Factors Associated with Tuberculosis Incidence in Tangerang City, Indonesia: A Cross-Sectional Study in 2021

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Abstract

Tuberculosis (TB) remains a major public health issue in Indonesia, with a consistently high burden reported across various regions. In Tangerang City, the Health Office recorded 4,019 confirmed TB cases in 2020, which increased to 4,791 in 2021. This study aims to analysed the incidence and associated factors of tuberculosis in Tangerang City in 2021. A descriptive-analytical approach with a cross- sectional design was employed. The study utilized total sampling, involving all registered TB patients— both pulmonary and extrapulmonary—resulting in a total sample of 10,773 individuals. Secondary data were obtained from the Tangerang City Health Office TB surveillance database for the year 2021. The findings revealed that the majority of TB cases occurred among females, adults, HIV-negative individuals, non-diabetics, and those with a history of new case treatment. Bivariate analysis indicated significant associations between TB incidence and gender, HIV status, and treatment history. Furthermore, multivariate analysis identified gender as the most influential factor in predicting TB incidence in the study population. These results highlight the need for targeted TB control strategies that consider gender-specific vulnerabilities and reinforce integrated screening for comorbid conditions. Strengthening surveillance and programmatic responses tailored to local epidemiological profiles is essential for effective TB prevention and control in urban settings like Tangerang City.

Keywords: Tuberculosis, Risk Factors, Gender, HIV, Cross-Sectional Study

Introduction

Tuberculosis (TB) is an airborne infectious disease caused by *Mycobacterium tuberculosis*, a bacterium that primarily attacks the lungs but can also affect other parts of the body [1]. TB is transmitted through respiratory droplets released into the air when an infected individual coughs, sneezes, speaks, or spits. Despite being both preventable and curable, TB continues to be a significant public health concern, particularly in low- and middle-income countries where social determinants of health contribute to its persistence [2].

According to the Global Tuberculosis Report 2023 published by the World Health Organization (WHO), an estimated 9.87 million individuals were living with TB in 2022. Thirty countries accounted for 87% of global TB cases, with eight countries—India, Indonesia, China, the Philippines, Pakistan, Nigeria, Bangladesh, and the Democratic Republic of the Congo—carrying the heaviest burden. Indonesia alone contributed approximately 10% of the total global TB burden, ranking second after India in terms of case numbers [3]. This statistic highlights the urgent need for intensified and targeted TB control efforts within the country.

The trend in Indonesia reflects a significant increase in case detection over recent years. In 2020, the Ministry of Health recorded 351,936 TB cases, which rose to 397,377 in 2021. In 2022, the number of detected TB cases exceeded 700,000, indicating a substantial escalation [4]. This increase may reflect both the resurgence of TB transmission following disruptions caused by the COVID-19 pandemic, as well as improved case-finding strategies. Nevertheless, it also underscores the ongoing transmission and public health burden that TB continues to pose.

The provincial level, Banten Province reported a total of 215,827 suspected TB cases, in Tangerang City specifically, data from the local health office show a similar upward trajectory. In 2020, 13,739 suspected TB cases were reported, with 4,019 confirmed cases. This number rose in 2021 to 20,501 suspected cases and 4,719 confirmed cases. By 2022, the number of suspected TB cases had almost doubled to 40,394, with 9,438 confirmed cases. Such trends suggest not only higher detection rates but also point to the need for strengthened intervention and prevention strategies at the community level.

In response to the escalating TB burden, the Indonesian government enacted Presidential Regulation No. 67 of 2021 concerning Tuberculosis Control. This regulation mandates comprehensive health measures aimed at increasing public awareness, reducing risk factors, and strengthening preventive efforts. These include personal hygiene promotion, behavioral change interventions, environmental improvements in housing and settlements, and the implementation of infection control procedures in healthcare and public facilities. The regulation also emphasizes the importance of multi-sectoral collaboration—recognizing that TB control requires the involvement of not only health institutions but also stakeholders from education, infrastructure, environmental health, and community-based organizations [5].

The epidemiology of TB is strongly associated with social determinants of health, particularly poverty and inequality. Individuals with low socioeconomic status often face crowded living conditions,

inadequate ventilation, limited access to health care, and nutritional deficiencies—all of which are risk factors for TB. Study highlights that TB disproportionately affects those in the productive age group (15–54 years), with approximately three-quarters of all TB cases occurring among individuals of working age. This places a considerable burden not only on the health system but also on economic productivity [6].

Furthermore, TB affects vulnerable populations such as young people and women, and in some settings, it remains one of the leading causes of death from infectious diseases. Several studies have reported consistent associations between demographic and occupational factors and TB incidence. Study found that age was significantly associated with pulmonary TB cases in the Bolangitang Public Health Center service area [26]. Similarly, a study by Zhussupov *et al*. (2016) demonstrated that increasing age was a predictor of TB risk in high-burden settings [7] [8].

