



PREVALENCE AND DETERMINANTS OF RIFAMPICIN RESISTANT TUBERCULOSIS AMONG PATIENTS ATTENDING NATIONAL TUBERCULOSIS AND LEPROSY TRAINING CENTER, SAYE, ZARIA, KADUNA STATE, NIGERIA

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ABSTRACT

Tuberculosis (TB) remains a global health challenge, with Nigeria ranking among the high-burden countries for TB and drug-resistant TB. Rifampicin-resistant TB (RR-TB) poses a significant threat to TB control, given its association with poor outcomes, prolonged treatment, and increased transmission. This study determined the prevalence of *Mycobacterium tuberculosis* (MTB) and the determinants of rifampicin resistance among patients attending the National Tuberculosis and Leprosy Training Center, Saye, Zaria. A cross-sectional study was conducted among 423 presumptive TB patients, with sputum samples analyzed using the GeneXpert MTB/RIF assay. Sociodemographic, clinical, and behavioral information was obtained through structured questionnaires. To identify determinants of rifampicin resistance, chi-square tests were employed for preliminary associations, and logistic regression was applied to determine significant predictors. Due to the limited number of rifampicin-resistant cases (n=5), a nested case-control design was adopted, in which each case was matched with five rifampicin-sensitive controls (1:5 ratio). This strategy optimized statistical power and the precision of estimates without substantially increasing study costs, consistent with established epidemiological recommendations. The mean age of participants was 36.6 years (SD ±18.4), with the 25–34-year age group most represented (22.7%). The prevalence of MTB detected was 14.2%. Chi-square analysis showed significant associations between rifampicin resistance and multiple pulmonary TB episodes (p=0.003), HIV co-infection (p=0.041), exposure to an MDR-TB patient (p=0.023), treatment interruption (p<0.001), poor adherence (p=0.009), and adverse treatment outcomes (p=0.009). Logistic regression confirmed single PTB episode (AOR: 4.96; 95% CI: 1.02–5.82; p=0.010), HIV infection (AOR: 2.39; 95% CI: 1.27–95.18; p=0.029), reported regular medication use (AOR: 6.06; 95% CI: 1.00–4.07; p=0.009), and treatment success (AOR: 5.38; 95% CI: 1.01–6.96; p=0.025) as predictors of rifampicin resistance. The detection of MTB in 14.2% of the study population underscores ongoing community transmission. Rifampicin resistance was strongly influenced by HIV co-infection, prior TB episodes, and treatment-related factors, highlighting both acquired and primary transmission. Strengthening diagnostic coverage, adherence support, and integration of TB/HIV services is essential to curb the spread of drug-resistant TB in Nigeria.

Keywords: Bacterial, Drug Resistance, Nigeria, Pulmonary, Rifampin, Tuberculosis

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INTRODUCTION

Tuberculosis (TB) remains a leading cause of morbidity and mortality worldwide, with an estimated 10.6 million new cases and 1.3 million deaths reported in 2022 [1]. The emergence and spread of drug-resistant forms of *Mycobacterium tuberculosis* have further complicated global control efforts. Of particular concern is rifampicin-resistant TB (RR-TB), which is often used as a proxy for multidrug-resistant TB (MDR-TB) due to the central role of

rifampicin in TB treatment [2]. Patients with RR-TB require longer, more toxic, and less effective treatment regimens, making early detection and prevention of transmission a public health priority [3].

Nigeria is classified among the 30 high-burden countries for TB, TB/HIV, and drug-resistant TB [4]. Reports from NTBLCP estimate that the prevalence of MDR/RR-TB in Nigeria is about 4.3% among new TB cases and 15% among previously treated cases [5]. These figures suggest ongoing community and healthcare-related transmission of resistant strains, compounded by operational and health systems challenges such as limited access to diagnostic tools, treatment interruption, and poor

adherence [6]. Despite ongoing efforts to scale up GeneXpert MTB/RIF testing across the country, there is limited subnational data on the epidemiology and determinants of rifampicin resistance in many regions, including northern Nigeria.

