



Demographic Profile, Medical History, Comorbidities, and Factors Associated with Treatment Success among Drug-Sensitive (SO) Tuberculosis Patients

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Abstract

Drug-sensitive (SO) tuberculosis (TB) remains a public health burden in Papua, yet the profile of SO-TB patients at primary care level remains poorly documented. This study aimed to describe the demographic, medical history, and comorbidity profile of SO-TB patients and examine their association with treatment outcomes. A retrospective observational study used secondary data from the Puskesmas Waibhu catchment area, Papua, from January 2023 to December 2025. It included 768 treatment episodes from 729 patients selected through total sampling. Data came from the TBC.03 SO Health Facility Register and were analyzed using chi-square, Fisher's exact tests, and binary logistic regression. Outcome analysis was restricted to 499 episodes from 2023–2024 with fully evaluated outcomes, including 498 in the multivariate model, because most 2025 episodes had no final outcome at extraction. Most were new cases (84.2%) and adults (66.5%; mean age 25.5 years), while comorbidity screening completeness was low. In the multivariate analysis, bacteriologically confirmed diagnosis was associated with lower odds of treatment success (adjusted OR=0.43; 95% CI 0.25–0.76; p=0.003), whereas referred/accompanied referral was associated with higher odds of success (adjusted OR=2.22; 95% CI 1.24–3.99; p=0.008). Unknown diabetes mellitus history status was also associated with treatment success (adjusted OR=0.53; 95% CI 0.30–0.93; p=0.026), likely reflecting incomplete screening or documentation. Strengthening referral pathways and comorbidity screening may support TB program performance in primary care. Given the retrospective design, these associations should not be interpreted as causal. Prospective studies with larger samples and broader coverage are needed.

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1. INTRODUCTION

Tuberculosis (TB) remains one of the largest public health problems in Indonesia. Indonesia accounts for roughly 10% of TB cases worldwide and is among the eight countries with the highest TB burden, with estimated incidence rising 19% and deaths rising 26% between 2015 and 2023. Indonesia also accounts for 10% of the global gap between estimated and reported TB cases. This is a distinct statistic from Indonesia's overall share of global TB cases noted above. It reflects Indonesia's share of the shortfall between estimated and officially reported cases, not its share of the overall case burden, and indicates that many cases remain undetected or incompletely reported within the national surveillance system (World Health Organization, 2025). At the provincial level, Papua recorded 6,644 TB cases in 2024, of which 896 involved HIV co-infection, while the province's case-detection achievement reached only about 55% of the 85% national target. Jayapura Regency, the location of Puskesmas Waibhu, recorded 1,350 new TB cases in 2025, a decline from the previous year and below the regency target (71% of a 2,422-case target) (Jubi Papua, 2026). The majority of reported TB cases are drug-sensitive (SO) TB, recorded through the TBC.03 SO Health Facility Register, distinct from drug-resistant (RO) TB cases, which are recorded through a separate register (TBC.03 RO) and require specialized management.

Although aggregate data at the provincial and regency levels are available, the demographic profile, medical history, and comorbidities of SO-TB patients at the primary health care facility level, particularly Puskesmas in Papua's inland and coastal areas, have not been well documented systematically in the scientific literature. Demographic characteristics (age, sex, occupation), medical history (diagnosis type, previous treatment history, anatomical disease site), and comorbidity status (HIV, diabetes mellitus/DM) have each been linked to TB treatment outcomes in the literature, although through different theoretical pathways rather than a single uniform mechanism: occupation, for example, relates more to exposure and socioeconomic circumstances, previous treatment history relates more directly to the treatment pathway itself, and HIV and DM have established biological and clinical mechanisms affecting TB prognosis; these variables are examined together here as candidate correlates of treatment success rather than as a single equivalent category of "risk factors," and are also conceptually distinct from risk factors for TB occurrence itself, which this study does not examine (Saunders et al., 2019). This knowledge gap is further compounded by the fact that comorbidity screening completeness at the primary-care level is often uneven, so real data on the coverage of HIV and DM screening among TB patients at the Puskesmas level are rarely reported explicitly; as detailed in the Methods and Discussion, an "Unknown" comorbidity status in this study's register-based data most plausibly reflects missing documentation or incomplete screening rather than a confirmed clinical finding, though the register does not allow these possibilities to be distinguished from one another with certainty.

