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RESPONSE OF STANDARD ATT IN CAVITARY TUBERCULOSIS VERSUS NON- CAVITARY TUBERCULOSIS: A CROSS-SECTIONAL STUDY

Original Research

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ABSTRACT

Background: Tuberculosis (TB) remains a significant global health challenge, with pulmonary tuberculosis (PTB) being the most prevalent form. Cavitary PTB represents a more advanced and severe manifestation, characterized by destructive lung lesions that impede therapeutic penetration and delay bacterial clearance. This clinical phenotype is associated with higher bacillary load and poorer treatment response. Understanding the differential outcomes between cavitary and non-cavitary PTB is essential for optimizing disease management, directing clinical surveillance, and informing therapeutic modifications in high-burden settings.

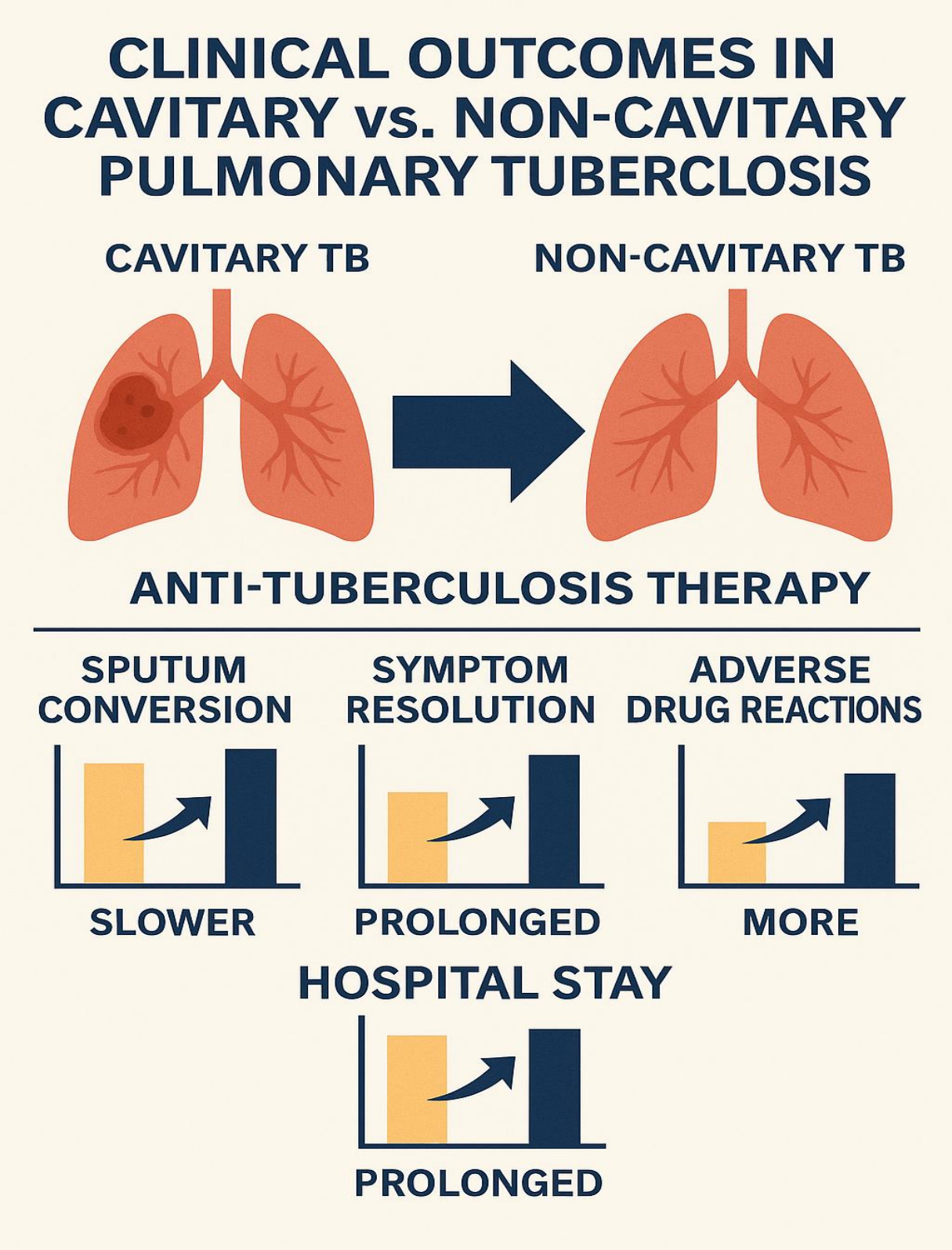
Objective: To compare sputum conversion, symptom resolution, adverse drug reactions, and clinical outcomes in patients with cavitary and non-cavitary PTB receiving standard first-line anti-tuberculosis therapy (ATT).

