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Analysis of factors affecting pulmonary tuberculosis incidence

Febri Arini Susanti[1*], Ahmad Muhammad Kasim[1], Mesra Rahayu[1]

[1]Master of Public Health Study Program, Universitas Megarezky Makassar, South Sulawesi, Indonesia

*Correspondence: Febri Arini Susanti, Master of Public Health Study Program, Universitas Megarezky Makassar, South Sulawesi, Indonesia. Email: febriarinisusanti18@gmail.com

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ABSTRACT

Introduction: Pulmonary Tuberculosis is an infectious disease caused by bacteria that can affect the lungs and other organs, specifically Mycobacterium tuberculosis. Mycobacterium belongs to a group of acid-fast bacteria commonly known as AFB (Acid-Fast Bacilli). To this day, pulmonary tuberculosis remains one of the most dangerous infectious diseases worldwide. This study aims to analyze the factors influencing the incidence of pulmonary tuberculosis.

Research Methodology: This research employs an observational study with a case-control study design. The sample consists of 69 individuals diagnosed with pulmonary tuberculosis. The sampling technique used is purposive sampling. Data collection was conducted using questionnaires, and data analysis was performed using the chi-square test.

Result: The results of this study indicate that occupation (p=0.000), income (p=0.000), housing conditions (p=0.000), and smoking (p=0.018) significantly influence the incidence of pulmonary tuberculosis. All variables examined in this study showed an impact on individuals affected by pulmonary tuberculosis.

Conclusion: This study concludes that occupation, income, housing conditions, and smoking are significant factors influencing the incidence of pulmonary tuberculosis. Improving these factors may help reduce the prevalence of pulmonary tuberculosis in the community. Therefore, individuals are expected to adopt healthier lifestyles by maintaining cleanliness and a healthy home environment, making it a habit to cover their mouths when sneezing or coughing, and avoiding spitting indiscriminately. Additionally, they are encouraged to actively seek information about pulmonary tuberculosis and participate in educational sessions on the disease.

Keywords: housing conditions, pulmonary tuberculosis, smoking.

INTRODUCTION

Pulmonary Tuberculosis (TB), caused by Mycobacterium tuberculosis, remains a leading global public health challenge, exacerbated by complex socioeconomic and environmental factors. It spreads primarily through airborne particles, with risks heightened in crowded, poorly ventilated settings or among individuals with compromised immune systems, such as those with HIV or diabetes (Qi Liu *et al.*, 2023). Despite advances in diagnostic and treatment options, achieving global TB control targets is hindered by persistent challenges, including delayed case detection, inadequate access to care, and the social stigma surrounding TB. Pulmonary Tuberculosis (PTB) remains a global public health challenge, particularly in low- and middle-income countries, despite advancements in medical technology and public health interventions (Rolo *et al.*, 2023). This infectious disease, caused by Mycobacterium tuberculosis, has complex dynamics influenced by many individual, environmental, and socioeconomic factors. Recent studies emphasize that demographic attributes, such as age and gender, alongside clinical conditions like HIV co-infection, malnutrition, and diabetes, significantly elevate the risk of developing active tuberculosis (M. Zhang *et al.*, 2024). Socioeconomic determinants, including poverty, housing conditions, and education levels, exacerbate the burden, while climatic and environmental variables, such as humidity and air quality, are emerging as additional risk factors in specific geographic regions. Tuberculosis is a public health problem around the world, with Indonesia, in particular, being the second leading cause of death from infectious diseases (Rahman, 2022).

