RESEARCH ARTICLE **Open Access**

Gema Lingkungan Kesehatan
Vol. 23, No. 2 (2025), pp 211-220
e-ISSN 2407-8948 p-ISSN 16933761
Doi: https://doi.org/10.36568/gelinkes.v23i2.283 *Journal Hompage: https://gelinkes.poltekkesdepkes-sby.ac.id/*

Determinant Factors of Lung Tuberculosis in North Sumatera Province: Analysis of Indonesia Health Survey Data 2023

Agil Maritho Lauchan[1*], Yulia Khairina Ashar[1], Putra Apriadi Siregar[1], Hasrat Efendi Samosir[2]

[1] Faculty of Public Health, State Islamic University of North Sumatra, Medan, Indonesia
[2] Faculty of Islamic Da'wah and Communication, State Islamic University of North Sumatra, Medan, Indonesia

*Correspondence: maritholauchanagil@gmail.com

ABSTRACT

Pulmonary Tuberculosis disease is a chronic, contagious infection that remains a global public health challenge today. Indonesia ranks as the country with the second highest number of pulmonary TB cases in the world, behind India and followed by China. North Sumatra Province is ranked third in Indonesia for the highest burden of pulmonary TB after West Java and East Java with an estimated case of 74,434 cases in 2024. The purpose of the study was to analyze the determinant factors and the most influential factors and see the probability prediction of the incidence of Lung Pulmonary Tb in North Sumatra Province based on the 2023 Indonesian Health Survey (IHS) data. This research is a type of quantitative method research with a cross sectional design. The sample size in this study was 54,397 respondents. Data were analyzed through univariate, bivariate, and multivariate approaches by applying logistic regression tests. Based on the results of the study, there are factors that influence the incidence of Pulmonary TB in North Sumatra Province, namely gender factors, age factors, lighting factors, and nutritional status factors with a value of (p = <0.05). The multiple logistic regression test showed that the age factor was the most dominant factor associated with the incidence of Pulmonary TB in North Sumatra Province with a value of (OR = 3.976, 95% CI = 2.105 - 7.521). The probability of developing pulmonary TB if all risk factors such as male gender, productive age, inadequate lighting, and poor nutritional status are present is 65.3%. This study is expected to provide a comprehensive picture of the factors that contribute to the incidence of Pulmonary TB in North Sumatra Province, so that it can be the basis for formulating strategies for prevention and control of this disease.

Keywords: Physical House Condition, Sociodemographics, Nutritional Status, Pulmonary TB.

INTRODUCTION

Based on the Global TB Report 2023 released by the World Health Organization (WHO), pulmonary tuberculosis (TB) is a chronic infectious disease that remains a global public health problem (Chen, Zhi Wang, Tao Du, Jingli Sun, 2025). Globally, by 2022, pulmonary TB will cause an estimated 1.3 million deaths. The number of newly diagnosed cases in 2022 will reach 7.5 million globally. (WHO, 2022). As many as 89% of pulmonary TB cases occur in adults, with a distribution of 56.5% in men and 32.5% in women. Meanwhile, 11% of pulmonary TB cases were found in children. This data shows that pulmonary TB is more dominant in the adult population, especially men. (Komala Dewi & Fazri, 2023). Most of the estimated deaths attributable to pulmonary pulmonary TB are recorded in four countries, namely India, Indonesia, Myanmar, and the Philippines (Abbas Ali et al., 2024). Indonesia has the second highest number of pulmonary TB cases in the world after India, followed by China. (T. Lestari et al., 2023). There are an estimated 1,060,000 cases of pulmonary TB in Indonesia (Pralambang & Setiawan, 2021).

Based on data on pulmonary TB cases in 2021, North Sumatra Province ranked 6th with 22,169 cases, making it one of the regions with a significant burden of pulmonary TB in Indonesia (Damanik et al., 2023). In 2023, the province ranked 4th as the region with the highest number of Lung Tuberculosis cases in Indonesia. Plt. Head of the North Sumatra Provincial Health Office, Drs. Basarin Yunus Tanjung, M.Si., said that in 2024, North Sumatra is estimated to occupy the 3rd position after West Java and East Java, with an estimated number of cases reaching 74,434. This data shows an increasing trend of pulmonary TB cases in North Sumatra which requires a more effective control strategy through

prevention, early detection, and more optimal disease management (Dinas Kesehatan Provinsi Sumatera Utara, 2024).

According to the World Health Organization (WHO), the main factor involved in pulmonary TB transmission is transmission through the respiratory tract (Amin et al., 2021). In addition, low social and economic status also contributes to increasing the risk of infection (Nidoi et al., 2021). The increase in TB cases is influenced by various health determinants, including individual immunity, nutritional status, personal hygiene, and residential density in the neighborhood (Othman et al., 2024). According to the Ministry of Health in Indonesia, several factors that significantly increase the risk of TB incidence include smoking, malnutrition, housing density, and the presence of comorbidities such as diabetes. In addition, sociodemographic factors contribute significantly to the transmission of the disease, including aspects such as gender, age, education level, marital status, family income, employment type, and body mass index (BMI) (Ministry of Health, 2020). Environmental factors also contribute to the incidence of tuberculosis, including the level of sunlight exposure in the house, the presence of artificial ventilation, exposure to individuals with pulmonary TB, and the number of family members living in the same house. By understanding these risk factors, prevention and control strategies for pulmonary TB can be optimized to reduce the spread of the disease (Pralambang & Setiawan, 2021).

