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# A Comparative Study of The Clinical and Radiological Features of Pulmonary Tuberculosis in Individuals with And Without Diabetes

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## ABSTRACT

### Background

People with diabetes are three times more likely to develop tuberculosis than those without diabetes. The clinical presentation and response to treatment in diabetic patients exhibit distinct patterns compared to non-diabetic individuals. This research focused on examining the clinical and radiological characteristics of pulmonary tuberculosis in patients with diabetes compared to those without diabetes.

### Methods

This study was conducted in the General Medicine Department at Chettinad Hospital and Research Institute in Chennai. It included two groups: diabetic patients with pulmonary tuberculosis and non-diabetic patients with the same condition. All participants provided written informed consent prior to the study.

### Results

The analysis comprised 163 participants, with 79 individuals from the diabetic cohort and 84 individuals from the non-diabetic cohort. Within diabetic group, the radiology observations were as follows: 19% exhibited cavitary lesions, 39.2% showed consolidation, and 13.9% had fibro-cavitary lesions. In contrast, the non-diabetic group presented the following radiological findings: 10.7% with cavitary lesions, 29.8% with consolidation, and 9.5% with fibro-cavitary lesions.

### Conclusion

The research indicated that the clinical manifestations of tuberculosis were largely similar between diabetics and non-diabetics. However, notable differences were observed in the radiographic presentation of tuberculosis among diabetic patients, who demonstrated a higher prevalence of cavitation and a more extensive involvement of the lower lung lobes, in contrast to the upper lobe involvement that was more frequently observed in non-diabetic patients....

**Keywords**: *Diabetes, tuberculosis, radiographic features, cavitary lesions, age-related incidence..*

## 1. INTRODUCTION

Tuberculosis (TB) and diabetes mellitus (DM) are two major global health concerns, with a well-established bidirectional relationship. TB is an infectious disease caused by *Mycobacterium tuberculosis*, primarily affecting the lungs but potentially involving other organs. It remains a leading cause of morbidity and mortality, especially in low- and middle-income

countries. Diabetes, a chronic metabolic disorder characterized by hyperglycemia, has been rapidly increasing worldwide due to lifestyle changes, obesity, and aging populations.

Diabetes significantly increases the risk of developing active TB by two to three times due to immune system impairment, including reduced macrophage function and altered cytokine responses. Poor glycemic control further predisposes individuals to severe TB manifestations, delayed sputum conversion, and higher mortality rates. Conversely, TB itself can worsen glycemic control through systemic inflammation, weight loss, and medication-induced hyperglycemia, complicating diabetes management.

The co-existence of TB and diabetes presents significant challenges in diagnosis and treatment. Diabetic patients with TB may have atypical presentations, and TB treatment can be less effective due to altered drug metabolism. Given this interaction, routine screening for TB in diabetic patients and vice versa is essential. Integrated management strategies are crucial for improving outcomes and reducing the dual burden of these diseases.

Management of tuberculosis typically involves a treatment regimen of 2+4 months, consisting of an intensive initial treatment phase lasting 2 months, followed by a continuation phase of 4 to 6 months. The primary anti-tuberculosis medications utilized are isoniazid, rifampin, pyrazinamide, and either ethambutol or streptomycin. Although some studies have investigated the association between diabetes, TB drug resistance, and treatment outcomes, it is increasingly acknowledged that addressing both tuberculosis and diabetes is vital for public health, particularly in low- and middle-income countries where these conditions frequently coexist

## 2. METHODS

This study was done from January 2023 to June 2024, involving patients with pulmonary tuberculosis who visited both the outpatient and inpatient departments of internal and pulmonary medicine. Data was meticulously gathered using a pre-structured case record form, which ensured a thorough history and detailed clinical examination were documented.

The diagnosis of pulmonary tuberculosis was established through a comprehensive clinical history, sputum analysis for AFB, chest radiography, and the CB--NAAT. The diagnosis of diabetes mellitus was made in accordance with the criteria set forth by the National Diabetes Data Group and the World Health Organization (WHO), which encompass specific diagnostic parameters.