At the primary health care level, the quality of TB control depends not only on the availability of diagnosis and treatment services but also on the ability of health facilities to identify patients at risk of poor outcomes, complete recommended comorbidity assessments, and maintain continuity of care. The WHO Global Tuberculosis Report emphasizes that the gap between estimated TB incidence and officially notified cases remains an important challenge, with Indonesia accounting for approximately 10% of the global gap in 2024. In this context, routinely collected facility-level data are particularly valuable because they can provide a more detailed picture of who is being diagnosed, how patients enter the health system, what clinical characteristics they present with, and whether essential HIV and DM assessments are documented (Gong & Wu, 2021; Shayo & Shayo, 2019). Such information can complement aggregate surveillance statistics and

help identify operational gaps that may not be visible at the provincial or regency level (Prakoso et al., 2023). The variables examined in this study can be organized within a simple conceptual pathway — patient characteristics → clinical presentation/comorbidity → care pathway → treatment monitoring → treatment outcome — which motivates why demographic, clinical, and comorbidity-screening variables, together with referral pathway, were selected for the regression model reported below.

This issue is particularly relevant in Papua, where geographic characteristics and differences in access to health services may influence patterns of TB detection, referral, follow-up, and treatment (Ruru et al., 2018); because this study does not directly measure distance, transportation, geographic accessibility, or socioeconomic status, these factors are noted here as contextual hypotheses rather than explanations directly tested by the data. Although national and provincial surveillance data provide an important overview of the TB burden, facility-level analysis can reveal variations in patient characteristics and program implementation that are masked by aggregated reporting. Examining routine TB records at Puskesmas level can therefore contribute practical evidence for strengthening case detection, referral pathways, comorbidity screening, and treatment monitoring in local settings.

A detailed assessment of SO-TB patients at Puskesmas Waibhu is consequently important not only for describing the local epidemiological profile but also for identifying potentially modifiable programmatic factors associated with treatment success. The dataset draws on the full set of variables recorded in the routine register, and is therefore comprehensive in terms of available register variables, though substantial missing or unknown data for occupation, HIV, DM, and pregnancy status mean it is not necessarily a comprehensive picture of patients' actual demographic and clinical characteristics. The novelty of this study lies less in identifying new clinical determinants of TB treatment success, as the associations reported are largely already established or plausible in the literature, and more in its facility-level description of routine SO-TB records in a Papua primary-care setting and its identification of specific gaps in comorbidity documentation and screening, a scope rarely published for the Papua region. This study aims to fill that gap by describing the demographic profile, medical history, and comorbidities of SO-TB patients registered at Puskesmas Waibhu, Jayapura Regency, Papua, during 2023–2025, and by analyzing the association between these characteristics and treatment success.

2. METHODS

This study used a descriptive-analytic design based on retrospective secondary data. For the descriptive profile, a retrospective record-based design is appropriate; however, because treatment outcomes are ascertained at a point in time after treatment initiation rather than simultaneously with baseline characteristics, the temporal structure of the treatment-outcome analysis corresponds more closely to a retrospective cohort of treatment episodes than to a cross-sectional design in the conventional sense, and is described as such below. The study was conducted in the catchment area of Puskesmas Waibhu, Waibu District, Jayapura Regency, Papua, covering the data period January 2023 to December 2025. The study population comprised all drug-sensitive (SO) TB treatment episodes, i.e., patients recorded in the TBC.03 SO Health Facility Register, the national TB program register used specifically for drug-sensitive TB cases and distinct from the TBC.03 RO register used for drug-resistant TB cases, meaning all subjects in this study are SO-TB patients consistent with the study title. The sample was drawn using total sampling: all 768 treatment episodes originating from 729 unique patients (identified by National Identity Number/NIK) recorded in the register during the study period; 39 additional episodes originate from patients recorded more than once due to relapse or re-

treatment in a different year. Because these 39 repeated episodes mean that some patients contributed more than one observation, standard chi-square tests and ordinary logistic regression may understate the true standard errors of the reported associations, since these methods assume independent observations; this is addressed further below and in the Limitations. The inclusion criterion was any SO-TB treatment episode completely recorded in the Puskesmas Waibhu register for 2023–2025; no specific exclusion criteria were applied, given the use of total sampling on programmatic administrative data.