Methods: A cross-sectional study was conducted at Combined Military Hospital, Peshawar, including 150 PTB patients (75 cavitary, 75 non-cavitary) treated with a standard six-month ATT regimen comprising Rifampicin, Isoniazid, Pyrazinamide, and Ethambutol. Patient records were reviewed for demographic characteristics, clinical symptoms, laboratory findings, adverse drug reactions, and treatment outcomes. Data analysis was performed using SPSS version 22.0. Independent t-tests and Chi-square tests were applied to compare outcomes between groups, with significance set at $p \leq 0.05$.

Results: Sputum conversion rates were significantly lower among cavitary TB patients at 2 months (72% vs. 85%, $p = 0.01$) and at 6 months (92% vs. 98%, $p = 0.03$). Symptom persistence at 6 months was also higher in the cavitary group, with cough (34% vs. 22%), fever (20% vs. 10%), and weight loss (18% vs. 8%). Adverse drug reactions were more frequent among cavitary TB patients, including gastrointestinal disturbances (14% vs. 5%, $p = 0.02$), hepatotoxicity (16% vs. 9%, $p = 0.01$), and peripheral neuropathy (6% vs. 2%, $p = 0.04$). Cavitary TB patients experienced longer hospital stays (9.4 ± 3.5 vs. 6.8 ± 2.9 days, $p < 0.001$) and higher in-hospital mortality (22.5% vs. 12.5%, $p = 0.03$).

Conclusion: Cavitary PTB was associated with delayed sputum conversion, slower symptomatic recovery, higher rates of adverse drug reactions, prolonged hospitalization, and increased mortality. These findings underscore the need for intensified monitoring, individualized treatment planning, and enhanced supportive care for patients with cavitary TB to improve clinical outcomes.

Keywords: Adverse Drug Reaction, Cavitary Tuberculosis, Clinical Outcomes, Pulmonary Tuberculosis, Sputum Conversion, Treatment Outcome, Tuberculosis Therapy.



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INTRODUCTION

Tuberculosis (TB) remains one of the most significant global public health challenges, consistently ranking among the top ten causes of death worldwide despite decades of advancements in diagnostic and therapeutic strategies. According to the World Health Organization, approximately 10 million new cases and 1.5 million TB-related deaths are reported annually, underscoring its continued burden on low- and middle-income countries in particular (1). Pulmonary tuberculosis (PTB) represents the most common clinical form, often leading to substantial structural damage to the lungs, especially when advanced manifestations such as cavitary disease occur (2). Cavitary pulmonary TB is radiologically characterized by destructive lesions resulting from chronic inflammation and progressive tissue necrosis. These cavities not only provide an ideal microenvironment for Mycobacterium tuberculosis to persist but also hinder therapeutic penetration, thereby complicating disease control (3,4). Patients with cavitary TB are known to exhibit higher bacillary loads, delayed sputum conversion, prolonged symptom resolution, and increased risk of treatment failure or relapse. Drug resistance and adverse drug reactions are also more frequently observed in these individuals, leading to extended and more intensive therapeutic regimens (5–7). In contrast, non-cavitary TB generally presents with less extensive pulmonary involvement and responds more rapidly to standard first-line anti-tuberculosis treatment (ATT), which typically includes Rifampicin, Isoniazid, Pyrazinamide, and Ethambutol administered over six months (8). The divergent treatment trajectories between these two disease forms highlight the potential impact of radiological phenotype on clinical outcomes. Despite growing recognition of these differences, evidence remains limited regarding how patients with cavitary versus non-cavitary TB respond to standardized ATT, particularly in terms of sputum conversion rates, clinical improvement, and treatment-related adverse events. Previous studies have suggested poorer outcomes in cavitary disease, yet comprehensive comparative data remain insufficient, leaving clinicians without clear guidance on whether treatment duration or monitoring strategies should differ between these groups (9,10). This knowledge gap has meaningful implications for optimizing TB management, improving patient prognosis, and reducing the risk of ongoing transmission. Therefore, the present study seeks to compare key treatment outcomes—including sputum conversion, symptom resolution, and adverse drug reactions—between patients with cavitary and non-cavitary TB receiving standard ATT. By determining whether disease phenotype influences therapeutic response, the study aims to provide evidence that may inform whether patients with cavitary TB require modified or intensified clinical management.

