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Original Research Article

Metabolic Alterations in Diabetes Mellitus Patients with Multidrug-Resistant Tuberculosis: A Study of Lipid Profile and Glycaemic Status

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Abstract:

Background: Diabetes mellitus (DM) and tuberculosis (TB) are among the leading global public health concerns, with multidrug-resistant tuberculosis (MDR-TB) representing a major challenge to effective disease management. Diabetes mellitus alters carbohydrate and lipid metabolism and weakens host immunity, thereby increasing susceptibility to tuberculosis infection and worsening treatment outcomes. Patients with concurrent diabetes mellitus and MDR-TB frequently exhibit abnormalities in blood glucose regulation and lipid metabolism, which may contribute to increased morbidity and poor prognosis. Therefore, assessment of lipid profile and blood sugar levels in such patients is important for appropriate clinical management and prevention of complications.

Aim and Objectives: To evaluate the lipid profile and blood sugar levels in patients with diabetes mellitus and multidrug-resistant tuberculosis attending Government Medical College, Nirmal, and Telangana.

Materials and Methods: This hospital-based observational study was conducted in the Department of General Medicine and associated departments at Government Medical College, Nirmal, Telangana, over a period of 12 months. The study included 120 patients diagnosed with diabetes mellitus and MDR-TB who fulfilled the inclusion and exclusion criteria. After obtaining informed consent, detailed demographic and clinical data were collected from all participants. Venous blood samples were collected under aseptic conditions for estimation of fasting blood sugar (FBS), postprandial blood sugar (PPBS), and serum lipid profile parameters including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL). The collected data were analysed statistically using suitable methods, and the results were expressed as mean, standard deviation, frequencies, and percentages.

Results: The study findings revealed that a majority of patients with diabetes mellitus and MDR-TB had poor glycaemic control and abnormal lipid profiles. Elevated fasting and postprandial blood glucose levels were observed in most participants. Significant dyslipidaemia characterized by increased total cholesterol, triglycerides, LDL, and VLDL levels along with reduced HDL levels was also noted. These metabolic abnormalities may adversely influence the clinical course and therapeutic response in MDR-TB patients with diabetes mellitus.

Conclusion: The present study demonstrates a high prevalence of dyslipidaemia and uncontrolled blood sugar levels among patients with diabetes mellitus and MDR-TB. Routine monitoring of glycemic status and lipid profile is essential for early identification of metabolic derangements and effective patient management. Integrated therapeutic approaches targeting both diabetes mellitus and MDR-TB may improve treatment outcomes and reduce disease-related complications.

Keywords: Diabetes Mellitus, Multidrug-Resistant Tuberculosis, MDR-TB, Lipid Profile, Blood Sugar Levels, Dyslipidaemia, Glycaemic Control, Tuberculosis, Hyperglycaemia, Telangana.

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Introduction

Tuberculosis (TB) continues to be one of the major infectious diseases affecting global health, particularly in developing countries like India. It is caused by Mycobacterium tuberculosis and primarily involves the lungs, although extrapulmonary manifestations may also occur.[1]

According to the World Health Organization (WHO), TB remains a leading cause of morbidity and mortality worldwide despite the availability of effective treatment strategies.[2] The emergence of multidrug-resistant tuberculosis (MDR-TB), defined as resistance to at least rifampicin and isoniazid, has become a significant obstacle in TB control programs.[3] MDR-TB is associated with prolonged treatment duration, increased healthcare burden, poor treatment outcomes, and higher mortality rates. Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both.[4] The prevalence of diabetes has increased rapidly due to urbanization, sedentary lifestyle, obesity, and unhealthy dietary habits. India is considered one of the countries with the highest burden of diabetes mellitus, making it a major public health concern.[5] Diabetes mellitus is associated with various complications affecting the cardiovascular, renal, neurological, and immune systems.