The primary outcome variables analyzed in this study included hemoglobin levels, neutrophil counts, total leukocyte count, lymphocyte counts, fasting blood sugar, postprandial blood sugar, HbA1c, and various lung characteristics such as lesion types, lung field involvement, and radiological features. Additionally, demographic factors (age and sex), medical history, presenting symptoms, physical examination findings, vital signs, and respiratory system assessment results were considered.

Patients were categorized into two groups—diabetic and non-diabetic—serving as the key explanatory variables. The normality of quantitative data within each group was assessed using histograms, Q-Q plots, and the Shapiro-Wilk test, where a p-value above 0.05 indicated a normal distribution. Mean values were compared to examine the relationship between categorical explanatory variables and quantitative outcomes.

For statistical analysis, an independent sample t-test was used for normally distributed variables, while the Mann-Whitney U test was applied to non-normally distributed data. Associations between categorical variables and outcomes were assessed using cross-tabulation and percentage comparisons. The odds ratio, along with a 95% confidence interval (CI), was calculated, and statistical significance was determined using the Chi-square test.

## 3. RESULTS

The final analysis included a total of 163 subjects, comprising 79 individuals with diabetes and 84 without diabetes. The mean age of the diabetic group was 55.76 ± 12.

In terms of gender distribution, among the 79 diabetic participants, 25 (31.65%) were female, and 54 (68.35%) were male. In the non-diabetic group of 84 participants, 27 (32.14%) were female, and 57 (67.86%) were male. The gender distribution difference between the two groups was insignificant.

Regarding presenting complaints, in the diabetic group, 67 (84.81%) participants reported a cough, 60 (75.95%) had a fever, 25 (31.65%) experienced dyspnea, 27 (34.18%) had anorexia, 32 (40.51%) reported weight loss, 4 (5.06%) had hemoptysis, 5 (6.33%) experienced chest pain, and 10 (12.66%) had night sweats. In the non-diabetic group, 72 (85.71%) participants had a cough, 69 (82.14%) had a fever, 34 (40.48%) experienced dyspnea, 34 (40.48%) had anorexia, 38 (45.2%) reported weight loss, 7 (8.33%) had hemoptysis, 7 (8.33%) experienced chest pain, and 12 (14.29%) had night sweats. The differences in the proportions of these symptoms between the two groups were not significant. (Fig.1)

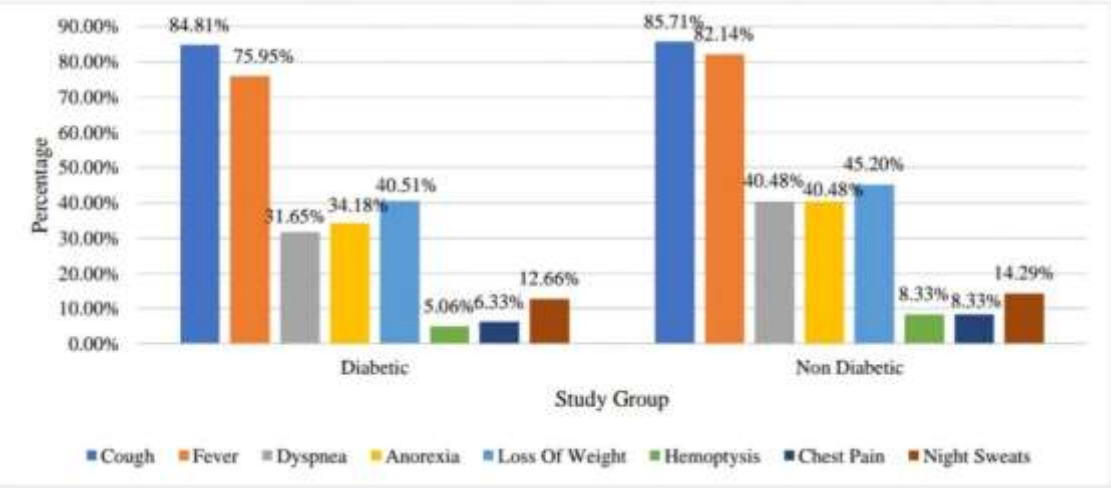


**Figure 1 : Clustered bar chart for comparison of presenting complaints between the study group**

Regarding past medical history, in the diabetic group, 6 (7.6%) had hypertension, 6 (7.6%) had a history of ischemic heart disease, 17 (21.5%) had smoking, and none with family history of pulmonary tuberculosis (PTB). In the non-diabetic group, 6 (7.1%) participants had a history of hypertension, 1 (1.2%) had a history of ischemic heart disease, 14 (16.7%) had a history of smoking, and 2 (2.4%) had a family history of PTB. The differences in these past medical histories between the groups were not significant.

