



Nonadherence to tuberculosis treatment and associated factors among patients using directly observed treatment short-course in north-west Nigeria: A cross-sectional study

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Cyilia Nkechi Iweama¹, Olaoluwa Samson Agbaje¹ ,
Prince Christian Ifeanchor Umoke¹, Chima Charles Igbokwe¹,
Eyuche Lawretta Ozoemena¹, Nnenna Lois Omaka-Amari²
and Benjamin Mudi Idache³

Abstract

Introduction: Tuberculosis is a public health problem in Nigeria. One of the most effective ways of controlling tuberculosis is the directly observed treatment short-course. However, some factors influence tuberculosis patients' treatment nonadherence via directly observed treatment short-course. The study objective was to assess medication nonadherence and associated factors among tuberculosis patients in north-west Nigeria.

Methods: A cross-sectional study enrolled tuberculosis patients using directly observed treatment short-course in public health facilities in Kano and Kaduna States from January 2015 to June 2016. The sample selection was conducted via a multistage sampling procedure. Data were collected using tuberculosis patients' demographic and clinical characteristics forms, well-validated structured instruments, and medical records. SPSS version 20 was used for data analysis. Logistic and multivariable logistic regression analyses to determine factors of medication nonadherence ($P < 0.05$)

Results: Complete responses from 390 patients out of the 460 patients recruited for the study were used for data analyses. The mean age was 51.5 (standard deviation = ± 13.8) years. The mean tuberculosis medication adherence questionnaire score was 4.35 ± 1.12 . The prevalence of nonadherence to tuberculosis medication was 30.5%. Multivariable logistic regression analysis showed that having a monthly income between #100,000 and #199,000 (adjusted odds ratio = 0.01; 95% confidence interval: 0.00–0.13), being widowed (adjusted odds ratio = 26.74, 95% confidence interval: 2.92–232.9), being married (adjusted odds ratio = 120.49, 95% confidence interval: 5.38–271.1), having a distance < 5 km to directly observed treatment short-course center from home (adjusted odds ratio = 0.06, 95% confidence interval: 0.00–0.01), having a tuberculosis/HIV coinfection (adjusted odds ratio = 0.01, 95% confidence interval: 0.12–0.35), use of antiretroviral treatment and cotrimoxazole prophylaxis therapy medications (adjusted odds ratio = 24.9, 95% confidence interval: 19.6–304.3) were associated with tuberculosis medication nonadherence.

Conclusion: Tuberculosis medication nonadherence was high among the patients. Thus, patient-specific adherence education, attenuation of potential factors for tuberculosis medication nonadherence, and continual resource support for tuberculosis patients are needed to improve treatment outcomes.

Keywords

Tuberculosis, directly observed treatment short-course, nonadherence, Nigeria

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¹Department of Human Kinetics and Health Education, Faculty of Education, University of Nigeria, Nsukka, Nigeria

²Department of Human Kinetics and Health Education, Faculty of Education, Ebonyi State University, Abakaliki, Nigeria

³Department of Health and Physical Education, Faculty of Education, Kogi State University, Anyigba, Nigeria

Corresponding author:

Olaoluwa Samson Agbaje, Department of Human Kinetics and Health Education, Faculty of Education, University of Nigeria, 400001 Nsukka, Enugu, Nigeria.

Emails: agbajesam@yahoo.com; samsonagbaje@unn.edu.ng



Introduction

Tuberculosis (TB) is one of the diseases of public health importance worldwide. TB is responsible for 1.6 million deaths in 2017 and the leading cause of mortality from a single infectious agent, especially in developing countries.^{1–3} TB is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*, and an acid-fast bacillus spread mainly via the respiratory pathway.⁴ Research evidence suggests that TB incident cases have not reduced considerably compared to their mortality.^{2,4} For instance, one in three persons across the world, representing 2 to 3 billion individuals, is known to be infected with mycobacterium TB, of which 5%–15% are likely to develop active TB disease during their lifetime.⁴

The rate of new TB infections is also high in Africa. Africa has the highest rates of active TB per capita, driven primarily by the HIV epidemic.⁴ The incidence of TB was estimated to be rising, with 1500 deaths daily in Africa.⁵ Global reports showed that 10 countries accounted for 80% of the 3.6 million global gaps, and they include India (26%), Indonesia (11%), and Nigeria (9%).⁴

Despite current global efforts to reduce TB, Nigeria's TB prevalence is increasing in many communities, including the north west.⁵ Evidence suggests that over 80% of TB cases are still undetected and undiagnosed.⁶ For instance, the World Health Organization (WHO) reported that less than a quarter of TB cases (15%) were notified in 2015, and the proportion of patients with rifampicin or multidrug-resistant tuberculosis (MDR/RR-TB) is 4.3% among new cases and 25% among previously treated cases.^{6,7} The high incidence rates of TB may be one of the reasons why Nigeria is considered one of the 30 high-burden countries for TB/HIV and drug-resistant TB (DR-TB), MDR-TB, and extensively drug-resistant TB (XDR-TB) TB.⁶

TB prevalence remains high, especially in northern Nigeria. Northern Nigeria is an overwhelming majority Muslim region. The Fulani live with their cattle and at increased risk of developing *Mycobacterium bovis* that can complicate human immunodeficiency virus (HIV). The TB survey in Nigeria showed that there were thousands of new cases of TB in the north-west, north-central, and north-east.^{8–10} Furthermore, north-west region had TB infection rate of 47 persons per 100,000 population; north-east, 65 per 100,000 population; 80 per 100,000 population for north-central. The new cases of TB were relatively higher compared to the southern part of the country.^{8–10} To control TB's high prevalence in the country, the Nigerian government established the National TB Control Program (NTP) in 1993 and introduced the directly observed treatment short-course (DOTS).

