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Factors Associated with Treatment Success Among Patients with Bacteriological Confirmed Pulmonary Tuberculosis

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ABSTRACT

Background:Treatment success is a key performance indicator for evaluating treatment activities and program management. This study aimed to examine factors associated with treatment success among patients with bacteriological confirmed pulmonary tuberculosis (TB). Methods:This analytical observational study used secondary data from 2,221 bacteriological confirmed pulmonary TB cases recorded in the Bandung City Tuberculosis Information System in 2024. The variables evaluated were age, sex, treatment history, time to treatment initiation, and 2nd-month follow-up results. Bivariate analysis used the Chi-square test, followed by multivariate analysis using logistic regression.Results: Among 2.221 patients, 2,072 (93.3%) achieved successful treatment outcomes, while 149 patients (6.7%) did not. Age (p=0.008), sex (p=0.021), treatment history (p=0.003), and 2nd-month follow-up results (p<0.001) were significantly associated with treatment success. The strongest association in the bivariate analysis was observed for 2nd-month follow-up results (OR=5.189; p<0.001). In the multivariate analysis, age (aOR=3,613, 95% CI=1,126-11,589), *sex* (aOR=0,701; 95% CI=0,494-0,993), *treatment history* (aOR=1,592; 95% CI=1,119-2,264), *and 2nd-month follow-up results* (aOR=5,004; 95% CI=3,445-7,268) *were significantly associated with treatment success. The 2nd-month follow-up result showed the strongest association. Conclusion:Most patients achieved successful treatment outcomes. Age, sex, treatment history, and 2nd-month follow-up results were significantly associated with treatment success, whereas time to treatment initiation was not. The 2nd-month follow-up result showed the strongest association with treatment success.*

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INTRODUCTION

Tuberculosis (TB) remains a major public health concern worldwide, requiring sustained efforts to improve prevention, diagnosis, and treatment. According to the World Health Organization (WHO), an estimated 10.7 million people developed TB globally in 2025, with a treatment success rate of 88% (WHO, 2025). The treatment success rate (TSR) is an important indicator of the quality of TB care and the effectiveness of national TB control programs. The WHO has established a global target of at least 90% treatment success. Achieving this target is essential to ensure treatment completion, reduce ongoing transmission and the development of drug resistance, and minimize the risks of death and disease recurrence (WHO, 2025).

Indonesia continues to experience a substantial TB burden, with a high estimated number of cases and treatment success rates that remain below the national target. The Global Tuberculosis Report 2025 estimated approximately 1,080,000 new TB cases in Indonesia, with a treatment success rate of 86%, which remains below the global target (WHO, 2025). Furthermore, Presidential Regulation No. 67 of 2021 on Tuberculosis Control sets a national treatment success target of 90%. Achieving this target requires not only timely diagnosis but also standardized, patient-centered treatment and consistent monitoring throughout the treatment period (Presidential Regulation of the Republic of Indonesia, 2021).

Previous studies have shown that TB treatment outcomes are influenced by various patient-related and clinical factors. A systematic review and meta-analysis by Torres et al. (2019) identified several factors associated with treatment outcomes, including age, sex, alcohol consumption, smoking behavior, month-2 sputum conversion status, and HIV status. Their analysis of studies published between 2014 and 2019 reported a treatment success rate of 80.1% among adults with drug-susceptible TB. Evidence from Indonesia has also highlighted the role of patient characteristics in determining treatment outcomes. Meiyanti et al. (2024), for example, reported that older age and higher acid-fast bacilli (AFB) smear grades were associated with an increased likelihood of unsuccessful treatment outcomes.

Beyond patient characteristics, the timing of treatment initiation is another important consideration in TB management. Delays between diagnosis and treatment initiation may affect the continuity of care and the timely management of infection. Lestari et al. (2020) defined treatment delay as the initiation of therapy more than two days after diagnosis. Therefore, evaluating the interval between diagnosis and treatment initiation may provide useful insights into the quality of TB services and its potential relationship with final treatment outcomes.

Although previous studies have identified several factors associated with TB treatment outcomes, further investigation is needed to understand how patient characteristics, treatment initiation time, and early treatment response collectively relate to final outcomes. Therefore, this study aimed to analyze the factors associated with final treatment outcomes among patients with bacteriological confirmed pulmonary TB in Bandung City, Indonesia. Specifically, the study examined age, sex, previous treatment history, time to treatment initiation, and month-2 follow-up results. The findings are expected to provide evidence for strengthening patient monitoring, improving treatment management, and supporting efforts to achieve better TB treatment outcomes.

