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MODELLING OUTCOME OF DRUG RESISTANT TUBERCULOSIS AND DRUG SUSCEPTIBLE TUBERCULOSIS PATIENTS IN OYO STATE

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ABSTRACT: *TB is perhaps the most important contagious disease in the world and the leading cause of mortality by an infectious disease. As a result, WHO declared that achieving the reduction in TB incidence rate for achievement of the 90-90-90 target of the END-TB strategy will be an illusion, if something severe is not done. Therefore, it is imperative to assess the visibility of achieving the END-TB goal in the country (Nigeria) by assessing the success of TB treatments so far in the country. Hence, this paper aims to model the outcome of drug-resistant-tuberculosis and drug-susceptible-tuberculosis patients in Oyo state of Nigeria using the logit function of estimating binary logistic regression model vis-à-vis identifying the success of these TB treatments. At baseline, based on WHO categorization, the study revealed the commonest cases of patients receiving DS-TB seen are 'New' (90.5%) followed by relapse after failure (4.2%). Contrarily, the commonest cases of patients receiving DR-TB seen are treatment after failure (44.3%), new (27.5%) and relapse after failure cases (20.6%). Four months after starting treatment, 91.5% and 3.2% were reportedly alive and dead respectively for patients receiving DS-TB treatment while 85.3% and 11.5% were reportedly alive and dead respectively for receiving DR-TB treatment. Hence, the percentage success of DS-TB recorded was higher than the recorded for DR-TB patients. Furthermore, the chi-square results for DS-TB patients indicated that mortality significantly associated with DS-TB categorised patients (i.e. Relapse) and HIV status (i.e. Negative). Also, for the DR-TB patients, the results depicted that mortality significantly associated with DR-TB categorised patients (i.e. TAF, Treatment after Loss to Follow Up and New), both HIV status and Sputum Smear status (i.e. Positive). Nevertheless, among other findings, the binary logistic regression model estimations revealed that categorised New patients and Sputum Smear status unfavourably and significantly predicted the treatment outcome (mortality) of DS-TB and DR-TB patients. As well, categorised Relapse patients unfavourably and significantly predicted the treatment outcome (mortality) of DR-TB patients. Thus, the DS-TB method of treatment is recommended in order to achieve the target goal of the END-TB strategy in Oyo state Nigeria.*

KEYWORDS: Drug resistant, Drug susceptible, Tuberculosis, Chi-square binary logistics model.

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INTRODUCTION

Background Information

In spite of the accessibility of effective tuberculosis (TB) treatment or therapy, TB remains one of the key problems in many countries. Since 2008, death statistics reveal that about one-third of the world's populations are disease-ridden with TB (Jeon & Murray, 2008). Therefore, it is established by Rosa and Torres (2019) that TB is one of the 10 major causes of death among transmittable diseases worldwide. TB suffering and death have stirred-up global-health concern and several approaches have been developed to address the disease from the outbreak (Rosa & Torres, 2019). TB is a transmittable disease triggered by the bacillus Mycobacterium TB that classically affects the lungs (pulmonary TB) which can as well affect other sites as well (extra-pulmonary TB). TB spreads easily in the air when people who are sick with pulmonary TB excrete the bacteria, for instance coughing. Similar to what is observed from other transmittable diseases, TB epidemiology is closely linked with socio-economic conditions which makes its prevention, care and control very challenging (Arcoverde et al., 2018; Lacerda et al., 2014). Overall, a relatively small proportion of people infected with Mycobacterium TB will develop TB disease. However, the probability of developing TB is much higher among people infected with HIV (Lacerda et al., 2014).

Drug-Resistant Tuberculosis (DR-TB) is TB disease caused by Mycobacterium tuberculosis (MTB) that is resistant to at least one 1st-line anti-TB drug (World Health Organization, 2009). DRTB is diagnosed using drug-susceptibility testing in the laboratory. Though, this test can take quite a lot of weeks, so the treatment could start with a treatment-regimen based on expert advice and after the test results are out, the treatment-regimen is then adjusted. Treating or curing DR-TB is complicated and managing it inappropriately can be life-threatening. Also, another form of TB is the Multi Drug-Resistant Tuberculosis (MDR-TB). WHO (2009) defined MDR-TB as TB caused by bacteria that are resistant to the most effective anti-tuberculosis drugs (i.e. isoniazid and rifampicin); this may be as a result of either primary infection or may develop in the course of a patient's treatment.

