RESEARCH ARTICLE

Prevalence of diabetes mellitus and its associated risk factors among newly diagnosed adult patients with tuberculosis at Basrah TB centre

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ABSTRACT

Introduction: Globally, Tuberculosis (TB) remains one of the most widespread infectious diseases, and it is the leading cause of death from infection. Simultaneously, diabetes mellitus (DM) is becoming increasingly prevalent, particularly in low- and middle-income countries. DM is recognised as a risk factor for TB; patients with DM are two to three times more likely to develop TB compared to those without DM.

Objective: To estimate the prevalence of diabetes mellitus (DM) among newly diagnosed adult tuberculosis (TB) patients. To explore the demographic, clinical, and socioeconomic risk factors associated with TB and DM coexistence and evaluate the relationship between DM and TB characteristics, including disease severity and type (pulmonary versus extrapulmonary).

Methods: A cross-sectional analytical study was designed to include 249 newly diagnosed adult TB patients with specific inclusion criteria. DM diagnosis was based on standard glucose level and HbA1c criteria, with data collected through interviews and medical records. Variables examined included demographics, type and severity of TB, socioeconomic status, smoking status, and comorbidities.

Results: The prevalence of DM among TB patients was 19.3 %. Diabetic TB patients were significantly older (mean age: 55.83 years) compared to non-diabetic patients (33.04 years). Male gender and pulmonary TB were more common in DM-TB patients. High TB severity was excessively seen in those with DM, with significant associations observed between DM and comorbidities like hypertension, socioeconomic status, and high positivity rate.

Conclusion: The study concluded that diabetes mellitus is significantly prevalent among tuberculosis patients (19.3%), with strong associations found between DM and a patient with old age, being a male, and having pulmonary TB. Comorbid conditions, particularly hypertension, were also linked to greater disease severity in TB patients with DM. .

Key words: Tuberculosis (TB), Diabetes Mellitus (DM), Prevalence, Risk Factors, Basrah.

INTRODUCTION

Tuberculosis (TB) is a chronic infectious disease caused by Mycobacterium tuberculosis (MTB), a slow-growing, aerobic, and acid-fast bacillus. TB remains a major global health threat, and the World Health Organization (WHO) reported 10.6 million new cases and 1.6 million deaths in 2021, making it one of the leading infectious causes of death worldwide.[1] Although it primarily affects the lungs (pulmonary TB), MTB can disseminate to other organs, resulting in extrapulmonary TB. The disease affects low- and middle-income countries where healthcare infrastructure is limited, and social determinants such as poverty, malnutrition, and overcrowding exacerbate the burden.[2] The pathogenicity of

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Mycobacterium tuberculosis (M. tuberculosis) is linked to its ability to evade and modulate the host immune system.[3]

On the other hand, diabetes mellitus (DM) is a chronic metabolic disorder characterised by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The International Diabetes Federation (IDF) reported a global prevalence of 537 million adults living with diabetes mellitus (DM) in 2021, which is projected to rise due to lifestyle changes, urbanisation, and ageing populations.[4]

Diabetes mellitus (DM) significantly affects the microbiology and immunology of tuberculosis (TB), leading to increased susceptibility to infection and more severe disease progression. The interaction between TB and DM is bidirectional and multifaceted, with hyperglycemia playing a central role in exacerbating TB infection. Hyperglycemia alters the host immune response, creating an environment suitable for MTB survival and replication. Furthermore, chronic inflammation and oxidative stress associated with DM contribute to the breakdown of granulomas, facilitating bacterial dissemination.[5] On the other hand, TB infection can negatively impact glucose metabolism, leading to hyperglycemia and, in some cases, the development of overt DM. Studies have shown that diabetic TB patients have higher bacterial loads, delayed sputum conversion, and worse treatment outcomes compared to non-diabetic TB patients.[6,7]