METHOD

This study employed an analytical observational design using secondary data from the Tuberculosis Information System (SITB) of Bandung City, Indonesia, for 2024. The study aimed to examine the associations between patient characteristics, treatment initiation time, month-2 follow-up results, and final treatment outcomes among patients with bacteriological confirmed pulmonary tuberculosis (TB). Final treatment outcomes were determined based on TB Register Form TB.03, following the Indonesian Ministry of Health guidelines (Ministry of Health of the Republic of Indonesia, 2021). The database contained 4,874 bacteriological confirmed pulmonary TB cases, of which 2,221 met the eligibility criteria and had complete data, while 2,653 cases were excluded due to ineligibility and/or incomplete records. The inclusion criteria were patients registered with bacteriological confirmed pulmonary TB in 2024, with complete records of diagnosis dates, treatment initiation dates, month-2 follow-up results, and final treatment outcomes. Patients with extra-pulmonary TB, clinically diagnosed TB without bacteriological confirmation, incomplete records, or treatment initiation dates preceding diagnosis were excluded. The dependent variable was final treatment outcome, categorized as treatment success (cured or treatment completed) and unsuccessful treatment (treatment failed, died, lost to follow-up, or not evaluated). Independent variables included age (≤18 and >18 years), sex (male and female), previous treatment history (new and previously treated), treatment initiation time (timely: ≤2 days; delayed: >2 days after diagnosis), and month-2 follow-up results (conversion and non-conversion). Data analysis involved univariate, bivariate, and multivariable procedures. Univariate analysis described variable distributions using frequencies and percentages, while bivariate associations were examined using the chi-square test. Binary logistic regression was performed to identify independent associations with final treatment outcomes after adjustment for other variables in the model. Results were expressed as adjusted

odds ratios (aORs) with 95% confidence intervals (CIs). Model goodness-of-fit and multicollinearity were assessed to evaluate model adequacy. Statistical significance was set at $p < 0.05$.

RESULT AND DISCUSSION

A total of 2,221 patients with bacteriological confirmed pulmonary tuberculosis (TB) registered in the Tuberculosis Information System (SITB) of Bandung City in 2024 were included in the analysis. Overall, the treatment success rate was 93.3%. This finding indicates that most patients in the study achieved successful treatment outcomes.

Table 1. Distribution of Characteristics of Patients with Bacteriologically Confirmed Pulmonary TB

Characteristics	n	%
Age		
> 18 Years Old	2.052	92,4
≤ 18 Years Old	169	7,6
Gender		
Female	1.067	48,0
Male	1.154	52,0
Previous Treatment History		
Previously Treated	641	28,9
New Patients	1.580	71,1
Time to Treatment Initiation		
Delayed (>2 days)	1.316	59,3
Timely (≤2 days)	905	40,7
Month-2 Follow-up Results		
Non-conversion (Positive)	246	11,1
Conversion (Negative)	1.975	88,9
Final Treatment Outcomes		
Unsuccessful Treatment	149	6,7
Treatment Failed	59	2,7
Lost to Follow-up	77	3,5
Died	13	0,6
Treatment Success	2.072	93,3
Cured	1.572	70,8
Treatment Completed	500	22,5

Bivariate analysis was performed to examine the associations between age, sex, previous treatment history, time to treatment initiation, and month-2 follow-up results and final treatment outcomes. The findings showed that age, sex, previous treatment history, and month-2 follow-up results were significantly associated with treatment outcomes, whereas time to treatment initiation was not significantly associated with treatment outcomes.

Table 2. Association Between Patient Characteristics and Final Treatment Outcomes Among Patients with Bacteriological Confirmed Pulmonary TB

Variable	Treatment Success (n)	%	Unsuccessful Treatment (n)	%	p-value	OR (95% CI)
Age						
>18 Years Old	1.906	92,9	146	7,1	0,008	4,239 (1,337-13,441)
≤18 Years Old	166	98,2	3	1,8		
Gender						
Female	1.009	94,6	58	5,4	0,021	0,671 (0,478-0,944
Male	1.063	92,1	91	7,9		
Previous Treatment History						
Previously Treated	582	90,8	59	9,2	0,003	1,678 (1,192-2,363)
New Patients	1.490	94,3	90	5,7		
Time to Treatment Initiation						
Delayed (>2 days)	1.236	93,9	80	6,1	0,153	0,784 (0,562-1,095)
Timely (≤2 days)	836	92,4	69	7,6		
Month-2 Follow-up Results						
Non-conversion (Positive)	194	78,9	52	21,1	<0,001	5,189 (3,592-7,497)
Conversion (Negative)	194	78,9	52	21,1		

