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DEMOGRAPHIC AND OCCUPATIONAL DETERMINANTS OF RIFAMPICIN-RESISTANT MYCOBACTERIUM TUBERCULOSIS IN PATIENTS LIVING IN BAYELSA STATE, NIGERIA

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ABSTRACT

Background: Rifampicin-resistant tuberculosis (RR-TB) is a major public health challenge, particularly in low-resource countries such as Nigeria, where diagnosis and treatment gaps exist. Study on Demographic and Occupational Distribution of Rifampicin Resistant Mycobacterium Tuberculosis among TB Patients. **Methods:** A cross-sectional study was conducted to detect rifampicin resistance among confirmed TB patients by GeneXpert MTB/RIF assay. Sociodemographic variables like age, gender and occupation were analysed. Statistical significance was defined at $p < 0.05$. **Results:** All 15 (100%) TB isolates detected were rifampicin resistant. The prevalence was significantly higher in males than females (80.0% vs 20.0%) ($p < 0.05$). The prevalence was higher among individuals aged 14–57 years, although not statistically significant ($p > 0.05$). The occupational analysis revealed that the highest prevalence was among traders (43.9%) followed by civil servants and students with significant variation ($p < 0.05$). **Conclusion:** Rifampicin resistant TB is strongly associated with male gender and certain occupational categories, especially traders. The findings emphasise the need for targeted public health interventions for high-risk populations.

KEYWORDS: Rifampicin resistance, Tuberculosis, GeneXpert, Epidemiology, Nigeria.

1. INTRODUCTION

M. tuberculosis acquires drug resistance predominantly through spontaneous genetic changes that affect either the structures targeted by the drugs themselves or the pathways required for drug activation (for prodrugs). For example, mutations in the rpoB gene are strongly associated with rifampicin resistance, while mutations in katG and inhA are associated with isoniazid resistance (Traoré et al., 2023; Isakova et al., 2023). These genetic changes ultimately diminish drug effectiveness, leading to persistent infection and poor clinical outcomes. In addition to genetic factors, the development and spread of drug-resistant TB are also influenced by programmatic issues (WHO, 2024; Liebenberg et al., 2022). These range from delayed diagnosis, inappropriate treatment regimens, patient non-adherence to medications and insufficient funding of healthcare infrastructure.

Rifampicin resistant TB (RR-TB) is a surrogate marker for multidrug-resistant TB (MDR-TB) and has become a significant priority for global TB control. The early diagnosis has been clearly improved by the introduction of rapid molecular diagnostic tools such as the GeneXpert MTB/RIF assay and other genotypic methods to detect rifampicin resistance via mutations in the rpoB gene (WHO, 2023). Early diagnosis is important for the prompt initiation of appropriate treatment and the prevention of transmission in the community.

Nigeria is one of the high TB burden countries in the 2020 WHO Global TB Report and review of the national TB program. The situation is worsened by the emergence of drug resistance, delayed case detection and poor treatment adherence. Recent surveillance studies from different parts of the country have reported a considerable burden of rifampicin-resistant TB with

important implications for disease control efforts (Ibrahim et al., 2022; Ulasi et al., 2022).

Also, demographic and socioeconomic factors, such as age, sex, and occupation, have been found to be important factors influencing TB transmission and drug resistance patterns (Madaki et al., 2024). Occupational settings with high contact with many people could increase the risk of infection, especially in crowded or poorly ventilated workplaces (Mphande-Nyasulu et al., 2022). But the data on the occupational distribution of rifampicin-resistant TB is scanty, especially when considering Bayelsa State, Nigeria.

Therefore, this study was carried out to determine the demographic and occupational distribution of rifampicin resistant Mycobacterium tuberculosis isolates in Bayelsa State, Nigeria, to provide evidence-based information for public health interventions.

2. MATERIALS AND METHODS

2.1 Study Site

This study was conducted in Bayelsa State in the Niger Delta, South-South region of Nigeria. The state is a riverine state with the land mass of about 21,110 km2 with over 75% of the landmass made up of water bodies. It is bounded to the north by Delta State, to the east by Rivers State and to the west and south by the Atlantic Ocean.