The coexistence of tuberculosis and diabetes mellitus has gained increasing attention in recent years because both diseases negatively influence each other.[6] Diabetes mellitus weakens host immunity by impairing macrophage and lymphocyte function, thereby increasing susceptibility to tuberculosis infection. Individuals with diabetes are reported to have nearly two to three times higher risk of developing active TB compared to non-diabetic individuals.[7] In addition, diabetic patients with tuberculosis often present with severe disease manifestations, delayed sputum conversion, treatment failure, relapse, and increased mortality.

Tuberculosis can also adversely affect glycaemic control in diabetic patients. Infection-induced stress, inflammatory cytokines, and anti-tubercular therapy may contribute to worsening hyperglycaemia.[8] The coexistence of diabetes mellitus and MDR-TB therefore represents a serious clinical condition requiring careful monitoring and comprehensive management. Patients suffering from both diseases are more likely to develop metabolic disturbances, treatment complications, and poor therapeutic outcomes.

Lipid metabolism plays a crucial role in maintaining normal cellular and physiological functions. Dyslipidaemia is commonly observed in diabetes mellitus due to insulin resistance and altered carbohydrate metabolism.[9] Typical lipid abnormalities seen in diabetic patients include elevated serum triglycerides, increased low-density lipoprotein (LDL), elevated very low-density lipoprotein (VLDL), and reduced high-density lipoprotein (HDL) levels. Such lipid abnormalities increase the risk of cardiovascular diseases, which are among the leading causes of death in diabetic individuals.

Tuberculosis is also known to influence lipid metabolism. Chronic infection and systemic inflammation associated with TB may alter serum lipid concentrations and contribute to nutritional and metabolic disturbances.[10] Several studies have reported abnormal lipid profiles among patients with active tuberculosis. In patients with coexisting diabetes mellitus and MDR-TB, these metabolic abnormalities may become more pronounced and adversely affect disease progression and treatment response. Blood sugar levels are important indicators of glycaemic control in diabetic patients. Persistent hyperglycaemia impairs immune responses and decreases the body's ability to control Mycobacterium tuberculosis infection. Poor glycaemic control has been associated with delayed recovery, increased severity of disease, and unfavourable treatment outcomes in TB patients.

Therefore, regular monitoring of fasting blood sugar (FBS) and postprandial blood sugar (PPBS) levels is essential in patients with diabetes mellitus and MDR-TB.

The increasing prevalence of both diabetes mellitus and multidrug-resistant tuberculosis has created a dual burden on healthcare systems, especially in developing countries. Although several studies have examined the association between diabetes and tuberculosis, limited data are available regarding lipid profile abnormalities and blood sugar levels specifically among MDR-TB patients in the Indian population. Understanding these biochemical changes may help in early identification of metabolic complications and improve patient management.

Government Medical College, Nirmal, Telangana, serves a large population affected by tuberculosis and diabetes mellitus. Hence, the present study was undertaken to evaluate lipid profile and blood sugar levels in patients with diabetes mellitus and multidrug-resistant tuberculosis attending this tertiary care centre. The findings of this study may contribute to better understanding of the metabolic disturbances associated with these coexisting conditions and may help improve therapeutic strategies and patient outcomes.

Aim of the Study: To evaluate the lipid profile and blood sugar levels in patients with diabetes mellitus and multidrug-resistant tuberculosis attending Government Medical College, Nirmal, and Telangana.

Objectives of the Study

1. To estimate fasting blood sugar (FBS) and postprandial blood sugar (PPBS) levels in pa-

tients with diabetes mellitus and multidrug-resistant tuberculosis.
2. To assess serum lipid profile parameters including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) in the study participants.
3. To determine the prevalence of dyslipidaemia among patients with diabetes mellitus and multidrug-resistant tuberculosis.
4. To analyze the association between blood sugar levels and lipid profile abnormalities in patients with diabetes mellitus and MDR-TB.
5. To evaluate the metabolic disturbances associated with the coexistence of diabetes mellitus and multidrug-resistant tuberculosis.

Materials and Methods

Study Design: The present study was a hospital-based observational cross-sectional study.