In terms of general physical examination findings, in the diabetic group, 3 (3.8%) participants had pallor, 5 (6.3%) had clubbing, and 2 (2.53%) had edema. In the non-diabetic group, 1 (1.2%) participant had pallor, and 1 (1.2%) had clubbing. None of the participants in either group showed signs of icterus, cyanosis, or lymphadenopathy. The differences in general physical examination findings between the two groups were not statistically significant (P Value > 0.05).

The mean pulse rate was 82.49 ± 11.76 per minute in the diabetic group and 81.07 ± 11.29 per minute in the non-diabetic group. The mean systolic blood pressure was 123.96 ± 20.49 mmHg in the diabetic group, compared to 121.43 ± 21.63 mmHg in the non-diabetic group. The mean diastolic blood pressure was 78.61 ± 10.47 mmHg in the diabetic group and 76.31 ± 11.49 mmHg in the non-diabetic group. Results showed non significant.

The median respiratory rate was examined and noted 18.00 cycles per minute (range 16.00 to 18.00) in the diabetic group, while it was noted 16.00 cycles per minute (range 16.00 to 18.00) in the non-diabetic group. The difference in median respiratory rate between the two groups was not statistically significant (P Value > 0.05).

In the respiratory system examination, 20 (25.3%) participants in the diabetic group had fibrosis, 43 (54.4%) had cavitary lesions, 31 (39.24%) had consolidation, 2 (2.5%) had pleural effusion, and 9 (11.39%) had other findings. In the non-diabetic group, 38 (43.2%) participants had fibrosis, 23 (27.4%) had cavitary lesions, 25 (29.8%) had consolidation, 2 (2.4%) had pleural effusion, and 8 (9.55%) had other findings. Results showed significant(Fig.2)

| Respiratory system examinations | Study Group | | Chi square | P value |
|---|---|---|---|---|
| | Diabetic (n=79) | Non-Diabetic (n=84) | | |
| Fibrosis | 20 (25.3%) | 38 (43.2%) | 7.049 | 0.008 |
| Cavitary | 43 (54.4%) | 23 (27.4%) | 12.362 | <0.001 |
| Consolidation | 31 (39.24%) | 25 (29.8%) | 0.887 | 0.346 |
| Pl. Effusion | 2 (2.5%) | 2 (2.4%) | 0.004 | 0.950 |
| Others | 9 (11.39%) | 8 (9.5%) | 0.765 | 0.382 |

**Figure 2: Respiratory system examinations**

The mean hemoglobin level was 13.69 ± 2.31 g/dl in the diabetic group and 13.46 ± 2.12 g/dl in non-diabetic group. The mean neutrophil count was 72.21 ± 14.03 in the diabetic group and 71.95 ± 12.49 in the non-diabetic group. The differences in mean hemoglobin levels and neutrophil counts between the two groups were not statistically significant (P Value > 0.05).

The median total leukocyte count was 9.0 (range 7.68 to 11.6) in the diabetic group and 9.0 (range 7.25 to 10.0) in non-diabetic group. Median lymphocyte count was 34.5 (range 28.5 to 39.2) in diabetic group and 36.0 (range 30.2 to 39.2) in non-diabetic groupThe median fasting blood sugar levels were 230 mg/dL (range 199–278) in the diabetic group and 106.0 mg/dL (range 93.3–113.8) in the non-diabetic group. For postprandial blood sugar, the median levels were 312 mg/dL (range 256–355) in the diabetic group and 139 mg/dL (range 126.0–160.0) in non-diabetics. The median HbA1c level was 9.7 (range 8.3–12.4) in the diabetic group compared to 5.4 (range 5.2–5.8) in the non-diabetic group. While differences in total leukocyte and lymphocyte counts between the groups were not statistically significant ($P > 0.05$), significant differences were observed in fasting blood sugar, postprandial blood sugar, and HbA1c levels ($P < 0.05$).

