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Research Article

Assessment of Awareness of Anti-Tuberculosis Drug Resistance Among Tuberculosis Patients in a North-Central State of Nigeria

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Abstract

Tuberculosis (TB), a disease that remains preventable and curable, continues to represent a significant global health burden, particularly in regions like Nigeria. In this context, the emergence of drug-resistant strains of Mycobacterium tuberculosis poses an escalating challenge. This study aimed to assess awareness of anti-TB drug resistance among TB patients in Kwara State, Nigeria. Utilizing a descriptive cross-sectional design, data were gathered from 272 TB patients across six local government areas (LGAs) using a multi-stage sampling technique. Respondents were selected through a pre-tested, semi-structured questionnaire, targeting crucial socio-demographic factors, awareness levels, and other factors associated with drug resistance. Results revealed that 51.0% of the participants were male, and 64.5% lived in rural areas, with 43.3% having attained tertiary

education. Alarmingly, over half of the respondents—62.8%—displayed poor awareness of anti-TB drug resistance, with only 4.1% demonstrating adequate knowledge of the concept. Additionally, merely 19.6% of the patients understood drug resistance, while only 6.5% were aware that multidrug-resistant TB (MDR-TB) is curable. These findings are concerning, especially since 10.2% of participants exhibited resistance to at least one first-line anti-TB drug, such as 2.9% to Isoniazid and 3.3% to Rifampicin. Furthermore, dual resistance to Rifampicin and Isoniazid was identified in 4.0% of respondents. Socio-demographic factors significantly affected TB prevalence, particularly among younger adults (40.8% of respondents were aged 30–39 years) and males (51.0%). However, there was no significant association found between resistance patterns and HIV status, as only 4.1% of respondents were HIV-positive. Contrastingly, behavioral factors such as alcohol consumption (17.1%) and history of close contact with TB patients (6.5%) were linked to increased drug resistance. Among those tested for second-line drug resistance, 4.1% displayed resistance, with specific cases involving combinations like Kanamycin and Protionamide. Notably, 27.8% had a history of incarceration, and 40% had been previously admitted to a hospital, both recognized as factors contributing to the spread of drug-resistant strains. Further analysis showed that only 10 (4.0%) of respondents experienced delayed treatment commencement, while 49.4% of participants reported never receiving any health talks or awareness about TB from their healthcare providers. Despite 86.9% of patients being informed about the lengthy treatment duration, there was a clear need for more comprehensive health communication. This study underscores the necessity for intensified public health interventions, emphasizing patient education, early diagnosis, and routine drug susceptibility testing prior to treatment initiation.

Keywords

1. Introduction

Tuberculosis (TB), an ancient yet preventable and curable infectious disease, continues to pose significant global health challenges despite advances in diagnostics and treatment. It is primarily caused by *Mycobacterium tuberculosis*, which affects both animals and humans, with the primary transmission route being the inhalation of infected droplets from individuals suffering from active TB [1]. Although TB has been effectively treated for many decades, the emergence of drug-resistant strains has significantly hampered control efforts. Drug resistance, especially multidrug-resistant TB [MDR-TB], has introduced new complexities to public health interventions [2]. In Nigeria, which ranks as the sixth-highest burdened country globally, the rate of TB infection remains alarmingly high, with over 460,000 cases reported annually [3]. Yet, despite ongoing efforts, a significant portion of the population remains unaware of drug resistance patterns, complicating control strategies [4]. This study seeks to assess the level of awareness about anti-tuberculosis drug resistance among TB patients in Kwara State, to identify gaps in knowledge and enhance public health education.

The problem of drug-resistant TB is especially pronounced in regions like Kwara State, where public awareness remains suboptimal, and TB patients often lack comprehensive knowledge about the disease's drug-resistant variants. Awareness regarding the emergence of MDR-TB and extensively drug-resistant TB (XDR-TB) remains low in Nigeria, with only 36.4% of respondents in a recent survey being aware of drug resistance or its contributing factors [5]. Such lack of awareness contributes to poor treatment ad-

herence and the subsequent development of drug-resistant strains. Effective TB treatment, especially in cases of drug resistance, requires not only the correct prescription of medications but also patient adherence to treatment regimens, which is often hindered by limited awareness [6]. The situation in Kwara State mirrors broader national trends, where knowledge about transmission routes, proper treatment protocols, and the consequences of drug resistance remain insufficient [7].

