Section: Miscellaneous

Original Research Article

SCREENING FOR TUBERCULOSIS AND ASSOCIATED FACTORS AMONG PATIENTS WITH DIABETES MELLITUS IN A TERTIARY CARE HOSPITAL

Sharadhi P[1], Dr Sushma J[2], Dr Karun Mahesh KP[3], Divyashree N[4]

[1]*MBBS Student, CDSIMER, Harohalli, Bengaluru South, Karnataka, India*
[2]*Assistant Professor, Department of Community Medicine, CDSIMER Harohalli, Bengaluru South, Karnataka, India*
[3]*Associate Professor, Department of General Medicine, CDSIMER Harohalli, Bengaluru South, Karnataka, India*
[4]*Tutor cum Statistician, Department of Community Medicine, CDSIMER Harohalli, Bengaluru South, Karnataka, India*

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Corresponding Author:
Dr. Karun Mahesh KP,
Associate Professor, Department of General Medicine, CDSIMER Harohalli, Bengaluru South, Karnataka, India.

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ABSTRACT

Background: Tuberculosis (TB) and diabetes mellitus (DM) represent a significant dual burden in India, with diabetes increasing the risk of active TB, delayed diagnosis, and poor treatment outcomes. Classical TB symptoms may be absent or atypical in diabetic patients, leading to missed diagnoses. This study aimed to determine the prevalence of pulmonary and extrapulmonary TB among diabetic patients and identify factors associated with TB in a tertiary care setting.

Materials and Methods: A prospective observational study was conducted among 146 adult patients with diabetes mellitus attending the Non-Communicable Disease clinic of a tertiary care hospital. Eligible participants underwent symptom screening, chest X-ray (CXR) evaluation, and microbiological testing, including sputum smear microscopy and nucleic acid amplification test (NAAT), as indicated. Data regarding sociodemographic characteristics, diabetes profile, glycaemic control, comorbidities, and TB risk factors were collected using a pre-designed semi-structured questionnaire. Statistical analysis was performed using SPSS version 20.0. Associations were assessed using Pearson's chi-square test, with $p<0.05$ considered statistically significant.

Results: The mean age of participants was 61.7 ± 12.1 years, and 56.8% were male. Most participants (71.2%) had diabetes for more than five years, while 79.5% had poor glycaemic control (HbA1c >7%). Chest X-ray abnormalities were observed in 52.1% of participants. Microbiological testing identified pulmonary TB in 3 participants, yielding a prevalence of 2.05%, while no cases of extrapulmonary TB were detected. All TB-positive participants were asymptomatic, and none of the classical TB symptoms or traditional TB risk factors demonstrated a significant association with TB diagnosis. Although all TB-positive participants had abnormal CXR findings, the association between CXR abnormalities and NAAT positivity was not statistically significant ($p=0.246$). Blurring of vision was the only symptom significantly associated with abnormal CXR findings ($p=0.044$).

Conclusion: The prevalence of pulmonary TB among diabetic patients was low; however, all confirmed cases were asymptomatic, highlighting the limitations of symptom-based screening. Routine chest X-ray screening combined with microbiological testing may facilitate early detection of subclinical TB in diabetic individuals. Integrating systematic TB screening into routine diabetes care could strengthen bidirectional TB-DM management and support national TB elimination efforts.

Keywords: Diabetes mellitus; Tuberculosis; Pulmonary tuberculosis; Chest X-ray; Bidirectional screening; Glycaemic control.

INTRODUCTION

Public health in India has a considerable challenge due to the high burden of Tuberculosis (TB) and Diabetes Mellitus (DM). The coexistence of tuberculosisTB and DM has emerged as a growing public health concern in recent years. With the rapid rise in diabetes prevalence, particularly in countries

with an already high burden of TB, the intersection of these two diseases has created a challenging clinical scenario.[1] Diabetes weakens immune function, making individuals more prone to develop active TB and also increasing the risk of delayed diagnosis, complications, and poor treatment outcomes.[2] As healthcare systems continue to manage increasing numbers of diabetic patients, early identification of TB within this vulnerable population has become an essential priority.[3]

The significance of screening diabetic individuals for TB lies in the fact that many of them do not present with the classical symptoms commonly used in routine screening programmes. Several studies have highlighted that TB in diabetic patients may be clinically silent, radiologically masked, or biologically atypical, leading to missed or late diagnoses.[4] Early, active screening therefore becomes a critical component of integrated diabetes care. Detecting TB at an early stage is likely to improve both TB outcomes and glycemic control, while also reducing transmission within the community.[5]

Diabetic patients form a distinctive high-risk group, and studying them offers important advantages. Their unique immune and metabolic profile often results in unusual or absent symptoms, making symptom-based screening unreliable.[6] This provides a strong rationale for exploring whether chest X-rays and microbiological tests can serve as more dependable tools in this population. Existing literature also shows that many healthcare settings still rely heavily on symptoms, despite evidence suggesting that radiological changes or microbiological positivity may appear even in asymptomatic diabetics.[7] This gap underscores the need for studies that systematically evaluate the combined value of symptoms, CXR findings, and laboratory confirmation. Despite the growing awareness of TB–DM comorbidity, important knowledge gaps remain. Few studies have explored the full screening pathway, symptoms, radiology, and microbiology within the same group of diabetic patients.[8] There is also limited data from Indian tertiary care centres evaluating the burden of asymptomatic abnormalities detected through routine X-rays.[9]

