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RISK FACTORS OF PULMONARY TUBERCULOSIS: A CASE-CONTROL STUDY FROM EASTERN INDONESIA

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ABSTRACT

Pulmonary Tuberculosis (TB) remains a major public health concern in Indonesia, including in Teluk Bintuni District. The increasing trend of cases underscores the urgency of identifying risk factors, particularly in underserved areas. This study aimed to analyze risk factors associated with pulmonary TB incidence in Teluk Bintuni. A quantitative case-control (1:2) was applied, involving 336 purposively selected respondents who sought care between January and December 2024. Cases were confirmed TB patients, and controls were non-TB patients. Secondary data were obtained from the Tuberculosis Information System (*Sistem Informasi Tuberkulosis* or SITB) and health center records. Univariate analysis indicated that most pulmonary tuberculosis cases were observed among respondents with lower education, productive age group, non-smokers, and Papuan ethnicity. Bivariate analysis using chi-square and Fisher's exact tests identified variables with $p<0.25$ for inclusion in multivariate logistic regression. Significant associations were found between TB and HIV status, education, distance to health facilities, and ethnicity. HIV positivity was observed in 12.5% of cases versus 3.1% of controls (p=0.001; OR=4.429). Low education was more common among controls (79.5%) than cases (55.4%) ($p<0.001$;OR=0.320), non-Papuan ethnicity accounted for 25.0% of cases and 8.5% of controls ($p<0.001$; OR=0.278). Living ≥5 km from health services was less frequent among cases (14.3%) than controls (24.1%) (p=0.037; OR=0.525). In multivariate analysis, HIV status, ethnicity, and education remained significant, with HIV status emerging as the strongest predictor (OR=4.376; p=0.003). The lower TB prevalence among individuals with less-education may reflect underdiagnosis due to limited access to service or reduced or care-seeking. These findings highlight the need for HIV control, improved detection, and culturally tailored TB strategies in remote communities.

Keywords: tuberculosis, risk factors, human immunodeficiency virus, ethnicity, education level

Introduction

Pulmonary Tuberculosis (TB) remains a major public health problem in Indonesia, which currently has the second-highest global burden and the second-largest gap between estimated incidence and reported cases. Between 2015 and 2023, the estimated incidence increased by 19% and deaths rose by 26%, showing a worsening trend. Although free treatment is provided through the national health insurance system, coverage of preventive therapy and diagnostic targets remain far below WHO milestones. These persistent gaps demonstrate that national tuberculosis control efforts have not yet been fully effective.[1]

The Global Tuberculosis Report 2023 [1] reveals that Indonesia ranks second globally in TB burden after India, with an estimated 1.060.000 cases and 134.000 TB-related deaths in 2023. [1] To address this, the government has issued Presidential Regulation No. 67 of 2021 on tuberculosis control, outlining a national strategy focused on early detection, effective treatment, and community-based prevention. [2]

Several factors contribute to the risk of developing pulmonary TB, including age, gender, educational level, type of occupation, smoking habits, comorbidities such as HIV and diabetes mellitus, as well as access to adequate healthcare services. Recent studies emphasize that both individual and socio-environmental factors significantly influence vulnerability to TB infection. [3,4] Furthermore, disparities in socioeconomic status and unequal healthcare infrastructure across regions continue to hinder TB control efforts. [5,6]

In addition, low public awareness and education, couple with inadequate treatment monitoring, often contribute to delayed diagnosis and poor treatment adherence. [7,8,9] These barriers highlight the need for localized and context-sensitive strategies in tuberculosis prevention and treatment. Evidence shows that low education levels are associated with non-adherence to therapy, while factors such as limited knowledge, stigma, and inadequate treatment monitoring hinder timely diagnosis and adherence; moreover, interventions tailored to social and cultural contexts can significantly improve treatment behavior. [9,10,11]

In recent years, Teluk Bintuni District in Papua Barat Province has recorded a significant increase in pulmonary TB cases. According to 2024 local health department data, the number of individuals tested using Xpert MTB/RIF assay increased from 561 in 2020 to 1,572 in 2024. Over the same period, confirmed TB cases rose from 149 to 459, and the number of patients undergoing treatment increased from 136 to 456. Alarmingly, the number of patients declared cured declined from 21 in 2023 to only 16 in 2024. [12] This trend indicates that while case detection has improved, the effectiveness of treatment and therapy completion remains a challenge. One possible explanation for the low cure rate is poor treatment adherence among pulmonary TB

patients. Although this study does not specifically measure adherence, it utilizes secondary data to examine key risk factors associated with TB incidence, which may indirectly reflect broader patterns of health-seeking behavior and treatment outcomes. These findings underscore the urgent need to identify the specific risk factors driving TB transmission in this region.