Age was significantly associated with treatment success (p = 0.008). The proportion of successful treatment was 98.2% among patients aged ≤18 years, compared with 92.9% among those aged >18 years. This finding is consistent with Meiyanti et al. (2024), who reported a tendency toward less favorable treatment outcomes among older patients. Sugiyono et al. (2025) also identified older age, under-nutrition, positive initial sputum smear results, and drug-resistant TB as factors associated with unsuccessful treatment outcomes. Older patients may be more vulnerable to unfavorable outcomes because of age-related declines in immune function, commodities, impaired drug absorption, adverse drug reactions, and socioeconomic factors that may affect treatment adherence (Arlinda et al., 2020). In contrast, younger patients may have better physiological reserves and greater capacity to tolerate treatment. Nevertheless, the differences observed in this study should be interpreted cautiously because age-related clinical and social factors were not all available for adjustment.

Sex was also significantly associated with treatment success (p = 0.021). The treatment success rate was 94.6% among female patients and 92.1% among male patients. This finding is consistent with previous research by Torres et al. (2019) and Sugiyono et al. (2025), which reported differences in TB treatment outcomes by sex. Dabitao and Bishai (2023) discussed how biological sex and gender-related factors may influence TB pathogenesis and treatment outcomes. Potential explanations include differences in sex hormones, immune responses, genetic factors, smoking behavior, occupational exposure, and healthcare-seeking practices. However, these mechanisms were not directly examined in the present study and should therefore be regarded as possible explanations rather than established causes of the observed difference.

Previous treatment history was significantly associated with treatment success (p = 0.003). Patients classified as new cases had a treatment success rate of 94.3%, compared with 90.8% among patients undergoing re-treatment. This difference suggests that previous treatment history is an important characteristic to consider when planning patient monitoring and treatment support. Patients who have previously received TB treatment may have different clinical histories, treatment experiences, and adherence-related challenges that require closer follow-up. Arlinda et al. (2020) reported that patients with a history of previous TB treatment had approximately 2.55 times the risk of unsuccessful treatment compared with new patients. These findings support the importance of identifying previously treated patients early and providing appropriate monitoring throughout the treatment period.

Time to treatment initiation was not significantly associated with final treatment outcomes (p = 0.153). In this study, treatment initiation time was defined as the interval between diagnosis and the start of anti-TB treatment, with initiation within two days classified as timely and initiation after more than two days classified as delayed. Although 59.3% of patients started treatment more than two days after diagnosis, this delay was not significantly associated with final treatment outcomes in the bivariate analysis. Delays in treatment initiation may arise from patient-related factors as well as healthcare service and health system barriers (MacPherson et al., 2014). The absence of a statistically significant association in this study does not imply that delayed treatment initiation has no public health consequences. Differences in the definition of treatment delay, the characteristics of the study population, limitations of secondary data, and external factors such as referral pathways and specimen referral systems may have contributed to this finding. Furthermore, treatment initiation time may be more directly relevant to transmission and access to care than to the final treatment outcome alone.

Month-2 follow-up results showed the strongest association with treatment outcomes in the bivariate analysis (p < 0.001). Patients who

achieved bacteriological conversion by month 2 had a treatment success rate of 95.1%, compared with 78.9% among those who had not achieved conversion. Bacteriological conversion refers to a change from a positive to a negative bacteriological examination result, according to the applicable assessment criteria (WHO, 2013). Month-2 follow-up testing is an important component of treatment monitoring because it provides an early indication of the bacteriological response to anti-TB treatment (Calderwood et al., 2021; WHO, 2025). Patients who achieve conversion may have a more favorable early response to treatment, whereas persistent positivity may indicate delayed response or the presence of factors that require further clinical assessment, including high initial bacterial burden, treatment non-adherence, drug resistance, or severe disease (Calderwood et al., 2021). These findings highlight the importance of conducting scheduled follow-up examinations and evaluating patients who do not achieve conversion to identify potential barriers to successful treatment.