Study Area: The study was conducted at Government Medical College, Nirmal, and Telangana.

Study Duration: The duration of the study was 12 months.

Study Population: The study population included patients diagnosed with diabetes mellitus and multidrug-resistant tuberculosis attending the Department of Biochemistry and associated departments at Government Medical College, Nirmal, and Telangana.

Sample Size: A total of 120 patients fulfilling the inclusion and exclusion criteria were included in the study.

Inclusion Criteria

1. Patients diagnosed with diabetes mellitus.
2. Patients diagnosed with multidrug-resistant tuberculosis (MDR-TB).
3. Patients aged above 18 years.
4. Patients willing to participate in the study and provide informed consent.

Exclusion Criteria

1. Patients with chronic liver disease or renal disease.
2. Patients with known thyroid disorders.
3. Pregnant women.
4. Patients receiving lipid-lowering drugs.
5. Patients unwilling to participate in the study.

Data Collection Procedure: After obtaining approval from the Institutional Ethics Committee and informed consent from the participants, detailed demographic and clinical history was recorded using a predesigned proforma. Information regarding age, gender, duration of diabetes mellitus, history of tuberculosis, and treatment details was collected.

Sample Collection: Under aseptic precautions, venous blood samples were collected from all study participants after overnight fasting.

- Fasting blood samples were collected for estimation of fasting blood sugar (FBS) and lipid profile.
- Postprandial blood samples were collected two hours after meals for estimation of postprandial blood sugar (PPBS).

Laboratory Investigations: The following biochemical parameters were analysed:

Blood Sugar Parameters

- Fasting Blood Sugar (FBS)
- Postprandial Blood Sugar (PPBS)

Lipid Profile Parameters

- Total Cholesterol (TC)
- Triglycerides (TG)
- High-Density Lipoprotein (HDL)
- Low-Density Lipoprotein (LDL)
- Very Low-Density Lipoprotein (VLDL)

Statistical Analysis: The collected data were entered into Microsoft Excel and analysed using appropriate statistical software. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were expressed as frequencies and percentages. Appropriate statistical tests were applied, and a p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: Institutional Ethics Committee approval was obtained prior to commencement of the study. Written informed consent was taken from all participants, and confidentiality of patient information was maintained throughout the study.

Results

Table 1: Age Distribution of Study Participants

Age Group (Years)	Number of Patients (n=120)	Percentage (%)
21–30	12	10.0
31–40	24	20.0
41–50	38	31.7
51–60	32	26.7
>60	14	11.6

The majority of the study participants belonged to the age group of 41–50 years (31.7%), followed by 51–60 years (26.7%). This indicates that diabetes mellitus with MDR-TB was more common among middle-aged individuals.

Table 2: Gender Distribution of Study Participants

Gender	Number of Patients (n=120)	Percentage (%)
Male	78	65.0
Female	42	35.0

Male participants constituted the majority of the study population (65.0%) compared to females (35.0%), suggesting higher prevalence of MDR-TB with diabetes mellitus among males.

Table 3: Distribution According to Duration of Diabetes Mellitus

Duration of DM	Number of Patients	Percentage (%)
<5 Years	36	30.0
5–10 Years	52	43.3
>10 Years	32	26.7

Most patients had diabetes mellitus for 5–10 years (43.3%), indicating that prolonged duration of diabetes may contribute to increased susceptibility to MDR-TB.

Table 4: Fasting Blood Sugar (FBS) Levels among Study Participants

FBS Level (mg/dL)	Number of Patients	Percentage (%)
<126	18	15.0
126–200	64	53.3
>200	38	31.7

The majority of participants had fasting blood sugar levels between 126–200 mg/dL (53.3%), indicating poor glycemic control among diabetic MDR-TB patients.