Additionally, MDR-TB cases are classified into two categories; those who have primary resistance and those who have acquired resistance, consisting of the majority of cases as insufficient previous treatment is a strong prognostic factor in the development of MDR-TB. Many of the MDR-TB patients had been taking anti-TB drugs for a long time, and often irregularly, which resulted in treatment failure. Multidrug-resistant TB (MDR-TB) is multifactorial and fueled by improper treatment of patients, poor management of supply and quality of drugs, and airborne transmission of bacteria in public places. Case management becomes difficult and the challenge is compounded by catastrophic economic and social costs that patients incur while seeking help and on treatment. The treatment for MDR/RR-TB lasts 9 to 12 months, which is largely standardised, and whose composition and duration follows closely the one for which there is documented evidence from different settings.

The usual structure is as follows: 4-6 Km (Am)-Mfx-Pto(Eto)-Cfz-Z-High-dose-E/5 Mfx-Cfz-Z-Eup (WHO, 2018). Globally, 160,684 cases of MDR/RR-TB were detected and notified in 2017. Between 2016 and 2017, the number of reported MDR/RR-TB cases increased by more than 30% in six of the 30 high MDR-TB burden countries: Angola, Democratic People's Republic of Korea, Indonesia, Nigeria, Somalia and Thailand (WHO Global Report, 2018). Globally, Nigeria is among the fourteen countries that are in all the three lists of high burden

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countries for TB, TB/HIV and MDR-TB. The country is ranked 17th amongst the 30 high TB-burden and 2nd in the continent. The estimated incident for TB in the country is 219/100,000 pop, translating to about 407,000 TB cases occurring annually in Nigeria, the mortality rate (excludes HIV+TB) is 63/100,000 population. Nigeria ranks fourth among the 22 high-burden TB countries and first in Africa. Knowledge of the determinants of TB treatment default and mortality is critical for informing health policy solutions needed to improve the outcomes of TB care and contain the spread of the disease. Studies in other settings have identified several determinants for treatment (Annabel-Kanabus, 2020).

Research Problem

TB is perhaps the most important contagious disease in the world and the leading cause of mortality by an infectious disease. Nigeria is among the fourteen countries that are in all the three lists of high burden countries for TB, TB/HIV and MDR-TB. The country is ranked 14th amongst the 30 high TB-burden and 2nd in the continent whereby the mortality rate has triggered the public health concern (WHO Report, 2019) and TB treatments have been modified in order to arrest the outbreak of the disease such as Drug Resistant Tuberculosis and Drug Susceptible Tuberculosis treatments. Annabel-Kanabus (2020) declared that achieving the reduction in TB incidence rate for achievement of the 90-90-90 target of the END-TB strategy will be an illusion, if something severe is not done. Therefore, it is imperative to assess the visibility of achieving the END-TB goal in the country (Nigeria) by assessing the success of TB treatments so far in the country. Hence, this paper aims to model the outcome of drug-resistant-tuberculosis and drug-susceptible-tuberculosis patients in Oyo state of Nigeria using the binary logistic regression approach vis-à-vis identifying the success of these TB treatments.

Aim and Objectives

This study aims to model the outcome of drug-resistant-tuberculosis (DR-TB) and drug-susceptible-tuberculosis (DS-TB) patients in Oyo state of Nigeria using the logit function of estimating binary logistic regression model. The specific objectives are to:

i. Identify the categories of independent variables such as the demographic parameters, clinical parameters and types of DS-TB or DR-TB patients that influence TB treatment outcomes (Death); and to

ii. Identify the best treatment between the DS-TB and DR-TB treatment.

Study Area

This study is conducted in Ibadan, the largest indigenous city, located at an altitude generally ranging from 152 m to 213 m with isolated ridges and peaks rising to 274 m. It is the state capital of Oyo State (see Figure 1 below) which is near the forest grassland boundary of south-west of Nigeria on longitude 3° east of the Greenwich meridian and latitude 7° north of the equator. It is at a distance of about 145 km north-east of Lagos. Oyo State is divided into 33 local government areas. It comprises largely the Yoruba-speaking tribe and other ethnic groups. Ibadan is dominantly a civil service city with some level of industrial activity, private businesses and other forms of trade and peasant jobs. The estimated population is 2.6 million people. Religious groups in the city are the Christians, Muslims and traditionalists.

