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SPATIAL ANALYSIS OF THE RISK FACTORS OF THE PHYSICAL HOME ENVIRONMENT WITH THE INCIDENT OF TUBERCULOSIS AND ECO ENZYME IN REDUCING THE INCIDENT OF TUBERCULOSIS IN WORK AREAS TANJUNG MORAWA DISTRICT HEALTH CENTER DELI SERDANG 2024

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Track Record Article Accepted: Published:	Abstract <i>Tuberculosis is an infectious disease caused by the Mycobacterium tuberculosis bacteria. This bacteria is spread from TB sufferers through the air and usually attacks the lungs. The North Sumatra Provincial Health Office reported 2,967 cases of tuberculosis in Deli Serdang Regency. Based on a preliminary survey, the Deli Serdang area is characterized by damp houses, inadequate ventilation, dust, and inadequate lighting, all of which pose a high risk of Mycobacterium tuberculosis infection.</i> <i>Spatial analysis is used to determine spatial variations in both disease incidence and risk factors, allowing mapping to determine the geographic distribution of potential disease risks and their relationship to existing environmental risk factors. Given the high incidence of tuberculosis, research is needed to determine the distribution patterns and risk of tuberculosis and the production of eco-enzymes in the Tanjung Morawa Community Health Center, Deli Serdang Regency.</i> <i>The purpose of this study was to determine environmental risk factors and the distribution pattern of tuberculosis in the working area of Tanjung Morawa Community Health Center, Deli Serdang Regency. The benefit of this study was to determine the distribution of environmental risk factors in relation to tuberculosis incidence so that it can be used as input for the health department in the context of tuberculosis control activities. This research method was observational analytic with a case control design to obtain an overview of the distribution pattern of tuberculosis and environmental factors using a geographic information system application. The population of this study was all residents in the working area of Tanjung Morawa Community Health Center, totaling 414 people. The research sample was taken using the Slovin formula which obtained a sample size of 80 cases and 80 controls. The sampling technique was simple random sampling. The results of bivariate data analysis used Chi square, multivariate using multiple logistic regression tests with $\alpha = 5\%$, distribution pattern analysis used average nearest neighbor, overlay and buffer.</i> Keywords: Tuberculosis, Distribution Pattern, Risk Factors
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BACKGROUND

Tuberculosis is a major global health problem. For 20 years, the World Health Organization (WHO), along with its member countries, has been working to reduce pulmonary TB. Pulmonary TB is a chronic infection caused by *Mycobacterium tuberculosis*, a bacterium that typically forms granulomas in the lungs, leading to tissue necrosis. (Limbong et al., 2021)

According to the WHO, tuberculosis is a disease of global concern. Despite various control efforts, the incidence and mortality from tuberculosis have declined, but tuberculosis still affects an estimated 9.6 million people and causes 1.2 million deaths in 2014. India, Indonesia, and China are the countries with the highest tuberculosis cases, accounting for 23%, 10%, and 10% of all cases worldwide, respectively. (SARI, AP 2021)

Housing, as a place to live and shelter for residents, is one reason we can ensure the health of residents. Home environmental components that do not conform to health status are risk factors for the transmission of various types of diseases, especially environmental diseases. Therefore, homes must meet health requirements, because unhealthy homes and environments will cause disease both among family members and others. Host factors affecting the risk of pulmonary TB include population characteristics such as gender, age, nutritional status, and socioeconomic conditions. While behavioral factors of home occupants include the habit of opening windows, house cleaning behavior, coughing behavior, sanitation behavior of food utensils, and smoking habits. (Fawzi, A. 2022).

Tuberculosis remains a public health problem that poses a global challenge. In North Sumatra, in 2021, the number of tuberculosis cases detected was 19,147, an increase compared to the 17,303 cases detected in 2020. By gender, the number of tuberculosis cases in men was 12,375, or 64.63 percent, higher than the number of tuberculosis cases in women, which was 6,772, or 35.37 percent. In each district/city, the number of cases in men was known to be higher than in women. Based on data from the North Sumatra Provincial Health Office, the highest number of cases was reported in Deli Serdang Regency, with 2,967 cases.

Based on data obtained from the Deli Serdang District Health Office, the Tanjung Morawa Community Health Center (Puskesmas) has the third highest tuberculosis incidence rate, with 207 cases. Tuberculosis data in Deli Serdang District is not yet in GIS format. Residential ventilation still does not meet health standards, and appropriate technology to prevent tuberculosis transmission is lacking. Case distribution mapping has not been conducted. This results in an uncertain picture of the distribution of tuberculosis cases by region in Deli Serdang District. Identification and analysis of environmental risk factors associated with tuberculosis incidence in Deli Serdang District are essential. Implementing

ventilation that meets health standards and producing eco-enzymes for tuberculosis prevention are essential for optimal control efforts. Research is needed to analyze the distribution patterns of environmental risk factors related to tuberculosis incidence in Deli Serdang District.

Formulation of the problem

1. The distribution pattern of environmental risk factors with tuberculosis incidents in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency is not yet known.

