

Analysis of the Prevalence of the Tuberculosis Patients with Diabetes Mellitus in South India

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Abstract

Background: Tuberculosis (TB) is caused by *Mycobacterium TB*, which represents a global public health concern and leads to death due to a single infectious agent. Also, diabetes mellitus (DM), predominantly type-2 diabetes (T2DM), upsurges the risk of infections, including TB. Hence, this study aimed to reveal the prevalence of TB patients with DM, particularly in South India.

Methods: A descriptive study was conducted using the India TB Dataset 2023 of the Ministry of Health and Family Welfare and the Department of Health and Family Welfare, India, through the Kaggle platform. The data were analyzed using descriptive statistics.

Results: The overall percentage of TB patients with DM in six South Indian states was highest in Puducherry (99%), followed by Andhra Pradesh (98.9%), Tamil Nadu (96.6%), Karnataka (95%), Telangana (93.7%) and Kerala (93.3%). The percentage of patients diagnosed with DM among those tested is high in Kerala (32.6%) and low in Telangana (6%). Meanwhile, the percentage of TB patients with DM initiating anti-diabetic treatment was high in Puducherry (95.9%) and lowest in Andhra Pradesh (67.7%). Also, the percentage of TB patients with DM was highest in Dam and Due (99.2%) and the lowest in Manipur (74.3%).

Conclusion: Six states of South India had more prevalence of TB patients with DM. The percentage of TB patients diagnosed with DM while testing was high in Kerala (32.6%). 95.9% of TB patients initiating anti-diabetic treatment were observed in Puducherry. Although the World Health Organization's End TB Strategy supports India with an excellent plan for promoting the prevention and treatment of TB, the number of TB cases is still higher in South Indian states, which requires more attention.

Keywords: Tuberculosis, South India, Diabetes Mellitus, Prevalence, States

Introduction

Tuberculosis (TB) is a bacterial infection caused by *Mycobacterium TB* that primarily affects the lungs but can also affect other parts of the body, which has been a primary global health concern for many years. World Health Organization (WHO) stated that TB is a preventable and curable disease; however, it is one of the significant causes of death across the globe and leads to death due to a single infectious agent. In 2022, it caused more

deaths than human immunodeficiency virus (HIV) / acquired immunodeficiency syndrome (AIDS). It was the second foremost cause of death due to a single infectious agent after Coronavirus disease (COVID-19) [1]. TB, a highly infectious disease, represents an important public health issue, predominantly in low- and middle-income nations. The eight countries with the highest TB burden, accounting for two-thirds of the disease, are India [27%], China [9%], Indonesia [8%], the Philippines [6%], Pa-

kistan [5%], Nigeria [4%], Bangladesh [4%], and South Africa [3%] [2]. In 2015, WHO launched the End TB Strategy to lessen 95% of TB-related fatalities and 90% of TB incidents by 2035 [3]. Although progress has been made, TB remains a significant healthcare challenge, specifically in low- and middle-income nations around the globe.

In 2021, India reported an estimated 3 million TB cases and 494,000 TB-related fatalities among people without HIV and recorded an estimated 2.77 million TB cases in 2022, accounting for 25% of the global burden [4, 5]. In addition, the case fatality ratio, i.e., the estimated fatality/estimated occurrence, is 5% in high-income nations, and it remains about 20% in high-burden nations [3]. These alarming figures highlight the pressing need for more effective measures to combat this communicable disease and its adverse impacts on public health. However, reducing the burden of TB and associated fatalities in India is a critical component for achieving ambitious global targets set by WHO. The National Strategic Plan for TB Elimination in India aims to reduce occurrence by 80% and TB deaths by 90% by 2025, compared to 2015 estimates [6]. This target is achievable through early diagnosis, comprehensive evaluation, and management of comorbidities necessary to prevent TB mortality [7].

