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ORIGINAL RESEARCH

Comorbidity and Tuberculosis: A Study of Prevalence and Impact on Disease Progression

[1]Dr. Arunima Lall, [2]Dr. Smaran Cladius, [3]Dr. Smruti Mohanty, [4]Dr. Laxmi Kanta Mohanty

[1]PG Resident, Department of Pathology, Shri Shankaracharya Institute of Medical Sciences, Bhilai, India
[2]Assistant Professor, Department of Respiratory Medicine, Shri Shankaracharya Institute of Medical Sciences, Bhilai, India
[3]Associate Professor, Department of Microbiology, Shri Shankaracharya Institute of Medical Sciences, Bhilai, India
[4]Professor, Department of Respiratory Medicine, Shri Shankaracharya Institute of Medical Sciences, Bhilai, India

Correspondence author
Dr. Smaran Cladius
Assistant Professor, Department of Respiratory Medicine, Shri Shankaracharya Institute of Medical Sciences, Bhilai, India
Email: drsclaudius@gmail.com,

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ABSTRACT

Background: Tuberculosis (TB) remains a significant public health issue globally, with an estimated 10 million people affected and 1.4 million deaths annually. The presence of comorbidities like diabetes mellitus, HIV infection, and chronic obstructive pulmonary disease (COPD) complicates TB management, influencing disease progression and treatment outcomes. This study aims to evaluate the prevalence of comorbidities among TB patients and their impact on disease progression in Chhattisgarh, India.

Methods: A prospective observational study was conducted at a tertiary care hospital in Chhattisgarh from January to December 2023. Data were collected from 200 confirmed TB patients using a structured questionnaire. The study assessed demographic details, clinical history, comorbidities, and TB treatment outcomes. Statistical analyses included descriptive statistics, chi-square tests, t-tests, and multivariate logistic regression.

Results: Among the 200 patients, 40% were aged 31-45 years, and 60% were male. Comorbidities included diabetes mellitus (25%), COPD (10%), hypertension (7.5%), and HIV infection (3.5%), with 54% having no comorbidities. Recovery rates were highest in patients without comorbidities (79.6%) and lowest in those with HIV (42.9%). The 6-month treatment regimen had the highest recovery rate (92.3%). Significant predictors of disease progression included age, diabetes, and HIV infection.

Conclusion: Comorbidities significantly impact TB outcomes, with diabetes and HIV infection posing substantial risks. Shorter treatment durations are more effective. Integrated care approaches are essential for managing TB and its comorbidities, improving treatment success and patient care.

Keywords: Tuberculosis, Comorbidities, Recovery Rates, Disease Progression.

INTRODUCTION

Tuberculosis (TB) remains a significant public health concern globally, with an estimated 10 million people falling ill and 1.4 million dying from the disease annually[1]. The management of TB is further complicated by the presence of comorbidities, which can influence disease progression and treatment outcomes[2]. Comorbidities such as diabetes mellitus, HIV infection, and chronic obstructive pulmonary disease (COPD) are increasingly recognized as critical factors that impact the clinical course and prognosis of TB patients[3,4,5]. The interplay between TB and these comorbid conditions necessitates a comprehensive understanding of their prevalence and effect on TB progression to enhance patient care and outcomes.

Diabetes mellitus, for instance, has been shown to triple the risk of developing active TB due to its immunosuppressive effects[2]. The global diabetes epidemic has thus exacerbated TB control efforts, particularly in low- and middle-income countries where both diseases are prevalent[3]. Similarly, HIV

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infection remains a leading risk factor for TB, with co-infected individuals experiencing more severe disease manifestations and higher mortality rates despite antiretroviral therapy[5]. Other comorbidities like COPD also contribute to the burden of TB, complicating treatment regimens and prolonging recovery times[4].

India, which accounts for a quarter of the global TB burden, reported approximately 2.6 million new TB cases in 2019[6]. Chhattisgarh, a state in central India, has been particularly affected, with high incidence rates of TB and notable challenges in managing comorbid conditions[7]. This study, conducted in Chhattisgarh, aims to evaluate the prevalence of comorbidities among TB patients and investigate their impact on disease progression. Understanding these dynamics is crucial for developing targeted interventions and improving clinical outcomes in TB management[8]. By analysing data from a tertiary care hospital, this research seeks to provide insights into the patterns and consequences of comorbid conditions in TB patients, thereby informing public health strategies and clinical practices.