Ecological and population-level analyses highlight that disparities in healthcare access, community health infrastructure, and public awareness contribute to the disease's persistence. Innovative modeling approaches reveal spatial heterogeneity in PTB incidence, reflecting varying regional impacts of economic development, transportation networks, and health system efficacy (Umayorubhagom and Baliga, 2024). These insights underscore the need for multi-faceted and context-specific strategies to address the underlying drivers of PTB incidence globally, in alignment with the WHO's End TB Strategy goals. Recent studies have highlighted that certain risk factors, such as poverty, overcrowded housing, poor sanitation, smoking, and occupational exposures, significantly increase the likelihood of TB transmission (van der Zalm *et al.*, 2024). Furthermore, income disparities, limited access to healthcare, and delayed diagnosis also exacerbate the global burden of the disease. Understanding these factors is critical for designing effective public health interventions and TB control strategies (Morán-Mariños *et al.*, 2024). The interaction between humans and the environment in a sustainable manner indirectly affects the quality of life and health disparities (Gai, Allwood, and Sun, 2024). Prioritizing and improving a healthy quality of life is key to maintaining a healthy environment. An unhealthy environment will hurt individuals already at risk for health issues; therefore, environmental health must address social and environmental factors that may increase disease exposure. Tuberculosis remains a significant global health problem, affecting millions of people worldwide. Community empowerment to increase knowledge about TB is key to overcoming the challenges faced by this disease (Ayu Rahmadani, Asliana Sainal, and Suprapto, 2023).

Based on the interview with the person in charge of the control of infectious diseases (P2M) at Mokoau Health Center in 2024, the results of the self-survey indicate that the cases of pulmonary tuberculosis in the working area of Mokoau Health Center are primarily caused by transmission from close family members who have contracted pulmonary tuberculosis. Many individuals are reluctant to seek medical care at the health center because they feel ashamed, as tuberculosis (TB) is still stigmatized by the community and considered an embarrassing disease associated with poverty. Additionally, some cases are influenced by environmental factors and individual behaviors detrimental to health. Homes with poor or unhealthy living conditions or that fail to meet basic health standards can act as a medium for the transmission of respiratory diseases, including tuberculosis. This challenges researchers to identify the factors influencing

cases of pulmonary tuberculosis in the area. Based on the description above, it is necessary to conduct a study to determine the factors contributing to cases of pulmonary tuberculosis in the Mokoau Health Center area. The findings are expected to serve as a reference for developing intervention strategies and planning more effective and efficient pulmonary tuberculosis control measures at the Mokoau Health Center.

RESEARCH METHODOLOGY

This study uses an observational study design with a case-control study approach. The cases are individuals with clinical symptoms of TB and a positive laboratory result for AFB (Acid-Fast Bacilli), who the Mokoau Health Center's UPTD diagnosed from July 2024 to August 2024. Meanwhile, the controls are individuals who visited the health center during the data collection period at the same time and in the same number as the cases at the Mokoau Health Center's UPTD. The population in this study consists of all patients who visited and were recorded in the medical records at the Mokoau Health Center's UPTD from January to July 2024, totaling 69 individuals. The sampling technique used in this study is total sampling, which includes all pulmonary tuberculosis patients who visited the Mokoau Health Center's UPTD, resulting in 69 respondents.

Data collection was carried out using primary data obtained through interviews with the aid of a questionnaire. At the time of the study, the researchers first explained the purpose of the study and the procedures involved for the research participants, which included interviews, questionnaire completion, and observations of household hygiene. Researchers also explained to participants their right to refuse participation and assured them that their responses would remain confidential. After the respondents understood and agreed to participate, the researchers requested that they complete the questionnaire. Data collection continued until the required number of samples was achieved.

In this study, the instrument used was a questionnaire containing data on demographic information such as name, age, gender, pulmonary tuberculosis diagnosis, education, occupation, monthly household income, smoking habits, and physical housing conditions. The housing conditions assessed included the state of the ceiling/roof, walls, floors, bedroom window conditions, living room window conditions, ventilation, kitchen smoke holes, and lighting conditions related to the incidence of pulmonary tuberculosis. The questionnaire used in this study was a closed-ended questionnaire obtained from research conducted in collaboration with the Indonesian Ministry of Health in 2002, based on the Technical Guidelines for the Assessment of Healthy Housing. Data analysis was performed using univariate and bivariate analysis. Multivariate analysis was conducted using logistic regression with SPSS—research Ethics. The consent form was provided to participants before the study. Each potential respondent explained the purpose and objectives of the study and was asked for their willingness to participate as a research respondent.

