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PREVALENCE AND PUBLIC HEALTH IMPACT OF MULTIDRUG-RESISTANT TUBERCULOSIS IN LOW-INCOME COMMUNITIES

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ABSTRACT

Background: This study aimed to assess the prevalence and public health impact of multidrug-resistant tuberculosis (MDR-TB) in low-income communities, with a focus on identifying key risk factors, symptom burden, and socioeconomic consequences.

Materials and Methods: A cross-sectional study was conducted among 200 participants in community health centers and public hospitals located in underserved urban slums and rural areas. Participants were selected based on clinical suspicion of TB or a history of prior TB treatment. Data collection included clinical and laboratory assessments, drug susceptibility testing, and structured interviews. Primary outcomes were MDR-TB prevalence, symptom burden, and time to diagnosis and treatment initiation. Secondary outcomes examined socioeconomic impacts, treatment adherence, adverse events, and household transmission.

Results: MDR-TB prevalence was found to be 30% among participants, with significant associations observed with prior TB treatment, contact with TB-infected individuals, and comorbid conditions ($p<0.05$). The average time to diagnosis and treatment initiation was 15.3 and 20.5 days, respectively. Socioeconomic impacts included a decrease in employment from 40% to 27.5% and a reduction in average household income by INR 2,250. Quality of life improved following treatment, but adverse events were reported by 33.3% of participants, and 7.5% experienced secondary household transmission.

Conclusion: MDR-TB poses a significant public health and socioeconomic challenge in low-income communities. The findings highlight the urgent need for targeted interventions, improved diagnostic access, and comprehensive support systems to reduce MDR-TB transmission and support affected individuals.

Keywords: Multidrug-resistant tuberculosis, public health impact, low-income communities, socioeconomic burden, drug resistance.

INTRODUCTION

Multidrug-resistant tuberculosis (MDR-TB) is a significant global health challenge, particularly in low-income communities where resources for prevention, diagnosis, and treatment are limited. MDR-TB is caused by strains of *Mycobacterium tuberculosis* that are resistant to at least isoniazid and rifampicin, two of the most effective first-line anti-TB drugs. This resistance complicates treatment, prolongs illness, and increases the risk of transmission within communities. The rise of MDR-TB has serious implications for public health, as the disease is more difficult to treat and requires prolonged use of second-line drugs, which are often more toxic, expensive, and less effective. The World Health Organization has classified MDR-TB as one of the primary threats to TB control efforts, with low-income areas facing the brunt of the epidemic due to limited healthcare access and socioeconomic vulnerabilities.[1] The spread of MDR-TB in low-income communities is influenced by several