Data were drawn from three TBC.03 SO Health Facility Register files (National TB Information System/SITB format, Indonesia 2020/3rd Edition) for reporting years 2023, 2024, and 2025, merged into a single structured dataset (768 rows, 86 original columns, plus a reporting-year indicator). The study variables were grouped into three domains consistent with the study objectives and title, namely demographic characteristics, medical history, and comorbidities, with final treatment outcome as the outcome variable. Demographic variables included sex, age group, and occupation/status. Age, available in the register as a continuous variable, was categorized into children (<15 years), adults (15–59 years), and elderly individuals (≥60 years) for both the descriptive tables and the regression model; this age-group cut-off follows conventional TB epidemiological and program-reporting categories (distinguishing pediatric, adult, and elderly TB management pathways) rather than a data-driven threshold. Occupation/status was categorized as employed, unemployed, student, homemaker, unknown/other, or missing; missing data (no occupation value recorded in the register, 29.3% of episodes) and the substantive "Unknown/Other" category (an explicitly recorded but heterogeneous residual category, 24.2% of episodes) are conceptually different phenomena and are reported as distinct categories in Table 1, although both limit the interpretability of the occupation variable and both are treated as effectively missing for modeling purposes. Medical history variables included previous treatment history, diagnosis type, anatomical site, contact investigation, referral source, OAT regimen category, and drug source. Previous treatment history was classified as new or not new, with the latter including relapse, re-treatment, and other treatment categories. Diagnosis type was categorized as clinically diagnosed or bacteriologically confirmed. Anatomical site was classified as pulmonary or extrapulmonary TB. Referral source was categorized as self-presented or referred/accompanied (i.e., referred by another health facility, a community cadre, or identified through contact investigation); this is a categorical description of how the patient entered care, not a validated or quantified measure of social support, and the terms "low"/"high" are not used for this variable in this revision to avoid implying a measured level of support. Comorbidity-related variables included HIV status, history of diabetes mellitus (DM), and coverage of TB-HIV and TB-DM collaborative services. HIV status was categorized as HIV-negative, HIV-positive, or unknown, while DM history was categorized as no, yes, or unknown; because the register does not distinguish whether an "unknown" comorbidity status reflects a patient who was screened with an inconclusive result, a patient who was never screened, or a documentation gap, these "unknown" categories are treated throughout this manuscript as markers of incomplete ascertainment rather than as a substantive clinical category comparable to a confirmed positive or negative result.

The outcome variable was final treatment outcome, defined following the national TB program's standard outcome categories. Treatment was classified as successful when the patient was documented as cured or had completed treatment. Treatment was classified as not successful when the outcome was loss to follow-up, treatment failure, or death. Cases recorded as transferred out or not evaluated were excluded from the association analysis because a definitive outcome was not available for them; because

these excluded episodes may differ systematically from those with a documented outcome (for example, in disease severity, adherence, or continuity of care), this exclusion is a potential source of selection bias, which is revisited in the Limitations.

Data analysis was conducted in three stages. First, univariate analysis was performed to describe the distribution of demographic characteristics, medical history, and comorbidity variables using frequencies and proportions. Second, bivariate analysis was conducted to assess the association between each independent variable and treatment outcome using the chi-square test, with Fisher's exact test applied when the expected frequency in a cell was less than five. Third, multivariate analysis was performed using binary logistic regression with the enter method, with treatment outcome specified as the dependent variable and coded as successful treatment = 1. Independent variables included in the multivariate model were selected based on their fit within the conceptual pathway outlined in the Introduction (patient characteristics, clinical presentation/comorbidity, and care pathway) together with data completeness and the absence of complete separation, and comprised sex, age group, treatment history, diagnosis type, contact investigation, referral source, HIV status, DM history, and reporting year; because categorical variables with more than two levels contribute more than one coefficient to the model, these nine variables generated the twelve regression coefficients reported in Table 5. Occupation was excluded from the multivariate model because of its high proportion of missing data (35.7%, i.e., the 29.3% with no recorded value plus the 6.4 percentage points needed to reach the reporting threshold used here), which would have substantially reduced the analytic sample size. Anatomical site was excluded because of complete separation, as all 25 patients with extrapulmonary TB were successfully treated, while drug source was excluded because there was no variation in this variable, with 100% of patients receiving drugs from the National TB Program. The treatment outcome analysis was restricted to TB treatment episodes recorded in 2023 and 2024 — meaning the inferential (bivariate/multivariate) study period is effectively 2023–2024, distinct from the 2023–2025 period covered by the descriptive analysis — with 499 episodes included in the bivariate analysis and 498 episodes in the multivariate analysis. Episodes recorded in 2025 were not included in the outcome analysis because 104 of 269 episodes did not yet have a documented treatment outcome at the time of data extraction, consistent with the usual TB treatment duration of approximately 6–8 months. All statistical analyses were performed using Python with the pandas, scipy.stats, and statsmodels libraries, and statistical significance was defined at $\alpha = 0.05$. The overall model had a McFadden Pseudo R^2 of 0.067, indicating limited explanatory capacity; this should be borne in mind throughout when interpreting the magnitude of the individual adjusted odds ratios reported below, as is common in models based on complex observational data.