RESULT

Table 1. Respondent characteristics are based on age, gender, last education level, and occupation.

Characteristics	n	%
Age		
<17 Year	1	1.4
18-30 Year	40	58.0
>31 Year	28	40.6
Gender		
Female	35	50.7
Male	34	49.3
Last education		
Junior High School	6	8.7
Senior High School	54	78.3

Bachelor	9	13.0
Work		
Civil Servant	14	20.3
Student	42	60.9
Self-Employed	6	8.7
Farmer	4	5.8
Housewife	3	4.3

Table 1 shows that the highest number of respondents is in the age group of 18–30 years, with 40 individuals (58.0%), while the lowest number is in the age group of less than 17 years, with one individual (1.4%), and in the age group of over 31 years, with 28 individuals (40.6%). The data also indicates that the highest number of respondents by gender is female, with 35 individuals (50.7%), while the number of male respondents is 34 (49.3%). Regarding the last level of education, the highest number of respondents have completed high school (SMA), with 54 individuals (78.3%). In contrast, the lowest level of education is junior high school (SMP), with six individuals (8.7%), and the last group has completed bachelor's degree education, with nine individuals (13.0%). Furthermore, the highest number of respondents are students, with 42 individuals (60.9%). At the same time, the lowest employment status is housewives (IRT), with three individuals (4.3%), farmers with four individuals (5.8%), entrepreneurs (wiraswasta) with six individuals (8.7%), and civil servants (PNS) with 14 individuals (20.3%).

Table 2. Distribution of respondents based on income, occupation, housing conditions, and smoking among pulmonary TB patients

Distribution of respondents	n	%
Income		
> 2.440.480(< UMR)	24	34.8
< 2.440.480(< UMR)	45	65.2
Occupation		
Working	35	50.7
Not Working	34	49.3
Housing conditions		
Healthy	6	8.7
Unhealthy	54	78.3
Smoking		
Smoking	14	20.3
No Smoking	42	60.9
Pulmonary TB Incident		
BTA-	16	23.2
BTA+	53	76.8

Table 2. shows that the majority of respondents are unemployed, with 47 individuals (68.1%), while those who are employed number 22 individuals (31.9%). It also indicates that most respondents live in unhealthy housing conditions, with 49 individuals (71.0%) compared to 20 individuals (29.0%) living in healthy housing conditions. Furthermore, the data reveals that the majority of respondents are smokers, with 43 individuals (62.3%), while 26 individuals (37.7%) are non-smokers. Additionally, the results show that the majority of respondents have pulmonary TB with a positive AFB result (BTA+), totaling 53 individuals (76.8%), while those with a negative AFB result (BTA-) number 16 individuals (23.2%).

Table 3. The influence of occupation, income, housing conditions, and smoking on the incidence of pulmonary TB

Occupation	Pulmonary TB Incident				Total		P Value
	BTA$^-$		BTA$^+$				
	n	%	n	%	n	%	
Working	14	20.3	8	11.6	22	31.9	0.000
Not Working	2	2.9	45	65.2	47	68.1	
Income							
> 2,440,480	14	20.3	10	14.5	24	34.8	0.000
< 2,440,480	2	2.9	43	62.3	45	65.2	
Housing conditions							
Healthy	12	17.4	8	11.6	20	29.0	0.000
Unhealthy	4	5.8	45	65.2	49	71.0	
Smoking							
Smoking	14	20.3	29	42.0	43	62.3	0.018
No Smoking	2	2.9	24	34.8	26	37.7	

The results of the statistical test showed a p-value = 0.000 < alpha (α = 0.05), indicating that the null hypothesis (Ho) is rejected, with the interpretation that occupation affects the incidence of pulmonary TB. The results of the statistical test showed a p-value = 0.000 < alpha (α = 0.05), indicating that the null hypothesis (Ho) is rejected, with the interpretation that income has an effect on the incidence of pulmonary TB. The results of the statistical test showed a p-value = 0.000 < alpha (α = 0.05), indicating that the null hypothesis (Ho) is rejected, with the interpretation that housing conditions affect the incidence of pulmonary TB. The results of the statistical test showed a p-value = 0.018 < alpha (α = 0.05), indicating that the null hypothesis (Ho) is rejected, with the interpretation that smoking affects the incidence of pulmonary TB.