Occupational factors also play a role. Study reported a significant association between employment status and TB incidence [9]. Their findings suggest that individuals working in high-exposure environments or under poor working conditions may be more vulnerable to infection. This aligns with the results of Ayaturrahmi and Lestari (2019), who also found that occupational exposure was significantly linked to pulmonary TB [10].

The findings reinforce the multifactorial nature of TB transmission and suggest that effective control strategies must address not only biomedical aspects of the disease but also its broader social and environmental determinants. Despite ongoing efforts, many regions—including urban centers like Tangerang City—continue to report increasing cases, raising concerns about the adequacy of current strategies and the need for more localized, data-driven interventions.

Material and Methods

This study applied a descriptive-analytical design with a cross-sectional approach. The aim was to analysed the relationship between selected risk factors and the incidence of tuberculosis (TB) within a defined population during a specific period. The cross-sectional method allowed for the simultaneous observation of exposures and outcomes, making it suitable for identifying associations between variables in an observational context.

The research was conducted in Tangerang City, Indonesia, using TB surveillance data from the year 2021. The study population consisted of individuals who were diagnosed with pulmonary or extrapulmonary TB and registered at health facilities across the city. A total sampling technique was applied, including all cases that met the eligibility criteria. This approach ensured that the entire accessible population was captured, reducing selection bias and increasing the generalizability of the findings. A total of 10,773 TB cases were included in the final analysis.

Inclusion criteria for this study were as follows: patients of all age groups and genders who were diagnosed suspect with TB in 2021 and had complete records in the TB surveillance database, including demographic data, clinical classification, HIV and diabetes status, and treatment history. Exclusion criteria included cases with incomplete data in one or more key variables, such as unknown treatment category, missing diagnostic confirmation, or undocumented HIV or DM status.

Patients who were transferred out or whose treatment outcomes were not reported were also excluded from multivariate analysis to maintain analytical accuracy.

The data used in this study were secondary in nature and obtained from the official TB reporting system managed by the Tangerang City Health Office. The database was compiled from routine medical records and reporting by

public health centers and hospitals, and had been reviewed and verified as part of the district-level TB surveillance process. Variables extracted from the database included demographic characteristics (age and sex), type of TB (pulmonary or extrapulmonary), HIV status, diabetes mellitus status, treatment history (new case, relapse, default, or treatment failure), and treatment outcomes (cured, completed, died, failed, lost to follow-up, or not evaluated).

The primary outcome variable in this study was TB status, classified as either TB (confirmed case) or Not TB, based on diagnostic confirmation following national and WHO tuberculosis guidelines. Diagnosis was determined using clinical assessment, radiographic findings, sputum smear microscopy, or GeneXpert MTB/RIF testing. The outcome variable, TB incidence, was defined as a confirmed diagnosis recorded in the city's 2021 TB registry.

The independent variables included several demographic and clinical risk factors. Sex was categorized as male or female. Age group was classified as children (aged <15 years) or adults (aged ≥15 years), in accordance with WHO classifications. HIV status was recorded as either HIV positive or HIV negative, based on testing results at the time of TB diagnosis. Diabetes mellitus (DM) status was categorized as DM positive or DM negative, reflecting the presence or absence of diabetes as a comorbidity. Treatment history was categorized as new case, referring to individuals who had never received TB treatment before, or previously treated, which included relapse, treatment failure, or loss to follow-up. These definitions were based on the national TB control program classification.

All variables were treated as categorical and coded accordingly. The data analysis process was conducted in three stages. Univariate analysis was performed to describe the frequency distribution of each study variable. Bivariate analysis was then used to assess associations between independent variables and TB incidence using Chi-square tests, with a statistical significance threshold set at $p < 0.05$. Multivariate analysis was conducted using multiple logistic regression to identify dominant predictors of TB incidence, controlling for confounding variables. Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were calculated to quantify the strength of associations and the precision of estimates. All statistical analyses were performed using statistics software.

This study utilized anonymized secondary data and involved no direct interaction with patients. Ethical approval was obtained from Health Research Ethics Committee (non-medical) Muhammadiyah University Prof. Dr. Hamka No. 04/23.07/02704, and all procedures were conducted in accordance with national ethical standards for research involving human data.