The immune deficits in DM contribute to various challenges in TB management, including faster reactivation of latent TB, increased disease severity, prolonged treatment durations, increased risk of post-TB complications, such as chronic obstructive and chronic restrictive lung disease and higher relapse rates; moreover, Individuals with DM-TB comorbidity are at increased risk of developing drug-resistant TB strains due to factors such as delayed diagnosis, poor adherence to treatment regimens, and altered pharmacokinetics of anti-TB drugs.[5,8] The WHO has highlighted the need for intensified screening and specially designed treatment strategies for TB-DM patients to mitigate these risks.[9]

TB-DM comorbidity is a growing concern worldwide, with approximately 15% of TB cases attributed to DM. High-burden countries such as India, China, and Indonesia report DM prevalence rates among TB patients ranging from 20% to 30%.[10,11] The global rise in DM, particularly in low- and middle-income countries, threatens to reverse gains made in TB control. In the Middle East, including Iraq, the dual burden of TB and DM is becoming increasingly evident.[10] In Baghdad, the prevalence of DM-TB comorbidity was 8.6% in 2011.[12]

Risk factors like older age and male gender are associated with higher prevalence rates of TB-DM. Advanced age weakens the immune response, making individuals more susceptible to TB infection. Similarly, the male gender does so due to biological and sociocultural factors, such as occupational exposure and health-seeking behaviours.[9,13] Behavioral factors like smoking, alcohol use, and sedentary lifestyles exacerbate risks. Smoking impairs lung function and reduces the body's ability to clear Mycobacterium tuberculosis, while chronic alcohol consumption compromises immune function and leads to poor glycemic control. Additionally, sedentary behaviours, often associated with urbanisation and lifestyle changes, are strongly linked to the development of DM and its complications, creating a feedback loop that exacerbates TB susceptibility.[14,15] Obesity, another hallmark of type 2 DM, is associated with chronic low-grade inflammation that may predispose individuals to active TB. Furthermore, coexisting conditions such as HIV, which also compromises immunity, dramatically increase the risk of TB, creating a syndemic relationship that complicates management and treatment outcomes.[16] Recent studies highlight the influence of socioeconomic factors, such as poverty and limited healthcare access, which excessively affect vulnerable populations.

Additionally, genetic predispositions, including polymorphisms in immune-related genes, have been linked to variations in susceptibility to TB and DM.[17,18]

Managing TB in diabetic patients requires addressing unique microbiological and clinical challenges. Drug-drug interactions, altered drug absorption, and increased side effects are common in TB-DM patients. Furthermore, hyperglycemia can reduce the efficacy of rifampicin, a cornerstone drug in TB treatment, necessitating close monitoring and dose adjustments.[19,20]

Both evidence and attention are increasing rapidly in the area of TB-DM comorbidity. However, there are gaps in epidemiological information, necessitating further research, especially in low- and middle-income countries (LMICs) such as Basrah. This study aims to help fill some of these gaps. The present study aimed to estimate the prevalence of DM among newly diagnosed adult patients with TB, explore demographic, clinical, and socioeconomic risk factors associated with the coexistence of DM-TB comorbidity, and evaluate the relationship between DM and TB characteristics, including disease severity and type; pulmonary versus extrapulmonary during the study period from 2nd of January 2024 to 1st of October 2024.

METHODS

Study design and setting: A cross-sectional analytical study was conducted at the Basrah TB Centre, Iraq, from the 2nd of January 2024 to 1st of October 2024.

Ethical consideration: Preliminary approval was obtained From the administration of the tuberculosis centre in Basrah governorate. Sputum and blood samples were collected from the patients after obtaining their consent, and the tests were performed at the Basrah TB Centre Laboratories. The data from the subjects were obtained using the previously arranged questionnaire.

Study Population: The target population includes all adult patients newly diagnosed with TB who attended the Basrah TB Center during the data collection period. Inclusion criteria include all adult patients newly diagnosed with TB, including both pulmonary and extrapulmonary forms, confirmed through clinical, radiological and microbiological methods, such as AFB staining, culture, and PCR gene Xpert. Exclusion criteria include Patients below 18 years of age.

