Original Research Article

Prevalence and Clinical Profile of Tuberculosis Patients in a Rural Teaching Hospital in South-South Nigeria: A Ten-Year Retrospective Study

ABSTRACT

Objective: This study aimed to determine the prevalence, distribution, and treatment outcomes of tuberculosis (TB) in a rural hospital in Nigeria.

Methods: This was a retrospective cross-sectional study conducted between 2013 and 2022. The data on all patients diagnosed with TB during the study period were collected from the hospital's registry. The data was then entered into SPSS for analysis. The level of statistical significance was set at $P < 0.05$.

Results: The overall prevalence of TB among TB suspects was 41.3%. Pulmonary TB was the most common form of TB, accounting for 87.1% of the cases, while extrapulmonary TB accounted for 12.9%. Among extrapulmonary TB cases, TB lymphadenitis was the most common (27.2%). The mean age of the patients was 44.7±10.9 years, with the majority of cases in the 51-60 and 31-40-year age groups. Males were more affected than females (59.1% vs. 40.9%), and 5.6% of TB patients were HIV-positive. The frequency of rifampicin-resistant TB was 9.5%. The majority of patients (96.5%) had a successful treatment outcome, with 28.9% being cured and 67.6% completing their treatment. Treatment failure occurred in 0.4% of TB cases, while 0.9% defaulted, and 2.2% died. Patients with rifampicin-resistant TB had lower odds of treatment success than those without rifampicin-resistant TB ($P = 0.03$; OR: 0.5; CI: 0.26-0.96).

Conclusions: The study revealed that TB remains a significant public health problem in Nigeria, especially in rural areas. Therefore, there is a need for increased collaboration and stronger measures to prevent and control TB, particularly in low-resource settings.

Keywords: Clinical profile; Tuberculosis; Nigeria; GeneXpert; Treatment outcome

1. INTRODUCTION

Tuberculosis (TB) is a communicable disease that causes significant ill-health and remains one of the top global causes of death. It is the second leading cause of death from a single infectious agent, ranking above even Human Immunodeficiency Virus (HIV) infection and surpassed only by Coronavirus Disease 2019 (COVID-19) [1]. Notably, TB is the leading cause of death among people living with HIV (PLHIV) and a significant contributor to deaths linked to antimicrobial resistance [1]. The disease is caused by *Mycobacterium tuberculosis* (MTB) and primarily spreads through respiratory droplets. Although TB primarily affects the lungs, it can present in extrapulmonary organs. An estimated one-quarter of the world's population is thought to have been infected with TB and is at risk of contracting the disease [1]. Factors such as the HIV pandemic, economic downturns, and conflicts have contributed significantly to the increase in TB incidence and spread, particularly in developing countries [2].

Developing countries bear the brunt of the burden caused by TB, with more than 90% of cases and deaths occurring in these regions. Of these cases, 75% affect individuals in the most economically active age groups [3]. In 2021, approximately 10.6 million people worldwide developed TB, with men (6.0 million), women (3.4 million), and children (1.2 million) all affected. PLHIV accounted for 6.7% of the total [4]. Among the eight countries that account for two-thirds of the global TB burden is Nigeria, which alone contributes 4% of the total global burden [4]. Despite years of decline between 2005 and 2019, the number of TB deaths globally increased between 2019 and 2021. In 2021, 1.6 million individuals lost their lives to TB, including 187,000 PLHIV [1].

Nigeria ranks first in Africa and sixth among the 30 countries with the highest TB burden worldwide [3]. Drug-resistant TB and the HIV epidemic are contributing factors to Nigeria's TB crisis. In 2021, Nigeria had approximately 467,000 TB cases with an incidence rate of 219 per 100,000 people, and a mortality rate (excluding PLHIV) of 53 per 100,000 [5]. In 2021 an estimated 112 000 individuals without HIV and 13 000 PLHIV died of TB [5].

Despite significant efforts to increase case finding and directly observed treatment short-course (DOTS) coverage in Nigeria over the past 15 years, the country's national case detection rate of 44% is still far below the global target of 70% [6]. This is due to factors such as the limited capability for sputum culture and mycobacterial detection, poor healthcare access, and the health-seeking behaviour of TB suspects, particularly in rural areas. Early diagnosis and treatment are critical to achieving TB control and elimination goals, as delays in diagnosis and treatment can lead to increased community infectivity, disease severity, reduced cure rates, and the development of drug-resistant TB [7]. Therefore, this study aimed to investigate the prevalence, pattern, and treatment outcomes of TB cases in a rural Nigerian teaching hospital.