The justification for this study lies in the persistent TB burden in Kwara State and the need for improved awareness regarding anti-TB drug resistance. Despite the availability of diagnostic tools like GeneXpert, which enhances detection of resistant TB strains, the incidence of drug-resistant TB continues to rise. Recent reports from the Kwara State National Tuberculosis and Leprosy Control Programme suggest a 20% increase in drug-resistant TB cases, attributed largely to the gaps in awareness and patient adherence to treatment protocols [7]. Inadequate patient knowledge about TB drug resistance not only exacerbates the spread of resistant strains but also hampers efforts to reduce TB incidence in the state [8]. Hence, it becomes crucial to assess the level of awareness among patients and to identify areas where public health interventions can be strengthened to address these knowledge deficits.

The primary objective of this study is to assess the awareness of TB patients in Kwara State regarding drug resistance to anti-TB medications. By understanding the patients' level of knowledge about drug-resistant TB, this study aims to

inform strategies for enhancing public health education and treatment adherence among the population. Additionally, the study seeks to determine the impact of awareness on patient treatment outcomes and adherence rates. It is hypothesized that higher levels of awareness about drug resistance will correlate with better adherence to treatment regimens, which in turn could reduce the spread of drug-resistant TB strains in the region. In the broader context, this study aims to contribute to TB control efforts in Nigeria by providing empirical evidence on the role of patient awareness in managing and reducing the incidence of drug-resistant TB.

2. Method

2.1. Study Design

This study employed a descriptive study design to assess the awareness of anti-tuberculosis (TB) drug resistance among TB patients in Kwara State. The design is appropriate for obtaining a snapshot of the patient's awareness at a single time. The study aimed to evaluate patients' knowledge and understanding of drug resistance, particularly concerning anti-TB medication, and to identify potential gaps in awareness that may contribute to the development and spread of drug-resistant TB.

2.2. Sampling Technique

A multi-stage sampling technique was used to select participants for the study. Kwara State is divided into 16 Local Government Areas (LGAs), and two LGAs were randomly selected from each of the three senatorial districts in the state: Kwara Central, Kwara South, and Kwara North. This resulted in six LGAs being included in the study: Asa, Ilorin East, Ifelodun, Offa, Edu, and Moro. From each selected LGA, four Directly Observed Treatment Short-course (DOTS) clinics were chosen randomly. Proportionate allocation was applied to determine the number of participants recruited from each clinic based on the number of TB patients managed in the previous year. A total sample size of 272 was derived using Fisher's formula, adjusted for a 10% non-response rate. Systematic sampling was employed to select participants within each clinic, ensuring the inclusion of both new and retreatment TB cases.

2.3. Data Collection

Data were collected using a pre-tested, semi-structured interviewer-administered questionnaire. The questionnaire consisted of four sections: Section A covered socio-demographic characteristics, while Section B focused on patients' awareness of anti-TB drug resistance. Data collection took place between July and December 2021, with trained research assistants administering the questionnaire to eligible patients. The interview lasted approximately 20 minutes for each participant. Additionally, sputum samples were collected to confirm TB diagnosis, and the patients' drug resistance status was recorded. A total of six research assistants, fluent in local languages, were trained for this purpose, ensuring that all participants understood the questions and provided accurate information.

2.4. Ethical Considerations

Ethical approval for the study was obtained from the University of Ilorin Teaching Hospital Ethical Review Committee. All participants provided written informed consent after being fully briefed on the objectives and procedures of the study. They were assured of the confidentiality of their responses, and all collected data were anonymized using unique codes. The risks and benefits of participation were clearly explained, with participants informed that no financial incentives would be offered. Respondents were also assured that their participation would not affect the care they received at the DOTS clinics.

3. Result

3.1. Socio-Demographic Characteristics

Table 1 shows the socio-demographic characteristics of the study participants shows that of the total respondents, 100 (40.8%) were in the age group 30-39 years, while 3 (1.2%) were of the age group 10-19 years and 2 (0.8%) were of the 60 and above age group. More than half of the respondents were male 125 (51.0%) and 158 (64.5%) were rural dwellers. Among the participants 106 (43.3%) had tertiary education as their highest level of education.