Sample Size and Sampling Technique: The total sample size comprised 249 patients, including 142 male patients (57.0%) and 107 female patients (42.9%), representing the entire population of eligible TB patients attending the Basrah TB Centre during the study period. A consecutive sampling approach was utilised, including all patients who met the eligibility criteria within the study period.

Diagnosis of Tuberculosis and Diabetes Mellitus: TB diagnosis in this study was based on international laboratory guidelines.[21] Patients were classified into pulmonary or extrapulmonary TB based on the following diagnostic methods: Pulmonary TB: Confirmed through sputum smear microscopy (AFB), GeneXpert testing, or culture results. In cases of smear-negative TB, radiological evidence such as chest X-rays coupled with clinical symptoms was used, and a specialist pulmonologist confirmed the diagnosis. Extrapulmonary TB: Diagnosed based on site-specific investigations, including histopathology, imaging studies (e.g., ultrasound, CT, or MRI), and microbiological confirmation from aspirates or biopsies. Patients were classified as having active TB based on these diagnostic criteria, ensuring accurate differentiation between pulmonary and extrapulmonary cases. The diagnosis depended on the confirmation of the relevant specialist doctor and patients registered as Active TB in the Basrah TB centre and included in the study if they fulfilled the inclusion criteria.

The diagnosis of DM was made according to international diagnostic criteria.[22] The tests were conducted routinely in the general laboratory unit by spectrophotometric biochemical analysis of all newly diagnosed TB patients, and data were collected by performing

glucose tests or reviewing patient medical records. The diagnostic criteria included:

- A fasting plasma glucose (FPG) level of ≥126 mg/dL (7.0 mmol/L).
- Glycated haemoglobin (HbA1c) levels of ≥6.5%.
- A random plasma glucose level of ≥200 mg/dL (11.1 mmol/L).
- Documentation of a prior diagnosis of DM in the medical history, supported by laboratory evidence

We collected data through direct interviews with patients or, when necessary, by reviewing patient records to ensure a comprehensive understanding of patient demographics, clinical features, and risk factors. A standardised data collection form was used at the Basrah TB centre to capture the following variables:

1. Demographic Data: Gender, Age, Place of residence (urban vs. rural).
2. TB-Specific Variables: Type of TB (pulmonary or extrapulmonary), classified into low, moderate, and high based on clinical and laboratory findings.[23,24]
3. DM-Specific Variables: Presence or absence of DM based on diagnostic criteria.
4. Socioeconomic and Risk Factors: Socioeconomic status is based on income and education levels.[25] Smoking status (current smoker or non-smoker) and comorbidities, including hypertension.

Statistical analysis: Using SPSS to identify associations and predictors, with results reported as frequencies, odds ratios, and significance levels, to ensure robust insights into the TB-DM relationship. Chi-square tests were applied to assess associations between categorical variables. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to evaluate the strength of associations between risk factors (e.g., smoking, hypertension). Multivariate analysis for associated factors with the prevalence of DM among patients with TB was performed to adjust for potential confounders and identify independent predictors of DM in TB patients. Statistical significance was set at p-value <0.05.

RESULTS

We enrolled and analysed 249 patients newly diagnosed with TB; 48 of them had DM, with a prevalence rate of 19.28%. TB Patients with DM have a higher mean age (55.83±16.34 years) than patients without DM (33.04±15.77 years), and the result was statistically significant p-value <0.001; most of the DM-TB patients were males 33 (68.8%), though the rate of male in non-diabetic patients was slightly higher than the females 54.2% vs 45.8% respectively.

Extrapulmonary TB was found in 15 out of 48 patients (31.3%) in the TB-DM group and 98 out of 201(48.8 %) patients with TB without DM; this result was statistically significant with a p-value of 0.002.

Positive TB patients were found in 83 out

Table 1 | Statistical analysis for factors associated with diabetes prevalence among newly diagnosed adult TB patients.