The DOTS is one of the most cost-effective TB control strategies for ending TB infections and ensuring effective treatment.^{11,12} DOTS service offers several benefits to TB patients. Isaakidis et al.¹³ affirmed that DOTS service provides day-to-day contact with TB patients and facilitates close monitoring for the development of adverse outcomes combined with other interventions such as emotional support, nutritional

supplementation, and other types of enablers. The DOTS services were scaled up across Nigeria due to TB's declaration as a national emergency in 2006. Now, the National Tuberculosis and Leprosy Control Program (NTBLCP) co-ordinates TB control in Nigeria. The aims of the NTBLCP are anchored on the "Stop TB Partnership" initiatives whose ultimate target is to eliminate TB as a public health problem (less than 1 case per million population) by the year 2050.¹⁴ Also, the NTBLCP aims are consistent with the WHO's End TB Strategy. The End TB Strategy aims to reduce TB-related deaths to 90% of those in 2015 and TB incidence to 80% in 2015. It also aims to ensure that families do not face calamitous costs due to TB by 2030.^{14–16}

Furthermore, the private (not-for-profit) mission health facilities and public (tertiary, secondary, and some primary) health institutions are involved in the TB control program in Nigeria.^{17,18} Although DOTS has helped in the control of TB in Nigeria, however, there are some limitations. The limitations include the inability to emphasize smear-negative TB, extra-pulmonary TB, childhood TB, drug-resistant TB (DR-TB),^{7,3} poor adherence to anti-TB drugs,⁷ and delays in treatment.⁸ Other factors that undermine TB control in Nigeria include TB patients' characteristics, inaccessibility to DOTS centers, perceived quality of care, and inability to afford high-quality TB care.¹⁹ To effectively curb the incidence rates of TB, promote effective TB control in North-west Nigeria, and attain WHO's End TB Strategy targets, identifying factors that influence TB medication adherence among patients is a public health priority.

Medication/treatment adherence is essential for the attainment of the desired clinical outcomes.²⁰ According to WHO, medication adherence refers to "the extent to which a person's behavior-taking medication, following a diet, or executing lifestyle changes, corresponds with agreed recommendations from a health care provider."²⁰ Studies have shown that non-adherence may be more prevalent in developing countries due to poor accessibility to medicines and healthcare services.^{21,22}

Studies conducted in different regions of Ethiopia showed reported that factors such as patients' forgetfulness, patients' on the continuation phase of chemotherapy, TB/HIV co-infection, health system, patient and socio-economic attributes, presence of more than one co-morbidity, poor knowledge about TB and anti-TB therapy, poor patient-provider relationship, alcohol intake, patients' experience of side effects, the distance of the home to the health facility, and long waiting time before access to treatment were strong predictors of anti-TB medication non-adherence.^{23–25} Similarly, a Japanese study revealed that non-acceptance, frustration, and anxiety among TB patients were associated with anti-TB treatment nonadherence.²⁶ A study conducted in East Nusa Tenggara, Indonesia, reported that a lack of knowledge and incorrect perception of TB before therapy were associated with anti-TB treatment default.²⁷

Nonadherence to anti-TB medications was attributed to positive or negative attributes inherent in the health system, social or family issues, personal factors, and drug factors (e.g. medication side effects).²⁸ However, there is limited

data on TB medication nonadherence and associated factors among TB patients in north-west Nigeria.

Regarding the outcomes of anti-TB medication nonadherence, Adane et al. reported that 0.7% of the TB patients had treatment failure, and nonadherence to anti-TB treatment regimen was identified as the possible cause of treatment failure.²³ Also, Shiratani reported that 37.3% of TB patients indicated no significant improvement in their condition, and 9.5% of them stated that their condition deteriorated.²⁶ In addition, nonadherence to recommended treatment regimens such as TB medications may lead to the uncontrolled spread of TB infections, the occurrence of adverse drug reactions, morbidity, and drug resistance. Moreover, the uncontrolled spread of TB among the population might lead to a considerable healthcare financial cost and significant loss in human resources. Besides, the northern part of the country has significantly worse health indicators than the national averages.²⁹ For instance, the Nigerian health system is weakened and fragile due to underinvestment and poor financial management, poor budgeting, and a limited supply of essential medicines and equipment.³⁰

Researchers have employed theories and models to explain factors that might affect and change people's behaviors.⁴ Thus, the socioecological model (SEM) is one of the most frequently used theories to explain this phenomenon. The SEM contemplates the intricate interplay between individual, interpersonal, and environmental (community, organizational, build environmental, and political) factors, which are essential to promoting healthy behavior such as medication adherence.^{31–33} According to the SEM, the individual is at the center of the web of influencing factors that positively or negatively impact health behavior. Therefore, the use of SEM could provide a more comprehensive understanding of nonadherence to TB medications among patients. Many studies have utilized SEM to explain different health behaviors such as HIV treatment adherence,³⁴ access to and acceptability of HIV/AIDS treatment and care services.³⁵

The Global Burden of Diseases, Injuries, and Risk Factors data for TB (1990–2016) show that if current trends in TB incidence persist, only a few countries are likely to end the TB epidemic by 2030.³⁶ Therefore, an improved understanding of the factors associated with anti-TB drugs/medication nonadherence among TB patients using DOTS in north-west Nigeria could provide evidence for the needed interventions and policies. This study aimed to identify associated factors of TB medication nonadherence among pulmonary TB patients using DOTS in north-west Nigeria.

Methods

Study population and design

The study was a facility-based cross-sectional survey conducted from January 2015 to June 2016 in Kaduna and Kano States, north-west Nigeria. The 2015 projected population for the two states were 7,994,350 and 12,625,460, respectively. The popular Hausa–Fulani ethnic group

predominantly dominated the states.³⁷ There were 226 and 181 DOTS centers in Kano and Kaduna States, respectively, and 72,448 TB patients (PTB and EPTB) receiving treatment at DOTS centers in North-west, Nigeria, at the time of the study. However, this study focused on public health facilities considered regional, tertiary, and reference DOTS facilities. The facilities included the National TB and Leprosy Training Center (NTBLTC), Saye, Zaria, the Barau Dikko Hospital (BDH) in Kaduna City, Aminu Kano Teaching Hospital (AKTH), Infectious Disease Hospital (IDH), Kano, Murtala Mohammed Specialist Hospital (MMSH), Bebeji General Hospital, Tiga General Hospital, Bichi General Hospital, Fagwalawa Cottage Hospital, Danbatta, Dawakin Kudu General Hospital, and Yusuf Maitama Sule Teaching Hospital, Dawakin Kudu, Kano that provide TB screening, diagnosis, and treatment services to patients. TB case finding in Kano and Kaduna States uses the passive case finding strategy.¹⁷

Sample and sampling technique

The study's sample size was computed based on a single population proportion formula. The sample size was calculated using the Open Epi v 2.3 software.³⁸ The criteria used to calculate the sample size were the prevalence of TB in Nigeria, $P=27\%$;³⁹ margin of error, $d=5\%$; a design effect of 1.5 to compensate for a random error due to a multistage sampling, and $Z\alpha=1.96$ for a 95% confidence level. Therefore, the estimated minimum sample size required to identify factors associated with anti-TB medication nonadherence was 460.