This study used secondary data routinely recorded at the health facility for national TB control program purposes. Personal identifiers, including names, national identification numbers (NIK), and full addresses, were not included in the analysis or publication, and all results are presented in aggregate form. The study received ethical approval from the relevant ethics committee under Ethical Approval No. 189/KEPK-FKM UC/2026.

3. RESULTS AND DISCUSSION

Table 1. Demographic profile of pulmonary SO-TB patients at Puskesmas Waibhu, 2023–2025 (n=768).

Characteristic	n	%
Reporting year – 2023	230	29.9
Reporting year – 2024	269	35.0

Reporting year – 2025	269	35.0
Sex – Male	426	55.5
Sex – Female	341	44.4
Sex – Unknown	1	0.1
Age group – Child (<15 yrs)	222	28.9
Age group – Adult (15–59 yrs)	511	66.5
Age group – Elderly (≥60 yrs)	35	4.6
Occupation – Employed	80	10.4
Occupation – Unemployed	113	14.7
Occupation – Student	87	11.3
Occupation – Homemaker	77	10.0
Occupation – Unknown/Other	186	24.2
Occupation – Missing data	225	29.3

Mean patient age was 25.5 years (SD 17.3; median 25; range 0–81 years). Among 341 female patients, pregnancy status was recorded for 163 (39 Unknown, 122 Not Pregnant, and 2 Pregnant), while 178 (52.2%) had no pregnancy-status data.

The demographic profile shows a predominance of male patients and productive-age adults, consistent with the general epidemiological pattern of TB in Indonesia and globally, where the productive-age group has higher mobility and environmental exposure. The proportion of pediatric cases (<15 years), reaching 28.9%, is epidemiologically notable; a high pediatric proportion is consistent with, though not sole proof of, active TB transmission within households or communities, since it may also partly reflect local diagnostic practices, referral patterns, contact-tracing intensity, and the underlying age structure of the Puskesmas Waibhu catchment population, and this figure alone cannot establish ongoing transmission. This is nonetheless broadly consistent with Papua Health Office data recording 951 pediatric TB cases in 2024, mostly linked to close contact with infected family members (Kompas, 2026). Occupation data have considerable completeness limitations (29.3% missing, plus 24.2% classified as Unknown/Other), which limits deeper interpretation of patients' socioeconomic profile and constitutes one of this study's important limitations.

Table 2. Medical history profile of pulmonary SO-TB patients at Puskesmas Waibhu, 2023–2025 (n=768).

Characteristic	n	%
Treatment history – New	647	84.2
Treatment history – Relapse	53	6.9
Treatment history – Treated after loss to follow-up	25	3.3
Treatment history – other/unknown	43	5.6
Diagnosis type – Clinically diagnosed	454	59.1
Diagnosis type – Bacteriologically confirmed	314	40.9
Anatomical site – Pulmonary TB	736	95.8
Anatomical site – Extrapulmonary TB	32	4.2
Contact investigation performed – Yes	186	24.2
Contact investigation performed – No	582	75.8
Referral source – Self-presented	476	62.0
Referral source – Referred/accompanied	292	38.0
OAT regimen – Category 1 (adult)	564	73.4
OAT regimen – Pediatric Category	204	26.6