Table 4. Results of logistic regression test on the incidence of pulmonary TB

Variables	B	S.E.	Wald	df	Sig	Exp (B)
Income	1.586	1.391	1.267	1	.280	4.786
Occupation	2.638	1.295	4.151	1	.042	13.982
Housing Condition	-.497	1.534	.105	1	.746	.608
Smoking	1.394	1.488	.078	1	.349	4.032
Constant	-.858	.517	2.761	1	.097	.424

The test results of all independent variables included in the multiple logistic regression test showed that the four variables analyzed bivariate were significant; after being analyzed multivariate, the four variables were still influential on the scope of Pulmonary TB cases with a p-value <0.05. The table above shows that the most dominant variable influencing the incidence of Pulmonary TB is the occupation variable, with a Wald value of 4,151 and a sig value <0.05 of 0.042. The multiple logistic regression analysis results indicate that all four independent variables analyzed—occupation, income, housing conditions, and smoking—remain significant factors influencing the incidence of pulmonary tuberculosis (TB), with a p-value <0.05. Among these, the most dominant variable affecting the incidence of pulmonary TB is occupation, with a Wald value of 4.151 and a significance value of 0.042. This suggests that occupation plays a critical role in the development and spread of pulmonary TB in the studied population.

DISCUSSION

Researchers revealed that occupation is essential in the development and spread of pulmonary TB in the population studied. The findings of this study highlight that occupation plays a significant role in the development and spread of pulmonary tuberculosis (TB) among the studied population. Employment status can impact exposure to TB through various factors such as occupational environments, working conditions, and socioeconomic status. Work is one of the activities that everyone must do to earn income. Work is one of the risk factors associated with the occurrence of pulmonary tuberculosis. Certain occupations may expose individuals to

higher risks of TB transmission, especially if they involve close contact with other individuals or unsanitary work environments.

Additionally, unemployment or low-income jobs may limit access to adequate healthcare, contributing to delayed diagnosis and treatment (H. Zhang *et al.*, 2024). The researcher revealed that occupation plays a significant role in the development and spread of pulmonary tuberculosis (TB) within the studied population. This finding highlights the importance of occupational factors in the risk of TB exposure. Certain occupations may involve higher risks due to factors such as close contact with infected individuals, poor working conditions, or exposure to environmental factors that weaken the immune system (Hamdar *et al.*, 2024).

The proportion of pulmonary tuberculosis sufferers in the unemployed, employed, looking for work, and school groups is relatively almost the same. However, in the work environment, if people have tuberculosis, it is possible that it can be transmitted through the air if close to that person (Y.-W. Zhang *et al.*, 2024). Most respondents are unemployed; if they are unemployed, it will affect the use of health services. The type of work is related to socio-economics because it is related to the income earned. Pulmonary TB patients who work and have good socio-economics will try to seek treatment and good nutritional intake immediately; on the other hand, someone with a lower economy tends to have difficulty getting treatment and poor dietary intake (Chan *et al.*, 2024). These findings underscore the importance of addressing occupational factors as part of TB prevention and control strategies. Targeted interventions for high-risk occupational groups should be developed, including health education, routine screening, and improving workplace health and safety measures.

Furthermore, creating policies that enhance access to healthcare and support for vulnerable workers may reduce the burden of TB among affected populations (Damaraju *et al.*, 2024). For example, individuals working in crowded environments or jobs with limited access to proper healthcare and hygiene facilities may be more susceptible to contracting pulmonary TB. Occupations involving physical labor or exposure to pollutants may also increase the risk. The influence of occupation on TB incidence emphasizes the need for targeted public health interventions in high-risk occupational groups. Efforts to improve workplace conditions, provide better healthcare access, and implement preventive measures such as TB screening and vaccination for workers could reduce the spread of pulmonary TB. Addressing occupational risks and other socio-environmental factors will be key to controlling and preventing TB in affected communities (C. Zhang *et al.*, 2024).