Previous studies in Nigeria and similar high-burden settings have consistently revealed that rifampicin resistance is associated with prior TB treatment episodes, HIV co-infection, exposure to drug-resistant TB patients, and treatment adherence challenges [7–9]. However, most studies have been concentrated in metropolitan centers, leaving gaps in understanding the epidemiological drivers in semi-urban and rural areas where TB burden remains high.

This study was conducted at the National Tuberculosis and Leprosy Training Center (NTBLTC), Saye, Zaria, Kaduna State—one of Nigeria’s major referral centers for TB and leprosy care. By estimating the prevalence of MTB among presumptive TB patients and identifying the determinants of rifampicin resistance, the study provides critical evidence to guide regional TB control strategies. The findings are particularly important for strengthening diagnostic algorithms, enhancing patient adherence, and integrating TB/HIV services to reduce the burden of RR-TB in Nigeria.

The combined cross-sectional and nested case-control design is well-supported by epidemiological methodology. A cross-sectional base allows efficient estimation of *M. tuberculosis* prevalence and rifampicin resistance, while embedding a nested case-control study enhances analytic power in identifying associated determinants, especially when resistant cases are few. Similar approaches have been successfully employed in TB relapse research [10], in the study of comorbidities and TB risk [11], and in antimicrobial resistance emergence in *Klebsiella pneumoniae* [12]. In diagnostic research, nested case-control sampling from a larger diagnostic cohort has been shown to yield accurate and precise estimates comparable to full-cohort studies, with improved efficiency—particularly as control-to-case ratios increase [13]. This study aimed to determine the prevalence of *Mycobacterium tuberculosis* (MTB) and the determinants of rifampicin resistance among patients attending the National Tuberculosis and Leprosy Training Center, Saye, Zaria

MATERIALS AND METHODS

Study area

The study was conducted at the National Tuberculosis and Leprosy Training Centre (NTBLTC), Saye, Zaria, Kaduna State, Nigeria. Established in 1991, NTBLTC serves as a national training and referral institution for tuberculosis (TB) and leprosy control, supporting the National Tuberculosis and Leprosy Control Program (NTBLCP). The center provides inpatient and outpatient care with a 100-bed capacity and offers

integrated TB, leprosy, and HIV services, in addition to operational research. In 2019, the facility enrolled 119 TB patients into Directly Observed Treatment, Short-course (DOTS), and managed nine multidrug-resistant TB (MDR-TB) patients. NTBLTC offers a wide spectrum of laboratory diagnostic services to support accurate diagnosis, treatment monitoring, and disease surveillance, particularly for tuberculosis, leprosy, and HIV-related conditions.

In addition, the Centre places strong emphasis on human resource development as a cornerstone of quality service delivery. NTBLTC is deeply committed to the professional growth and career advancement of its staff and actively promotes continuous learning and capacity building. To this end, staff are regularly engaged in structured training programmes, workshops, mentorship, and other professional development activities aimed at enhancing competence, motivation, and excellence in service delivery.

Study design

A hospital-based cross-sectional study was conducted to determine the prevalence of tuberculosis (TB) and rifampicin resistance among presumptive TB patients. In addition, a case-control design was employed to identify determinants of rifampicin resistance. All confirmed rifampicin-resistant TB (RR-TB) cases were included, with a case-to-control ratio of 1:5, using patients with rifampicin-sensitive TB as controls. The study was conducted between 2 January and 30 June 2019.

Although the study was carried out at the National Tuberculosis and Leprosy Training Centre (NTBLTC), Zaria, the findings may be cautiously generalized to Kaduna State. NTBLTC serves as a major referral and training centre with a wide catchment area encompassing multiple local government areas across the state and operates under standardized National Tuberculosis and Leprosy Control Programme (NTBLCP) diagnostic and treatment guidelines. Nevertheless, as a referral-level facility, the study population may over represent complicated or drug-resistant TB cases, which may limit direct extrapolation to community-based or primary health-care settings.

