org/10.20473/JKL.V15I1.2023.76-83

Yuniar, I., Rusmindarti, S., & Sarwono, S. (2021). The Level of Lighting and Ventilation on the Incidence Rate of Pulmonary TB. *Proceedings of the 2nd Borobudur International Symposium on Humanities and Social Sciences-EAI*. https://doi.org/10.4108/EAI.18-11-2020.2311724

Zahratul Jannah, R., Azizah, R., Binti Jalaludin, J., Sulistyorini, L., & Scorpia Lestari, K. (2023). Meta-Analysis Study: Environmental Risk Factors of Tuberculosis (TB). *Jurnal Kesehatan Lingkungan*, *15*(2), 84–91. https://doi.org/https://doi.org/10.20473/jkl.v15i1.2023.84-91

Zulaikhah, S. T., Ratnawati, R., Sulastri, N., Nurkhikmah, E., & Lestari, N. D. (2019). Hubungan Pengetahuan, Perilaku dan Lingkungan Rumah dengan Kejadian Transmisi Tuberkulosis Paru di Wilayah Kerja Puskesmas Bandarharjo Semarang. *Jurnal Kesehatan Lingkungan Indonesia*, *18*(2), 81. https://doi.org/10.14710/jkli.18.2.81-88