***Table 1.** Socio-demographic characteristics of respondents (N=245)*

Socio-demographic characteristics	Frequency (n)	Percentages
Age group (Years)		
10-19	3	1.2
20-29	66	26.9
30-39	100	40.8
40-49	57	23.3
50 and above	19	7.8
Mean Age = 36.45 ± 3.42		
Sex		
Male	125	51.0
Female	120	49.0
Ethnic Group		

Socio-demographic characteristics	Frequency (n)	Percentages
Hausa	16	6.5
Igbo	33	13.5
Yoruba	187	76.3
Others	9	3.8
Religion		
Christianity	47	19.2
Islam	198	80.8
Education		
Quranic	34	13.9
Primary	27	11.0
Secondary	74	30.2
Tertiary	106	43.3
None	4	1.6
Monthly Income (#)		
Less than 20,000	90	36.7
20,000-50,000	96	39.1
51,000-100,000	32	13.1
Above 100,000	27	11.1
Place of Residence		
Urban	87	35.5
Rural	158	64.5
Marital Status		
Single	44	18.0
Married	177	72.2
Divorced	4	1.6
Seperated	15	6.1
Widowed	5	2.0

3.2. Level of Awareness of Resistance to Anti-TB Drugs

Table 2 revealed that 112 (45.7%) of the respondents have ever heard anything about TB, 43.3% knew that TB is preventable and only 108 (44.1%) knew that it is treatable while very few of the participants, 13.9% were aware of the duration of TB treatment. This study further revealed that only 48 (19.6%) knew what resistance to anti-TB drugs is and just 16 (6.5%) knew that MDR-TB is curable.

Table 2. Variables on Awareness about TB among TB patients.

Variables on awareness about TB	N= 245 Frequency (%)
Ever heard of TB	112(45.7)
Ever been infected with TB	66(26.9)
Aware about someone who has been infected with TB	30(12.2)
Aware about TB	117(47.8)
Aware about infectivity	106(43.3)
Aware about prevention	78(31.8)
Aware about treatment	108(44.1)
Duration of treatment	34(13.9)
Complete recovery	53(21.6)
Drug resistance	48(19.6)
Know what MDR-TB is	130(53.1)
Know if MDR-TB is curable	16(6.5)
Treatment duration of MDR-TB	32(13.0)
Close contact with MDR-TB	10(4.1)
Know free management of TB	210(85.7)

Table 3 revealed that the majority of the patients 218 (89.0%) had no resistance to all the three first-line drugs, while 25 (10.2%) of them had resistance to at least one of the first-line anti-TB drugs.

Table 3. Resistance to first-line anti-TB drugs among respondents.

Resistance to First-line TB Drugs	Frequency (n)	Percentages
Yes	25	10.2
No	218	89.0
Contaminated	2	0.8
Total	245	100

Table 4 revealed that Seven (2.9%) and 8 (3.3%) had resistance to only Isoniazid and only Rifampicin, respectively. Ten of the respondents (4.0%) had resistance to both Rifampicin and Isoniazid while none of the respondents had resistance to ethambutol. Among the respondents, only 2 (0.8%) had their sample contaminated and there was no growth.

Table 4. Pattern of resistance to first-line anti-TB drugs among respondents.

The pattern of resistance to First-line Anti-TB drug	Frequency (n)	Percentages
INH only	7	2.9
Rif only	8	3.3
Rif and INH	10	4.0
No resistance to any first-line drugs	218	89.0
Contaminated	2	0
Total	245	100

Table 5 showed that 233 (95.1%) out of the 245 study participants had no resistance to all five (Amikacin, Capreomycin, Kanamycin Protionamide, and Ofloxacin) of the second-line drugs for TB.

Table 5. Resistance to second-line anti-TB drugs among respondents.

Second-line Anti-TB drug	Frequency (n)	Percentages
Yes	10	4.1
No	233	95.1
Contaminated	2	0.8
Total	245	100

Table 6 showed that Just 1 (0.4%) of the participants had resistance to kanamycin and protionamide, the same as the combination of ofloxacin and capreomycin. Among the respondents, only 2 (0.8%) had no growth as they were contaminated.

Table 6. Pattern of resistance to second-line anti-TB drugs among respondents.

