



Evaluation of First-Line Anti-Tuberculosis Treatment Based on Radiological Findings in Patients with Pulmonary Tuberculosis and Diabetes Mellitus at Persahabatan Hospital

Btari Octa Jayanti,¹ Hany Yusmaini,^{2*} Yosha Putri Wahyuni,³ Erna Harfiani,² Heidy Agustin⁴

¹Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta, Jakarta

²Department of Pharmacology, Faculty of Medicine,

Universitas Pembangunan Nasional "Veteran" Jakarta, Jakarta

³Department of Biology, Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta, Jakarta

⁴Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Indonesia, Persahabatan Hospital, Jakarta

Corresponding Author:

Hany Yusmaini | Department of Pharmacology, Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta, Jakarta | hanyyusmaini@upnvj.ac.id

Submitted: April 10th, 2026

Accepted: September 15th, 2026

Published: October 26th, 2026

Respir Sci. 2026; 7(1): 18-26

<https://doi.org/10.36497/respirsci.v7i1.234>



[Creative Commons Attribution-NonCommercial 4.0 International License](#)

Abstract

Background: Pulmonary tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis*, which is transmitted via droplets inhaled by individuals near active TB patients. Meanwhile, diabetes mellitus (DM) is an independent risk factor for TB infection and can increase the risk of latent TB reactivation due to a weakened immune system. The coexistence of TB and DM can impair the absorption of first-line anti-tuberculosis drugs (ATD), making patients more vulnerable to treatment failure, relapse, and increased mortality. Therefore, this study aims to assess the association between glycemic control status and treatment outcomes of first-line ATD therapy.

Method: This study used an analytical observational, cross-sectional design and included 86 medical records of pulmonary TB patients with DM, selected through simple random sampling. Bivariate analysis was conducted using the Chi-square test or Fisher's exact test, with $P < 0.05$ considered statistically significant.

Results: Most patients were adults aged 18–59 years (66.3%) and male (55.8%), with the majority having uncontrolled blood glucose levels (75.6%) and normal nutritional status (38.4%). The most common treatment duration was nine months (76.7%). All patients showed clinical improvement and sputum conversion (100%), while 81.4% showed radiological improvement. Bivariate analysis showed a significant difference in radiological improvement between patients with controlled and uncontrolled DM ($P = 0.009$).

Conclusion: The majority of pulmonary TB patients with DM were aged 18–59 years, male, and had uncontrolled blood glucose levels. All patients showed clinical improvement and sputum conversion, while 81.4% experienced radiological improvement, with a significant difference between controlled and uncontrolled DM.

Keywords: diabetes mellitus, first-line anti-tuberculosis drugs, pulmonary tuberculosis, treatment evaluation

INTRODUCTION

Pulmonary tuberculosis (TB) is an infection by *Mycobacterium tuberculosis*, transmitted primarily through airborne droplets and mainly targets the lung parenchyma, although other organs may occasionally be involved.¹ In 2022, Indonesia ranked second globally for TB burden, reporting an estimated 824,000 new cases.² At the same time, the prevalence of diabetes mellitus (DM) in the country has also risen sharply, with around 19.5 million adults in 2021.³

The high occurrence of both conditions increases the probability that TB will present alongside DM. This comorbidity can adversely affect disease progression and treatment effectiveness. The success of TB control largely depends on the host's immune response, which comorbidities such as diabetes may weaken.¹ Diabetes mellitus represents a chronic metabolic disorder characterized by persistent hyperglycemia, arising from defects in insulin secretion, insulin action, or both, and linked to impaired cellular and humoral immunity.⁴

Research has consistently shown that DM is an independent risk factor for developing pulmonary TB and is linked to poorer treatment outcomes, particularly in patients with suboptimal glycemic control.^{5,6} Prolonged hyperglycemia can impair the function of macrophages and lymphocytes, increase bacterial load, and delay sputum conversion. Furthermore, DM may affect the pharmacokinetics of first-line anti-TB medications by disrupting gastrointestinal

motility and absorption, which could lead to extended treatment periods and a higher risk of therapy failure.⁷

Despite the established connection between TB and DM, limited data exist regarding the outcomes of first-line anti-TB therapy among patients with both conditions, especially in national referral hospitals. Persahabatan Hospital, serving as a tertiary referral center dedicated to pulmonary disease management, treats a considerable number of TB patients with comorbid DM, making it an appropriate setting to evaluate treatment outcomes.

