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PREVALENCE OF MULTIDRUG-RESISTANT TUBERCULOSIS AMONG PULMONARY TB PATIENTS IN A HIGH-BURDEN REGION: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Multidrug-resistant tuberculosis (MDR-TB) poses a growing threat to global TB control, especially in high-burden regions with limited diagnostic and treatment resources.
Objective: To determine the prevalence of MDR-TB among pulmonary TB patients in a high-burden region and to identify clinical and demographic factors associated with drug resistance.
Methods: This descriptive cross-sectional study was conducted at tertiary care hospital Lahore from November 2024 to April 2025. A total of 225 confirmed pulmonary TB patients were enrolled using non-probability consecutive sampling. Drug resistance was assessed using GeneXpert MTB/RIF and Line Probe Assay. Demographic, clinical, and adherence-related data were collected.
Results: The overall prevalence of MDR-TB was 20.9%. Among previously treated patients, the prevalence was significantly higher at 35.2%, compared to 11.7% in newly diagnosed cases ($p < 0.001$). MDR-TB was also significantly associated with HIV co-infection ($p = 0.02$), irregular treatment adherence ($p = 0.001$), and known contact with MDR-TB cases ($p = 0.03$). Additional resistance to ethambutol and streptomycin was noted in 31.9% and 25.5% of MDR-TB patients, respectively. Extensively drug-resistant TB (XDR-TB) was identified in 1.3% of cases.
Conclusion: It is concluded that MDR-TB is alarmingly prevalent in this high-burden region, particularly among retreatment cases and patients with poor adherence. These findings highlight the need for early drug resistance screening, patient education, and strengthening of treatment monitoring and support systems to prevent the emergence and spread of MDR and XDR-TB.

Introduction

Tuberculosis (TB) remains a critical global health challenge, especially in low- and middle-income countries where the burden of disease is highest. According to the World Health Organization (WHO), TB caused approximately 1.3 million deaths among HIV-negative individuals in 2022 and remains among the top 10 causes of death worldwide [1]. Even though TB is an entirely preventable and curable illness, the progression of its occurrence has been made tricky with the evolution of drug-resistant compound forms, especially multidrug-resistant tuberculosis (MDR-TB) [2]. MDR-TB is characterized by resistance against at least two most effective first-line anti-tuberculosis drugs, including isoniazid and rifampicin. The rising spread of MDR-TB has compromised the TB control efforts in most parts of the world and poses a great risk to the health of the population, especially where TB is highly prevalent [3]. The high-burden areas, which are usually overcrowded, impoverished, nutritionally poor, and lack proper healthcare facilities, make the perfect setting to allow transmissions and sustain TB. This is even more dangerous in the case of misuse of first-line anti-TB by ineffective adherence, improper prescribing, or lack of supply of drugs [4]. These increased occurrences are a direct resultant effect that leads to the building up of drug-resistant strains. In addition, few fast-diagnostic tests to detect drug resistance imply that many cases of MDR-TB go unnoticed and unsolved, resulting in continuous spreading. Most of these environments do not allow routine drug-susceptibility testing (DST), or, when available, it has received little uptake; thus, patients are usually receiving standard treatment regimens despite their drug resistance or not [5]. MDR-TB is not only a clinical problem, but it will also impose heavy economic costs to the patient, families, and national health dispensary. The treatment usually invokes long-term exposure (18-24 months) to second-line drugs that are more toxic, less effective, and significantly more expensive to use when compared to normal therapy. Also, the adverse reactions of such medicines may mean weak adherence to the treatment and elevated default levels, which aggravate the diagnosis [6]. The overall cure rate of MDR-TB remains at approximately 60 percent, which drastically drops compared to drug-sensitive TB, which recorded a cure rate of about 85 percent, further highlighting the necessity to detect and provide a personalized approach to treatment [7]. Emerging data suggest that the burden of MDR-TB is unevenly distributed within countries and is often concentrated in urban, impoverished, or previously conflict-affected areas. In such high-burden regions, the prevalence of MDR-TB among new and previously treated pulmonary TB cases varies widely, with some studies reporting resistance rates exceeding 20% in retreatment cases [8]. Prior TB treatment, lack of adherence to DOTS (Directly Observed Treatment, Short-Course), HIV co-infection, and exposure to known MDR-TB contacts are considered major risk factors [9]. However, regional surveillance is inconsistent, and few studies provide real-time estimates of MDR-TB prevalence at the local or district level gaps that severely limit strategic planning and resource allocation. The current study seeks to address this gap by estimating the prevalence of MDR-TB among patients with pulmonary TB in a defined high-burden region [10].

