



Demographic and Clinical Factors Associated with Unsuccessful Treatment Outcomes among Tuberculosis Patients in Mimika Regency, Central Papua

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Abstract

Tuberculosis (TB) remains a public health issue in Indonesia, which had the world's second-highest TB burden in 2024, accounting for 10% of global cases. Mimika Regency, Central Papua, is among districts with a high TB burden in Indonesia. This study aimed to describe demographic and clinical characteristics of TB patients and identify factors associated with unsuccessful treatment outcomes in Mimika Regency in 2025. A retrospective analysis of secondary program data was conducted using the Mimika Regency SITB TB.03 patient register from January to December 2025. Of 2,407 registered patients, 857 (35.6%) had a final treatment outcome at extraction; analyses were restricted to this subset, and incomplete outcome recording may introduce selection bias. Univariate, bivariate (chi-square/Fisher's exact test), and multivariate logistic regression analyses used Python. Most patients were male (57.5%), with median age 31 years; 88.7% had pulmonary TB and 73.7% were new cases. Among patients with outcomes, 72.7% achieved treatment success, while 27.3% had unsuccessful outcomes. Bivariate analysis showed associations with age group, TB site, previous treatment, HIV status, and occupational status. Multivariate analysis identified HIV-positive status (aOR=2.19; 95%CI: 1.24–3.87; p=0.007), extrapulmonary TB (aOR=1.78; 95%CI: 1.12–2.82; p=0.015), and unknown occupational status (aOR=1.64; 95%CI: 1.09–2.45; p=0.017) as factors associated with unsuccessful outcomes, while age <15 years was associated with lower odds (aOR=0.56; 95%CI: 0.36–0.88; p=0.012). Given limited outcome data, findings should be interpreted cautiously. Strengthening TB-HIV services, comorbidity screening, and completeness of TB recording may improve treatment outcomes and program monitoring.

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1. INTRODUCTION

Tuberculosis (TB) remains one of the deadliest infectious diseases in the world. According to the Global Tuberculosis Report 2025 published by the World Health Organization (WHO), an estimated 10.7 million people fell ill with TB in 2024, corresponding to an incidence of 131 cases per 100,000 population, with most cases occurring in the South-East Asia (34%), Western Pacific (27%), and African (25%) regions. Although global TB incidence declined for the first time since the COVID-19 pandemic in 2024, the cumulative 12% reduction between 2015 and 2024 remains far short of the 50% reduction milestone set under the End TB Strategy for 2025 (World Health Organization, 2025).

Indonesia is the country with the second-highest TB burden in the world after India, accounting for approximately 10% of global TB cases in 2024 (World Health Organization, 2025). The Indonesian government has developed the Tuberculosis Information System (SITB) as a national database for recording and reporting the TB control program. A national retrospective cohort study of more than one million drug-sensitive TB cases in the 2020–2022 period found a national treatment success rate of 92.1%, with female sex, younger age, and new case status associated with higher treatment success. However, the same study also found notable regional disparities: treatment success was highest in western Indonesia (93.2%), followed by central Indonesia (91.5%), and lowest in eastern Indonesia (89.8%) (Fitriangga et al., 2025).

The economic burden of TB in Indonesia is also substantial; an analysis of national trends for 2017–2019 estimated the considerable clinical and economic burden borne by both patients and the health system due to drug-susceptible TB (Iskandar et al., 2022). The COVID-19 pandemic had a significant impact on national TB program achievements, with a 26% decline in case notification and an 11% decline in treatment coverage compared with the pre-pandemic period, with the most pronounced impacts occurring in districts with the highest COVID-19 incidence and the most limited diagnostic capacity and health resources (Surendra et al., 2023). To support achievement of the 2030 TB elimination target, expanding access to rapid molecular diagnostics such as Xpert MTB/RIF continues to be pursued, although implementation requires substantial financial investment (Nadjib et al., 2022); stochastic epidemiological projections also indicate that sustained program strengthening is still needed to reach that target (Sasmita et al., 2025).

Mimika Regency, Central Papua Province, is among the districts with the highest TB burden in eastern Indonesia. As a multicultural regency with large-scale mining activity, Mimika recorded a TB case notification rate of 818 per 100,000 population in 2019. Strengthening of TB services through the STRATUM program between 2014 and 2021 increased annual case notification by 67% during 2015–2019 and increased the proportion of bacteriologically confirmed cases by 89%, although the COVID-19 pandemic caused an 18.7% decline in notification in 2020 (Lestari et al., 2022). As a district with high socio-demographic complexity, TB control achievements are also shaped by broader social determinants such as human development level, social protection spending, and health program performance, as found in an ecological study across 116 countries (Költringer et al., 2023). However, because this evidence is drawn from a country-level ecological analysis, it should be interpreted as broader contextual background rather than direct evidence of the mechanisms operating at the patient or district level in Mimika.