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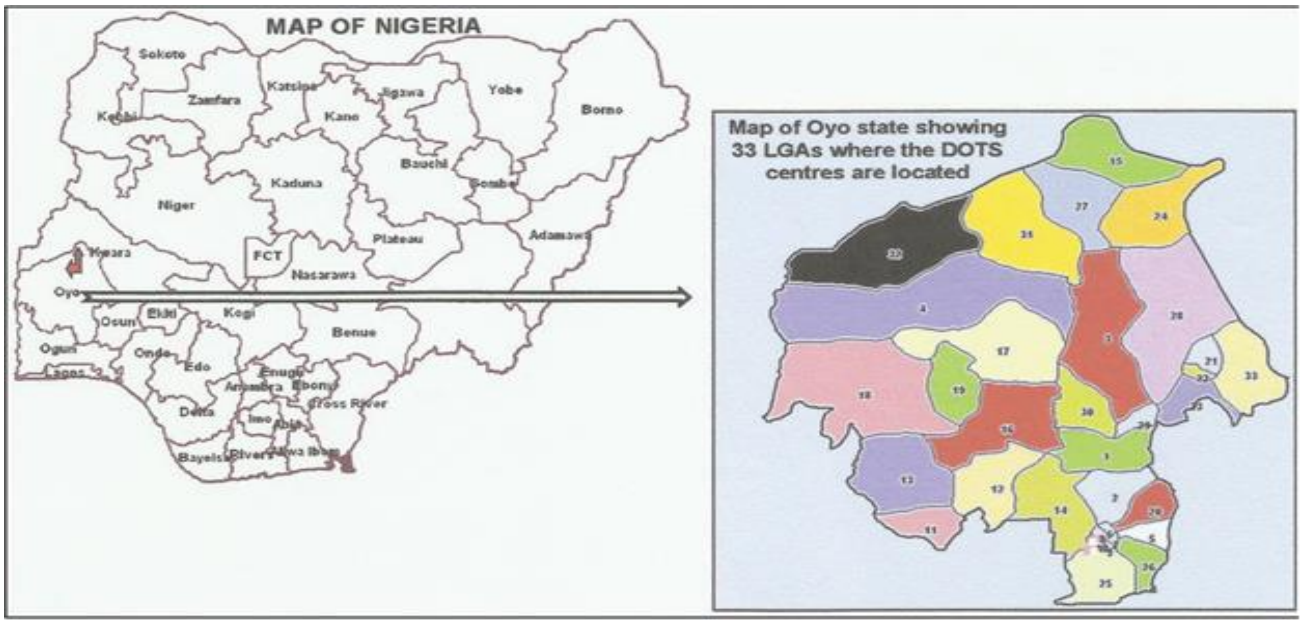

Figure 3.1: Nigeria (Ibadan, south-west of Nigeria). (Source: Nigeria Demographic and Health Survey, 2013).

The facilities (Government Chest Hospital, Jericho and University College Hospital (UCH) in make Oyo State remains the only state that have two functioning treatments among existing 66 DR-TB treatment centres from 12 States in Nigeria; Plateau, Benue, Kaduna, Kano, Bauchi, Cross Rivers, Taraba, Rivers, Imo, Ogun, Ondo and Osun by design, the facility like all other treatment centre admits diagnosed MDR-TB patients for minimum of four months from various states (Oyo inclusive) in the country.

RESEARCH METHODOLOGY

Sample Size and Sampling Technique

In order to achieve the research objective of the study, a Simple Random Sampling (SRS) technique was adopted. The Slovin's (1960) formula was used to calculate the size of the TB patients to be assessed from the population $TB\ patients\ in\ the\ hospital$. The formula is stated as thus;

$$n = \frac{N}{1+Ne^2} \qquad 3.1$$

where $n = TB\ patients\ to\ examine$ (sample size), $N = TB\ patients\ in\ the\ hospital$ (the Population size) while e is the Margin of Error. This was employed for two reasons; first, is to ensure that the sample is large enough to represent the population such that the sampling statistic will be the same with the population parameter and to make sure that each patient is truly represented in the population. The samples of study are calculated as follows:

$$DSTB\ Patients\ sample = \frac{358}{1+358(0.05^2)} = 189;$$

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$$DRTB\ Patients\ sample = \frac{195}{1 + 195(0.05^2)} = 131$$

Methodologies

Chi-square test

In order to see if there is any significant association existing between the demography of the TB patients, the categories of the TB patients, the patients' HIV status and their corresponding treatment outcomes, we utilised the chi-square analysis approach. Chi-square test is used to detect the group's dependencies (association). The formula for calculating a Chi-Square is:

$$\chi^2 = \sum_i \quad \sum_j \quad \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \qquad 3.2$$

where O_{ij} is the observed value (the actual count of cases in each cell of the group) E_{ij} is the expected value (calculated below). E_{ij} is calculated thus

$$E_{ij} = \frac{M_R \times M_C}{N} \qquad 3.3$$

where E_{ij} represents the cell expected value, M_R represents the row marginal for that cell, M_C represents the column marginal for that cell. N represents the total sample size.