Objective

To determine the prevalence of MDR-TB among pulmonary TB patients in a high-burden region and to identify clinical and demographic factors associated with drug resistance.

Methodology

This was a descriptive cross-sectional study at tertiary care hospital Lahore from November 2024 to April 2025. A total of 225 patients with confirmed pulmonary tuberculosis were enrolled in the study. Non-probability consecutive sampling was

used to recruit eligible participants from outpatient and inpatient TB clinics.

Inclusion Criteria:

- Adults aged 18 years and above.
- Confirmed diagnosis of pulmonary TB based on sputum smear microscopy, GeneXpert MTB/RIF assay, or culture.
- Patients willing to undergo drug susceptibility testing (DST).
- Informed consent provided.

Exclusion Criteria:

- Patients with only extrapulmonary TB.
- Individuals previously diagnosed and currently undergoing treatment for MDR-TB.
- Patients with incomplete medical records or those unwilling to participate.

Data Collection

After obtaining informed consent, demographic and clinical information were recorded using a structured questionnaire. Variables included age, gender, residence, socioeconomic status, history of previous TB treatment, HIV status, and known contact with drug-resistant TB cases. Each patient provided sputum samples, which were processed using the GeneXpert MTB/RIF assay for initial detection of rifampicin resistance. Patients with rifampicin resistance or high clinical suspicion were further subjected to culture and Line Probe Assay (LPA) or phenotypic DST to confirm multidrug resistance (resistance to both isoniazid and rifampicin). MDR-TB was defined as TB resistant to at least both isoniazid and rifampicin, detected by GeneXpert, LPA, or phenotypic DST.

Data Analysis

Data were entered into and analyzed using SPSS version 26. Descriptive statistics were used to summarize demographic and clinical variables. The prevalence of MDR-TB was calculated as a proportion of confirmed MDR cases among all pulmonary TB patients. Chi-square tests were applied to identify associations between MDR-TB and potential risk factors. A p-value of less than 0.05 was considered statistically significant.

Results

data were collected from 225 patients, the mean age was 41.7 ± 14.6 years, with a male predominance (60.4%). A majority of patients resided in urban areas (62.2%) and belonged to a low socioeconomic background (69.8%). Previously treated TB cases accounted for 39.1% of the sample, while 60.9% were new diagnoses. HIV co-infection was present in 11.6% of the participants.

Table 1: Demographic and Clinical Characteristics (n = 225)

Characteristic	Value
Total Patients	225
Mean Age (years)	41.7 ± 14.6
Gender: Male	136 (60.4%)
Gender: Female	89 (39.6%)
Urban Residence	140 (62.2%)
Low Socioeconomic Status	157 (69.8%)
Previously Treated TB	88 (39.1%)
New TB Cases	137 (60.9%)
HIV Co-infection	26 (11.6%)

Among the 225 pulmonary TB patients, a total of 47 were diagnosed with MDR-TB, resulting in an overall prevalence of 20.9%. The prevalence was significantly higher in previously treated cases (35.2%) compared to new cases (11.7%), indicating a strong association between treatment history and the development of drug resistance.

Table 2: Prevalence of MDR-TB

Group	MDR-TB Cases (n)	Prevalence (%)
Total Patients	47	20.9%
New Cases	16	11.7%

Previously Treated Cases	31	35.2%

All 47 MDR-TB patients in the study showed resistance to both isoniazid and rifampicin. Additional resistance to ethambutol was observed in 31.9% of these cases, while 25.5% also exhibited resistance to streptomycin. Notably, 1.3% of the MDR-TB patients met the criteria for extensively drug-resistant TB (XDR-TB), indicating a more severe resistance profile with limited treatment options.