METHODS

The study was designed as a cross-sectional investigation and was conducted at the Combined Military Hospital (CMH) Peshawar between January 2024 and December 2024. A total of 150 patients diagnosed with pulmonary tuberculosis (TB) were included and subsequently divided into two equal groups: 75 patients with cavitary TB and 75 with non-cavitary TB. All participants received the standard first-line anti-tuberculosis treatment (ATT) regimen consisting of Rifampicin, Isoniazid, Pyrazinamide, and Ethambutol, initiated within two weeks of diagnosis. The purpose of the study was to compare clinical outcomes—including sputum conversion, symptom resolution, and adverse drug reactions—between the two disease phenotypes. Patients aged 18 to 65 years with microbiologically or radiologically confirmed active pulmonary TB were deemed eligible for inclusion. Diagnosis was established using sputum smear microscopy and chest radiography, with classification into cavitary or non-cavitary TB based on radiological findings. Individuals were excluded if they had multidrug-resistant TB (MDR-TB), HIV or other immunocompromising conditions, severe comorbid illnesses such as malignancy or renal failure, or if they were non-compliant or lost to follow-up (11,12). All eligible patients provided informed consent prior to participation, and the study received approval from the institutional ethics and research committee of CMH Peshawar, ensuring adherence to ethical research standards. Data collection was performed through patient medical records and included demographic characteristics (age, gender, socioeconomic status, residence), clinical features (fever, cough, weight loss, night sweats), laboratory parameters (sputum smear results, chest X-ray findings, serum bilirubin, ALT, AST, and albumin levels), and treatment outcomes. The primary outcome measure was sputum conversion at 2 and 6 months of therapy. Secondary outcomes included the resolution of cardinal TB symptoms, incidence of adverse drug reactions such as gastrointestinal disturbances, and overall adherence to therapy. Statistical analysis was conducted using SPSS version 22.0. Continuous variables were summarized as means and standard deviations, whereas categorical variables were presented as frequencies and percentages. Group comparisons were made using independent t-tests for continuous variables and chi-square tests for categorical variables. A p-value of ≤ 0.05 was considered statistically significant.

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RESULTS

The study analyzed 150 patients, with 75 individuals in each group of cavitary and non-cavitary tuberculosis. The mean age in the cavitary TB group was 37.4 ± 10.2 years, while the non-cavitary TB group demonstrated a mean age of 38.9 ± 11.5 years. Gender distribution was comparable, with 45 males and 30 females in the cavitary TB group and 44 males and 31 females in the non-cavitary group. Urban residence constituted 58% of cavitary TB patients and 60% of non-cavitary TB patients, while the remaining participants were from rural areas. Baseline hepatic co-infections included Hepatitis B and C, recorded in 22% and 58% of cavitary TB patients and 21% and 54% of non-cavitary TB patients, respectively. Child-Pugh class distribution (B/C) was identical in both groups at 40% and 60%. Sputum conversion outcomes demonstrated slower early response among cavitary TB patients. At two months, sputum negativity was achieved by 72% of cavitary TB patients compared with 85% of non-cavitary TB patients ($p = 0.01$). By the sixth month, conversion further increased to 92% in the cavitary group and 98% in the non-cavitary group ($p = 0.03$). Both groups ultimately showed high end-of-treatment sputum clearance. Symptom resolution at six months revealed persistent cough in 34% of cavitary TB patients and 22% of non-cavitary TB patients. Fever persisted in 20% of cavitary and 10% of non-cavitary TB patients ($p = 0.05$). Weight loss remained in 18% of cavitary TB cases and 8% of non-cavitary cases ($p = 0.03$). These findings demonstrated consistently slower symptomatic improvement among cavitary TB patients. Adverse drug reactions occurred more frequently among cavitary TB patients. Gastrointestinal disturbances were reported in 14% of cavitary and 5% of non-cavitary TB patients ($p = 0.02$). Hepatotoxicity, defined as ALT > 40 U/L, occurred in 16% of cavitary and 9% of non-cavitary TB patients ($p = 0.01$). Peripheral neuropathy was recorded in 6% of cavitary TB cases and 2% of non-cavitary TB cases ($p = 0.04$).