2. METHODS

2.1. Study design and duration

This was a ten-year retrospective analysis conducted from January 2013 to December 2022 in the Department of Internal Medicine at Irrua Specialist Teaching Hospital, Irrua. Irrua is the administrative centre of the Esan Central Local Government Area in Edo State, in South-South Nigeria. The hospital is a reference facility serving neighbouring states and caters to all categories of patients. It is a centre of excellence for the diagnosis and management of viral haemorrhagic fever and emergent pathogens. The hospital features a specialised unit that manages TB cases following national guidelines. It provides free laboratory testing for the diagnosis of TB and free treatment for patients diagnosed with TB. Participants in this study were adult patients who were diagnosed with TB and recorded in the TB register during the study period.

2.2. Case selection

All consecutive adult patients who were diagnosed with TB during the study period were included in the study.

2.3. Exclusion criteria

All patients diagnosed with TB during the study period whose medical records were missing, those with incomplete information, and those with a non-TB diagnosis were excluded from the study.

2.4. Data collection

The data of all adult patients diagnosed with TB during the study period were reviewed. Data were extracted from the TB register, which served as the primary source of information and included the patient's age, gender, sites and types of TB, patient type, HIV status, GeneXpert status, and treatment outcomes.

2.5. Data analysis

The data was entered and analysed using IBM SPSS statistics® version 24.0 for Windows. Continuous variables were presented as means and standard deviation, and categorical variables as frequency and percentages**.** The association between variables was analysed using Pearson's Chi-square or Fisher's exact test. A *P*-value of less than 0.05 was considered significant.

2.6. Operational definitions

The definitions were based on the World Health Organisation (WHO) standard definitions [8].

Pulmonary TB (PTB): This is TB involving the lungs that has been bacteriologically confirmed or clinically diagnosed.

Extrapulmonary TB (EPTB): This is TB that has been bacteriologically confirmed or clinically diagnosed in organs other than the lungs.

New case: A patient who has never had treatment for TB or who has taken anti-TB for less than four weeks.

Cured: A patient who had bacteriologically confirmed TB at the start of treatment and was smear- or culture-negative in the last month of treatment and on at least one previous occasion.

Treatment completed: A TB patient who completed treatment without evidence of failure but with no record to show that sputum smear or culture results in the last month of treatment and on at least one previous occasion were negative, either because tests were not done or because results were unavailable.

Default: This refers to a TB patient who had been on treatment for at least 4 weeks and whose treatment was interrupted for 8 or more consecutive weeks.

Treatment failure: A TB patient with a positive sputum smear or culture at month five or later during treatment; or a patient with multidrug-resistant (MDR) strain at any point during treatment, whether smear-negative or positive.

Died: A TB patient who dies before or during treatment for any reason.

Treatment success: The total of all patients that were cured and those that completed treatment.

3. RESULTS

During the period being evaluated, the hospital diagnosed and treated 2,083 patients with TB, which accounted for 41.3% of the total number of suspected TB cases, amounting to 5,047. Figure 1 depicts the patients' recruitment flow chart.