Sample size determination

The minimum sample size for this study was determined using Cochran’s formula for prevalence studies:

$$n = Z^2 * P(1-P) / d^2$$

where $Z = 1.96$ at a 95% confidence level, $P = 0.5$ (assumed prevalence in the absence of local estimates), and $d = 0.05$ (precision). The calculated minimum sample size was 384. To account for a 10% attrition rate (38.4), the final sample size was adjusted to 423 participants.

Study population

A total of 423 consenting presumptive TB patients of all ages who presented to the National Tuberculosis and Leprosy Training Centre (NTBLTC) between January and December 2019 were recruited into the study. Cases were defined as GeneXpert-confirmed rifampicin-resistant TB patients. Controls comprised rifampicin-sensitive TB patients receiving first-line anti-tuberculosis therapy who were classified as cured or as having completed treatment during the study period.

Eligibility criteria

Inclusion criteria: All presumptive TB patients, defined as individuals presenting with cough lasting more than two weeks (or any cough in high-risk patients), fever, night sweats, unexplained weight loss, history of TB contact, or abnormal chest radiograph. High-risk groups included people living with HIV (PLHIV), previously treated TB patients, prisoners, contacts of TB cases, diabetics, health workers, miners, and refugees.

Exclusion criteria: Patients not meeting presumptive TB criteria or those unwilling to provide informed consent.

Data collection

Socio-demographic and clinical data were collected using a structured interviewer-administered questionnaire (Copy attached Appendix ii at the end). Variables included age, sex, marital status, occupation, educational level, HIV status, TB history, treatment adherence, comorbidities (e.g., diabetes), substance use, and history of exposure to MDR-TB patients.

Sample collection and transport

Approximately 5 mL of sputum was collected from each participant in a well labelled sterile, screw-capped containers. Patients were instructed to provide deep expectorated sputum rather than saliva. Specimens from outside NTBLTC were transported in triple-layer biohazard packaging, stored at 2–8°C, and processed promptly at the NTBLTC laboratory.

Laboratory analysis

All samples were processed using the GeneXpert MTB/RIF assay (Cepheid, Sunnyvale, USA), which detects *Mycobacterium tuberculosis* complex DNA and mutations associated with rifampicin resistance through automated real-time polymerase chain reaction (PCR). According to the manufacturer's recommendations, the assay provides results within three hours and has been validated to demonstrate high sensitivity and specificity for tuberculosis diagnosis. All tests were performed by trained laboratory personnel in accordance with quality-assured protocols.

Methods of analysis

Data management and statistical analysis

Data were double-entered into Microsoft Excel and analyzed using Epi Info version 7.0 (CDC, Atlanta, USA). Descriptive statistics summarized socio-demographic and clinical characteristics. Chi-square test was used to compare categorical variables. Odds ratios (OR) with 95% confidence intervals (CI) were calculated for potential determinants of rifampicin resistance. Logistic regression was performed to adjust for confounders. Statistical significance was set at $p < 0.05$.

Ethical considerations

Ethical approval was obtained from the Ethics Committee of the National Tuberculosis and Leprosy Training Centre, Saye, Zaria, Kaduna State. Written informed consent was obtained from all participants. For minors, assent was obtained in addition to parental/guardian consent. Confidentiality was maintained by de-identifying patient information.

RESULTS

Sociodemographic characteristics of the participants

A total of 423 respondents were included in the study. The mean age was 36.6 years (SD ± 18.4). Participants aged 25–34 years constituted the largest proportion (22.7%), followed by those aged 35–44 years (18.7%) and 15–24 years (14.7%). Children aged 0–14 years accounted for 10.9% of the study population, while 12.8% and 12.1% were aged 45–54 years and 55–64 years, respectively. Participants aged 65 years and above constituted the smallest proportion (8.3%). The sex distribution was nearly equal, with 50.1% males and 49.9% females. Regarding marital status, 61.5% were married, 31.7% were single, and 6.9% were widowed.

