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Effectiveness of Directly Observed Treatment, Short Course (DOTs) Centers in the control of Tuberculosis in Niger State, Nigeria

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Abstract

Background: Tuberculosis is still one of the major diseases of global health importance. It causes high mortality and morbidity worldwide. A lot of strategies to contain the infection of TB have been initiated among which are Directly Observed Treatment, and Short Courses (DOTs). The study aims to investigate the effectiveness of DOTs centers in the control of Tuberculosis in Niger State, Nigeria

Method: In this cross-sectional descriptive study, a multistage sampling technique was used to select participating healthcare facilities of Niger state with DOTs centers. A set of structured pretested questionnaires was used to obtain relevant information on diagnosis distribution, treatment outcome, characteristics of DOTs centers, challenges faced by DOTs centers, and the impact of COVID-19 on the study participants.

Result: A total of 1633 TB patients were enrolled. 37.2% (608) were female and 62.8% (1025) male. 26 DOTs centers were assessed, out of which 11 were primary, 13 were secondary, and 2 were tertiary health facilities respectively. Based on the result of this study, only 42.3% of DOTS centers met the WHO treatment success target, but the overall treatment success rate was 76.0% and the cure rate was 78.3% which is still below the WHO target of 85%.

Conclusion: There is a need to initiate some strategies that will lead to improvements in the control of tuberculosis in Niger State.

Keywords: Assessment Patients, Surveillance, Tuberculosis, treatment

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Introduction

Tuberculosis (TB) is an infectious Communicable disease caused by a bacterium called Mycobacterium tuberculosis with droplet inhalation as the route of transmission. It is known to be common among developing nations like Nigeria.[21] It is one of the top 10 killer infectious diseases in the world and it has become a pandemic.[11] TB is a highly contagious infectious disease that has a significant impact on public health. According to WHO, 10.4 million people suffered from TB and 1.8 million died in 2015. Over 95% of TB deaths occur in low- and middle-income countries and South-East Asia contributes about 60% of the total TB burden in the world.[26] Since the Emergence of this disease has been found to affect the host immune system, many strategies have been put in place to curb the spread of this debilitating infection. The control of tuberculosis continues to be topical as the burden and complexity of the disease are still a source of much concern both globally and locally. In more recent years, it has become even more complex due to a rise in its drug-resistant strains, amidst a range of other issues including human immunodeficiency virus (HIV) co-infection and TB (tuberculosis) co-morbidities - diabetes, congestive heart failure, asbestosis, sarcoidosis, etc.[39] The World Health Organization (WHO) estimates that Nigeria has one of the highest TB burdens in the world, accounting for 9% of all tuberculosis cases globally.[22] The disease cuts across all spheres, with the largest number of new TB rates by country happening in Southeast Asian and African countries. In 2020, for example, eight countries accounted for Two-thirds of new TB infections comprising 474,000 patients with multi-drug resistant TB (MDR-TB) in all.[28] Nigeria ranks second in TB prevalence in Africa with India ranking first and 7th of the top 8 Countries with the Highest Number of New TB Infections. Statistics show nearly 407,000 people are infected with TB every year. The situation is worsened by the HIV/AIDS epidemic and a high number of drug-resistant TB infections.[27] The outbreak of COVID-19 has significantly impacted the effectiveness of tuberculosis control programs, such as the Directly Observed Treatment, Short-course (DOTs) Center, in Nigeria.[38] According to a study by Ogbudebe et al., the pandemic has considerably affected the delivery of tuberculosis services, including diagnosis, treatment, and follow-up.[40]

Directly Observed Treatment, Short Course (DOTs) is a proven strategy for the control of TB, which involves direct observation of patients taking their medication by trained healthcare professionals. The effectiveness of the DOTs Centers is particularly important in preventing the emergence of drug-resistant TB strains, which pose a significant challenge to the control of TB.[24] Furthermore, the efficient delivery of DOTs services has the potential to reduce the duration of TB treatment, improve patient outcomes, and reduce the recurrence of TB cases. Niger State is still battling to meet the WHO cure rate standard in the control of TB. Niger is a state in the North Central region of Nigeria and the largest state in the country. Niger State has three political zones, zone A, B and C. The state's capital is at Minna. Other major cities are Bida, Kontagora, and Suleja.