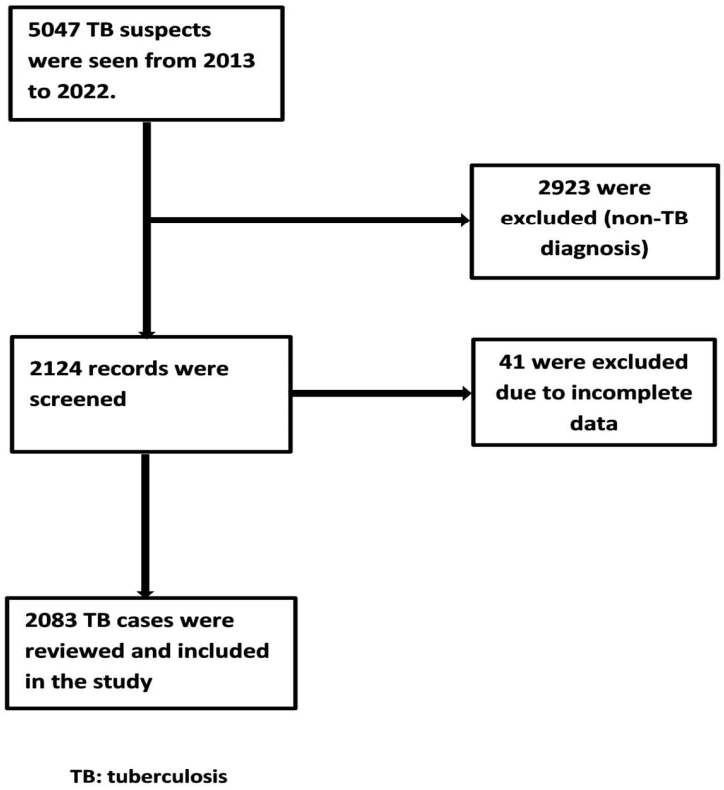

Figure 1. Patients' recruitment flowchart

The number of annual TB cases showed a gradual increase with a nadir in 2020 (Figure 2). The patients had a mean age of 44.7±10.9 years. Among them, 642 (30.8%) and 595 (28.6%) TB cases were observed in the age groups of 51-60 and 31-40 years, respectively. Males accounted for 1,232 (59.1%) and females accounted for 851 (40.9%), resulting in a male-to-female ratio of 1.4:1. The number of TB cases who were HIV-positive was 117 (5.6%). Of the total number of TB cases, 87.1% were diagnosed with PTB, while 12.9% had EPTB. The most common types of EPTB were TB lymphadenitis (27.2%), pleural TB (18.7%), and skeletal TB (15.7%) (Figure 3). There were 102 (9.5%) cases of rifampicin-resistant TB (RR-TB). The majority of patients (96.5%) had treatment success (cured: 28.9% and treatment completed: 67.6%). Treatment failure was observed in 9 (0.4%) patients, while 18 (0.9%) defaulted, and 45 (2.2%) died. Table 1 summarizes the sociodemographic and clinical characteristics of TB patients.