Numerous factors have been shown to be associated with TB treatment success globally. A systematic review with meta-analysis of 151 studies found an overall treatment success rate of 80.1% for drug-sensitive TB in adults, with age under 65 years, female sex, HIV-negative status, and negative sputum conversion at month two as predictors of success (Chaves Torres et al., 2019); a registry-based cohort study in Saudi Arabia

similarly underscored the importance of patient clinical characteristics in predicting unsuccessful outcomes (AlOsaimi et al., 2024). HIV co-infection has been associated with poorer TB treatment outcomes; a study in Kuala Lumpur, Malaysia, for example, found that 42.1% of TB-HIV coinfecting patients experienced unsuccessful treatment outcomes (Selimin et al., 2021). Diabetes mellitus (DM) has also been reported as a comorbidity associated with poorer TB treatment outcomes (Xu et al., 2023). Other behavioral and clinical factors also contribute to treatment outcomes, including smoking, which increases the risk of poor outcomes by 51% (Burusie et al., 2020), alcohol consumption, which nearly doubles the risk of poor outcomes (Ragan et al., 2020), and undernutrition, which has been consistently reported to increase the risk of unsuccessful outcomes across multiple cohort studies (Wagnew et al., 2024). Recognizing this complexity of risk factors and comorbidities, WHO issued a collaborative framework to support the integration of TB services with the management of comorbidities such as HIV, DM, undernutrition, alcohol use, and smoking (World Health Organization, 2022a).

The anatomical classification of disease has also been associated with treatment outcomes, although the direction of this association varies across studies depending on the heterogeneity of extrapulmonary clinical forms analyzed (Ranzani et al., 2017; VidyaRaj et al., 2025). Drug resistance is a further challenge for Indonesia's TB program, with an increasing trend in multidrug-resistant TB (MDR-TB) cases reported for 2021–2023 (Kapugu et al., 2026); because the TB.03 SITB register used in this study does not record drug-susceptibility testing results, this study is unable to examine drug resistance directly and this is noted as a limitation below. Among children, the complexity of TB diagnosis remains a distinct challenge, as reflected in the development and evaluation of a childhood TB diagnostic algorithm in Indonesia compared with the WHO algorithm (Triasih et al., 2025; World Health Organization, 2022b); this diagnostic complexity is relevant background for interpreting the childhood age-group finding reported below. From a demographic perspective, male predominance in TB cases has been consistently reported globally and is thought to reflect a combination of differential epidemiological exposure and barriers to care access among men (Horton et al., 2016), consistent with the male predominance observed in this study's population. Case finding through contact investigation has also been shown to be effective in improving early TB detection, particularly among children and other high-risk groups (Bonnet et al., 2023), although the coverage of this activity varies across districts and was not directly analyzed in this study.

Although Mimika Regency has previously been the subject of TB program research, that work primarily focused on case notification trends and the impact of service strengthening through 2021 (Lestari et al., 2022). To date, no patient-level analysis of the demographic and clinical characteristics and factors associated with final treatment outcomes in Mimika Regency using the most recent full-year program data (2025) has been published; this represents a specific and current gap that the present study addresses. Understanding these local determinants is important for guiding more targeted case management strategies, particularly given the burden of TB-HIV co-infection and the geographic conditions that constrain access to health services in Papua.

Based on the foregoing, this study aimed to describe the demographic and clinical characteristics of TB patients registered in Mimika Regency in 2025 and to analyze the factors associated with unsuccessful treatment outcomes using univariate, bivariate, and multivariate approaches based on SITB program data.

2. METHODS

This study was an observational, descriptive-analytic study using secondary program data. Because treatment outcomes were ascertained at a point in time after

treatment initiation rather than measured simultaneously with baseline characteristics, the temporal structure of this study corresponds more closely to a retrospective cohort/record-review design than to a cross-sectional design in the conventional sense, in which exposure and outcome are typically measured at approximately the same point in time; this study is therefore described as a retrospective, register-based analysis of routinely collected secondary data. The study was conducted in Mimika Regency, Central Papua Province, covering all types of health facilities (primary health centers/Puskesmas, hospitals, and clinics) reporting to SITB.