The Directly Observed Treatment, Short Course (DOTs) strategy has been implemented in Minna, Niger state to control the spread of the disease. However, there is a need to assess the effectiveness of DOTs center in Minna in achieving treatment success and reducing morbidity and mortality rates from TB. Also, over the past decades, many studies have evaluated the DOTs program and its effectiveness worldwide where TB health workers were involved however there is a paucity of research done to evaluate the effectiveness of DOTs centers in Nigeria, especially Niger State. In view of these, there is a need to evaluate the effectiveness of the DOTs center in controlling TB in Minna, Niger state, and identify potential areas for improvement in the implementation of the DOTs strategy.

Despite being recommended by the WHO[26] as the preferred approach to treating TB, the effectiveness of the strategy in the control of the disease in Niger State is not well established. Also, considering the high prevalence of drug-resistant tuberculosis in Nigeria, The effectiveness of the DOTs Centers is particularly important in preventing the emergence of drug-resistant TB strains, which pose a significant challenge to the control of TB. Therefore, this research topic aims to investigate the effectiveness of DOTs centers in the control of TB in Niger State, Nigeria.

Method

Study Area

This study was conducted in health facilities offering DOTs services of each Zone within Niger state. Niger State is located in North central part of Nigeria between Longitude 10°00'N and latitude 6°00'E. It has a total of 26 Local Government Areas.

Study Population

This study was conducted among Lab Technician, Pharmacist, and DOTS officers who are involved in the delivery of health services in the health facilities in Niger state

Inclusion Criteria and Exclusion Criteria

Only those health facilities in each local government with higher TB patients turn out that offer DOTs in Niger state were included and those centers unwilling to participate were excluded from the study.

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Study Design and Sampling Technique

This was a descriptive cross-sectional study. The researcher adopted the Multistage Sampling technique.[36, 37] in the first stage; simple random sampling was used to select health care facilities in Niger State offering DOTs services. The second stage involves the selection of Local Government (LGA), at this level, the list of all the health care facilities in Niger state offering DOTs was stratified into LGA offering DOTs. In the third stage, Twenty-six facilities with the highest TB patient load from all the 26 LGA of Niger state were selected for the study using systematic random sampling.

Instrument of Data Collection

A set of structured pretested questionnaires was used to obtain relevant information from Lab Technicians, pharmacists, and DOTS officers. The questionnaire had four sections as follows: Section A: Diagnosis distribution and treatment outcome, Section B: Characteristics of DOTs center, Section C: DOTs centers Assessment variables and Challenges faced by DOTs centers, and Section D: Measures to ensure compliance and drug supply to patients during COVID-19 lockdown. The questionnaire was developed based on the objectives and scope of the study which were clearly defined, in other to draw relevant questions. The questions were later revised, reviewed for clarity, and organized into sections. The questionnaire was pretested among health workers in DOTs centers that weren't selected for the main research work. Necessary amendments were made thereafter.

Method of Data Collection

An account was created on https://kobo.humanitarianresponse.info to have access to the server. This questionnaire was then inputted onto the server after which it was deployed. The deployed questionnaire was then accessed by downloading an app called ODK (open data kit) which was used in the collection of the data. The data collected was sent to the server from where it was downloaded for analysis.

Data Analysis

The categorical variables were analyzed and presented as frequencies and percentages while quantitative variables were analyzed and presented as summary measures in the form of measures of central tendency and their corresponding measures of dispersion e.g. mean and standard deviation depending on whether the data is normally distributed or not. The chi-square test was used to determine the relationship between some factors responsible for the effectiveness of DOTs center and the overall standard success Variables. P-values less than 0.05 were considered statistically significant at 0.05 or 95% Confidence level.