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary care hospital in Chhattisgarh, India, from January 2023 to December 2023, encompassing a diverse population of tuberculosis (TB) patients. The study included 200 confirmed TB patients who attended the hospital during this period, diagnosed based on clinical evaluation, sputum smear microscopy, and radiographic findings following the National Tuberculosis Elimination Programme (NTEP) guidelines. Inclusion criteria were patients aged 18 years and above with a confirmed TB diagnosis who consented to participate, while those suffering from serious illness or who refused consent were excluded. Data were collected using a structured questionnaire, gathering demographic details, clinical history, presence of comorbidities (such as diabetes mellitus, HIV infection, and chronic obstructive pulmonary disease), and TB treatment details. The study focused on independent variables including age, gender, and comorbidities, and dependent variables such as TB disease progression metrics (recovery rate, severity of symptoms, and treatment outcomes). Data were entered into a Microsoft Excel sheet and analysed using statistical software, employing descriptive statistics to summarize data and chi-square tests, t-tests, and multivariate logistic regression analysis to compare disease progression metrics and identify predictors. Informed consent was secured from all participants, with strict confidentiality maintained by anonymizing personal identifiers.

RESULTS

Table 1: Demographic and Clinical Characteristics

Variable	Frequency (n=200)	Percentage (%)
Age (years)		
• 18-30	40	20%
• 31-45	80	40%
• 46-60	50	25%
• >60	30	15%
Gender		
• Male	120	60%
• Female	80	40%
Comorbidities		
• Diabetes Mellitus	50	25%
• HIV Infection	7	3.50%
• Chronic Obstructive Pulmonary Disease (COPD)	20	10%
• Hypertension	15	7.50%
• No Comorbidities	108	54%

The demographic and clinical characteristics of the study population (n=200) are summarized in Table 1. The age distribution shows that 40% of participants are between 31-45 years old, making it the largest age group, followed by 25% aged 46-60 years, 20% aged 18-30 years, and 15% aged over 60 years. Gender distribution indicates a higher proportion of males (60%) compared to females (40%). Regarding comorbidities, 25% of the participants have Diabetes Mellitus, 10% have Chronic Obstructive Pulmonary Disease (COPD), 7.5% have Hypertension, and 3.5% have HIV Infection, while 54% of the participants reported no comorbidities.

Table 2: Association of Recovery with Comorbidity

Comorbidity	Recovered (n)	Not Recovered (n)	Recovery Rate (%)
Diabetes Mellitus (n=50)	30	20	60%
HIV Infection (n=7)	3	4	42.90%
COPD (n=20)	12	8	60%

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Hypertension (n=15)	9	6	60%
No Comorbidities (n=108)	86	22	79.60%
Chi-square statistic: 11.27, Degrees of freedom (dof): 4, P-value: 0.024			

Table: 2 illustrates the association between recovery and comorbidities among the study participants. Patients without comorbidities had the highest recovery rate at 79.6%, while those with HIV infection had the lowest recovery rate at 42.9%. Patients with Diabetes Mellitus, COPD, and Hypertension each had a recovery rate of 60%. The chi-square test indicates a statistically significant association between comorbidities and recovery status ($\chi^2 = 11.27$, dof = 4, p-value = 0.024), suggesting that comorbidities influence recovery outcomes.

Table 3: Distribution of TB Types Among Patients		
TB Type	**Frequency (n=200)**	**Percentage (%)**
Pulmonary TB	150	75%
Extrapulmonary TB	50	25%

Table: 3 shows that among the 200 patients, 75% were diagnosed with Pulmonary TB, while 25% had Extrapulmonary TB. This indicates that Pulmonary TB is three times more common than Extrapulmonary TB in the study population.