Variable	TB only (%) (n=201)	DM+TB (%) (n=48)	P value
Age group			<0.001*
<50 years	161(80.1)	17(35.4)	
≥ 50 years	40(19.9)	31(64.6)	
Gender			0.047*
Male	109 (54.2)	33 (68.8)	
Female	92(45.8)	15 (31.3)	
TB type			0.002*
Pulmonary	103(51.2)	33(68.8)	
Extra pulmonary	98 (48.8)	15(31.3)	
Positivity rate(infectivity)			0.025*
Positive	83(41.3)	28(58.3)	
Negative	118(58.7)	20(41.7)	
TB severity			<0.001*
Low	91(45.3)	13(27.1)	
Moderate	102(50.7)	24(50)	
High	8(4%)	11(22.9)	
Socioeconomic status			0.018*
Low	45(22.4)	4(8.3)	
Medium	156(77.6)	44(91.7)	
Residency			0.39
Urban	132(65.7)	30 (62.5)	
Rural	69 (34.3)	18 (37.5)	
Hypertension			<0.001*
No	170 (84.6)	21(43.6)	
Yes	31 (15.4)	27(56.3)	
Smoking status			0.27
Smokers	96(47.8)	20(41.7)	
Non-smoker	105(52.2)	28(58.3)	

Table 2 | Multivariate analysis for associated factors with the prevalence DM among patients with TB.

Category	Crude POR*	95% CI**	Adjusted POR	95% CI
Sociodemographic, behavioural and clinical characteristics:				
Gender: Male versus Female	0.53	0.275-1.053	1.658	0.95-2.89
Age(years): ≥50 versus <50	7.34	3.698-14.566	9.88	4.29-25.216
Site of TB: PTB versus EPTB	0.478	0.244-0.934	1.828	1.047-3.191
TB test: Positive versus Negative	0.502	0.265-0.952	1.741	1.038-2.918
Place of residence: Urban versus Rural	1.148	0.598-2.205	0.895	0.531-1.510
Smoking status: Yes versus No	1.280	0.677-2.420	1.048	0.929-1.183
Socioeconomic status: Medium versus low	3.173	1.082-9.306	1.177	1.053-1.316
Associated diseases: Yes versus No	7.051	3.548-14.012	1.665	1.303-2.128

of 201 patients who have TB without DM (41.3%) and 28 out of 48 patients with DM (58.3%); this result was statistically significant with a p-value of 0.025. Similarly, high severity was found in 8/201 patients without DM (4%) compared to 11/48 patients with DM (22.9%), with a p-value of <0.001.

Regarding positivity rate, there was a significant relationship between positivity rates (infectivity of the patient) in DM-TB comorbidity with a p-value of 0.025. Regarding the severity of TB, higher severity of TB was seen in patients with DM compared to non-diabetic patients with a p-value of <0.001. Regarding socioeconomic status, a significant relationship was found between medium socioeconomic status and the diagnosis of DM, with a p-value of 0.018.

A statistically significant association was found between medium socioeconomic status and having TB with DM compared to those without, with 44/48 (91.7%) and 156/201 (77.6%) cases, respectively, and a p-value of 0.018. There was a higher percentage of HT seen in patients with DM-TB compared to non-DM patients with a p-value of <0.001. For other demographic features, see **Table 1**.

Table 2 shows risk estimation (adjusted prevalence of odd ratio (POR), males have an adjusted POR of 1.658 (greater than 1), those aged ≥50 years have an adjusted POR of 9.88, and site of TB pulmonary type have an adjusted POR of 1.828. An odds ratio of 1 indicates no association between TB and diabetes, while an odds ratio greater than 1 suggests that diabetes is associated with higher odds of TB. An odds ratio <1 indicates that DM is associated with lower odds of TB.