Diabetes mellitus (DM), particularly type-2 diabetes (T2DM), is a disease of unknown cause, involving changes in genetic predisposition and glucose metabolism that result in insufficient insulin production or utilization. T2DM increases the risk of infections, including TB. It is also known that various metabolic disorders in diabetes can increase the risk of TB. However, no conclusive evidence directly links the relationships, but the infectious disease (TB) and metabolic disorder (DM) have intricate pathologies that promote inflammation [8-10]. Worldwide research has conclusively demonstrated a strong association between DM and TB [11-13]. The systemic metabolic alterations in diabetes inhibit neutrophil function and increase susceptibility to infectious diseases, namely TB [14, 15]. The findings of these studies suggest a possible association between TB and DM, which could have significant implications for public health policy and disease management strategies. It is worth noting that several studies have found a correlation between diabetes and an increased risk of contracting TB.

Research conducted in South India also revealed that the presence of DM significantly impairs the efficacy of TB treatment and increases the risk of adverse outcomes. Failure to address this challenge may lead to suboptimal treatment outcomes and hamper efforts to control and eradicate TB. Patients who had a history of DM and were treated for TB experienced delayed sputum conversion. The relative risk of remaining sputum smear-positive was estimated to be higher at the end of the intensive phase of TB treatment in these individuals [16, 17]. Therefore, it is essential to consider the impact of DM when designing

treatment strategies for TB patients. It is also crucial that various studies demonstrate the harmful impact of hyperglycemia on successful TB treatment. Ignoring this critical factor could lead to suboptimal treatment outcomes [18, 19].

India, the world's second most populated nation, experiences an important challenge due to the high burden and prevalence of DM and TB. Previous studies in South India showed a high prevalence of DM in patients enrolled in the Revised National TB Control Program [20, 21]. The high prevalence of DM in countries like India has been a cause for concern as it creates an enabling environment for the emergence and recurrence of TB cases. This phenomenon highlights the interplay between two significant public health challenges and underscores the need for measures to address both problems simultaneously. Hence, this study intends to examine the secondary data available from the India TB Dataset 2023 of the Ministry of Health and Family Welfare and the Department of Health and Family Welfare, India, through the Kaggle platform to analyze the current TB burden of South India.

Methodology and Data Source

A descriptive study was conducted using secondary data from the India TB Dataset 2023. This dataset provides a comprehensive overview of the TB epidemic in India and efforts to end TB across the country. It is published by the Ministry of Health and Family Welfare and the Department of Health and Family Welfare, India. The data collected by the public and private sector organizations were presented. The report highlights India's progress in TB control while also revealing ongoing challenges such as underreporting of TB cases, treatment adherence issues, and the impact of risk factors like HIV and malnutrition. By evaluating India's TB burden and response at national and state levels annually, this report enables targeted interventions and policies to successfully combat tuberculosis in alignment with the targets of the WHO End TB strategy. This dataset also allows researchers, policymakers, and health professionals to understand TB trends and gaps to strengthen India's response to this significant public health threat.

Statistical Analysis

The retrieved data was analyzed using SPSS (Statistical Package for the Social Sciences) software version 27.0. Descriptive statistics, namely frequency and percentages, were used to describe the variables related to TB in South India.

Results

Table 1 shows that the overall percentage of TB patients with DM in six states of South India was highest in Puducherry (99%), followed by Andhra Pradesh (98.9%), Tamil Nadu (96.6%), Karnataka (95%), Telangana (93.7%) and Kerala (93.3%). Also, the percentage of TB patients with DM was highest in Dam and Due (99.2%) and the lowest in Manipur (74.3%).

Table 1: State-Wise Percentage of TB Patients with known DM in India

State/Union Territories of India	TB patients with known DM (%)
Andaman & Nicobar Islands	95.1
Andhra Pradesh	98.9
Arunachal Pradesh	79.0

Assam	81.2
Bihar	77.1
Chandigarh	94.6
Chhattisgarh	91.0
Diu and Daman	99.2
Delhi	80.8
Goa	93.9
Gujarat	96.0
Haryana	94.1
Himachal Pradesh	99.0
Jammu & Kashmir	95.4
Jharkhand	88.8
Karnataka	95.0
Kerala	93.3
Ladakh	91.3
Lakshadweep	95.5
Madhya Pradesh	90.7
Maharashtra	96.7
Manipur	74.3
Meghalaya	76.8
Mizoram	98.6
Nagaland	84.1
Odisha	96.3
Puducherry	99.0
Punjab	91.5
Rajasthan	90.1
Sikkim	97.5
Tamil Nadu	96.6
Telangana	93.7
Tripura	94.4
Uttar Pradesh	91.6
Uttarakhand	96.1
West Bengal	92.6

