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Original Research Article

Co-Infection of Tuberculosis and Diabetes: Implications for Treatment and Management

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ABSTRACT: ***Background:*** Tuberculosis (TB) and diabetes mellitus (DM) are two major public health concerns, particularly in low- and middle-income countries. The co-existence of these conditions complicates treatment outcomes and increases morbidity and mortality. Despite the growing burden of TB-DM co-infection, data on its clinical profile, treatment adherence, and associated risk factors in Bangladesh remain limited. ***Objective:*** This study aims to assess the sociodemographic characteristics, clinical profiles, treatment adherence, and predictors of poor treatment outcomes among elderly TB patients with diabetes in Bangladesh. ***Methods:*** A cross-sectional study was conducted at the Ad-din Barrister Rafique-ul Huq Hospital, Dhaka, from January to December 2023. A total of 130 TB patients aged ≥60 years with co-existing diabetes were included. Data were collected from Ad-din Medical College and Hospital, Magbajar, Dhaka through structured interviews, medical record reviews, and laboratory investigations. Descriptive statistics, chi-square tests, and logistic regression were performed to identify significant associations, with a p-value of <0.05 considered statistically significant. ***Results:*** The majority of participants were male (64.6%) and aged 60-64 years (32.3%). 64.6% of patients had uncontrolled diabetes (HbA1c ≥7.0%), and 20.8% had multidrug-resistant TB (MDR-TB). Hypertension (54.6%) and cardiovascular disease (32.3%) were the most common comorbidities. Poor treatment adherence was observed in 29.2% of patients, which was significantly associated with unfavorable treatment outcomes (p<0.001). Logistic regression revealed that MDR-TB (AOR: 5.01, p<0.001) and uncontrolled diabetes (AOR: 4.12, p<0.001) were the strongest predictors of poor outcomes. ***Conclusion:*** TB-DM co-infection is associated with high rates of poor glycemic control, MDR-TB, and treatment non-adherence, leading to adverse outcomes. Integrated management strategies focusing on early detection, glycemic control, and adherence counseling are crucial for improving patient outcomes.

Keywords: Tuberculosis, Diabetes Mellitus, Co-infection, Treatment Outcomes, Bangladesh.

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INTRODUCTION

The convergence of tuberculosis (TB) and diabetes mellitus (DM) represents a significant global health challenge that bridges the traditional divide between communicable and non-communicable diseases [1]. Once considered a disease of poverty, TB continues to be one of the world's most prevalent infectious diseases, while DM, historically associated with affluence, now increasingly affects populations across all

