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CLINICAL PROFILE AND RADIOLOGICAL PATTERNS OF PULMONARY TUBERCULOSIS IN PATIENTS WITH DIABETES MELLITUS: A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE CENTER IN INDIA

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ABSTRACT

Background: Tuberculosis (TB) and diabetes mellitus (DM) are major public health problems, particularly in developing countries like India. Diabetes is an established risk factor for active tuberculosis and has been associated with altered clinical presentation, atypical radiological findings, delayed diagnosis, and poor treatment outcomes. The present study was undertaken to evaluate the clinical profile and radiological patterns of pulmonary tuberculosis in patients with diabetes mellitus.

Materials and Methods: A hospital based cross-sectional observational study was conducted at a tertiary care hospital in Maharashtra, India, from June 2015 to November 2018. Fifty adult patients with confirmed pulmonary tuberculosis and diabetes mellitus were enrolled. Demographic characteristics, clinical features, laboratory investigations, glycemic status, sputum examination, and chest radiographic findings were recorded using a predesigned proforma. Glycemic control was assessed using glycated hemoglobin (HbA1c). Statistical analysis was performed using SPSS software, and a p-value of <0.05 was considered statistically significant.

Results: A total of 50 patients were included in the study, with a mean age of 47.12 ± 12.17 years. The majority of patients belonged to the 46–60-year age group (42%) and were male (74%). The most common presenting symptoms were cough (90%), fever (74%), dyspnea (66%), anorexia (54%), and weight loss (52%). Diabetes was diagnosed before tuberculosis in 86% of patients. Poor glycemic control (HbA1c ≥7%) was observed in 74% of participants. Chest radiography revealed lower lung field involvement in 60% of patients and cavitary lesions in 36%, the latter being the most common radiological abnormality. Pulmonary tuberculosis was confirmed by sputum smear positivity in 30% of patients, while the remaining patients were diagnosed based on clinical and radiological findings.

Conclusion: Pulmonary tuberculosis in patients with diabetes mellitus predominantly affected middle aged men and was frequently associated with poor glycemic control, cavitary lesions, and lower lung field involvement. These findings emphasize the importance of routine bidirectional screening for tuberculosis and diabetes, early recognition of atypical radiological patterns, and optimal glycemic control to improve diagnosis and clinical outcomes. Larger multicenter prospective studies are required to further clarify the impact of diabetes on the clinical presentation and prognosis of pulmonary tuberculosis.

Keywords: Pulmonary tuberculosis, Diabetes mellitus, Clinical profile, Radiological patterns, Glycemic control, Chest radiography, Pulmonary cavitation.

INTRODUCTION

Tuberculosis (TB) remains one of the leading infectious causes of morbidity and mortality worldwide despite the availability of effective preventive and therapeutic measures. The disease continues to pose a major public health challenge, particularly in low and middle income countries where the burden of tuberculosis remains high. Simultaneously, Diabetes Mellitus (DM) has emerged as one of the fastest growing non-communicable diseases globally, with a rapidly increasing prevalence in developing nations. The coexistence of these two conditions has created a significant challenge for healthcare systems, especially in countries like India that have a high burden of both tuberculosis and diabetes.[1-4]

Accumulating evidence suggests a strong association between diabetes mellitus and active tuberculosis. A systematic review by Jeon and Murray demonstrated that individuals with diabetes have approximately a threefold higher risk of developing active tuberculosis compared to non-diabetic individuals.[1] Several studies have further shown that diabetes adversely affects the clinical course of tuberculosis, resulting in delayed sputum conversion, increased treatment failure, higher relapse rates, and increased mortality.[2,5-7] Poor glycemic control has also been identified as an important determinant of tuberculosis risk and unfavorable treatment outcomes.[7,13]