Addressing these gaps is vital for strengthening screening guidelines and ensuring that high-risk individuals are not overlooked. This study aims to determine the prevalence of pulmonary TB among diabetic patients and to assess how symptoms and chest X-ray findings relate to TB detection. The central hypothesis is that a proportion of diabetic individuals may have TB despite lacking typical symptoms, and that chest X-ray and microbiological testing will play a more decisive role in diagnosis than symptom screening alone. Using a structured screening model that includes symptom assessment, CXR evaluation, and confirmatory tests such as sputum microscopy and CBNAAT, this study seeks to provide evidence that can support more effective TB screening strategies in diabetic care settings.

Objectives

1. Primary objective: To determine the proportion of pulmonary and extra-pulmonary tuberculosis among diabetic patients attending tertiary care hospital.
2. Secondary objectives:
3. a) To estimate the proportion of tuberculosis in patients with uncontrolled diabetes. b) To study the risk factors in diabetic patients that would predispose to tuberculosis.

MATERIALS AND METHODS

Study design: Prospective, observational study

Study participants: Diabetic patients attending Noncommunicable disease (NCD) clinic in the outpatient department (OPD) of General Medicine.

Sample size: Based on a study done by S Nimkar et al. in Udupi, the sample size was calculated to be 145.6 and rounded off to 146.

Inclusion criteria:

a) Diabetic patients aged above 18 years attending NCD clinic.
b) Those willing to participate in the study.

Exclusion criteria:

DM patients already diagnosed with tuberculosis.

Participant recruitment procedures: Diabetes patients attending NCD clinic fulfilling eligibility criteria will be screened for Tuberculosis after obtaining informed consent. Verbal screening for symptoms of tuberculosis and associated risk factors such as age, gender, occupational exposure, poor socioeconomic status, nutritional status, contact history of TB, previous history of TB, immunocompromised conditions namely HIV, CKD, prolonged use of steroids. Secondary data will be obtained from patient's record.Chest X-ray was done for all patients (symptomatic and asymptomatic) as a screening tool for TB

Study tools: Pre-designed semi-structured questionnaire, chest X-ray.

Methods of collection of data: Eligible subjects were screened for Tuberculosis using a pre designed semi structured questionnaire after obtaining informed consent. The participants were explained about the purpose of the study and the importance of preventing tuberculosis in them. Data was collected in the sections namely sociodemographic details, diabetes history, nutritional assessment, screening for tuberculosis and radiology findings of chest X-Ray. Data on the laboratory parameters such as random blood sugar levels and Hba1c levels was also collected from the patients. If the tests were already done within a span of three months, then the tests were not repeated. A handheld chest X-ray machine was also employed with support from the District Tuberculosis Office to capture CXR of the consented patients. Those with symptoms of presumptive tuberculosis were subjected to further diagnostic tests under NTEP and the results were documented.

Outcomes/Endpoints observed

Primary endpoint: Proportion of diabetic patients diagnosed with active TB based on symptoms screening, chest X-ray findings, and microbiological tests.

Secondary endpoint: Identification of key determinants associated with risk of TB positivity among diabetic patients such as age, BMI, glycemic control, comorbidities, and lifestyle factors.

Statistical analysis: Statistical analysis was done using the statistical package for the social science system version SPSS 20.0. Continuous variables was presented as mean and standard deviation for normally distributed data and categorical variables was expressed as frequencies and percentages. Pearson's Chi-squared test was used to compare between the groups for nominal categorical data.

RESULTS

Among 146 participants, 45.9% were aged 25-60 years, and 54.1% were >60 years. Mean age was 61.7 ± 12.07 years. 56.8% of the participants were male and 43.2% were female.. 66.43% of the study subjects had secondary education, 25.3% were illiterate, 4.7% had primary education, and 2.1% were graduates and above. About 62.3% of them were farmers, 17.1% were businessmen, 15.1% were factory workers, 5.5% mentioned that they were housewives. As per the Modified BG Prasad classification,: 56.2% belonged to lower middle class, 38.4% were middle, 5.5% were from upper middle class of socioeconomic status. Only 13.69% of the participants reported to have any of the habits (tobacco/alcohol), with tobacco being most common (50% of those with habits).

Table 1: Socio demographic profile of study participants

Variable	Percentage (%)	Frequency (n)
Age (In Yrs)		
25-60	45.9	67
> 60	54.1	79
Gender		
Male	56.8	83
Female	43.2	63
Transgender/Transsexual		
Education		
Illiterate	25.3	37
Primary	4.7	7
Secondary	66.43	97
Graduate and above	2.1	3
Occupation		
Farmer	62.3	91
Factory worker	15.1	22
Businessman	17.1	25
House Wife	5.5	8
Unemployed	0	0
Socio- Economic Status (Modified BG Prasad Classification)		
Upper middle		
Middle	5.5	8
Lower middle	38.4	56
	56.2	82
Habits		
Yes	13.69	20
No	86.30	126
Habits		
Tobacco use (Smoking/ Smokeless)	50	10
Alcohol	10	2
Both	40	8

