International Journal of Research in Medical Sciences
Piruthivirajan N et al. Int J Res Med Sci. 2025 Oct;13(10):4078-4082
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20253145

Original Research Article

Tuberculosis and diabetes: bidirectional screening and management challenges in South Indian population

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Received: 15 May 2025
Accepted: 09 August 2025

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ABSTRACT

Background: The World Health Organization (WHO) and the International Union Against Tuberculosis and Lung Disease have advocated for bidirectional screening testing TB patients for diabetes and vice versa—as a strategic approach to early detection and integrated management. Aim of the study is to evaluate the effectiveness, feasibility, and challenges of bidirectional screening for tuberculosis (TB) and diabetes mellitus (DM), and to identify barriers and opportunities for integrated management of coexisting TB and DM in high-burden settings.
Methods: This was a prospective, observational, cross-sectional study conducted to evaluate the implementation and challenges of bidirectional screening for tuberculosis (TB) and diabetes mellitus (DM) in a high-burden tertiary care setting. The study was carried out over a period of three years from February 2022 to January 2025.
Results: High undiagnosed DM in TB patients (27.2%) and TB in DM patients (15.3%), underscoring bidirectional screening gaps. TB and DM patients had poorer treatment outcomes (73.5% success vs. 85.7%, *p=0.03*). Systemic barriers: kit shortages (52%) and protocol inconsistencies (44%) dominated challenges. Age >45 and pulmonary TB doubled DM risk (OR>1.8, p<0.02).
Conclusions: Our study demonstrated a substantial prevalence of undiagnosed diabetes among TB patients and active TB among diabetic patients, both of which adversely affected treatment outcomes. Bidirectional screening is crucial for early detection, timely intervention, and improved clinical outcomes.

Keywords: Tuberculosis, Lung disease, Extra pulmonary tuberculosis, Comorbidity, Screening diabetes

INTRODUCTION

Tuberculosis (TB) and diabetes mellitus (DM) are two significant global health challenges, each contributing substantially to morbidity and mortality worldwide. The intersection of these diseases is particularly concerning, as individuals with diabetes have a 2–3 times higher risk of developing active TB compared to those without diabetes.[1,2] This comorbidity not only complicates the clinical management of both conditions but also exacerbates treatment outcomes, leading to higher rates of treatment failure, relapse, and mortality.[3,4]

In response to this dual burden, the World Health Organization (WHO) and the International Union Against Tuberculosis and Lung Disease have advocated for bidirectional screening testing TB patients for diabetes and vice versa—as a strategic approach to early detection and integrated management.[5] Implementing such screening protocols is especially pertinent in countries like India, which bears the highest TB burden and the second-highest

diabetes prevalence globally.[6-9] Despite the recognized importance of bidirectional screening, several challenges impede its widespread adoption. These include limited awareness among healthcare providers, inadequate training, resource constraints, and the absence of standardized screening and reporting systems.[10,11] Addressing these challenges is crucial for the successful integration of TB and diabetes care, ultimately improving patient outcomes and reducing the public health impact of these diseases.[12,13]

Aim

To evaluate the effectiveness, feasibility, and challenges of bidirectional screening for tuberculosis (TB) and diabetes mellitus (DM), and to identify barriers and opportunities for integrated management of coexisting TB and DM in high-burden settings.

Objectives

The objectives of the study are: (1) to determine the prevalence of undiagnosed diabetes among patients diagnosed with tuberculosis through bidirectional screening protocols in selected healthcare settings, (2) to assess the prevalence of latent or active tuberculosis among patients with known or newly diagnosed diabetes, especially in high TB-endemic areas, (3) to evaluate the current practices and guidelines followed by healthcare providers for bidirectional screening of TB and DM, including diagnostic tools, frequency, and follow-up mechanisms, (4) to identify operational, logistical, and systemic challenges faced by healthcare professionals and public health programs in implementing bidirectional screening strategies (5) to analyze the treatment outcomes and complications in patients co-infected with TB and DM and compare them with those having TB alone, (6) to recommend evidence-based strategies for strengthening bidirectional screening and integrated management of TB and diabetes at both primary and tertiary care levels.

METHODS

Study design

This was a prospective, observational, cross-sectional study conducted to evaluate the implementation and challenges of bidirectional screening for tuberculosis (TB) and diabetes mellitus (DM) in a high-burden tertiary care setting. The study was carried out over a period of three years from February 2022 to January 2025.