The basic strategy in the fight against Pulmonary TB over the past 40 years has been the provision of diagnosis and treatment to sick individuals and those seeking health services. The main assumption of this strategy is that by curing patients with active TB, mortality rates can be reduced, disease prevalence can decrease, and transmission can be reduced. However, in reality, in many countries, the decline in TB incidence has been slow, only about 1.5% per year (Feng et al., 2024).

The high incidence of pulmonary TB in North Sumatra Province is influenced by various factors, such as population density, high mobility, and socioeconomic aspects. Limited access to health services, crowded living conditions with poor ventilation, and low awareness and adherence to treatment exacerbate the situation. Poor nutrition and comorbidities such as diabetes increase the risk of infection, while limited health facilities hamper detection and treatment efforts. In addition, air pollution aggravates lung conditions, increasing susceptibility to pulmonary TB (Lorensyifa et al., 2022).

Various studies conducted in areas in North Sumatra Province have identified various factors that contribute to the incidence of pulmonary tuberculosis (TB). Research conducted by Nasution et al. (2022) concluded that the level of individual knowledge is the main factor influencing the incidence of pulmonary TB. Meanwhile, research conducted by Sikumbang et al. (2022) found an association between Lung pulmonary TB and factors such as gender, age, residential density, and lighting levels in the residence. In addition, a recent study by (Pratiwi, 2024) revealed that being male, a history of contact with TB patients, and poor lighting in the residence were significant risk factors for the incidence of Pulmonary TB. These findings suggest that environmental aspects and individual characteristics play an important role in the spread of Lung TB in the region. However, there are no studies focusing on the province of North Sumatra that link the incidence of pulmonary TB.

Pulmonary TB is also one of the challenges in achieving Sustainable Development Goals (SDGs) point 3, which is to ensure healthy and prosperous lives (Kementerian PPN/BAPPENAS, 2021). The global target by 2030 is to end the epidemic of infectious diseases, including pulmonary TB. The disease not only impacts individual health, but also contributes to increased morbidity and mortality rates and burdens health systems and economies. Therefore, prevention, early detection, and effective treatment are necessary to reduce the spread of pulmonary TB and achieve sustainable development targets in the health sector (Lee et al., 2022).

The TB treatment success rate in North Sumatra Province in the second quarter of 2024 reached 84%. Although this figure is quite high, the coverage of Lung TB case finding still needs to be increased in order to accelerate the elimination of TB in the region (Kustiyanti, 2023). The Indonesian Health Survey (IHS) aims to collect national data to monitor, evaluate, and support the development of health policies in Indonesia. Based on the 2023 SKI, the prevalence of Lung TB in Indonesia reached 0.30%, while in North Sumatra Province it was 0.17% (SKI, 2023).

The high prevalence of Pulmonary TB in North Sumatra and the increasing trend of cases each year, this study aims to analyze the influencing factors and the most dominant risk factors and see the prediction of the probability of incidence of Pulmonary TB in North Sumatra Province based on the Indonesian Health Survey (IHS) data in 2023.

METHODS

Participants and Study Design

This study applies quantitative methods with cross-sectional analysis to see the determinants of the incidence of pulmonary TB in North Sumatra Province.

This study utilized secondary data that had been collected from the 2023 Indonesian Health Data Survey (IHSS) organized by the Ministry of Health. The population in this study involved 34,500 Census Blocks (BS) as the selected sample. Of these, 34,065 BS (98.74%) were successfully visited and updated through the data updating process. The 2023 IHS covered 38 provinces and 514 districts/municipalities in Indonesia. Indonesian Health Survey (IHS) data are collected through interviews, measurements, and examinations as part of activities organized by the Indonesian Ministry of Health. The IHS data collection process begins with

determining the number and distribution of random samples to ensure data representativeness. The participants of this study were determined based on the 2023 SKI data for North Sumatra Province, with a total of 57,317 respondents.

Measurements and Procedures

The sample used in this study came from the 2023 Indonesian Health Survey (IHS) data in North Sumatra Province, with a total of 57,317 respondents. Next, a data cleaning process was carried out to ensure the quality and accuracy of the data. At this stage, missing data was found on the respondent's Body Mass Index (BMI) variable. Therefore, deletion or adjustment of missing data was carried out to reduce potential research bias and increase the validity of the analysis results. After cleaning the data, the final sample size used in this study was 54,397 respondents.

Research Variables

The variables in the study were taken from the 2023 SKI data, consisting of the incidence of Pulmonary TB as the dependent variable, as well as several independent variables including sociodemographic (gender, age, education, and economic status), physical conditions of the house (ceiling, wall type, floor type, and lighting), and nutritional status factors.

In this study, the gender variable was categorized into male and female. In addition, the age variable was categorized into productive age (15-64 years) and unproductive age (<15 years and >65 years). Education variables were classified into low education, which includes respondents with a maximum education level of junior high school, and high education, which includes respondents with a minimum education level of senior high school or above. Meanwhile, economic status is categorized into low economic status, medium economic status, and high economic status, which is measured based on the number of goods owned by respondents. This categorization aims to obtain a clearer analysis of the relationship between demographic factors and socioeconomic conditions on pulmonary TB.