Accordingly, this study aims to assess the association between glycemic control status and treatment outcomes of first-line anti-tuberculosis drug (ATD) therapy in patients with pulmonary TB and diabetes at Persahabatan Hospital during 2023–2024, considering clinical recovery, sputum conversion, radiological improvement, and treatment duration.

METHOD

This study was a descriptive, observational, cross-sectional study conducted at Persahabatan Hospital, Jakarta, from November to December 2025. This study obtained ethical clearance from the Health Research Ethics Committee of Persahabatan Hospital.

The data used were secondary data obtained from outpatient and inpatient medical records. The study population comprised all pulmonary TB patients with DM who received first-line ATD therapy during the 2023–2024 period and attended

the Pulmonology Outpatient Clinic at Persahabatan Hospital.

A total of 704 medical records of patients with pulmonary TB and DM were identified. Simple random sampling was performed to select study participants. Each selected medical record was then assessed against the predefined inclusion and exclusion criteria. If a selected record did not meet the eligibility criteria, another medical record was randomly selected until the required sample size of 86 eligible patients was reached. The sample size calculation included an additional margin to account for potential data loss.

The inclusion criteria were patients aged ≥ 18 years, diagnosed with pulmonary tuberculosis and diabetes mellitus, receiving first-line ATD therapy, attending routine follow-up at least once per month, and having complete medical record data for the study variables. Exclusion criteria included patients with extrapulmonary tuberculosis, drug-resistant tuberculosis receiving second-line ATD therapy, and those with other comorbid conditions such as HIV coinfection, renal impairment, or hepatic dysfunction. The study included 86 patients, selected through simple random sampling based on a sample size calculation with an additional margin to account for potential data loss.

The variables analyzed included age, gender, fasting blood glucose levels, nutritional status, final sputum conversion, clinical improvement, radiological improvement, and duration of first-line ATD treatment. The assessment of

controlled diabetes mellitus using fasting blood glucose levels recorded in the medical records because HbA1c measurements were not routinely available for all patients during the study period.

Clinical improvement was determined based on the attending physician's documentation in the medical records. Meanwhile, radiological improvement was defined as a reduction in pulmonary infiltrates on follow-up chest X-ray compared with the baseline examination, as documented in the medical records. Radiological findings were obtained from the medical records, and no independent reassessment of the chest X-rays was performed by the investigators.

Data processing involved data collection, editing, coding, entry, and cleaning, followed by statistical analysis using statistical software. Univariate analysis was performed to describe the frequency distribution and proportions of each variable. Bivariate analysis was also conducted to assess the association between glycemic control status and treatment outcomes of first-line ATD therapy using the Chi-square test or Fisher's exact test when the expected cell count was less than five, with $P < 0.05$ considered statistically significant.

RESULT

The analysis showed that most patients were adults (18–59 years), with 66.3%, and males (55.8%). Assessment of fasting blood glucose levels revealed poor glycemic control in most patients, with

75.6% of patients presenting fasting glucose levels above 130 mg/dL. Meanwhile, nutritional evaluation using body mass index indicated that 38.4% of patients had normal nutritional status.

Treatment duration analysis demonstrated that 76.7% of patients completed first-line anti-tuberculosis therapy within nine months, while 23.3% of patients completed treatment within six months.