Ethical Consideration

Ethical clearance was obtained from the Department of Public Health, National Open University of Nigeria with the reference number (ETC/22/04/Noun214075940). Approval to conduct the study was also, obtained from the Ministry of Health Niger State, Nigeria. Before participation, all participants were informed about the aims and objectives of the study, their freedom of participation, and the anonymity of their participation. Only those centers that gave informed consent to partake in the study were recruited. The data obtained was handled with the utmost confidentiality.

Results

A total of 26 DOTs centers were assessed, out of which 11 were primary, 13 secondary, and 2 tertiary health facilities respectively. A total of 1633 TB patients undergoing treatment were enrolled in the study among which about 37.2% (608) were female and 62.8% (1025) male.

Table 1: DOTs facility profile and profile of enrolees

Variable	Freq (N)	Percent (%)
Primary	11	42.3
Secondary	13	50.0
Tertiary	2	7.7
Total Number of Enrolee	1633	100
Male	1025	62.8
Female	608	37.2

Table 2 showed that only about 57% (922) of the enrollees tested positive for Laboratory tests. Thirty-two percent (32%) of the study participants completed treatment. Among those who tested positive only 44 (2.7%) died in the course of treatment or after completing treatment, Forty-four (44%) percent of the TB treatment enrollees were completely cured. The Overall cure rate per facility is 78.3% and the overall treatment success rate per facility is 76%.

Table 2: Diagnosis distribution and treatment outcome

Variables	Frequency (N)	Percentages (%)
Total Number of patient who tested Positive to laboratory Test AFB/GeneXpert	922	56.5
GeneXpert Alone	837	51.3
Number of patients who Complete treatment	519	31.8
Total number of deaths	44	2.7
Number of Patient with TB/HIV co-infection	162	9.9
Number of Patient who are cured	722	44.2
Cure rate	78.3%	
Treatment success rate	76.0%	

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Table 3 showed that the majority of the DOTs centers 16 (61.50%) have a good overall Quality of training. In addition to this, a little above half of the centers 14(53.80) has efficient Surveillance in Niger despite the challenges noted in the state. The table also, revealed that more than two-thirds of the DOTs centers had problems with adequate capacity building, staff attrition, and lack of motivation and office equipment. It was noted from the tables that overall, only 15 (57.7%) of the DOTs centers evaluated had a good treatment success rate (treatment success rate of 85% and above) whereas 11 (42.3) had a poor treatment success rate. The table showed 21(80.80%) of DOTs facilities agreed that COVID-19 locked down affects the effectiveness of service delivery and 22 (84.6%) also agreed that COVID-19 prevents TB patient from accessing their treatment in the DOTs center, however, the Majority of the centers 25(96.2%) didn't record mortality during the locked down

Table 3: DOTs centers Assessment variables and Challenges faced by DOTs centers

Variables	No. of Centers	Percent (%)
Overall Quality of Training (QOT)		
Poor QOT	10	38.50
Good QOT	16	61.50
Overall treatment success rate		
Good treatment rate	15	57.70
Poor treatment rate	11	42.30
Overall surveillance		
Efficient	14	53.80
In-efficient	12	46.20
Challenges faced by DOTs centers		
Inadequate office space	3	12.00
Need capacity building	17	64.08
Staff attrition	17	64.08
Lack motivation	19	72.00
Inadequate office equipment	12	46.00
Unavailability of drugs	9	34.00
Reagent shortage	1	4.00
Impact of COVID 19 on effectiveness of DOTs centre		
COVID-19 affects service delivery?		
Yes	21	80.80
No	5	19.20
COVID-19 Affect Patient outpour		
Yes	22	84.50
NO	4	15.50
Do you lost any patient on DOTS to COVID-19?		
Yes	1	4.00
No	25	96.00