$$n = \frac{Z\alpha^2 \cdot p(1-p)}{d^2}$$

$$n = \frac{1.960^2 \cdot 0.27(1-0.27)}{0.05^2}; n = \frac{3.8416 \times 0.27(1-0.27)}{0.0025};$$

$$n = \frac{3.8416 \times 0.27(0.73)}{0.0025}$$

$$n = \frac{0.75717936}{0.0025}; n = 303; n = 303 \times 1.5 = 455 \sim 460$$

Multistage sampling was used to select the states, primary sampling units (health facilities), and the study units (adult TB patients aged ≥ 18 years). Out of the seven states in north-west Nigeria, two states (Kaduna and Kano) were randomly selected. A sampling frame was created using a list of public health facilities obtained from the two states. Furthermore, the investigators proportionally allocated the study sample to each of the selected states based on their size (i.e. the population of registered TB patients using the DOTS). Purposive sampling was used to select the 15 primary sampling units (i.e. public health facilities that provide DOTS services). Using the population of registered TB

patients at the health facilities, nine public DOTS facilities, including AKTH, IDH, and MMSH, were selected in Kano state. Also, six public DOTS facilities were selected from Kaduna State. These include NTBLTC and BDH from Zaria and Kaduna City, respectively. The remaining four public DOTS facilities were selected from Ikara, Makera Doka, Sanga, and Kachia in Kaduna State. The selection of TB patients in the DOTS facilities was drawn through proportionate random sampling. In other words, the proportionate allocation of patients was conducted based on the population of TB patients using the DOTS in the sampled states (i.e. Kano and Kaduna). For Kano state, 276 TB patients were selected (i.e. $9/15 = 0.6 \times 460 = 276$), while in Kaduna state, 184 TB patients were selected (i.e. $6/15 = 0.4 \times 460 = 184$). Therefore, 60% and 40% of the participants were selected from Kano and Kaduna States. Furthermore, 93, 72, and 35 TB patients were drawn from AKTH, IDH, and MMSH, respectively, in Kano State. Also, 15, 10, and 12 patients were selected from Bebeji General Hospital, Tiga General Hospital, and Bichi General Hospital, respectively. In addition, 10, 15, and 14 TB patients were drawn from Fagwalawa Cottage Hospital, Danbatta, Dawakin Kudu General Hospital, and Yusuf Maitama Sule Teaching Hospital, Dawakin Kudu, respectively. In Kaduna state, 74 and 32 TB patients were conveniently drawn from NTBLTC, Zaria, and BDH, Kaduna City, respectively. In addition, 78 TB patients were selected from other 4 DOTS centers in Ikara (22 patients), Makera Doka (20 patients), Sanga (19 patients), and Kachia (17 patients).

Also, written informed consent was obtained from each TB patient after a detailed explanation of the study objectives. The participants were further informed about their voluntary participation, and they were free to withdraw from the study at any time. The healthcare workers (i.e. nurses) in charge of the TB patients assisted in the collection of TB patients' clinical features.

The inclusion criteria included adult TB patients aged ≥ 18 years, a diagnosis of PTB and EPTB, the use of DOTS, access, and receipt of care from doctors, nurses, and homehelpers for more than 2 months. The exclusion criteria included patients below 18 years and those who refused to participate in the study. Also, older TB patients (i.e. ≥ 70 years), bedridden adult TB patients, and those who had a disability limiting activity were excluded from the study. The questionnaires were administered with the health workers' assistance (nurses, community health officers-CHOs) and DOTS supporters in a quiet and conducive room at the DOTS centers where TB patients came for follow-up or regular checkups. The questionnaires were distributed to TB patients between 19 January 2015 and 9 May 2016.

Ethics approval

The participants gave written informed consent before each interview, and no personal identification was registered.

Information concerning the study purpose, confidentiality, willingness to participate, and the decision to withdraw was provided to all the participants. The permission to conduct the study was obtained from each health facility, and the approval for the study was given by the institutional review board (IRB) of the University of Nigeria, Nsukka (Ref no: NHREC/05/01/2008B-FWA00002458-IRB00002323).

Measures

We used a structured data collection form to collect TB patients' sociodemographic data. The independent/explanatory variables included self-reported sociodemographic information (e.g. age, gender, place of residence, occupational status, educational level, monthly income, marital status, ethnicity, distance to a DOTS center/health facility from home, TB stigma, perceived quality of DOTS services, perceived satisfaction with TB treatment, alcohol use, tobacco smoking status and knowledge of TB and DOTS). Age groups ($\geq 18/20-40/41-59/60-69$ years); gender (male/female); place of residence (urban/rural); marital status (single/married/divorced or separated/widowed); education (no formal education/Primary/Secondary/Tertiary); occupation (student/self-employed/ trader & artisan/civil servant/ employed in a private firm/unemployed/); monthly income ($< \#18,000.00/\#18,000-\#99,000/\#100,000-\#199,000/\geq \#200,000.00$); ethnicity (Hausa-Fulani/Yoruba/Igbo/Others); distance to a DOTS center/facility from home (< 5 km/ ≥ 5 km); TB stigmatization (Yes/No) (Appendix 1).

The clinical characteristics such as TB patient type, TB drug resistance status, TB/HIV co-infection, treatment duration, and antiretroviral treatment (ART) and cotrimoxazole prophylaxis therapy (CPT) drug use were extracted from the patients' medical records with nurses' assistance. One question was used to evaluate the severity of TB drugs side effects: "Side effects of TB drugs were not painful and did not interfere with my adherence to anti-TB medication" (coded as mild=0), "the side effects of TB drugs were so painful, and they interfered with my adherence to TB medication" (coded as severe=1).

Medication nonadherence was the outcome variable in this study. To measure medication nonadherence, the investigators developed and administered a pre-tested structured patient-reported outcome measure (PROM), Tuberculosis Medication Adherence Questionnaire (TBMAQ) (Supplementary Material 1). The items included in the TBMAQ were derived from literature.^{23,40} The TBMAQ was used to assess patients' adherence to the recommendations for DOTS. The TBMAQ was organized into four categories containing structured or closed-ended questions. The TBMAQ was self-administered; however, a research facilitator was available to provide support if required. The TBMAQ contains eight items grouped into four subscales: (1) problems with medication use, (2) appointment keeping, (3) proper medication use, and (4) social support for medication use from family members and friends. Each item is

scored on a 4-point scale, response options consist of “never=0,” “sometimes=1,” “most of the time=2,” and “all the time=3.” The score ranges from 0 to 24 points; higher scores imply a higher adherence level, while lower scores indicate a lower adherence level (Supplementary material 1). A binary categorization of scores on the TBMAQ into nonadherence versus adherence was performed to determine the prevalence of TB medication adherence.