The physical condition of a house is eligible if it meets the structural aspects, building materials, ventilation, lighting, and sanitation. Qualified ceilings must be sturdy, easy to clean, and use durable materials such as gypsum board, caliboard, PVC, fiber cement, or metal ceilings. Qualified walls must be weatherproof, sturdy, and able to withstand moisture to prevent damage and mold growth. Qualified flooring should be strong, flat, non-slip, stable, easy to clean, and watertight, to enhance comfort and safety. In addition, lighting must meet the standards of quality, quantity, and lighting rules for good visibility and a healthy environment. The nutritional status variable in this study was categorized based on Body Mass Index (BMI). Normal nutritional status was assigned to individuals with a BMI of 18.5-22.9, while undernutrition was assigned to individuals with a BMI <18.5. Meanwhile, individuals with a BMI >23 are categorized as overnourished.

Data Analysis

The data analysis process was carried out through several stages. The first stage was univariate analysis which aimed to describe the frequency distribution of each variable. Next, bivariate analysis was conducted using the chi-square test to identify the relationship between the independent variables and the incidence of Pulmonary Tuberculosis. The last stage was multivariate analysis, which applied the logistic regression test to determine the variables that significantly influenced the incidence of Pulmonary TB. In addition, this test was also used to estimate the probability of incidence of Lung TB based on predetermined risk factors. Multivariate analysis was applied when the results of the bivariate analysis showed a p value <0.25, as a measure to control bias and improve the accuracy of the statistical model.

RESULT AND DISCUSSION

The results of this study are presented through three forms of analysis, namely univariate, bivariate, and multivariate, which are displayed in tabular format.

Univariate Analysis

Table 1. Lung TB Cases in North Sumatra 2023

Incidence of Pulmonary TB	Frekuensi	Percentage
Yes	113	0,2
No	54284	99.8
Total	54397	100

Frequency Distribution of Pulmonary TB Incidence in North Sumatra Province Based on 2023 SKI Data Based on the data presented in Table 1, it is known that the number of pulmonary tuberculosis cases in North Sumatra Province reached 113 cases, which is equivalent to 0.2% of the total population studied. This figure indicates a relatively low incidence of pulmonary tuberculosis in the region, although it still requires attention in disease prevention and control efforts.

Based on Table 2, the results indicate a significant association between certain sociodemographic factors and the incidence of pulmonary tuberculosis. There was a significant association between gender and the incidence of pulmonary tuberculosis, with a P-value of 0.000 (<0.05) and an odds ratio (OR) of 0.397 with 95% CI (0.266-0.592), indicating that women have a lower risk of developing pulmonary tuberculosis than men. In addition, the age factor also showed a significant relationship with the incidence of pulmonary tuberculosis, with a P-value of 0.004 and OR 1.969 (95% CI: 1.254-3.091), which means that individuals in the productive age group have a risk of 1.969 times higher than individuals in the unproductive age group. The economic status factor has a significant relationship with the incidence of pulmonary tuberculosis. Individuals with low economic status had a risk of 1.961 times higher than

individuals with high economic status (P-Value 0.031, OR 1.961, 95% CI: 1.166-3.297). In addition, individuals with middle economic status were also more at risk than individuals with high economic status, with an OR of 1.837 (95% CI: 1.056-3.194). However, education did not show a significant association with the incidence of pulmonary tuberculosis, as indicated by a P-value of 0.819.

Bivariate Analysis

Table 2
Relationship between Sociodemographic Factors, Physical Conditions of the House and Nutritional Status with the Incidence of Pulmonary TB in North Sumatra Province

Variables	Group				Total		P	POR	95% CI
	Yes		No						
	n	%	n	%	n	%			
Sociodemographic Factors									
Gender*									
Men	78	0.3	25481	99.7	25559	100	0.000	0.397	0.266- 0.592
Women	35	0.1	28803	99.1	28838	100			
Age*									
Non-productive Age	24	0.1	18825	99.9	18849	100	0.004	1.969	1.254-3.091
Productive Age	89	0.3	35459	99.7	35291	100			
Education									
Low	76	0.2	35715	99.8	35791	100	0.819	1.068	0.721-1.583
High	37	99.8	18569	99.8	18606	100			
Economic Status*									
Low	37	0.2	16034	99.8	16071	100	0.031		1.166-3.297
Medium	57	0.2	23130	99.9	23187	100		1.961	1.056-3.194
High	19	0.1	15120	99.9	15139	100		1.837	
Home Physical Condition Factor									
House ceiling									
Not Eligible	111	0.2	53447	99.8	53558	100	1.000	0.869	0.214-3.255
Eligible	2	0.2	837	99.8	839	100			
Wall Type*									
Not Eligible	45	0.3	16336	99.7	16381	100	0.032	1.537	1.054-2.241
Eligible	68	0.2	37948	99.8	38016	100			
Floor Type									
Not Eligible	73	0.2	32468	99.8	32541	100	0.213	0.783	0.532-1.152
Eligble	40	0.2	21816	99.8	21856	100			
Lighting *									
Not Enough	62	0.3	24149	99.7	24221	100	0.034	1.517	1.047-2.198
Enough	51	0.2	30135	99.8	30186	100			
Nutritional Status Factors									
Nutrition Status									
Less	26	0,2	13320	99,8	13246	100			
More	19	0,1	15729	99,8	15748	100	0,006	0,450	0,271-0,749
Normal	68	0,3	25355	99,7	25403	100		0,766	0,466-1,152