socioeconomic strata, particularly in low- and middle-income countries. This evolving epidemiological landscape presents a complex public health challenge, as these conditions not only coexist but also interact synergistically, each amplifying the impact of the other [2-4]. The global burden of this dual epidemic is particularly concerning. TB affects approximately 10 million people annually, with 1.3 million deaths reported in 2019 alone. Meanwhile, the rising prevalence of DM, especially in TB-endemic regions, creates a perfect storm for public health systems [4-6]. The World Health Organization estimates that people with DM are 2-3 times more likely to develop TB, and this risk increases in regions with high TB transmission rates. This interaction is particularly worrisome in developing nations, where healthcare resources are often stretched thin, and both diseases remain prevalent [7]. The relationship between TB and DM is bidirectional and complex. DM impairs immune function, increasing susceptibility to TB infection and potentially complicating treatment outcomes. Conversely, TB infection can worsen glycemic control in diabetic patients, creating a vicious cycle that complicates the management of both conditions [8]. This interaction is further complicated by the rising prevalence of multi-drug resistant TB (MDR-TB), which requires more expensive, longer-duration treatment regimens and poses additional challenges in patients with comorbid DM [9]. In the context of demographic transitions and urbanization, particularly in developing countries, the convergence of these diseases presents unique challenges. The traditional risk factors for TB – including poverty, malnutrition, and overcrowding – now overlap with the rising prevalence of DM risk factors such as obesity, sedentary lifestyle, and aging populations. This overlap creates new challenges for healthcare systems, requiring integrated approaches to disease management and prevention [10-12]. Understanding the intersection of TB and DM is crucial for several reasons. First, it challenges the traditional approach of treating these diseases in isolation. Second, it highlights the need for integrated screening and treatment programs. Finally, it emphasizes the importance of considering how socioeconomic factors influence disease outcomes in both conditions [13]. This understanding is particularly relevant in regions where healthcare resources are limited and where both diseases maintain a significant presence in the population [14]. The global health community increasingly recognizes that addressing TB and DM requires a coordinated approach that takes into account their interrelated nature. This recognition has led to calls for integrated care models, enhanced surveillance systems, and research into how these conditions interact at both clinical and public health levels. As both diseases continue to affect millions globally, understanding their relationship becomes crucial for developing effective prevention and treatment strategies [15-17]. Despite these growing concerns, limited data exist on the clinical characteristics, treatment adherence, and outcomes of TB-DM co-infection in Bangladesh, where both conditions are highly prevalent. The National Tuberculosis Control Program (NTP) of Bangladesh has made significant efforts in controlling TB, yet the impact of diabetes on TB treatment remains underexplored. Understanding the burden and risk factors associated with TB-DM co-infection is crucial for designing targeted interventions that improve patient outcomes. This study aims to evaluate the clinical profile, treatment adherence, and predictors of poor treatment outcomes in elderly TB patients with diabetes in Bangladesh.

METHODOLOGY

This cross-sectional study was conducted in Dhaka at Ad-din Barrister Rafique-ul Huq Hospital, from January to December 2023. The study included 130 tuberculosis (TB) patients with coexisting diabetes mellitus (DM), all aged over 60 years. Data were collected exclusively from Ad-din Medical College Hospital records, including patient medical files, laboratory test results, and treatment history. A structured data extraction sheet was used to gather relevant clinical and demographic information systematically. Ethical approval was obtained before data collection, and strict confidentiality measures were maintained. As the study relied on hospital records, informed consent was not required from patients, but institutional permission was secured to access medical data. The collected data were analyzed using appropriate statistical software to assess treatment outcomes and management challenges in TB-DM co-infected patients.

RESULTS

Table 1: Sociodemographic Characteristics of TB-DM Patients (n=130)

Variables	Categories	Frequency (n)	Percentage (%)
Age (years)	60-64	42	32.3
	65-69	38	29.2
	70-74	29	22.3
	≥75	21	16.2
Gender	Male	84	64.6
	Female	46	35.4
Educational Level	No formal education	49	37.7
	Primary	32	24.6
	Secondary	28	21.5
	Higher secondary and above	21	16.2
Smoking History	Smoker	76	58.5
	Non-smoker	54	41.5
BMI (kg/m²)	<18.5 (Underweight)	49	37.7
	18.5-24.9 (Normal)	58	44.6
	≥25 (Overweight)	23	17.7

Table 1 presents the sociodemographic characteristics of the study population. The majority of participants were male (64.6%), aged between 60-64 years (32.3%), and nearly 37.7% were underweight. Additionally, 58.5% had a history of smoking, which is a known risk factor for TB and diabetes complications.

Table 2: Clinical Profile of TB-DM Patients (n=130)

Variables	Categories	Frequency (n)	Percentage (%)
Type of TB	Pulmonary TB	98	75.4
	Extrapulmonary TB	32	24.6
Duration of DM (years)	<5	41	31.5
	5-10	55	42.3
	>10	34	26.2
HbA1c Level (%)	<7.0 (Controlled)	46	35.4
	≥7.0 (Uncontrolled)	84	64.6
Presence of MDR-TB	Yes	27	20.8
	No	103	79.2

Table 2 provides the clinical profile of TB-DM patients. Pulmonary TB (75.4%) was more prevalent than extrapulmonary TB (24.6%). A significant proportion (64.6%) had uncontrolled diabetes (HbA1c ≥7.0), which may contribute to poor treatment outcomes. Additionally, 20.8% of patients had multidrug-resistant tuberculosis (MDR-TB).