Data were obtained from the Mimika Regency SITB TB.03 patient register for the period January–December 2025, provided in electronic format (.xls) by the Mimika Regency Health Office. The study population comprised all TB patients registered to begin treatment during that period, with the individual registered patient/treatment record in the SITB register serving as the unit of analysis; eligible records were all TB patients registered in Mimika Regency during the study period with the core register fields necessary to derive age, sex, occupational status, diagnosis type, anatomical site, treatment history, HIV status, DM history, and facility type. After data cleaning (removal of header/blank rows in the export file), 2,407 patient records were available for the univariate analysis. For the bivariate and multivariate analyses of treatment outcome, subjects were restricted to patients with a recorded final treatment outcome at the time of data extraction, namely 857 patients (35.6%); 1,550 patients (64.4%) were excluded from this stage because they were still undergoing treatment or had not yet been evaluated, given that the observation period included patients newly registered through December 2025. Because this exclusion is substantial, it is flagged here, at the point where it first arises, as a potential source of selection bias, in addition to being revisited in the Discussion and Limitations: patients whose outcomes were already recorded at the time of extraction may differ systematically from those still on treatment (for example, in disease severity, adherence, or time since registration), and the 857-patient analytic subsample should not be assumed to be representative of the full 2,407-patient registered cohort.

The dependent variable was final treatment outcome, categorized as binary following the standard definitions of the national TB control program into "Successful" (Cured and Treatment Completed categories) and "Unsuccessful" (Died, Failed, Lost to Follow-up, and Not Evaluated/Transferred Out categories). Although Died, Failed, Lost to Follow-up, and Not Evaluated/Transferred Out represent clinically distinct pathways (for example, mortality versus loss to follow-up versus an administratively unresolved outcome), they were combined into a single "Unsuccessful" category because this binary definition follows the national program's own standard outcome-monitoring convention and because several of the individual sub-categories had small cell counts within the 857-patient outcome subset (10 treatment failures and 10 not evaluated/transferred out), which would not have supported a separate multi-category analysis. We acknowledge that this combination limits the ability to distinguish, for example, mortality from administrative loss to follow-up, and note this explicitly as a limitation. Independent variables included age group, sex, occupational status, diagnosis type (bacteriologically confirmed/clinically diagnosed), anatomical site classification (pulmonary TB/extrapulmonary TB), classification of previous treatment history (new/previously treated/unknown), HIV status, diabetes mellitus history, and type of health facility where treatment was provided.

Data processing was performed using Python 3.11. The xlrld library was used to read the .xls files, while the pandas library was used for data cleaning, recoding, and category consolidation. The "Unknown" or blank category for each variable was retained as a distinct category and was not imputed, given that routine program data inherently contains a proportion of incomplete data as part of field-level recording realities. Incomplete data in

routine health information systems, including SITB-based systems, is a common challenge also reported across other low- and middle-income countries (Lemma et al., 2020).

Data analysis was conducted in stages. Univariate analysis was used to describe the frequency distribution and proportion of each categorical variable, as well as the mean, median, and standard deviation for age. Bivariate analysis was conducted using the chi-square (Pearson) test to examine the association between each independent variable and treatment outcome; Fisher's exact test was used as a supplement when a cell had an expected count of less than 5. A p-value <0.05 was considered statistically significant. Multivariate analysis was conducted using multiple logistic regression, with the dependent variable defined as unsuccessful treatment outcome (coded 1) versus successful (coded 0). Variables with a bivariate p-value <0.25 were entered into the multivariate model following a purposeful selection approach. Several categories (occupational status and facility type) were consolidated to maintain an adequate events-per-variable ratio (>10 events per parameter); similarly, age group, described using eight categories for descriptive purposes in Table 3, was recoded into a binary child (<15 years) versus adult (≥15 years) category for the multivariable model. This binary cut-point was chosen because it distinguishes pediatric from adult TB management pathways and corresponds to a conventional epidemiological threshold, and because retaining all eight age categories in the multivariable model would have consumed additional degrees of freedom without a corresponding gain in events per parameter, given that some individual age strata contained relatively few unsuccessful outcomes. Logistic regression results are presented as adjusted odds ratios (aOR) with 95% confidence intervals (CI).

All statistical analyses and data visualizations were performed using Python 3.11 with the pandas, NumPy, SciPy, statsmodels, and Matplotlib libraries. This study used routine secondary program data (not primary data obtained through direct patient contact); personal identifiers such as national identity numbers (NIK) and medical record numbers were not used in the analysis or reported in this manuscript, and all results are presented in aggregate form to protect patient confidentiality.