Notes: *p ≤ 0.05, significant; POR, Prevalence Odds Ratio

The results of the analysis indicate that the physical condition of the house is significantly associated with the occurrence of Pulmonary Tuberculosis. The type of wall showed a significant association with the incidence of pulmonary tuberculosis, with a P-value of 0.032 and an odds ratio (OR) of 1.537 (95% CI: 1.054-2.241),

indicating that houses with unqualified wall types had a 1.537 times higher risk than houses with qualified wall types. Lighting also showed a significant association with the incidence of Pulmonary Tuberculosis, indicated by a p-value of 0.034 and an odds ratio (OR) of 1.517 (95% CI: 1.047-2.198). This indicates that houses with insufficient lighting have a 1.517 times higher risk of developing Pulmonary Tuberculosis than houses with adequate lighting. In addition, nutritional status was also significantly correlated with the incidence of Pulmonary TB, with a p-value of 0.006.c

Multivariate Analysis

In the multivariate analysis, variable selection was performed using a simple logistic regression test. Variables that had a significance value of less than 0.25 were selected as candidates for multivariate analysis, as this value was considered broad enough to capture potential influential factors. Next, variables were selected for multivariate analysis based on significance values. Variables that have a P-value > 0.05 will be excluded from the model gradually. However, if after a variable was excluded there was a change in odds ratio (OR) of ≥10% in other independent variables, then the variable was categorized as a confounder. Confounder is a variable that can cause bias in model interpretation because it has an influence on the relationship between the independent and dependent variables. Therefore, variables identified as confounders were still included in the multivariate model to ensure more accurate analysis results.

Variables with a Sig. > 0.05 will be eliminated one by one, starting from the variable with the highest significance value using the Enter method. This method ensures that each excluded variable does not have a significant impact on the stability of the model, so that only variables that really contribute to the model are retained.

Table 3
Final Multivariate Modeling

Variables	B	Sig.	Exp (B)	95%CI
Gender	-877	0.000	0.416	0.279 - 0.621
Age	1.380	0.000	3.976	2.105 – 7.521
Lighting	0.391	0.039	1.479	1.109 – 2.143
Nutrition Status		0.000		
Nutrition Status (1)	0.783	0.003	0.457	0.274 – 0.763
Nutrition Status (2)	0.663	0.037	1.941	1.040 – 3.622
Constant	-6,778			
***Omnibus Test*: 0,000**				

Based on Table 3, in the final stage of regression analysis, there are several variables that are included in the final equation because they have a significant influence on the dependent variable. These variables include lighting, nutritional status, and the interaction between sex and age. This indicates that these factors contribute significantly to the observed results, and thus can be considered as the main determinants in the model. The model that was formed was declared feasible, because it met the meaning of the model as seen from the omnibus test value (p = 0.000).

The results revealed that the factors that determine the incidence of Pulmonary Tuberculosis include age, gender, lighting, and nutritional status. The most influential factor is age, with an Odds Ratio (OR) value of 3.976 and a 95% confidence interval (2.105 - 7.521). This indicates that individuals in productive age have a 3.976 times greater risk of developing pulmonary TB compared to unproductive age. The wide confidence interval indicates that the effect of age on the incidence of Lung TB is significant. Gender also acted as a risk factor, with an OR = 0.416, meaning that women were 58.4% less likely to develop Lung TB than men.

The lighting factor had an OR = 1.479, indicating that individuals with inadequate lighting had a 47.9% higher risk of developing pulmonary TB than those with adequate lighting. The 95% confidence interval (1.109 - 2.143) that does not include the number 1 indicates that this association is statistically significant. Poor lighting may increase the risk of Lung TB as it contributes to high humidity and poor ventilation, which favor the survival of Mycobacterium tuberculosis. Individuals with undernutrition had an OR = 0.457 (95% CI 0.274 - 0.763), meaning they had a 54.3% lower risk of developing Pulmonary TB than individuals with normal nutritional status. In contrast, individuals with overnutrition had an OR = 1.941 (95% CI 1.040 - 3.622), indicating a 1.941 times higher risk of developing Pulmonary TB. Confidence intervals that do not include 1 in both categories indicate that the association is statistically significant. These results indicate that being overweight may increase the risk of developing pulmonary TB, while the association between undernutrition and pulmonary TB requires further analysis in relation to other immune factors or health conditions.

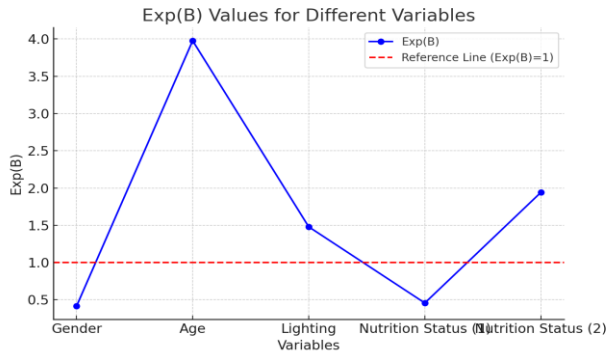

Figure 1. Dominant Variable Based on Exp (B) Value

Based on Figure 1, the most dominant variable for the incidence of Lung TB is age. The results of the logistic regression analysis indicate that the Exp(B) value for the age variable is 3.976, which means that individuals in the productive age group are almost 4 times more likely to develop pulmonary TB than individuals outside the productive age group. This indicates that age has a significant influence in increasing susceptibility to Lung TB.