Results and Discussion

Results

Table 1. Distribution of Characteristics Suspected Tuberculosis Cases and Independent Variables in Tangerang City, 2021

Characteristics	Total	
	n	%
TB Cases		
Yes	3401	24,0
No	10773	76,0
Sex		
Male	6985	49,3
Female	7189	50,7
Age		
Child	1630	11,5
Adult	12544	88,5
HIV		
Positive	3300	23,3
Negative	10874	76,7
DM Status		
Positive	1173	8,3
Negative	13001	91,7
Treatment History		
Never	11488	81,0
Ever	2686	19,0

A total of 14,174 individuals were identified as suspected tuberculosis (TB) cases in Tangerang City. Of these, 6,985 (49.3%) were male and 7,189 (50.7%) were female, indicating a marginal predominance of female cases among the suspected population. In terms of age distribution, 1,630 individuals (11.5%) were classified as children under 15 years, whereas 12,544 individuals (88.5%) were adults aged 15 years or older, demonstrating that the majority of suspected TB cases occurred in the adult population. Regarding HIV status, 3,213 individuals (22.8%) were HIV-positive, while 10,872 (77.2%) were HIV- negative. Analysis of diabetes mellitus (DM) history showed that 13,001 suspected TB patients (91.7%) had no previous diagnosis of DM, whereas 1,173 (8.3%) had a positive DM history. Concerning TB treatment history, 11,488 individuals (81.0%) had never received prior TB therapy, while 2,686 (19.0%) had previously undergone treatment.

These findings provide a comprehensive overview of the demographic and clinical profile of suspected TB cases in Tangerang City. The data serve as the basis for subsequent bivariate and multivariate analyses aimed at identifying significant predictors of confirmed TB incidence.

Table 2. Bivariate Test Results of Tuberculosis Incidence in Tangerang City in 2021 Tuberkulosis

Characteristics	Incidence				Total		PR (95% CI)	Pvalue
	TB		Non TB					
	n	%	n	%	n	%		
Gender								
Male	1974	28,3	5011	71,7	6985	100	1,59 (1,47-1,72)	<0,001
Female	1427	19,8	5762	80,2	7189	100		
Age								
Child	415	25,5	1215	74,5	1630	100	1,09 (0,97-1,23)	0,150
Adult	2986	23,8	9558	76,2	12544	100		
DM Status								
DM Positive	302	25,7	871	74,3	1173	100	1,11 (0,97-1,27)	0,152
DM Negative	3099	23,8	9902	76,2	13001	100		
HIV Status								
HIV Positive	874	26,5	2426	73,5	3300	100	1,19 (1,09-1,30)	<0,001
HIV Negative	2527	23,2	8347	76,8	10874	100		
Treatment History								
Never	2905	25,3	8583	74,7	11488	100	1,49 (1,34-1,66)	<0,001
Ever	496	18,5	2190	81,5	2686	100		

Bivariate tests of factors influencing tuberculosis incidence generally showed a correlation. However, several factors showed no association with tuberculosis incidence, namely age (p = 0.150) and diabetes mellitus status (p = 0.152). The analysis results showed no association between age and diabetes mellitus status.

Table 3. Candidate Variables in Multivariate Analysis

Variables	*Pvalue*	OR (95% CI)
Gender	< 0,001	1,59 (1,47-1,72)
Age	0,14	1,09 (0,97-1,23)
Treatment History	< 0,001	1,49 (1,34-1,66)
HIV Status	< 0,001	1,19 (1,10-1,30)
DM Status	0,14	1,11 (0,97-1,27)

Each independent variable is analyzed together with the dependent variable in a two-way relationship. If the analysis of two variables shows a p-value below 0.25 but is still significant, then that variable can still be included in the multivariate analysis model.

Table 4. Stage 1 Results of Multivariate Logistic Regression Modeling

Variables	*Pvalue*	OR (95% CI)
Gender	< 0,001	1,59 (1,47-1,72)
Treatment History	< 0,001	1,49 (1,34-1,66)
HIV Status	< 0,001	1,19 (1,10-1,30)

The analysis results showed that after selecting variables for multivariate analysis, the variables age and diabetes mellitus status had P-values greater than 0.05. For this reason, these variables were removed from the modeling. Variable elimination was carried out in stages, starting with the variable with the highest P-value. It is important to note that variable elimination was carried out separately, not simultaneously.

Table 5. Stage 2 OR Changes After Age Out

Variables	OR Before	OR After	OR Change
Gender	1,58	1,58	0%
Treatment History	1,51	1,50	0,01%
HIV Status	1,19	1,19	0,01%
DM Status	1,14	1,13	0,01%

The results of the multivariate modeling analysis showed no change in OR for the other variables, so the age variable was eliminated from the model. After eliminating these variables, the final model obtained from the multivariate analysis.

Table 6. Stage 3 OR Changes After DM Status Is Out

Variables	OR Before	OR After	OR Change
Gender	1,58	1,58	0%
Treatment History	1,50	1,51	0,01%
HIV Status	1,19	1,19	0%

The results of the multivariate modeling analysis showed no change in the OR for any other variables, so the DM status variable was eliminated from the model. After eliminating these variables, the final model was obtained from the multivariate analysis.