Hospitalization outcomes showed significantly longer admissions in cavitary TB patients, with a mean stay of 9.4 ± 3.5 days compared with 6.8 ± 2.9 days among non-cavitary TB patients ($p < 0.001$). In-hospital mortality was also higher in the cavitary TB group at 22.5%, compared with 12.5% in the non-cavitary TB group ($p = 0.03$), reflecting greater disease severity. Treatment adherence was evaluated based on treatment completion without interruption beyond seven consecutive days. Adherence was lower in cavitary TB patients, with 82% completing treatment as prescribed compared with 93% in the non-cavitary TB group. Missed doses were more frequent among patients who developed gastrointestinal adverse effects or hepatotoxicity. Subgroup analysis revealed that hepatotoxicity occurred predominantly among individuals with underlying hepatitis B/C co-infection, with 28% of co-infected cavitary TB patients developing elevated ALT levels compared with 14% of co-infected non-cavitary TB patients. Furthermore, patients classified as Child-Pugh Class C exhibited significantly higher hepatotoxicity rates (24%) than those in Class B (9%). Prolonged hospitalization (mean 10.6 days) and increased in-hospital mortality (28%) were also more common in patients who developed hepatotoxicity compared with those without hepatic complications (mean 7.2 days; mortality 11%). These findings suggest that baseline liver dysfunction and viral hepatitis co-infection were strong predictors of poor outcomes, contributing to higher adverse drug reactions, reduced adherence, and prolonged recovery among cavitary TB patients.

Table 1: Baseline Characteristics of Study Participants

Variable	Cavitary TB (n=75)	Non-Cavitary TB (n=75)
Age (mean ± SD)	37.4 ± 10.2	38.9 ± 11.5
Gender		
Male	45%	44%
Female	30%	31%
Residence		
Urban	58%	60%
Rural	42%	40%
Etiology		
Hep B	22%	21%
Hep C	58%	54%

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Variable	Cavitary TB (n=75)	Non-Cavitary TB (n=75)
Child-Pugh Class		
Class B	40%	40%
Class C	60%	60%

Table 2: Sputum Conversion Rates at 2 and 6 Months

Group	2 Months (%)	6 Months (%)
Cavitary TB (n=75)	72%	92%
Non-Cavitary TB (n=75)	85%	98%
p-value	0.01	0.03

Table 3: Symptom Resolution Rates at 6 Months

Symptom	Cavitary TB (n=75)	Non-Cavitary TB (n=75)	p-value
Cough	34%	22%	0.04
Fever	20%	10%	0.05
Weight Loss	18%	8%	0.03

Table 4: Adverse Drug Reactions (ADR)

Adverse Reaction	Cavitary TB (n=75)	Non-Cavitary TB (n=75)	p-value
Gastrointestinal (Nausea, Vomiting)	14%	5%	0.02
Hepatotoxicity (ALT > 40 U/L)	16%	9%	0.01
Peripheral Neuropathy	6%	2%	0.04

Table 5: Length of Stay and Mortality

Group	Length of Stay (Days)	In-Hospital Mortality (%)
Cavitary TB (n=75)	9.4 ± 3.5	22.5%
Non-Cavitary TB (n=75)	6.8 ± 2.9	12.5%
p-value	<0.001	0.03

Table 6: Hepatotoxicity by Hepatitis B/C Status

Hepatitis Status	Cavitary TB (n=75)	Non-Cavitary TB (n=75)
HBV/HCV Positive (overall %)	80%	75%
Hepatotoxicity in HBV/HCV Positive (%)	28%	14%
Hepatotoxicity in HBV/HCV Negative (%)	5%	3%

Table 7: Hepatotoxicity by Child-Pugh Class

Child-Pugh Class	Hepatotoxicity (%)	Length of Stay (Days, mean ± SD)	In-Hospital Mortality (%)
Class B	9%	7.8 ± 2.6	12%
Class C	24%	10.6 ± 3.9	28%