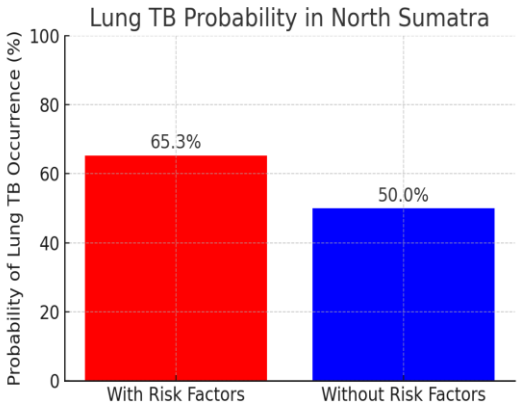

Figure 2. Probability of Lung TB Occurrence in North Sumatra

Based on calculations with logistic regression equations using the logit model, if all risk factors are present, the probability of developing pulmonary TB in North Sumatra Province reaches 65.3%. Conversely, if no risk factors are present, the probability of Lung TB occurrence remains at 50%. This suggests that the risk factors analyzed have contributed to increasing the likelihood of Lung TB occurrence in the region.

The Effect of Age on the Incidence of Pulmonary TB

This study indicates that age has a significant influence on the incidence of pulmonary tuberculosis, where unproductive age is 3.976 times more risky than unproductive age. This finding is in line with research conducted by (Nur et al., 2022), which showed that TB cases occurred more in the productive age group than in the unproductive age. The World Health Organization (WHO) reports that tuberculosis (TB) cases have a significant proportion in the productive age group (Chidambaram et al., 2021). In line with these findings, the Indonesian Ministry of Health's 2022 report noted that 60.1% of TB cases occurred in individuals aged 15-54 years. This data indicates that TB remains a major health threat to the productive age population, which plays an important role in economic growth and social development (Susanti et al., 2024).

In this study, age was found to be the greatest risk factor for the incidence of Lung TB, with the productive age group being the most vulnerable. This is in line with research findings (N. P. W. A. Lestari et al., 2022) , It was mentioned that 75% of patients with pulmonary tuberculosis were in the productive age group. However, the research is not in line with that conducted by (An et al., 2020), where the age of 60-69 years is more at risk of developing Pulmonary TB with a ratio of about more than 7 times than the age < 60. Risk factors such as unhealthy lifestyles, including smoking and alcohol consumption, further increase susceptibility to this disease (Ismah et al., 2024). Therefore, efforts to prevent and control Lung TB need to be focused through health education-based interventions to change risk behaviors and increase awareness of the importance of prevention and early detection of Lung TB.

Around 75 percent of the Indonesian population affected by pulmonary tuberculosis infection is in the productive age group of 15-55 years. This is due to the high mobility of the productive group, which then makes it easy for germs to settle and enter the deepest tissues of the body. WHO emphasizes that health education and counseling are key components of the global TB control strategy. Approaches that consider specific factors such as productive age are recommended to improve the effectiveness of pulmonary TB prevention and treatment programs (Sutter et al., 2022). These strategies include improving access to health services, anti-smoking campaigns, and counseling on the importance of a healthy lifestyle as part of efforts to reduce the incidence of pulmonary TB, especially in high-risk groups (Armidah Salsiah Alisjahbana, 2021). Although this study identified age as a risk factor for the incidence of pulmonary TB, several other studies have found pulmonary TB to be more prevalent in older age groups,

The Effect of Gender on the Incidence of Pulmonary TB

The findings of this study indicate that gender plays a role in influencing the occurrence of Pulmonary Tuberculosis (Pulmonary TB). The data obtained indicates that women tend to have a lower risk of developing pulmonary TB than men, with a lower risk of 58.8%. This finding is in line with research conducted by (Sunarmi & Kurniawaty, 2022), the study showed that the prevalence of pulmonary TB was more prevalent in men than women. Of all cases detected, there were 63 cases in men, while only 36 cases were found in women. However, the

findings of this study are not in line with (Dong et al., 2022), the results of this study revealed that women under the age of 40 years had a greater risk of developing Pulmonary TB than men, while in the age group above 40 years, men showed a higher risk.

According to the Indonesian Ministry of Health, lifestyle factors such as higher alcohol consumption in men also contribute to the increased risk of pulmonary TB. Alcohol can lower the immune system, making a person more susceptible to infection. The combination of smoking, alcohol consumption, and exposure to risky work environments increases the likelihood of men developing pulmonary TB compared to women (Kakuhes et al., 2020).

Based on a report from the World Health Organization (WHO), in 2020 there are an estimated 10 million cases of Tuberculosis globally, consisting of 5.6 million cases in men, 3.3 million in women, and 1.1 million in children. On the other hand, the Tuberculosis Control Program Report 2022 notes that in Indonesia, the number of pulmonary TB cases is more prevalent among men than women. In 2021, men accounted for 57.7% of TB cases, while women accounted for 42.3%. In 2022, these percentages changed slightly to 57.8% for men and 42.2% for women. This data confirms that males account for a higher proportion of pulmonary TB cases in Indonesia (Febriyanti et al., 2024).

Thus, it can be concluded that men are more susceptible to pulmonary TB than women due to a combination of biological and environmental factors, including smoking, alcohol consumption, exposure to unhealthy work environments, and high mobility. Therefore, efforts to prevent and control pulmonary TB should consider these factors, including improving health education, providing safer work environments, and encouraging healthy lifestyle changes among men. Although this study focused on men, it is necessary to increase health education to women because Pulmonary TB can also be affected by women in addition to lifestyle, women's immune systems are weaker than men.