Table 1. Distribution of characteristic sample (n=86)

Characteristics	n	%
Age		
Adult (18-59 years)	57	66.3
Elder (>60 years)	29	33.7
Gender		
Male	48	55.8
Female	38	44.2
Fasting Blood Glucose		
Controlled (<130 mg/dL)	21	24.4
Uncontrolled (>130 mg/dL)	65	75.6
Nutritional Status (IMT)		
Underweight (<18.5 kg/m ²)	14	16.3
Normal (18.5-22.9 kg/m ²)	33	38.4
Overweight (23-24.9 kg/m ²)	20	23.3
Obesity I (25-29.9 kg/m ²)	17	19.8
Obesity II (≥30 kg/m ²)	2	2.3
Duration of First-Line ATD Treatment		
6 months	20	23.3
9 months	66	76.7

Treatment outcomes showed that all patients experienced clinical improvement and achieved sputum conversion after therapy. Clinical recovery involved reduced or resolved key symptoms, including persistent cough, afternoon or evening fever, dyspnea, weight loss, and loss of

appetite. In addition, sputum testing also confirmed conversion from positive to negative status in all patients by the end of treatment. Different with radiological assessments that revealed improvement in chest X-rays only in 70 patients (81.4%), whereas 16 patients (18.6%) had persistent radiological lesions (Table 2).

Table 2. Treatment outcome sample (n=86)

Characteristics	n	%
Sputum Conversion Evaluation		
Improvement observed	86	100.0
No Improvement observed	0	0.0
Clinical Improvement Evaluation		
Improvement observed	86	100.0
No Improvement observed	0	0.0
Radiological Findings Evaluation		
Improvement observed	70	81.4
No improvement observed (STQA)	16	18.6

Bivariate analysis examined the relationship between glycemic control and treatment outcomes. Statistical evaluation was applied exclusively to radiological findings due to 100% success rates for clinical improvement and sputum conversion, which prevented meaningful statistical testing. Fisher's exact test indicated that patients with controlled glycemia consistently showed radiological improvement, while some individuals with uncontrolled glycemia retained residual lesions. The analysis produced a value of $P=0.009$, demonstrating that a statistically significant difference emerged in glycemic control and radiological outcomes (Table 3).

Table 3. Bivariate analysis of glycemic control status and radiological findings

DM Control Status	Radiology Findings		P
	Improvement	No Improvement	
Controlled	21 (24.4%)	0 (0.0%)	0.009
Uncontrolled	49 (57.0%)	16 (18.6%)	

DISCUSSION

Demographic analysis showed that most TB–DM patients were adults (18–59 years). This pattern aligns with previous studies reporting higher TB–DM comorbidity among individuals in productive age groups.^{8,9} Increased mobility and social interactions in this population may elevate exposure risk to *Mycobacterium tuberculosis*. Furthermore, diabetes typically manifests during adulthood, often linked to lifestyle factors that impair immune defense and heighten susceptibility to TB infection.¹⁰

Male patients predominated in the sample, consistent with findings that observed higher TB risk among men, particularly with coexisting diabetes. Behavioral aspects, such as smoking, alcohol use, and occupational hazards, likely contribute to immunosuppression and increased TB vulnerability.¹¹ Despite a smaller proportion of female patients, lower representation does not necessarily indicate lower risk. Hormonal differences and barriers to healthcare access may delay TB diagnosis among women.^{12,13}

Analysis of glycemic control revealed that most patients experienced poor fasting blood glucose regulation. Suboptimal glycemic control frequently occurs in TB–DM patients and is associated with slower treatment response.^{14,15} Chronic hyperglycemia can impair alveolar macrophage function,¹⁶ reduce neutrophil chemotaxis and phagocytosis, and compromise cell-mediated immunity, thereby facilitating persistent TB

infection.^{17,18} Hyperglycemia also affects ATD pharmacokinetics through reduced gastrointestinal motility and absorption, potentially delaying resolution of pulmonary lesions and extending treatment duration in TB–DM patients.^{7,19}

Meanwhile, nutritional assessment demonstrated that most patients maintained normal body mass index, followed by overweight and obese categories. TB–DM patients do not necessarily present malnutrition. The interaction between TB and DM creates a complex metabolic state that balances TB-induced catabolic processes with diabetes-related metabolic disruption.^{20,21} TB infection elevates basal energy expenditure and triggers systemic inflammation, enhancing proteolysis and lipolysis, while chronic hyperglycemia further perturbs energy and protein metabolism. Consequently, nutritional status may vary dynamically during the disease course and treatment.²²

Treatment duration analysis showed that most patients completed first-line ATD therapy within nine months, consistent with national guidelines recommending extended therapy for TB–DM patients, particularly under poor glycemic control.¹⁰ Prior research also indicates that TB–DM patients often require longer treatment due to slower immune recovery and altered drug metabolism.^{23,24}