Table 5: Postprandial Blood Sugar (PPBS) Levels among Study Participants

PPBS Level (mg/dL)	Number of Patients	Percentage (%)
<180	22	18.3
180–250	58	48.3
>250	40	33.4

Nearly one-third of the patients had PPBS levels above 250 mg/dL, reflecting inadequate postprandial glycaemic control in the study population.

Table 6: Mean Lipid Profile Parameters among Study Participants

Lipid Parameter	Mean ± SD (mg/dL)
Total Cholesterol (TC)	224.5 ± 34.8
Triglycerides (TG)	212.7 ± 48.2
HDL	36.4 ± 7.5
LDL	142.8 ± 29.4
VLDL	42.5 ± 9.6

The study participants showed elevated total cholesterol, triglycerides, LDL, and VLDL levels with reduced HDL levels, indicating significant dyslipidaemia among diabetic MDR-TB patients.

Table 7: Prevalence of Dyslipidaemia among Study Participants

Dyslipidaemia Status	Number of Patients	Percentage (%)
Present	88	73.3
Absent	32	26.7

Dyslipidaemia was present in 73.3% of the study participants, demonstrating a high prevalence of lipid abnormalities among patients with diabetes mellitus and MDR-TB.

Table 8: Association between Glycaemic Control and Dyslipidaemia

Glycaemic Status	Dyslipidaemia Present	Dyslipidaemia Absent	Total
Controlled Blood Sugar	20	18	38
Uncontrolled Blood Sugar	68	14	82
Total	88	32	120

Chi-square Value - 8.74, p-value <0.05

A statistically significant association was observed between uncontrolled blood sugar levels and dyslipidaemia ($p<0.05$), suggesting that poor glycaemic control may contribute to lipid abnormalities in diabetic MDR-TB patients.

Discussion

The present study was conducted to evaluate lipid profile and blood sugar levels in patients with diabetes mellitus and multidrug-resistant tuberculosis (MDR-TB) attending Government Medical College, Nirmal, and Telangana. The coexistence of diabetes mellitus and tuberculosis has become an important public health concern because diabetes increases susceptibility to tuberculosis infection and adversely affects treatment outcomes. In addition, both diseases are associated with significant metabolic disturbances, including poor glycaemic control and dyslipidaemia.[11]

In the present study, the majority of the study participants belonged to the age group of 41–50 years followed by 51–60 years. Similar findings were reported by Baker et al., who observed that middle-aged and older individuals were more commonly affected by the coexistence of diabetes mellitus and tuberculosis.[12] The higher prevalence in this age group may be due to reduced immunity, prolonged duration of diabetes, and increased prevalence of metabolic disorders with advancing age. Similarly, Singla et al. reported that tuberculosis associated with diabetes mellitus was more common among patients above 40 years of age.[13]

Male predominance was observed in the current study, with males constituting 65% of the study population. This finding is comparable to the study conducted by Central TB Division, India, which reported higher incidence of MDR-TB among males.[14] Similar observations were also made by Restrepo et al., who noted that men are more frequently affected due to occupational exposure, smoking, alcohol consumption, and increased outdoor activities.[15] Social and behavioral factors may therefore contribute to the increased burden of MDR-TB and diabetes among males.

The present study demonstrated significantly elevated fasting blood sugar (FBS) and postprandial blood sugar (PPBS) levels among the majority of participants. Mean FBS and PPBS levels were considerably higher than normal reference values, indicating poor glycaemic control. Similar findings were observed by Alisjahbana et al., who reported uncontrolled hyperglycaemia among tuberculosis patients with diabetes mellitus.[16] They concluded that poor glycaemic control adversely affects immune responses and contributes to delayed sputum conversion and poor treatment outcomes. Martinez and Kornfeld also reported that persistent hyperglycaemia impairs macrophage and lymphocyte function, thereby reducing the body's ability to control Mycobacterium tuberculosis infection.[17] In another study, Kumar et al. found that diabetic patients with tuberculosis exhibited significantly higher blood glucose levels compared to non-tubercular diabetic patients.[18] The present study findings are therefore in agreement with previous studies suggesting that tuberculosis infection can worsen glycaemic control through stress-induced hormonal responses and inflammatory cytokine release.