Effect of Lighting on the Incidence of Pulmonary TB

The results of this study indicate that lighting has a significant influence on the incidence of pulmonary tuberculosis. The study is not in line with (Ruhban, Andi Lestary, Indah Dwi Rakhmansya, 2020), which found that there was no relationship between house lighting and the incidence of pulmonary TB (p=0.757). However, this finding is in line with research conducted by (Zakiudin et al., 2021), this study indicates that lighting, especially natural lighting, plays a role as a factor influencing the incidence of pulmonary TB. Natural lighting that enters directly into the home can help reduce the transmission of pulmonary TB, as ultraviolet light from the sun has the ability to kill pathogenic bacteria, including Mycobacterium tuberculosis (Gultom et al., 2022). Adequate lighting in the home plays an important role in preventing the growth and transmission of Mycobacterium tuberculosis, the bacteria that cause pulmonary TB. Conversely, inadequate artificial lighting or operating under conditions that increase humidity can create an environment that favors the development of Mycobacterium tuberculosis (Coleman et al., 2022).

This study found that inadequate lighting has a 1.479 times greater chance of increasing the risk of developing pulmonary TB compared to adequate lighting conditions. The same research was conducted by (Monintja N, Warouw F, 2020), the study revealed that respondents with lighting less than 60 lux had a 4.808 times higher risk of developing pulmonary tuberculosis compared to those with natural lighting of 60 lux or more. Based on the Minister of Health Regulation Permenkes No. 1077/MENKES/PER/V/2011, which regulates guidelines for air health in home spaces, including lighting, it is stated that lighting in homes must meet the minimum requirements of 60 Lux (Permenkes, 2011).

Lighting that does not meet the standards can have a negative impact, not only on respiratory health but also on visual health, such as damage to the retina of the eye. In addition, lighting that is too high can cause a rise in room temperature, potentially affecting the humidity in the home. A well-maintained room temperature helps to reduce humidity in the home, creating a less favorable environment for the growth and development of Mycobacterium tuberculosis (Nardell, 2021). High humidity is known to prolong the survival of TB bacteria, so optimizing good air circulation, implementing sufficient natural lighting, and controlling stable room temperature are strategic steps in preventing the spread of this disease (Li et al., 2021).

Thus, this study confirms that optimal natural lighting in the household environment should be a major concern in efforts to control pulmonary TB. Promotive and preventive efforts that prioritize natural lighting and good air circulation in the home should be an integral part of public health policy in reducing the prevalence of pulmonary TB in Indonesian. The limitation in this study to find the effect of lighting is cross-sectional, so it cannot fully confirm the effect of lighting and the incidence of pulmonary TB. So further research with a longitudinal or experimental design is needed to go deeper into how lighting affects the incidence of Lung TB, especially in North Sumatra Province.

The Effect of Nutritional Status on the Incidence of Pulmonary TB

This study showed a significant influence between nutritional status and the incidence of pulmonary tuberculosis. These results are in line with research conducted by (Khoirunnisa et al., 2023), which identified a significant association between nutritional status and the incidence of pulmonary TB. Poor nutritional status has long been associated with an increased risk of Mycobacterium tuberculosis infection, as deficiencies in protein, vitamins, and essential minerals can weaken the

immune system, thereby increasing susceptibility to Pulmonary TB.

The results showed that overnourished individuals were 1.951 times more likely to suffer from pulmonary TB than those with normal nutritional status. Meanwhile, individuals with undernutrition showed a protective factor with 0.489 times or 54.3% lower chance of experiencing Pulmonary TB compared to individuals with normal nutritional status. This finding seems to contradict most previous studies which generally state that undernutrition increases the risk of Pulmonary TB.

in line with a study published in the journal Meditory (Wijayanto et al., 2024) found that almost half of respondents with undernourished nutritional status had pulmonary TB, with a significant association between low nutritional status and the incidence of pulmonary TB Therefore, although this study found that undernutrition acts as a protective factor, further studies are needed to understand the mechanisms behind this phenomenon (Rupang et al., 2024).

Addressing the influence of nutritional status on pulmonary TB requires a comprehensive approach, including nutrition education, improved access to health services, and regular monitoring of nutritional status, especially for at-risk individuals. Nutritional deficiencies can be addressed through nutritional supplementation and food assistance for vulnerable groups. Obesity as a risk factor for Lung TB can be prevented by regular physical activity and a balanced diet. The government needs to limit consumption of foods high in sugar and fat and strengthen primary health care services to improve access to nutrition consultation and routine check-ups for at-risk individuals. The North Sumatra Provincial Government's policy in overcoming Lung TB cases through Governor Regulation Number 22 of 2019 which establishes a regional action plan that includes the objectives of TB control, planned activities, and community participation in these efforts which increase education to the community in preventing Lung TB, especially nutritional interventions that seek to reduce the incidence of Lung TB and achieve TB elimination targets in accordance with the national plan.

CONCLUSIONS

This study concluded that the determinants of the incidence of Pulmonary TB in North Sumatra Province based on the Indonesian Health Survey data (2023) are gender, age, lighting, and nutritional status. The most influential factor on the incidence of Lung TB is age, where productive age is more at risk 3.976 times than non-productive age. The probability of pulmonary TB if all risk factors such as male sex, unproductive age, inadequate lighting, and nutritional status are present is 65.3%. These findings emphasize the importance of age-based interventions in preventing and controlling pulmonary TB. In addition, attention to lighting factors and nutritional status may also help reduce the incidence of pulmonary TB in the region. This study is a suggestion and recommendation to the government to pay attention to the environment, nutritional status, and sociodemographics of the community in order to solve the problem of Pulmonary TB, especially in the province of North Sumatra.