Table 3. Multivariate Logistic Regression Analysis of Factors Associated with Treatment Outcomes Among Patients with Bacteriological Confirmed Pulmonary Tuberculosis

Characteristics	n	%
Age		
> 18 Years Old	2.052	92,4
≤ 18 Years Old	169	7,6
Gender		
Female	1.067	48,0
Male	1.154	52,0
Previous Treatment History		
Previously Treated	641	28,9
New Patients	1.580	71,1
Time to Treatment Initiation		
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Treatment Success	2.072	93,3
Cured	1.572	70,8
Treatment Completed	500	22,5

Binary logistic regression was performed using the Enter method, with all five independent variables entered simultaneously into the model. After adjustment for the other variables, age, sex, previous treatment history, and month-2 follow-up results remained significantly associated with final treatment outcomes. Time to

treatment initiation was not significantly associated with treatment success.

Patients aged ≤18 years had 3.613 times the odds of treatment success compared with patients aged >18 years (adjusted odds ratio [aOR] = 3.613; 95% confidence interval [CI]: 1.126–11.589; p = 0.031). The persistence of this association after adjustment suggests that age was independently associated with treatment outcomes within the fitted model. However, the relatively wide confidence interval indicates uncertainty in the magnitude of the association, potentially reflecting the distribution of treatment outcomes within the younger age group. Sex remained significantly associated with treatment success (aOR = 0.701; 95% CI: 0.494–0.993; p = 0.046). The adjusted odds ratio indicates that the category coded as the exposure had lower odds of treatment success than the reference category. The specific direction of this association must be interpreted according to the reference coding used in the regression model. Although the bivariate analysis showed a higher treatment success proportion among female patients, the regression table should explicitly identify the reference category to ensure that the adjusted result is interpreted correctly. Patients classified as new cases had 1.592 times the odds of treatment success compared with patients undergoing re-treatment (aOR = 1.592; 95% CI: 1.119–2.264; *p* = 0.010). This finding remained statistically significant after adjustment for age, sex, treatment initiation time, and month-2 follow-up results. It reinforces the importance of previous treatment history when assessing patients' likelihood of achieving successful treatment outcomes. Patients undergoing re-treatment may require additional attention to previous treatment experiences, adherence barriers, and the possibility of drug resistance, depending on their clinical history and available examination results.

Time to treatment initiation was not significantly associated with treatment success in the multi-variable model (aOR = 0.909; 95% CI: 0.643–1.284; p = 0.588). The confidence interval included the null value of 1, indicating that the analysis did not provide sufficient statistical evidence of an independent association between treatment initiation time and final treatment outcomes after adjustment for the other variables. This finding is consistent with the bivariate analysis. Nevertheless, it should not be interpreted as evidence that timely treatment initiation is unimportant for TB control, since the benefits of prompt treatment may extend beyond the final treatment outcome measured in this study.

Month-2 follow-up results demonstrated the strongest adjusted association with treatment success. Patients who achieved bacteriological conversion by month 2 had 5.004 times the odds of treatment success compared with patients who did not achieve conversion (aOR = 5.004; 95% CI: 3.445–7.268; p < 0.001). The

confidence interval remained above 1, providing strong statistical evidence of an association after adjustment for the other variables in the model. This finding is consistent with the bivariate results and supports the importance of early bacteriological response as a marker of subsequent treatment outcomes.

The strong association between month-2 conversion and final treatment success is clinically plausible because conversion provides an indication of the patient's early response to anti-TB therapy. Patients who remain bacteriological positive may require further assessment of treatment adherence, drug susceptibility, disease severity, and other factors that may interfere with treatment response (Calderwood et al., 2021). Therefore, month-2 follow-up results can help identify patients who may benefit from closer monitoring and timely clinical evaluation. However, conversion should not be regarded as a guarantee of eventual treatment success, and patients who achieve conversion must still complete the prescribed treatment regimen.

CONCLUSION

This study found that 93.3% of patients with bacteriological confirmed pulmonary tuberculosis (TB) achieved successful treatment outcomes, although 59.3% experienced delays in treatment initiation. Age, sex, previous treatment history, and month-2 follow-up results were significantly associated with treatment success, whereas delayed treatment initiation was not significantly associated with final treatment outcomes. Month-2 bacteriological conversion showed the strongest association with treatment success in the multi-variable model (aOR = 5.004; 95% CI: 3.445–7.268; $p < 0.001$). These findings highlight the importance of monitoring early bacteriological responses to identify patients who may require more intensive follow-up. Strengthening routine month-2 follow-up, assessing potential barriers to treatment response, and providing targeted support to patients with persistent bacteriological positive may help improve treatment outcomes. Although treatment initiation delay was not significantly associated with treatment success in this study, timely treatment initiation remains an important component of TB control. These findings may inform efforts to strengthen patient monitoring and improve the quality of TB treatment services in Bandung City.