The interaction between tuberculosis and diabetes is believed to be mediated through alterations in host immune responses. Chronic hyperglycemia impairs both innate and adaptive immunity, leading to defective macrophage function, altered cytokine responses, and reduced cell-mediated immunity against Mycobacterium tuberculosis.[19,20] These immunological changes may influence the clinical presentation and radiological manifestations of pulmonary tuberculosis in diabetic patients. Previous studies have reported a higher frequency of cavitary lesions, lower lung field involvement, extensive pulmonary disease, and higher bacillary loads among diabetic individuals with tuberculosis.[6,12,18]

India carries one of the highest burdens of both tuberculosis and diabetes worldwide. Studies conducted in different regions of India have reported a high prevalence of diabetes among patients with tuberculosis, supporting the need for bidirectional screening and integrated disease management.[21,22,25,27] However, data regarding the clinical profile and radiological characteristics of pulmonary tuberculosis among diabetic patients remain limited, particularly from tertiary care settings in India.

The present study was therefore undertaken to evaluate the clinical profile and radiological patterns of pulmonary tuberculosis in patients with diabetes mellitus and to assess differences in presentation between patients with well controlled and poorly controlled diabetes.

MATERIALS AND METHODS

This cross-sectional observational study was conducted in a tertiary care hospital in Maharashtra, India, from June 2015 to November 2018. The study was undertaken to evaluate the clinical profile and radiological patterns of pulmonary tuberculosis in patients with diabetes mellitus and to compare the manifestations between patients with well controlled and poorly controlled diabetes. A total of 50 patients with pulmonary tuberculosis and diabetes mellitus were included in the study. Patients were recruited from the Medicine Department, Tuberculosis Ward, Tuberculosis Outpatient Department, Medicine Outpatient Department, and Tuberculosis Unit of the hospital.

Patients aged 18 years and above with confirmed pulmonary tuberculosis and diabetes mellitus who provided informed consent were included in the study. Patients with extrapulmonary tuberculosis, pulmonary tuberculosis without diabetes mellitus, and those unwilling to participate were excluded.

The diagnosis of diabetes mellitus was established based on previous medical records or according to standard diagnostic criteria, including fasting plasma glucose ≥126 mg/dL, random plasma glucose ≥200 mg/dL in the presence of classical symptoms, or glycated hemoglobin (HbA1c) ≥6.5%. Patients were categorized into well controlled and poorly controlled diabetes groups based on glycemic control as assessed by HbA1c levels. Pulmonary tuberculosis was diagnosed on the basis of clinical presentation, sputum examination for acid-fast bacilli, and chest radiographic findings in accordance with national tuberculosis control program guidelines.

A detailed clinical history was obtained from all participants. Information regarding age, sex, duration of diabetes, presenting symptoms, smoking and alcohol history, and associated comorbidities was recorded. Particular attention was paid to symptoms suggestive of pulmonary tuberculosis, including cough, fever, weight loss, loss of appetite, hemoptysis, chest pain, dyspnea, and night sweats. All patients underwent a comprehensive general and systemic physical examination.

Laboratory investigations included complete blood count, urine examination, blood urea, serum creatinine, liver function tests, fasting blood glucose, postprandial blood glucose, and glycated hemoglobin (HbA1c). Sputum samples were examined for acid-fast bacilli, and chest radiography was performed in all patients. Additional investigations were carried out whenever clinically indicated.

Chest radiographs were assessed for the extent and distribution of pulmonary lesions, including upper lobe involvement, lower lung field involvement,

cavitary lesions, consolidation, fibrosis, and bilateral disease. Radiological findings were analyzed and compared between patients with well controlled and poorly controlled diabetes mellitus.

The primary outcome measure was the assessment of the clinical profile and radiological pattern of pulmonary tuberculosis in diabetic patients. The secondary outcome was the comparison of clinical and radiological manifestations between patients with good glycemic control and those with poor glycemic control.

Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequencies and percentages. Comparisons between groups were performed using Student's t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, wherever appropriate. A p-value of less than 0.05 was considered statistically significant.

Written informed consent was obtained from all participants prior to enrollment, and confidentiality of patient information was maintained throughout the study.