Although several national and regional studies have examined TB risk factors, most have focused on western parts of Indonesia, such as Sulawesi Selatan, Sumatera Utara, and Jawa Tengah, leaving eastern regions, particularly Papua and Papua Barat, relatively underexplored. [3] For instance, a study in Jayawijaya found that living in traditional ethnic houses and the habit of indiscriminate spitting were associated with increased TB risk, with the latter showing a significant effect (OR = 4.750). While culturally relevant, such findings may not fully capture the geographical isolation and limited healthcare access characteristic of remote coastal areas like Teluk Bintuni. [13] This lack of localized evidence hinders the development of context-specific TB control strategies. Moreover, despite national TB programs promoting early detection and free treatment, challenges such as limited access and low treatment adherence persist in remote districts. These challenges may partly explain why TB incidence remains high in areas like Teluk Bintuni, despite increased case detection efforts.

Therefore, this study seeks to fill that gap by analyzing the risk factors associated with pulmonary TB, specifically in Teluk Bintuni District. The objective is to identify the characteristics of TB patients based on age, sex, education, occupation, smoking status, HIV status, diabetes status, and access to healthcare services. Furthermore, the study examines the relationship between these factors and TB incidence and determines which among them plays the most dominant role. The findings are expected to provide a scientific basis for more targeted and effective TB control policies in Teluk Bintuni District.

Methods

Data analysis in this study followed several systematic stages to process and interpret data obtained from 24 primary health centers across Teluk Bintuni District. This study employed a case-control design with a 1:2 ratio of cases to controls and was conducted between March and April 2025. As the study utilized secondary data, no instrument validity testing was conducted. Instead, data quality was assessed based on completeness, relevance, consistency, and the credibility of the data sources. The unit of analysis was individual patients who underwent pulmonary TB examinations in 2024.

The total sample comprised of 336 individuals, including 112 pulmonary TB cases and 224 non-TB controls, selected using purposive sampling based on the availability of complete secondary data. No matching was applied between cases and controls to avoid restricting the analysis of variables. This purposive sampling method may introduce selection bias, which is

acknowledged as a limitation of the study. Inclusion criteria for the case group included patients diagnosed with pulmonary TB and having complete data, while controls were patients with negative TB examination results and complete records. Patients with incomplete data or severe comorbidities were excluded from the analysis. Since the study used secondary data, no interviews were conducted, and therefore, no direct interaction or differential treatment occurred between cases and controls.

The study analyzed one dependent variable and nine independent variables. The dependent variable was the incidence of pulmonary tuberculosis (TB), defined based on physician-confirmed diagnoses recorded in medical records or documented laboratory results. The independent variables were education level, employment status, distance to health facilities, smoking habits, HIV status, diabetes mellitus status, age, sex, and ethnicity. he variables of smoking habits, HIV status, and diabetes mellitus status were obtained from patients' medical records, with smoking categorized as smoker or non-smoker, HIV status and diabetes mellitus status as positive or negative.

All variables were measured using nominal or ordinal scales based on secondary data obtained from medical records and the Tuberculosis Information System (SITB). Each variable was categorized according to predefined operational definitions. Education level was categorized as low (no schooling, elementary school, or junior high school) and high (senior high school or tertiary education). Employment status was categorized as unstable (unemployed, informal, or irregular work) and stable (formal or permanent jobs). These categorizations were based on data availability and their relevance to the study context.

Univariate analysis was performed to describe the distribution, central tendency, and variability of each variable, providing an overview of the dataset and assessing its suitability for further analysis. Bivariate analysis was conducted to examine associations between independent variables and pulmonary tuberculosis (TB) status using Chi-square tests or Fisher's Exact Test when expected cell frequencies were small. Odds ratios (OR) were calculated from 2x2 contingency tables to quantify the strength of associations.

To identify independent risk factors for pulmonary TB, a multivariate analysis was conducted using a logistic regression model. Variables significant in bivariate analysis were entered into the regression model to adjust for potential confounders. The final model was selected using the backward elimination method based on the significance level of $p < 0.05$. The analysis was conducted using statistical software, and results are presented as adjusted odds ratios (OR) with 95% confidence intervals and corresponding p-values.

Prior to regression analysis, assumptions such as the absence of multicollinearity among predictors were verified to ensure model validity. Ethical approval for this study was obtained from the Health Research Ethics Committee, Faculty of Public Health, University of Cenderawasih, with

approval number No. 031/KEPK-FKM UC/2025. Data confidentiality and patient anonymity were maintained throughout the study by using de-identified secondary data.