With respect to education, 35.9% had secondary education, 34.8% tertiary education, 13.0% Qur'anic education, and 12.8% primary education, while 3.5% had only pre-primary education. In terms of occupation, 29.1% were daily labourers, 25.1% students, 14.9% traders, 12.1% civil servants, 9.7% housewives, and 9.2% were unemployed. Most respondents were Muslims (92.7%), while Christians comprised 7.3%. Ethnically, Hausa constituted 75.4%, followed by Fulani (12.1%), Yoruba (3.1%), Igbo (2.4%), and others (7.1%) (Table 1).

Table 1: Sociodemographic characteristics of respondents (N = 423)

Age group (years)	Frequency	Percentage
0–14	46	10.87
15–24	62	14.66
25–34	96	22.70
35–44	79	18.68
45–54	54	12.77
55–64	51	12.06
≥65	35	8.26
Mean ± SD	—	36.6 ± 18.4
Sex		
Male	212	50.12
Female	211	49.88
Marital status		
Single	134	31.68
Married	260	61.47
Widow	29	6.85
Educational status		
Qur’anic	55	13.00
Primary	54	12.77
Secondary	152	35.93
Tertiary	147	34.75
Pre-primary	15	3.55
Occupation		
No work	39	9.22
Daily labourer	123	29.08
Civil servant	51	12.06
Trading	63	14.89
Housewife	41	9.69
Student	106	25.06
Religion		
Islam	392	92.67
Christianity	31	7.33
Tribe		
Hausa	319	75.41
Fulani	51	12.06
Yoruba	13	3.07
Igbo	10	2.36
Others	30	7.10

Prevalence of *Mycobacterium tuberculosis*

Out of 423 presumptive TB patients tested using the GeneXpert assay, *Mycobacterium tuberculosis* was detected in 60 participants, giving an overall prevalence of 14.2%. The remaining 363 participants (85.8%) tested negative for *M. tuberculosis* Table 2.

Prevalence of rifampicin resistance

Among the 60 *M. tuberculosis*-positive cases, 55 (13.0% of the total study population) were rifampicin-sensitive, while 5 (1.2%) were rifampicin-resistant. Overall, rifampicin resistance accounted for 1.2% of all participants and 8.3% of *M. tuberculosis*-positive cases Table 2.

Table 2: Prevalence of Rifampicin-Sensitive and Rifampicin-Resistant *Mycobacterium tuberculosis* GeneXpert-Based

TB Status	Rifampicin Resistance Status	Frequency	Percentage (%)
MTB Positive	Sensitive	55	13.0
MTB Positive	Resistant	5	1.2
MTB Negative	—	363	85.8
Total		423	100.0

Case–Control analysis of determinants of rifampicin resistance

Determinants of rifampicin resistance were further explored using a nested case–control design (5 rifampicin-resistant cases and 15 rifampicin-sensitive controls, 1:3 ratio). This ratio was chosen to maximize statistical power and precision given the limited number of cases, consistent with methodological recommendations that gains plateau beyond a 1:4 ratio.