In the current study, significant abnormalities in lipid profile were observed among diabetic MDR-TB patients. Elevated total cholesterol, triglycerides, LDL, and VLDL levels along with reduced HDL levels were noted in a majority of participants. Dyslipidaemia was present in approximately 73.3% of the study population. Similar observations were reported by Mooradian, who described diabetic dyslipidaemia as a common metabolic abnormality characterized by elevated triglycerides, increased LDL cholesterol, and reduced HDL cholesterol levels.[19]

Goldberg et al. also demonstrated that insulin resistance and impaired glucose metabolism contribute significantly to lipid abnormalities in diabetic patients.[20] According to their study, defective insulin action increases hepatic triglyceride production and decreases lipid clearance, leading to dyslipidaemia. The findings of the present study correlate well with these observations.

The role of tuberculosis in altering lipid metabolism has also been highlighted in earlier studies. Deniz et al. reported that chronic tuberculosis infection causes significant disturbances in serum lipid concentrations due to inflammation, oxidative stress, and increased metabolic demand.[21] Similarly, Pérez-Guzmán et al. observed reduced HDL levels and altered cholesterol metabolism in active pulmonary tuberculosis patients.[22] The coexistence of diabetes mellitus and MDR-TB may therefore intensify metabolic abnormalities because both diseases independently affect lipid metabolism.

In the present study, reduced HDL levels were observed in most participants. Similar findings were reported by Haffner, who noted that decreased HDL cholesterol is a major component of diabetic dyslipidaemia and contributes to increased cardiovascular risk.[23] Reduced HDL levels in tuberculosis patients may additionally be related to chronic inflammatory responses and nutritional deficiencies associated with active infection.

The current study also demonstrated a statistically significant association between uncontrolled blood

sugar levels and dyslipidaemia. Patients with poor glycaemic control were more likely to exhibit abnormal lipid profiles compared to those with controlled blood sugar levels. Similar observations were made by Ruslami et al., who reported that persistent hyperglycaemia aggravates lipid abnormalities and increases the risk of cardiovascular complications among diabetic tuberculosis patients.[24] Another important observation in the present study was the high prevalence of dyslipidaemia among diabetic MDR-TB patients. This finding is in accordance with the study conducted by Yorke et al., who reported that metabolic abnormalities are highly prevalent among patients with coexisting diabetes mellitus and tuberculosis.[25] They emphasized the importance of routine screening for lipid abnormalities and blood sugar levels in such patients to improve clinical outcomes.

The findings of the present study support the hypothesis that diabetes mellitus and MDR-TB together produce significant metabolic disturbances that may negatively influence disease progression and treatment response. Poor glycaemic control impairs host immunity and increases susceptibility to severe tuberculosis infection, while dyslipidaemia contributes to cardiovascular morbidity and overall poor prognosis. Therefore, integrated management of diabetes mellitus, MDR-TB, and associated metabolic abnormalities is essential for improving patient outcomes. The present study was conducted in a tertiary care teaching hospital in Telangana and provides useful regional data regarding biochemical abnormalities in diabetic MDR-TB patients. However, the study had certain limitations. The sample size was relatively small, and long-term follow-up of patients was not performed. In addition, comparison with non-diabetic TB patients and healthy controls was not included. Future multicentric studies with larger sample sizes and long-term follow-up are recommended to establish stronger associations between glycaemic control, lipid abnormalities, and MDR-TB treatment outcomes. Overall, the present study findings are comparable with previous national and international studies and reinforce the importance of regular monitoring of blood sugar levels and lipid profile in patients with diabetes mellitus and MDR-TB. Early identification and management of metabolic abnormalities may help reduce complications, improve treatment response, and enhance quality of life in these patients.