2. There are physical conditions of the house that do not meet health requirements.

Research purposes

1. To determine the distribution pattern of environmental risk factors with the incidence of tuberculosis in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency.

2. Carrying out community response efforts with inadequate ventilation

3. To determine the relationship between home ventilation and the incidence of pulmonary TB in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency.

4. To determine the relationship between house humidity and the incidence of pulmonary TB in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency.

5. To determine the relationship between residential density and the incidence of pulmonary TB in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency.

6. To determine the relationship between floor conditions and the incidence of pulmonary TB in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency.

Benefits of research

This study can help Analyze Spatial Risk Factors of Home Physical Environment With Tuberculosis Incidence and Eco Enzyme in Reducing Tuberculosis Incidence in Tanjung Morawa Health Center Work Area, Deli Serdang Regency in 2025. And the results of this study can be used as a basis for developing effective and efficient Tuberculosis control strategies in the Tanjung Morawa Health Center area. As well as helping to increase public awareness about the importance of Tuberculosis control and ways to prevent the spread of the disease.

Research methods

This type of research is quantitative research using a *case-control study design*, comparing the case group with the control group based on their exposure status with the aim of identifying risk factors for a disease. The *case-control study design* is retrospective, that is, looking backward to determine whether the case group had risk factors or not (Syahdrajat, 2015). *Case-control* studies are used to identify risk factors or health problems suspected to be closely related to diseases occurring in the community.

METHOD

This study is a quantitative study using a case-control study design by comparing the case group with the control group based on their exposure status with the aim of identifying risk factors for the occurrence of a disease. Where *case-control studies* are used to determine risk factors or health problems that are suspected to have a close relationship with diseases that occur in the community. Thus, a spatial analysis of risk factors for the physical environment of the house with the incidence of Tuberculosis and Eco Enzyme in reducing the incidence of Tuberculosis in the work area of the Tanjung Morawa Health Center, Deli Serdang Regency in 2024 was obtained.

RESULTS

Univariate Analysis

Table 1 Frequency Distribution Based on Respondents' Gender in the Tanjung Morawa Community Health Center Work Area in 2025

No	Gender	Pulmonary TB				Total	
		Case		Control			
		Number (n)	%	Number (n)	%	Number (n)	%
1.	Man	46	58.97	32	41.03	78	50
2.	Woman	32	41.03	46	58.97	78	50

Total	78	100	78	100	156	100
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Table 1 shows that the number of tuberculosis sufferers is higher among males (58.97%) than females (41.03%). This result indicates that males are more susceptible to TB. This is in line with epidemiological findings that indicate that males are more frequently exposed to the risk factors mentioned above. This is also supported by the fact that males tend to be slower to seek treatment, increasing the likelihood of TB detection in this group.

Table 2 Frequency Distribution Based on Respondents' Age in the Tanjung Morawa Community Health Center Work Area in 2025

No	Age	Pulmonary TB				Total	
		Case		Control			
		Number (n)	%	Number (n)	%	Number (n)	%
1.	< 25 Years ; > 55 Years	36	46.15	17	21.79	53	33.97
2.	25 – 55 Years	42	53.85	61	78.21	103	66.03
	Total	78	100	78	100	156	100

Table 2 shows that tuberculosis cases are most common in the productive age group (25–55 years) (53.85%). This suggests that tuberculosis tends to affect age groups that are physically active and play a significant role in social and economic activities. The high number of cases in the productive age group may be influenced by high mobility, lifestyle, and exposure to risky work environments. However, cases in the elderly still require attention because cases in this age group are generally accompanied by decreased immunity and comorbidities.

Table 3 Frequency Distribution Based on Respondents' Income Level in the Tanjung Morawa Community Health Center Work Area in 2025

No	Income	Pulmonary TB				Total	
		Case		Control			

		Number (n)	%	Number (n)	%	Number (n)	%
1.	≥ Rp. 2,000,000	21	26.9	18	13.1	39	25
2.	< Rp. 2,000,000	57	73.1	60	76.9	117	75
	Total	78	100	78	100	156	100

Table 3 shows that the majority of tuberculosis sufferers come from groups with low income levels or less than Rp. 2,000,000/month, amounting to 73.1%. This indicates a link between socioeconomic conditions and the risk of tuberculosis. Low income often impacts limited access to good nutrition, crowded and unhealthy living environments, and delays in seeking treatment due to limited costs. However, the same condition also occurs in the control group where 76.9% of respondents have low incomes (<Rp. 2,000,000). Therefore, in order to prevent the transmission of tuberculosis in the community at the study location, a multidimensional approach is needed that includes health education, environmental improvements, socioeconomic support, and increased access to health services.