Regarding the location of the lung lesion, in the diabetic group, 34 (43.0%) participants had bilateral lesions, 22 (28.8%) had left-sided lesions, 2 (2.5%) had normal findings, 21 (26.6%) had right-sided lesions, and none had upper lobe lesions. In the non-diabetic group, 25 (29.8%) participants had bilateral lesions, 22 (26.2%) had left-sided lesions, 15 (17.9%) had normal findings, 21 (25.0%) had right-sided lesions, and 1 (1.2%) had an upper lobe lesion.

In terms of lung field involvement, 16 (20.3%) participants in the diabetic group had lower lobe involvement, 1 (1.3%) had middle lobe involvement, 35 (44.3%) had multilobar involvement, 2 (2.5%) had normal findings, and 25 (31.6%) had upper lobe involvement. In the non-diabetic group, 11 (13.1%) participants had lower lobe involvement, 3 (3.6%) had middle lobe involvement, 12 (14.3%) had multilobar involvement, 15 (17.9%) had normal findings, 1 (1.2%) had pleural effusion, and 42 (50%) had upper lobe involvement.(Fig.3)

Finally, the radiological findings showed that among the entire study population, 24 (14.7%) participants had cavitary lesions, 54 (34.4%) had consolidation, 19 (11.7%) had fibrocavitatory lesions, 30 (18.4%) had fibrosis, 16 (9.8%) had normal findings, and 18 (11.0%) had other findings. Specifically, in the diabetic group, 15 (19%) participants had cavitary lesions, 31 (39.2%) had consolidation, 11 (13.9%) had fibrocavitatory lesions, 9 (11.4%) had fibrosis, 2 (2.5%) had normal findings, and 11 (13.9%) had other findings. In the non-diabetic group, 9 (10.7%) participants had cavitary lesions, 25 (29.8%) had consolidation, 8 (9.5%) had fibrocavitatory lesions, 21 (25%) had fibrosis, 14 (16.7%) had normal findings, and 7 (8.3%) had other findings. The differences in radiological appearances between the diabetic and non-diabetics were significant (Fig.3)

| Chest x-ray | Study Group | | Chi square | P value |
|---|---|---|---|---|
| | Diabetic (n=79) | Non-Diabetic (n=84) | | |
| **Side of Lesion** | | | | |
| Bilateral | 34 (43.0%) | 25 (29.8%) | * | * |
| Left | 22 (28.8%) | 22 (26.2%) | | |
| Normal | 2 (2.5%) | 15 (17.9%) | | |
| Right | 21 (26.6%) | 21 (25.0%) | | |
| Upper | 0 (0%) | 1 (1.2%) | | |
| **Lung Fields** | | | | |
| lower | 16 (20.3%) | 11 (13.1%) | * | * |
| Middle | 1 (1.3%) | 3 (3.6%) | | |
| Multilobar | 35 (44.3%) | 12 (14.3%) | | |
| Normal | 2 (2.5%) | 15 (17.9%) | | |
| P.ef | 0 (0%) | 1 (1.2%) | | |
| Upper | 25 (31.6%) | 42 (50%) | | |

**No statistical test was applied due to 0-subjects in one of the cells.*

**Figure 3: Chest X-ray Findings**

## 4. DISCUSSION

Diabetic patients are at an increased risk for tuberculosis (TB) infection due to impaired leukocyte function and diminished serum bactericidal activity. Diabetics face a threefold higher risk of developing TB. This heightened susceptibility is linked to various factors, including altered macrophage function, tissue changes due to glycosylation, and reduced bronchial reactivity and dilation. TB not only exacerbates glucose intolerance but also disrupts glycemic control in diabetics. The coexistence of diabetes and TB creates a complex interplay where each condition adversely affects the other. Diabetes

influences the clinical presentation, radiographic findings, diagnosis, management, and treatment outcomes of TB. Both diseases are emerging as co-epidemics, with TB already prevalent in India and diabetes increasing due to modern lifestyle changes. Diabetics experience more frequent cases of active TB and reactivation of latent infections, leading to higher TB incidence despite the implementation of directly observed therapy. Diabetes not only alters the clinical and radiological aspects of TB but also leads to poor treatment adherence and outcomes, primarily due to drug interactions that cause adverse reactions. Understanding the differences in disease presentation, sputum conversion, and treatment outcomes in diabetic patients will enhance the management of both conditions.