All patients exhibited clinical improvement and achieved sputum conversion after completing therapy. Favorable outcomes remain achievable in TB–DM patients when diabetes is closely

monitored and therapy is administered properly.^{25,26} Clinical improvement and sputum conversion indicate effective bacterial clearance; however, radiological recovery did not always correspond with clinical and microbiological cure. Some patients retained a status quo ad ante (STQA) appearance on chest imaging, likely representing residual lesions or post-infectious fibrosis despite clinical recovery.²⁴

Bivariate analysis between glycemic control and radiological improvement indicated a significant relationship. Patients with well-regulated blood glucose showed more complete radiological resolution, whereas poor glycemic control was associated with residual pulmonary lesions.²⁷

Hyperglycemia correlates with more extensive pulmonary involvement and severe radiological findings.²⁷ From a pathophysiological perspective, diabetes impairs alveolar macrophage activity,²⁸ disrupts ventilation–perfusion balance, and increases alveolar oxygen tension, particularly in lower lung lobes, creating an environment conducive to *Mycobacterium tuberculosis* growth. These mechanisms likely explain delayed radiological resolution in TB–DM patients with poor glycemic control compared with those with better blood glucose regulation.²⁹

This study followed established research protocols; nevertheless, several limitations require consideration. The main limitation involves reliance on secondary data from medical records, as some records lacked complete information for the

variables of interest. Therefore, only records meeting the inclusion criteria qualified for analysis. Similar constraints frequently arise in retrospective studies utilizing medical records, given their dependence on accurate and comprehensive clinical documentation.

Acknowledge that HbA1c is a more reliable indicator of long-term glycemic control in patients with TB–DM. However, because this study was based on medical records, HbA1c data were not routinely available for all patients during the study period. To ensure consistency and maximize the available sample, fasting blood glucose measurements which were routinely recorded in the medical records, to assess glycemic status.

CONCLUSION

Evaluation of first-line anti-tuberculosis drug (ATD) therapy among patients with TB–DM at Persahabatan Hospital during 2023–2024 indicates that most patients were adults (18–59 years) and predominantly male. The majority exhibited uncontrolled glycemic levels while maintaining normal nutritional status, and most completed first-line ATD therapy within nine months.

Assessment of treatment outcomes demonstrated universal clinical improvement and sputum conversion, reflecting effective clinical and microbiological response to first-line therapy. Radiological improvement was not uniform, as some patients retained a status quo ante appearance on chest imaging.

Bivariate analysis identified a significant association between glycemic control and radiological outcomes. Patients with well-regulated glycemia consistently achieved radiological resolution, whereas those with poor glycemic control showed residual pulmonary lesions. These findings highlight the critical role of glycemic status in pulmonary lesion recovery among TB–DM patients undergoing first-line ATD therapy.

ACKNOWLEDGMENTS

The authors express sincere gratitude to all parties who contributed to this study at Persahabatan Hospital, particularly the Medical Records Department, for granting permission and supporting access to the data used in this study. The authors also thank the Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta, for academic support throughout the implementation of this research. Further appreciation is directed to all parties whose contributions supported this work and facilitated the smooth process of data collection and analysis, contributing to the successful completion of this study. This manuscript is original, has not been published previously, and is not currently under consideration for publication elsewhere.