Logistic Regression Analysis

Binary logistic regression was utilised in modelling the TB treatment outcomes i.e. alive or dead. The logistic regression model is basically a nonlinear transformation of linear regression. The logistic distribution is a S-shaped distribution function (cumulative density function) which is similar to the standard normal distribution. Logistic regression permits one to predict a discrete outcome, from a set of variables that may be continuous, discrete, dichotomous, or mixed. In most cases, the response variable is dichotomous, such as in this case alive/dead, this type of variable is termed Bernoulli or binary variable.

Once the response variable is Bernoulli, there would be an indicator, taking on the values 1 (alive) and 0 (dead) with probabilities π and 1-π respectively. Hence, Y is a Bernoulli random variable with parameter E(Y)=π (Atanlogun et al., 2015). The model is stated thus:

$$E\left(\frac{Y}{X}\right) = \pi = \frac{exp\ (\beta' X_i)}{1 + exp\ (\beta' X_i)} \qquad 3.6$$

The equation for multiple is:

$$\pi = \frac{e^{(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k)}}{1 + e^{(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k)}} \qquad 3.7$$

where β_0 is the constant and β_i is the coefficient of the predictor variables.

The Logit Transformation

In logistic regression, a mathematical model of a set of explanatory variables is used to predict a *logit* transformation of the dependent variable. Suppose the numerical values of 0 and 1 are assigned to the two outcomes of a binary variable. Suppose *p* is the proportion of observations

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with an outcome of 1, then 1-*p* is the probability of an outcome of 0. The ratio *p*/(1-*p*) is called the *odds* and the *logit* is the logarithm of the odds, or just *log odds*. Mathematically, the logit transformation is written

$$l = logit\ p = ln\frac{p}{1-p} \quad 3.8$$

Then the *logistic* transformation (the inverse of the logit transformation) is written as

$$p = logistic(l) = \frac{e^l}{1+e^l} \quad 3.9$$

Redefining the dependent variable; $Y = \Phi(X\beta + e)$

$$\Phi^{-1}(Y) = X\beta + e$$

$$Y' = X\beta + e \quad 3.10$$

Then the link function is $F(Y) = \Phi^{-1}(Y)$. This link is called the Probit function.

DATA AND EMPIRICAL ANALYSIS

Data

The data utilised in this research were primarily sourced from treatment centres. Data comprised 189 and 131 DS-TB and DR-TB patients respectively receiving treatment. Information on the demographic data of participants to the responses to DS-TB and DR-TB treatments (Table 1) reveals that 57.7% (109) of the patients receiving DS-TB treatment were male and 42.3% (80) of them were female while 64.9% (85) were male and 35.1% (46) were female receiving DR-TB treatment. The age pattern of the patients receiving DS-TB treatment reveals that a significant minority of them were between 31-40 years (25.4%) followed by 41-50 years (15.9%), 21-25 years (15.3%) and 26-30 years (15.3%). Similarly, a significant minority of patients within 31-40 years (30.5%) were receiving the DR-TB treatment followed by 26-30 years (19.1%) and 41-50 years (17.6%). The results further show that nearly half of patients receiving DS-TB treatment were married (49.7%); more than half of them were employed (69.8%); and almost all (91.5%) of them were overweight. Similarly, more than half of patients receiving DR-TB treatment were married (60.3%) and employed (62.6%). However, majority of patients receiving DR-TB treatment have a normal body mass (83.9%).

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Table 1. Demographic Data of TB Patients

Variables	DS-TB (%)	DR-TB (%)
Age		
10-19 Years	18 (9.5)	10 (7.6)
20-29 Years	29 (15.3)	18 (13.7)
30-39 Years	29 (15.3)	25 (19.1)
40-49 Years	48 (25.4)	40 (30.5)
50-59 Years	30 (15.9)	23 (17.6)
60-69 Years	22 (11.6)	9 (6.9)
69-70Years	13 (6.9)	6 (4.6)
Gender		
Male	109 (57.7)	85 (64.9)
Female	80 (42.3)	46 (35.1)
Marital Status		
Single	88 (46.6)	47 (35.9)
Married	94 (49.7)	79 (60.3)
Divorced	7 (3.7)	2 (1.5)
Widow/Widower	_	3 (2.3)
Occupation		
Employed	132 (69.8)	82 (62.6)
Unemployed	29 (15.3)	16 (12.1)
Students/Apprentice	28 (14.8)	5 (3.8)
NA	-	28 (21.5)
Body Mass		
Underweight	2 (1.1)	16 (12.2)
Normal	14 (7.4)	110 (83.9)
Overweight	173 (91.5)	1 (0.8)
NA	-	4 (3.1)