Study setting

The study was conducted at Sri Lakshmi Narayana Institute of Medical Sciences, Pondicherry, India, a tertiary care hospital recognized for its TB and DM management programs, located in Pondicherry, India. The hospital serves a diverse patient population with a high burden of infectious and non-communicable diseases.

Study population

Inclusion criteria

Adult patients (≥18 years) newly diagnosed with active pulmonary or extrapulmonary TB and adult patients (≥18 years) with known or newly diagnosed with diabetes mellitus (type 1 or type 2) are enrolled for the study.

Exclusion criteria

Patients who are already diagnosed with TB and are under treatment are excluded from the study. Individuals with multi drug resistant (MDR) or extensively drug-resistant (XDR) TB, pregnant women, patients with severe co-morbidities that preclude participation.

Sample size

Based on the prevalence data of TB and DM co-morbidity from previous studies, and considering a 5% margin of error and 95% confidence interval, a minimum sample size of 320 was calculated using standard statistical formulae. Stratified sampling was employed to ensure adequate representation of both TB and DM patient groups.

Screening procedure

For TB patients

Diabetes screening was performed at the time of TB diagnosis using the tests such as, Fasting blood glucose (FBG), HbA1c levels (≥6.5% was considered diagnostic), Random blood sugar (RBS) if FBG was not feasible

For DM patients

TB screening was performed based on WHO symptom-based approach, followed by: chest X-ray, sputum smear microscopy and/or GeneXpert (CBNAAT), Tuberculin Skin Test (TST) or Interferon-Gamma Release Assay (IGRA) for latent TB detection in asymptomatic cases.

Data collection

Data was collected using a pre-tested structured questionnaire was used to record demographic data, medical history, clinical symptoms, lab findings, treatment status, and comorbidities. Healthcare providers involved in TB and DM care were interviewed to identify operational challenges in implementing bidirectional screening. Patient records were reviewed periodically to evaluate clinical outcomes.

Data analysis

Data were entered into Microsoft Excel and analysed using SPSS version 16.0. Descriptive statistics (Mean, SD, frequency, percentage) were used for demographic and clinical characteristics. Chi-square test and logistic

regression were used to identify associations between TB-DM comorbidity and treatment outcomes. A p-value <0.05 was considered statistically significant.

Ethical considerations

The study was approved by the Institutional Ethics Committee of Sri Lakshmi Narayana Medical College, Pondicherry, India. Informed written consent was obtained from all participants prior to enrolment. Patient confidentiality was maintained throughout the study.

RESULTS

Study enrolment and population characteristics

A total of 400 participants were enrolled, comprising 250 tuberculosis (TB) patients and 150 diabetes mellitus (DM) patients. The mean age was 42.6±13.2 years in the TB group and 50.3±11.7 years in the DM group. Males constituted 62% of the TB group and 58% of the DM group. Most TB patients (78%) had pulmonary TB, while 22% had extrapulmonary TB presentations.

Prevalence of diabetes among TB patients

Out of the 250 TB patients screened, 68 patients (27.2%) were newly diagnosed with diabetes mellitus. The mean HbA1c among newly diagnosed cases was 7.6±1.3%. While 52.9% of newly diagnosed diabetics had poor glycaemic control (HbA1c>8%). Among the TB patients already known to have diabetes (n=30, 12%), 70% were poorly controlled (HbA1c>7%). The DM group was significantly older than the TB group (p<0.001), aligning with the typical age-related onset of diabetes. No significant sex-based differences were observed between groups (p=0.42) (Table 1).

Table 1: Demographic and clinical characteristics of study population.

Characteristics	TB group (n=250)	DM group (n=150)
Mean age (years)	42.6±13.2	50.3±11.7
Male (%)	62	58
Female (%)	38	42
Pulmonary TB (%)	78	-
Extrapulmonary TB (%)	22	-
Known diabetes (%)	12	100
Newly diagnosed diabetes (%)	27.20	-
Newly diagnosed TB (%)	-	15.30

Prevalence of tuberculosis among DM patients

Among 150 diabetes patients screened, 23 patients (15.3%) were diagnosed with active TB. In this study Pulmonary TB accounted for 87% of these cases. While 13% had extrapulmonary TB (mainly pleural and lymph node TB). Most TB-positive DM patients had poorly controlled diabetes (HbA1c>8%) (Table 2).

Table 2: Screening outcomes and diagnostic methods.