3. RESULTS AND DISCUSSION

During the period January–December 2025, 2,407 TB patients were registered for treatment in Mimika Regency. The mean patient age was 31.8 years (SD±18.6), with a median of 31 years (range 0–85 years). Patients' demographic characteristics are presented in full in Table 1.

Table 1. Demographic characteristics of TB patients in Mimika Regency, 2025 (n=2,407).

Variable	n	%
Age Group (years)		
0–4	251	10.4
5–14	199	8.3
15–24	453	18.8
25–34	424	17.6
35–44	411	17.1
45–54	371	15.4
55–64	204	8.5
≥65	94	3.9
Sex		
Male	1,383	57.5

Female	1,024	42.5
Occupational Status		
Employed (formal/informal/laborer)	330	13.7
Farmer/Fisher/Livestock breeder	170	7.1
Student	125	5.2
Homemaker	355	14.7
Unemployed	498	20.7
Other	96	4.0
Unknown/blank	833	34.6

Source: Mimika Regency SITB TB.03 register, 2025 (processed data). Mean±SD age: 31.8±18.6 years; median 31 years

Male patients outnumbered female patients (57.5% vs 42.5%), with the highest proportions in the productive age groups 15–24 years (18.8%) and 25–34 years (17.6%). The proportion of unknown/missing occupational status data was relatively high (34.6%), indicating a gap in the completeness of recording for this variable.

In terms of clinical characteristics (Table 2), most patients were clinically diagnosed (59.1%) rather than bacteriologically confirmed (40.9%). Anatomical site was dominated by pulmonary TB (88.7%), and the majority were new cases (73.7%). The known prevalence of HIV-positive status was 6.4%, but HIV status was unknown for 38.0% of patients. Diabetes mellitus history was reported in 3.7% of patients, with 28.7% of unknown status. Most patients received treatment at a primary health center/Puskesmas (66.6%).

Table 2. Clinical Characteristics of TB patients in Mimika Regency, 2025 (n=2,407).

Variable	n	%
Diagnosis Type		
Bacteriologically confirmed	985	40.9
Clinically diagnosed	1.422	59.1
Anatomical Site		
Pulmonary TB	2.135	88.7
Extrapulmonary TB	272	11.3
Previous Treatment History		
New case	1.773	73.7
Previously treated (relapse/failure/lost to follow-up)	177	7.4
Unknown	457	19.0
HIV Status		
HIV-negative	1.339	55.6
HIV-positive	153	6.4
Unknown	915	38.0
Diabetes Mellitus History		
No	1.626	67.6
Yes	89	3.7
Unknown	692	28.7
Health Facility Type		
Primary health center (Puskesmas)	1.604	66.6
Hospital	794	33.0
Clinic	9	0.4

Of the 2,407 registered patients, 857 patients (35.6%) had a recorded final treatment outcome at the time of data extraction, while 1,550 patients (64.4%) were still undergoing treatment or had not yet been evaluated. Among the 857 patients with recorded outcomes, 623 patients (72.7%) had a successful treatment outcome (184 cured [21.5%] and 439 treatment completed [51.2%]), while 234 patients (27.3%) had an unsuccessful outcome, comprising lost to follow-up (143 patients; 16.7%), died (71 patients; 8.3%), not evaluated/transferred out (10 patients; 1.2%), and treatment failure (10 patients; 1.2%).

Bivariate analysis was performed on the 857 patients with recorded treatment outcomes to test the association between each independent variable and treatment outcome (Table 3). Chi-square test results showed that unsuccessful treatment outcome was significantly associated with age group ($p=0.015$), anatomical site ($p<0.001$), classification of previous treatment history ($p=0.003$), HIV status ($p<0.001$), health facility type ($p=0.012$), and occupational status ($p=0.005$). In contrast, sex ($p=0.640$), diagnosis type ($p=0.838$), and DM history ($p=0.250$) showed no statistically significant association.

The highest proportions of unsuccessful outcomes were found among patients with extrapulmonary TB (42.7%, compared with 25.0% for pulmonary TB), HIV-positive patients (43.1%, compared with 22.8% for HIV-negative patients), patients with unknown previous treatment history (35.5%, compared with 23.9% for new cases), and patients with unknown occupational status (35.6%, compared with 17.2% for the employed group). By age group, the highest proportion of unsuccessful outcomes was found in the 15–24 years group (35.2%) and the lowest in the 5–14 years group (17.2%).