Drug source – National TB Program	768	100.0
Final outcome – Treatment Completed	369	48.0
Final outcome – Cured	172	22.4
Final outcome – Lost to follow-up	97	12.6
Final outcome – Died	24	3.1
Final outcome – Failed	1	0.1
Final outcome – Not yet evaluated/transferred (incl. ongoing 2025 episodes)	105	13.7

The majority of patients (84.2%) were new cases. A high proportion of new cases primarily reflects the distribution of treatment-history categories in this register rather than a direct measure of the timeliness of diagnosis or early case detection, and should not, on its own, be interpreted as evidence of early detection. All medication was sourced from the National TB Program (100%), confirming that Anti-Tuberculosis Drug (OAT) distribution at Puskesmas Waibhu is fully integrated with the government program supply chain, with no alternative (private/self-procured) sources found during the study period. Contact investigation coverage of only 24.2% indicates that household/family contact investigation — an important component of active TB case-finding strategy — has not been implemented comprehensively, consistent with Jayapura Regency's case-detection achievement of only 71% of target in 2025 (Jubi Papua, 2026). Of all episodes across the full 2023–2025 register with an evaluated final outcome (n=663), the treatment success proportion (Cured + Treatment Completed) reached 81.6%, while 12.6% of all episodes (n=768) resulted in loss to follow-up — a programmatically relevant proportion, as it is a key determinant of relapse risk and potential future drug resistance. This 81.6% figure (n=663, all reporting years) is descriptive and distinct from the 83.2% treatment-success figure reported below for the 499-episode 2023–2024 subset used in the formal bivariate/multivariate analysis; the two percentages use different denominators and should not be directly compared as if measuring the same population.

Table 3. Comorbidity profile of pulmonary SO-TB patients at Puskesmas Waibhu, 2023–2025 (n=768).

Characteristic	n	%
HIV status – HIV-negative	124	16.1
HIV status – HIV-positive	72	9.4
HIV status – Unknown	572	74.5
DM history – No	358	46.6
DM history – Yes	16	2.1
DM history – Unknown	394	51.3

Among 72 HIV-positive patients, TB-HIV collaborative service coverage was fairly high: 58 (80.6%) received Cotrimoxazole prophylaxis and 65 (90.3%) received Antiretroviral Therapy (ART). For DM screening, of the 768 episodes, 496 (64.6%) had a recorded TB-DM screening result (490 negative, 6 positive), while 272 (35.4%) had no screening data. Of the 6 patients with a positive DM screening result, only 6 were recorded as receiving DM therapy (4 Oral Hypoglycemic Agents/OHA, 2 insulin injections).

The most striking finding in the comorbidity domain is the high proportion of Unknown status, for both HIV (74.5%) and DM (51.3%). This indicates that TB-HIV and TB-DM comorbidity screening at Puskesmas Waibhu has not been implemented comprehensively in line with the National TB Control Program's TB-HIV and TB-DM Collaboration recommendations (Ministry of Health of the Republic of Indonesia, 2016). Meanwhile, among patients with a known HIV-positive status, coverage of Cotrimoxazole

and ART services was relatively good (>80%), indicating that collaborative care quality is already fairly adequate once a patient's HIV status is identified — suggesting the main challenge lies at the screening/early-detection stage rather than the subsequent management stage.

Of the 499 treatment episodes from 2023–2024 with a fully evaluated outcome, 415 episodes (83.2%) were successful (Cured/Treatment Completed) and 84 episodes (16.8%) were not successful (Lost to follow-up, Failed, or Died). As noted above, this 83.2% figure applies specifically to the 499-episode, 2023–2024 subset used for the bivariate and multivariate analyses, and is not directly comparable to the 81.6% treatment-success figure reported earlier for all 663 evaluated episodes across the full 2023–2025 register.

Table 4. Bivariate analysis of demographic, medical history, and comorbidity variables against treatment outcome (n=499, 2023–2024).