In this study, the majority of participants were asymptomatic (83.6%), indicating that most diabetics did not present with features suggestive of active TB. Among symptoms, only small proportions reported fever (9.6%), cough (12.3%), neck swelling (6.2%), weight loss (9.6%), and loss of appetite (6.2%), showing low overall symptom burden. No one reported unusual tiredness or weakness lasting more than one month, indicating a 0% prevalence of this symptom in the study population.No one reported any additional symptoms including back pain, joint pain or swelling, abdominal discomfort, headache or neck stiffness, or persistent rashes indicating a 0% prevalence of these complaints in the study population. Blurring of vision was relatively more common at 32.9%, likely related to diabetic complications rather than TB. Sputum production was uncommon at 6.8%, and sputum positivity for AFB was very low (2.1%), reinforcing minimal symptomatic or microbiological evidence of TB in this group. Overall, Table 2 reflects that most diabetic individuals lacked classic TB symptoms, highlighting the silent or subclinical nature of TB risk in this population.

Table 2: Distribution of symptoms of presumptive TB among the study subjects

Variable	Percentage	Frequency
Fever		

>2weeks	4.1	6
<2weeks	15.8	23
NIL	80.1	117
Cough		
>2weeks	6.2	9
<2weeks	15.1	22
NIL	78.8	115
Loss of weight for >1month duration		
Yes	6.8	10
No	93.2	136
Loss of appetite for >1month duration		
Yes	12.3	18
No	87.7	128
Swelling or lump in the neck		
Yes	2.7	4
No	97.3	142
Blurring of vision		
Yes	16.4	24
No	83.6	122

In this study group, only 2.7% reported a history of contact with TB, and just 1.4% had a past history of TB, indicating minimal known exposure among participants. A family history of TB was present in 4.1%, again showing low familial clustering. The majority 86.3% had no known exposure, emphasizing that most diabetics lacked identifiable TB risk contacts.No participant reported a history of HIV infection.This indicates a 0% prevalence of HIV in the study population. None of the participants reported CKD, chemotherapy, or long-term steroid use. Thus, no immunocompromised conditions were identified in the study group. A very small proportion of participants reported a previous history of TB, with 2.7% (n=4) having PTB and 0.7% (n=1) having EPTB, while the vast majority (96.6%) reported no past TB. Among those with a history of TB, 3.4% (n=5) had completed treatment, and none reported incomplete treatment. Regarding BMI, 27.4% were underweight, while 72.6% had normal or higher BMI, indicating that undernutrition a known TB risk factor was not predominant. Participants with comorbid conditions increasing susceptibility (e.g., immunosuppressive states) were few at 5.5%, and recent travel history was almost negligible at 2.1%, suggesting very low additional epidemiological or behavioural exposure risks. Overall, Table 3 shows that traditional TB risk factors (contact, past TB, underweight status, immunocompromised, and travel) were uncommon in this diabetic individuals.

Table 3: Distribution of risk factors for TB among the study subjects

Variable	Percentage	Frequency
Contact history of TB		
Yes	4.1	6
No	95.9	140
Family history of TB		
YES	3.5	5
NO	96.5	141
Family history of TB		
Spouse	20	1
Parents	0	0
Siblings	40	2
Children	0	0
Other relatives	20	1
Previous history of TB		
PTB	2.7	4
EPTB	0.7	1
Both	0	0
NIL	96.6	141
History of COVID		
Yes	1.4	2
No	98.6	144
BMI		
<18.5	2.7	4
18.5 to 24.9	89.7	131
25.0 to 29.9	0	0
>30	7.5	11

All participants had Type II diabetes, with no cases of Type I diabetes reported, indicating a 100% prevalence of Type II DM in the study population. Most participants 71.2% had diabetes for more than 5 years, indicating a predominantly long-standing diabetic population with greater vulnerability to complications. Only 28.8% had diabetes for less than five years, suggesting fewer newly diagnosed or early-stage cases. All participants reported undergoing annual health checkups, with none indicating otherwise, showing a 100% compliance rate in the study population.Poor glycemic control was common, with 79.5% (n=116) having HbA1c >7, while only 20.5% (n=30)

achieved HbA1c <7. This indicates inadequate diabetes control in the majority of participants. Most participants monitored their glucose infrequently: 46.57% (n=68) once in 3–6 months and 41.78% (n=61) once in more than 6 months. Only 11.6% (n=17) monitored once in 1–3 months, and none monitored monthly showing poor self-monitoring practices. Overall, 15.7% (n=23) reported complications, while 84.2% (n=123) had none. Among those with complications, neuropathy (43.4%) and retinopathy (39.1%) were most frequent, and 17.39% had both. Diabetes treatment was mainly oral agents: 45.8% (n=67) used a metformin + glimepiride combination, while 39.72% (n=58) used metformin alone. Only 14.38% (n=21) used glimepiride alone, and none were untreated. Overall, Table 4 highlights that the study population mainly consisted of chronic, long-duration Type 2 diabetic patients who inherently carry higher metabolic and infectious risk burdens.