RESULTS

A total of 50 patients with concomitant pulmonary tuberculosis (TB) and diabetes mellitus (DM) were included in this cross-sectional study.

Demographic characteristics

The majority of patients were aged 46–60 years (42.0%), followed by 31–45 years (36.0%). Patients aged 13–30 years and 61–70 years accounted for 10.0% and 12.0%, respectively. The study population was predominantly male (74.0%), with females constituting 26.0%. Most participants belonged to rural areas (60.0%), while 40.0% were from urban areas.

Among male participants, 70.2% were smokers compared with 7.7% of females. A greater proportion of patients belonged to the below poverty line category (60.0%).

Nutritional status and duration of diabetes

Most patients had a normal body mass index (62.0%), whereas 26.0% were underweight and 12.0% were pre-obese.

The duration of diabetes was less than one year in 44.0% of patients, 2–5 years in 34.0%, 6–10 years in 12.0%, and more than 10 years in 10.0%.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N = 50)

Variable	n (%)
Age group (years)	
13–30	5 (10)
31–45	18 (36)
46–60	21 (42)
61–70	6 (12)
Mean age ± SD	47.12 ± 12.17
Male	37 (74)
Female	13 (26)
Rural residence	30 (60)
Urban residence	20 (40)
Smokers	27 (54)
Below poverty line	30 (60)
Normal BMI	31 (62)
Underweight	13 (26)
Pre-obese	6 (12)

Clinical presentation

The most common presenting symptom was cough (90.0%), followed by fever (74.0%), dyspnea (66.0%), anorexia (54.0%), weight loss (52.0%), chest pain (26.0%), night sweats (20.0%), and hemoptysis (18.0%).

The frequency of symptoms was generally similar across age groups, although cough, fever, and dyspnea remained the predominant symptoms in both younger (<50 years) and older (>50 years) patients. Symptom distribution was also comparable between males and females.

Table 2: Clinical Presentation of Patients with Pulmonary Tuberculosis and Diabetes Mellitus (N = 50)

Clinical feature	n (%)
Cough	45 (90)
Fever	37 (74)
Dyspnea	33 (66)
Loss of appetite	27 (54)
Weight loss	26 (52)
Chest pain	13 (26)
Night sweats	10 (20)
Hemoptysis	9 (18)

Radiological findings

Chest radiography demonstrated cavitary lesions in 36.0% of patients, making them the most frequent abnormality. This was followed by infiltrates (22.0%), non-homogeneous opacities (20.0%), miliary shadows (12.0%), and fibrotic lesions (10.0%).

Cavitary lesions were observed more frequently in males and younger patients, with statistical significance (p=0.05). No significant age related differences were observed for infiltrates, non-homogeneous opacities, miliary shadows, or fibrotic lesions.

Regarding the anatomical distribution of pulmonary lesions, the lower lung zone was the most common site of involvement (60.0%), followed by the upper lung zone (22.0%), all lung zones (12.0%), and miliary tuberculosis (6.0%). Lower-lung-field involvement did not differ significantly between age groups (p=0.40).

Table 3: Radiological Findings on Chest Radiography (N = 50)

Radiological finding	n (%)
Cavitary lesions	18 (36)
Infiltrates	11 (22)
Non-homogeneous opacities	10 (20)
Miliary shadows	6 (12)
Fibrotic lesions	5 (10)

Table 4: Distribution of Pulmonary Lesions (N = 50)

Site of involvement	n (%)
Lower lung field	30 (60)
Upper lung field	11 (22)
Bilateral/all lung fields	6 (12)
Miliary involvement	3 (6)

Glycemic profile

Fasting blood glucose levels ranged widely, with 42.0% of patients having values between 151 and 200 mg/dL, followed by 22.0% with values below 126 mg/dL, 18.0% between 126 and 150 mg/dL, and 14.0% between 210 and 300 mg/dL.

Postprandial blood glucose levels were 200–250 mg/dL in 40.0%, 251–300 mg/dL in 28.0%, below 200 mg/dL in 20.0%, and above 300 mg/dL in 12.0%. The postprandial glucose distribution was statistically significant (p=0.03).