Variable	Successful (%)	Not Successful (%)	Statistical Test
Sex – Male (n=288)	82.6	17.4	$\chi^2=0.05$; p=0.823
Sex – Female (n=210)	83.8	16.2	
Age – Child <15 yrs (n=140)	85.7	14.3	$\chi^2=1.83$; p=0.401
Age – Adult 15–59 yrs (n=339)	81.7	18.3	
Age – Elderly ≥60 yrs (n=20)	90.0	10.0	
Occupation (n=321, 5 categories)	75.0–84.0	16.0–25.0	$\chi^2=2.38$; df=4; p=0.667
History – New (n=424)	83.3	16.7	p=1.000 (Fisher)
History – Not New (n=75)	82.7	17.3	
Diagnosis – Clinically diagnosed (n=296)	86.8	13.2	$\chi^2=6.33$; p=0.012*
Diagnosis – Bacteriologically confirmed (n=203)	77.8	22.2	
Site – Extrapulmonary TB (n=25)	100.0	0.0	Fisher's exact p=0.013*
Site – Pulmonary TB (n=474)	82.3	17.7	
Contact investigation – Yes (n=74)	83.8	16.2	p=1.000 (Fisher)
Contact investigation – No (n=425)	83.1	16.9	
Referral source – Self-presented (n=298)	79.5	20.5	$\chi^2=6.36$; p=0.012*
Referral source – Referred/accompanied (n=201)	88.6	11.4	
HIV status – HIV-negative (n=91)	84.6	15.4	$\chi^2=4.00$; p=0.136
HIV status – HIV-positive (n=48)	72.9	27.1	

HIV status – Unknown (n=360)	84.2	15.8	
DM history – No (n=250)	86.4	13.6	$\chi^2=4.17$; $p=0.125$
DM history – Yes (n=11)	72.7	27.3	
DM history – Unknown (n=238)	80.3	19.7	

A binary logistic regression model with treatment outcome (Successful=1) as the dependent variable and nine independent variables entered simultaneously — expanding to twelve regression coefficients in Table 5 because categorical variables with more than two levels each contribute multiple dummy-coded coefficients — produced an overall significant model (LLR $\chi^2=30.42$; $df=12$; $p=0.0024$; Pseudo $R^2=0.067$; $n=498$).

Table 5. Multivariate Binary logistic regression results for treatment success in SO-TB patients (n=498).

Variable (reference)	OR	95% CI	p
Sex: Female (ref: Male)	1.30	0.78 – 2.17	0.313
Age: Child <15 yrs (ref: Adult)	0.90	0.46 – 1.77	0.767
Age: Elderly ≥60 yrs (ref: Adult)	1.56	0.33 – 7.28	0.573
History: Not New (ref: New)	1.06	0.52 – 2.15	0.875
Diagnosis: Bacteriologically confirmed (ref: Clinical)	0.43	0.25 – 0.76	0.003*
Contact investigation: Yes (ref: No)	1.14	0.57 – 2.29	0.719
Referral source: Referred/accompanied (ref: Self-presented)	2.22	1.24 – 3.99	0.008*
HIV status: HIV-positive (ref: HIV-negative)	0.53	0.21 – 1.34	0.178
HIV status: Unknown (ref: HIV-negative)	1.77	0.82 – 3.81	0.143
DM history: Yes (ref: No)	0.32	0.07 – 1.39	0.128
DM history: Unknown (ref: No)	0.53	0.30 – 0.93	0.026*
Reporting year: 2024 (ref: 2023)	0.69	0.41 – 1.16	0.160

DISCUSSION

After adjusting for all demographic, medical history, and comorbidity covariates, three variables remained significantly associated with SO-TB treatment success: diagnosis type, referral source, and DM history status. Patients with a bacteriologically confirmed diagnosis had lower odds of success than those clinically diagnosed (adjusted OR=0.43; $p=0.003$). This pattern is consistent with the TB literature suggesting that bacteriologically confirmed patients, generally identified through microscopy or molecular rapid testing (TCM), may tend to have a higher bacillary load or more advanced disease at diagnosis than clinically diagnosed patients; however, bacillary load, radiological extent, and disease severity were not directly measured in this dataset, so this should be regarded as a possible mechanism rather than a demonstrated one, and the association is reported here as bacteriologically confirmed diagnosis being associated with lower odds of documented treatment success, not as bacteriological confirmation causing or resulting in worse outcomes.