Table 4. Frequency Distribution Based on Respondents' Education Level in the Tanjung Morawa Community Health Center Work Area in 2025

No	Education	Pulmonary TB				Total	
		Case		Control		Number (n)	%
		Number (n)	%	Number (n)	%		
1.	Tall	49	62.8	40	51.3	89	57
2.	Low	29	37.2	38	48.7	67	43
	Total	78	100	78	100	156	100

Table 4 shows that the education level of both cases (62.8%) and controls (51.3%) tended to be high. This phenomenon suggests that education is not a dominant risk factor for the spread of tuberculosis in the community health center's work area, but may be influenced by other factors such as dense residential environments,

workplace exposure, lifestyle, and adherence to treatment. Therefore, a high level of education does not always guarantee optimal health behaviors or avoidance of disease exposure.

Table 1 Frequency Distribution Based on Respondents' Occupations in the Tanjung Morawa Community Health Center Work Area in 2025

No	Work	Pulmonary TB				Total	
		Case		Control		Number (n)	%
		Number (n)	%	Number (n)	%		
1.	Doesn't work	10	18.8	20	25.6	30	19
2.	Work	68	81.2	58	74.4	126	81
	Total	78	100	78	100	156	100

Table 5 shows that the majority of tuberculosis sufferers are workers (81.2%), this can be suspected that work is one of the risk factors in tuberculosis transmission in the community health center work area, several potential aspects in the workplace that can trigger tuberculosis transmission include the condition of the workplace environment such as poor ventilation, overcrowding of workers in closed spaces, and exposure to dust or pollution that can weaken the respiratory tract. In addition, long working hours that cause fatigue, limited access to health services, and risky behaviors such as smoking also increase the chance of transmission.

Bivariate Analysis

Table 6 Results of Bivariate Analysis of Home Physical Environmental Risk Factors and Tuberculosis Incidence

No	Variables	Pulmonary TB				OR	95%CI	P
		Case		Control				
		Numbe r (n)	%	Numbe r (n)	%			
1.	Ventilation Qualify	40	26	32	21	0.66	0.35-1.24	0.970
	Not eligible	38	24	46	29			
2.	House Floor		33	72	46	6.35	2.44-16.50	

	Qualify	51						
	Not eligible							0.002
		27	17	6	4			
3.	Wall							
	Qualify	45	29	58	37	2.12	1.07-4.19	0.297
	Not eligible	33	21	20	13			
4.	Residential							
	Density	51	33	61	39			
	Qualify					1.9	0.93-3.87	0.246
	Not eligible	27	17	17	11			
5.	Humidity							
	Qualify	2	1	42	27	44.3	10.16-	
	Not eligible	76	49	36	23	3	193.37	0,000
6.	Lighting							
	Qualify	17	11%	58	37%			
						10.4	4.96-21.8	0,000
	Not eligible	61	39%	20	13%			

Based on the results of the bivariate analysis in table 6, it shows that of the six environmental risk factors studied, there are three risk factors, namely the condition of the house floor, humidity and lighting, which are significant with the incidence of tuberculosis in the work area of the Tanjung Morawa Health Center. The results of the analysis show that most respondents have a residence with a floor condition that meets the requirements so that in this case the condition of the floor tends to be protective against the spread of tuberculosis in the work area of the Tanjung Morawa Health Center.

The analysis results also showed that inadequate room humidity levels were proven to be associated with increased cases of tuberculosis with an *Odds Ratio (OR)* value of 44.33 indicating that respondents who lived in houses with high humidity had a 44.33 times greater chance of suffering from tuberculosis compared to respondents who lived in houses with normal humidity. A damp house creates poor air quality, reduces comfort, and affects the immune system of residents, making them more susceptible to infection by *Mycobacterium tuberculosis*.

Another risk factor associated with the spread of tuberculosis in the Tanjung Morawa Community Health Center work area is lighting. Lighting conditions with an *Odds Ratio (OR)* value of 10.4 indicate that respondents who live in homes with

insufficient natural lighting have a 10.4 times greater chance of suffering from tuberculosis compared to respondents whose homes are well lit. This finding strengthens the understanding that natural lighting, especially sunlight exposure, plays a crucial role in suppressing the survival of *Mycobacterium tuberculosis*. Sunlight has a natural disinfectant effect that can kill germs, so homes with adequate lighting are more protective against TB transmission.

Spatial Analysis

Spatial analysis is an approach used to understand the distribution of tuberculosis by utilizing geographic information in the Tanjung Morawa work area. In this tuberculosis research, spatial analysis aims to determine the distribution of cases at the village level, thereby identifying areas with high case concentrations (clusters) and areas with low cases. This analysis reveals the relationship between case distribution and environmental conditions, population density, and socioeconomic factors within a region.

Based on the analysis using the *Nearest Neighbor Ratio (NNR) method*, it is known that the z-score is -18.908 with a p-value of 0.00, this means that the Z-score value is very negative and the p-value <0.05 indicates that the distribution pattern of tuberculosis cases is not random, but rather forms a clustered pattern, so it can be concluded that tuberculosis cases tend to be concentrated in certain areas, not spread evenly throughout the study area.