Note: NA denotes Not Available ***Source:*** *Field Survey, 2019.*

Furthermore, Table 2 depicts the exploratory TB patients' data. The results show the categorised distribution of patients as follows: majority of DS-TB patients were New (90.5%, n=171); while most of DR-TB patients were TAF (43.9%, n=58). In addition, Table 2 depicts the HIV status of the patients as follows: majority (80.4%, n=152) of DS-TB patients tested Negative while few (6.3%, n=12) tested Positive; also, majority (83.3%, n=110) of DR-TB patients tested Negative while 12.9% (n=17) tested Positive. Similarly, the Sputum Smear results of the patients show that majority (81.5%, n=154) of DS-TB patients were Negative while 14.3% (28) were Positive also few (38.6%, n=51) of DR-TB patients were Negative while majority (59.1%, n=78) were Positive. Furthermore, the treatment outcomes of the TB patients as at three months under examination were revealed as follows: majority (77.2%, n=146) of DS-TB patients were reportedly Alive while few (3.2%, n=6) were reportedly Dead; also, majority (85.6%, n=113) of DR-TB patients were reportedly Alive while few (11.4%, n=15) were reportedly Dead.

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Table 2. Exploratory Data of Respondents (TB Patients)

Variables	DS-TB (%)	DR-TB (%)
Categorised patients		
New	171 (90.5)	36 (27.5)
Other Previously Treated TB Patients	3 (1.6)	1 (0.8)
Relapse	8 (4.2)	27 (20.6)
Transferred in Patients	2 (1.1)	-
Treatment after Failure (TAF)	3 (1.6)	58 (44.3)
Treatment after Loss to Follow Up	2 (1.1)	8 (6.1)
Unknown	-	1 (0.8)
HIV Test		
Negative	152 (80.5)	110 (84.0)
Positive	12 (6.3)	17 (13.0)
Unknown	25 (13.2)	4 (3.1)
Sputum Smear Test		
Negative	154 (81.5)	51 (38.9)
Positive	28 (14.8)	78 (59.5)
Unknown	7 (3.7)	2 (1.5)
Treatment Outcome		
Alive (Cured)	173(91.5)	113 (85.3)
Dead (Treatment Failed)	6 (3.2)	15 (11.5)
Treatment Just Completed	10 (5.3)	3 (2.3)

Source: *Field Survey, 2019.*

Association between Demographic Status of TB Patients and Reported Mortality

Table 3 reveals the associations between the demographic status of DS-TB patients and treatment outcome. Results showed that the participants' demographic characteristics are significantly associated with the treatment outcomes except the body mass of the DS-TB patients [i.e. $p-value(0.041) < 0.05$]. TB mortality was significantly higher (4%) among Overweight DS-TB patients compared to the under and normal weight patients. Additionally, TB mortality was insignificantly higher among female (4%), single (4%), unemployed (4%), student/apprentice (4%) and age between 26-30 years (8%) of DS-TB patients. However, as observed the cured DS-TB patients were higher across all the demographic characteristics compared to mortality (dead).

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Table 3: Association between Demographic Status of DS-TB Patients and Reported Mortality

Variables	Categories	Treatment outcome		X^2 (P-value) [DF]
		Cured	Treatment Failed (Dead)	
Age	10-19 Years	94.4%	5.6%	4.143 (0.657) [6]
	20-29 Years	100.0%	0.0%	
	30-39 Years	92.3%	7.7%	
	40-49 Years	95.6%	4.4%	
	50-59 Years	96.3%	3.7%	
	60-69 Years	100.0%	0.0%	
	69-70 Years	100.0%	0.0%	
Gender	Male	97.0%	3.0%	0.135(0.713) [1]
	Female	96.0%	4.0%	
Marital Status	Single	96.5%	3.5%	0.217(0.897) [2]
	Married	96.6%	3.4%	
	Divorced	100.0%	0.0%	
Employment Status	Employed	96.8%	3.2%	0.021(0.990) [2]
	Unemployed	96.3%	3.7%	
	Students/Apprentice	96.4%	3.6%	
Body Mass	Underweight (<= 18kg)	100.0%	0.0%	9.941(0.041*) [2]
	Normal (18.5-40kg)	100.0%	0.0%	
	Overweight (>40kg)	96.3%	3.7%	

Note: * denotes significant at 0.05 level

Source: Researchers' compilations using IBM-SPSS 23

Similarly, Table 4 reveals the associations between demographic status of DR-TB patients and treatment outcome. Results showed that the participants' demographic characteristics are significantly associated with the treatment outcomes except the body mass of the DR-TB patients [i.e. p-value (0.023) <0.05]. TB mortality was significantly higher among under-weighted (13%) and normally-weighted (11%) DR-TB patients compared to the overweight patients. Additionally, TB mortality was insignificantly higher among female (16%), married (12%), student/apprentice (20%) and age between 41-50 years (18%) of DR-TB patients. However, as observed the cured DR-TB patients were higher across all the demographic characteristics compared to mortality (dead).