DISCUSSION

In this study, the prevalence of DM is 19.28%, a rate that is significantly higher compared to a previous study conducted in Baghdad, which revealed a DM prevalence among TB patients of 8.6%.[12] This finding is consistent with many international studies that emphasise the increasing comorbidity of DM and TB.[4,10] This indicates a significant health challenge in regions with high TB incidence. Basrah shares many of the risk factors seen in these regions, such as limited healthcare resources, high TB burden, and a rising prevalence of DM.[4] The elevated DM prevalence in Basrah could be attributed to common local factors such as regional lifestyle, dietary habits, healthcare access differences, and delayed diagnosis. Furthermore, Basrah's socioeconomic and environmental conditions may contribute to the higher prevalence of both diseases, emphasising the need for localised public health strategies. This study showed a significant association between older age and DM among TB patients, with those aged ≥50 years having almost 10 times the odds of developing DM compared to younger patients; this emphasises the importance of targeted screening for older adults to DM in TB care programs.

Regarding gender, males constituted 68.8% of TB patients with DM in this study. Men may face a higher risk due to differences

in occupational exposure, health-seeking behaviours, and lifestyle factors such as smoking and alcohol use, as well as biological differences in immune responses to TB.[11,26] A strong association was identified between pulmonary TB and DM, with 68.8% of DM-TB patients presenting with pulmonary TB.

Diabetic patients were more likely to develop pulmonary TB; this supports prior evidence suggesting that hyperglycemia impairs macrophage and neutrophil function and cytokine responses, which are critical for containing TB infections.[15,20] Pulmonary TB predominance may also reflect the higher transmissibility of respiratory TB in community settings, particularly when amplified by the metabolic effects of DM. This study found that 22.9% of severe TB cases were associated with DM. Patients with DM often present with more severe forms of TB due to delayed diagnosis, poor glycemic control, and reduced immune defence; this finding is consistent with studies indicating that poorly controlled DM exacerbates TB outcomes due to delayed bacterial clearance and increased treatment failure rates. The co-occurrence of these conditions not only increases disease severity but also prolongs treatment duration and heightens the risk of complications such as multidrug-resistant TB (MDR-TB).[8,12]

Interestingly, 91.7% of DM-TB patients in this study came from middle socioeconomic backgrounds, challenging the conventional association of lower socioeconomic status with higher DM prevalence. Lifestyle changes associated with urbanisation and an increasingly unstable lifestyle may also explain the high prevalence among this demographic. The burden of DM is shifting towards middle-income groups due to dietary transitions and reduced physical activity.[4]

Hypertension was present in 56.3% of DM patients in this study, consistent with the global recognition of hypertension as a frequent comorbidity in DM. The strong association between DM and hypertension highlights the clustering of metabolic syndromes in TB patients. This is consistent with global data showing that DM and hypertension frequently co-occur in TB patients due to shared risk factors such as Obesity and chronic inflammation.[27]

This study found no significant association between smoking and DM among TB patients. The lack of association in this study may be attributed to sample-specific characteristics or unmeasured confounders, such as the intensity of smoking, concurrent use of other substances or the denial of smoking.[9]

CONCLUSION

Age of 50 years and younger, male gender, site of TB, positive sputum for TB, severity of TB, socioeconomic status, and hypertension have statistically significant associations with DM-TB comorbidity. Multivariate analysis has shown that age, gender, site of TB and positive TB tests have a strong association with DM. To ensure the provision of optimal care for patients with TB–DM, TB patients should be screened for DM immediately after the diagnosis of TB, and they should be monitored periodically during TB treatment. To reduce the dual burden of TB–DM comorbidity, strategic planning for integrated TB–DM services through dual diagnosis should be initiated.

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Abbreviations list: Acid-fast bacillus (AFB), Computed Tomography (CT), Confidence Intervals (CIs), Diabetes mellitus (DM), International Diabetes Federation (IDF), Low- and middle-income countries (LMICs), Magnetic Resonance Image (MRI), Multidrug-resistant TB (MDR-TB), Mycobacterium tuberculosis (MTB), Odds Ratios (ORs), Polymerase Chain reaction (PCR), Statistical Package for Social Sciences (SPSS), Tuberculosis (TB), World Health Organization (WHO).

Conflict of interest: Authors have nothing to declare.

Funding: Nothing apart from personal fund.