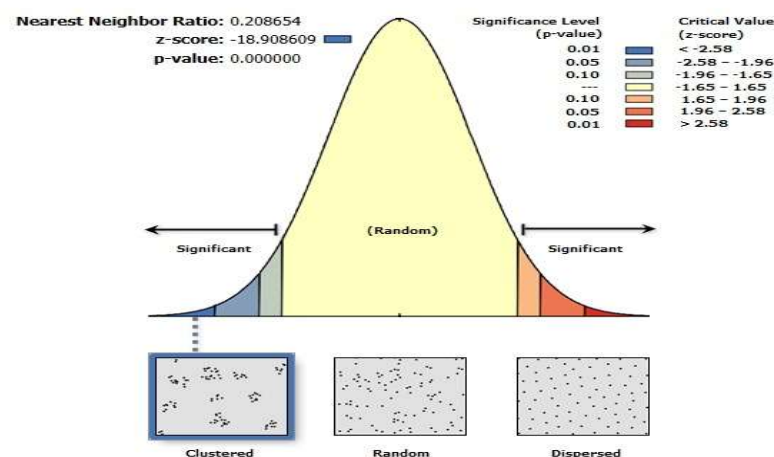


Figure 1. Results of Analysis of the Distribution Pattern of Pulmonary TB Cases in the Tanjung Morawa Community Health Center Work Area

The findings regarding the clustered distribution of tuberculosis in the Tanjung Morawa Community Health Center's work area indicate that areas with a concentration of tuberculosis cases should be a top priority in planning prevention and control programs. Interventions can be focused on areas at the center of the outbreak, as shown in Figures 2 and 3.

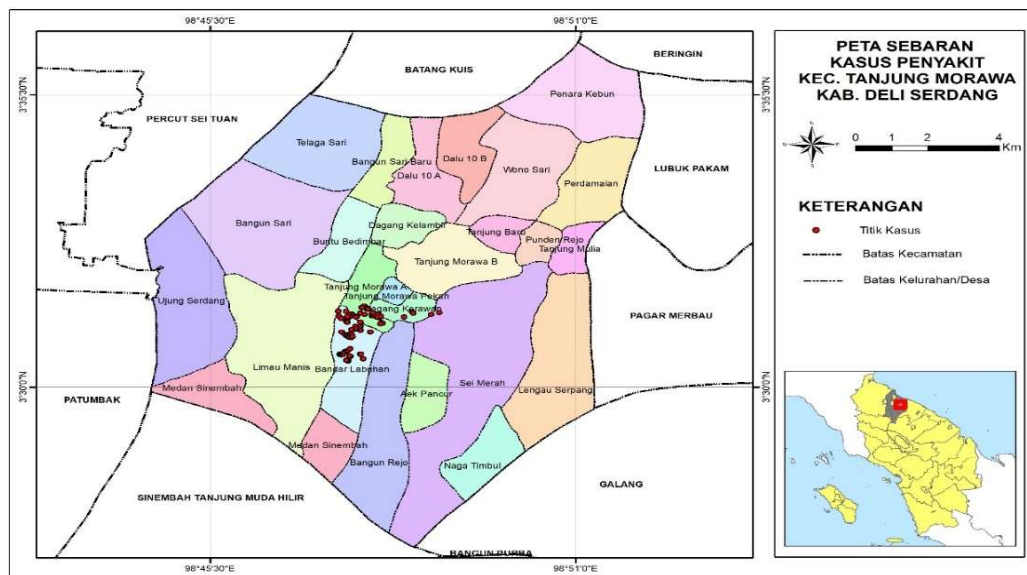


Figure 2. Map of Disease Case Distribution in Tanjung Morawa District, Deli Serdang Regency

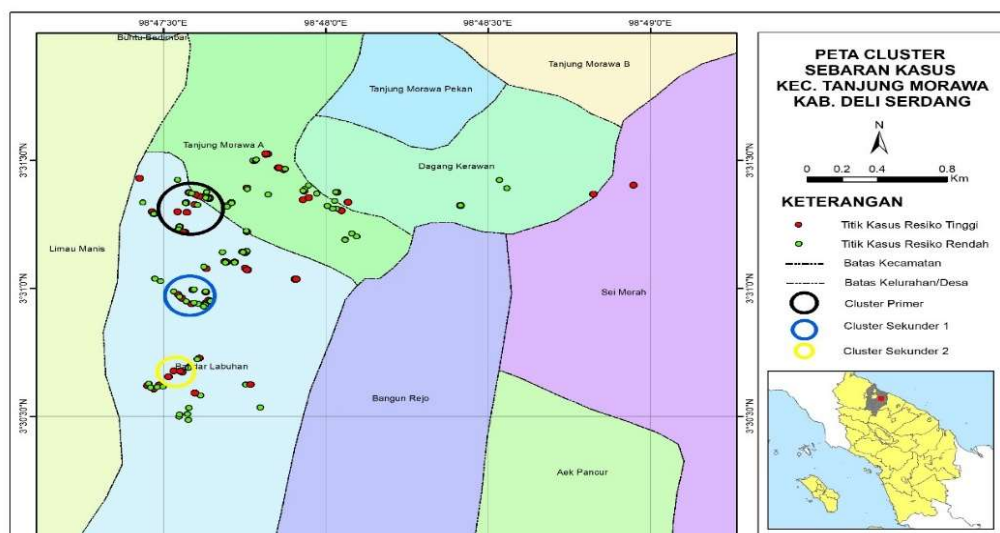


Figure 3 Map of the Distribution of Disease Cases Based on Dominant Risk Factors in Tanjung Morawa District, Deli Serdang Regency