Table 4: Overall Characteristics of DOTs centers

Variables	Freq	Percent
Regularity of holding meetings		
None	6	23.1
Weekly	1	3.8
Monthly	13	50.0
Two Months and above	6	23.1
Is standard operation protocol use in this Center?		
Yes	22	84.6
No	4	15.4
Do you have a work plan in this center?		
Yes	19	73.1
No	7	26.9
Is there special training on TB service provision?		
Yes	13	50.0
No	13	50.0
Is there training on TB / HIV co infection?		
Yes	12	46.2
No	14	53.8
Do you conduct community outreaches?		
Yes	4	15.4
No	22	84.6
Do you Conduct home visits?		
Yes	2	7.7
No	24	92.3
Do you conduct follow-up activities		
Yes	20	76.9
No	6	23.1
Is there regular monitoring and evaluation of activities in this Center?		
Yes	17	65.4
No	9	34.6
What are your sources of drug supply?		
NGO	5	19.2
Federal Government	21	80.8
Do you have shortage of drugs?		
Yes	3	11.5
No	23	88.5
Do you ever noticed cases of drug resistances?		
Yes	13	50.0
No	13	50.0
Where do you store your drugs?		
Others	5	19.2
Shelves	21	80.8
Do you have a Laboratory for detecting cases?		
Yes	1	3.8
No	25	96.2
Do you have a functional refrigerator for keeping reagents?		

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Yes	16	61.5
No	10	38.5

This table shows variables answering the facility-based characteristics which includes the Center monitoring, quality training, laboratory characteristic and pharmaco-vigilance.

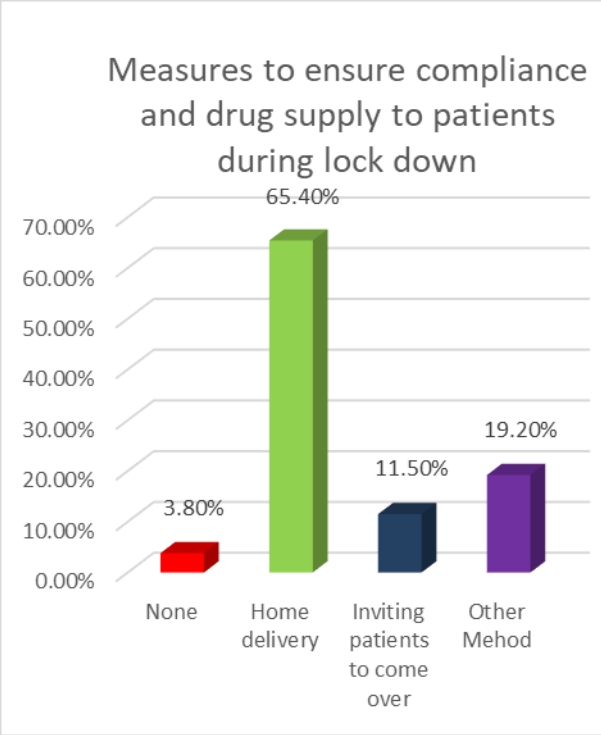

Figure 1: Measures to ensure compliance and drug supply to patients during lock down

Despite the affectation of service delivery during COVID-19, efforts were still made to ensure the compliance of medication to TB. Among the measures put in place by the service provider at the DOT's center was to deliver the drug to TB patients at home during the period of COVID-19 lockdown.

Table 5: Association between Quality of training, Supervision, pharmacovigilance and some selected DOTS Centre characteristic and the Treatment success rate of WHO standard.