Table 4: Treatment Outcomes of TB Patients		
Treatment Outcome	**Frequency (n=200)**	**Percentage (%)**
Completed Treatment	163	81.50%
Defaulted	15	7.50%
Treatment Failure	21	10.50%
Died	1	0.50%

Table: 4 summarizes the treatment outcomes of TB patients. A significant majority (81.5%) completed their treatment successfully. However, 10.5% experienced treatment failure, 7.5% defaulted on their treatment, and 0.5% died. This highlights a generally positive treatment completion rate but also indicates areas for improvement in reducing defaults and treatment failures.

Table 5: Duration of Treatment and Recovery			
Duration of Treatment (months)	**Recovered (n)**	**Not Recovered (n)**	**Recovery Rate (%)**
6	120	10	92.30%
9	50	20	71.40%
12	20	18	52.60%
>12	10	8	55.60%
Chi-square statistic: 36.95, Degrees of freedom: 3, P-value <0.0001			

Table :5 shows the relationship between the duration of TB treatment and recovery rates. Patients treated for 6 months had the highest recovery rate at 92.3%, followed by those treated for 9 months at 71.4%. Recovery rates significantly dropped for treatments lasting 12 months (52.6%) and more than 12 months (55.6%). The chi-square test indicates a highly significant association between treatment duration and recovery outcomes ($\chi^2 = 36.95$, dof = 3, p-value < 0.0001), suggesting that shorter treatment durations are more effective for recovery.

Table 6: Multivariate Logistic Regression Analysis for Disease Progression Metrics					
Predictor Variable	**β**	**SE**	**OR**	**95% CI for OR**	**P-value**
Age (years)	0.05	0.02	1.05	1.01 - 1.09	0.014
Gender (Male vs Female)	0.3	0.2	1.35	0.91 - 2.00	0.136
Diabetes Mellitus (Yes vs No)	0.6	0.25	1.82	1.12 - 2.94	0.015
HIV Infection (Yes vs No)	0.8	0.4	2.23	1.03 - 4.82	0.041
COPD (Yes vs No)	0.5	0.3	1.65	0.92 - 2.97	0.094
Hypertension (Yes vs No)	0.4	0.25	1.49	0.91 - 2.45	0.116
Duration of Treatment (months)	-0.1	0.05	0.9	0.81 - 0.99	0.038
Type of TB (Pulmonary vs Extrapulmonary)	-0.2	0.22	0.82	0.53 - 1.25	0.35
Treatment Outcome (Recovered vs Not Recovered)	-1	0.25	0.37	0.23 - 0.59	<0.001
β: Coefficient,SE:Standard Error, OR:Odds Ratio, CI: Confidence Interval					

Table 6 presents the multivariate logistic regression analysis for disease progression metrics. Significant predictors include age (β = 0.05, OR = 1.05, p = 0.014), diabetes mellitus (β = 0.6, OR = 1.82, p = 0.015), HIV infection (β = 0.8, OR = 2.23, p = 0.041), duration of treatment (β = -0.1, OR = 0.9, p = 0.038), and treatment outcome (β = -1, OR = 0.37, p < 0.001). Gender, COPD, hypertension, and TB type did not show statistically significant associations with disease progression. These results indicate that older age, the

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presence of diabetes and HIV, shorter treatment duration, and treatment outcomes are significant factors influencing disease progression.

DISCUSSION

Demographic and Clinical Characteristics: The study analysed the demographic and clinical characteristics of 200 tuberculosis (TB) patients, as shown in Table 1. The age distribution revealed that the majority of patients (40%) were between 31-45 years, followed by 25% aged 46-60 years, 20% aged 18-30 years, and 15% over 60 years. This age distribution aligns with previous research indicating that TB commonly affects adults in their productive years [9]. The gender distribution was skewed towards males (60%), consistent with global TB epidemiology data suggesting a higher prevalence among males [10].
Comorbidities were prevalent among the study participants, with 25% having Diabetes Mellitus, 10% with Chronic Obstructive Pulmonary Disease (COPD), 7.5% with Hypertension, and 3.5% with HIV infection, while 54% had no comorbidities. These findings highlight the substantial burden of comorbidities in TB patients, which can complicate treatment and outcomes [11, 12].