Bivariate analysis of factors associated with rifampicin resistance

Bivariate chi-square analysis revealed several significant predictors of rifampicin resistance. Patients with ≥3 pulmonary TB (PTB) episodes were disproportionately rifampicin-resistant ($\chi^2 = 16.752, p = 0.003$). HIV co-infection was strongly associated ($\chi^2 = 6.000, p = 0.041$), with 60% of rifampicin-resistant patients being HIV-positive compared to 12% of controls. Living with an MDR-TB patient also showed a strong link ($\chi^2 = 10.714, p = 0.023$), highlighting the role of household or close-contact transmission. Treatment interruption was highly significant ($\chi^2 = 16.500, p < 0.001$), as all rifampicin-resistant patients had interrupted therapy compared to 12% of controls. Poor adherence and outcomes further contributed, with failure to take medications as prescribed ($\chi^2 = 11.308, p = 0.009$) and adverse treatment outcomes ($\chi^2 = 13.108, p = 0.009$) being significantly more common among cases. Sociodemographic variables such as age, sex, marital status, occupation, and education were not significantly associated with rifampicin resistance. Other factors—including smoking history, lack of health worker supervision, and treatment side effects—showed trends but did not reach statistical significance, likely due to the small sample size (Tables 3a, b and c).

Table 3a: Socio-Demographic Characteristics of Cases and Controls

Age group (years)	Cases (n=5) Freq (%)	Controls (n=25) Freq (%)
0–14	0 (0.0)	2 (8.0)
15–24	2 (40.0)	4 (16.0)
25–34	1 (20.0)	13 (52.0)
35–44	1 (20.0)	2 (8.0)

Age group (years)	Cases (n=5) Freq (%)	Controls (n=25) Freq (%)
45–54	1 (20.0)	2 (8.0)
55–64	0 (0.0)	1 (4.0)
≥65	0 (0.0)	1 (4.0)
Mean ± SD	29.8 ± 10.8	30.2 ± 14.9
Sex		
Male	2 (40.0)	17 (68.0)
Female	3 (60.0)	8 (32.0)
Marital status		
Single	2 (40.0)	12 (48.0)
Married	3 (60.0)	13 (52.0)
Educational status		
Qur'anic	0 (0.0)	2 (8.0)
Primary	0 (0.0)	1 (4.0)
Secondary	3 (60.0)	7 (28.0)
Tertiary	2 (40.0)	14 (56.0)
None	0 (0.0)	1 (4.0)
Occupation		
No work	0 (0.0)	3 (12.0)
Daily labourer	2 (40.0)	7 (28.0)
Civil servant	1 (20.0)	7 (28.0)
Trading	0 (0.0)	3 (12.0)
Housewife	0 (0.0)	0 (0.0)
Student	2 (40.0)	5 (20.0)
Household size		
1–5	4 (80.0)	12 (48.0)
6–10	1 (20.0)	10 (40.0)
11–15	0 (0.0)	3 (12.0)

Table 3b: Risk Factors Associated with Rifampicin Resistance (*statistically significant at $p < 0.05$)

RIF resistance Factors	Cases (n=5) Freq (%)	Controls (n=25) Freq (%)	χ^2	P-value
No. of PTB episodes			16.752	*0.003
1	2 (40.0)	23 (92.0)		
2	0 (0.0)	2 (8.0)		
3	3 (60.0)	0 (0.0)		
HIV status			6.000	*0.041
Positive	3 (60.0)	3 (12.0)		
Negative	2 (40.0)	22 (88.0)		
Ever lived with MDR-TB patient?			10.714	*0.023
Yes	2 (40.0)	0 (0.0)		
No	3 (60.0)	25 (100.0)		
Smoker	2 (40.0)	2 (8.0)	3.692	1.119
Other diagnoses – Diabetes	1 (20.0)	0 (0.0)	5.314	0.310
Other diagnoses – Hypertension	0 (0.0)	1 (4.0)		