Pattern of Resistance to Second-line Anti-TB drug	Frequency (n)	Percentages
Amk and CAP only	2	0.8
CAP only	6	2.4
Km and Pto only	1	0.4
Ofl and CAP only	1	0.4
No resistance to any second-line drugs	233	95.1
Contaminated	2	0.8

Pattern of Resistance to Second-line Anti-TB drug	Frequency (n)	Percentages
Total	245	100

Table 7 showed that out of the total respondents, 113 (46.1 %) know their HIV status (out of which 10 (4.1%) were HIV positive). Among the participants, 102 (41.6%) have BCG scars and 42 (17.1%) consume alcohol. Only 21 (8.6%) had contact with someone with a chronic cough, while 16 (6.5%) had contact with TB patients.

3.3. Patient-Related and Healthcare-Giver-Related Factors

Table 7. Patient- related factors that affect pattern of resistance to Anti-TB drugs.

Patient- related factors	Frequency (n)	Percentages
HIV Status		
Yes	10	4.1
BCG Scar		
Yes	102	41.6
Alcohol Consumption		
Yes	42	17.1
Smoke cigarette		
Yes	39	15.9
History of Incarceration		
Yes	8	27.8
History of Hospital admission		
Yes	98	40.0
Contact with Chronic Cough		
Yes	21	8.6
Contact with TB patient		
Yes	16	6.5
Ever diagnosed with TB		
Yes	29	11.8
Use drug as prescribed		
Yes	63	25.7

Table 8 showed that out of the total respondents, only 10 (4.0%) experienced delay in treatment commencement, while a little above half, 126 (51.4%) had DOT observed by their healthcare giver. A total of 121 (49.4%) had no health talk or

awareness about TB. Of the total participants, 213 (86.9%) were informed about the long duration of treatment.

Table 8. Healthcare-giver-related factors that affect pattern of resistance to Anti-TB drugs.

Healthcare-giver related factors	Frequency (n)	Percentages
Delay in treatment commencement after diagnosis		
Yes	10	4.0
Compliance with DOTS		
Yes	126	51.4
Provision of Health talk and awareness		
Yes	124	50.6
Prompt attention by health worker		
Yes	122	49.8
Provision of Information about long duration of treatment		
Yes	213	86.9
Provision of Information on reasons for daily intake of drugs		
Yes	213	86.9
Provision of Information on protection of others		
Yes	213	86.9

4. Discussion

4.1. Socio-Demographic Characteristics

Tuberculosis (TB) remains a global health challenge, even though the causative organism was discovered over a century ago and effective treatments have been developed [9]. Despite ongoing control efforts, the emergence of drug-resistant TB continues to undermine global eradication strategies, including in Nigeria.

The study revealed a mean age and standard deviation like findings by Daniel et al. [9] in Southwest Nigeria, where TB patients had a mean age of 32.0 years with a peak age range of 20-49 years [10]. However, these results differ from Isara and Akpodiete's study in Delta State, which reported a higher mean age of 41.7 years [11]. This variance may reflect differences in TB epidemiology across Nigeria's geopolitical zones.

Young adults, particularly those between 20-39 years, were

predominantly affected by TB in this study. This aligns with the trend that TB disproportionately affects younger, economically productive individuals in developing regions, unlike in developed nations, where the elderly are more affected [11]. This presents a major socio-economic concern, as TB's impact on the workforce hampers overall economic growth in high-burden states like Nigeria.

The study also observed a higher prevalence of TB among males, consistent with findings from Berhanu et al. in Ethiopia and Daniel et al. in Ibadan [9, 12]. In contrast, Isara and Akpodiete reported a higher percentage of female TB patients in Delta State [11]. The discrepancy may be due to cultural and religious factors that limit women's access to healthcare, requiring male approval or support for medical evaluation. In many regions, women face cultural restrictions that require male approval to seek healthcare, further exacerbating delays in diagnosis and treatment [13]. This disparity is compounded by economic dependencies, where women often lack financial autonomy to afford medical care [14]. Furthermore, stigma surrounding TB tends to disproportionately affect women, discouraging them from accessing care due to fear of social ostracism or impacts on marriage prospects [15]. The contrasting findings by Isara and Akpodiete [11] in Delta State, where women constituted a higher percentage of TB patients, may indicate regional variations in healthcare accessibility, potentially influenced by targeted interventions or unique cultural dynamics. Such findings underscore the need for gender-sensitive TB strategies that address barriers to healthcare access, promote equity in service delivery, and mitigate stigma through community-driven approaches. Addressing these challenges is critical for reducing TB burden and ensuring effective control efforts globally.