HbA1c values showed that only 26.0% achieved HbA1c <7%, while 54.0% had HbA1c between 7% and 9%, 14.0% between 9.1% and 12%, and 6.0% had HbA1c >12%, indicating suboptimal glycemic control in the majority of patients (p=0.002).

Table 5: Glycemic Profile of the Study Participants (N = 50)

Parameter	Category	n (%)
Fasting Blood Glucose (mg/dL)	<126	11 (22)
	126–150	9 (18)
	151–200	21 (42)
	201–300	7 (14)
	>300	2 (4)
Postprandial Blood Glucose (mg/dL)	<200	10 (20)
	200–250	20 (40)
	251–300	14 (28)
	>300	6 (12)
HbA1c (%)	<7	13 (26)
	7–9	27 (54)
	9.1–12	7 (14)
	>12	3 (6)

Pattern of disease presentation

Diabetes was diagnosed before tuberculosis in 43 patients (86.0%), whereas tuberculosis was diagnosed before diabetes in 7 patients (14.0%).

Pulmonary tuberculosis was diagnosed by sputum positivity in 30.0% of patients, while 70.0% were diagnosed primarily based on radiological findings.

Table 6: Pattern of Tuberculosis and Diabetes Mellitus (N = 50)

Variable	n (%)
Diabetes diagnosed before TB	43 (86)
TB diagnosed before diabetes	7 (14)
Sputum smear positive	15 (30)
Diagnosed predominantly by radiology	35 (70)

Hematological and urinary findings

Moderate anemia (hemoglobin 7–9.9 g/dL) was present in 54.0% of patients, while 32.0% had mild anemia and only 14.0% had normal hemoglobin levels.

Proteinuria was absent in 40.0% of patients. Among those with proteinuria, 30.0% had 1+, 16.0% had trace protein, 8.0% had 2+, and 6.0% had 3+ proteinuria.

Similarly, glycosuria was absent in 32.0% of patients, while 30.0% had 1+, 24.0% had trace glycosuria, 12.0% had 2+, and 2.0% had 3+ glycosuria. Overall, the study demonstrated that pulmonary tuberculosis in diabetic patients predominantly affected middle-aged males from rural backgrounds, with cough as the leading presenting symptom, lower-lung-field involvement and cavitary lesions as the characteristic radiological features, and poor glycemic control in the majority of cases.

Table 7: Laboratory Findings (N = 50)

Parameter	n (%)
Hemoglobin	
Normal	7 (14)
Mild anemia	16 (32)
Moderate anemia	27 (54)
Proteinuria	
Absent	20 (40)
Present	30 (60)
Glycosuria	
Absent	16 (32)
Present	34 (68)

Antidiabetic therapy

Nearly half of the patients (46.0%) were receiving oral hypoglycemic agents, 38.0% were on insulin, and 16.0% required combined oral agents and insulin

Table 8: Antidiabetic Treatment (N = 50)

Treatment modality	n (%)
Oral hypoglycemic agents	23 (46)
Insulin	19 (38)
Combination therapy	8 (16)

DISCUSSION

The present cross-sectional study evaluated the clinical profile and radiological pattern of pulmonary tuberculosis (TB) among patients with diabetes mellitus (DM). The coexistence of these two diseases represents an important public health challenge, particularly in countries like India where the burden of both tuberculosis and diabetes is among the highest worldwide. Previous systematic reviews have established that diabetes increases the risk of developing active tuberculosis by approximately two to three fold because of impaired innate and cell-mediated immunity, delayed macrophage activation, and chronic hyperglycemia-associated immune dysfunction. These mechanisms provide the biological basis for the increasing burden of TB-DM comorbidity observed globally.[1-4]

In the present study, the majority of patients belonged to the 46–60-year age group, and nearly three-fourths were males. Similar age and sex distributions have been reported by Restrepo et al., Viswanathan et al., Balakrishnan et al., and Raghuraman et al., who demonstrated that pulmonary tuberculosis associated with diabetes predominantly affects middle-aged and elderly men.[5,21,22,27] Male predominance may be explained by greater exposure to smoking, occupational risk factors, delayed healthcare seeking, and a higher prevalence of type 2 diabetes among adult men in high TB burden countries.