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Table 4: Association between Demographic Status of DR-TB Patients and Reported Mortality

Variable	Categories	Treatment outcome		X^2 (P-value) [DF]
		Cured	Treatment Failed (Dead)	
Age	10-19 Years	90.0%	10.0%	3.560 (0.736) [6]
	20-29 Years	94.1%	5.9%	
	30-39 Years	91.7%	8.3%	
	40-49 Years	84.6%	15.4%	
	50-59 Years	81.8%	18.2%	
	60-69 Years	100.0 %	0.0%	
	69-70 Years	83.3%	16.7%	
Gender	Male	90.5%	9.5%	1.246 (0.264) [1]
	Female	83.7%	16.3%	
Marital Status	Single	88.9%	11.1%	0.679 (0.878) [3]
	Married	88.0%	12.0%	
	Divorced	100.0 %	0.0%	
	Widow	100.0 %	0.0%	
Employment Status	Employed	87.2%	12.8%	0.211 (0.900) [2]
	Unemployed	86.7%	13.3%	
	Students/Apprentice	80.0%	20.0%	
Body Mass	Underweight (<= 18kg)	86.7%	13.3%	17.696 (0.023*) [2]
	Normal (18.5-40kg)	88.8%	11.2%	
	Overweight (>40kg)	100.0 %	0.0%	

Note: * denotes significant at 0.05 level

Source: Researchers' compilations using IBM-SPSS 23

Association between TB Patients Category, HIV Status, Sputum Smear Status and Reported Mortality

Table 5 reveals the associations between HIV status, sputum smear status, the categorisation of patients and DS-TB treatment outcome. The results depict that all the examined independent variables i.e. DS-TB categorised patients and HIV status associated significantly (i.e. p-values < 0.1) with the DR-TB treatment outcomes. Specifically, the results indicate that mortality was significantly higher among the 'Relapse' (17%) and 'HIV Negative' (3%) patients compared to other corresponding categories of independent variables. The results in Table 4.5 further reveal that Sputum Smear status shows no significant association with the DS-TB treatment outcomes though higher mortality was observed among Sputum Smear positive (14%) patients compared to the negatively tested.

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Conversely, Table 6 results reveal the associations between HIV status, sputum smear status, categorised of patients and DR-TB treatment outcomes. The results depict that all the examined independent variables i.e. DR-TB categorised patients, HIV status and sputum smear status associated significantly (i.e. p-values < 0.05) with the DR-TB treatment outcomes. Explicitly, the results indicate that mortality was significantly higher among the TAF (16%), 'Treatment after Loss to Follow Up' (13%), New (11%) DR-TB categorised patients compared to others. It further indicates that mortality was significantly higher among the Sputum Smear positive (17%) patients compared to the negatively tested ones. Lastly, the results return equal significant mortality percent for the Negative (17%) and Positive (17%) HIV patients.

Table 5: Association between DS-TB Patients Categories, HIV Status, Sputum Smear Status and Reported Mortality

Variable	**Category**	**Treatment outcome**		X^2 **(DF) [P-value]**
		Cured	**Treatment Failed (Dead)**	
DS-TB Categorised Patients	New	97%	3%	10.998 (5) [0.041**]
	Other Previously Treated TB Patients	100%	0%	
	Relapse	83%	17%	
	Transferred in Patients	100%	0%	
	Treatment after Failure	100%	0%	
	Treatment after Loss to Follow Up	100%	0%	
HIV Test Status	Negative	97%	3%	8.371 (1) [0.068*]
	Positive	100%	0%	
Sputum Smear Results	Positive	100%	0%	0.114 (1) [0.486]
	Negative	96%	4%	

Note: * and ** denote significant at 0.1 and 0.05 level respectively

Source: Researcher's SPSS Output Compilations

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Table 6: Association between DR-TB Patients Categories, HIV Status, Sputum Smear Status and Reported Mortality