Variables	Treatment success rate		Test Statistics
	Poor (<85%)	Good (≥85)	
Total Number of trained staff per year			χ=0.200
0	6 (60.0%)	4 (40.0%)	p=0.905
1	7 (53.8)	6 (46.2%)	
2	2 (66.7)	1 (33.3%)	
Regularity of holding meeting			χ =3.887
None	5 (83.3%)	1 (16.7%)	p=0.274
Weekly	0	1(100%)	
Monthly	6 (46.2%)	7 (53.8%)	
Two Months and above	4 (66.7%)	2 (33.3%)	
Regular monitoring and evaluation of activities in this centre			Fisher's Exact
Yes	10(47.6%)	11 (52.4%)	Test
No	5 (100%)	0	p=0.046
Workers use standard operation protocol in the this centre			Fisher's Exact
Yes	12 (54.5%)	10 (45.5%)	Test
No	3 (75%)	1(25%)	P=0.614
Have DOT Centre work plan			Fisher's Exact
Yes	10 (52.6%)	9 (47.4%)	Test
No	5 (71.4%)	2 (28.6%)	P=0.658
Shortage of Reagent			Fisher's Exact
Yes	0	1 (100)	Test
No	15 (60.0%)	10 (40.0)	p=0.423

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Availability of Functional refrigerator for Keeping Reagent			Fisher's Exact
Yes	7 (43.8%)	9 (56.3%)	Test
No	8 (80.0%)	2 (20.0%)	p= 0.109
Shortage of Drug			Fisher's Exact
Yes	3 (100.0%)	0	Test
No	12(52.20%)	13 (47.80%)	P=0.238
Where do you store your drugs?			Fisher's Exact
Others	5 (100)	0	P=0.046
Shelves	10 (47.6%)	11 (52.4%)	
Surveillance			Fisher's Exact
Inefficient	8 (66.7)	4 (33.3%)	Test
Efficient	7 (50.0%)	7 (50.0%)	P=0.453
Quality of training (QOT)			Fisher's Exact
Poor QOT	6 (60.0%)	4 (40.0%)	Test
Good QOT	9 (56.3%)	7 (43.8%)	P=1.000

Table 5 revealed that there is statistical significant association between Regular monitoring and evaluation of activities in this centre; and the mode of drug storage and Treatment success rate ($p<0.05$). Other variables show no significant association with treatment success rate. ($p< 0.05$= significant difference and $p>0.05$= non-significant difference.

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Discussion

Directly Observe Treatment Short course adopted by WHO in Nigeria entails political will and commitment at all levels for the provision of free TB services to all Nigerians through prompt laboratory diagnosis of TB and ensuring consistent and strict drug uptake by patients according to the studied guidelines. This study is one of the few research endeavors to evaluate the effectiveness of DOTs centers in the control of Tuberculosis in Niger State. This study showed that thousand six hundred and thirty-three patients diagnosed with TB were managed in the selected DOTs Centers across the 26 LGA of Niger state. Half of these facilities were secondary and others were primary and tertiary. The sex distribution of the study population showed a higher prevalence of the disease in males with a ratio of 1.7 to 1 which is in keeping with the global ratio of 1.2 to 1 which in turn is similar to the findings from previous studies by[21]in Minna,[13] in 3 DOTs Centers in Anambra,[17] in Ogbomoso,[19] in Eku hospital, and[36] in Delta. Males are known to have an increased risk of contracting TB due to several risk factors, occupational hazards, carefree attitudes, and some other lifestyle choices that can compromise immunity. Males are also known to have poorer health-seeking behavior than females hence usually seek medical attention late at advanced stages of the disease. In addition, males are known to have poor adherence to treatment and often default to treatment compared to females.[10&32]