SUGGESTION

This study is expected to provide a comprehensive picture of the factors that contribute to the incidence of Pulmonary TB in North Sumatra Province, so that it can be the basis for formulating strategies for prevention and control of this disease. For future researchers, the results of this study can serve as a reference for further exploration of other risk factors that have the potential to influence the incidence of Pulmonary TB and evaluate the effectiveness of interventions that have been implemented.

REFERENCES

Abbas Ali, M., Gupta, V., Divakar Addanki, R. N., Mannava, A. S., & Parashar, K. D. (2024). "A cross-sectional study to assess stigma associated with tuberculosis in patients, family members, and health care staff in central India." *Indian Journal of Tuberculosis*, *71*(S2), S237–S244. [Crossref], [Publisher]

An, S. J., Kim, Y. J., Han, S. S., & Heo, J. (2020). Effects of age on the association between pulmonary tuberculosis and lung cancer in a South Korean cohort. *Journal of Thoracic Disease*, *12*(3), 375–382. [Crossref], [Publisher]

Armidah Salsiah Alisjahbana, E. M. (2021). Sustainable Transport, Sustainable Development. In *Sustainable Transport, Sustainable Development*. [Crossref], [Publisher]

Chen, Zhi Wang, Tao Du, Jingli Sun, L. (2025). Decoding the WHO Global Tuberculosis Report 2024: A Critical Analysis of Global and Chinese Key Data. *Zoonoses (Ireland)*, *5*(1), 1–16. [Crossref], [Publisher]

Chidambaram, V., Tun, N. L., Majella, M. G., Ruelas Castillo, J., Ayeh, S. K., Kumar, A., Neupane, P., Sivakumar, R. K., Win, E. P., Abbey, E. J., Wang, S., Zimmerman, A., Blanck, J., Gupte, A., Wang, J. Y., & Karakousis, P. C. (2021). Male sex is associated with worse microbiological and clinical outcomes following tuberculosis treatment: A retrospective cohort study, a systematic review of the literature, and meta-analysis. *Clinical Infectious Diseases*, *73*(9), 1580–1588. [Crossref], [Publisher]

Coleman, M., Martinez, L., Theron, G., Wood, R., & Marais, B. (2022). Mycobacterium tuberculosis Transmission in High-Incidence Settings—New Paradigms and Insights. *Pathogens*, *11*(11). [Crossref], [Publisher]

Damanik, B. N., Yani, A., & Daulay, D. (2023). Analisis Pelaksanaan Strategi Directly Observed Treatment Shortcourse (DOTS) dalam Program Penanggulangan TB di Puskesmas Bromo

Kecamatan Medan Denai Tahun 2023. *Kesehatan Deli Sumatera*, *1*(1), 1–8. [Crossref], [Publisher]

Dinas Kesehatan Provinsi Sumatera Utara. (2024). *Profil Kesehatan Provinsi Sumatera Utara* (Vol. 4, Issue 1, pp. 1–23). [Publisher]

Dong, Z., Wang, Q. Q., Yu, S. C., Huang, F., Liu, J. J., Yao, H. Y., & Zhao, Y. L. (2022). Age–period–cohort analysis of pulmonary tuberculosis reported incidence, China, 2006–2020. *Infectious Diseases of Poverty*, *11*(1), 62–71. [Crossref], [Publisher]

Febriyanti, A., Laila, I., & Azzahra, R. (2024). Analisis Faktor-Faktor Risiko Penularan Tuberkulosis di Indonesia. *Seroja Husada: Jurnal Kesehatan Masyarakat*, *1*(2), 194–201. [Publisher]

Feng, Q., Zhang, G., Chen, L., Wu, H., Yang, Y., Gao, Q., Asakawa, T., Zhao, Y., Lu, S., Zhou, L., & Lu, H. (2024). Roadmap for ending TB in China by 2035: The challenges and strategies. *BioScience Trends*, *18*(1), 11–20. [Crossref], [Publisher]

Gultom, A. M., Nurmaini, N., & Siregar, F. A. (2022). the Effect of Physical Conditions of Home and Work Environment on the Event of Pulmonary Tuberculosis in Construction Workers. *Jurnal Riset Kesehatan*, *11*(1), 40–47. [Crossref], [Publisher]

Kakuhes, H., Sekeon, S. A. S., & Ratag, B. T. (2020). Hubungan antara merokok dan kepadatan hunian dengan status tuberkulosis paru di wilayah kerja Puskesmas Tuminting Kota Manado. *KESMAS: Jurnal Kesehatan Masyarakat Universitas Sam Ratulangi*, *9*(1), 96–105. [Publisher]

Kementerian PPN/BAPPENAS. (2021). Buku Saku - Terjemahan Tujuan Dan Target Global 17 Tujuan Pembangunan Berkelanjutan. [Publisher]

Khoirunnisa, Mufiidatun Ummah ZA, Putri Sari Wulandari, Raihanah Suzan, Rita Halim, & Erny Kusdiyah. (2023). Hubungan Status Gizi Dengan Tuberkulosis Di Puskesmas KotaJambi. *E-SEHAD*, *4*(2), 99–108. [Publisher]

Komala Dewi, R. R., & Fazri, E. (2023). Determinan Kejadian Tuberkulosis Paru Di Kalimantan Barat (Studi Data Riskesdas Tahun 2018). *Jumantik*, *9*(2), 69. [Crossref], [Publisher]

Kustiyanti, S. A. (2023). *Transformasi Rumah Sakit Indonesia Menuju Era Masyarakat 5.0*. [Publisher]