Table 4: Diabetes Managementamong the study subjects

Variable	Percentage	Frequency
Duration of DM		
>5yrs	71.2	104
<5yrs	28.8	42
HbA1c		
<7	20.5	30
>7	79.5	116
Complications		
YES	15.7	23
NO	84.24	123
Complications		
Retinopathy	39.1	9
Neuropathy	43.4	10
Both	17.39	4
Frequency of monitoring of blood glucose		
Once a month	0	0
Once in 1-3 months	11.6	17
Once in 3-6months	46.57	68
Once in >6months	41.78	61
Treatment of DM		
Only Metformin	39.72	58
Only Glimeperide	14.38	21
Both	45.8	67
NIL	0	0

None of the participants had undergone TST or IGRA testing in the past, as 100% (n=146) reported not having either of these tests done previously.Chest X-ray findings showed that just over half (52.1%) had abnormalities, while 47.3% were normal and one was unclear. Smear microscopy demonstrated 2.1% positivity, with about half negative and nearly half not done due to inadequate sputum. NAAT results showed the same pattern, with 2.1% positive, 48.6% negative, and 47.9% untested, indicating limited bacteriological evaluation. Ultimately, 2.05% of participants were diagnosed with pulmonary TB, with no extra-pulmonary cases, confirming low TB prevalence in this diabetic population.

Table 5: Investigations for TB diagnosis

Variable	Percentage	Frequency
CXR		
Normal	47.3	69
Abnormal	52.1	76
Not clear	7	1
Smear microscopy		
Positive	2.1	3
Negative	48.6	71
Missing	1.4	2
NA	47.9	70
NAAT		
Positive	2.1	3
Negative	48.6	71
Missing	1.4	2
NA	47.9	70
Diagnosis		
PTB	2.05	3
EPTB	0	0
Both	0	0
NIL	97.95	143

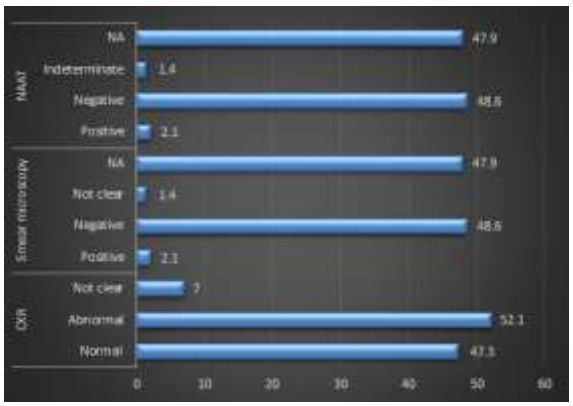

Figure 1: Results of investigations for TB diagnosis

The mean age of participants was 61.7 ± 12.1 years, indicating an elderly population with a wide age range. The average duration of diabetes was 7.85 ± 6.53 years, showing that most had long-standing disease with considerable variability. The mean BMI was 22.5 ± 3.18 kg/m², reflecting a predominantly normal-weight group. Glycemic control was poor, as shown by a mean HbA1c of 8.03 ± 1.54%. Symptom duration was generally short, with the average duration of cough being 1.92 ± 4.64 weeks and fever 0.87 ± 2.16 weeks, indicating that most symptomatic patients experienced brief or minimal symptoms.

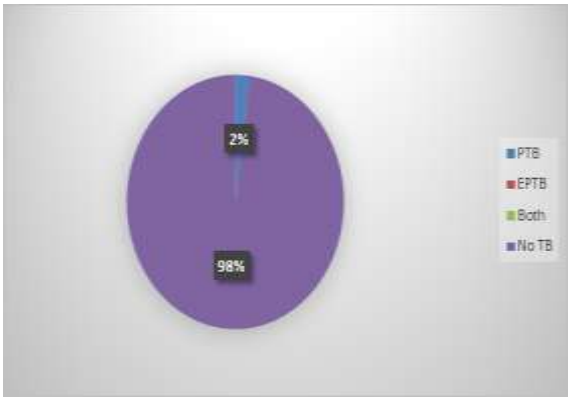

Figure 2: Diagnosis of TB among study subjects

Table 6: Mean of various characteristics of study subjects

Variables	Mean	Std. Deviation
Age (in years)	61.699	12.0684
Duration of DM (in years)	7.849	6.5341
BMI (in kg/m2)	22.5173	3.17612
HbA1c	8.0336	1.53522
Duration of cough(in weeks)	1.918	4.6364
Duration of fever(in weeks)	0.87	2.165

In this study, none of the symptoms showed a statistically significant association with abnormal chest X-ray findings except blurring of vision. Fever, whether lasting less than or more than two weeks, showed no meaningful relationship with CXR status (p = 0.540). Similarly, cough duration (<2 weeks or >2 weeks) was not associated with abnormal radiographs (p = 0.789). Weight loss (p = 0.239), loss of appetite (p = 0.185), shortness of breath (p = 0.490), and neck or axillary swellings (p = 0.934) also showed no significant associations, indicating that these symptoms did not predict radiological abnormalities. Only blurring of vision demonstrated a statistically significant association with abnormal CXR findings (p = 0.044), although this may be influenced by diabetic complications rather than TB-specific changes. Overall, the table highlights that common TB-related symptoms were not reliable predictors of abnormal chest X-ray findings in this diabetic population.