Table 3: Comorbidities Among TB-DM Patients (n=130)

Comorbidities	Present (n)	Percentage (%)
Hypertension	71	54.6
Chronic Kidney Disease	39	30.0
Cardiovascular Disease	42	32.3
Diabetic Neuropathy	36	27.7
Diabetic Retinopathy	28	21.5

Table 3 illustrates the prevalence of comorbidities among TB-DM patients. Hypertension (54.6%) was the most frequently observed comorbidity, followed by cardiovascular diseases (32.3%) and chronic kidney disease (30.0%). These comorbidities may complicate TB management and worsen patient outcomes.

Table 4: Treatment and Medication Usage (n=130)

Variables	Categories	Frequency (n)	Percentage (%)
TB Treatment Regimen	Standard ATT (HRZE)	103	79.2
	MDR-TB Regimen	27	20.8
Diabetes Medication	Metformin	62	47.7
	Insulin	41	31.5
	Combination Therapy	27	20.8
Treatment Adherence	Good	92	70.8
	Poor	38	29.2

Table 4 presents treatment details. Most patients (79.2%) received standard anti-tubercular therapy (HRZE), while 20.8% required an MDR-TB regimen. Regarding diabetes management, 47.7% used metformin, while 31.5% required insulin therapy. Treatment adherence was good in 70.8% of cases.

Table 5: Treatment Outcomes and Associated Factors (n=130)

Variables	Favorable Outcome (n=85)	Unfavorable Outcome (n=45)	p-value
Age ≥70 years	24 (28.2%)	26 (57.8%)	0.002*
Uncontrolled DM (HbA1c ≥7.0)	38 (44.7%)	46 (84.4%)	<0.001*
MDR-TB	9 (10.6%)	18 (40.0%)	<0.001*
Hypertension	39 (45.9%)	32 (71.1%)	0.011*
Poor Treatment Adherence	15 (17.6%)	23 (51.1%)	<0.001*

*p-value <0.05 is statistically significant

Table 5 examines factors associated with treatment outcomes. Advanced age, uncontrolled diabetes, MDR-TB, hypertension, and poor treatment adherence were significantly associated with unfavorable treatment outcomes ($p<0.05$).

Table 6: Multivariate Logistic Regression Analysis of Factors Associated with Unfavorable Treatment Outcomes

Variables	Adjusted OR (95% CI)	p-value
Age ≥70 years	2.79 (1.44-5.39)	0.002*
Uncontrolled DM	4.12 (2.05-8.27)	<0.001*
MDR-TB	5.01 (2.12-11.81)	<0.001*
Hypertension	2.21 (1.19-4.12)	0.014*
Poor Adherence	3.78 (1.92-7.43)	<0.001*

*p-value <0.05 is statistically significant

Table 6 provides a logistic regression analysis of risk factors for unfavorable treatment outcomes. MDR-TB (AOR: 5.01, p<0.001) and uncontrolled diabetes (AOR: 4.12, p<0.001) were the strongest predictors.