Table 3. Bivariate analysis of factors associated with TB treatment outcome (n=857)

Variable	Successful n (%)	Unsuccessful n (%)	Total	p
Age Group				0.015*
0–4	80 (76.2)	25 (23.8)	105	
5–14	53 (82.8)	11 (17.2)	64	
15–24	116 (64.8)	63 (35.2)	179	
25–34	107 (66.5)	54 (33.5)	161	
35–44	114 (78.6)	31 (21.4)	145	
45–54	87 (77.7)	25 (22.3)	112	
55–64	46 (75.4)	15 (24.6)	61	
≥65	20 (66.7)	10 (33.3)	30	
Sex				0.640
Male	359 (73.4)	130 (26.6)	489	
Female	264 (71.7)	104 (28.3)	368	
Diagnosis Type				0.838
Clinically diagnosed	382 (73.0)	141 (27.0)	523	
Bacteriologically confirmed	241 (72.2)	93 (27.8)	334	
Anatomical Site				<0.001*
Pulmonary TB	560 (75.0)	187 (25.0)	747	
Extrapulmonary TB	63 (57.3)	47 (42.7)	110	
Treatment History				0.003*
New case	436 (76.1)	137 (23.9)	573	
Previously treated	29 (74.4)	10 (25.6)	39	
Unknown	158 (64.5)	87 (35.5)	245	
HIV Status				<0.001*

HIV-negative	348 (77.2)	103 (22.8)	451
HIV-positive	37 (56.9)	28 (43.1)	65
Unknown	238 (69.8)	103 (30.2)	341
DM History			0.250
No	398 (74.7)	135 (25.3)	533
Yes	25 (69.4)	11 (30.6)	36
Unknown	200 (69.4)	88 (30.6)	288
Facility Type			0.012*
Puskesmas	395 (75.8)	126 (24.2)	521
Hospital	228 (68.1)	107 (31.9)	335
Clinic	0 (0.0)	1 (100.0)	1
Occupational Status			0.005*
Employed (formal/informal)	106 (82.8)	22 (17.2)	128
Homemaker	96 (75.0)	32 (25.0)	128
Student	37 (75.5)	12 (24.5)	49
Farmer/Fisher/Livestock breeder	42 (67.7)	20 (32.3)	62
Unemployed	144 (73.8)	51 (26.2)	195
Other	39 (81.2)	9 (18.8)	48
Unknown	159 (64.4)	88 (35.6)	247

Source: Processed data, 2025. Chi-square (Pearson) test; *significant at $p < 0.05$. The Clinic category for facility type had $n=1$, so results for this variable should be interpreted with caution.

Variables with a bivariate p -value < 0.25 (age group, anatomical site, treatment history, HIV status, DM history, facility type, and occupational status) were entered into a multiple logistic regression model to obtain adjusted odds ratios (aOR) for unsuccessful treatment outcome. The overall logistic regression model was statistically significant (likelihood ratio test $p < 0.001$), with a McFadden Pseudo R^2 of 0.041. Unlike the R^2 of ordinary least squares regression, McFadden's pseudo- R^2 does not represent the proportion of outcome variance explained; rather, it is a relative measure of how much the model's fit improves over an intercept-only (null) model, on a scale where higher values indicate greater improvement. A value of 0.041 is low, indicating that the variables examined explain only a limited part of what distinguishes patients with successful from unsuccessful treatment outcomes, and this should be borne in mind when interpreting the magnitude of the individual adjusted odds ratios reported below, as is common in models based on complex observational data.