The study was conducted in major tuberculosis (TB) diagnosis and treatment centers like the National Tuberculosis and Leprosy Training Center (NTBLTC), Federal Medical Center (FMC) Yenagoa, Niger Delta University Teaching Hospital (NDUTH) Okolobiri, Bayelsa State Medical University Diagnostic Center and Tobis Clinic and Consulting, Yenagoa. These facilities are the primary referral centers for TB diagnosis and management in the state.

2.2 Study Population and Design

The study design was cross-sectional. A total of 110 newly diagnosed pulmonary TB patients (age ≥14 years) were recruited from selected health care facilities. TB diagnosis was confirmed by sputum smear microscopy and GeneXpert MTB/RIF assay according to standard guidelines (World Health Organization [WHO], 2023).

2.3 Ethical concerns

Ethical approval was obtained from the Bayelsa State Ministry of Health and the participating health institutions. The study was conducted in compliance with the Declaration of Helsinki for research involving human subjects (WHO, 2022). All participants provided written informed consent. The procedures of the study were explained verbally to illiterate participants and consent was obtained.

2.4 Inclusion and Exclusion Criteria

Criteria for inclusion Newly diagnosed patients with Mycobacterium tuberculosis, aged ≥14 years, who gave consent to participate and were eligible for treatment according to national TB control guidelines.

Exclusion criteria: Patients with history of TB treatment, relapse, comorbid conditions (e.g., diabetes, hypertension), renal or hepatic impairment, and patients on treatment for leprosy.

2.5 Sample Size Determination

Sample size was estimated using the Cochran (1977) formula:

$$n = \frac{t2\ X\ P(1-P)}{m2}$$

= confidence level at 95% (standard value of 1.96) – p = estimated prevalence of TB (SS+) in the project area, 21.8. – m = relative precision

where t = confidence level at 95% (standard value of 1.96), p = estimated prevalence of TB (SS+) in the project area, (0.218), and m = 0.05, yielding a minimum sample size of approximately 70 participants. However, 110 eligible participants who completed the study were included to improve statistical power.

2.6 Collection of Samples

Sputum samples (spot and early morning) were collected from the participants according to standard operating procedures. Participants were trained on how to expectorate sputum properly to ensure quality of specimen. Samples were collected in sterile containers and transported to the laboratory in cold chain (2–8°C). Salivary or <2 mL samples were excluded due to less diagnostic reliability (Yoon et al., 2020).

2.7 Laboratory testing

2.7.1 Ziehl-Neelsen Smear Microscopy

Sputum smears were prepared and stained by Ziehl–Neelsen method for detection of acid-fast bacilli (AFB) by standard protocols [WHO, 2021].

2.7.2 GeneXpert MTB/RIF Test

M. tuberculosis and rifampicin resistance were detected using the GeneXpert MTB/RIF assay. The assay detects rpoB gene mutations associated with rifampicin resistance and gives results in about 2 hours.

2.7.3 Line probe assay (LPA)

Further drug resistance profiling was done using GenoType MTBDRplus and MTBDRsl assays for detection of mutations in rpoB, katG and inhA genes associated with rifampicin and isoniazid resistance (Hain Lifescience, 2021).

2.8 Variables and Data

Structured questionnaires were used to obtain sociodemographic data such as age, gender and

occupation (students, farmers, civil servants and traders). These variables were associated with resistance to rifampicin.

2.9 Statistical Analysis

Data were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize variables. Associations between categorical variables were evaluated using the Chi-square test, while Student's *t*-test was used for continuous variables where appropriate. Statistical significance was set at $p < 0.05$.