Consequently, a “never” response to any questions on the TBMAQ was assigned a score of zero (0), while “sometimes,” “most of the time,” or “all the time,” response was assigned a score of one (1). In the binary scoring procedure, the total score ranges from 0 to 8. The scores that range from 0 to 4 (i.e. total score ≤ 4) were considered nonadherence, and a score of 5 and above (i.e. total score ≥ 5) was considered good adherence. The TBMAQ was assessed for content validity by two physicians and two pharmacists selected from the study sites. Twenty randomly selected newly diagnosed TB patients selected from the Specialist Hospital, Kaduna, were used for face validity assessment. Feedback from the pre-test and validity assessment informed some minor modifications, including rephrasing a few items to ensure the participants’ comprehension and clarity of intention. The reliability of the TBMAQ via Cronbach’s alpha was 0.71.

TB stigmatization was measured with one question: “have you experienced shame or disgrace due to TB infection from someone (friends, family members, or health workers) in the past 6 months?” Respondents were asked to indicate their TB-related stigma experience using the “Yes” or “No” response option.

The perceived quality of DOTS services was measured using the DOTS SERVIQUAL questionnaire. The DOTS SERVIQUAL has 10 items. For instance, the perceived quality of care via DOTS covered five areas, such as the provision of essential drugs, and hygienic conditions (tangibles), adherence to treatment protocol, and timely attention during visits (reliability), treatment with care and respect, and willingness of health worker to help (responsiveness), good provider–patient interactions (assurance), and patient-centered care (empathy) (see Supplementary Material 2). These items were derived based on literature.^{41,42} The scale’s content validity was established by two public health education experts and one public health expert. The questionnaire was developed in English with back-and-forth translation in Hausa—the predominant language in Northern Nigeria. The DOTS SERVIQUAL questionnaire in Hausa was then piloted with a convenient sample for validity and reliability. We administered 30 copies of the instrument to TB patients attending DOTS in a state in north-central Nigeria. The DOTS SERVIQUAL scale was assigned a 4-point Likert-type response option of “strongly agree” (coded as 4) to “strongly disagree” (coded as 1). The scale scores range from 0 to 32. Scores between 0 and 20 (≤ 20) were categorized as poor (i.e. poor quality of care), and scores from 21

and above (≥ 21) were considered good (i.e. perceived good quality of care). Higher scores indicate the perceived good quality of care. The Cronbach’s alpha coefficient for the scale was .71.

The perceived satisfaction with DOTS services was measured with 15 items based on the literature review.^{43–46} The perceived satisfaction with the DOTS questionnaire covered important areas such as health facility environment, the process of care, healthcare experience, diagnosis and treatment, and patient–health worker relationship. For instance, “the nurse or doctor’s instructions on your condition and treatment procedures are clear,” and “the seats in the waiting area are neat and comfortable.” Patients were requested to respond to each statement using a 4-point Likert-type scale “excellent” (coded as 4) to “poor” (coded as 1) (Supplementary Material 3). A panel of experts consisting of a medical doctor, two public health experts, and two TB patients who have received DOTS service evaluated the questionnaire’s face and content validity. Also, 30 copies of the instrument were administered to TB patients attending DOTS in a state in north-central Nigeria. After the pilot test, the items were revised, rephrased, or deleted where necessary. The perceived satisfaction with DOTS services scores ranges from 1–60. Scores between 1 and 25 (≤ 25) were categorized as poor satisfaction (i.e. not satisfied), and scores from 26 and above (≥ 26) were considered good satisfaction (i.e. satisfied). The Cronbach’s alpha coefficient for the scale was .87

We assessed the history of alcohol use and tobacco smoking during the past 12 months. We requested TB patients to report their past 12-month experiences of alcohol drinking and cigarette smoking. We recorded the participants’ self-reported alcohol use and tobacco smoking using “non-smoker” (coded as 0), “current smoker” (coded as 1, and “ex-smoker” (coded as 2), while alcohol use was categorized into “drinker” (coded as 1) versus non-drinker” (coded as 0).

Furthermore, the investigators measured the knowledge of TB, treatment, and DOTS service among participants using eight items. The items were used to measure patients’ knowledge about TB etiology, transmission, susceptibility, and DOTS treatment. The eight items were selected based on literature review.^{47–49} Also, 30 copies of the instrument were administered to TB patients attending DOTS in a state in north-central Nigeria. After the pilot test, the items were revised and rephrased, where necessary. Patients were asked to indicate their response to each question by choosing either “Yes” or “No.” The knowledge scores range between 0 and 8. Scores between 0 and 2 were regarded as “poor knowledge” (coded as 0), scores that range from 3 to 5 were considered “fair knowledge” (coded as 1), and scores ≥ 6 were considered “good knowledge” (coded as 2). In this study, the questionnaires were pre-tested on 110 TB patients accessing DOTS in north-west Nigeria. This represents 0.15% of the total population of registered TB patients (72,448) at the time of the study.

Quality control

We adopted a rigorous quality assurance and quality control program to ensure the study's good validity and reliability. In this study, all the data collectors were well-trained to administer standardized questionnaires for data collection. The nurses who oversaw the clinical systems conducted the data collection process for the clinical characteristics of TB patients. The investigators carefully supervised the data collection procedures. Filled questionnaires were examined for completeness and correctness. The questionnaires with a defect or incomplete responses were discarded and considered as a non-response. Of the total 460 samples, responses from 390 subjects who completed the survey with complete information were used for data analysis.

Statistical analysis

Descriptive statistics were calculated for all demographic and clinical variables. Binary logistic regression was used to analyze factors that were associated with TB medication adherence. We conducted bivariate logistic regression to check the crude association between the outcome variables and predictors using the forced entry method. The variables with $p < 0.20$ were selected for further exploration in the multivariable logistic regression analysis.

In addition, the investigators examined multi-collinearity among selected independent variables through the variance inflation factor (VIF < 10), and none was detected. The multivariable logistic regression analysis was employed to identify factors that independently predict TB treatment/medication adherence. Hosmer and Lemeshow⁵⁰ used to check the goodness of fit of the final model and was found fit ($p = 0.60$). The results were summarized using crude odds ratio (COR), adjusted odds ratio (AOR), and 95% confidence interval (CI). Association between the dependent variable (TB medication adherence) and explanatory variables (predictors) was considered statistically significant at $p < 0.05$. The IBM SPSS Statistics for Windows v. 20.0 software (IBM Corp., Armonk, NY, USA) was used for data analyses.

Results

Sociodemographic and clinical characteristics of participants

Out of the 460 TB patients who enrolled in the study, a total of 390 (84.8%) TB patients completed the study. The data of 70 TB patients were not included in the analysis due to illness and data incompleteness. Table 1 shows the demographic and clinical characteristics of the respondents. About half (46.7%) of the study participants were aged between 20 and 40 years, while one-fifth (19.5%) were aged ≥ 60 years and above. The study participants' mean age was 51.5 (standard deviation (SD) = ± 13.8). More than two-thirds (68.2%)

Table 1. Demographics and clinical characteristics of respondents.