Table 7. Final Multivariate Analysis Model

Variables	*Pvalue*	OR (95% CI)
Gender	< 0,001	1,58 (1,46-1,70)
Treatment History	< 0,001	1,51 (1,36-1,68)
HIV Status	< 0,001	1,19 (1,09-1,30)

Discussion

This study of 14,174 individuals suspected of tuberculosis (TB) in Tangerang City, the majority ultimately tested negative for the disease. This reflects effective screening strategies aimed at capturing all potential cases, as similar trends have been documented in Indonesia [20] [21] [22] [23], demonstrating that broader case detection yields many negatives as a necessary byproduct of comprehensive surveillance.

Sex Disparity in TB Incidence

A striking sex-related disparity emerged, with significantly higher TB incidence among males. This aligns with global evidence: a large meta-analysis of population-based surveys revealed that adult men display significantly higher immunoreactivity to *Mycobacterium tuberculosis* compared to women—by approximately 1.4 times by age 30, and up to 1.28 times beyond age 40 [19]. Moreover, BMC Medicine's recent report on African countries reports consistently higher TB incidence in men, not only due to behavioral risk exposures such as mining, smoking, or alcohol use, but also structural health access barriers for men [11]. This underscores a global epidemiological pattern: male gender is a robust predictor of TB risk.

Age: A Non-Significant Factor in This Cohort

Contrary to expectations, age did not significantly predict TB incidence. This mirrors local findings, which similarly found no clear age-related discrepancies [12] 13]. However, other models—such as Xu et al.'s heterogeneity model in China—suggest that age stratification, particularly targeting high-contact elderly populations, may be critical for transmission control [8]. In our setting, it appears that age effects were overshadowed by stronger determinants like sex, HIV status, and treatment history.

Treatment History and Recurrence Risk

Treatment history was significantly associated with current TB incidence. Similarly documented elevated TB risk among those previously treated [20] [24]. A retrospective cohort study in Eastern China further confirmed that individuals with diabetes had a 2.4-fold increased hazard of TB recurrence post-treatment (HR: 2.40; 95% CI: 1.68–3.45 [14]. This reinforces the need for robust surveillance of previously treated patients and highlights the intersection with comorbid conditions like diabetes, which may further amplify relapse or resistance risk.

HIV Coinfection: A Major Risk Amplifier

Our study found a strong correlation between HIV status and TB incidence. BMC Infectious Diseases reported elevated risk factors for TB among people living with HIV in China, including low CD4^+ counts, smoking, and intravenous drug use [15]. Additionally, a hospital-based descriptive study from Chengdu documented that HIV-positive TB inpatients had higher odds of rifampicin resistance and worse treatment outcomes [19] [25]. These findings affirm longstanding evidence of HIV's role in increasing TB vulnerability and mortality.

Diabetes Mellitus: A Complex, Emerging Influence

Interestingly, our results did not reveal a significant association between diabetes mellitus (DM) and TB incidence. This echoes earlier Indonesian findings [16]. Nevertheless, the global narrative paints a different picture: DM is widely recognized to impair immunity and increase TB risk, treatment failure, and relapse rates. A comprehensive review in Frontiers in Endocrinology emphasizes the metabolic and microbial biomarkers linking TB–DM comorbidity, illustrating the need for integrated diagnostic approaches [17]. A study in Yemen reported that TB patients with DM were three times more likely to have complications, relapse, or die [18].These insights suggest that the lack of significant association in our data may stem from underdiagnosis or reporting limitations, rather than a true absence of effect.

Multivariate Model: Primary Predictors of TB Incidence

The result of analysed, male sex, HIV-positive status, and history of previous treatment surfaced as the most influential factors. Males had approximately 1.6 times higher odds of TB—a finding consistent with immunoreactivity surveys and case-level analyses [11]. This underscores the need for interventions tailored to high-risk male populations.

Conclusion

The limitations of this study have several important implications for interpreting the findings and applying them to public health practice. The cross-sectional design further restricts the ability to infer causality, as it only captures variables at a single point in time, preventing conclusions about temporal or causal relationships between risk factors and TB incidence. Additionally, because the study population included only individuals registered at health facilities, the findings may not fully represent undiagnosed or asymptomatic cases in the community, limiting the generalizability of the results. The absence of critical confounders such as nutritional status, socioeconomic conditions, and environmental exposures may also contribute to residual confounding, affecting the accuracy of the observed associations. Despite these limitations, the study provides valuable insights into key predictors of TB incidence and highlights the need for future research employing prospective designs, comprehensive data collection, and community-based sampling to strengthen evidence for targeted public health interventions.

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