3. RESULTS

3.1 Distribution of GeneXpert Rifampicin Resistance in Patients by Age, Gender and Occupation

Rifampicin resistance detection by GeneXpert showed that 15(100) *Mycobacterium tuberculosis* harbored the rifampicin resistance gene, 12(80.0%) and 3(20.0%) were from male and female participants respectively. The prevalence of rifampicin resistant strains of MTB was significantly higher in males than in females (P<0.005). The distribution of *rif* resistant strains of MTB by age also revealed that patients in the age brackets 14-24, 25-35, 36-46 and 47-57 recorded the highest prevalence of 87.6% each respectively, though not statistically significant when compared to other age groups (P>0.05). However, the distribution of *rif* resistant strains of MTB by occupation showed traders 7(43.9%) recorded significantly high prevalence when compared to civil servants, students who had prevalences of 6(37.6%), and 3(18.8%) and 4(25.0%) respectively P<0.05) (Table 3.1).

Table 3.1: Distribution of GeneXpert Rifampicin resistance by age, gender and occupation.

Keys: ST=STUDENT, FM=FARMER, CV=CIVILSERVANT, TR=TRADER

	MALE					FEMALE					Grand Total
Age Range	ST (%)	FM (%)	CV (%)	TR (%)	TOTAL (%)	ST (%)	FM (%)	CV	TR (%)	Total(%)	
14-24	-	-	-	2(12.5)	2(12.5)	1(6.3)	-	-	-	-	3(18.8)
25-35	2(12.5)	-	-	1(6.3)	3(18.8)	-	-	-	1(6.3)	1(6.3)	4(25.0)
36-46	-	-	2(12.5)	2(12.5)	4(25.0)	-	-	1(6.3)	-	1(6.3)	5(31.3)
47-57	-	-	2(12.5)		2(12.5)	-	-	-	-	-	2(12.5)
58-68	-	-	-	1(6.3)	1(6.3)	-	-	-	-	-	1(6.3)
69-79	-	-	-	-	0(0)	-	-	-	1(6.3)	1(6.3)	1(6.3)

3.2 Demographic Distribution of the Patients

Of the 110 TB positive samples by GeneXpert used for this study, 16 (14.4%) were obtained from students, 14 (12.6 %) were from males while 2 (1.8%) were from females. Of the 51 (48.6%) positive specimens from traders, 25 (22.5%) were obtained from males and 26 (26.1%) were from females. The distribution of 19 (17.1%) and 22 (19.8%) specimens from farmers and civil servants showed that 12 (10.8%) and 7(6.3%); 19 (17.1%) and 3 (2.7%) were obtained from males and females respectively. The prevalence of TB was statistically higher in traders than in any other group (p<0.05). Furthermore, the distribution of TB positive cases by age revealed that 38 positive specimens were obtained from participants aged between 36 and 46 years of which 22 (19.8) and 16(15.3) were from males and females respectively. These findings also showed that 34 (30.6%), 12(10.8%), and 16 (14.4%) positive specimens were obtained from patients aged between 25-35, 47-57 and 14-24years old respectively (Table 3.2).

Table 3.2 Demographic distribution of the TB patients in the study.

MALE						FEMALE					TOTAL (%)
Age Range	ST (%)	FM (%)	CV (%)	TR (%)	TOTAL (%)	Age Range	ST (%)	FM (%)	CV (%)	TR (%)	
14-24	3 (2.7)	2(1.8)	-	3 (2.7)	8(6.4)	14-24	2(1.8)	1(0.9)	-	6(5.4)	9(8.1)
25-35	9 (8.1)	1(0.9)	6(5.4)	9 (8.1)	25 (22.8)	25-35	-	1(0.9)	1(0.9)	8(7.3)	10(9.0)
36-46	1(0.9)	1 (0.9)	11 (9.9)	10 (9.0)	22 (20.0)	36-46	-	2(1.8)	2(1.8)	12 (10.9)	16(15.3)
47-57	-	5 (4.5)	1(0.9)	3(2.7)	9(8.1)	47-57	-	1(0.9)	-	2(1.8)	3(2.7)
58-68	-	5 (4.5)	-	-	5 (4.5)	58-68	-	1(0.9)	-	-	1(0.9)
69-79	-	1 (0.9)	-	-	1(0.9)	69-79	-	-	-	-	1(0.9)

Keys: ST=STUDENT, FM=FARMER, CV=CIVILSERVANT, TR=TRADER

4. DISCUSSION

The study evaluated the epidemiological and socio-occupational predictors of rifampicin resistance in Mycobacterium tuberculosis (RR-TB) in Bayelsa State, Nigeria. The observed 100% rifampicin resistance among all detected resistant isolates was much higher than the global estimate (3-4%) of rifampicin resistance among new TB cases (World Health Organization [WHO], 2023). High proportion of cases may be primarily explained by local outbreaks of resistant pathogens, late presentation of cases or referral bias, as referral centers may manage outpatients with more severe forms or complications of the disease. In high burden settings with limited early diagnostic coverage, clustered patterns of drug resistance have been described (Liebenberg et al., 2022).