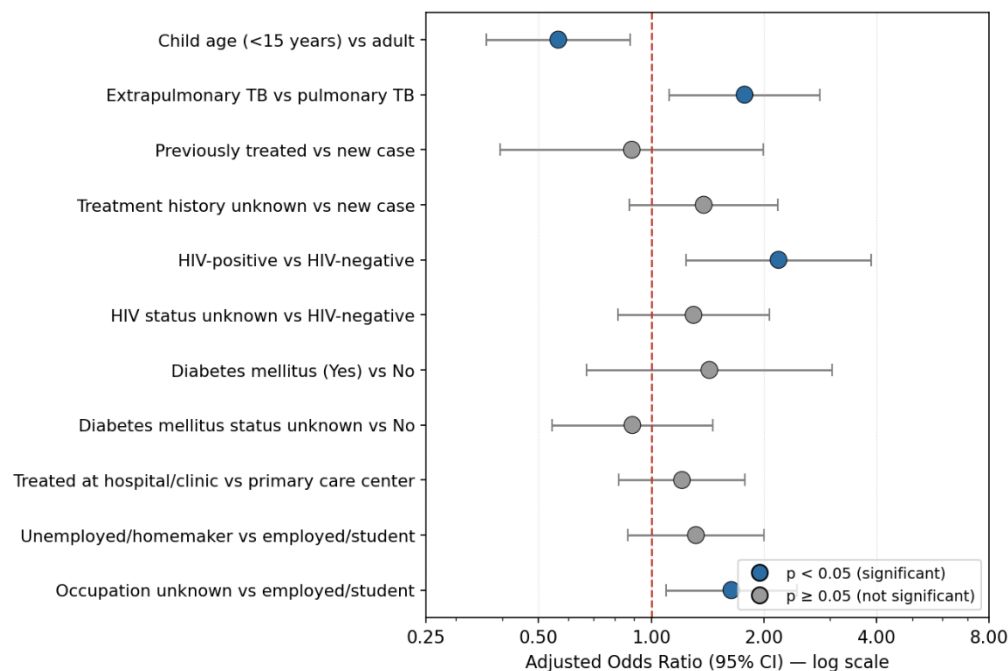
Table 4. Multivariate analysis (Multiple Logistic Regression) of factors associated with unsuccessful treatment outcome ($n=857$).

Variable	aOR	95% CI	p
Child age (< 15 years) vs adult (≥ 15 years)	0.56	0.36–0.88	0.012*
Extrapulmonary TB vs pulmonary TB	1.78	1.12–2.82	0.015*
Previously treated vs new case	0.89	0.40–1.99	0.771
Treatment history unknown vs new case	1.38	0.87–2.18	0.168
HIV-positive vs HIV-negative	2.19	1.24–3.87	0.007*
HIV status unknown vs HIV-negative	1.30	0.81–2.07	0.275
DM history (Yes) vs No	1.43	0.67–3.05	0.355
DM history unknown vs No	0.89	0.54–1.46	0.642

Treated at hospital/clinic vs Puskesmas	1.21	0.82–1.78	0.339
Unemployed/homemaker vs employed/student	1.32	0.87–2.00	0.197
Occupational status unknown vs employed/student	1.64	1.09–2.45	0.017*

Source: Processed data, 2025. aor=adjusted odds ratio; ci=confidence interval; *significant at $p < 0.05$.

As above, the associations reported here should be interpreted with reference to the 857-patient subset with recorded outcomes (35.6% of all registered patients). The multivariate analysis identified four factors independently and significantly associated with unsuccessful treatment outcome. HIV-positive status was associated with more than double the odds of an unsuccessful outcome compared with HIV-negative status (aOR=2.19; 95%CI 1.24–3.87; $p=0.007$). Extrapulmonary TB was associated with 78% higher odds of an unsuccessful outcome compared with pulmonary TB (aOR=1.78; 95%CI 1.12–2.82; $p=0.015$). Unknown/unrecorded occupational status was associated with 64% higher odds of an unsuccessful outcome compared with patients recorded as employed/students (aOR=1.64; 95%CI 1.09–2.45; $p=0.017$); because this category reflects missing rather than substantively different occupational information, it should not be interpreted as evidence that being unemployed or having an unrecorded occupation itself causes worse outcomes, but rather as a possible marker of incomplete case-management documentation (see Discussion). Conversely, childhood age (<15 years) was associated with 44% lower odds of an unsuccessful outcome compared with the adult group (aOR=0.56; 95%CI 0.36–0.88; $p=0.012$). Previous treatment history, DM history, facility type, and the unemployed/homemaker occupational group did not show a statistically significant independent association after adjusting for other variables. A summary of these findings is visualized in Figure 1.



Note: Blue points indicate a statistically significant association ($p < 0.05$); gray points indicate a non-significant association. The dashed red line marks the reference point OR=1.

Figure 1. Factors Associated with Unsuccessful Treatment Outcome among TB Patients in Mimika Regency, 2025 (Multiple Logistic Regression, $n=857$).

DISCUSSION

This study found that TB patients in Mimika Regency in 2025 were predominantly male (57.5%) and in the productive age group. This pattern is consistent with global systematic review evidence showing consistently higher TB case notification ratios for men compared with women in low- and middle-income countries, thought to reflect a combination of differences in disease prevalence due to epidemiological exposure (e.g., occupation, housing density, smoking history) and barriers to care access for men (Horton et al., 2016). As a regency with large-scale mining activity, the high proportion of cases among working-age men in Mimika is likely also influenced by patterns of mobility and high-risk employment in the informal and mining sectors.