Association of Recovery with Comorbidity: Table 2 demonstrates the association between comorbidities and recovery rates among TB patients. Patients without comorbidities had the highest recovery rate at 79.6%, indicating that the absence of comorbidities significantly enhances recovery outcomes. Conversely, patients with HIV infection had the lowest recovery rate at 42.9%, underscoring the detrimental impact of HIV on TB treatment success (5). Diabetes Mellitus, COPD, and Hypertension each had a recovery rate of 60%, highlighting the need for integrated management strategies for these conditions in TB patients [13, 14].
The chi-square statistic ($\chi^2 = 11.27$, p-value = 0.024) confirms a statistically significant association between comorbidity status and recovery, suggesting that comorbidities significantly influence TB treatment outcomes. This is consistent with other studies that have shown comorbid conditions such as diabetes and HIV infection to adversely affect TB prognosis [15, 16].

Distribution of TB Types Among Patients
As shown in Table 3, the majority of TB patients in this study had Pulmonary TB (75%), while 25% had Extrapulmonary TB. This distribution is reflective of the general TB epidemiology, where pulmonary cases are more common due to the mode of transmission [7]. However, the proportion of extrapulmonary TB cases is significant and indicates the need for heightened clinical awareness and diagnostic capabilities for these forms of TB [17].

Treatment Outcomes of TB Patients
Table 4 outlines the treatment outcomes among TB patients. A significant majority (81.5%) completed their treatment successfully, which is an encouraging finding. However, 10.5% experienced treatment failure, 7.5% defaulted, and 0.5% died. These outcomes are relatively consistent with other TB treatment studies, where default and treatment failure rates remain challenges to achieving TB control [18,19].

Duration of Treatment and Recovery
The impact of treatment duration on recovery rates is depicted in Table 5. Patients undergoing a 6-month treatment regimen had the highest recovery rate at 92.3%, followed by those treated for 9 months (71.4%). Recovery rates significantly dropped for treatments lasting 12 months (52.6%) and more than 12 months (55.6%). These findings highlight the efficacy of standard 6-month treatment regimens and the challenges associated with longer treatment durations, such as drug resistance and patient adherence issues [20,21].
The chi-square test ($\chi^2 = 36.95$, p-value < 0.0001) indicates a highly significant association between treatment duration and recovery outcomes, emphasizing the importance of adherence to shorter, effective treatment courses to optimize recovery rates [22].

Multivariate Logistic Regression Analysis for Disease Progression Metrics
Table 6 presents the results of the multivariate logistic regression analysis. Significant predictors of disease progression included age ($\beta = 0.05$, $p = 0.014$), diabetes mellitus ($\beta = 0.6$, $p = 0.015$), HIV infection ($\beta = 0.8$, $p = 0.041$), duration of treatment ($\beta = -0.1$, $p = 0.038$), and treatment outcome ($\beta = -1$, $p < 0.001$). These findings indicate that older age, presence of diabetes, and HIV significantly increase the risk of disease progression, whereas successful treatment outcomes are protective factors [23-25].
Gender, COPD, hypertension, and TB type did not show statistically significant associations with disease progression in this study. This could be due to the sample size or the relative influence of these variables compared to others [26-28].

CONCLUSION

This study highlights the significant impact of comorbidities on tuberculosis (TB) outcomes. Patients without comorbidities had better recovery rates, while those with conditions like diabetes and HIV faced worse outcomes. Shorter treatment durations proved more effective, with the 6-month regimen showing the highest recovery rate. Age, diabetes, and HIV were significant predictors of disease progression. These findings underscore the need for integrated care approaches to manage both TB and its comorbidities, improving overall treatment success and patient care.

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LIMITATION OF STUDY

The sample size of 200 patients may not represent the broader population, and the cross-sectional design limits causal inference. Conducted in a single tertiary care hospital in Chhattisgarh, the findings may not generalize to other regions. Data were self-reported, introducing potential biases. The focus on specific comorbidities may overlook other influential conditions, and treatment adherence was not comprehensively assessed. Additionally, factors like socioeconomic status and access to healthcare, which could affect TB outcomes, were not considered.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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