Table 3: Additional Drug Resistance Among MDR-TB Patients (n = 47)

Drug Resistance Pattern	Number of Patients	Percentage (%)
Isoniazid + Rifampicin (MDR-TB)	47	100%
+ Ethambutol	15	31.9%
+ Streptomycin	12	25.5%
Extensively Drug-Resistant (XDR-TB)	3	1.3%

The study identified several factors significantly associated with MDR-TB. A previous history of TB treatment showed the strongest association ($p < 0.001$), indicating its major role in resistance development. HIV co-infection ($p = 0.02$) and irregular adherence to TB therapy ($p = 0.001$) were also significantly linked to MDR-TB. Additionally, contact with a known MDR-TB case was a notable risk factor ($p = 0.03$).

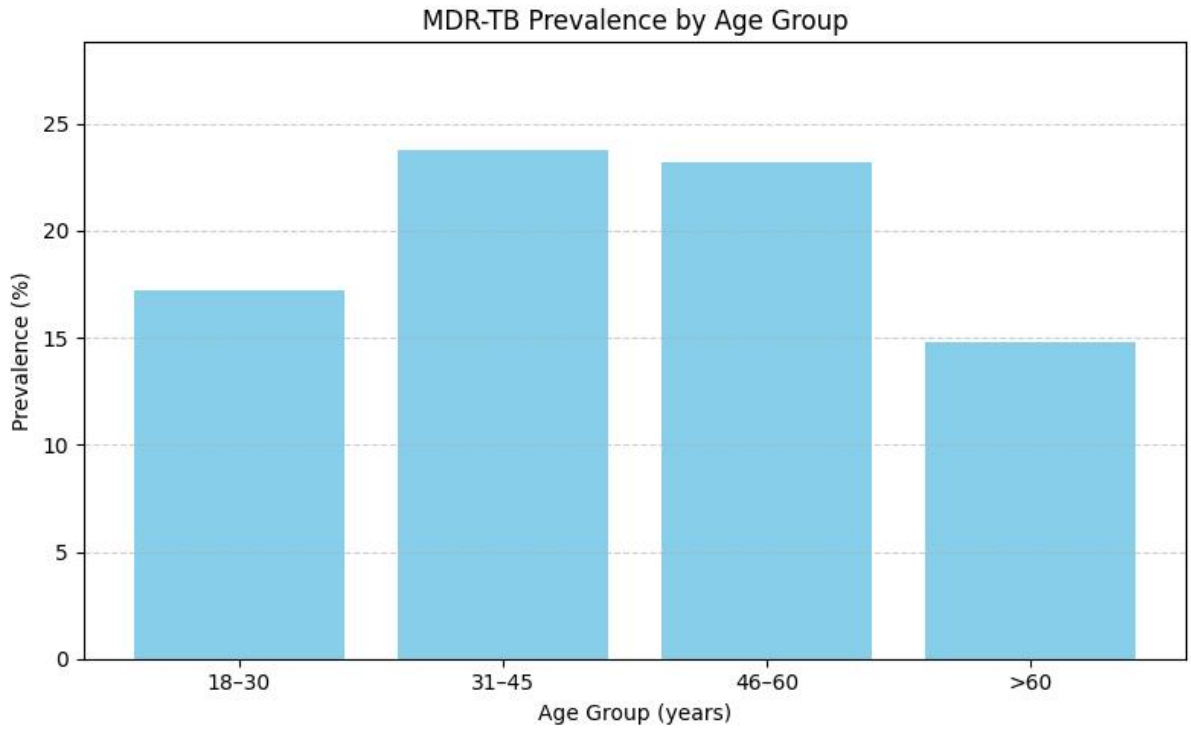
Table 4: Factors Associated with MDR-TB