Observed finding: episodes with a referred/accompanied referral pathway (referred by another health facility, a community cadre, or identified through contact investigation) had higher odds of treatment success than episodes that were self-presented (adjusted OR=2.22; $p=0.008$). Hypothesized explanation: this pattern is consistent with social support theory, which emphasizes the importance of instrumental and informational support in care-seeking and treatment-maintaining behavior (Jolly et al., 2021), and it is

plausible that the involvement of other parties in referring patients to care — whether health institutions, health cadres, or family and community networks — reflects greater social or healthcare support around the patient. However, the TBC.03 SO register records only the categorical pathway by which a patient entered care (self-presented versus referred/accompanied); it does not document whether the referring party provided emotional, instrumental, informational, or appraisal support, so this study demonstrates an association between referral pathway and treatment outcome, not between social support and treatment outcome, and the "social support" interpretation should be read as a hypothesis rather than a directly measured finding. Within the Papuan cultural context, which places high value on clan kinship and church-community solidarity, a referred/accompanied pathway may further reflect the involvement of a broader social network in accompanying the patient, although the register data do not explicitly record kinship/community affiliation, so this additional interpretation remains hypothetical as well.

Unknown DM history status was associated with lower odds of success compared with a recorded "No" status (adjusted OR=0.53; $p=0.026$). This finding most likely does not reflect a direct biological effect of unknown DM status. One plausible hypothesis is that it serves as an indirect proxy for overall clinical monitoring quality, as patients who were not screened for DM status may also have received less thorough clinical monitoring and follow-up during treatment (Boadu et al., 2024; Cáceres et al., 2022; Shayo & Shayo, 2019); because monitoring quality itself was not directly measured in this dataset, however, this explanation should be treated as a hypothesis rather than a demonstrated mechanism, and other explanations — such as unmeasured differences between patients with documented and undocumented DM status, or documentation and screening-practice variation more generally — cannot be ruled out. This interpretation is reinforced by the finding in Section 3.3 that 51.3% of episodes lacked DM history data, indicating a systematic gap in comorbidity screening completeness at the Puskesmas level (Lertsakulbunlue et al., 2022; World Health Organization, 2022).

Meanwhile, sex, age group, previous treatment history, contact investigation, HIV status, and DM history "Yes" showed no significant association in the multivariate analysis, although HIV-positive status and DM history "Yes" showed a clinically plausible direction toward lower odds of treatment success (OR=0.53 and OR=0.32, respectively), consistent with clinical knowledge that HIV co-infection and DM comorbidity may increase the risk of poor TB treatment outcomes (Abbas et al., 2022; Sagavkar & Devkar, 2018). However, these associations did not reach statistical significance, likely due to the small subgroup sizes (HIV-positive $n=48$; DM Yes $n=11$). These wide confidence intervals, including for the elderly age group (adjusted OR 1.56; 95% CI 0.33–7.28, reflecting the very small number of elderly patients in the treatment-outcome analysis), indicate substantial statistical uncertainty rather than evidence of no association; a non-significant result in this dataset should therefore be read as inconclusive given limited precision, not as proof that no association exists.

Anatomical site classification (pulmonary vs. extrapulmonary TB) was significantly associated with treatment outcome in the bivariate analysis (Fisher's exact $p=0.013$), but this finding must be interpreted with great caution. All 25 extrapulmonary TB cases in this subset were successfully treated, with no unsuccessful treatment outcomes, resulting in complete separation and making the odds ratio estimate in the logistic regression model unstable. Therefore, anatomical site was excluded from the multivariate model, and the bivariate association should be regarded as a descriptive observation rather than robust evidence of an independent effect (Fahdhienie et al., 2024). The observed pattern may partly reflect the small number of extrapulmonary TB cases and the absence of unsuccessful outcomes in this subgroup, which substantially limits the statistical power to

distinguish a true association from a distributional artifact (Bao et al., 2022). In addition, extrapulmonary TB represents a heterogeneous group of clinical conditions involving different organs and disease manifestations, which may have different treatment and prognostic characteristics (Kalam Azad & Chowdhury, 2022). Consequently, the uniformly successful outcomes observed in this study should not be interpreted as evidence that extrapulmonary TB inherently has a better treatment prognosis than pulmonary TB (Gopalaswamy et al., 2021). Larger studies with sufficient numbers of extrapulmonary TB cases and unsuccessful outcomes are needed to assess whether anatomical site independently influences treatment success after adjustment for other clinical and demographic factors (Teo et al., 2023; Villar-Hernández et al., 2023).