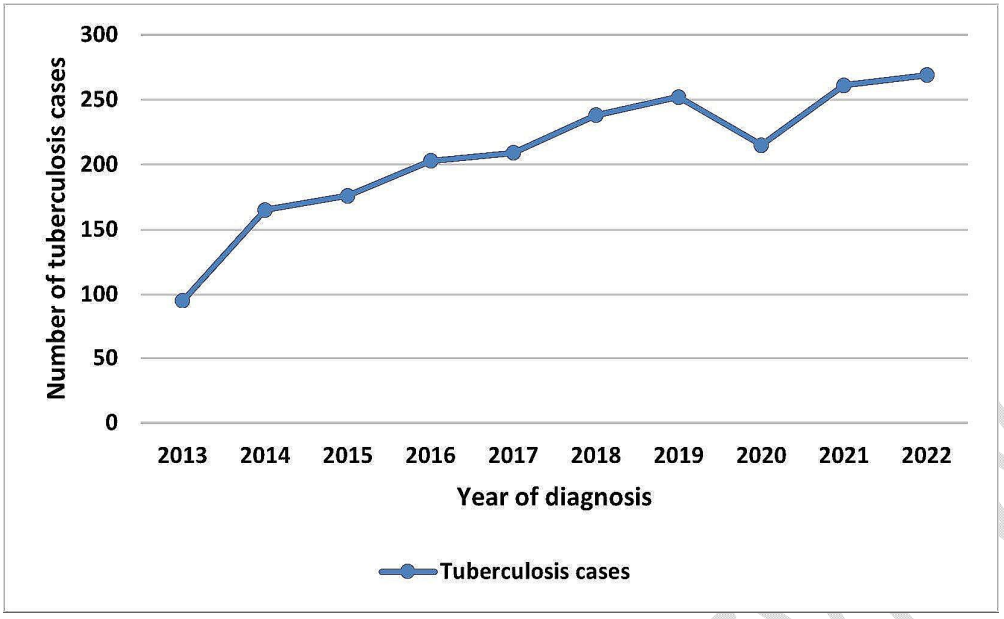

Figure 2: Annual trend in the number of TB cases

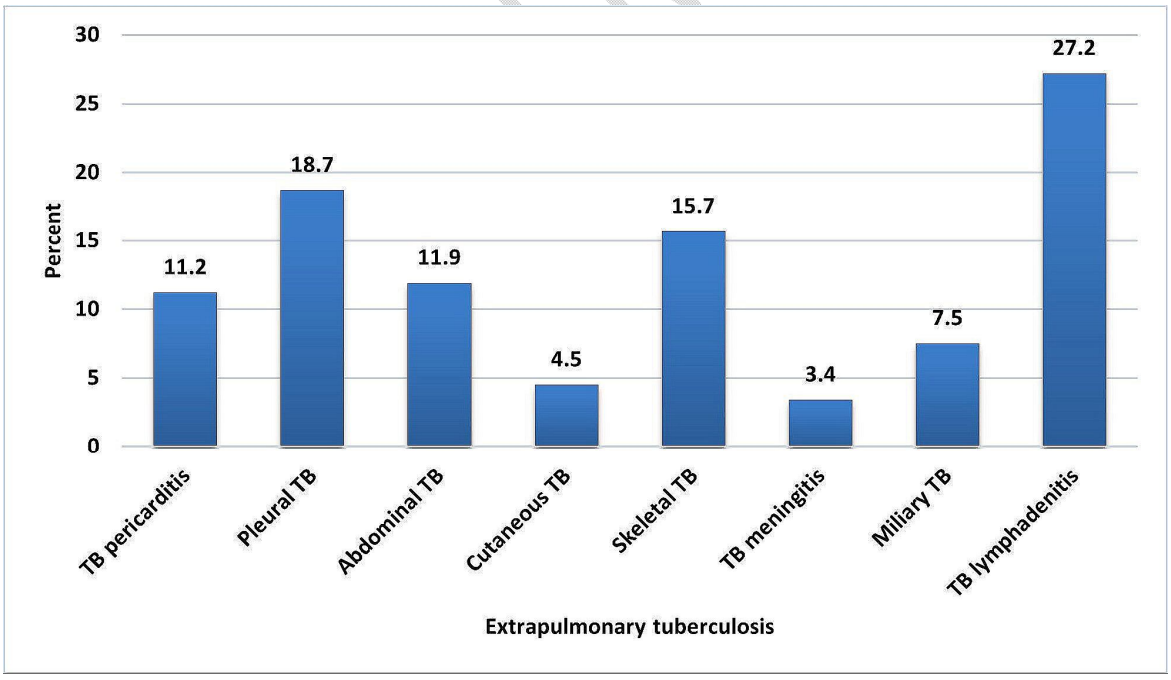

Figure 3. Spectrum of extrapulmonary TB

Table 1. Sociodemographic and clinical characteristics of TB cases

Characteristics	Frequency (n = 2083)	Percentage
Age group (years)		
11-20	64	3.1
21-30	137	6.6
31-40	595	28.6
41-50	528	25.3
51-60	642	30.8
>60	117	5.6
Mean ± SD	44.7 ± 10.9	
Gender		
Male	1232	59.1
Female	851	40.9
Type of patients		
Retreatment	31	1.5
New cases	2052	98.5
HIV status		
Positive	117	1.5
Negative	1966	94.4
Types of TB		
PTB	1815	87.1
EPTB	268	12.9
GeneXpert status (n = 1647)		
MTB positive	1070	65.0
MTB negative	577	35.0
RR-TB (n =1070)		
Yes	102	9.5
No	968	90.5
Treatment outcome		
Cured	602	28.9
Completed	1409	67.6
Failure	9	0.4
Default	18	0.9
Death	45	2.2

TB: tuberculosis; EPTB: extrapulmonary tuberculosis; MTB, *Mycobacterium tuberculosis*; RR-TB: rifampicin-resistant tuberculosis; HIV; Human immunodeficiency virus

The presence of RR-TB ($P = 0.033$) and a positive MTB GeneXpert test ($P < 0.001$) were found to be significantly associated with treatment success. Patients with RR-TB had 0.5 times lower odds of achieving treatment success compared to those without RR-TB ($P = 0.033$; CI: 0.26-0.96). Age ($P = 0.975$; CI: 0.59-1.51) and gender ($P = 0.528$; CI: 0.73-1.87) were not significantly associated with treatment success, although males had 1.2 times higher odds of treatment success than females. There was no significant relationship between HIV status ($P = 0.586$) and treatment success. Table 2 represents the association between TB treatment success and various socio-demographic and clinical characteristics.

Table 2. Association between TB treatment success and socio-demographic/clinical characteristics of the patients.