Table 3c: Treatment-Related Conditions

Treatment related conditions	Cases (n=5) Freq (%)	Controls (n=25) Freq (%)	χ^2	P-value
Smear positive at first TB treatment?	5 (100.0)	19 (76.0)	1.500	0.553
Counseled by HCW?	3 (60.0)	17 (68.0)	0.120	1.000
Drug taking under HCW supervision?	3 (60.0)	24 (96.0)	6.000	0.064
Alcohol consumption	0 (0.0)	1 (4.0)	0.207	1.000
Encountered side effects	2 (40.0)	1 (4.0)	6.000	0.064
Vomiting during treatment	2 (40.0)	3 (12.0)	2.352	0.183
Treatment duration	4 (80.0)	22 (88.0)	0.231	0.538
Observed by HCW?	3 (60.0)	21 (84.0)	1.500	0.254
Months observed by HCW	5 (100.0)	22 (88.0)	0.667	1.000
Ever interrupted TB treatment?	5 (100.0)	3 (12.0)	16.500	*0.000
– Reason: side effects	2 (40.0)	0 (0.0)	2.880	0.643
– Reason: forgot dose	1 (20.0)	0 (0.0)		
– Reason: felt well	2 (40.0)	3 (100.0)		
Took medication as prescribed?	2 (40.0)	24 (96.0)	11.308	*0.009
Treatment outcome			13.108	*0.009
– Success	2 (40.0)	24 (96.0)		
– Default	1 (20.0)	1 (4.0)		
– Failure	2 (40.0)	0 (0.0)		

Determinants of rifampicin-resistant TB from Logistic Regression Model

Logistic Regression Analysis

Key determinants of Rifampicin-Resistant TB (RR-TB) identified via logistic regression models includes; **Number of PTB episodes:** Patients with a single PTB episode had increased odds of rifampicin resistance compared to those with multiple episodes (AOR: 4.96, 95% CI: 1.02–5.82; $p = 0.010$), suggesting ongoing primary transmission. **HIV status:** HIV-positive

individuals had more than twice the odds of rifampicin resistance (AOR: 2.39, 95% CI: 1.27–95.18; $p = 0.029$). **Treatment adherence:** Reported regular medication intake paradoxically predicted resistance (AOR: 6.06, 95% CI: 1.00–4.07; $p = 0.009$), possibly reflecting self-reporting bias, poor drug quality, or undetected adherence lapses. **Treatment outcome:** Patients recorded as “treatment success” had higher odds (AOR: 5.38, 95% CI: 1.01–6.96; $p = 0.025$) of rifampicin resistance than defaulters. This may reflect misclassification bias or undiagnosed mixed infections (Table 4).

Table 4: Determinants of Rifampicin-Resistant TB from Logistic Regression Model

Number of PTB Episodes	Crude Odds Ratio (COR)	Adjusted Odds Ratio (AOR, 95% CI)	p-value
1	0.10	4.96 (1.02 – 23.8)	*0.010
2 (ref)	1.00	–	–
3+	3.20	5.12 (0.88 – 29.6)	0.071
HIV status			
Positive	11.0	2.39 (1.20 – 8.50)	*0.029
Negative (ref)	1.00	–	–
Ever lived with MDR-TB patient	1.35	1.42 (0.21 – 9.46)	0.710
No (ref)	1.00	–	–
Ever interrupted anti-TB	1.43	1.88 (0.30 – 11.6)	0.510
No (ref)	1.00	–	–

Number of PTB Episodes	Crude Odds Ratio (COR)	Adjusted Odds Ratio (AOR, 95% CI)	p-value
Took medication regularly	0.03	2.15 (0.62 – 7.46)	0.220
No (ref)	1.00	–	–
Treatment outcome			
Treatment success	0.06	5.38 (1.01 – 28.7)	*0.025
Default (ref)	1.00	–	–

*Statistically significant at $p < 0.05$

DISCUSSION

Tuberculosis remains a major public health concern in high-burden settings. In this study, the overall prevalence of *Mycobacterium tuberculosis* (MTB) detected by GeneXpert was 14.2%, which is epidemiologically significant in a human population survey. Despite appearing modest, this finding highlights a considerable reservoir of infection in the community, sustaining ongoing transmission and posing risks of drug resistance development. Previous studies in Nigeria and other high-burden settings have reported GeneXpert positivity rates ranging between 10% and 18%, consistent with our findings [14–16]. The public health implications of such a prevalence are profound, as each undiagnosed or untreated case has the potential to infect 10–15 individuals annually, perpetuating the TB epidemic in resource-limited settings [17].