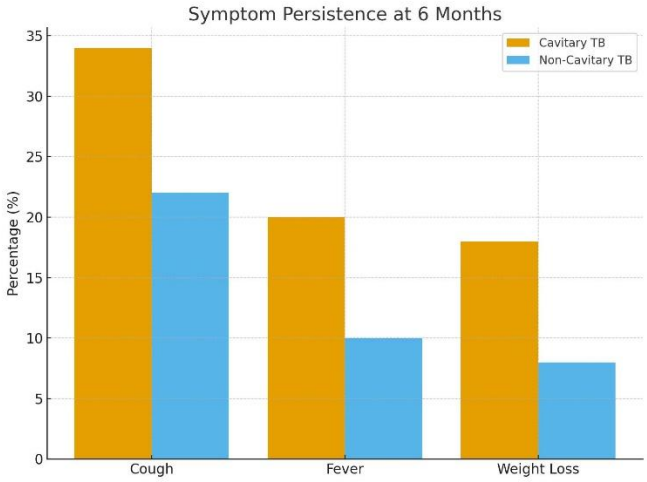

Figure 1 Symptom Persistence at 6 Months

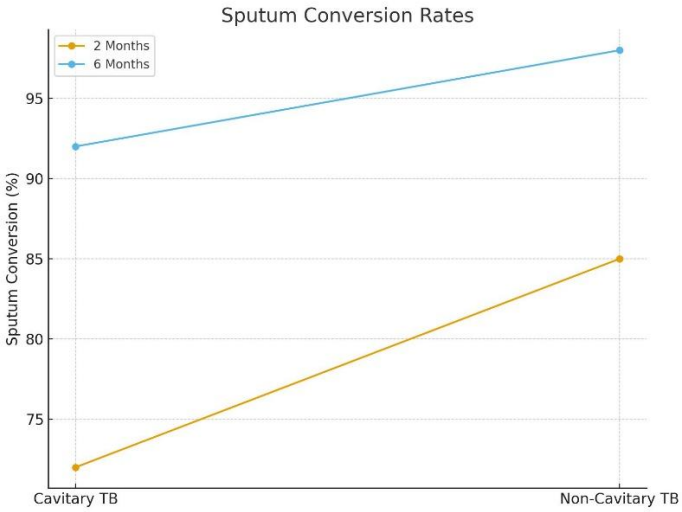

Figure 2 Sputum Conversion Rates

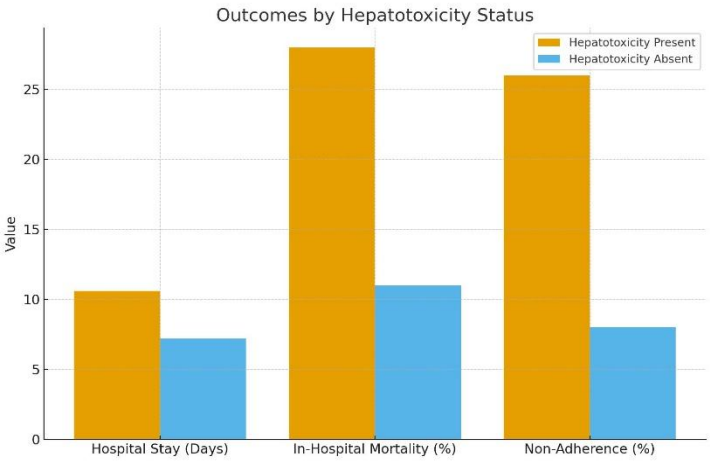

Figure 3 Outcomes by Hepatotoxicity Status

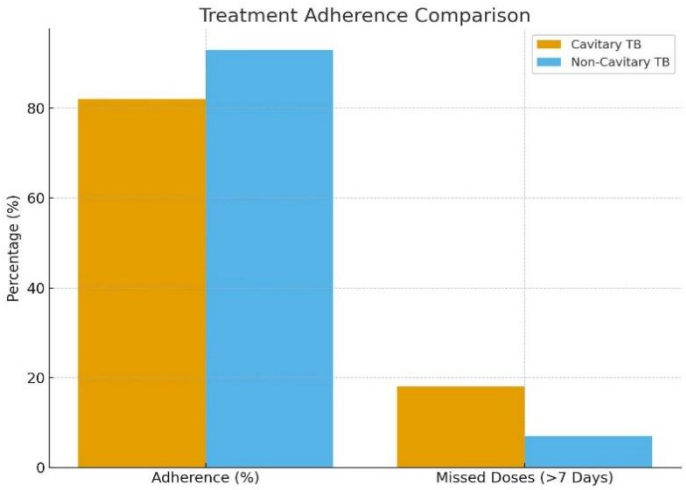

Figure 4 Treatment Adherence Comparison

DISCUSSION

The findings of the present study demonstrated that cavitary pulmonary tuberculosis (TB) represented a more severe clinical phenotype, showing a consistently slower response to treatment, a higher frequency of adverse drug reactions, and poorer short-term outcomes compared with non-cavitary TB. The delayed sputum conversion observed among cavitary TB patients reflected a well-established association between cavitary lesions and prolonged bacterial persistence. The markedly lower conversion rate at two months, and the slightly reduced rate at six months, were consistent with prior evidence indicating that extensive tissue necrosis, impaired drug penetration, and elevated mycobacterial burden within cavitary lesions contribute to slower bacteriological clearance (13–15). Although most patients in both groups achieved sputum negativity by the end of therapy, the persistent gap suggested that patients with cavitary

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TB required closer monitoring and potentially extended treatment durations, as supported by global TB management recommendations (16). Symptom resolution followed a similar pattern, with cavitary TB patients exhibiting a higher prevalence of persistent cough, fever, and weight loss. These observations aligned with previous literature highlighting delayed radiological and clinical improvement in cavitary disease (17). Chronic inflammatory activity and residual structural damage likely accounted for the slower symptom recovery. The findings underscored the importance of comprehensive follow-up, including respiratory rehabilitation, nutritional support, and timely reassessment of treatment response, particularly in patients with significant cavitary involvement. Adverse drug reactions were more frequent among cavitary TB patients, particularly hepatotoxicity, gastrointestinal intolerance, and peripheral neuropathy. This pattern was in accordance with earlier studies documenting enhanced susceptibility to drug-induced toxicity in patients with extensive disease burden and systemic inflammation (18,19). The high prevalence of hepatitis B and C in this cohort may have further amplified the risk of hepatotoxicity. These outcomes reinforced the need for vigilant biochemical monitoring, early identification of toxicity, and personalized dose adjustments to reduce treatment interruptions and prevent severe adverse events.