Characteristics	Treatment success		COR (95% CI)	*P*-value
	Yes	No		
Age group (years)				
<45	1086 (96.4)	40 (3.6)	0.9 (0.59-1.51)	0.975
≥45	925 (96.7)	32 (3.3)		
Gender				
Male	1192 (96.8)	40 (3.2)	1.2 (0.73-1.87	0.528
Female	819 (96.2)	32 (3.8)		
Type of patients				
Retreatment	16 (94.1)	1 (5.9)	0.6 (0.07-4.29)	0.583
New cases	1995 (96.6)	71 (3.4)		
HIV status				
Positive	114 (97.4)	3 (2.6)	1.4 (0.43-4.46)	0.586
Negative	1897 (96.5)	69 (3.5)		
Types of TB				
PTB	1755 (96.7)	60 (3.3)	1.4 (0.7-2.58)	0.327
EPTB	256 (95.5)	12 (4.5)		
GeneXpert status				
MTB positive	1008 (94.2)	62 (5.8)	0.3 (0.15-0.56)	< 0.001*
MTB negative	567 (98.3)	10 (1.7)		
RR-TB				
Yes	90 (60.8)	12 (39.2)	0.5 (0.26-0.96)	0.033*
No	908 (96.7)	60 (3.3)		

COR: crude odds ratio; CI: confidence interval; TB: tuberculosis; RR-TB: rifampicin-resistant tuberculosis; EPTB: extrapulmonary tuberculosis; MTB: *Mycobacterium tuberculosis*; HIV: human immunodeficiency virus; *Statistically significant *P*-value; All values are stated in number (percentages) unless otherwise stated.

4. DISCUSSION

To establish an effective program for controlling TB, it is crucial to have sufficient information about the prevalence and patterns of the disease in a given region. Therefore, this study aimed to assess the burden of TB in a rural hospital in Nigeria. Our findings indicated a steady increase in the number of TB cases reported annually at our centre, with a slight decline in 2020, which coincided with the peak of the COVID-19 pandemic in the country. This trend is consistent with global reports indicating that the COVID-19 pandemic has significantly disrupted TB healthcare services and led to a reduction in TB notifications worldwide, as compared to previous years [3]. Our findings are also consistent with earlier research, which has similarly reported an increase in annual TB cases [9,10].

In this study, the average age of TB patients was 44.7 years, which is similar to the mean age of 41.2 years reported by Bilagi et al. [11]. However, some earlier Nigerian studies reported lower mean age ranges [12,13]. The age groups that had the highest incidence of TB in this study were individuals aged 31-40 and 51-60 years old. Previous studies have shown that more cases of TB occur in the third and fourth decades of life [9,12]. On the other hand, in Cambodia, China, and Vietnam, individuals aged 65 years and older were most affected [14]. The variations in study methodologies, populations, and geographical distribution may account for some of these age disparities. Some studies have found that there are two peaks in the age distribution (15-25 and 60-70 years) for TB cases [15]. It has been emphasized that TB has a significant impact on the most economically active age group in any community, which places a significant strain on the economy [12]. This may be due to increased exposure to risk factors such as exposure to occupational hazards, travel, and sociocultural practices that promote TB transmission and acquisition. Additionally, this age group tends to be more sexually active, which puts them at a higher risk of contracting HIV infection, another factor that contributes to increased TB prevalence [12].

The gender distribution observed in this study aligns with the documented global epidemiology of TB [3]. Specifically, the gender incidence rate ratio for TB is in favour of males in this present study, which is consistent with earlier studies [16,17]. However, Ahmad et al. [18] reported a higher incidence of TB in females in Pakistan. The reason for this gender discrepancy is not fully understood, but potential factors such as biological mechanisms and social and ethnic disparities in access to healthcare have been suggested as possible reasons for gender susceptibility differences [19].

The observed prevalence rate of TB among TB suspects was 41.3% in this study. Similar rates of 48% and 49.3% were reported by Ukwaja et al. [20] in Ebonyi State and Jemikalajah et al. [21] in Delta State, respectively. On the other hand, some African studies have reported lower prevalence rates ranging from 8.9% to 25.5% [16,22,23]. Differences in study populations, geographical regions and methodology may explain the variations found among these studies. The high burden of TB observed in this study suggests that TB is

hyperendemic in Nigeria. Factors such as the emergence of multidrug-resistant TB (MDR-TB), poverty, HIV infection, overcrowding, malnutrition, and a weak healthcare system have all contributed to the TB epidemic in Nigeria.

The distribution of TB sites in favour of PTB (87.1%) is consistent with findings from other studies [9,12,16]. However, Karir et al. [24] in Kolkata, India reported a higher proportion of EPTB (51.2%). The most common form of EPTB observed in this study was TB lymphadenitis, followed by pleural TB and skeletal TB (Pott's disease). Other forms of EPTB identified included abdominal TB, TB pericarditis, cutaneous TB, miliary TB, and TB meningitis. Similar distribution patterns of EPTB have been documented in other similar studies as well [9,25]. However, Salami et al. [12] reported abdominal TB as the most prevalent form of EPTB. The reason for this discrepancy in findings is not yet clear, however, consumption of unpasteurised milk may be a factor, especially in a rural area where such practices exist.