DISCUSSION

This study examined tuberculosis (TB) co-infection and diabetes mellitus (DM) among elderly patients in Dhaka, Bangladesh. The findings reveal significant clinical and sociodemographic associations impacting disease progression and treatment outcomes. The majority of participants were male (64.6%) and aged 60-64 years (32.3%), which aligns with previous studies indicating a higher prevalence of TB-DM co-infection among older males [18]. The high prevalence among men may be attributed to lifestyle factors, including smoking (58.5%), a known risk factor for TB [19]. Additionally, 37.7% of the patients were underweight, which could be linked to the catabolic effects of chronic TB infection and poorly controlled diabetes [20]. A major concern in this study was the high proportion (64.6%) of patients with uncontrolled diabetes (HbA1c ≥7.0%). Previous studies have shown that poor glycemic control increases susceptibility to TB and worsens outcomes [21]. The prevalence of multidrug-resistant tuberculosis (MDR-TB) in this cohort was 20.8%, comparable to studies in China, which reported MDR-TB rates ranging from 15-25% among diabetic TB patients [22]. The presence of MDR-TB complicates treatment and necessitates prolonged therapy, further exacerbating health risks. Hypertension was the most frequently observed comorbidity (54.6%), followed by cardiovascular diseases (32.3%) and chronic kidney disease (30.0%). A study by Restrepo et al. (2016) also found a strong association between hypertension and TB-DM co-infection [23]. The co-existence of these conditions may result in increased inflammation, vascular complications, and a higher risk of mortality [23]. Additionally, diabetic neuropathy (27.7%) and diabetic retinopathy (21.5%) were noted, indicating that TB-DM patients often suffer from multiple chronic conditions requiring comprehensive management. Treatment adherence was a critical factor influencing outcomes, with 70.8% of patients demonstrating good adherence. However, 29.2% exhibited poor adherence, which was significantly associated with unfavorable treatment outcomes (p<0.001). Non-adherence among TB-DM patients has been reported in studies from sub-Saharan Africa and Southeast Asia, where medication side effects, financial constraints, and lack of awareness contributed to poor compliance [24]. The study found that 34.6% of patients required insulin therapy, while 47.7% were on metformin. Previous research suggests that metformin may offer protective benefits against TB progression due to its anti-inflammatory properties [24]. However, in cases of poorly controlled diabetes, insulin therapy becomes necessary to regulate glucose levels effectively [20]. Multivariate logistic regression analysis revealed that MDR-TB (AOR: 5.01, p<0.001) and uncontrolled diabetes (AOR: 4.12, p<0.001) were the strongest predictors of poor treatment outcomes. Patients aged ≥70 years (AOR: 2.79, p=0.002) and those with hypertension (AOR: 2.21, p=0.014) also had significantly higher risks of unfavorable outcomes. These findings are consistent with research, where older age, poor glycemic control, and MDR-TB were associated with increased mortality and prolonged recovery [13]. Given the increasing burden of TB-DM co-infection in Bangladesh, the study highlights the need for integrated disease management programs.

Regular screening for diabetes in TB patients and vice versa, along with intensified monitoring of glycemic control, can improve treatment outcomes. Additionally, improved MDR-TB detection and adherence counseling programs are essential to minimize drug resistance and treatment failure [25-31].

Limitations

This study was conducted at a single tertiary hospital in Dhaka, limiting its generalizability to the broader population. Additionally, it relied on self-reported treatment adherence, which may introduce recall bias. Future multicenter studies with larger sample sizes and prospective designs are needed to further validate these findings.

CONCLUSION

This study underscores the significant impact of the dual burden of tuberculosis (TB) and diabetes mellitus (DM) among elderly patients in Dhaka, Bangladesh. The findings reveal that advanced age, uncontrolled diabetes, multidrug-resistant tuberculosis (MDR-TB), hypertension, and poor treatment adherence are critical factors associated with unfavorable treatment outcomes. The high prevalence of uncontrolled diabetes and MDR-TB highlights the need for targeted interventions to manage these comorbidities effectively. Given the complex interaction between TB and DM, integrated care models and improved adherence strategies are essential to improve patient outcomes. These findings emphasize the importance of addressing both diseases concurrently, considering their interrelated nature, and the need for healthcare systems in TB-endemic regions to adapt to the growing challenge posed by TB-DM co-infection. Further research and the implementation of integrated disease management strategies are crucial to optimizing treatment outcomes for this vulnerable population.

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