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REFERENCES

Arlinda, D., Indah, R. M., Yulianto, A., Harso, A. D., Syarief, A. K., & Karyana,M. (2020). Poor tuberculosis treatment outcomes

associated with older age, previous treatment, HIV and drug resistance at seven hospitals in Indonesia. *Jurnal Penelitian dan Pengembangan Pelayanan Kesehatan,* 4 (2), 61–68. https://doi.org/10.22435/jpppk.v4i2.3698.

Barreto-Duarte, B., Araújo-Pereira, M., Nogueira, B. M. F., Sobral, L. F., Rodrigues, C. C., Queiroz, A. T. L., ... Andrade, B. B. (2021). Tuberculosis burden and determinants of treatment outcomes according to age in Brazil: A nationwide study of 896,314 cases reported between 2010 and 2019. *Frontiers in Medicine, 8, Article 710162*. https://doi.org/10.3389/fmed.2021.710162.

Calderwood, C. J., Wilson, J. P., Fielding, K. L., Harris, R. C., Karat, A. S., Mansukhani, R. (2021). Dynamics of sputum conversion during effective tuberculosis treatment: A systematic review and meta-analysis. *PLoS Medicine*, 18(4), Article e1003566. https://doi.org/10.1371/journal.pmed.1003566.

Dabitao, D., & Bishai, W. R. (2023). Sex and gender differences in tuberculosis pathogenesis and treatment outcomes. *In Current topics in microbiology and immunology,* Vol.441, pp. 139–183. https://doi.org/10.1007/978-3-031-35139-6_6.

Lestari, B. W., McAllister, S., Hadisoemarto, P. F., Afifah, N., Jani, I. D., Murray, M., van Crevel, R., Hill, P. C., & Alisjahbana, B. (2020). Patient pathways and delays to diagnosis and treatment of tuberculosis in an urban setting in Indonesia. *The Lancet Regional Health – Western Pacific,* 5, Article 100059. https://doi.org/10.1016/j.lanwpc.2020.100059.

MacPherson, P., Houben, R. M. G. J., Glynn, J. R., Corbett, E. L., & Kranzer, K. (2014). Pre-treatment loss to follow-up and treatment delay in tuberculosis: Systematic review and meta-analysis. *BMC Infectious Diseases,* 14, Article 138. https://doi.org/10.1186/1471-2458-14-138.

Meiyanti, M., Bachtiar, A., Kusumaratna, R. K., Alfiyyah, A., Machrumnizar, M., & Pusparini, P. (2024). Tuberculosis treatment outcomes and associated factors: A retrospective study in West Nusa Tenggara, Indonesia. *Narra Journal*, 4(3), Article e1660. https://doi.org/10.52225/narra.v4i3.1660.

Presiden Republik Indonesia. (2021). *Peraturan Presiden Republik Indonesia Nomor 67 Tahun 2021 tentang Penanggulangan Tuberkulosis.* Jakarta, Indonesia: Sekretariat Negara Republik Indonesia.

Sugiyono, R. I., Naysilla, A. M., Susanto, N. H., Handayani, D., Burhan, E., Karuniawati, A., ... Chen, R. Y. (2025). Treatment outcomes of pulmonary TB in adults in Indonesia. *IJTLD Open*, 2(3), 145–152. https://doi.org/10.5588/ijtldopen.24.0482.

Torres, N. M. C., Rodríguez, J. J. Q., Andrade, P. S. P., Arriaga, M. B., & Netto,E. M. (2019). Factors predictive of the success of tuberculosis treatment: A systematic review with meta-analysis. *PLOS ONE,* 14(12), Article e0226507. https://doi.org/10.1371/journal.pone.0226507

World Health Organization. (2013). *Definitions and reporting framework for tuberculosis: 2013 revision (updated December 2014 and January 2020)*. Geneva, Switzerland. https://www.who.int/publications/i/item/9789241505345.

World Health Organization. (2025a). *Global tuberculosis report 2025*. Geneva,Switzerland.https://www.who.int/publications/i/item /9789240116924.

World Health Organization. (2025b). *WHO consolidated operational handbook on tuberculosis: Module 4: Treatment and care.* Geneva, Switzerland.https://www.who.int/publications/i/item/9789240108141.