Length of hospital stay and mortality were both significantly higher among cavitary TB patients. These findings reflected the greater clinical burden, more severe pulmonary destruction, and higher risk of complications associated with cavitation. Previous work has similarly linked cavitary TB with longer hospitalization, recurrent complications, and increased mortality (20). The current results therefore highlighted the need for early detection of cavitation, aggressive management of comorbidities, and enhanced inpatient care strategies to mitigate the excess risk. The study's strengths included its direct comparison of two clinically distinct TB phenotypes within the same treatment framework and its evaluation of multiple clinically relevant outcomes. The use of standardized ATT regimens allowed meaningful comparison of treatment response. However, several limitations must be acknowledged. The study design was cross-sectional despite the assessment of longitudinal outcomes, creating methodological ambiguity. Radiological improvement was not evaluated, limiting understanding of structural recovery. Treatment adherence, although a stated objective, was not systematically measured, and no multivariate analysis was performed to adjust for confounders such as viral hepatitis or baseline liver function. Additionally, the study population was restricted to a single center, limiting generalizability to broader TB-affected communities. Future research would benefit from a prospective cohort design with serial radiological assessments, detailed adherence monitoring, and comprehensive analysis of predictors influencing treatment outcomes. Further exploration of host–pathogen interactions in cavitary disease, the role of nutritional interventions, and optimal follow-up intervals may also enhance TB management strategies (21,22). Overall, the study reaffirmed that cavitary TB represented a clinically demanding form of the disease with slower recovery, higher toxicity, and poorer outcomes. Early identification, individualized management, and strengthened follow-up protocols remain essential to improving treatment success and reducing the burden of complications in patients with cavitary pulmonary TB.

CONCLUSION

This study demonstrated that cavitary pulmonary tuberculosis represents a more severe clinical form of the disease, showing slower treatment response, greater susceptibility to adverse drug reactions, and poorer short-term outcomes compared with non-cavitary TB. These findings affirm that cavitation is an important marker of disease severity and should guide clinical decision-making. The results underscore the value of early diagnosis, strengthened monitoring, and individualized supportive care to improve therapeutic outcomes in affected patients. Prioritizing cavitary TB cases for closer follow-up and timely management may help reduce complications and mortality. Future multicenter and longitudinal studies are warranted to explore relapse patterns and evaluate whether tailored or extended treatment strategies can further enhance outcomes for this high-risk population.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Khayam*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Maryam Hussain	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Fiza Gul	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Rabia Parveen	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Yaseen	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Shahnawaz Khan	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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