Patient's variables	Frequencies or mean (SD)	% or (range)
Age (years)	51.5 (13.8)	(18–69)
> 18 years	67	17.2
20–40 years	182	46.7
41–59 years	65	16.7
≥ 60 years	76	19.5
Gender		
Male	124	31.8
Female	266	68.2
Employment status		
Student	47	12.1
Self-employed	131	33.6
Traders/artisans	78	20.0
Civil servant	73	18.7
Employed in a private firm	46	11.8
Unemployed	15	3.8
Level of education		
Primary education	18	4.6
Secondary education	264	67.7
Tertiary education	98	25.1
NFE	10	2.6
Monthly income		
<#18,000.00	160	41.0
#18,000–#99,999.00	175	44.9
#100,000–#199,999.00	35	9.0
#200,000–#299,999.00	20	5.1
Marital status		
Single	115	29.5
Widowed	10	2.6
Separated/divorced	51	13.1
Married	214	54.9
Ethnicity		
Yoruba	25	6.4
Hausa/Fulani	144	36.9
Igbo	39	10.0
Other tribes ^a	182	46.7
Place of residence		
Rural	203	52.1
Urban	187	47.9
Distance to DOTS center/health facility		
<5 km	297	76.2
>5 km	93	23.8
Perceived of quality of DOTS services	21.5 (3.89)	(1–32)
Good	207	53.1
Poor	183	46.9
Perceived satisfaction with DOTS services	27.5 (1.68)	(1–40)
Satisfied	212	54.4
Not satisfied	178	45.6
TB patient's Stigmatization		
Yes	243	62.3
No	147	37.7

(Continued)

Table 1. (Continued)

Patient's variables	Frequencies or mean (SD)	% or (range)
Alcohol use		
Never drank	215	55.1
Current drinker	175	44.9
Tobacco smoking status		
Non-smoker	276	70.8
Current smoker	85	21.8
Ex-smoker	29	7.4
Knowledge of TB and DOTS	4.54 (1.51)	(0–8)
Poor knowledge	36	9.2
Fair knowledge	232	59.5
Good knowledge	122	31.3
Type of TB patient		
PTB–	0 97	24.9
PTB+	241	61.8
EPTB	0 52	13.3
Drug-resistant TB status		
No resistance	297	76.2
Mono-resistance	76	19.5
MDR-TB	17	4.4
DOTS treatment duration		
<6 months	315	80.8
≥6 months	75	19.2
TB/HIV co-infection status		
No	305	78.2
Yes	85	21.8
ART and CPT use		
No	333	85.4
Yes	57	14.6
Anti-TB drugs side effects of affect adherence		
No (mild)	169	43.3
Yes (severe)	221	56.7

SD: standard deviation; NFE: no formal education; DOTS: directly observed treatment short-course; PTB–: smear-negative pulmonary TB; PTB+: smear-positive pulmonary TB; EPTB: extra-pulmonary TB.
^aKamaku, Kadaras, Kuramas, Hamis, Asholios, Kagoros, Katabs, Kajes, Nupes, Cyprians, Mandigos.

of the respondents were females, one-third (33.6%) of the respondents were self-employed, the majority (67.7%) of the respondents had secondary education, and 98 (25.1%) had higher education degrees. In terms of their monthly income, 175 participants (44.9%) earned between #18,000–#99,000 monthly, and 160 participants (41.0%) earned below #18,000 per month. More than half (54.9%) of the participants were married, more than one-third (36.9%), and about half (46.7%) of the participants were Hausa/Fulani and from other tribes, respectively. Besides, more than half (52.1%) of the respondents reside in the rural areas, the majority (76.2%) of the participants live less than 5 kilometers to a health facility/DOTS center from home, more than half (53.1%) of the respondents perceived the quality of DOTS service as

Table 2. Treatment adherence among TB patients using DOTS.

Primary outcome	Frequencies or mean (SD)	% or (range)
Medication adherence	4.35 (1.12)	(0–8)
Non-adherents	119	30.5
Adherents	271	69.5

SD: standard deviation.

good while more than half (54.4%) of respondents were satisfied with the treatment received. Also, about two-thirds (62.3%) of the participants reported that TB patients were stigmatized, more than half (55.1%) of the participants were non-drinkers, the majority (70.8%) of the participants were non-smokers, and about two-thirds (59.5%) of the participants had a fair knowledge of TB and DOTS treatment. Considering the clinical characteristics, about two-thirds (61.8%) of the participants had smear-positive PTB, 76 (19.5%) of the respondents had mono-resistance (resistance to rifampicin or isoniazid), and 17 (4.4%) had MDR-TB, and the majority (80.8%) of the respondents had DOTS treatment less than 6 months. Also, out of the 85 TB patients with TB/HIV co-infection, 57 (67.1%) received ART and CPT, and more than half (56.7%) reported that side effects of anti-TB drugs affected their treatment adherence. The prevalence of TB/HIV co-infection in this study was 21.8%.

Prevalence of medication nonadherence

Based on the TBMAQ cut-off point, 271 participants (69.5%) were classified as adherents and 119 (30.5%) as nonadherents. Therefore, the prevalence of TB medication nonadherence in this study was 30.5% (Table 2).

Factors associated with treatment/medication nonadherence among TB patients

Table 3 shows the bivariate logistic regression analysis findings between sociodemographic, clinical factors, and TB treatment/medication nonadherence among TB patients in north-west Nigeria. In the bivariate analysis, monthly income, marital status, ethnicity, distance to DOTS center/health facility from home, TB patient stigmatization, tobacco smoking, knowledge of TB and DOTS, DOTS treatment duration, TB/HIV co-infection status, ART and CPT use, and anti-TB drugs side effects were statistically significant variables ($p < 0.05$).

Table 4 indicates the multivariable logistic regression analysis on the predictors of anti-TB medication nonadherence among patients. Having a monthly income between #100,000 and #199,000, being a widow and married, distance to DOTS center/health facility, knowledge of TB and DOTS, having TB/HIV co-infection, use of ART and CPT drugs were statistically significant predictors. TB patients who earned between #100,000 and #199,000 were 0.01 time

Table 3. Bivariate analysis of sociodemographic and clinical factors associated with medication adherence among TB patients in public health care facilities, north west Nigeria (N = 390).