TB -Tuberculosis, DM – Diabetes Mellitus

Concerning the public sector organizations, Puducherry had 99% of TB patients with known DM. However, Andhra Pradesh showed 99.6% of TB patients with known DM for the private sector organizations. Overall, Puducherry had the highest percentage of TB patients with known DM (99%) (Table 2).

Table 2: TB Patients with known DM Regarding Sector Type

States	TB patients with known DM		
	Data collected by Public Sector Organizations n (%)	Data collected by Private Sector Organizations n (%)	Total n (%)
Andhra Pradesh	65,235 (98.7%)	26,883 (99.6%)	92,118 (98.9%)
Karnataka	64,615 (95.9%)	10,593 (90.0%)	75,208 (95.0%)
Kerala	19,388 (94.1%)	2,557 (88.2%)	21,945 (93.3%)
Puducherry	1,510 (99.0%)	2 (100.0%)	1,512 (99.0%)
Tamil Nadu	76,635 (97.9%)	16,054 (90.8%)	92,689 (96.6%)
Telangana	51,411 (94.3%)	17,215 (92.2%)	68,626 (93.7%)

TB -Tuberculosis, DM – Diabetes Mellitus

While testing for DM, public sector organizations revealed that Kerala had the highest percentage (32.9%) of TB patients diagnosed with DM. Private sector organizations stated that Tamil Nadu had the highest (22.8%). Overall, Kerala had the highest percentage of TB patients (32.6%) who were diagnosed with DM, and Telangana had the lowest percentage (6%). (Table 3).

Table 3: Diagnosis of TB Patients with DM Regarding Sector type

States	TB diagnosed with DM on Testing		
	Data collected by Public Sector Organizations n (%)	Data collected by Private Sector Organizations n (%)	Total n (%)
Andhra Pradesh	8,816 (13.5%)	2,940 (10.9%)	11,756 (12.8%)
Karnataka	9,616 (14.9%)	975 (9.2%)	10,591 (14.1%)
Kerala	6,376 (32.9%)	770 (30.1%)	7,146 (32.6%)
Puducherry	464 (30.7%)	0 (0.0%)	464 (30.7%)
Tamil Nadu	20,196 (26.4%)	3,655 (22.8%)	23,851 (25.7%)
Telangana	3,250 (6.3%)	892 (5.2%)	4,142 (6.0%)

TB -Tuberculosis, DM – Diabetes Mellitus

Regarding the public sector organizations, Puducherry had the highest percentage (95.9%) of TB patients with DM who initiated Anti-diabetic treatment. On the other hand, Tamil Nadu showed the highest percentage (87%) of TB patients with DM who initiated Anti-diabetic treatment from the viewpoint of the private sector organizations. Overall, the percentage of TB patients with DM who initiated anti-diabetic treatment in Puducherry was high (Table 4).

Table 4. TB Patients with DM who Initiated Anti-Diabetic Treatment Regarding Sector Type

States	TB patients with DM who initiated Anti-diabetic treatment		
	Data collected by Public Sector Organizations n (%)	Data collected by Private Sector Organizations n (%)	Total n (%)
Andhra Pradesh	6,282 (71.3%)	1,671 (56.8%)	7,953 (67.7%)
Karnataka	7,379 (76.7%)	742 (76.1%)	8,121 (76.7%)
Kerala	4,163 (65.3%)	446 (57.9%)	4,609 (64.5%)
Puducherry	445 (95.9%)	NA	445 (95.9%)
Tamil Nadu	19,144 (94.8%)	3,179 (87%)	22,323 (93.6%)
Telangana	2,691 (82.8%)	738 (82.7%)	3,429 (82.8%)