Most TB patients in this study were rural dwellers, unlike findings in Ethiopia, where more urban residents were affected [11]. Additionally, a significant portion of respondents had low income, earning less than 20,000 Naira. This mirrors findings by Gaude and Kumar in India, where low socioeconomic status was strongly correlated with TB prevalence [16]. Poverty not only increases vulnerability to TB but also perpetuates the cycle of poverty through lost productivity, underscoring the necessity of addressing social determinants in TB control efforts.

4.2. Level of Awareness of Resistance to Anti-TB Drugs

This study reveals that more than half of the respondents have poor awareness about resistance to anti-TB drugs. This is consistent with the findings of Isara and Akpodiete [11] in Delta State Nigeria, they reported that more than half of the respondents (60.5%) have no information at all about resistance in TB. Findings by Hasnain et al. revealed that less than half of the respondents had poor awareness about resistance to anti-TB drugs, although this study was among students of tertiary institution in Pakistan, likewise Rupali and

Gautam also reported few of the respondents (36.6%) to have poor knowledge about resistance to anti-TB drugs [5]. The widespread lack of awareness, rooted in cultural beliefs and misconceptions, significantly influences treatment-seeking behavior and adherence, thereby increasing the risk of resistance development [14].

It has been observed that providing TB patients with insufficient or incomplete information can increase their already incorrect ideas, which are frequently based on cultural beliefs and myths. Numerous studies conducted in Nigeria and elsewhere have demonstrated that patients' lack of knowledge about TB is typically detrimental to appropriate health seeking behavior, decreasing the likelihood of completing treatment, which has been noted to be a major risk factor for the development of anti-TB drug resistance [17]. Therefore, it is important for HCWs to provide their TB patients with high-quality health education throughout their treatment because doing so will allow them to impart the correct information and correct any false beliefs or views. The outcomes of treatment and, ultimately, the control efforts will be negatively impacted by the lack of knowledge about TB and its medications.

Findings from this study reported a very low percentage of respondents with mono-resistance to either Isoniazid or Rifampicin and even resistance to both drugs. This is inconsistent with findings of Akananyene *et al.* [18] in Calabar, Nigeria, who documented no mono-resistance to rifampicin in contrast to 38% resistance seen in Lagos. In Ethiopia, Berhanu *et al.* [12] also reported a low resistance to only rifampicin (2.8%), this is also consistent with findings from this study, however, Gaude and Kamar [16] in India reported 91.9% resistance to rifampicin, this is a very sharp contrast with findings of this study. This sharp contrast can be explained with the high burden of the MDR -TB disease in India and overcrowding which constitute the major drivers of TB epidemiology. The low level of mono-resistance may indicate that more can be done to slow the spread of TB resistance in the nation if the control program can quickly improve and build on its current successes. Onyedum *et al.* [19] in a systematic review and meta-analysis of prevalence of drug-resistance in Nigeria reported that resistance to anti-TB drugs in Nigeria varied according to methods of drug susceptibility testing and geographic region of the country. Hence, this confirms the varying reports from the different regions of the country. However, the low prevalence of resistance to any of the first-line anti-TB drug in this study contrasts with findings by Otu and colleagues who reported that 42% of the TB patients in Calabar, Nigeria [18].

The ineffective management of active pulmonary TB eventually leads to the development of drug-resistant TB. This might be the outcome of poor drug selection methods and short-term treatment regimens used by physicians when they write prescriptions. This may also be due to the inadequate knowledge of concerned HCWs. Therefore, it is essential that HCWs receive proper training in accordance with the NTP recommendations to guarantee that both HCWs and patients have access to all relevant information and, as a result, knowledge of the subject.

Resistance to second-line anti-TB drugs was very low in comparison to various literature seen where resistance pattern reported was high, however, most of the studies were conducted among known resistant-TB patients and/or patients with previous history of anti-TB treatment [10]. The findings from this study shows that some patients with DS-TB are likely to have resistant strains even before treatment commencement or could have acquired the resistant strains while still on treatment for DS-TB. This indicates that the patients from whom these isolates were obtained have already developed resistance to some of the first-line or second-line anti-TB drugs. This type of primary drug resistance to the reserved anti-TB drugs has a serious implication indicating that administration of anti-TB drugs (first-line or second-line) without initial evaluation of DST might not be beneficial to the patient and may even further lead to increase in the rate of resistance to the second line drugs which could lead to increase in the TB burden as well increase in acquisition of XDR-TB. This therefore reemphasizes the need to perform drug susceptibility test prior to administration of the drugs [20].