REFERENCES

1. Kementrian Kesehatan RI. Laporan Program Penanggulangan Tuberkulosis Tahun 2022. Jakarta: Kementrian Kesehatan RI; 2023.
2. WHO. Global tuberculosis report 2022. Geneva: WHO; 2022. 104–116 p.
3. International Diabetes Federation. IDF Diabetes Atlas, 2021. 10th ed. International Diabetes Federation; 2021.
4. Kumar V, Abbas AK, Fausto N, Aster Jon C. Robbins & Cotran Pathologic Basis of Disease, Tenth Edition. Philadelphia: Elsevier; 2021.
5. Aditya Nugraha IB, Gotera W, Yustin WEF. Diabetes Melitus Sebagai Faktor Risiko Tuberkulosis. Jurnal Kedokteran Meditek. 2021;27(3):273–81. doi:10.36452/jkdoktmeditek.v27i3.2126
6. Ugarte-Gil C, Alisjahbana B, Ronacher K, Riza AL, Koesoemadinata RC, Malherbe ST, et al. Diabetes Mellitus Among Pulmonary Tuberculosis Patients From 4 Tuberculosis-endemic Countries: The TANDEM Study. Clinical Infectious Diseases. 2020;70(5):780–8. doi:10.1093/cid/ciz284
7. Boadu AA, Yeboah-Manu M, Osei-Wusu S, Yeboah-Manu D. Tuberculosis and diabetes mellitus: The complexity of the comorbid interactions. International Journal of Infectious Diseases. 2024;146:107140. doi:10.1016/j.ijid.2024.107140
8. Evangelista M do SN, Maia R, Toledo JP, Abreu RG de, Barreira D. Tuberculosis associated with diabetes mellitus by age group in Brazil: a retrospective cohort study, 2007–2014. The Brazilian Journal of Infectious Diseases. 2020;24(2):130–6. doi:10.1016/j.bjid.2020.03.005

9. Dinan RNI, Julia Hartati, Muflihah H. Keberhasilan Pengobatan Tuberkulosis Paru dengan Komorbid Diabetes Mellitus di RSUD Al Ihsan Bandung Tahun 2020. Bandung Conference Series: Medical Science. 2023;3(1):872–7. doi:10.29313/bcsms.v3i1.6795
10. Kementerian Kesehatan RI. Pedoman Nasional Pelayanan Kedokteran: Tata Laksana Tuberkulosis. 2020.
11. Yosephine MK, Hardy FR, Wenny DM, Nurrizka RH, Pulungan RM. Faktor yang Memengaruhi Kejadian Tuberkulosis Paru pada Penderita Diabetes Mellitus di Rumah Sakit X. Jurnal Kesehatan. 2021;12(3):344–51. doi:10.26630/jk.v12i3.2542
12. Savitri AR, Muliani, Yuliana. Karakteristik Penderita Tuberkulosis Paru dengan Diabetes Melitus di Kabupaten Badung Tahun 2017-2018. E-Jurnal Medika Udayana. 2021;10(1):60–4. doi:10.24843/MU.2021.V10.i1.P11
13. Harfiani E, Mashoedjo, Nurhakim AD. Faktor Apa Yang Mempengaruhi Rendahnya Tingkat Pengobatan Tuberkulosis di Lagoa Jakarta? Jurnal Ilmiah Kesehatan Masyarakat : Media Komunikasi Komunitas Kesehatan Masyarakat. 2020;12(3):110–7. doi:10.52022/jikm.v12i3.80
14. Adlanta V, Sari RS, Octavia NAH. Angka Kejadian Tuberkulosis Paru Pada Pasien Diabetes Mellitus Tipe II Yang Menjalani Rawat Inap Di RS Umum Daerah Dr. Pringadi Medan. Ibnu Sina: Jurnal Kedokteran dan Kesehatan - Fakultas Kedokteran Universitas Islam Sumatera Utara. 2022;21(2):223–32. doi:10.30743/ibnusina.v21i2.303
15. Lee PH, Fu H, Lai TC, Chiang CY, Chan CC, Lin HH. Glycemic Control and the Risk of Tuberculosis: A Cohort Study. PLoS Med. 2016;13(8):e1002072. doi:10.1371/journal.pmed.1002072
16. Bustamam N, Widyawardani N, Wahyuni YP, Ayu Aprilia C. Peningkatan Kapasitas Kader Posbindu Delima Kelurahan Bedahan, Sawangan Depok Dalam Pencegahan dan Pengendalian Diabetes Mellitus. BERNAS: Jurnal Pengabdian Kepada Masyarakat. 2023;4(3):2349–56. doi:10.31949/jb.v4i3.6092
17. Martinez N, Kornfeld H. Diabetes and immunity to tuberculosis. Eur J Immunol. 2014;44(3):617–26. doi:10.1002/eji.201344301
18. Zhao L, Gao F, Zheng C, Sun X. The Impact of Optimal Glycemic Control on Tuberculosis Treatment Outcomes in Patients With Diabetes Mellitus: Systematic Review and Meta-Analysis. JMIR Public Health Surveill. 2024;10:e53948. doi:10.2196/53948
19. Ayu LA, Yusmaini H, Herardi R. Prevalensi Efek Samping Gangguan Gastrointestinal Terapi Metformin pada Pasien DM Tipe 2 dan Faktor yang Mempengaruhinya di Puskesmas Kecamatan Pasar Rebo Tahun 2020. Quality: Jurnal Kesehatan. 2023;17(1):1–9. doi:10.36082/qjk.v17i1.327