The results of the spatial analysis indicate the presence of primary and secondary clusters in the distribution of tuberculosis cases in Tanjung Morawa A Village and Bandar Labuhan Village. The primary cluster describes the main area with the highest concentration of cases and carries the greatest risk of tuberculosis transmission. This area is the center of transmission and has the potential to be the main source of transmission in the surrounding area. Meanwhile, the secondary cluster indicates an area with a lower concentration of cases than the primary cluster, but still significantly contributes to tuberculosis cases. The emergence of secondary clusters can be influenced by environmental factors such as population mobility, which allows cases to spread to other areas. Therefore, identifying primary and secondary clusters is crucial in determining intervention priorities. Primary clusters should be the primary focus of tuberculosis control programs, while secondary clusters must continue to be monitored and preventative measures implemented to prevent them from developing into new centers of transmission.

DISCUSSION

1. The Influence of Type on the Incidence of TB

Based on table 4.1, it can be seen that pulmonary TB sufferers are dominated by men, amounting to 58.97% of the 78 cases, while the control group is dominated by women, amounting to 58.97%. This could be due to the fact that in selecting respondents in the case and control groups, matching was not carried out based on gender.

Epidemiologically, pulmonary TB is more common in men than in women. This has been found in numerous studies to be a significant risk factor. The male

predominance in pulmonary TB cases is thought to be related to behavioral and social factors, such as men's tendency to smoke more, consume more alcohol, and have wider social contacts, thus increasing their risk of TB infection compared to women. Furthermore, women tend to be more health conscious, thus receiving a quicker diagnosis and treatment, which can slow disease progression. (Nopita S, 2022).

2 Research by Sunarmi and Kurniawaty (2022) found a statistically significant relationship between gender and the incidence of pulmonary TB, with the result that men suffered from pulmonary TB more often than women, which is in line with research by Marleni (2020). This finding is also supported by data from Ponorogo Regency (2011-2015), which showed a higher proportion of pulmonary TB cases in men over the years (Atik. P, 2016).

However, this gender imbalance between the case and control groups poses a methodological weakness that can introduce bias. Case-control studies should incorporate matching to control for confounding variables such as gender and enhance the validity of the analysis. Without matching, differences in gender distribution can introduce confounder bias, making it difficult to distinguish whether disease differences are truly due to risk factors or simply differences in the sample populations. Gordis L, ect, 2014).

2. The Influence of Age on the Incidence of TB

13 Based on Table 4.2, it can be seen that of the total respondents, there were 53 (34%) non-vulnerable age groups and 103 (66%) vulnerable age groups. In the non-vulnerable age group, there were 36 (23%) cases and 17 (11%) controls. In the vulnerable age group, there were 42 (27%) cases and 61 (39%) controls.

7
2 This research is in line with several epidemiological studies in Indonesia which show that the productive age group (around 15-55 or 15-64 years) is more susceptible to pulmonary TB than the non-productive age group or the elderly. For example, research by Sari & Arisandi (2018) in the Walantaka Community Health Center area found a significant relationship between age and the incidence of pulmonary TB, where productive age has a higher risk due to higher mobility and

intensity of interaction which facilitates transmission ($p < 0.05$). Another study at Depati Hamzah Pangkalpinang Regional Hospital also stated a significant relationship between age and the incidence of pulmonary TB, with an odds ratio of 4.439 (95% CI 1.708-11.537), which indicates that the risk of pulmonary TB increases in productive age ($p = 0.003$). Fitrianti E, 2025).

Some factors that cause a higher risk of pulmonary TB at this vulnerable age are:

- High mobility and more intense social contact, for example at work, school and other social environments.
- Decreased body resistance due to heavy physical activity and stress.
- Immunological factors that are more susceptible in certain age groups.

This contrasts with the results of another study in Palembang that examined relapsed pulmonary TB, which found no significant association between age and the incidence of relapsed pulmonary TB ($p = 0.309$). This indicates that the impact of age on the first incident of pulmonary TB is more significant than on recurrent pulmonary TB (Sikumbang R, 2017).

In summary, the results of this study are consistent with other scientific evidence which confirms that vulnerable (productive) age groups statistically have a greater proportion of pulmonary TB cases than non-vulnerable age groups, thus becoming an important risk indicator for the control and prevention of this disease.

3. The Influence of Income on the Incidence of TB

These results indicate that the majority of respondents, both cases and controls, came from low-income groups. This distribution does not reveal any significant differences between the case and control groups based on income, possibly indicating that income is not a significant differentiating factor in the incidence of pulmonary TB in this population.