factors, including poor living conditions, high population density, limited healthcare resources, and high rates of other diseases such as HIV. These factors create an environment where MDR-TB can thrive and spread rapidly. Overcrowded living conditions, often found in urban slums and informal settlements, facilitate close contact among residents, increasing the likelihood of airborne transmission. Similarly, a lack of ventilation, inadequate sanitation, and compromised nutrition can weaken immune responses, making individuals more susceptible to TB and other respiratory infections. These communities frequently experience barriers to timely diagnosis and effective treatment, contributing to a higher likelihood of incomplete or inadequate treatment, which further drives drug resistance. In low-income settings, access to healthcare services is often limited due to economic constraints, lack of facilities, and inadequate staffing. Many individuals with TB symptoms may delay seeking care or avoid it altogether due to financial hardships, resulting in advanced disease stages by the time they reach a healthcare provider. When they do seek care, diagnostic and treatment resources for MDR-TB are often insufficient or unavailable, leading to misdiagnosis or incomplete treatment. The absence of comprehensive drug susceptibility testing further complicates early identification of MDR-TB, meaning patients may be placed on ineffective treatment regimens that do not target resistant strains. This treatment delay not only harms individual patients but also poses a broader risk of transmission within the community. [2] One of the most concerning aspects of MDR-TB is the economic burden it places on affected individuals and communities. Treatment for MDR-TB is lengthy, often requiring patients to be on medication for 18-24 months, compared to the standard six months for drug-susceptible TB. This prolonged treatment not only strains healthcare systems but also impacts patients' financial stability. Many patients in low-income areas face a loss of income due to inability to work, either from prolonged illness or due to the side effects of second-line TB drugs, which can be debilitating. Additionally, the high costs of MDR-TB treatment, including hospitalization, frequent clinic visits, and monitoring of drug side effects, create substantial out-of-pocket expenses. Families are often forced to make difficult decisions, such as prioritizing healthcare expenses over basic needs, leading to a cycle of poverty and illness that is difficult to escape.[3] The public health impact of MDR-TB extends beyond the individuals directly affected, influencing entire communities. Household transmission is a critical concern, particularly in overcrowded settings where family members, including vulnerable populations such as children and the elderly, are at increased risk of exposure. Within these communities, MDR-TB can quickly spread, with family members of infected individuals often at the forefront of secondary infections. Additionally, stigma and discrimination associated with TB, and particularly MDR-TB, discourage individuals from seeking care or disclosing their illness. Stigmatization can isolate patients and their families, creating social barriers to support and further complicating effective disease management and prevention.[4] From a healthcare perspective, MDR-TB poses unique challenges in terms of treatment and control. Second-line drugs used to treat MDR-TB have more severe side effects, including hearing loss, kidney damage, and mental health effects. Patients often experience treatment fatigue due to the long duration and adverse reactions associated with MDR-TB medications, which can lead to poor adherence and increased risk of further resistance. For healthcare providers, managing MDR-TB patients in low-resource settings is demanding, as it requires specialized training, access to high-cost drugs, and regular monitoring of treatment outcomes. Healthcare systems in low-income communities frequently lack the resources to provide adequate follow-up care, support treatment adherence, or monitor for potential adverse drug reactions, which are critical to preventing the development of extensively drug-resistant TB (XDR-TB).[5] The prevalence of MDR-TB in low-income communities is thus both a medical and social issue, necessitating a multifaceted approach that addresses the underlying social determinants of health. Improved access to diagnostic facilities, targeted public health interventions, and education programs can all play a role in preventing and controlling MDR-TB. Public health strategies must focus on ensuring timely diagnosis, accessible treatment, and community-based support systems to reduce the spread of MDR-TB and mitigate its impact. Moreover, there is a pressing need for global and national health organizations to invest in resources and infrastructure to strengthen TB control programs in low-income areas. Addressing MDR-TB in these communities is essential not only to improve the lives of those directly affected but also to protect global health security by preventing further spread of this dangerous, drug-resistant form of tuberculosis.[6]

MATERIALS AND METHODS

This cross-sectional study was conducted to assess the prevalence and public health impact of multidrug-resistant tuberculosis (MDR-TB) in low-income communities. The study was carried out in selected community health centers and public hospitals in underserved regions, including urban slums and rural areas. The study included a total of 200 participants, who were selected based on clinical suspicion of tuberculosis (TB) and eligibility for drug susceptibility testing. Participants were both males and females aged 18 years and

older, with either a recent TB diagnosis or a history of prior TB treatment.

Sampling Technique

A purposive sampling method was utilized to recruit participants from areas identified by local health authorities as having high TB prevalence. Healthcare workers at each site facilitated recruitment, approaching eligible individuals during TB testing and treatment visits.

Data Collection Procedures

Data collection for this study involved comprehensive clinical and laboratory assessments, along with structured interviews to gather information on sociodemographic characteristics and potential risk factors associated with multidrug-resistant tuberculosis (MDR-TB). Clinical assessments began with collecting detailed clinical histories from each participant, including information on any previous TB treatment, known contact with individuals infected with TB, and co-existing health conditions such as HIV/AIDS and diabetes, which are recognized as risk factors for MDR-TB. Physical examinations were also performed to document the presence and severity of TB-related symptoms, including persistent cough, fever, night sweats, and significant weight loss.

For the laboratory component, sputum samples were obtained from each participant. Two sputum samples per participant were collected and subsequently cultured to identify Mycobacterium tuberculosis. The samples underwent drug susceptibility testing (DST) to detect resistance to isoniazid and rifampicin, the two primary first-line anti-TB drugs, in accordance with protocols established by the World Health Organization (WHO). This process allowed for accurate identification of MDR-TB cases.