There was no significant association between any of the socio-demographic characteristics and the resistance pattern among respondents of this study. This is consistent with findings of Olarewaju *et al.,* [10] where some socio-demographic factors such as age and gender were not significantly associated with drug resistant TB Likewise, findings from this study are in keeping with Akaninneye *et al* in Calabar who reported that age, sex, and educational status were not significantly associated with resistant TB [18]. However, in contrast to the findings of this study, Gaude and Kamar reported age, sex, socio-economic status and education status to be significantly associated with drug resistance pattern [16]. This contrast could be as a result of the fact that the study in India involved people of different race and ethnic group.

4.3. Patient-related and Healthcare-giver Related Factors

Patient's characteristics such as HIV status, BCG Scar, alcohol consumption, contact with chronic cough, contact with TB patient, previous history of TB etc were tested for association with resistance pattern. From this study, HIV was not significantly associated with resistance to anti-TB drugs. This is in keeping with findings Gaude and Kamar in India and Otu *et al* in Calabar, Nigeria [16, 18]. Findings from this study is however inconsistent with reports by Berhanu *et al* [12] from Ethiopia who reported HIV to be significantly associated with resistance pattern.

Drug malabsorption in HIV-infected patients, especially rifampicin and ethambutol, can lead to drug resistance and

these resistant strains may be less virulent and preferentially lead to disease progression in immunocompromised patients, as opposed to immunocompetent individuals. However, this present study did not identify a significant association between HIV infection and pattern of resistance to anti-TB drugs. This could be explained because of the small number of patients with known HIV status, this goes to show that majority of the patients were not tested for HIV, or they do not know their status. This is not in compliance to the stipulated NTP guidelines in Nigeria where it is stated that HIV test should be conducted prior to TB treatment and upon completion of treatment. The large proportion of the respondent who do not know their HIV status or not tested for HIV shows an inadequacy of program implementation in the state and may be associated with poor outcome in the management of TB and development of resistance.

Also from this study, history of previous history of TB was not found to be significantly associated with resistance pattern among the respondents. This is inconsistent with findings by Daniel and Osman, and Gaude and Kamar who reported a significant association between previous history of TB and resistance pattern among TB patients [10, 12]. This may be because they conducted their research at a referral facility rather than a typical DOT center, where patients who develop specific problems are referred for specialized care. Hospitalization history and prior incarceration experience were not substantially linked to resistance pattern. This is in keeping with findings by Gaude and Kamar [16]. Chen *et al* [21] documented a significant association between history of previous TB treatment and resistance pattern to anti-TB drugs, this was inconsistent with findings from this study. Although DR-TB has recently been discovered in many new TB cases, previous treatment has been shown in numerous studies to be a decisive factor in the development of resistance to anti-TB medications.

Alcohol consumption was found to be significantly associated with resistance patterns in this present study. This is in tandem with findings by Gaude and Kamar, they reported alcoholism as a factor that is significantly associated with a pattern of resistance to anti-TB drugs [16]. Drug resistance has been linked to an eightfold rise in alcohol consumption and dependency. Alcoholism has been linked to worse treatment outcomes for TB patients due to increased treatment defaults.

This study also shows that contact with a known TB patient is significantly associated with pattern of resistance to anti-TB drugs, this is consistent with findings by Otu *et al* [15]. Findings by Berhanu *et al*. [12] in Ethiopia and Gaude and Kamar [16] in India showed that contact with known TB cases was not significantly associated with resistance pattern. This probably explains the earlier studies in Nigeria that most patients with resistant TB are acquired cases and not primary cases of resistant TB [18]. Contact with a person with chronic cough from this study shows a significant association with resistance pattern, this is inconsistent with findings by

Olarewaju *et al.,* [10] Berhanu *et al* [12] also reported a non-significant association with resistance pattern. [19, 20] The effect of contact with person with chronic cough may varies from place to place as it is largely dependent on some other factors i.e. duration of the contact and dose of bacilli received.

Factors such as delay in treatment commencement, DOTs observation, information on protection of others etc. were analysed against pattern of resistance. There was no significant association between the factors and pattern of resistance. Chen et al. [21] reported delay in treatment commencement to have a significant association with pattern of resistance, this was inconsistent with findings from this study. Findings from this study is in tandem with what was reported by *Olarewaju et al.,* [10] who also reported no significant association between these health-related factors and resistance pattern among their study population. History of previous TB treatment was reported to be the only factor associated with resistance pattern by Olarewaju *et al.,* this was inconsistent with findings from this study.