Table 7: Association between presumptive TB symptoms and CXR

Variable		CXR		p-value
		Abnormal	Normal	
Fever	<2weeks	10(13.16%)	13(18.57%)	0.540
	>2weeks	4(5.26%)	2(2.86%)	
	0	62(81.58%)	55(78.57%)	
Cough	<2weeks	10(13.16%)	12(17.14%)	0.789
	>2weeks	5(6.58%)	4(5.71%)	
	0	61(80.26%)	54(77.14%)	
Weight loss	No	69(90.79%)	67(95.71%)	0.239
	Yes	7(9.21%)	3(4.29%)	
Loss of appetite	No	64(84.21%)	64(91.43%)	0.185
	Yes	12(15.79%)	6(8.57%)	
Shortness of breath	No	56(73.68%)	55(78.57%)	0.490
	Yes	20(26.32%)	15(21.43%)	
Swellings in the neck/armpits	No	74(97.37%)	68(97.14%)	0.934
	Yes	2(2.63%)	2(2.86%)	
Blurring of vision	No	5977.63%)	63(90%)	0.044
	Yes	17(22.37%)	7(10%)	

In this analysis, none of the evaluated TB risk factors showed a significant association with abnormal chest X-ray findings. Participants with or without a contact history of TB had similar CXR patterns (p = 0.464), and the presence of a family history of TB also showed no meaningful association (p = 0.717). A

previous history of TB did not influence CXR abnormalities (p = 0.717), and the type of past TB (PTB/EPTB) similarly showed no correlation (p = 0.380). Treatment history from previous TB episodes did not affect current radiographic findings (p = 0.717). HIV status showed no notable association with CXR abnormalities (p =1). BMI categories including underweight, normal, and obese also showed no significant relationship with abnormal CXR findings (p = 0.726). Overall, the table indicates that traditional TB risk factors and comorbidities did not predict abnormal CXR changes in this diabetic population.

Table 8: Association between risk factors for TB and CXR

Variable		CXR finding		p-value
		Abnormal	Normal	
Contact with TB	No	72(94.74%)	68(97.14%)	0.464
	Yes	4(5.26%)	2(2.86%)	
Family history	No	73(96.05%)	68(97.14%)	0.717
	Yes	3(3.95%)	2(2.86%)	
Previous history	No	73(96.05%)	68(97.14%)	0.717
	Yes	3(3.95%)	2(2.86%)	
Type of TB	EPTB	0(0%)	1(1.43%)	0.380
	NA	73(96.05%)	68(97.14%)	
	PTB	3(3.95%)	1(1.43%)	
Treatment	NA	73(96.05%)	68(97,14%)	0.717
	Yes	3(3.95%)	2(2.89%)	
BMI	<18.5	2(2.63%)	2(2.89%)	0.726
	>30	7(9.21%)	4(5.71%)	
	18.5 - 24.9	67(88.16%)	64(91.43)	

The association between diabetes management factors and chest X-ray findings showed no statistically significant relationships. Participants with a diabetes duration of less than 5 years and those with more than 5 years had almost identical proportions of abnormal CXR findings (p = 0.960), indicating duration of diabetes did not influence radiological abnormalities. Similarly, glycemic control showed no meaningful association, as both HbA1c <7% and >7% groups had comparable rates of abnormal CXR findings (p = 0.571). Treatment type also showed no significant association (p = 0.076), although patients on glimepiride alone had slightly higher proportions of abnormal CXRs compared to those on metformin or combination therapy. Overall, none of the diabetes-related variables were predictive of abnormal chest X-ray findings in this study population.

Table 9: Association between variables of DM management and CXR

Variable		CXR finding		p-value
		Normal	Abnormal	
DM duration	<5yrs	22(28.95%)	20(26.32%)	0.960
	>5yrs	54(71.05%)	50(65.79%)	
Hba1c	<7	17(22.37%)	13(17.11%)	0.571
	>7	59(77.63%)	57(75.00%)	
Treatment	Glimepiride	8(10.53%)	13(17.11%)	0.076
	Metformin	26(34.21%)	31(40.79%)	
	Both	42(55.26%)	26(34.21%)	

The association between diabetes characteristics and PTB diagnosis showed no statistically significant relationships. All PTB-positive patients had HbA1c values >7%, but this was not significant (p = 0.193), indicating poor glycemic control alone did not predict PTB. Duration of diabetes also showed no meaningful association (p = 0.406); although two of the three PTB cases had diabetes for more than 5 years, this pattern was not statistically reliable. Regarding treatment, most PTB cases were on metformin (66.7%), one was on combination therapy, and none were on glimepiride alone, but this trend again lacked significance (p = 0.561). Overall, none of the diabetes-related variables (HbA1c, duration, or treatment type) demonstrated a significant association with PTB in this study.