Patient's variables	Medication adherence		COR	95% CI		p value
	Adherents	Non-adherents				
	n (%)	n (%)				
Age (years)						
> 18 years	62 (92.5)	5 (7.5)	1			
20–40 years	111 (61.0)	71 (39.0)	0.721	0.017	0.482	0.899
41–59 years	34 (52.3)	31 (47.7)	1.250	0.043	0.327	0.796
≥60 years	64 (84.2)	12 (15.8)	0.189	0.050	0.679	0.999
Gender						
Male	119 (96.0)	5 (4.0)	1			
Female	152 (57.1)	114 (42.9)	1.013	0.012	0.097	0.984
Occupation						
Student	47 (100.0)	0 (0.0)	1			
Self-employed	97 (74.0)	34 (26.0)	0.285	0.019	0.579	0.800
Traders/artisans	70 (89.7)	8 (10.3)	0.215	0.231	1.534	0.900
Civil servant	31 (42.5)	42 (57.5)	1.829	0.444	0.012	0.998
Employed in a private firm	35 (76.1)	11 (23.9)	0.463	0.250	0.761	0.800
Unemployed	15 (100.0)	0 (0.0)	134.785	0.130	0.325	0.999
Level of education						
Primary education	9 (50.0)	9 (50.0)	1			
Secondary education	228 (86.4)	36 (13.6)	0.070	0.233	0.009	0.993
Tertiary education	29 (29.6)	69 (70.4)	0.013	0.015	0.108	0.985
NFE	5 (50.0)	50 (50.0)	0.040	0.110	0.532	0.993
Monthly income						
<#18,000.00	131 (81.9)	29 (18.1)	1			
#18,000–#99,999.00	107 (61.1)	68 (38.9)	0.065	0.011	0.375	0.002
#100,000–#199,999.00	20 (57.1)	15 (42.9)	0.125	0.017	0.916	0.041
#200,000–#299,999.00	13 (65.0)	7 (35.0)	0.243	0.033	1.791	0.165
Marital status						
Single	107 (93.0)	8 (7.0)	1			
Widowed	7 (70.0)	3 (30.0)	3.772	0.373	38.129	0.261
Separated/divorced	13 (25.5)	38 (74.5)	0.066	0.017	0.263	<0.001
Married	144 (67.3)	70 (32.7)	0.318	0.093	1.088	0.068
Ethnicity						
Yoruba	13 (52.0)	12 (48.0)	1			
Hausa/Fulani	108 (75.0)	36 (25.0)	5.249	1.361	20.241	0.016
Igbo	39 (100.0)	0 (0.0)	2530.718	0.000	0.034	0.797
Other tribes ^a	111 (61.0)	71 (39.0)	1.157	0.346	3.868	0.813
Place of residence						
Rural	138 (68.0)	65 (32.0)	1			
Urban	133 (71.1)	54 (28.9)	1.362	0.792	2.343	0.264
Distance to DOTS center/health facility						
<5 km	219 (73.7)	78 (26.3)	1			
>5 km	52 (55.9)	41 (44.1)	.100	0.028	0.362	<0.001
Perceived quality of DOTS services						
Good	125 (60.4)	82 (39.6)	1			
Poor	146 (79.8)	37 (20.2)	0.002	0.001	0.016	0.891
Perceived satisfaction with DOTS						
Satisfied	130 (61.3)	82 (38.7)	1			
Not satisfied	141 (79.2)	37 (20.8)	254.448	0.004	0.013	0.872
TB patient's stigmatization						
Yes	198 (81.5)	45 (18.5)	1			
No	73 (49.7)	74 (50.3)	6.970	3.374	14.401	<0.001

(Continued)

Table 3. (Continued)

Patient's variables	Medication adherence		COR	95% CI		p value
	Adherents	Non-adherents				
	n (%)	n (%)				
Alcohol use						
Never drank	136 (63.3)	79 (36.7)	1			
Current drinker	135 (77.1)	40 (22.9)	0.538	0.259	1.116	0.096
Tobacco smoking status						
Non-smoker	189 (68.5)	87 (31.5)	1			
Current smoker	69 (81.2)	16 (18.8)	2.130	1.099	4.127	0.025
Ex-smoker	13 (37.9)	16 (55.2)	0.711	0.296	1.708	0.445
Knowledge of TB and DOTS						
Poor knowledge	36 (97.3)	1 (2.7)	1			
Fair knowledge	169 (73.2)	62 (26.8)	0.073	0.010	0.559	0.012
Good knowledge	66 (54.1)	56 (45.9)	0.039	0.005	0.301	0.002
Type of TB patient						
PTB-	50 (51.5)	47 (48.5)	1			
PTB+	181 (75.1)	60 (24.9)	2.077	0.939	4.593	0.071
EPTB	40 (76.9)	12 (23.1)	1.271	0.448	3.606	0.652
Drug resistance TB status						
No resistance	199 (67.0)	98 (33.0)	1			
Monoresistance	55 (72.4)	21 (27.6)	2.057	0.828	5.112	0.120
MDR-TB	17 (100.0)	0 (0.0)	143.529	0.000	0.007	0.798
DOTS treatment duration						
<6 months	232 (73.7)	83 (26.3)	1			
≥6 months	39 (52.0)	36 (48.0)	2.692	1.030	7.037	0.043
TB/HIV co-infection status						
No	261 (85.6)	44 (14.4)	1			
Yes	10 (11.8)	75 (88.2)	0.028	0.011	0.075	<0.001
ART and CPT use						
No	259 (77.8)	74 (22.2)	1			
Yes	12 (21.1)	45 (78.9)	3.812	1.330	10.926	0.013
TB drugs side effects affect adherence						
No	153 (90.5)	16 (9.5)	1			
Yes	118 (53.4)	103 (46.6)	0.099	0.043	.231	<0.001

CI: confidence interval; PTB-: smear-negative pulmonary TB; PTB+: smear-positive pulmonary TB; EPTB: extra-pulmonary TB.

*Kamikus, Kadaras, Kuramas, Hamis, Asholios, Kagoros, Katabs, Kajes, Nupes, Cyprians, Mandigos.

*p value < 0.05; *p value < 0.01.

(AOR=0.01; 95% CI: 0.00–0.13) less likely to default in their TB treatment regimen compared to those who earned less. Widowed TB patients were 26 times (AOR=26.74, 95% CI: 2.92–232.9), more likely to default in their TB medication adherence than the single TB patients. Also, married TB patients were 120 times (AOR=120.49, 95% CI: 5.38–271.1) more at risk of treatment nonadherence than the single TB patients. The TB patients who traveled less than 5 km to a DOTS center/health facility were 0.06 times (AOR=0.06, 95% CI: 0.00–0.01) less likely to default in their TB treatment than those who traveled more than 5 km to a health facility. The TB patients who had fair knowledge and good knowledge about TB and DOTS treatment were 0.04 (AOR=4.6, 95% CI: 0.01–1.63) and 0.01 times (AOR=0.01, 95% CI: 0.18–0.30) less likely to default in their TB

medications than those who had poor knowledge. Patients with TB/HIV co-infection were 0.01 time (AOR=0.01, 95% CI: 0.12–0.35) less likely to adhere to TB medications than those without TB/HIV co-infection. The use of ART and CPT medications was a strong risk factor (AOR=24.9, 95% CI: 19.6–304.3) for TB medication nonadherence among patients.