Screening group	Test performed	Positive cases	Diagnostic yield (%)
TB patients	FBG, HbA1c	68	27.20%
DM patients	Symptoms, CXR, GeneXpert	23	15.30%

Impact of TB-DM comorbidity on treatment outcomes

TB patients with diabetes had significantly worse treatment outcomes compared to those without diabetes. Treatment success rate was 73.5% in TB+DM patients versus 85.7% in non-diabetic TB patients (p=0.03). Odds of treatment failure or death were 2.1 times higher in TB+DM patients (OR 2.1, 95% CI 1.1–4.0, p=0.02) (Table 3).

Table 3: TB treatment outcomes in diabetic vs non-diabetic patients.

Outcome	TB+DM (n=68)	TB without DM (n=182)	P value
Treatment success (%)	73.50	85.70	0.03*
Treatment failure (%)	8.80	4.90	0.12
Mortality (%)	10.30	6.00	0.18
Relapse (%)	7.40	3.40	0.09

*Statistically significant.

Operational challenges in bidirectional screening

From interviews with 50 healthcare providers: 44% reported lack of standardized screening protocols. 52% reported shortages of glucose testing kits and laboratory support. 36% reported that patients lacked awareness regarding the need for dual screening. In addition, 30% cited inadequate provider training regarding integrated management of TB-DM comorbidity (Table 4).

Table 4: Operational challenges reported by healthcare providers.

Challenge	Number Reporting (n=50)	Percentage (%)
Lack of standardized screening protocols	22	44
Shortage of glucose testing kits	26	52
Limited patient awareness	18	36
Inadequate provider training	15	30

DISCUSSION

This study highlights the significant burden of diabetes among tuberculosis (TB) patients and the notable prevalence of TB among individuals with diabetes mellitus (DM). 27.2% of TB patients were newly diagnosed with diabetes. 15.3% of DM patients were found to have active TB. Coexistent TB-DM significantly worsened TB treatment outcomes compared to TB without diabetes. These findings emphasize the critical need for bidirectional screening and integrated management strategies to address the growing dual burden, especially in high TB-endemic and diabetes-prevalent regions.[14,15]

The prevalence of newly diagnosed diabetes in TB patients observed in our study (27.2%) aligns with previous reports: The India TB-Diabetes Study Group reported a prevalence of 25% (Tropical Medicine & International Health, 2013). Studies in Southeast Asia have shown similar rates ranging from 20–30%.[10,11]

The prevalence of TB among diabetic patients (15.3%) in our study is consistent with findings from other high-burden settings where TB prevalence among diabetics ranges between 10–17%.[14-16]

Moreover, our findings that TB-DM comorbidity leads to poorer TB treatment outcomes (lower success rates and higher mortality) are supported by global meta-analyses, which suggest that diabetes triples the risk of unfavourable TB outcomes.[10]

Operational challenges such as lack of standardized screening protocols, shortages of diagnostic supplies, and limited patient awareness reported in our study mirror obstacles described in WHO's Collaborative Framework and by Alisjahbana et al.[5,7] These system-level gaps hinder effective early detection and integrated management of TB and diabetes.

Strengths of the study

Strengths of the study include large sample size with representation from both TB and DM cohorts, Standardized diagnostic criteria for both TB and DM (WHO and ADA guidelines), Real-world assessment of operational challenges through provider interviews.

Limitations

This study was hospital-based and may not reflect community prevalence. Cross-sectional design limits causal inferences. Potential selection bias, as symptomatic diabetic patients might have been more likely to be screened for TB.

Given the high burden of dual disease and their bidirectional negative impact: routine screening for diabetes among TB patients and screening for TB among diabetic patients should be incorporated into national TB and DM control programs, integrated management protocols, including glycaemic control during TB treatment, should be emphasized to improve outcomes and strengthening the health system's capacity with training, logistics, and patient education is urgently needed.

CONCLUSION

Tuberculosis and diabetes mellitus represent a growing dual public health challenge, especially in high-burden regions. Our study demonstrated a substantial prevalence of undiagnosed diabetes among TB patients and active TB among diabetic patients, both of which adversely affected treatment outcomes. Bidirectional screening is crucial for early detection, timely intervention, and improved clinical outcomes. Overcoming operational challenges such as resource shortages, lack of protocols, and limited awareness will be key to successful implementation. Integrated and patient-centred management strategies must be prioritized within national health programs to effectively combat the intersecting epidemics of TB and diabetes.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Piruthivirajan N, Keerthi KPE, Maruthupandian, Piruthivirajan K, Shanmugam M. Tuberculosis and diabetes: bidirectional screening and management challenges in South Indian population. Int J Res Med Sci 2025;13:4078-82.