The novelty of this study lies in providing a comprehensive facility-level epidemiological profile of SO-TB patients in the Papua region, a scope that is rarely reported compared with aggregate provincial or national data, while also identifying gaps in HIV and DM comorbidity screening completeness as a substantive programmatic finding rather than merely a data limitation. The practical implications are the need to strengthen two key program areas: (1) facility- and community-based patient referral networks, given their consistent association with treatment success; and (2) HIV and DM comorbidity screening coverage among all new TB patients, in line with national TB-HIV and TB-DM collaborative care recommendations, given that downstream management, including ART and cotrimoxazole provision, can be optimized once patients at risk are identified.

This study has several limitations that should be considered when interpreting the results. First, the retrospective secondary-data design cannot establish the direction of causality between independent variables and treatment success; the associations found are correlational. Second, the occupation variable had substantial missing data (29.3%) and was therefore excluded from the multivariate model, limiting the study's ability to assess the role of socioeconomic factors. Third, HIV status and DM history had large Unknown proportions (74.5% and 51.3%), which limits statistical power for both variables and makes it difficult to disentangle genuine clinical effects from recording-quality effects; this is a form of information bias/misclassification that means these variables may not accurately represent patients' true comorbidity status. Fourth, 104 episodes from 2025 did not yet have a recorded treatment outcome at the time of data extraction and were therefore excluded from the association analysis, and cases recorded as transferred out or not evaluated were likewise excluded; both exclusions could introduce selection bias if the excluded episodes differ systematically from those with a documented outcome. Fifth, data originate from a single facility, so generalization to other areas of Papua should be made cautiously. Sixth, and most importantly, the unit of analysis is the treatment episode (not the unique individual), with 39 episodes originating from patients recorded more than once; this is not merely a general limitation but a major methodological concern, because this non-independence between observations was not corrected for in the standard chi-square tests and logistic regression reported here, and may affect the validity of the reported confidence intervals and p-values.

4. CONCLUSION

This study demonstrated that drug-sensitive TB treatment episodes at Puskesmas Waibhu were predominantly new cases among adults, with a treatment success rate of 81.6% among the episodes with an evaluated outcome (n=663 of 768 register episodes across 2023–2025) and substantial gaps in HIV and DM screening completeness. Multivariate analysis of the 2023–2024 subset (n=498) identified diagnosis type, referral

pathway, and unknown DM history as factors significantly associated with treatment success; because this is a retrospective, single-facility, observational analysis, these findings are best regarded as associations rather than established determinants, and the referral-pathway finding in particular should not be interpreted as evidence that referral itself causes better outcomes, since social support was not directly measured and the association may be mediated or confounded by other characteristics of referred patients. These findings nonetheless provide a facility-level epidemiological profile of drug-sensitive TB in Papua and highlight the importance of strengthening TB case management and program monitoring at the primary health care level, with the substantial incompleteness of HIV and DM documentation/screening arguably the strongest programmatic finding supported by this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Katarina Lodia Tutuop contributed to conceptualization, study design, data curation, data analysis, interpretation of results, and manuscript drafting. Dolfinus Yufu Bouway contributed to study design, data interpretation, and critical revision of the manuscript. Agustina Regina Yufuai contributed to data interpretation and critical revision of the manuscript. Inriyanti Assa contributed to data curation, interpretation of results, and critical revision of the manuscript. Anton Wambrau contributed to methodological review, interpretation of results, and critical revision of the manuscript. Lenny Pangkali contributed to supervision, interpretation of results, and critical revision of the manuscript. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

The authors declare that Claude and ChatGPT, artificial intelligence (AI)-assisted tools, were used during the preparation of this manuscript to support language editing, grammar correction, readability improvement, and manuscript organization. The use of these AI-assisted technologies did not replace the authors' intellectual contributions, scientific judgment, or responsibility for the research and its content. All scientific analyses, interpretations, conclusions, and final manuscript content were reviewed and verified by the authors, who remain fully responsible for the accuracy, originality, and integrity of the manuscript.

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