TB -Tuberculosis, DM – Diabetes Mellitus, NA - Not Available

Discussion

This study analyzed the prevalence of TB patients with DM in South Indian states. The results showed that the percentage of TB patients with DM in the six states of South India was high in Puducherry (99%), followed by Andhra Pradesh (98.9%), Tamil Nadu (96.6%), Karnataka (95%), Telangana (93.7%) and Kerala (93.3%). This observation is in line with the previous study, which concluded that the incidence of DM in TB cases was 29% in Urban Puducherry. Screening TB patients to estimate fasting blood sugar and detect DM earlier is recommended. While analyzing the risk factors of DM in TB cases, 14% of TB patients reported a family history of DM, 2/3rd of males had the habit of smoking and tobacco use [22]. Another study found that the incidence of DM in TB patients was 13.1% in the city of Chandigarh, India. Comorbidity of TB and DM was more significant among people aged more than 50 years [23]. In India, Fazaludeen Koya et al. recently observed that the incidence of DM amongst TB patients ranged from 12.39 to 44%. The highest occurrence occurred in southern states (25.3%-44%), followed by northern states (12.8%-15.8%) [24]. Furthermore, Puducherry had 99% of TB patients with known DM, according to public sector organizations. However, Andhra Pradesh showed 99.6% of TB patients with known DM concerning private sector or-

ganizations. Overall, Puducherry had the highest percentage of TB patients with known DM (99%). In line with these findings, Rajaa et al. found that one out of three TB cases suffered from DM in the three districts of South India, including Puducherry. A previous study also observed that the occurrence of DM in TB patients was high (29%) in Puducherry, India [25, 22].

During testing for DM, public sector organizations discovered that Kerala had 32.9% of TB patients diagnosed with DM. Meanwhile, private sector organizations stated that Tamil Nadu had 22.8%. Overall, Kerala had the highest percentage of TB patients (32.6%) who were diagnosed with DM. This finding is in accord with the previous study, which concluded that the incidence of DM (22.6%) was higher in TB patients than in AIDS patients in Kerala [26]. A previous study also found that TB patients had a higher prevalence of DM (19.6%) than the general inhabitants of Northern Kerala [27].

Besides, Buasroung et al. stated that the WHO suggested screening DM in all TB patients during the initiation of their TB treatment. Concerning the public sector organizations, Puducherry showed the highest percentage (95.9%) of TB patients with DM who started their anti-diabetic treatment [28]. However, Tam-

il Nadu had the highest percentage (87%) of TB patients with DM who started their anti-diabetic treatment from the viewpoint of the private sector organizations. Overall, the percentage of TB patients with DM who initiated anti-diabetic treatment in Puducherry was high. An earlier study stated that diabetes in patients with active TB might adversely disturb TB treatment consequences by postponing the duration of microbiological response, dipping the chance of satisfactory results, and raising the danger of deterioration, death, and drug resistance. Indian government endorsed that TB patients should be detected for DM instantly after the TB diagnosis, but it can also be performed at any time during TB management [22]. As the long-term prognosis of TB patients with DM relies on DM treatment success, Active treatment of DM and periodic monitoring for its complications and TB deterioration should be warranted even following the accomplishment of TB management since prolonged prognosis of TB patients with DM rely on the achievement of the DM management [25].

Conclusion

This study observed a high prevalence of TB patients with DM in the Six states of South India. While testing, the highest percentage of TB patients diagnosed with DM was seen in Kerala (32.6%). Puducherry showed 95.9% of TB patients with DM who initiated anti-diabetic treatment. Early detection of DM among TB patients and periodic monitoring of blood glucose levels, along with appropriate anti-diabetic treatment, are essential to achieve positive outcomes in TB patients and avoid deterioration of their health, TB complications, and death. This study is limited to analyzing the prevalence of TB patients with DM in South Indian states; however, it can be extended to reveal the prevalence of those patients across India in the future. Further research can be performed by analyzing the prevalence of TB patients with DM in India according to their demographic variables and type of DM. Future studies can be conducted by including various demographic variables that influence the survival time of TB patients with DM.

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