A large proportion of patients in our study were from rural and economically disadvantaged backgrounds. Similar observations have been reported from India and other developing countries, where socioeconomic deprivation, overcrowding, malnutrition, and limited access to healthcare increase the risk of both tuberculosis and poor glycemic control.[9,11,12] These findings emphasize that socioeconomic determinants continue to influence the epidemiology of TB-DM despite advances in diagnostic and treatment strategies.

Most patients presented with cough, fever, dyspnea, anorexia, and weight loss. These findings are consistent with previous studies reporting that the clinical manifestations of pulmonary tuberculosis in diabetic patients remain largely similar to those in non-diabetic patients, although symptoms may be more severe or prolonged because of impaired immune responses.[3,4,15] The high frequency of constitutional symptoms observed in our study reflects the inflammatory burden associated with dual disease.

Radiological examination demonstrated that cavitary lesions were the most frequent abnormality, followed by infiltrates and non-homogeneous opacities. Lower lung field involvement was observed in the majority of patients. These findings agree with reports by Restrepo et al., Gopathi et al., and Zheng et al., who described increased cavitation and atypical lower-lung involvement among diabetic

tuberculosis patients.[5,12] Cavitary disease is thought to result from delayed immune containment of Mycobacterium tuberculosis, resulting in higher bacillary burden and more extensive pulmonary destruction. The predominance of lower-lung lesions in diabetic patients has been repeatedly described and may contribute to delayed diagnosis because these radiographic findings can mimic bacterial pneumonia.

Although sputum positivity was observed in only a proportion of patients, radiological abnormalities were present in most cases, indicating that chest radiography remains an important diagnostic tool in diabetic patients with respiratory symptoms. Previous studies have similarly demonstrated that diabetic patients frequently require both microbiological and radiological evaluation because atypical radiographic patterns may coexist with variable sputum positivity.[3,10]

An important observation in the present study was the poor glycemic control among the majority of participants. More than half of the patients had HbA1c values between 7% and 9%, while a considerable proportion had HbA1c levels exceeding 9%, indicating chronic hyperglycemia. Similar findings have been reported by Leung et al. and Lee et al., who demonstrated that poor glycemic control significantly increases the risk of active tuberculosis and adversely affects treatment outcomes.[7,13] Chronic hyperglycemia impairs macrophage function, neutrophil activity, antigen presentation, and T-cell responses, thereby facilitating progression from latent infection to active disease.[19,20]

The present study also found that diabetes was diagnosed before tuberculosis in most patients. This observation supports previous epidemiological evidence suggesting that diabetes is an independent risk factor for the development of active tuberculosis rather than merely a consequence of infection.[1,3,4] The systematic reviews by Jeon and Murray and Al-Rifai et al. consistently reported an approximately threefold increased risk of active TB among individuals with diabetes.[1,16]

Moderate anemia was common in the studied patients, while proteinuria and glycosuria were also frequently detected. These findings probably reflect the chronic inflammatory state of tuberculosis together with diabetic microvascular complications. Although these laboratory abnormalities were not the primary objectives of the study, they highlight the multisystem involvement commonly encountered in patients with TB-DM comorbidity.

Nearly half of the patients were receiving oral hypoglycemic agents, whereas more than one-third required insulin therapy. Previous studies have suggested that insulin may provide better glycemic control during active tuberculosis because rifampicin reduces the efficacy of several oral antidiabetic medications through hepatic enzyme induction.[3,20] Therefore, careful monitoring of blood glucose and adjustment of diabetic treatment are essential during anti-tubercular therapy.