TB notification rates are increasing due to a rise in HIV prevalence, which has become the primary cause of death among HIV patients. The WHO report found that 8% of incident TB cases were in PLHIV [3]. The index study reported that 5.6% of TB patients were PLHIV. The proportion of TB/HIV co-infection rates is highest in countries of the WHO African Region, with some parts of Southern Africa exceeding 50% [3]. Several studies have documented varying proportions of TB/HIV co-infection rates across Nigeria, ranging from 9.3% to 34.5% [21,26-29]. These high rates suggest that HIV plays a significant role in TB transmission.

Rifampicin remains one of the most effective drugs to treat TB, and the advent of resistance to it has significantly impacted the TB-control programme [23]. In resource-limited settings, RR-TB detected by GeneXpert is frequently used as a proxy for MDR-TB and is a strong predictor of MDR-TB [23]. The present study found that 9.5% of cases had RR-TB, which is comparable to the rate of 10.7% reported by Adetunji et al. [30] in South-West Nigeria. Additionally, Ikuabe et al. [22] in South-South Nigeria reported an RR-TB rate of 14.7%, while Gebretsadik et al. [23] in Ethiopia reported an RR-TB rate of 5.3%. These findings suggest that RR-TB is a public health concern in sub-Saharan Africa. Accurate and timely detection of RR-TB is critical to improve patient care and decrease TB transmission.

The vast majority of patients (96.5%) in our study achieved "treatment success," with a cure rate of 28.9% and a treatment completion rate of 67.6%. These results are consistent with previous studies [31,32]. However, a study conducted in South-East Nigeria reported a lower treatment success rate of 56.5% [33]. The high treatment success rate in our study may be attributed to the level of care provided to patients, such as proper supervision of treatment and effective implementation of the DOTS strategy at our centre. It should be noted that the presence of drug-resistant strains of MTB can negatively impact treatment success rates. Our study found that patients with RR-TB had lower odds of achieving treatment success compared to those without RR-TB. This finding is consistent with other studies that have reported a higher risk of treatment failure in patients with drug-resistant TB [34–36].

Although there was no significant association between HIV status and treatment success in our study, previous research has shown that HIV-positive individuals have lower treatment success rates [32,33,37]. This suggests that TB patients co-infected with HIV may have a lower chance of achieving treatment success than those without HIV infection.

In our study, a small proportion (3.5%) of patients experienced poor treatment outcomes, such as failure, default, and death. Among these outcomes, default is a major challenge for TB control programs. Interestingly, the default rate among TB patients in our study was 0.9%, which is considerably lower than the default rates observed in previous Nigeria studies [33,38]. These studies have identified various factors, including financial constraints, long distances to hospitals, poor supervision, lack of home care, and noncompliance with treatment regimens, as reasons for the high default rates [33,38]. Improved treatment supervision, health education programs, and the use of strategies such as the defaulter tracing system may have contributed to the lower default rate in this present study. Overall, our findings suggest that effective implementation of these interventions could help to improve treatment outcomes for TB patients. Treatment failure is a significant concern for TB control programs. In our study, 0.4% of TB patients experienced treatment failure, which is comparable to rates reported in some earlier studies [9,32,33]. Meanwhile, the TB-related death rate in our study was 2.2%, which is relatively low compared to rates reported in some previous Nigerian studies [31,33].

However, it is important to note that this study has some limitations. Firstly, the data was collected from a single health institution, so caution should be exercised when making generalizations. Additionally, hospital data may not accurately reflect the true burden of TB as community-based studies might. Finally, the study only included adults, so the findings may not apply to the paediatric population.

5. CONCLUSION

This study shows that TB is still a significant public health problem in Nigeria due to its increased burden. Therefore, a joint effort is necessary to combat TB, and measures aimed at achieving this must be escalated. More work needs to be done by relevant authorities and stakeholders to enhance TB control if the "Stop TB Partnership" objective of eliminating TB as a public health issue by 2050 is to be realized.

REFERENCES

1. World Health Organisation. Global tuberculosis report 2022. World Health Organisation. 2022. Accessed 18 April 2023. Available: https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2022.

2. Adhikari N, Bhattarai RB, Basnet R, Joshi LR, Tinkari BS, Thapa A, et al. Prevalence and associated risk factors for tuberculosis among people living with HIV in Nepal. PLoS One. 2022;17(1):e0262720.