5. Conclusion

In conclusion, tuberculosis (TB) continues to pose a significant global health challenge, particularly in developing regions like Nigeria, where drug-resistant strains undermine control efforts. This study highlights the socio-demographic factors, such as age and gender, that influence TB prevalence, with young adults and males being the most affected. The economic implications of TB are profound, as it disproportionately impacts the productive workforce, deepening poverty levels and hindering national economic growth. Addressing these socio-economic factors is vital to mitigate TB's broader societal impact.

The findings reveal poor awareness of drug resistance among TB patients, which perpetuates the emergence of drug-resistant strains. Crucially, patient-related factors like alcohol consumption and contact with known TB cases significantly correlate with resistance patterns, emphasizing the need for targeted behavioral interventions. Conversely, factors such as HIV status and previous TB history were not significantly associated with resistance in this study, suggesting that context-specific dynamics may shape resistance trends.

Future research should prioritize longitudinal studies to better understand the evolution of resistance patterns and their drivers. Additionally, the significance of implementing universal drug susceptibility testing (DST) before initiating treatment cannot be overstated, as this approach could prevent the spread of resistant strains and guide the use of both first- and second-line anti-TB drugs effectively. Studies should also evaluate the efficacy of tailored health education campaigns to enhance awareness of TB drug resistance, targeting not just patients but also healthcare providers to address gaps in knowledge and practice. Moreover, there is an urgent need for

integrated public health strategies that address the socio-economic determinants of TB, including poverty reduction, stigma elimination, and gender equity in healthcare access. These efforts could lead to more equitable TB control outcomes, particularly in resource-limited settings.

Abbreviations

MFX	Moxifloxacin
MDR-TB	Multi-Drug-Resistant Tuberculosis
NTP	National Tuberculosis Programme
P/PZH	Pyrazinamide
PLHIV	Persons Living with HIV/AIDS
PTB	Pulmonary Tuberculosis

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Rodriguez-Campos S, Smith NH, Boniotti MB, Aranaz A. Overview and phylogeny of Mycobacterium tuberculosis complex organisms: Implications for diagnostics and legislation of bovine tuberculosis. Res Vet Sci. 2014; 97. https://doi.org/10.1016/j.rvsc.2014.02.009

[2] Ahmad S, Mokaddas E. Trends in the diagnosis and treatment of drug-susceptible and drug-resistant tuberculosis. J Infect Public Health. 2014; 7(2): 75-91. https://doi.org/10.1016/j.jiph.2013.09.001

[3] World Health Organization. Global Tuberculosis Report. Geneva, Switzerland: WHO; 2014. https://www.who.int/teams/global-tuberculosis-programme/tb-reports

[4] Adisa R, Ayandokun TT, Ige OM. Knowledge about tuberculosis, treatment adherence, and outcome among ambulatory patients with drug-sensitive tuberculosis in two directly-observed treatment centres in Southwest Nigeria. BMC Public Health. 2021; 21: 677. https://doi.org/10.1186/s12889-021-10698-9

[5] Javed H, Tahir Z, Hashmi HJ, Jamil N. A cross-sectional study about knowledge and attitudes toward multidrug-resistant and extensively drug-resistant tuberculosis in a high-burden drug-resistant country. Int J Mycobacteriol. 2016; 5(2): 128-134. https://doi.org/10.1016/j.ijmyco.2015.12.004

[6] Pokam BT, Asuquo AE, Abia-Bassey LN, Idasa MB, Umoh NO, Eko FO, Rastogi N. Multidrug resistance and demography of newly diagnosed tuberculosis patients in Cross River State, Nigeria. Int J Mycobacteriol. 2013; 2(2): 89-93. https://doi.org/10.1016/j.ijmyco.2013.03.002

[7] Ogbo FA, Ogeleka P, Okoro A, Olusanya BO, Olusanya J, Ifegwu IK, Awosemo AO, Eastwood J, Page A. Tuberculosis disease burden and attributable risk factors in Nigeria, 1990-2016. Trop Med Health. 2018; 46: 34. https://doi.org/10.1186/s41182-018-0114-9

[8] Kooffreh ME, Offor JB, Ekerette EE, Udom UI. Prevalence of tuberculosis in Calabar, Nigeria: A case study of patients attending the outpatients Department of Dr. Lawrence Henshaw Memorial Hospital, Calabar. Saudi J Health Sci. 2016; 5(3): 130-133. https://doi.org/10.4103/2278-0521.195817

[9] Daniel O, Osman E, Oladimeji O, Dairo OG. Pre-extensive drug resistant tuberculosis (Pre-XDR-TB) among MDR-TB patients in Nigeria. Glob Adv Res J Microbiol. 2013; 2: 22-25.