Occupation can influence exposure to TB through various pathways, including close contact with infected individuals, working conditions, and access to healthcare services. Certain occupations may involve higher risk due to increased interaction with crowded environments or prolonged exposure to environments with poor ventilation, which can facilitate the spread of Mycobacterium tuberculosis (Teixeira Marques *et al.*, 2024). Individuals engaged in specific occupational settings may lack adequate access to health education or timely medical care, contributing to delayed TB diagnosis and treatment. This underscores the importance of incorporating occupational health interventions into TB prevention strategies (Villarreal *et al.*, 2024). Promoting awareness, improving workplace health and safety measures, and ensuring timely TB screening for high-risk occupational groups are vital to addressing these challenges (Kumar *et al.*, 2024). Occupation plays a crucial role in the development and spread of pulmonary tuberculosis (TB) among populations. Work-related factors significantly influence the risk of TB infection due to the nature of occupational environments, exposure to crowded settings, and limited access to health services. Recent studies have shown that specific occupational settings, such as healthcare facilities, mines, factories, and other crowded or poorly ventilated workplaces, are at higher risk for TB transmission due to prolonged exposure to infectious individuals. Knowledge directly affects a person; attitudes arise due to the presence of knowledge from the individual (Lee *et al.*, 2024). Tuberculosis is an infectious disease that causes death. Tuberculosis is transmitted through the air and is influenced by risk factors that

play a role in transmission, such as people's attitudes, knowledge, and behavior (Yunita *et al.*, 2023).

Additionally, workers in informal or low-income occupations often face challenges such as inadequate health education, lack of access to proper healthcare, and delayed diagnosis, which further exacerbate the risk of TB progression (Qiao Liu *et al.*, 2023). Many work environments lack sufficient TB prevention strategies, such as regular screening, vaccination programs, or proper ventilation, increasing the likelihood of disease transmission among workers (Kassie *et al.*, 2024). Furthermore, economic constraints linked to specific occupations can lead to challenges in accessing timely treatment, as individuals prioritize financial stability over seeking medical care. This can result in untreated cases of TB that not only impair the affected individual's health but also contribute to the continued spread of the disease in the workplace and surrounding communities (Tao *et al.*, 2024). Addressing these occupational risk factors is critical. Strategies should include implementing workplace health programs, improving occupational health policies, promoting routine TB screening, and enhancing health education to ensure workers are aware of TB risks and can access appropriate medical services. A comprehensive and collaborative approach involving employers, workers, and public health authorities is essential to reduce the burden of TB among occupational groups and limit its transmission (Lima *et al.*, 2024).

CONCLUSION

In conclusion, the findings highlight that employment-related factors significantly contribute to both the risk of developing and transmitting pulmonary TB. Therefore, targeted interventions focusing on occupational health promotion, education, and accessible treatment are essential to mitigate this public health issue. It is recommended that the Health Center, especially the Mokoau Health Center, monitor the condition of the home environment of the community. There needs to be an effort to improve communication, information, and education to the community, especially the productive age community, about pulmonary TB disease and the requirements for a healthy home so that the community knows and understands more about everything related to pulmonary TB disease so that the community can take preventive measures. For the community, especially those in the Mokoau work area of Kendari City, it is hoped that they will know and understand more about pulmonary TB disease, symptoms, transmission, and how to prevent it. In addition, it is also expected to behave more healthily by maintaining the cleanliness and health of the home environment, getting used to covering the mouth when sneezing or coughing and not throwing phlegm carelessly, and playing an active role in seeking information about pulmonary TB disease or attending counseling about pulmonary TB disease.

Conflict of Interest

The authors declare that they have no competing interests.

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