3. World Health Organisation. Global tuberculosis report 2021. World Health Organisation. 2021. Accessed 18 April 2023. Available: https://www.who.int/publications/i/item/9789240037021.

4. World Health Organisation. Global Tuberculosis Report 2022 Factsheet. World Health Organisation. 2022. Accessed 14 April 2023. Available: https://www.who.int/publications/m/item/global-tuberculosis-report-2022-factsheet.

5. World Health Organisation. TB profile: Nigeria. World Health Organisation. Accessed 8 April 2023. Available: https://worldhealthorg.shinyapps.io/tb_profiles/?_inputs_&entity_type=%22country%22&lan=%22EN%22&iso2=%22NG%22.

6. The World Bank Group. Tuberculosis case detection rate - Nigeria. World Bank Open Data 2020. Accessed 18 April 2023. Available: https://data.worldbank.org/indicator/SH.TBS.DTEC.ZS?locations=NG.

7. Ereso BM, Sagbakken M, Gradmann C, Yimer SA. Total delay and associated factors among tuberculosis patients in Jimma Zone, Southwest Ethiopia. PLoS One. 2023;18(2):e0281546.

8. World Health Organization. Definitions and reporting framework for tuberculosis – 2013 revision: updated December 2014 and January 2020. World Health Organisation. 2013. Accessed 19 April 2023. Available: https://apps.who.int/iris/handle/10665/79199.

9. Lamb AR, Khadilkar HA, Shoukat Ali SAA. Clinical profile and treatment outcome of tuberculosis patients under programmatic management in a tuberculosis unit at a tertiary care center. Int J Community Med Public Health. 2018;5(7):2825-8.

10. Dim CC, Dim NR. Trends of tuberculosis prevalence and treatment outcome in an under-resourced setting: The case of Enugu state, South East Nigeria. Niger Med J. 2013;54(6):392–7.

11. Bilagi RB, Deshmukh H. Study of clinical profile of tuberculosis patients admitted in respiratory medicine ward at a tertiary care hospital in Marathwada. Int J Adv Med. 2018;5(1):68-72.

12. Salami TAT, Samuel SO, Eze KC, Oziegbe OE. Tuberculosis in a Nigeria teaching hospital: Incidence and pattern of distribution. Trop J Health Sci. 2007;14(2):26–30.

13. Yonge SA, Otieno MF, Sharma RR, Nteka SS. Drug Susceptibility Patterns of Mycobacterium tuberculosis Isolates from Tuberculosis Patients in Coastal Kenya. J Tuberc Res. 2017;5(4):201–19.

14. Hoa NB, Wei C, Sokun C, Lauritsen JM, Rieder HL. Characteristics of tuberculosis patients at intake in Cambodia, two provinces in China, and Viet Nam. BMC Public Health. 2011;11:367.

15. Sreeramareddy CT, Panduru KV, Verma SC, Joshi HS, Bates MN. Comparison of pulmonary and extrapulmonary tuberculosis in Nepal- a hospital-based retrospective study. BMC Infect Dis. 2008;8:8.

16. Ogbudebe CL, Chukwu JN, Nwafor CC, Meka AO, Ekeke N, Madichie NO, et al. Reaching the underserved: Active tuberculosis case finding in urban slums in southeastern Nigeria. Int J Mycobacteriol. 2015;4(1):18–24.

17. Gupta S, Shenoy VP, Mukhopadhyay C, Bairy I, Muralidharan S. Role of risk factors and socio-economic status in pulmonary tuberculosis: a search for the root cause in patients in a tertiary care hospital, South India. Trop Med Int Health. 2011;16(1):74–8.

18. Ahmad T, Jadoon MA, Haroon, Khattak MNK. Prevalence of sputum smear positive pulmonary tuberculosis at Dargai, District Malakand, Pakistan: A four-year retrospective study. Egypt J Chest Dis Tuberc. 2016;65(2):461–4.

19. Nhamoyebonde S, Leslie A. Biological Differences Between the Sexes and Susceptibility to Tuberculosis. J Infect Dis. 2014;209(Suppl 3):S100–6.

20. Ukwaja K, Alobu I, Ifebunandu N, Osakwe C, Igwenyi C. From DOTS to the Stop TB Strategy: DOTS coverage and trend of tuberculosis notification in Ebonyi, southeastern Nigeria, 1998-2009. Pan Afr Med J. 2011;9:12.

21. Jemikalajah JD, Okogun GA. Health point prevalence of human immunodeficiency virus and pulmonary tuberculosis among patients in various parts of Delta State, Nigeria. Saudi Med J. 2009;30(3):387–91.