[10] Olarewaju S, Oladimeji O, Folorunso E, Akintunde B, Temitayo-Oboh A, Saliu A, Oluwatoyin A. Treatment outcome of tuberculosis patients registered at DOTS centre in Ogbomoso, southwestern Nigeria: A 4-year retrospective study. Tuberc Res Treat. 2014; 2014: 201705. https://doi.org/10.1155/2014/201705

[11] Isara AR, Akpodiete A. Concerns about the knowledge and attitude of multidrug-resistant tuberculosis among health care workers and patients in Delta State, Nigeria. Niger J Clin Pract. 2015; 18(5): 664-669. https://doi.org/10.4103/1119-3077.154212

[12] Berhanu S, Alemayehu W, Shiferaw B, Abraham A. Prevalence and drug resistance patterns of Mycobacterium tuberculosis among new smear positive pulmonary tuberculosis patients in Eastern Ethiopia. Tuberc Res Treat. 2014; 2014: 753492. https://doi.org/10.1155/2014/753492

[13] Sullivan, B. J., Esmaili, B. E., & Cunningham, C. K. (2017). Barriers to initiating tuberculosis treatment in sub-Saharan Africa: a systematic review focused on children and youth. Global health action, 10(1), 1290317. https://doi.org/10.1080/16549716.2017.1290317

[14] Horton, K. C., MacPherson, P., Houben, R. M., White, R. G., & Corbett, E. L. (2016). Sex Differences in Tuberculosis Burden and Notifications in Low- and Middle-Income Countries: A Systematic Review and Meta-analysis. *PLoS medicine*, *13*(9), e1002119. https://doi.org/10.1371/journal.pmed.1002119

[15] Sommerland, N., Wouters, E., Mitchell, E. M. H., Ngicho, M., Redwood, L., Masquillier, C., van Hoorn, R., van den Hof, S., & Van Rie, A. (2017). Evidence-based interventions to reduce tuberculosis stigma: a systematic review. *The international journal of tuberculosis and lung disease: the official journal of the International Union against Tuberculosis and Lung Disease*, *21*(11), 81–86. https://doi.org/10.5588/ijtld.16.0788

[16] Gaude GS, Hattiholli J, Kumar P. Risk factors and drug-resistance patterns among pulmonary tuberculosis patients in northern Karnataka region, India. Niger Med J. 2014; 55(4): 327-332. https://doi.org/10.4103/0300-1652.137194

[17] Shittu OR, Akanbi II AJ, Sanni AM, Alabi KM, Odeigah L, Sule GA, et al. Rifampicin resistant tuberculosis in a secondary health institution in Nigeria, West Africa. J Infect Dis Ther. 2014; 2: 139-146. https://doi.org/10.4172/2332-0877.1000139

[18] Otu A, Umoh V, Habib A, Ameh S, Lawson L, Ansa V. Drug resistance among pulmonary tuberculosis patients in Calabar, Nigeria. Pulm Med. 2013; 2013: 235190. https://doi.org/10.1155/2013/235190

[19] Onyedum CC, Alobu I, Ukwaja KN. Prevalence of drug-resistant tuberculosis in Nigeria: A systematic review and meta-analysis. PLoS One. 2017; 12(7). https://doi.org/10.1371/journal.pone.0180996

[20] Aminu AI, Tukur AD. Second line drug sensitivity test of multidrug-resistant tuberculosis (MDR-TB) isolates using proportional method. Bayero J Pure Appl Sci. 2018; 11(1): 64-67. https://doi.org/10.4314/bajopas.v11i1.10S

[21] Chen Y, Yuan Z, Shen X, Wu J, Wu Z, Xu B. Resistance to second-line antituberculosis drugs and delay in drug suscepti-bility testing among multidrug-resistant tuberculosis patients in Shanghai. Biomed Res Int. 2016; 2016: 2628913. https://doi.org/10.1155/2016/26289S13