The higher proportion of clinically diagnosed cases (59.1%) compared with bacteriologically confirmed cases (40.9%) indicates limited coverage of laboratory-based diagnostic examinations (such as molecular rapid tests/TCM), particularly at the Puskesmas level, where the majority of patients (66.6%) received treatment. This finding is consistent with challenges previously reported in Mimika Regency, where expansion of TCM testing access was carried out gradually through the addition of GeneXpert machines at several health facilities (Lestari et al., 2022). Limited bacteriological confirmation has the potential to affect diagnostic accuracy as well as monitoring of treatment response based on microscopy/culture examination.

The treatment success rate observed in this study (72.7% of the 857 patients with recorded outcomes) is considerably lower than Indonesia's national treatment success rate for 2020–2022 of 92.1%, including compared with the lowest-performing region nationally, eastern Indonesia (89.8%) (Fitriangga et al., 2025). This comparison must be interpreted with caution given the methodological difference: the analysis in this study covers only the subgroup of patients (35.6%) who had a recorded final outcome at the time of data extraction, while the remaining 64.4% of patients were still undergoing treatment or had not yet been evaluated and could not be included as a complete cohort. Consequently, the success rate in this study likely does not fully reflect the treatment success of the overall Mimika TB patient population in 2025 and may be subject to selection bias—for example, if patients whose outcomes were recorded sooner (whether due to early success or early failure) differ in characteristics from patients still undergoing longer-term treatment.

The finding that HIV-positive status was associated with more than double the odds of unsuccessful treatment outcome ($aOR=2.19$) is consistent with robust global evidence. A study in Kuala Lumpur, Malaysia, found that 42.1% of TB-HIV coinfecting patients experienced unsuccessful outcomes (Selimin et al., 2021), while a systematic review with meta-analysis found that HIV-negative patients were twice as likely to achieve treatment success compared with HIV-positive patients (Chaves Torres et al., 2019). Of particular concern, 38.0% of patients in this study had unknown HIV status, far exceeding the recommended coverage target for HIV testing among all TB patients. This suboptimal testing coverage risks delaying identification and management of TB-HIV co-infection, which in turn may worsen treatment outcomes in this high-risk group.

Extrapulmonary TB was associated with 78% higher odds of unsuccessful outcome ($aOR=1.78$) compared with pulmonary TB. This finding is consistent with a number of studies reporting worse outcomes for extrapulmonary TB, although evidence in the international literature tends to vary depending on the specific clinical form analyzed. A large-scale study in Brazil found that isolated extrapulmonary TB cases were actually associated with better outcomes, while disseminated/miliary forms were associated with worse outcomes (Ranzani et al., 2017). A recent study in South India similarly emphasized that the distribution of extrapulmonary TB clinical forms (e.g., lymph node, pleural, bone,

miliary) is highly heterogeneous, with each form having distinct predictors of treatment success (VidyaRaj et al., 2025). Because the TB.03 SITB register does not specify extrapulmonary anatomical subtypes in detail, heterogeneity in clinical severity within the "extrapulmonary TB" category likely influenced the observed outcomes and could not be further disentangled in this study.

Childhood age (<15 years) was associated with lower odds of unsuccessful outcome (aOR=0.56), consistent with evidence from various studies that clinical outcomes for childhood TB are generally better than for adults, with far lower mortality. A study in Lusaka, Zambia, for example, reported a high proportion of successful treatment outcomes for childhood TB (Ngosa et al., 2024). Nonetheless, this favorable outcome must be weighed against the inherently greater diagnostic challenge of childhood TB compared with adult TB, owing to less specific clinical symptoms and limited sensitivity of diagnostic tools in children, as shown by an evaluation of a childhood TB diagnostic algorithm in Indonesia that still found only moderate agreement between physician assessment, the WHO algorithm, and the national algorithm (Triasih et al., 2025). This finding further reinforces the importance of early detection and management of TB among children as a program priority, given that the 0–14 years age group accounted for 18.7% of all registered cases in this study.

Another notable finding is that unknown/unrecorded occupational status was associated with higher odds of unsuccessful outcome (aOR=1.64). Two possible interpretations exist: first, incomplete occupational data may serve as a proxy for lower recording quality and less intensive case management support from TB officers, which in turn is associated with suboptimal monitoring of treatment adherence; second, this incompleteness may also reflect characteristics of harder-to-reach patients (e.g., patients with high mobility or unstable addresses), who are simultaneously at higher risk of being lost to follow-up—consistent with evidence that social determinants such as human development level and social protection are associated with population-level TB program outcomes (Költringer et al., 2023). The variables DM history, facility type, and sex did not show a statistically significant independent association in the multivariate model of this study. For DM history, this is likely due to the low proportion of patients with confirmed-positive DM status (3.7%) and the high proportion of unknown status (28.7%), which limited statistical power to detect an association that may genuinely exist, consistent with a systematic review finding that DM increases the risk of poor outcomes particularly in drug-resistant TB (Xu et al., 2023).