Research supporting this finding is an analytical observational study in the Wundulako Community Health Center Working Area, Kolaka which found that economic status was not significantly associated with the incidence of pulmonary TB ($p = 1.000$) even though most respondents were of low economic status, indicating that unfavorable socioeconomic conditions are a common condition in the population studied and other factors such as exposure to TB bacteria and access to health services play a greater role in the incidence of pulmonary TB. (Annashre TM, 2024).

16 However, other studies have shown different results. A study in West Sulawesi found that income significantly influenced the incidence of pulmonary TB with an odds ratio (OR) of 2.632 (95% CI: 1.009–6.864), indicating a higher risk of pulmonary TB in low-income groups (Andriani S, et al., 2017). Meanwhile, a study in the Serang region also identified income as a significant risk factor with an OR of 6.575 (95% CI not reported), indicating that lower income significantly increases the risk of pulmonary TB (Faris Muaz, 2020).

2 These differences in results are likely due to other influencing variables, such as sample size, definition of income categories, and differences in local socioeconomic and environmental conditions. This suggests that economic status may play a role as a risk factor for pulmonary TB, but its influence may vary depending on the social context and other contributing factors.

2 In conclusion, based on this study and the existing literature, income is not a conclusive factor universally associated with the incidence of pulmonary TB. However, the influence of economic conditions remains important to consider as part of the social risk factors that can influence susceptibility and exposure to TB. 2 Thus, analysis of income as a risk factor for pulmonary TB needs to consider the population context and other supporting factors in interpreting research results.

4. The Influence of Education on the Incidence of TB

This study is interesting because, in general, low levels of education are often associated with a higher risk of infectious diseases, including pulmonary TB. Lower education is usually associated with less knowledge and awareness about TB prevention, transmission, and treatment, thus increasing the risk of contracting and transmitting the disease. However, in these results, TB cases were more common in the group with a standard education, which may be explained by other factors such as occupation, social environment, and behaviors not controlled for in the study.

2 A similar study by Shafa S. and Afriansya R. (2024) in Semarang found a significant association between education level and the incidence of pulmonary TB, 7 with most TB patients coming from low-educated groups (elementary and junior high school), supporting the importance of education as a risk factor for pulmonary TB. 2 The proposed explanation is that individuals with low education tend to have less knowledge about TB prevention and treatment, as well as possibly low motivation to seek treatment regularly.

In comparison, another study from the Girian Weru Community Health Center in Bitung City by Matayoshi et al. (2019) reported no statistically significant association between education level and the incidence of pulmonary TB ($p = 0.287$), indicating that education in that context was not a major risk factor. This demonstrates the diversity of research findings related to education as a risk factor for pulmonary TB, which may be influenced by population characteristics, sampling methods, and other confounding variables such as income and access to health services. (Nerli Ws, 2014).

In conclusion, although many studies have suggested that low education contributes to the risk of developing pulmonary TB, the results of this study show a nearly equal proportion of cases between the standard and substandard education groups. Therefore, in addition to education, other factors such as environmental factors, economic status, and individual behavior must also be considered in efforts to control pulmonary TB.

5. The Influence of Education on the Incidence of TB

These data show that the proportion of pulmonary TB cases is higher in the employed group than in the unemployed. This phenomenon can be explained because occupation can be associated with risk factors for pulmonary TB transmission, especially if the job involves contact with many people or an unhealthy environment. For example, work in the informal sector, factories, or jobs with exposure to dust and chemicals can increase the risk of TB infection. Furthermore, workers with busy and stressful schedules may have immune systems that are more susceptible to *Mycobacterium tuberculosis*.

Research by Hidayat et al. (2022) in the Korleko Community Health Center area, East Lombok, showed a significant association between occupation and the risk of pulmonary TB ($p=0.031$) with an odds ratio of 3.45, indicating that employed individuals had a greater chance of contracting pulmonary TB than unemployed individuals. Consistent with these findings, research from the Kertapati Community Health Center area, Palembang, also found a significant association between occupation and the incidence of pulmonary TB (Ayomi AC, et al, 2024).

However, other studies have shown insignificant results. A study from the Amurang Community Health Center in South Minahasa indicated that occupational factors were not the primary risk factor associated with pulmonary TB ($p > 0.05$), but rather that other factors, such as the residential environment and ventilation, played a more dominant role.

These differences in results may be influenced by population characteristics, the dominant type of employment in the study area, and other concurrent risk factors such as nutritional status and smoking habits. In conclusion, this study found that employed individuals had a higher proportion of pulmonary TB cases than unemployed individuals, which is consistent with several other studies showing a relationship between employment and pulmonary TB risk. However, the context of employment and other contributing factors should be considered for more accurate interpretation of the results.