Discussion

This study assessed TB medication or treatment nonadherence and the associated factors among TB patients using DOTS in public health facilities in north-west Nigeria. Every TB patient must have higher adherence to anti-TB medication;⁵¹ however, many TB patients default during treatment. The finding

Table 4. Multivariable logistics regression of sociodemographic and clinical factors associated with medication adherence among pulmonary TB patients in public health care facilities, north-west Nigeria (N= 390).

Patient's variables	Medication adherence		AOR	95% CI		p value
	Adherents	Non-adherents				
	n (%)	n (%)				
Monthly income						
<#18,000.00	131 (81.9)	29 (18.1)	1			
#18,000–#99,999.00	107 (61.1)	68 (38.9)	0.59	0.04	9.85	0.713
#100,000–#199,999.00	20 (57.1)	15 (42.9)	0.01	0.00	0.13	0.002
#200,000–#299,999.00	13 (65.0)	7 (35.0)	1.10	0.05	25.04	0.953
Marital status						
Single	107 (93.0)	8 (7.0)	1			
Widowed	7 (70.0)	3 (30.0)	26.74	2.92	232.90	0.015
Separated/divorced	13 (25.5)	38 (74.5)	19.93	0.64	617.74	0.088
Married	144 (67.3)	70 (32.7)	120.49	5.38	271.14	0.003
Ethnicity						
Yoruba	13 (52.0)	12 (48.0)	1			
Hausa/Fulani	108 (75.0)	36 (25.0)	2.29	0.32	16.31	0.405
Igbo	39 (100.0)	0 (0.0)	29.94	0.55	54.00	0.998
Other Tribes	111 (61.0)	71 (39.0)	0.13	0.01	1.64	0.114
Distance to DOTS center/health facility						
<5 km	219 (73.7)	78 (26.3)	1			
>5 km	52 (55.9)	41 (44.1)	0.06	0.00	0.01	<0.001
TB patient's stigmatization						
Yes	198 (81.5)	45 (18.5)	1			
No	73 (49.7)	74 (50.3)	6.16	0.57	66.96	0.136
Alcohol use						
Never drank	136 (63.3)	79 (36.7)	1			
Current drinker	135 (77.1)	40 (22.9)	0.54	0.26	1.12	0.096
Tobacco smoking status						
Non-smoker	189 (68.5)	87 (31.5)	1			
Current smoker	69 (81.2)	16 (18.8)	2.24	0.61	8.16	0.222
Ex-smoker	13 (37.9)	16 (55.2)	2.21	0.27	18.35	0.462
Knowledge of TB and DOTS						
Poor knowledge	36 (97.3)	1 (2.7)	1			
Fair knowledge	169 (73.2)	62 (26.8)	0.04	0.01	1.63	<0.001
Good knowledge	66 (54.1)	56 (45.9)	0.01	0.18	0.30	<0.001
DOTS treatment duration						
<6 months	232 (73.7)	83 (26.3)	1			
≥6 months	39 (52.0)	36 (48.0)	0.07	0.00	12.24	0.317
TB/HIV co-infection status						
No	261 (85.6)	44 (14.4)	1			
Yes	10 (11.8)	75 (88.2)	0.01	0.12	0.35	<0.001
ART and CPT use						
No	259 (77.8)	74 (22.2)	1			
Yes	12 (21.1)	45 (78.9)	24.85	19.55	304.25	<0.001
TB drugs side effects affect adherence						
No (mild)	153 (90.5)	16 (9.5)	1			
Yes (severe)	118 (53.4)	103 (46.6)	0.10	0.00	3.24	0.191

AOR: adjusted odds ratio; CI: confidence interval; DOTS: directly observed treatment short-course; TB: tuberculosis; HIV: human immunodeficiency virus. *p value < 0.05; p < 0.01.

of this study indicated that 30.5% of TB patients defaulted in their TB medication use. The prevalence of TB medication nonadherence in our study is higher than the nonadherence

rates previously reported.^{52–54} We assumed that the study findings' observed differences could be attributed to TB medication adherence's conceptualization. In this study, a self-reported

measure of TB medication adherence was used; thus, TB patients were classified into adherents versus non-adherents using TBMAQ scores. Since anti-TB medication adherence depends on the quantity and timing of missed medication or hospital appointments,⁵⁵ TB patients' self-report medication adherence using a well-validated tool could explain medication adherence and improve treatment outcomes. The higher nonadherence rate among the patients could have occurred during the continuation phase of treatment. Studies had reported that nonadherence among TB patients occurs most frequently in low-and-middle-income countries (LMICs) during this phase.^{25,56,57} Since poor adherence to anti-TB medication is a strong risk factor for MDR-TB,⁵⁸ interventions should be aimed at improving medication adherence among TB patients during the continuation phase. Such interventions could include health counseling, patient-specific drug education, multifaceted interventions that combine resilience and self-efficacy.

Also, the majority (80.8%) of the TB patients responded that they had DOTS treatment for less than 6 months. Since the treatment for TB lasts between 6 and 8 months,¹¹ many TB patients might have poorly estimated the timeframe for their treatment regimen compared with other minor ailments such as malaria. Therefore, the DOTS support staff and nurses should educate TB patients on the accurate duration for treatment and support them in achieving optimum medication adherence to achieve quick recovery, effective treatment, and prevent relapse or drug resistance.

In this study, we hypothesized that certain factors are associated with TB treatment nonadherence among TB patients. The study was conceived using a socioecological framework. This method enhances a more comprehensive understanding of medication adherence behavior among TB patients by studying the interplay of factors capable of influencing medication adherence.⁵⁹ Consequently, having a monthly income between #100,000 and #199,000, being a widow and married, distance to DOTS center/health facility, knowledge of TB and DOTS, having no TB/HIV co-infection, use of ART and CPT were predictors of TB drugs nonadherence. The finding is consistent with previous studies.^{8,24,28,39,51–53,56,57}

In addition, the country's harsh economic conditions might have plunged many poor TB patients into abject poverty. Thus, reducing their economic opportunities and their capacity to bear the cost of their care effectively. Inadequate income makes it difficult for ailing persons, especially people on long-term therapies, to bear the economic burden associated with chronic illnesses such as TB. Studies have shown that low income could interfere with good medication adherence among patients.^{56,57,59,60} Therefore, community, peer, and family support are vital for TB treatment adherence among patients by providing money for food and transportation. Furthermore, community-based healthcare insurance/financing could be a viable financial option for supporting TB treatment in north-west Nigeria. Liu et al. and Liu and Lu

reported that the community-based healthcare insurance/financing had been identified as a viable mechanism for attenuating the financial burden/cost of treatment accrued to long-term illnesses.^{60,61}