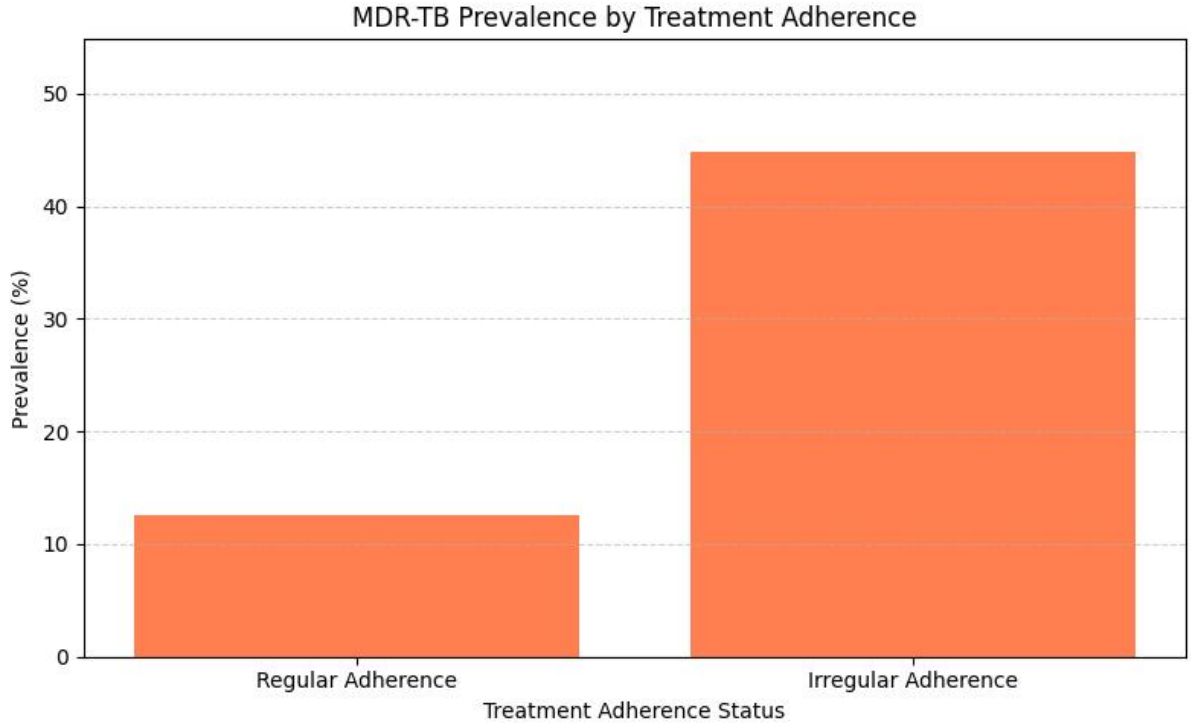
Associated Factor	p-value
Previous TB Treatment	<0.001
HIV Co-infection	0.02
Irregular Treatment Adherence	0.001
Known Contact with MDR-TB Case	0.03

MDR-TB prevalence varied across age groups, with the highest rates observed in the 31–45 (23.8%) and 46–60 (23.2%) age brackets, suggesting increased vulnerability in the economically active population. Younger patients (18–30) had a prevalence of 17.2%, while those above 60 showed the lowest rate at 14.8%. Treatment adherence had a marked impact on resistance patterns—only 12.6% of patients with regular adherence developed MDR-TB, compared to 44.8% among those with irregular adherence, indicating a strong link between noncompliance and drug resistance.