The present findings support the recommendations of the World Health Organization and the International Union Against Tuberculosis and Lung Disease regarding bidirectional screening.[10] Patients with tuberculosis should routinely be screened for diabetes, while diabetic patients presenting with persistent cough, weight loss, fever, or poor glycemic control should be evaluated for pulmonary tuberculosis. Several Indian studies have demonstrated that routine bidirectional screening is feasible and identifies a substantial number of previously undiagnosed cases of both diseases.[21,22,25-27]

CONCLUSION

Pulmonary tuberculosis associated with diabetes mellitus was observed predominantly among middle-aged males, with cough, fever, dyspnea, anorexia, and weight loss being the most common presenting symptoms. Most patients had poor glycemic control, and diabetes was diagnosed before tuberculosis in the majority of cases. Radiologically, lower lung field involvement and cavitary lesions were the most frequent findings, emphasizing the atypical presentation of pulmonary tuberculosis in diabetic patients.

The findings of this study reinforce the close association between diabetes mellitus and pulmonary tuberculosis and highlight the influence of poor glycemic control on disease presentation. Early recognition of tuberculosis in diabetic patients and prompt assessment of glycemic status in patients with tuberculosis are essential for timely diagnosis and appropriate management.

Routine bidirectional screening for tuberculosis among patients with diabetes and for diabetes among patients with tuberculosis should be incorporated into routine clinical practice, particularly in high burden countries like India. An integrated approach involving early diagnosis, strict glycemic control, appropriate anti-tubercular therapy, and regular follow-up may improve clinical outcomes and help reduce the dual burden of these diseases.

Further multicenter prospective studies with larger sample sizes are warranted to better define the impact of glycemic control on disease severity, treatment response, and long-term outcomes in patients with tuberculosis-diabetes comorbidity.

REFERENCES

1. Jeon CY, Murray MB. Diabetes mellitus increases the risk of active tuberculosis: a systematic review of 13 observational studies. PLoS Med. 2008;5(7).
2. Baker MA, Harries AD, Jeon CY, Hart JE, Kapur A, Lonnroth K, et al. The impact of diabetes on tuberculosis treatment outcomes: a systematic review. BMC Med. 2011;9:81.