This study has several limitations that should be considered when interpreting the results, the most important of which is selection bias. The outcome analysis covered only 35.6% of all registered patients because most patients were still undergoing treatment at the time of data extraction; this substantial exclusion (64.4% of the registered cohort) represents the primary threat to the internal validity of the associations reported here, because patients whose outcomes were already recorded may differ systematically from those still on treatment, and it limits generalization of the findings to the complete 2025 cohort more than any other single limitation described below. Second, the retrospective, register-based design using secondary routine program data does not permit causal inference, only association between variables. Third, the high proportion of "unknown" categories for several important variables (HIV status 38.0%, DM history 28.7%, occupational status 34.6%) reflects limitations in the completeness of routine program data recording, which may affect the validity of association estimates for these variables, consistent with the data-quality challenges of routine health information systems widely reported in other low- and middle-income countries (Lemma et al., 2020). Fourth, this study could not control for other clinical and behavioral variables that may be confounders

but are not recorded in the TB.03 SITB register, such as nutritional status (Wagnew et al., 2024), smoking (Burusie et al., 2020), alcohol consumption (Ragan et al., 2020), adherence to treatment supporters (PMO), drug-resistance status (Kapugu et al., 2026), or geographic distance/accessibility to health facilities, which is particularly relevant given Papua's geographic conditions. Fifth, and more minor by comparison, the coverage and outcomes of contact investigation as an early case-finding strategy shown to be effective in high-risk populations (Bonnet et al., 2023) were not analyzed in depth as a predictor in this study. Sixth, as a single-district study, generalization of the findings to other regions of Papua or eastern Indonesia should be made with caution.

Nonetheless, this study has the strength of a relatively large dataset (2,407 patients) covering one full calendar year, and represents one of the first patient-level analyses to specifically identify factors associated with TB treatment outcomes in Mimika Regency using a multivariate approach, complementing prior program-level research focused on case notification trends through 2021 (Lestari et al., 2022). These findings provide relevant local evidence to support more targeted TB control program planning in Mimika Regency.

4. CONCLUSION

TB patients in Mimika Regency in 2025 were predominantly working-age males with pulmonary TB and new-case status. Among the 857 patients with recorded treatment outcomes, 72.7% achieved treatment success, while 27.3% had unsuccessful outcomes; because this subset represents only 35.6% of all registered patients, these findings should be regarded as preliminary. HIV-positive status, extrapulmonary TB, and unknown occupational status were independently associated with higher odds of unsuccessful treatment outcomes, whereas age <15 years was associated with lower odds; the unknown-occupational-status finding in particular may partly reflect incomplete recording rather than a true occupational effect and should be interpreted cautiously, rather than as evidence that data completeness itself is an independent clinical determinant. Strengthening TB-HIV collaborative services and closer clinical monitoring for patients with HIV co-infection or extrapulmonary TB are recommended, along with continued efforts to improve the completeness of SITB recording, particularly for occupational status, DM history, and final treatment outcomes. Future studies should use a complete cohort of patients registered in 2025 after all final treatment outcomes have been recorded to provide a more representative assessment of TB treatment outcomes in Mimika Regency.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Dolfinus Yufu Bouway contributed to the conception and design of the study, data collection, data analysis and interpretation, and drafting of the manuscript. Anton Wambrauw contributed to the study design, interpretation of the findings, and critical revision of the manuscript. Erich Christian Wayangkau contributed to data interpretation and critical revision of the manuscript. Paula Nancy Lefaan contributed to the interpretation of the results and critical revision of the manuscript. Sherli Novita Mamoribo contributed to data interpretation, manuscript revision, and overall supervision of the study. All authors contributed to the final revision of the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

During the preparation of this manuscript, the authors used generative AI as a language-support tool to refine wording, improve grammatical accuracy, enhance readability, and organize the presentation of the manuscript. The use of AI was limited to these editorial purposes and did not extend to data analysis, scientific interpretation, formulation of research findings, or decision-making regarding the study. All scientific content was developed and evaluated by the authors, who reviewed the AI-assisted revisions and take full responsibility for the accuracy, originality, and integrity of the manuscript.

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