In addition to clinical and laboratory data, sociodemographic and environmental risk factor information was collected through a structured questionnaire administered to all participants. This questionnaire gathered data on a range of personal and environmental factors, including sociodemographic characteristics, socioeconomic status, smoking and alcohol use, and details regarding participants' living conditions, such as household overcrowding and sanitation quality. Additionally, information on participants' access to healthcare services and adherence to prior TB treatment regimens was recorded to assess potential barriers to effective TB management.

Outcome Measures

The primary outcomes for this study included the prevalence of multidrug-resistant tuberculosis (MDR-TB), symptom burden, and time to detection and treatment initiation. The prevalence of MDR-TB was defined as the proportion of tuberculosis cases resistant to both isoniazid and rifampicin among the total sample of participants. Symptom burden was measured using a composite severity score, incorporating clinical indicators such as the duration of cough, degree of weight loss, and intensity of fever. Another critical primary outcome was the time to detection and treatment initiation, calculated as the number of days from sputum sample collection to the diagnosis and commencement of MDR-TB-specific treatment.

The secondary outcomes focused on evaluating the broader impacts of MDR-TB on patients and their households. The socioeconomic impact of an MDR-TB diagnosis was assessed by tracking changes in participants' employment status, household income, and healthcare expenses over a six-month period following diagnosis. Treatment adherence was monitored by recording the proportion of participants who completed the full course of MDR-TB treatment as per the prescribed regimen, with data gathered from treatment logs and patient self-reports. Additionally, the incidence of adverse events during treatment was documented, capturing the frequency and severity of adverse drug reactions (ADRs) experienced by participants.

Quality of life (QoL) was assessed using the WHO Quality of Life-BREF (WHOQOL-BREF) scale, with baseline measurements taken and compared to scores after six months to determine the effect of MDR-TB and its treatment on overall well-being. Finally, the study explored the impact of MDR-TB on household members' health by documenting any cases of TB transmission within the household, especially among vulnerable individuals such as children and the elderly, to assess potential secondary cases linked to the primary MDR-TB patients.

Data Analysis

Data analysis was conducted using SPSS version 26.0. Descriptive statistics summarized demographic, clinical, and risk factor data. The prevalence of MDR-TB was calculated as a proportion of cases among the total 200 participants. Logistic regression analysis identified factors associated with MDR-TB, with adjusted odds ratios (ORs) and 95% confidence intervals (CIs). For secondary outcomes, paired t-tests and chi-square tests were used to assess changes in socioeconomic and quality-of-life parameters over time. Statistical significance was set at $p < 0.05$.

RESULTS

Demographic Characteristics of Study Participants

The study included 200 participants, with a gender distribution of 55% male and 45% female, and a statistically significant association with MDR-TB prevalence by gender (p=0.032). The age distribution revealed that 25% of participants were aged 18-30 years, 35% were 31-45 years, 30% were 46-60 years, and 10% were over 60 years, with younger age groups showing a significant association (p=0.041). Employment status showed that 40% of participants were employed, 45% were unemployed, and 15% were retired. Employment

was significantly associated with MDR-TB prevalence (p=0.015). In terms of education, 30% of participants had no formal education, 40% had completed primary education, 25% had completed secondary education, and 5% had higher education, with those without formal education showing a significant association (p=0.028). Most participants (65%) were classified as low socioeconomic status, followed by 25% medium and 10% high, with a significant association observed between low socioeconomic status and MDR-TB prevalence (p=0.049). Smoking was common, with 35% of participants identified as current smokers, showing a significant association (p=0.021). Additionally, 20% of participants reported alcohol consumption, which was also significantly associated with MDR-TB prevalence (p=0.045).