3. Dooley KE, Chaisson RE. Tuberculosis and diabetes mellitus: convergence of two epidemics. Lancet Infect Dis. 2009;9(12):737-746.
4. Restrepo BI. Diabetes and tuberculosis. Microbiol Spectr. 2016;4(6).
5. Restrepo BI, Fisher-Hoch SP, Crespo JG, Whitney E, Perez A, Smith B, et al. Type 2 diabetes and tuberculosis in a dynamic bi-national border population. Epidemiol Infect. 2007;135(3):483-491.
6. Jimenez-Corona ME, Cruz-Hervert LP, Garcia-Garcia L, Ferreyra-Reyes L, Delgado-Sanchez G, Bobadilla-Del-Valle M, et al. Association of diabetes and tuberculosis: impact on treatment and post-treatment outcomes. Thorax. 2013;68(3):214-220.
7. Leung CC, Lam TH, Chan WM, Yew WW, Ho KS, Leung G, et al. Diabetic control and risk of tuberculosis: a cohort study. Am J Epidemiol. 2008;167(12):1486-1494.
8. Stevenson CR, Critchley JA, Forouhi NG, Roglic G, Williams BG, Dye C, et al. Diabetes and the risk of tuberculosis: a neglected threat to public health? Chronic Illn. 2007;3(3):228-245.
9. Harries AD, Lin Y, Satyanarayana S, Lonnroth K, Li L, Wilson N, et al. The looming epidemic of diabetes-associated tuberculosis: learning lessons from HIV-associated tuberculosis. Int J Tuberc Lung Dis. 2011;15(11):1436-1444.
10. World Health Organization, International Union Against Tuberculosis and Lung Disease. Collaborative framework for care and control of tuberculosis and diabetes. Geneva: WHO; 2011.
11. Harries AD, Satyanarayana S, Kumar AMV, Nagaraja SB, Isaakidis P, Malhotra S, et al. Epidemiology and interaction of diabetes mellitus and tuberculosis and challenges for care: a review. Public Health Action. 2013;3(Suppl 1).
12. Zheng C, Hu M, Gao F. Diabetes and pulmonary tuberculosis: a global overview with special focus on the situation in Asian countries with high TB-DM burden. Glob Health Action. 2017;10(1):1264702.
13. Lee PH, Fu H, Lai TC, Chiang CY, Chan CC, Lin HH. Glycemic control and the risk of tuberculosis: a cohort study. PLoS Med. 2016;13(8).
14. Workneh MH, Bjune GA, Yimer SA. Prevalence and associated factors of tuberculosis and diabetes mellitus comorbidity: a systematic review. PLoS One. 2017;12(4).
15. Yorke E, Atiase Y, Akpalu J, Sarfo-Kantanka O, Boima V, Dey ID. The bidirectional relationship between tuberculosis and diabetes. Tuberc Res Treat. 2017;2017:1702578.
16. Al-Rifai RH, Pearson F, Critchley JA, Abu-Raddad LJ. Association between diabetes mellitus and active tuberculosis: a systematic review and meta-analysis. PLoS One. 2017;12(11).
17. Tegegne BS, Mengesha MM, Teferra AA, Awoke MA, Habtewold TD. Association between diabetes mellitus and multidrug-resistant tuberculosis: a systematic review and meta-analysis. Syst Rev. 2018;7(1):161.
18. Noubiap JJ, Nansseu JR, Nyaga UF, Nkeck JR, Endomba FT, Kaze AD, et al. Global prevalence of diabetes in active tuberculosis: a systematic review and meta-analysis. Lancet Glob Health. 2019;7(4).
19. Kumar NP, Sridhar R, Banurekha VV, et al. Type 2 diabetes mellitus coincident with pulmonary tuberculosis is associated with heightened systemic type 1, type 17, and other proinflammatory cytokines. Ann Am Thorac Soc. 2013;10(5):441-449. doi:10.1513/AnnalsATS.201305-112OC
20. van Crevel R, Critchley JA. The interaction of diabetes and tuberculosis: translating research to policy and practice. Trop Med Infect Dis. 2021;6(1):8.
21. Viswanathan V, Kumpatla S, Aravindalochanan V, Rajan R, Chinnasamy C, Srinivasan R, et al. Prevalence of diabetes and pre-diabetes and associated risk factors among tuberculosis patients in India. PLoS One. 2012;7.
22. Balakrishnan S, Vijayan S, Nair S, Subramoniapillai J, Mrithyunjayan S, Wilson N, et al. High diabetes prevalence among tuberculosis cases in Kerala, India. PLoS One. 2012;7.
23. Stevenson CR, Forouhi NG, Roglic G, Williams BG, Lauer JA, Dye C, et al. Diabetes and tuberculosis: the impact of the diabetes epidemic on tuberculosis incidence. BMC Public Health. 2007;7:234.
24. Wang Q, Ma A, Han X, Zhao S, Cai J, Ma Y, et al. Prevalence of type 2 diabetes among newly detected pulmonary tuberculosis patients in China. Public Health Nutr. 2013;16(2):368-371.
25. India Tuberculosis-Diabetes Study Group. Screening of patients with tuberculosis for diabetes mellitus in India. Trop Med Int Health. 2013;18(5):636-645. doi:10.1111/tmi.12084.
26. Kumpatla S, Sekar A, Achanta S, Sharath BN, Kumar AMV, Harries AD, et al. Characteristics of patients with diabetes screened for tuberculosis in India. Public Health Action. 2013;3(Suppl 1).
27. Raghuraman S, Vasudevan KP, Govindarajan S, Chinnakali P, Panigrahi KC. Prevalence of diabetes mellitus among tuberculosis patients in urban Puducherry. N Am J Med Sci. 2014;6(1):30-34.