Table 10: Association between characteristics of DM and TB diagnosis

Variable		PTB		P-value
		Present (N=3)	Absent (=143)	
HbA1C	<7	0	52(36.4%)	0.193
	>7	3(100%)	91 (63.6%)	
Duration of DM (in years)	<5	1(33.3%)	82 (57.3%)	0.406
	>5	2 (66.7%)	61 (42.7%)	
Treatment of DM	Metformin	2 (66.7%)	55 (38.5%)	0.561
	Glimepiride	0	21 (14.7%)	
	Both	1(33.3%)	67 (46.9%)	

None of the sociodemographic variables showed statistically significant associations with PTB diagnosis. Age distribution indicated that two of three PTB cases were >60 years and one between 25–60 years (p = 1.000), suggesting age was not predictive. All PTB cases were female (p = 0.078), though this was not statistically significant. Education level showed no meaningful trend; PTB cases were among illiterate and secondary-educated participants (p = 1.000). Occupation did not influence PTB risk, with cases spread across farmers, factory workers, and housewives (p = 0.142). Socioeconomic status was also not significant; all PTB cases belonged to the middle class (p = 0.158). Similarly, no PTB cases had a history of tobacco or alcohol use, and habits were not associated with PTB (p = 1.000). Overall, sociodemographic factors did not significantly predict PTB in this population.

Table 11: Association between sociodemographic profile and TB diagnosis

Variable	Category	PTB Present	PTB Absent	p-value
Age (In Yrs)	18-24	0 (0.0%)	0 (0.0%)	1.000
	25-60	1 (33.3%)	68 (47.6%)	
	> 60	2 (66.7%)	75 (52.4%)	
Gender	Male	0 (0.0%)	83 (58.0%)	0.078
	Female	3 (100.0%)	60 (42.0%)	
Education	Illiterate	1 (33.3%)	36 (25.2%)	1.000
	Primary	0 (0.0%)	10 (7.0%)	
	Secondary	2 (66.7%)	77 (53.8%)	
	Graduate and above	0 (0.0%)	19 (13.3%)	
Occupation	Farmer	1 (33.3%)	90 (62.9%)	0.142
	Factory worker	1 (33.3%)	20 (14.0%)	
	Businessman	0 (0.0%)	25 (17.5%)	
	House Wife	1 (33.3%)	7 (4.9%)	
Socio-Economic Status	Upper middle	0 (0.0%)	8 (5.6%)	0.158
	Middle	3 (100.0%)	53 (37.1%)	
	Lower middle	0 (0.0%)	82 (57.3%)	
Habits	Tobacco use	0 (0.0%)	8 (5.6%)	1.000
	Alcohol	0 (0.0%)	3 (2.1%)	
	Both	0 (0.0%)	7 (4.9%)	
	Nil	3 (100.0%)	123 (86.0%)	

None of the classical or non-specific TB symptoms were significantly associated with PTB diagnosis. All three PTB-positive patients were asymptomatic, reporting no fever, cough, weight loss, loss of appetite, unusual tiredness, neck or axillary swelling, or blurring of vision. Symptom durations and presence among PTB-negative participants varied, but the differences were not statistically significant (p = 1.000 for all variables). This indicates that PTB in this diabetic cohort was largely subclinical, highlighting the importance of routine screening rather than symptom-based detection.

Table 12: Association between Presumptive TB symptoms and TB diagnosis

Variable	Category	PTB Present	PTB Absent	p-value
Fever	>2weeks	0 (0.0%)	1 (0.7%)	1.000
	<2weeks	0 (0.0%)	22 (15.4%)	
	NIL	3 (100.0%)	120 (83.9%)	
Cough	>2weeks	0 (0.0%)	9 (6.3%)	1.000
	<2weeks	0 (0.0%)	22 (15.4%)	
	NIL	3 (100.0%)	112 (78.3%)	
Loss of weight	Yes	0 (0.0%)	2 (1.4%)	1.000
	No	3 (100.0%)	141 (98.6%)	
Loss of appetite	Yes	0 (0.0%)	2 (1.4%)	1.000
	No	3 (100.0%)	141 (98.6%)	
Unusual tiredness/weakness	Yes	0 (0.0%)	35 (24.5%)	1.000
	No	3 (100.0%)	108 (75.5%)	
Swelling in neck/armpits	Yes	0 (0.0%)	4 (2.8%)	1.000
	No	3 (100.0%)	139 (97.2%)	
Blurring of vision	Yes	0 (0.0%)	24 (16.8%)	1.000
	No	3 (100.0%)	119 (83.2%)	

None of the traditional TB risk factors showed a significant association with PTB in this cohort. All three PTB cases had no contact history, family history, or previous TB, and none had HIV or prior COVID infection, with all p-values equal to 1.000, indicating no statistical significance. BMI also showed no meaningful correlation; all PTB cases were within the normal range (18.5–24.9 kg/m²), while underweight, overweight, and obese categories did not include any PTB cases (p = 0.797). Overall, this suggests that in this diabetic population, classical TB risk factors and BMI were not predictive of PTB, highlighting the importance of routine screening.