Results

The characteristics of respondents and the results of bivariate analysis examining factors associated with pulmonary tuberculosis in Teluk Bintuni District are summarized in the Table 1 below.

Table 1. Characteristics of Respondents and Bivariate Analysis of Factors Associated with Pulmonary Tuberculosis

Characteristic of Respondent	Pulmonary Tuberculosis				p-value	OR	95%CI
	Case (n=112)		Control (n=224)				
	n	%	n	%			
Education Level							
Low Education (≤ Junior High School)	62	55.4	178	79.5	0.000	0.320	0.196-0.525
High Education (≥ Senior High School)	50	44.6	46	20.5		*ref	
Employment Status							
Unstable Employment	51	45.5	80	35.7	0.082	1.505	0.949-2.388
Stable Employment	61	54.5	144	64.3		*ref	
Distance to Health Facility							
Far Distance (> 5 km)	16	14.3	54	24.1	0.037	0.525	0.285-0.967
Close Distance (≤ 5 km)	96	85.7	170	75.9		*ref	
Smoking Habit							
Smoker	45	40.2	86	38.4	0.752	1.078	0.678-1.714
No Smoker	67	59.8	138	61.6		*ref	
HIV Status							
HIV Positive	14	12.5	7	3.1	0.001	4.429	1.733-
HIV Negative	98	87.5	217	96.9		*ref	11.316
Diabetes Status							
Diabetes Positive	4	3.6	4	1.8	0.448	2.037	
Diabetes Negative	108	96.4	220	98.2		*ref	0.500-8.301
Age Group							
Older Adult (46-65 years)	29	25.9	66	29.5	0.493	0.836	
Productive Age (≤ 45 years)	83	74.1	158	70.5		*ref	0.502-1.394
Gender							
Male	55	49.1	100	44.6	0.439	1.196	
Femele	57	50.9	124	55.4		*ref	0.759-1.885
Ethnic Group							
Papua	84	75.0	205	91.5	0.000	0.278	
Non Papua	28	25.0	19	8.5		*ref	0.147-0.525

Based on Table 1, the distribution of exposure between TB cases and controls varied across several variables. For example, 55.4% of TB cases had low education compared to 79.5% of controls. Unstable employment was reported by 45.5% of cases and 35.7% of controls. Among TB cases, 14.3% lived more than 5 km from a health facility versus 24.1% among controls. HIV infection was observed in 12.5% of cases compared to 3.1% of controls. Diabetes was present in 3.6% of cases and 1.8% of controls. Non-Papuan ethnicity accounted for 25.0% of cases and 8.5% of controls.

Bivariate analysis using chi-square tests identified variables with p-values less than 0.25, which were included in the multivariate logistic regression model. These variables were: education

level, employment status, distance to health facility, HIV status, diabetes status, age group, gender, and ethnic group.

Table 2. Multivariate Analysis

Model	Variable	p-value	OR	95%CI
Final	Education Level	0.006	0.454	0.259-0.794
	HIV Status	0.004	4.201	1.585-11.137
	Ethnic Group	0.005	0.374	0.179-0.736

The multivariate logistic regression analysis (Table 2) identified education level, HIV status, and ethnic group as significant factors associated with pulmonary tuberculosis in Teluk Bintuni District. Individuals with lower education levels had significantly lower odds of developing TB (OR = 0.454; 95% CI: 0.259–0.794; p = 0.006), indicating that in this sample, TB was more prevalent among individuals with higher education. This unexpected pattern may reflect differences in occupational exposure, urban residence, or better case detection among the more educated. HIV-positive individuals had a substantially increased risk of TB (OR = 4.201; 95% CI: 1.585–11.137; p = 0.004), reaffirming the well-established link between immunosuppression and TB vulnerability. Additionally, individuals of Papuan ethnicity had significantly lower odds of TB compared to non-Papuans (OR = 0.374; 95% CI: 0.179–0.736; p = 0.005), which could relate to differences in genetic susceptibility, living environments, or healthcare access. These findings highlight the need for targeted TB control strategies that consider educational background, HIV prevention, and ethnic disparities in disease burden.