Clinical Parameters of Participants

Regarding TB history, 60% of participants had previously been treated for TB, a factor significantly associated with MDR-TB (p=0.038). Contact with TB-infected individuals was equally distributed, with 50% reporting close contact and showing significant association (p=0.027). Comorbid conditions included 15% with HIV/AIDS and 20% with diabetes, with 5% having both, and comorbid HIV/AIDS was significantly associated with MDR-TB prevalence (p=0.022). In terms of symptoms, 90% of participants presented with a persistent cough (p=0.030), 75% had a fever, 50% experienced night sweats, and 65% had weight loss, indicating the clinical severity among MDR-TB patients.

Laboratory Parameters of Participants

In terms of drug resistance, 30% of participants tested positive for resistance to both isoniazid and rifampicin, which was significantly associated with MDR-TB cases (p=0.017). All participants (100%) had a positive sputum culture for Mycobacterium tuberculosis, with no negative results, showing a strong significance (p=0.001). Drug susceptibility testing revealed that 30% of participants were resistant to isoniazid and 30% to rifampicin, while 70% were sensitive to both drugs, with resistance to isoniazid showing a significant association (p=0.036).

Primary Outcomes of the Study

The prevalence of MDR-TB among the participants was 30% (60/200), with a statistically significant association (p=0.015). Symptom burden was assessed with a mean severity score of 6.8 (±1.5), showing a significant impact on patients' health (p=0.020). The average time to diagnosis from initial sample collection was 15.3 days (±4.1), with treatment initiation occurring after an average of 20.5 days (±5.3), both showing statistical significance (p=0.032 and p=0.025, respectively).

Secondary Outcomes of the Study

The socioeconomic impact of MDR-TB was considerable. Employment status dropped from 40% at baseline to 27.5% at the six-month follow-up, with a significant change (p=0.045). Average household income decreased from INR 9,000 (±3,750) at baseline to INR 6,750 (±3,375) after six months, which was also significant (p=0.030). Healthcare expenses rose from an average of INR 2,250 (±1,125) to INR 3,000 (±1,500), showing a significant financial burden (p=0.037). In terms of treatment adherence, 83.3% (50/60) of participants with MDR-TB completed the full course of treatment. Adverse events were reported in 33.3% (20/60) of cases, though this parameter was not statistically analyzed. Quality of life, measured by the WHOQOL-BREF score, showed an improvement from a baseline mean of 55.2 (±10.3) to 65.7 (±9.8) after six months, with a significant increase (p=0.018). Household transmission was noted, with 7.5% (15 participants) reporting secondary TB cases within their households, primarily affecting children and the elderly.

Table 1: Demographic Characteristics of Study Participants (N=200)

Variable	Number	Percentage (%)	p-value
Gender			
Male	110	55.0	0.032
Female	90	45.0	-
Age Group			
18-30 years	50	25.0	0.041
31-45 years	70	35.0	-
46-60 years	60	30.0	-
>60 years	20	10.0	-
Employment Status			
Employed	80	40.0	0.015
Unemployed	90	45.0	-
Retired	30	15.0	-
Education Level			
No Formal Education	60	30.0	0.028
Primary Education	80	40.0	-
Secondary Education	50	25.0	-
Higher Education	10	5.0	-
Socioeconomic Status			
Low	130	65.0	0.049
Medium	50	25.0	-
High	20	10.0	-
Smoking Status			

Current Smoker	70	35.0	0.021
Non-Smoker	130	65.0	-
Alcohol Consumption			
Yes	40	20.0	0.045
No	160	80.0	-

Table 2: Clinical Parameters of Participants

Clinical Parameter	Number	Percentage (%)	p-value
History of TB Treatment			
Yes	120	60.0	0.038
No	80	40.0	-
Contact with TB-Infected Individuals			
Yes	100	50.0	0.027
No	100	50.0	-
Comorbid Conditions			
HIV/AIDS	30	15.0	0.022
Diabetes	40	20.0	-
Both HIV/AIDS and Diabetes	10	5.0	-
None	120	60.0	-
Symptoms Present			
Persistent Cough	180	90.0	0.030
Fever	150	75.0	-
Night Sweats	100	50.0	-
Weight Loss	130	65.0	-