22. Ikuabe PO, Ebuenyi ID. Prevalence of rifampicin resistance by automated Genexpert rifampicin assay in patients with pulmonary tuberculosis in Yenagoa, Nigeria. Pan Afr Med J. 2018;29:204.

23. Gebretsadik D, Ahmed N, Kebede E, Mohammed M, Belete MA. Prevalence of Tuberculosis by Automated GeneXpert Rifampicin Assay and Associated Risk Factors Among Presumptive Pulmonary Tuberculosis Patients at Ataye District Hospital, North East Ethiopia. Infect Drug Resist. 2020;13:1507–16.

24. Karir S, Biswas A, Mandal A, Sagar V, Pal M. A study on clinical profile of indoor patients receiving anti-tuberculosis treatment at KPC Medical College and Hospital, Kolkata, India. Int J Community Med Public Health. 2016;3(10):2891–6.

25. Abudu EK, Onwuezobe IA. Extra-pulmonary tuberculosis in Uyo, South - South, Nigeria. Savannah J Med Res Pract. 2017;4(2):72.

26. Asuke S, Bimba J, Ngutor SM, Ejiga E, Miracle Sz, Anamayi DM. Prevalence of tuberculosis-HIV co-infection and factors associated with treatment outcome among the tuberculosis patients in HIV treatment facility in a teaching hospital in Jos, North Central Nigeria. Port Harcourt Med J. 2020;14(3):119-24.

27. Omote V, Ukwamedua H, Etaghene J, Oseji ME, Agwai IC. Pulmonary tuberculosis (PTB) among suspected cases in delta state, South-Southern Nigeria. J Lung Pulm Respir Res. 2018;5(5):145–9.

28. Enoch AS, Silas G, Pius MT, Nwozuke AI. Cross-Sectional Study of Tuberculosis and HIV/AIDS Co-Infections among Patients Attending Directly Observed Treatment Centers in Bayelsa State, Nigeria. J Tuberc Res. 2021;9(3):131–45.

29. Gyar SD, Dauda E, Reuben CR. Prevalence of Tuberculosis in HIV/AIDS Patients in Lafia, Central Nigeria. Int J Curr Microbiol Appl Sci. 2014;3(6):831-8.

30. Adetunji SO. Drug Resistant Tuberculosis in Oyo State, Nigeria: A Retrospective Study. Int J Trop Dis Health. 2020;41(2):39–45.

31. Ebuenyi I, Ikuabe P, Jumbo J. Treatment Outcome of Tuberculosis at One Year: A Single Centre's Experience in Niger Delta, Nigeria. Int J Trop Dis Health. 2016;12(1):1–6.

32. Abdulkader M, van Aken I, Niguse S, Hailekiros H, Spigt M. Treatment outcomes and their trend among tuberculosis patients treated at peripheral health settings of Northern Ethiopia between 2009 and 2014: a registry-based retrospective analysis. BMC Res Notes. 2019;12(1):786.

33. Umeokonkwo CD, Okedo-Alex IN, Azuogu BN, Utulu R, Adeke AS, Disu YO. Trend and determinants of tuberculosis treatment outcome in a tertiary hospital in Southeast Nigeria. J Infect Public Health. 2020;13(7):1029–33.

34. Talay F, Kumbetli S, Altin S. Factors associated with treatment success for tuberculosis patients: a single center's experience in Turkey. Jpn J Infect Dis. 2008;61(1):25–30.

35. Chaves Torres NM, Quijano Rodríguez JJ, Porras Andrade PS, Arriaga MB, Netto EM. Factors predictive of the success of tuberculosis treatment: A systematic review with meta-analysis. PloS One. 2019;14(12):e0226507.

36. Karo B, Hauer B, Hollo V, van der Werf MJ, Fiebig L, Haas W. Tuberculosis treatment outcome in the European Union and European Economic Area: an analysis of surveillance data from 2002–2011. Eurosurveill. 2015;20(49). 37.

37. Tola A, Mishore KM, Ayele Y, Mekuria AN, Legese N. Treatment Outcome of Tuberculosis and Associated Factors among TB-HIV Co-Infected Patients at Public Hospitals of Harar Town, Eastern Ethiopia. A five-year retrospective study. BMC Public Health. 2019;19(1):1658.

38. Ifebunandu NA, Ukwaja KN. Tuberculosis treatment default in a large tertiary care hospital in urban Nigeria: Prevalence, trend, timing and predictors. J Infect Public Health. 2012;5(5):340–5.