There was a notable gender imbalance with 80% of rifampicin resistant cases occurring in males. This finding is consistent with recent epidemiological studies reporting a higher incidence of TB and drug resistance among males in sub-Saharan Africa (Madaki et al., 2024; Mohammed et al., 2025). This can be attributed to several factors such as occupational exposure, delay in seeking healthcare and lifestyle related risk factors (smoking and alcohol consumption) which can influence the immune responses and increase the risk of TB infection and progression (Feldman et al., 2024; Quan et al., 2022; Wigger et al., 2022). Systematic analyses have also identified men as being at increased risk of TB disease and ongoing transmission from untreated cases (WHO, 2023).

While there was no statistically significant association between age and rifampicin resistance, the clustering of cases among persons aged ≤57 years supports the observation that the economically active population is a major contributor to this burden. This finding is consistent with the global epidemiology of TB which predominantly affects working-age individuals and consequently has expensive socioeconomic implications (WHO, 2023; Madaki et al., 2024). The observed trend has epidemiological importance, although the small number of resistant cases may have contributed to the lack of statistical significance.

Occupation was a significant predictor of rifampicin resistance with highest proportion being among traders (43.9%) and health workers. The finding points out the importance of occupational exposure in TB transmission dynamics. Traders are usually working in over-crowded and poorly ventilated environments, which provide an ideal environment for M. tuberculosis spread through airborne transmission. Similar findings have been observed in other occupational studies where TB risk is determined by frequent contact occupations (Mphande-Nyasulu et al., 2022). Besides, their trading activities may also hinder their ability to enjoy regular healthcare and treatment compliance, thereby increasing the risk of drug resistance.

The higher proportion found among civil servants and students also indicates that TB transmission is not limited to historically high-risk groups, but occurs in different occupational and social groups. This finding confirms earlier evidence of community transmission in Nigeria based on environmental and socioeconomic determinants (Ibrahim et al., 2022; Ulasi et al., 2022). It suggests the need for broad public health strategies rather than narrowly focused interventions.

The use of GeneXpert MTB/RIF assay for the rapid detection of rifampicin resistance in this study once again emphasized its importance as a frontline diagnostic tool in TB control programs. Timely initiation of appropriate treatment and reduction of transmission are facilitated by the rapid detection of mutations associated with resistance in the rpoB gene (WHO, 2023). However, rifampicin resistance alone as a surrogate for multidrug-resistant TB may misclassify the true proportion of resistance to other drugs. This underscores the necessity of additional diagnostic methods, such as line probe assays and culture-based testing.

There are some strengths and limitations of this study. The small number of cases with rifampicin resistance means that the analysis is relatively underpowered and the findings may be less generalizable. Secondly, the cross-sectional design does not permit to draw such inferences about causality or the direction of associations. More clarification on transmission dynamics and resistance patterns will require larger sample sizes, with longitudinal follow-up.

To summarize, this study has provided useful information on the epidemiology of rifampicin-resistant TB in Bayelsa State. More importantly, it unveils important demographic and occupational factors that can serve as a guide for targeted control strategies.

5. CONCLUSION

The results of this study indicate association of male sex and some occupations like trading with rifampicin resistant tuberculosis in Bayelsa state. The high proportion of cases among the economically active population also speaks of the public health and socioeconomic consequences of drug resistant TB. Strategies to control rifampicin-resistant TB are needed including active case finding, occupational health awareness and improved access to rapid diagnostic services and treatment adherence programs.

6. Conflict of Interest

There is no conflict of interest.

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