Table 3: Laboratory Parameters of Participants

Laboratory Parameter	Number	Percentage (%)	p-value
MDR-TB Positive (Drug Resistance)			
Positive for Isoniazid and Rifampicin	60	30.0	0.017
Negative for MDR-TB	140	70.0	-
Sputum Culture Results			
Positive for Mycobacterium tuberculosis	200	100.0	0.001
Negative	0	0.0	-
Drug Susceptibility Testing (DST)			
Resistant to Isoniazid	60	30.0	0.036
Resistant to Rifampicin	60	30.0	-
Sensitive to Both Drugs	140	70.0	-

Table 4: Primary Outcomes

Outcome Measure	Value	p-value
Prevalence of MDR-TB	60/200 (30.0%)	0.015
Symptom Burden and Severity Score	Mean score: 6.8 (±1.5)	0.020
Time to Detection	Mean days: 15.3 (±4.1)	0.032
Time to Treatment Initiation	Mean days: 20.5 (±5.3)	0.025

Table 5: Secondary Outcomes

Outcome Measure	Baseline	Six-Month Follow-Up	Change (p-value)
Socioeconomic Impact			
Employed Status Post-Diagnosis	80 (40.0%)	55 (27.5%)	p = 0.045
Average Household Income (INR/month)	9,000 (±3,750)	6,750 (±3,375)	p = 0.030
Healthcare Expenses (INR/month)	2,250 (±1,125)	3,000 (±1,500)	p = 0.037
Treatment Adherence			
Completed Full Treatment	50/60 (83.3%)	-	-
Adverse Events During Treatment			
Adverse Reactions Reported	20/60 (33.3%)	-	-
Quality of Life (QoL) Scores			
WHOQOL-BREF Score	55.2 (±10.3)	65.7 (±9.8)	p = 0.018
Household Transmission (Secondary Cases)			
Documented Secondary Cases	15 (7.5%)	-	-

DISCUSSION

The demographic findings of this study align with other research on MDR-TB prevalence across gender, age, socioeconomic status, and lifestyle factors. Our study found a higher prevalence of MDR-TB among males (55%) compared to females, with a statistically significant association (p=0.032). Similar studies have reported comparable gender distributions; for instance, Sharma et al. (2019).[6] reported 58% male and 42% female in an MDR-TB cohort, while Zaman et al. (2020) noted 60% male prevalence, indicating that men may be more at risk due to occupational exposures and lifestyle factors.[7] In terms of age, we found that 60% of participants were aged 18-45 years, with younger age groups showing a significant association with MDR-TB (p=0.041). Singh et al. (2021) reported

similar results, with 62% of their MDR-TB patients under the age of 45, reflecting the higher disease burden among young adults, often linked to delayed healthcare access and greater mobility within high-risk settings.[8]

Employment and socioeconomic status were also significantly associated with MDR-TB prevalence, with unemployed individuals and those of low socioeconomic status exhibiting higher MDR-TB rates (p=0.015 and p=0.049, respectively). A study by Chauhan and Jain (2022) reported that 65% of their MDR-TB sample was unemployed, attributing this to the substantial economic toll and healthcare barriers faced by low-income communities.[9] Education level was another factor, with 30% of participants lacking formal education, showing a significant association with MDR-TB (p=0.028). Wang et al. (2021) found similar associations, reporting 28% of their MDR-TB sample without formal education, underscoring the impact of education on health literacy and adherence to treatment protocols.[10]

Lifestyle factors such as smoking and alcohol consumption were significantly associated with MDR-TB in our study (p=0.021 and p=0.045). Studies by Lee et al. (2020) and Thomas et al. (2021) also found that 34% and 38% of MDR-TB patients, respectively, were current smokers, and noted alcohol as a significant risk factor. Lee et al. concluded that such habits contribute to compromised immunity, potentially accelerating the progression of drug-resistant TB.[11,12]

Our study showed that a history of TB treatment was significantly associated with MDR-TB, with 60% of participants having prior TB treatment (p=0.038). Similar findings were reported by Ramachandran et al. (2020), who observed that 64% of their MDR-TB patients had previous TB, underscoring that incomplete or inadequate treatment is a key risk factor for resistance. Contact with TB-infected individuals was also common, with 50% reporting exposure, and showing significant association (p=0.027).[13] Gupta et al. (2021) similarly found that 52% of MDR-TB patients had a known contact with TB, primarily within household settings, emphasizing the need for better infection control practices.[14]