Table 5: Distribution of MDR-TB Cases by Age Group

Age Group (years)	Total TB Patients (n)	MDR-TB Cases (n)	Prevalence (%)
18–30	58	10	17.2%
31–45	84	20	23.8%
46–60	56	13	23.2%
>60	27	4	14.8%
Treatment Adherence Status			
Regular Adherence	167	21	12.6%
Irregular Adherence	58	26	44.8%





Discussion

This study assessed the prevalence of multidrug-resistant tuberculosis (MDR-TB) among pulmonary TB patients in a high-burden region and identified associated risk factors. The observed prevalence of MDR-TB was 20.9%, a figure that is consistent with data from other high-burden countries where MDR-TB rates among pulmonary cases commonly range from 15% to 30%. These findings reaffirm that MDR-TB remains a pressing challenge in TB-endemic settings, particularly in communities with limited diagnostic access, treatment interruptions, and high rates of reinfection. The prevalence was notably higher among patients with a prior history of TB treatment (35.2%) compared to newly diagnosed cases

(11.7%). This aligns with global evidence showing that previous treatment is the most significant risk factor for the development of drug resistance. Inadequate or incomplete treatment regimens, poor adherence to therapy, and drug stockouts contribute to the selection of resistant *Mycobacterium tuberculosis* strains. These findings stress the importance of strengthening Directly Observed Therapy (DOT) and ensuring uninterrupted access to first-line anti-TB drugs [11].

Our study also revealed significant associations between MDR-TB and other clinical variables. HIV co-infection was present in 11.6% of the total sample and was significantly associated with MDR-TB ($p = 0.02$). Immunocompromised individuals are not only more susceptible to TB infection but may also have atypical presentations that complicate early diagnosis and increase the likelihood of incomplete or ineffective treatment, ultimately contributing to resistance [12]. A particularly concerning finding was the high prevalence of MDR-TB among patients with irregular treatment adherence. Among those who did not adhere regularly to TB treatment, 44.8% were MDR-TB positive, compared to just 12.6% in patients who completed treatment as prescribed. This association ($p = 0.001$) highlights the critical role of patient education, counseling, and consistent follow-up in TB control programs [13].

Age-wise distribution showed that MDR-TB was most prevalent in the 31–45 and 46–60 age groups. These are economically productive age groups, and resistance in this population can have broader socioeconomic impacts due to prolonged illness, disability, and loss of income. Moreover, patients in these age brackets may have greater mobility and social exposure, potentially contributing to wider community transmission of resistant strains [14]. Additional resistance to second-line drugs, such as ethambutol and streptomycin, was also documented in a significant proportion of MDR-TB patients [15]. Alarmingly, 3 cases (1.3%) of extensively drug-resistant TB (XDR-TB) were identified, posing further therapeutic and public health challenges. XDR-TB is associated with even poorer treatment outcomes and limited therapeutic options, necessitating urgent public health intervention and the use of novel agents or individualized regimens [16] [17]. These findings underscore the need for universal drug susceptibility testing (DST), particularly in patients with prior treatment history or suspected treatment failure. Rapid molecular diagnostic tools like GeneXpert and Line Probe Assays should be expanded and made accessible in peripheral and rural health settings. Furthermore, community-based interventions focusing on adherence support, stigma reduction, and nutritional supplementation may improve treatment outcomes and reduce resistance.

Conclusion

It is concluded that multidrug-resistant tuberculosis (MDR-TB) remains a significant public health concern among pulmonary TB patients in high-burden regions. The study found a notably high prevalence of MDR-TB, particularly among patients with a history of previous TB treatment, irregular adherence to therapy, and HIV co-infection. These findings reinforce the critical need for early drug susceptibility testing, especially in retreatment cases, and for scaling up rapid diagnostic tools like GeneXpert in primary care settings. Moreover, the strong association between MDR-TB and poor treatment adherence underscores the importance of patient-centered interventions, including counseling, community health support, and robust follow-up mechanisms.

Author Contribution

Aliya: Conceived the study, supervised data collection, and finalized the manuscript.

Muhammad Waqar Ali: Conducted statistical analysis and assisted in result interpretation.

Tuba Alim: Performed literature review and contributed to manuscript writing.

Abdullah Nawaz: Collected patient data and maintained clinical documentation.

Umbreen Farrukh: Developed methodology and formatted references.

Kashan Ali,Faiza Umoodi: Cleaned and organized data, drafted the result section and contributed to manuscript writing.

Laiba Shoaib: Proofread the manuscript and managed citations.

All authors read and approved the final version.

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