6. Environmental Risk Factors for Tuberculosis Incidence

The study results showed that several home environmental factors were significantly associated with tuberculosis incidence, particularly floor conditions, humidity, and lighting. Houses with dirt or non-permanent floors were more likely to have tuberculosis cases than houses with permanent floors. Dirt floors tend to be damp, difficult to clean, and can potentially serve as a breeding ground for microorganisms, increasing the risk of transmission. Furthermore, high humidity in homes has been shown to contribute to the rise in tuberculosis cases, as damp conditions worsen air quality and support the survival of *Mycobacterium tuberculosis* indoors. Natural lighting is another contributing factor. Houses with poor lighting are at greater risk of tuberculosis due to limited exposure to sunlight, which acts as a natural disinfectant that can kill tuberculosis bacteria.

This research is in line with the results of research by Ayomi et al. (2024) which stated that the intensity of natural lighting ($p\text{-value} = 0.006$), room humidity ($p\text{-value} = 0.012$) are risk factors for the spread of tuberculosis. Epidemiologically, the condition of the home environment is an important determinant in the incidence of tuberculosis. Physical factors such as floor conditions, humidity, and lighting contribute to the dynamics of *Mycobacterium tuberculosis* transmission. Houses with dirt or non-permanent floors create damp conditions, are difficult to clean, and have the potential to increase exposure to germs. Dirt floors are also closely related to low socioeconomic status, which epidemiologically becomes an indirect risk factor for tuberculosis.

High humidity in homes worsens air quality, increases exposure to airborne droplets, and facilitates the long-term survival of tuberculosis bacilli. Epidemiologically, this humidity is an environmental factor that increases *host exposure*, thus increasing the incidence of tuberculosis in populations living in homes with poor humidity.

CONCLUSION

Based on the results of research conducted in the working area of the Tanjung Morawa Health Center, Deli Serdang Regency, it can be concluded that:

1. The distribution pattern of environmental risk factors for tuberculosis incidence shows the presence of tuberculosis clusters in Tanjung Morawa A Village and Bandar Labuhan Village with a *z-score* of -18.908 and a *p-value* of 0.000.
2. There is no significant relationship (*p-value*: 0.970) between home ventilation conditions and the incidence of pulmonary tuberculosis.
3. Home humidity has been shown to be significantly associated with the incidence of pulmonary tuberculosis (*p-value*: 0.000). Homes with high humidity have a greater risk of being a place for the transmission of *Mycobacterium tuberculosis* OR = 44.33.
4. There is no significant relationship between residential density and the incidence of pulmonary tuberculosis (*p-value*: 0.246).
5. The condition of the house floor showed a relationship with the incidence of pulmonary tuberculosis (*p-value*: 0.000). Houses with permanent floors were more protective than houses with dirt or non-permanent floors.

SUGGESTION

Based on the results of research that has been conducted regarding environmental risk factors for tuberculosis incidents in the working area of the Tanjung Morawa Community Health Center, Deli Serdang Regency, the following suggestions are made:

1. Increase outreach activities to the community regarding the importance of a healthy home environment, particularly regarding ventilation, humidity, lighting, and housing density.

2. Conducting routine monitoring of the condition of the homes of tuberculosis sufferers and providing recommendations for simple improvements that can be carried out by the community.
3. Strengthening the *active case finding program* in areas with high case distribution patterns, so that transmission can be suppressed early.
4. For further research, it is necessary to conduct research with a wider area coverage and more diverse environmental variables, including socio-economic and behavioral factors, to obtain a more comprehensive picture of the determinants of tuberculosis incidence.

BIBLIOGRAPHY

- Andriani S, et al (2017). Risk factors for pulmonary tuberculosis in the working area of the Binanga Community Health Center, Mamuju Regency. West Sulawesi. *J Health*. 8(3):172-180.
- Annashre TM, Puji N (2024). The relationship between economic status and the risk of pulmonary tuberculosis transmission. *J Avicenna Health Sci Research*. 2024;3(3):342-349.
- Atik P (2016). Factors associated with the incidence of pulmonary tuberculosis. *J Public Health Ponorogo*. 10(1):15-22
- Ayomi AC, Setiani O, Joko T (2024). Risk factors of the physical environment of the house and regional characteristics as determinants of the incidence of pulmonary tuberculosis in the working area of the Kertapati Palembang Health Center. *BIKFOKES*. ;2(1):10-17.
- Azzahra, Z. (2017). *Factors Influencing the Incidence of Pulmonary Tuberculosis in the Working Area of Muliorejo Community Health Center, Sunggal District, Deli Serdang Regency in 2017*. Faculty of Public Health, University of North Sumatra.
- Batti, HT, Ratag, Budi, T., & Umboh, J. (2013). Analysis of the Relationship Between Ventilation Conditions, Occupancy Density, Air Humidity, Ministry of Health of the Republic of Indonesia, 2011. National Guidelines for TB Control in Indonesia. Jakarta: Ministry of Health of the Republic of Indonesia.
- North Sumatra Health Office. (2019). *Health Profile of North Sumatra Province* .
- Faris Muaz (2020). Factors influencing the incidence of positive bacillus pulmonary tuberculosis (BTA+ pulmonary TB) in the Serang Community Health Center Work Area. Thesis, UIN Jakarta.
- Fitrianti E, Wahyudi S (2025). Analysis of Pulmonary Tuberculosis Incidence at Depati Hamzah Regional Hospital, Pangkalpinang. *J Public Health Sciences*. ;9(1):100-110.
- Gordis L (2014). *Epidemiology*. 5th ed. Philadelphia: Elsevier Saunders; 2014
- Harahap, IW, Mutahar, R., & Yeni. (2017). Analysis of the Relationship between Smoking Degree and Tuberculosis Incidence in Smokers in Indonesia (Analysis of IFLS 2014 Data). *Public Health Sciences* , 8 (3), 169–179.
- Hidayat F, et al (2022). Analysis of risk factors for pulmonary tuberculosis in the Korleko Community Health Center work area, East Lombok. *J Public Health*. ;14(1):23-29.
- Hulu Trismanjaya, Salman, D. . . (2020). *Epidemiology of Infectious Diseases: History, Transmission and Prevention* . Yayasan Kita Menulis Medan.