Table 13: Association between risk factors for TB and TB diagnosis

Variable	Category	PTB Present	PTB Absent	p-value
Contact history of TB	Yes	0 (0.0%)	6 (4.2%)	1.000
	No	3 (100.0%)	137 (95.8%)	
Family history of TB	Yes	0 (0.0%)	5 (3.5%)	1.000
	No	3 (100.0%)	138 (96.5%)	
Previous history of TB	Yes	0 (0.0%)	5 (3.5%)	1.000
	No	3 (100.0%)	138 (96.5%)	
History of HIV	Yes	0 (0.0%)	0 (0.0%)	1.000
	No	3 (100.0%)	143 (100.0%)	
History of COVID	Yes	0 (0.0%)	2 (1.4%)	1.000
	No	3 (100.0%)	141 (98.6%)	
BMI	<18.5	0 (0.0%)	5 (3.5%)	0.797
	18.5 to 24.9	3 (100.0%)	130 (90.9%)	
	25.0 to 29.9	0 (0.0%)	7 (4.9%)	
	>30	0 (0.0%)	1 (0.7%)	

All three NAAT-positive PTB cases had abnormal chest X-rays, whereas among NAAT-negative participants, 51% also showed abnormal radiographs. Normal CXR findings were present in 49% of NAAT-negative cases. The association was not statistically significant (p = 0.246), indicating that while abnormal CXR may accompany microbiologically confirmed TB, an abnormal chest X-ray alone is not a reliable predictor of PTB in this diabetic population.

Table 14: Association between CXR finding and NAAT

CXR Finding	NAAT Positive	NAAT Negative	p-value
Normal	0 (0.0%)	70 (49.0%)	0.246
Abnormal	3 (100.0%)	73 (51.0%)	
Total	3 (100.0%)	143 (100.0%)	

Final Interpretation: The socio-demographic profile shows that the study included a fairly even distribution of adults aged 25–60 years and those above 60 years, with a slightly higher proportion of older participants. Males formed the majority of the sample. Most participants had completed secondary education, while a smaller proportion were illiterate or had lower/higher education levels.Habit-related data indicate that smoking was more common than alcohol use, and a notable number reported both habits together. When grouped, a majority of participants fell into the normal BMI range, with fewer individuals in the underweight, overweight, or obese categories. This suggests that lifestyle habits varied independently of BMI categories.Overall, the demographic spread shows a predominantly male, older, moderately educated population with mixed lifestyle habits. These characteristics may influence health-related outcomes in the study, and should be considered while interpreting further clinical or epidemiological results.

DISCUSSION

DM and TB comorbidity is a public health concern in many developing countries where healthcare resources are limited. There is strong epidemiological evidence on the relationship between DM and TB. The Pillar one of End TB strategy emphasises on the importance of integrated management of noncommunicable and communicable diseases. A collaborative framework for TB and Diabetes has been developed jointly by Ministry of health and family welfare and World Health Organisation in the year 2017 to strengthen the response of health system to deal with the double burden of TB-Diabetes co-morbidities in which screening for tuberculosis among diabetes patients has been emphasised. In the present study, we have tried to implement this part of the national guidelines to screen for TB among DM patients attending our tertiary care facility using verbal screening and chest X-ray as screening tools.

In our present study we examined the burden of tuberculosis (TB) risk among individuals with diabetes mellitus (DM) using an active screening approach. Our sample consisted predominantly of older adults (45.9% aged 25-60 years and 54.1% above 60 years), with a considerable proportion being male (56.8%). Education levels were varied, with 25.3% being illiterate, and the rest distributed across primary, secondary and graduate categories. These socio-demographic characteristics align with previous South Indian studies, where older age, lower socioeconomic backgrounds and poor educational status were strongly associated with under-diagnosed TB among diabetics.[1,2]

Clinically, several of our participants exhibited risk factors such as high HbA1c, past TB history and obesity. Chest X-ray screening revealed a small subset with fibrotic bands and nodular opacities features commonly seen in individuals with previous TB or at risk of reactivation. Importantly, all seven TB-suspect participants underwent sputum microscopy and CBNAAT testing. While this may suggest low active TB prevalence in our screened group, similar Indian studies have shown that diabetics often present with subtle or atypical radiological findings and may remain smear-negative despite early disease [3]. This emphasises the need for repeated or multi-modal screening strategies.

Our results resonate with Gröschel et al.'s findings from disadvantaged urban slum populations, where random glucose testing identified a high-risk diabetic cohort, yet microbiological confirmation of TB

remained modest due to early-stage disease or low bacillary load.[4] Likewise, a Tamil Nadu community-based study observed radiological abnormalities mimicking healed TB among diabetics but reported low sputum positivity on initial screening, attributing this to intermittent bacillary shedding and diabetes-induced immune dysfunction.[5]

From a public-health standpoint, our findings reinforce the magnitude of the TB-DM comorbidity problem in India. Although India's NTEP recommends routine bi-directional screening, the practical implementation remains limited. Our participants demonstrated inadequate awareness regarding TB symptoms, susceptibility and the need for annual screening barriers also reflected in other South Indian research, where knowledge gaps significantly contributed to delayed care-seeking.[6]

The low microbiological yield in our study does not diminish its public-health relevance. Instead, it highlights the well-documented challenge that TB in diabetics often presents with low-grade bacillary loads, necessitating stronger screening algorithms. International studies from China, Indonesia and Mexico have similarly reported low initial CBNAAT positivity among diabetics, despite radiological abnormalities, thereby advocating for combined approaches using repeat sputum, chest X-ray and glycemic profiling.[7,8]

Barriers identified in our population limited awareness, inconsistent follow-up, and reliance on single-time screening mirror national-level implementation challenges. Strengthening counselling within diabetic clinics, using patient reminders, improving sputum collection quality, and integrating electronic health records between endocrinology units and NTEP may significantly improve detection outcomes. Evidence from south India supports that even minimal counselling reinforcement can double adherence to TB screening among diabetics.[9]

Another important dimension of this study is that it was not limited to detecting active TB among individuals with diabetes but also aimed at identifying the underlying risk factors that increases their future susceptibility. By evaluating glycemic control, BMI, past TB history, lifestyle habits, and radiological abnormalities, the study provided insight into patterns that may predispose this population to progression from latent infection to active disease. Recognising these risk factors early enables targeted counselling, timely intervention, and preventive strategies, which are essential components of integrated DM–TB management. This preventive perspective adds significant value to the screening process and aligns with global recommendations for comprehensive risk reduction among diabetics.