Key outcome variables include hemoglobin levels, neutrophils, total leukocyte count, lymphocytes, fasting and postprandial blood sugar, HbA1c, lesion location, lung fields, and radiological appearance. Relevant study variables encompass age, gender, past medical history, presenting symptoms, physical examination findings, vital signs, and respiratory system evaluations, with the study group (diabetic vs. Non-diabetic) serving as the explanatory variable.

Gender distribution showed that 31.65% of diabetic participants were female and 68.35% were male, while 32.14% of non-diabetic participants were female and 67.86% were male.

Among diabetic participants, 84.81% reported a cough, 75.95% had a fever, 31.65% experienced dyspnea, 34.18% had anorexia, 40.51% noted weight loss, 5.06% had hemoptysis, 6.33% reported chest pain, and 12.66% experienced night sweats. In the non-diabetic group, 85.71% had a cough, 82.14% had a fever, 40.48% experienced dyspnea, 40.48% had anorexia, 45.2% noted weight loss, 8.33% had hemoptysis, 8.33% reported chest pain, and 14.29% had night sweats

Radiographic patterns of pulmonary TB in diabetic patients often show atypical presentations. Diabetics are more likely to have lower lobe involvement, whereas non-diabetics typically present with upper lobe infiltrations. In our study, 25.3% of diabetic participants had fibrosis, 54.4% had cavitary lesions, 39.24% had consolidation, 2.5% had pleural effusion, and 11.39% had other findings. Conversely, 43.2% of non-diabetics had fibrosis, 27.4% had cavitary lesions, 29.8% had consolidation, 2.4% had pleural effusion, and 9.55% had other findings. The greater prevalence of cavitary lesions in diabetics is consistent with studies indicating that poor glycemic control increases the risk of cavitation. Corroborate these findings, showing that diabetic patients often have more pronounced radiological signs of TB, including cavitary lesions.

With respect to lung field involvement, 20.3% of diabetic patients exhibited involvement in the lower lung field, 1.3% in the middle lobe, 44.3% in multiple lobes, 2.5% had normal lung fields, and 31.6% in the upper lobe. In contrast, non-diabetic patients had 13.1% involvement in the lower lung field, 3.6% in the middle lobe, 14.3% in multiple lobes, 17.9% with normal lung fields, 1.2% with pleural effusion, and 50% in the upper lobe. The higher prevalence of lower lung field involvement and cavitation in diabetic patients aligns with previous research, including studies by Mohammed A. Shaikh et al. And Siddiqui, which reported a greater frequency of these characteristics in diabetic individuals compared to non-diabetics.

Additional studies by Anasuya M. Et al. And Ikezoe J. Et al. Also highlight the increased prevalence of cavitation and multifocal lesions in diabetic patients with TB. Roghieh G. Et al. Further noted a higher occurrence of multilobar cavities in diabetics, reinforcing the need for tailored management strategies for diabetic patients with pulmonary TB.

## 5. CONCLUSION

This study found that while clinical symptoms of tuberculosis are similar between diabetic and non-diabetic patients, the radiographic features differ significantly. Diabetics showed high prevalence of cavitary lesions and more frequent involvement of the lower lung lobes, in contrast to the upper lobe involvement observed in non-diabetic patients. Consequently, radiographic assessment proves to be crucial for diagnosing tuberculosis in diabetic individuals. The study highlights that the incidence of tuberculosis in diabetics increases with age, and although clinical presentations are largely comparable across both groups, the distinct radiographic patterns underscore the importance of tailored diagnostic approaches for diabetic patients.

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