Comorbid conditions, including HIV/AIDS and diabetes, were significant risk factors for MDR-TB in our study, with HIV/AIDS showing a strong association (p=0.022). WHO (2021) and Patel et al. (2022),[15,16] have also highlighted the vulnerability of immunocompromised patients, with WHO reporting an MDR-TB prevalence of 20% among HIV-positive individuals, comparable to the 15% observed in our study. Symptoms were severe, with 90% of participants presenting with a persistent cough, 75% with fever, 50% with night sweats, and 65% with weight loss, reflecting similar findings by Kumar et al. (2020), who reported high symptom burdens in 88% of their MDR-TB sample.[17]

Our study showed that 30% of participants had resistance to both isoniazid and rifampicin (p=0.017), consistent with WHO (2021), which estimated a dual-resistance rate of around 28% in high-burden regions. All participants tested positive for Mycobacterium tuberculosis (p=0.001), reflecting the 100% positivity rate for sputum culture in MDR-TB patients reported by Patel et al. (2020). Furthermore, 30% of our sample showed resistance to either isoniazid or rifampicin individually, while 70% were sensitive to both drugs, aligning with studies by Patel et al., which found similar resistance levels, highlighting the importance of early drug susceptibility testing to guide appropriate treatment.[18,19]

The prevalence of MDR-TB in our study was 30%, which aligns closely with WHO's (2022) estimate of 28-32% in low-income countries. Symptom burden, with a mean severity score of 6.8, also aligned with Nair et al. (2020), who reported a mean symptom severity score of 6.5 in their cohort of MDR-TB patients. The average time to diagnosis (15.3 days) and treatment initiation (20.5 days) in our study were delayed, consistent with findings by Nair et al., which reported an average delay of 14.5 days for diagnosis and 18 days for treatment initiation, highlighting diagnostic and treatment access barriers in low-resource settings.[20,21]

The socioeconomic impact of MDR-TB was substantial. Employment dropped from 40% to 27.5% (p=0.045), while average household income decreased from INR 9,000 to INR 6,750 (p=0.030). Lal et al. (2021) reported similar impacts, with employment declining by 18% and average income reductions of approximately INR 2,500 among MDR-TB patients, underscoring the long-term economic burden. Healthcare expenses increased from INR 2,250 to INR 3,000 (p=0.037), mirroring Singh et al. (2022), who reported a similar 30% increase in healthcare costs for MDR-TB patients.[21,22]

Treatment adherence in our study was high, with 83.3% completing the course, though adverse reactions were reported by 33.3% of patients. Jain et al. (2020) similarly observed an 80% adherence rate in their MDR-TB sample but reported a higher adverse event rate of 40%, which they attributed to the intensive nature of MDR-TB treatment regimens. [23] Quality of life improved significantly, with WHOQOL-BREF scores rising from 55.2 to 65.7 (p=0.018), consistent with Rao et al. (2021), who observed a similar increase in quality of life scores by 10 points post-treatment in MDR-TB patients.[24]

Lastly, household transmission was reported by 7.5% of participants, comparable to the 8% secondary transmission rate reported by Li et al. (2020), who found that overcrowded households and lack of infection control measures contribute significantly to secondary MDR-TB transmission.[25]

CONCLUSION

In conclusion, this study highlights the significant prevalence and socioeconomic impact of multidrug-resistant tuberculosis (MDR-TB) in low-income communities, underscoring the challenges of disease management in resource-limited settings. Key factors associated with MDR-TB included prior TB treatment, close contact with TB-infected individuals, comorbidities, and low socioeconomic status. The study found that MDR-TB imposes a substantial financial burden on affected individuals, reduces quality of life, and poses a high risk of household transmission. Addressing MDR-TB in these communities requires targeted interventions, improved access to diagnostics and treatment, and support systems to ensure adherence and reduce transmission. Enhanced public health efforts are essential to mitigate the spread and impact of MDR-TB in vulnerable populations.

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