Furthermore, the widowed and married TB patients were more likely to default in their TB medication adherence than the single TB patients. The plausible explanation for the finding could be that widowed TB patients may lack adequate funds for out-of-pocket expenses such as transportation costs and the cost of other drugs for treating underlying ailments or comorbid conditions not covered by the DOTS program. In addition, the widowed TB patients may lack social support for treatment adherence due to their spouse's death. Spousal death may also be a strong risk factor for poor mental outcomes such as loneliness and depression. Thus, the widowed TB patients require adequate financial support from family members and non-profit organizations that support the less-privileged persons in the communities. Other drugs besides those covered by the DOTS program can be subsidized to relieve the financial burden on the poor and widowed TB patients.

Furthermore, psychosocial interventions are needed to improve the mental health of widowed patients. Hopefully, these measures may facilitate optimum TB medication adherence in widowed TB patients. This study finding contradicts a previous study,⁶² which reported that marital status is not a significant predictor of medication adherence among TB patients.

Also, married TB patients are more likely to default in their TB medication adherence than single women. For instance, in Nigeria, married women engage in domestic and job-related activities that could hinder their adherence to TB medication. Married women care for family members, especially children and the sick. Coupled with job demands, married TB patients may skip their routine medications. Thus, the finding may suggest the need for mobile health (mHealth) interventions tailored to improve medication adherence in married TB patients. Married women can be empowered to use mHealth interventions that are explicitly designed to remind them of their medication. Such interventions could improve TB medication adherence among married women. Research evidence indicates that well-designed and easy to use mHealth interventions are effective strategies for improving health care services delivery in LMICs since mobile phones are available and accessible.⁶³

Research evidence suggests that TB patients with HIV might have low drug adherence since they have several medications to take.^{54,64,65} Patients with TB/HIV should be given adequate care, supervision, and counseling during their treatment. Also, poor knowledge of TB and its treatment was a predictor of anti-TB drug nonadherence among patients. The finding is consistent with previous studies that reported poor knowledge about TB and its treatment as a strong risk factor for anti-TB medication nonadherence.^{47,48,52} Education has been identified as a tool for promoting knowledge, health

awareness, and care-seeking behavior of individuals.⁶⁴ Thus, health education experts, CHOs, and nurses at the community and health facility levels should implement a more intensive health education program to improve people's knowledge of TB and its treatment. In addition, more resources (funds, health workers) should be allocated to the DOTS program, and continual assessment of DOTS performance using the WHO's recommended guidelines becomes pertinent.

In this study, the use of ART and CPT was a strong predictor of TB medication nonadherence. The use of ART and CPT is an essential or crucial intervention to decrease mortality in HIV-infected TB patients.^{64,65} Also, their benefits in treating patients with TB/HIV co-infection have been shown in the literature.⁶⁶ However, the prolonged use of these therapies could be a barrier to TB treatment adherence among patients. Also, the side effects of these drugs and the fear of multiple drug therapy could be attributed to nonadherence to TB medications in this subgroup. Therefore, future research should explore interventions that could promote treatment adherence among patients with TB/HIV infections, especially in Nigeria.

This study had some notable limitations. The study is a facility-based survey; hence, TB patients who use traditional or alternative medicines were not included. Thus, the study's generalizability is limited. Furthermore, the study adopted a cross-sectional survey design, limiting causal inference, and is subject to reverse causality. The study used self-report scales to measure TB treatment adherence, perceived quality of DOTS services, and perceived satisfaction with care among TB patients. However, the validity of self-report measures is limited by recall and response bias. Also, selection bias could affect the study's findings because only patients who regularly reported at the health facilities were included. Besides, the investigators, research assistants, and nurses collected the data through direct interviews of patients, which may also introduce social desirability bias.

Conclusion

About one-third of TB patients defaulted in their TB medication adherence. TB medication nonadherence is a potential risk factor for poor health outcomes such as drug resistance, relapse, and even TB patients' deaths. Factors associated with TB drug nonadherence included having a monthly income between #100,000 and #199,000, being a widow and married, distance to DOTS center/health facility from home, knowledge of TB and DOTS, having TB/HIV co-infection, use of ART and CPT drugs. Thus, nurses and public health education experts at the community and health facility levels should implement a more intensive patient-specific education program to improve people's knowledge of TB and its treatment. For effective control of TB in north-west Nigeria, implementation of intensive public health education on TB treatment adherence, attenuation of factors that undermine

TB medication adherence, and continual resource support for TB patients and DOTS program in all ramifications. Future research should explore interventions that could promote treatment adherence among patients with TB/HIV infections in Nigeria.

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Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

The permission to conduct the study was obtained from each health facility, and the study was approved by the institutional review board (IRB) of the University of Nigeria, Nsukka (Ref #: NHREC/05/01/2008B-FWA00002458-IRB00002323).

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Informed consent

Written informed consent was obtained from all subjects before the study.

ORCID iD

Olaoluwa Samson Agbaje  <https://orcid.org/0000-0003-4332-3451>

Supplemental material

Supplemental material for this article is available online.

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Appendix I

Demographics

1. What is your current age? _____
2. Which of the following age groups do you belong?
 - a. 18–19 years
 - b. 20–40 years
 - c. 41–49 years
 - d. 60 years and above (≥ 60 years)
3. What is your gender/sex?
 - a. Male
 - b. Female
4. Please indicate the part of the state you reside:
 - a. Urban
 - b. Rural
5. Are you currently employed (i.e. employment status)?
 - a. Student
 - b. Self-employed
 - c. Traders/artisans
 - d. Civil servant
 - e. Employed in a private firm
 - f. Unemployed
6. Please indicate the highest level of education you have completed:
 - a. Primary education
 - b. Secondary education
 - c. Tertiary education
 - d. No formal education
7. What is your monthly household income?
 - a. <#18,000.00
 - b. #18,000–#99,999.00
 - c. #100,000–#199,999.00

- d. #200,000–#299,999.00
8. What is your marital status?
- a. Single
 - b. Widowed
 - c. Separated/divorced
 - d. Married
9. Please indicate your ethnic group:
- a. Yoruba
 - b. Hausa/Fulani
 - c. Igbo
 - d. Other tribes
10. Please indicate the estimate distance of your from this facility:
- a. Less than 5 km (<5 km)
 - b. More than 5 km (>5 km)