Variable	Category	Treatment outcome		X^2 (DF) [P-value]
		Cured	Treatment Failed (Dead)	
DR-TB Categorised Patients	New	89%	11%	5.788 (5) [0.013**]
	Other Previously Treated TB Patients	100%	0%	
	Relapse	96%	4%	
	Treatment after Failure (TAF)	84%	16%	
	Treatment after Loss to Follow Up	88%	13%	
HIV Test Status	Negative	88%	12%	3.072 (1) [0.048**]
	Positive	88%	12%	
	Unknown	100%	0%	
Sputum Smear Results	Positive	83%	17%	4.831 (1) [0.023**]
	Negative	96%	4%	

Note: ** denotes significant 0.05 level

Source: *Researcher's SPSS Output Compilations*

Binary Logistic Regression (BLR) Model Estimation

Binary logistic regression models were estimated to model the Mortality (treatment outcome) as the response treating Alive as the reference category using the logit functions. From the Omnibus test and models' effects test results presented in Table 7, logit functions depicted a likelihood ratio chi-square of 12.945 with degree of freedom 8, significant at 5% level of significance and significant effects of categorised DS-TB patients, HIV Status and Sputum Smear Status. This implies that adding the predictors i.e. categorised DS-TB patients, HIV Status, Sputum Smear Status have significant ability to predict the treatment outcome (mortality).

Table 7: Tests of Model Effects (DS-TB)

Variables	Wald Chi-Square	Df	Sig.
(Intercept)	2.232	1	.044**
DS-TB	1.235	5	.073*
Gender	.055	1	.814
HIV Status	3.816	1	.083*
Sputum Smear Status	2.234	1	.096*
Omnibus test (Logit Function)			
Likelihood Ratio Chi-Square	12.945	8	.049**

Dependent Variable: Treatment outcome (Mortality)
Note: * and ** denote significant at 0.1 and 0.05 levels respectively
Source: IBM SPSS 23

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Table 8: BLR Model Estimation (DS-TB)

Variables	Coefficients	Std. Error
(Intercept)	-41.796**	91324.9907
New	19.587*	79461.7245
Other Previously Treated TB Patients	8.558E-07	112376.0468
Relapse	.299	86511.7359
Treatment after Failure (TAF)	8.558E-07	112376.0468
Treatment after Loss to Follow Up	.105	97295.0584
Gender	-.220	.9331
HIV Status	-19.431*	23943.1247
Sputum smear status	19.441*	19057.9107
AIC value = 43.989		

Dependent Variable: Treatment outcome (Mortality)

Note: * and * denote significant at 0.1 and 0.05 levels respectively

Source: IBM SPSS 23

Table 8 presents the binary logistic regression estimations with goodness of fit of AIC=43.989. The model reveals the relationship between the dependent (Mortality) and independent variables; intercept, categorised DS-TB patients, gender, HIV status and Sputum smear status. The HIV status of the patients depicted significant negative effect on the mortality recorded at 0.1 level of significance while the categorised New DS-TB patients and Sputum smear status depicted significant positive effect on the mortality recorded at 0.1 level. This implies that every known HIV status of the DS-TB patients has the likelihood of being alive, while DS-TB (New) patients and Sputum smear status have more likelihood of contributing to the level of mortality.

Furthermore, from the Omnibus test and models' effects test results of DR-TB patients presented in Table 9, the logit functions depicted a likelihood ratio chi-square of 16.762 with degree of freedom 12, significant at 0.1 level of significance and significant effects of categorised DR-TB patients, HIV Status, Sputum Smear Status and Body Mass. This implies that adding the predictors i.e. categorised DR-TB patients, HIV Status, Sputum Smear Status and Body Mass have significant ability to predict the treatment outcome (mortality).

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Table 9: Tests of Model Effects (DR-TB)

Variable	Wald Chi-Square	Df
(Intercept)	.000	1
Sputum Smear Status	4.060*	1
DR-TB	2.187*	4
Body Mass	3.467*	2
Marital Status	.050	3
Gender	.967	1
HIV Status	5.002**	1
Omnibus test (logit function)		
Likelihood Ratio Chi-Square =16.762	DF=12	p-value=0.087 *

Dependent Variable: Treatment outcome (Mortality)

Note: * and ** denote significant at 0.1 and 0.05 levels respectively

Source: IBM SPSS 23

Table 10: BLR Model Estimation (DR-TB)

Parameter	Coefficients	Std. Error
(Intercept)	43.451	91130.1809
Sputum Smear Status	.195*	.7960
New	1.442*	1.3201
Other Previously Treated TB Patients	20.706	79461.9931
Relapse	11.415*	1.5488
Treatment after Loss to Follow Up (TALF)	-.223*	1.2033
Underweight (<= 18kg)	-20.995*	79461.9609
Normal (18.5-40kg)	-20.365*	79461.9609
Single	-20.725	44614.3398
Married	-20.580	44614.3398
Divorced	.661	71741.1632
Gender	-.642	.6530
HIV Status	-5.054**	1.2568
AIC=72.010		

Dependent Variable: Treatment outcome (Mortality)

Note: * and * denote significant at 0.1 and 0.05 levels respectively

Source: IBM SPSS, 23.