- Journal of Hygiene* , 4 (2), 125–128. *Incidence of Pulmonary TB in the Work Area of the Mandala Community Health Center, Medan Tembung District in 2017*. Poltekkes, Ministry of Health, Republic of Indonesia, Medan.
- Ministry of Health of the Republic of Indonesia. (2018a). *Tuberculosis Data Information* . Jakarta: Ministry of Health of the Republic of Indonesia.
- Ministry of Health of the Republic of Indonesia. (2018b). *North Sumatra Province Report on Basic Health Research and Development 2018*. Health Research and Development Agency.
- Ministry of Health of the Republic of Indonesia. (2018d). *Indonesian Health Profile 2018* .
- Ministry of Health of the Republic of Indonesia. (2020). *Indonesian Health Profile 2020*. In *Indonesian Health Profile 2020* .
- Decree of the Minister of Health of the Republic of Indonesia. (1999). *Requirements for Residential Housing According to Decree of the Minister of Health No. 829 / Menkes / SK / VII / 1999* (Issue 829).
- Maqfirah. (2017). Risk factors for pulmonary TB incidents in the working area of Liukang Tupabbiring Community Health Center, Pangkep Regency in 2017.
- Marleni., 2020. Risk factors for pulmonary tuberculosis in the community [thesis]. University of Indonesia; 2020
- Masriadi. (2017a). *Epidemiology of infectious diseases* . Depok: Rajawali Pers.
- Matayoshi R, et al (2019). Analysis of Pulmonary TB Risk Factors in the Working Area of Girian Weru Community Health Center, Bitung City. *J Public Health*. 2019;8(1):40-8
- Nerly WS (2014). Risk Factors for Pulmonary TB Patients Based on Nutritional Status and Education at Dr. Soedarso Regional Hospital. *J Faculty of Medicine, Untan*. 2014;1(1):20-5
- Nopita S, et al (2022). The relationship between education and the incidence of pulmonary tuberculosis in Musi Banyuasin Regency. *J Health Sci*. 2022;3(1):120-130
- Nugroho R, et al (2020). Risk factors for pulmonary TB in the Amurang Community Health Center work area. *J Health Sciences*. ;8(2):55-63
- Lung Disease at Irenk Medical Center Clinic 2019-2020. *Indonesian Scholar Journal of Medical and Health Science* , 1 (02), 68–75. <https://doi.org/10.54402/isjmhs.v1i02.49>
- Sari NA, Arisandi D (2025). Factors related to the incidence of pulmonary tuberculosis in the Walantaka Community Health Center work area. *J Nursing*. ;11(1):45-52
- Sari, AT (2021). The Relationship between Physical Condition of the House, Air Circulation, and History of Contact with Pulmonary TB Patients and the Incidence of TB

- Shafa S, Afriansya R (2024). The Relationship between Environment, Education, and Community Economy and the Incidence of Pulmonary TB in Kedungmundu, Semarang City. *Borneo J Med Lab Tech.* ;6(2):621-7
- Sikumbang R.(2017). Factors related to the incidence of relapsed pulmonary TB in Palembang. *J Health Palembang.* ;12(1):78-85.
- Simarmata, G. (2018). *The Relationship between the Physical Environment of the House and*
- Slam Fahrul, Priastomo Yoga, D. . . (2021). *Basics of Environmental Health* . Kita Menulis Foundation.
- Temperature and Natural Lighting of Houses with the Incidence of Pulmonary Tuberculosis in the Working Area of the Wara Utara Community Health Center, Palopo City. *UNSRAT E-Journal* , 1 (1).
- Sunarmi, Kurniawaty. The relationship between the characteristics of pulmonary TB patients and the incidence of pulmonary TB. *J 'Aisyiyah Medika.* 2022;7(2):184-191
- WHO. (2020). *Global Tuberculosis Report 2020* (Vol. 148). World Health Organization.
- Wiratna, S. (2022). *Research methodology* . PT. Pustaka Baru.