20. Lestari N, Yaasiin PIM. Hubungan Indeks Massa Tubuh Dan Diabetes Melitus Terhadap Kesembuhan Pasien Tuberkulosis Paru. *CoMPHI Journal: Community Medicine and Public Health of Indonesia Journal* . 2024;5(2):181–7.
21. Risanti ED, Susilo SR. Indeks Massa Tubuh Dan Kebiasaan Merokok Terhadap Outcome Pengobatan TB Paru TCM. *Ibnu Sina: Jurnal Kedokteran dan Kesehatan - Fakultas Kedokteran Universitas Islam Sumatera Utara*. 2025;24(1):166–72. doi:10.30743/ibnusina.v24i1.695
22. Arfiana MR, Kusmiati T, Prayitno JH. Profil Status Gizi Penderita Tuberkulosis Paru-Multi Drug Resistance dengan Diabetes Mellitus Tipe 2 di RSUD Dr. Soetomo Surabaya Tahun 2016. *Jurnal Respirasi*. 2018;4(1):1–4. doi:10.20473/jr.v4-I.1.2018.1-4
23. Widiastuti A, Sirait RH, Simatupang A, Idhayu AT. Effect of Poor Glycemic Control with Length of Pulmonary Tuberculosis Treatment in Type 2 Diabetes Mellitus Patients. *Indonesian Journal of Clinical Pharmacy*. 2023;12(1):1–10. doi:10.15416/ijcp.2023.12.1.1
24. Mily A, Sarker P, Taznin I, Hossain D, Haq MdA, Kamal SMM, et al. Slow radiological improvement and persistent low-grade inflammation after chemotherapy in tuberculosis patients with type 2 diabetes. *BMC Infect Dis*. 2020;20(1):933. doi:10.1186/s12879-020-05473-x
25. Desai A, Gupta N, Korishetty L, Saravu K. Treatment outcomes of patients with tuberculosis and diabetes: A prospective cohort study from India. *Int J Mycobacteriol*. 2021;10(2):111–5. doi:10.4103/2212-5531.307069 PubMed PMID: 34558460.
26. Udaykumar P, Kumar S, Chandralekha N, Reddy RH, Badarudeen M. N, Nagaraja SB. Daily monitoring of diabetic treatment amongst TB-DM patients under NTEP: Does it improve the treatment outcomes? *Clin Epidemiol Glob Health*. 2022;17:101118. doi:10.1016/j.cegh.2022.101118
27. Ardin MuhA, Ruslim D. Hubungan Diabetes Mellitus Tipe 2 Dengan Luas Lesi Pada Foto Toraks Penderita Tuberkulosis Di Rumah Sakit Kabupaten Konawe. *JURNAL RISET RUMPUN ILMU KEDOKTERAN*. 2023;2(1):63–70. doi:10.55606/jurrike.v2i1.989
28. Layali DJ, Sinaga BY, Siagian P, Eyaner PC. Relationship of Tuberculosis Radiographic Manifestation in Diabetic Patients with HbA1c Levels. *Jurnal Respirologi Indonesia*. 2019;39(3):154–9. doi:10.36497/jri.v39i3.67
29. Hossain M, Ahmed J, Afroz F. A Comparison of Clinical, Radiological, and Bacteriological Characteristics of Pulmonary Tuberculosis in Diabetic and Non-Diabetic Patients. *Chest*. 2016;149(4):A73. doi:10.1016/j.chest.2016.02.078