Lee, J. Y., Kwon, N., Goo, G. yeon, & Cho, S. il. (2022). Inadequate housing and pulmonary tuberculosis: a systematic review. *BMC Public Health*, *22*(1), 1–12. [Crossref], [Publisher]

Lestari, N. P. W. A., Dedy, M. A. E., Ariawan, M. I., & Febianti, I. (2022). Perbedaan Usia Dan Jenis Kelamin Terhadap Ketuntasan Pengobatan Tb Paru Di Puskesmas Di Kota Kupang. *Cendana Medical Journal*, *10*(1), 24–31. [Crossref], [Publisher]

Lestari, T., Fuady, A., Yani, F. F., Putra, I. W. G. A. E., Pradipta, I. S., Chaidir, L., Handayani, D., Fitriangga, A., Loprang, M. R., Pambudi, I., Ruslami, R., & Probandari, A. (2023). The development of the national tuberculosis research priority in Indonesia: A comprehensive mixed-method approach. *PLoS ONE*, *18*(2 February), 1–14. [Crossref], [Publisher]

Li, Z., Liu, Q., Zhan, M., Tao, B., Wang, J., & Lu, W. (2021). Meteorological factors contribute to the risk of pulmonary tuberculosis: A multicenter study in eastern China. *Science of the Total Environment*, *793*, 148621. [Crossref], [Publisher]

Lorensyifa, A., Nur'ainun, B., Nayoan, N. R. A. N., Astria, L. R. D., Yustrianti, S. M., & Chairani, H. V. C. (2022). *Isu Masalah Kesehatan Penyakit Menular dan Penyakit Tidak Menular*. [Publisher]

Monintja N, Warouw F, P. O. (2020). Hubungan Antara Kondisi Fisik rumah dengan kejadian tuberkulosis paru. *Indonesian Journal of Public Health and Community Medicine*, *1*(3), 94–100. [Crossref], [Publisher]

Nardell, E. A. (2021). Air Disinfection for Airborne Infection Control with a Focus on COVID-19: Why Germicidal UV is Essential†. *Photochemistry and Photobiology*, *97*(3), 493–497. [Crossref], [Publisher]

Nur, R. A., Gisely, V., Silviana, M. I., & Rini, H. (2022). Faktor – Faktor Yang Berhubungan Dengan Kejadian Tuberkulosis Paru Pada Usia Produktif Di Puskesmas Kecamatan Pasar Minggu Tahun 2021. *Jurnal Kesehatan Masyarakat*, *10*(5), 570–578. [Crossref], [Publisher]

Permenkes. (2011). *Peraturan Mentri Kesehatan Indonesia No 1077/Menkes/PER/2011*. [Publisher]

Pralambang, S. D., & Setiawan, S. (2021). Faktor Risiko Kejadian Tuberkulosis di Indonesia. *Jurnal Biostatistik, Kependudukan, Dan Informatika Kesehatan*, *2*(1), 60. [Crossref], [Publisher]

Ruhban, Andi Lestary, Indah Dwi Rakhmansya, A. A. (2020). Hubungan Kondisi Rumah Dengan Kejadian Penyakit TBC Paru Dikelurahan Baraya Kecamatan Bontoala Kota Makassar. *International Journal of Environmental Research and Public Health*, *1*(2), 1–10. [Crossref], [Publisher]

Rupang, E. R., Ginting, A. A. Y., & Veronika, S. (2024). Hubungan Status Gizi Dengan Kejadian Tb Paru Di Rumah Sakit Khusus Paru Sumatera Utara Tahun 2023. *Jurnal Ilmiah Keperawatan IMELDA*, *10*(1), 1–10. [Crossref], [Publisher]

SKI. (2023). Survei Kesehatan Indonesia (SKI). In *Kota Kediri Dalam Angka* (pp. 1–965). [Publisher]

Sunarmi, S., & Kurniawaty, K. (2022). Hubungan Karakteristik Pasien Tb Paru Dengan Kejadian Tuberkulosis. *Jurnal 'Aisyiyah Medika*, *7*(2), 182–187. [Crossref], [Publisher]

Susanti, E. L., Senen, P., Hasnaini, A., & Senen, P. (2024). *Karakteristik dan Analisis Risiko Kasus Tuberkulosis di Karakteristik dan Analisis Risiko Kasus Tuberkulosis di Puskesmas Senen , Jakarta Pusat tahun 2023*. *8*(2). [Crossref], [Publisher]

Sutter, A., Landis, D., & Nugent, K. (2022). The potential role for metformin in the prevention and treatment of tuberculosis. *Journal of Thoracic Disease*, *14*(6),

1758–1765. [Crossref], [Publisher]

WHO. (2022). *Global Tuberculosis Report 2022*. [Publisher]

Wijayanto, T., Solikhah, S., & Sulistyawati, S. (2024). Relationship Nutritional Status and Pulmonary Tuberculosis: Literature Review. *Disease Prevention and Public Health Journal*, *18*(1), 11–16. [Crossref], [Publisher]

Zakiudin, A., Keperawatan, A., & Hikmah, A. (2021). *JURNAL ILMU KEDOKTERAN DAN KESEHATAN INDONESIA Hubungan Pencahayaan Rumah Dengan Kejadian Tuberkulosis Paru Di Wilayah Kerja Puskesmas Tonjong Kabupaten Brebes Tahun 2021 Relationship Of Home Lighting With The Event Of Lung Tuberculosis In The Working Are*. *1*(3), 124–132. [Crossref], [Publisher]