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Table 10 presents the binary logistic regression estimations of DR-TB with goodness of fit of AIC=72.010. The model reveals significant relationships between the dependent (Mortality) and independent variables; categorised DS-TB patients (New, Relapse and TAF), HIV status, Sputum smear status and Body Mass. The HIV status, TALF patients and Body Mass (i.e. underweight and normal-weight) depicted significant negative effect on the mortality recorded while the categorised New & Relapse DR-TB patients and sputum smear status of the DR-TB patients depicted significant positive effect on the mortality recorded. This implies that the HIV status, categorised TALF DR-TB patients and DR-TB patients with under-weight and normal-weight body masses have more likelihood of being alive, while categorised New and Relapse patients and Sputum smear status have more likelihood of contributing to the level of mortality.

CONCLUSION AND RECOMMENDATION

This paper focused on the assessment of the treatments of DS-TB and DR-TB patients in Oyo state. The objectives of this research have been predominantly achieved by the exploration of the association between demographic status of the DS-TB and DR-TB patients and treatment outcomes (mortality). Additionally, it addressed the associations between some of the exploratory data such as HIV status, Sputum smear status, categorised DS-TB and DR-TB patients and the mortality level (treatment outcomes).

Majority of the respondents analysed were within the productive age group 21-50 years (71.9% and 80.2% for DS-TB and DR-TB patients respectively) and married (49.7% and 59.1% for DS-TB and DR-TB patients respectively). This was identical to a study done by Mpagama et al. (2013) on diagnosis and interim treatment outcome from the first cohort of multidrug resistant tuberculosis patients in Tanzania. In terms of gender, there were more males than females. Ratio 2:1. At baseline, based on WHO categorization, the commonest cases of DS-TB patients seen were ‘New’ (90.5%) followed by relapse after failure (4.2%). Contrarily, the commonest cases of DR-TB patients seen were treatment after failure, TAF (44.3%), New (27.5%) and Relapse after failure cases (20.6%). Four months after starting treatment, 91.5% are alive and 3.2% are dead for DS-TB patients while 85.3% are alive and 11.5% are dead for DR-TB patients. Hence, the percentage success of DS-TB recorded was higher than the recorded for DR-TB patients. This implies achieving the target goal of the END-TB strategy in Oyo State Nigeria by adopting the DS-TB method of treatment would be visible.

Our cross-tabulation and chi-square results for DS-TB patients indicated that mortality was significantly higher among the ‘Relapse’ (17%) and ‘HIV Negative’ (3%) patients compared to other corresponding categories of independent variables. Also, for the DR-TB results, it indicates that mortality was significantly higher among the TAF (16%), ‘Treatment after Loss to Follow Up’ (13%), New (11%) DR-TB categorised patients and positively tested Sputum smear (17%). The DR-TB results further return equal significant mortality percent for the Negative (17%) and Positive (17%) HIV patients. However, no significant association was observed between demographic status and treatment outcome among patients for both DS-TB and DR-TB treatments.

Furthermore, the binary logistic regression model estimations show that known-HIV status favourably and significantly predict the treatment outcome (Alive) of the DS-TB and DR-TB patients. Similarly, categorised TALF patients and Body Mass (i.e. under-weight and normal-

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weight) favourably and significantly predict the treatment outcome (Alive) of the DR-TB patients. However, the results show that categorised New patients and Sputum Smear status unfavourably and significantly predict the treatment outcome (mortality) of DS-TB and DR-TB patients. As well, categorised Relapse patients unfavourably and significantly predict the treatment outcome (mortality) of DR-TB patients. All models are statistically significant.

Nevertheless, the recommendations of the aforementioned findings provide that while the DS-TB and DR-TB treatments had recorded huge success, the DS-TB method of treatment is recommended in order to achieve the target goal of the END-TB strategy in Oyo State, Nigeria. Also, it is important that the treatment centre should pay more attention to categorise New and Relapse patients and their sputum smear status in order to lessen the mortality level especially among DR-TB patients. HIV screening and other related tests such as diabetes and their control should be incorporated into the follow-up evaluation.

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