Discussion

This study identified educational level, HIV status, and ethnicity as significant factors associated with pulmonary TB incidence in Teluk Bintuni. The association between educational level and the incidence of pulmonary Tuberculosis (TB). Individuals with lower education levels had significantly lower odds of developing TB compared to those with higher education. Although counterintuitive, this finding may reflect specific contextual factors in Teluk Bintuni. People with higher education are often more mobile, employed in urban or crowded environments, and are more likely to undergo health screening, all of which may increase case detection. In contrast, individuals with lower education levels may have limited access to healthcare facilities, lower awareness of TB symptoms, and are less likely to seek testing, potentially leading to under diagnosis. Previous studies have emphasized that education generally contributes to better health knowledge and TB prevention behavior, but differences in exposure and care-seeking patterns may explain the unexpected trend observed in this study. [5,14] Some research,

such as by Madji, also reported no significant association between education and TB, highlighting the influence of other factors like family support or proactive healthcare workers. [15]

In addition to education, recent evidence confirms a significant relationship between HIV status and pulmonary tuberculosis incidence, with HIV-positive individuals in Indonesia showing higher risk of TB when CD4 counts are low and viral load is elevated. [16] This increased vulnerability is explained by HIV-related immunosuppression, particularly the depletion and dysfunction of CD4 cells essential for anti-mycobacterial immunity. [17] This aligns with findings by Pralambang and Setiawan, who identified TB as the primary opportunistic infection in People Living With HIV/AIDS (PLWHA), with both conditions exacerbating immune compromise. [18]

This study also highlights a significant association between ethnicity and the incidence of pulmonary tuberculosis. Ethnic groups in Teluk Bintuni comprise both Papuan and non-Papuan populations. The Papuan groups include Wamesa, Sebyar, Kuri, Irarutu, Moskona, Sough, Sumuri, and migrants from other Papuan regions such as Nabire, Wamena, and Biak. The Non-Papuan groups consist of Javanese, Batak, and communities from Sulawesi such as Makassarese, Bugis, and Toraja. Interestingly, a higher incidence of TB was observed among the non-Papuan groups. This pattern may be linked to differences in healthcare-seeking behavior, as non-Papuan individuals are more likely to access formal medical services, leading to greater case detection. Conversely, many Papuan communities live in geographically remote areas with limited access to healthcare and lower levels of formal education. [13,19] In addition, cultural beliefs such as attributing prolonged illness to *suanggi* (sorcery) can delay health-seeking behavior, consistent with studies from Eastern Indonesia showing that mystical and traditional explanations of disease often lead to delayed treatment initiation and ongoing transmission. [11,13] These factors may contribute to the underreporting or underdiagnosis of TB among Papuan groups despite comparable or potentially higher transmission risks, in line with evidence from the national TB Inventory Study that documented substantial under-reporting of TB cases across Indonesia. [9]

Among the variables tested, only education level, HIV status, and ethnicity group remained significant in the final multivariate model. This is consistent with a previous study conducted in Banda Aceh, which showed that individuals with lower education were more likely to develop pulmonary tuberculosis. [20] Other factors such as diabetes mellitus, age, sex, employment status, smoking habits, and distance to health services were not statistically significant and are therefore not elaborated further in this discussion. Although several of these factors showed trends in the bivariate analysis, they did not meet the significance threshold in the adjusted model and were therefore excluded from interpretation.

This study acknowledges several potential sources of bias. As it relied on secondary data from routine health records, minor reporting errors might have occurred, for example, incomplete entries on smoking habits or underreporting of comorbidities such as diabetes mellitus.

Furthermore, ethnic classification was limited to "Papuan" and "non-Papuan" based on administrative reporting formats under Papua's Special Autonomy framework, without further disaggregation of ethnic subgroups. These limitations reflect the structure of available government data rather than methodological flaws. Such challenges are consistent with global experience, as the WHO has highlighted issues of completeness and accuracy in routine TB surveillance systems. [21]

In light of these potential biases, the generalizability of the findings is context-specific. While the results may not represent the entire Indonesian population, they remain highly relevant for geographically isolated and underserved areas, particularly remote indigenous communities across Papua Island. Challenges in completeness and accuracy of routine tuberculosis data especially in indigenous and remote settings are well-documented globally. [21] The findings therefore provide valuable evidence to inform more targeted and equitable TB control strategies in such settings.

Conclusion

This study identifies three key variables that significantly influence the incidence of pulmonary tuberculosis (TB) in Teluk Bintuni District: educational level, HIV status, and ethnicity. The association between higher education and TB may reflect differences in mobility and health-seeking behavior, underscoring the need to expand active case finding across both highly and less educated groups to minimize underdiagnosis. The strong relationship between HIV and TB highlights the importance of integrating HIV services with TB programs to improve early detection and outcomes. In addition, ethnic disparities point to the necessity of culturally sensitive health education and community-based strategies, particularly in remote Papuan communities. Collectively, these approaches can strengthen TB control efforts by promoting timely diagnosis and improving treatment adherence in diverse and underserved populations.

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Conflict of Interest

The authors affirm that there were no personal or professional conflicts that could have influenced the conduct or outcomes of this research.

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