The socio-demographic profile of respondents reflects the epidemiological distribution of TB in Nigeria. The mean age of 36.6 years, with the highest proportion of cases among the 25–34-year group, aligns with evidence that TB disproportionately affects young, economically productive adults [18]. This age-related vulnerability has major social and economic implications, as it threatens workforce productivity and exacerbates household poverty. The nearly equal sex distribution is in contrast to global TB trends that typically show male predominance [19], suggesting possible gender-related healthcare access differences in our study area. The predominance of daily labourers and students further underscores the role of poverty, overcrowding, and mobility in TB transmission [20].

Analysis of predictors of rifampicin-resistant TB (RR-TB) revealed several significant associations. A history of multiple pulmonary TB (PTB) episodes was strongly linked with resistance, consistent with studies indicating that repeated treatment increases the likelihood of resistant strain selection [21]. However, our logistic regression results interestingly suggested that even patients with a single PTB episode had nearly five-fold higher odds of rifampicin resistance. This supports reports that primary transmission of resistant strains is increasingly common, reflecting community spread rather than resistance acquired only after failed therapy [22, 23].

HIV co-infection emerged as a significant determinant of rifampicin resistance, with HIV-positive individuals having more than twice the odds of resistance compared to HIV-negative counterparts. This is consistent with studies from sub-Saharan Africa where HIV compromises host immunity, accelerates TB progression, and increases the likelihood of poor treatment outcomes [24, 25]. The synergistic interaction between TB and HIV presents a major public health challenge, reinforcing the need for integrated HIV/TB services.

Treatment-related factors were also important predictors. Interruption of therapy and poor adherence significantly increased the risk of resistance, echoing earlier findings that incomplete or irregular drug intake provides selective pressure for resistant *M. tuberculosis* strains [26, 27]. Notably, treatment interruption was universal among RR-TB cases in our cohort, underscoring it as a key driver of resistance. Exposure to an MDR-TB patient also showed a strong association with rifampicin resistance, supporting evidence of household or close-contact transmission of resistant strains [28].

Unexpectedly, some logistic regression findings suggested paradoxical associations, such as patients reporting regular drug intake and those with “successful treatment outcomes” having higher odds of rifampicin resistance. These anomalies may reflect recall bias, misclassification in treatment outcome reporting, or undetected mixed infections—a phenomenon reported in molecular studies of TB in high-burden regions [29, 30]. Such findings highlight the importance of incorporating molecular surveillance tools, such as line probe assays and whole-genome sequencing, to complement programmatic data and uncover hidden dynamics of resistance [31].

CONCLUSION

This study reveals a considerable burden of tuberculosis among presumptive patients, with a GeneXpert-confirmed prevalence of 14.2%, predominantly affecting young, economically productive adults with a mean age of 36.6 years and the highest occurrence in the 25–34-year age group. Rifampicin resistance was significantly associated with prior pulmonary TB episodes, HIV co-infection,

treatment interruption, and exposure to MDR-TB cases, indicating both acquired resistance and ongoing community transmission. The finding that all rifampicin-resistant cases had a history of treatment interruption underscores poor adherence as a major driver of resistance. Collectively, the results highlight persistent transmission and the growing threat of drug-resistant TB, reinforcing the importance of timely diagnosis, effective treatment, and robust surveillance.

RECOMMENDATIONS

Efforts to control tuberculosis should prioritize expanded access to rapid molecular diagnostics, particularly at primary health-care facilities, to ensure early case detection. Strengthened patient-centered adherence support and uninterrupted treatment are essential to prevent the emergence of rifampicin resistance. Integrated TB–HIV services should be reinforced to address the dual burden of co-infection. Enhanced contact tracing, infection prevention measures, and molecular surveillance are recommended to detect resistance early and limit transmission, alongside sustained health system strengthening and targeted interventions for high-risk populations.

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