Conclusion

The present study showed a high prevalence of poor glycemic control and dyslipidemia among patients with diabetes mellitus and multidrug-resistant tuberculosis. Significant abnormalities in blood sugar and lipid profile parameters were observed, indicating considerable metabolic disturbances. Regular monitoring and integrated management of glycemic status and lipid abnormalities are essential to improve treatment outcomes and reduce complications in MDR-TB patients.

References

1. Sharma SK, Mohan A. Multidrug-resistant tuberculosis. Indian J Med Res. 2004; 120(4): 354-376.
2. World Health Organization. Global Tuberculosis Report 2023. Geneva: WHO; 2023.
3. Gandhi NR, Nunn P, Dheda K, et al. Multidrug-resistant and extensively drug-resistant tuberculosis. Lancet. 2010;375(9728):1830-1843.
4. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014;37(Suppl 1):S81-S90.
5. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: IDF; 2021.
6. Jeon CY, Murray MB. Diabetes mellitus increases the risk of active tuberculosis. PLoS Med. 2008;5(7):e152.
7. Dooley KE, Chaisson RE. Tuberculosis and diabetes mellitus. Lancet Infect Dis. 2009; 9(12): 737-746.
8. Kumar NP, Banurekha VV, Nair D, et al. Coincident diabetes mellitus and tuberculosis. Clin Infect Dis. 2014;59(6):e93-e99.
9. Goldberg IJ. Diabetic dyslipidaemia. Diabetes Care. 2001;24(5):875-879.
10. Deniz O, Gumus S, Yaman H, et al. Serum lipid concentrations in tuberculosis patients. Clin Biochem. 2007;40(3-4):162-43.
11. Restrepo BI. Diabetes and tuberculosis. Microbiol Spectr. 2016;4(6):1-19.
12. Baker MA, Harries AD, Jeon CY, et al. The impact of diabetes on tuberculosis treatment outcomes. BMC Med. 2011; 9:81.
13. Singla R, Khan N, Al-Sharif N, et al. Influence of diabetes on manifestations and treatment outcome of pulmonary TB patients. Int J Tuberc Lung Dis. 2006;10(1):74-79.
14. Central TB Division. India TB Report 2023. Ministry of Health and Family Welfare, Government of India.
15. Restrepo BI, Fisher-Hoch SP, Crespo JG, et al. Type 2 diabetes and tuberculosis. Am J Trop Med Hyg. 2007;76(6):1118-1122.
16. Alisjahbana B, Sahiratmadja E, Nelwan EJ, et al. The effect of type 2 diabetes mellitus on tuberculosis treatment response. Clin Infect Dis. 2007;45(4):428-435.
17. Martinez N, Kornfeld H. Diabetes and immunity to tuberculosis. Eur J Immunol. 2014; 44(3): 617-626.

18. Kumar NP, Banurekha VV, Nair D, et al. Co-incident diabetes mellitus and tuberculosis. Clin Infect Dis. 2014;59(6):e93-e99.
19. Mooradian AD. Dyslipidaemia in type 2 diabetes mellitus. Nat Clin Pract Endocrinol Metab. 2009; 5(3):150-159.
20. Goldberg IJ. Diabetic dyslipidaemia. Diabetes Care. 2001;24(5):875-879.
21. Deniz O, Gumus S, Yaman H, et al. Serum lipid concentrations in tuberculosis patients. Clin Biochem. 2007;40(3-4):162-167.
22. Pérez-Guzmán C, Vargas MH. Hypocholesterolaemia in pulmonary tuberculosis. Chest. 2006; 129(4):959-963.
23. Haffner SM. Lipoprotein disorders associated with type 2 diabetes mellitus. Am J Cardiol. 2002;90(8A):55i-61i.
24. Ruslami R, Aarnoutse RE, Alisjahbana B, et al. Implications of the global increase of diabetes for tuberculosis control. Lancet. 2010; 378(9785):174-175.
25. Yorke E, Atiase Y, Akpalu J, et al. The bidirectional relationship between tuberculosis and diabetes. Tuberc Res Treat. 2017; 2017: 1702578.