Our study demonstrates that even with a modest sample size, meaningful insights can be derived regarding the clinical and epidemiological pattern of TB risk among diabetics. However, increasing the sample size in future studies would allow more precise estimation of TB burden, improve statistical validity, and enable stronger subgroup analyses. Importantly, the screening methodology utilised here—including demographic profiling, radiological screening and microbiological confirmation—proved practical and effective, and can be replicated on a larger scale for future research and public-health programs.

CONCLUSION

The present study highlights the substantial intersection between diabetes mellitus (DM) and tuberculosis (TB) within a tertiary care setting, reinforcing the importance of structured bi-directional screening in high-burden countries like India.

The study also underscores an important public-health message: absence of microbiological positivity does not equate to absence of risk. Diabetes-induced immune dysfunction, impaired macrophage activity, and decreased ability to contain latent infection are well established biological pathways that predispose patients to TB even when initial sputum tests are negative. Therefore, integrating annual TB screening into routine diabetic care is a necessary strategy rather than an optional measure.

From an implementation perspective, the study demonstrates that systematic screening involving symptom enquiry, chest X-ray evaluation, and microbiological confirmation is both feasible and acceptable in routine outpatient settings. It additionally revealed several barriers that our participants faced including limited awareness of TB symptoms, poor understanding of their heightened susceptibility due to diabetes, inconsistent health-seeking behaviour, and fragmented linkages between general medical services and the National TB Elimination Programme (NTEP). Addressing these gaps through improved counselling, patient education, clinical reminders, and greater coordination between NCD and TB programmes could substantially improve screening uptake and early diagnosis.

A larger sample would also enhance statistical reliability, allow subgroup analyses, and potentially detect early TB cases that may have been missed in this study. In addition to identifying active tuberculosis among individuals with diabetes mellitus, an important objective of this study was to assess the various risk factors that predispose diabetic patients to future TB development. Diabetes, especially when poorly controlled, increases vulnerability to TB through impaired immunity, chronic inflammation, and metabolic dysregulation. By systematically evaluating parameters such as glycemic control, BMI, lifestyle factors, past TB history, radiological changes, and associated comorbidities, this study not only enabled early screening but also provided an opportunity for

preventive counselling and risk stratification. This dual-purpose approach strengthens long-term TB prevention strategies and supports integrated diabetes-TB management.

With India striving toward TB elimination, diabetics represent a critical focus group where early diagnosis, preventive strategies, lifestyle modification, and improved glycemic control can significantly reduce progression to active disease. Strengthening patient education, improving clinic-based screening workflows, and ensuring continuity of care across programmes will be essential to overcoming the existing gaps.

Summary

Purpose of Study: This prospective observational study aimed to screen for tuberculosis among diabetes mellitus patients attending a tertiary care hospital and determine the proportion of pulmonary and extra-pulmonary TB in this population.

Model/Organism Used:

Human subjects: Diabetic patients aged above 18 years attending the General Medicine Outpatient Department (OPD)/Non-Communicable Disease (NCD) clinic (tertiary care hospital).

Key Methods Used: A total of 146 subjects aged above 18 years and above, who are diabetic were included in the study. A questionnaire based evaluation were conducted with a chest x-ray for all the subjects to asses the pulmonary and extra pulmonary symptoms.

Key results: PTB was found only in the 25-60 years (33.3%) and >60 years (66.7%) groups, but this difference was not statistically significant ($p = 1.000$). All PTB-positive cases were female, but the association was not significant ($p = 0.078$). None of the PTB-positive participants had common TB symptoms (fever, cough, weight loss, appetite loss, tiredness, neck swelling). A few PTB-negative participants reported these symptoms. No significant associations, showing symptoms alone are not reliable for detecting TB in diabetic patients. Participants with abnormal chest X-rays had slightly more symptoms, but only blurring of vision showed a significant association ($p = 0.044$). All other symptoms were not significantly linked to CXR abnormalities.

PTB cases had no symptoms. Most symptoms did not predict abnormal CXR. Diabetic patients may have silent or atypical TB, so routine CXR and microbiological testing are essential to avoid missed diagnoses.

Major Conclusions: This study found a 2.05% prevalence of pulmonary TB among diabetic patients, with all detected cases being completely asymptomatic. Symptom screening alone failed to identify TB, while chest X-ray played a more reliable role in early detection. Classical TB risk factors and demographic variables showed no significant association with PTB, highlighting the unpredictable nature of TB in diabetics. Routine CXR and microbiological testing should therefore be integrated into diabetes care to prevent missed diagnoses. Although the sample size was small, the findings provide valuable direction, and larger future studies are needed to confirm these results.

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