The effectiveness of DOTs centers in the control of tuberculosis depends on the quality of training, effective surveillance, and treatment success rate. In this study, slightly below half of the study participants achieved a cure rate (Table 2). In terms of treatment outcome, it's no longer news that Tuberculosis is still a major public health concern in Nigeria and the world at large as it causes a lot of morbidity and mortality. Despite the availability of treatment and easy access to treatment, the treatment outcome of TB is still below the WHO treatment success target. In this study, the overall treatment success rate which is a combination of treatment completed and cured was found to be below the 85% WHO recommended target. A study from north northwestern part of Nigeria recorded a treatment success rate of 80.2% which is slightly above the result of this study.[33] The findings from this study are also noticed to have a lower treatment success rate when compared with results of[17] in Ogbomoso (2008 to 2012) reported a success rate of 85.5% and[13] in 3 DOTs centers in Anambra with a success rate of 86.4%,[31] in Eastern Ethiopia,[35] in Ethiopia and[34] in Egypt (2019). However, some studies revealed results that are below this study's finding like research conducted in Eku, Nigeria[19] (2009 to 2013) with a success rate of 58.6%, another one.[7,9] With regards to the proportion of patients that died, findings from this study recorded 2.7%, which is similar to what was seen in recent studies in Nigeria and Ethiopia[19, 7, 34, 20, & 29] but lesser than what was observed in a few other studies[17,4] This could be due to loss of a patient to follow up and detached to the treatment plan.

In this study, we also looked into the quality of training which encompasses the regularity of holding meetings, use of standard operation protocol and center work plan, special training on TB service provision, and training on TB/HIV co-infection for health workers in charge of DOTs. Greater than half of the DOTs centers have good quality training which simply implies that the majority of the centers had at least a trained staff, used standard operating procedure (SOP), and have good knowledge of HIV/TB co-infection (Table 4). Organizing trainings or workshops for TB health workers are often included in the national TB control strategy to increase effective TB surveillance, Prompt TB case detection, and hence improve treatment success rate. Well, this may be because there are some factors like inadequate medical supplies, enhanced health care infrastructure, and effective laboratory and staff attrition which all contribute to the success of TB treatment in DOTs centers. It is also worthy of note to mention that there is no any significant association between effective surveillance, quality of training and treatment success rate (Table 5).

In terms of surveillance (Table 3), only a little above half of the centers evaluated have good surveillance practices. Proper health surveillance plays a critical role in the treatment success and control of TB. Early case detection, timely diagnosis, prompt treatment initiation, treatment adherence support, and effective monitoring and evaluation are key elements facilitated by health surveillance systems. These factors contribute to improved treatment success rates and overall TB control efforts. By strengthening health surveillance, policymakers and healthcare providers can enhance TB control strategies and achieve better treatment outcomes.

A study by Odone et al.[14] demonstrated that active case-finding strategies, such as contact tracing and systematic screening, significantly contributed to the early

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identification of TB cases, leading to improved treatment success rates. A study by Tassema et al.[23] and Awunor et al,[33] found that a comprehensive surveillance system integrated with rapid molecular diagnostic tools significantly reduced the time to diagnosis and improved treatment success rates. A study by Alene et al.[3] reported that active surveillance interventions, including patient-centered support, significantly improved treatment adherence and ultimately increased treatment success rates. It was also noted by Biadglegne et al.[6] in a study where its findings showed robust surveillance systems are essential for continuous program improvement and achieving optimal treatment success rates. The aforementioned statements are all in agreement with the findings of this research.

Regarding the proportion of facilities that meet the WHO target treatment success rate (Table 3), slightly below half of the centers meet requirements, this is worrisome, however, It's not surprising as some centers are not functional due to many reasons among which insecurity top the list, this invariably makes those DOTs center inaccessible to the patient as everyone is afraid of losing their life. Inadequate capacity building, office equipment, lack of staff motivation, and staff attrition are among other factors that affect the effectiveness of DOTs centers in the control of TB.

In addition, this study also evaluates the challenges faced by DOTs centers in Minna (Table 3). This study revealed that more than two-thirds of the DOTs centers reported inadequate capacity building, staff attrition, and lack of staff motivation, barely under half of centers also reported inadequate office equipment. Thirty-two percent of the centers reported unavailability of TB Drugs whereas only 12% of the center had a shortage of reagents. This is in consistence with the findings of Abdulraheem et al.[1] which report that inadequate training and low staff morale significantly affected the performance of healthcare workers in TB control programs in Nigeria thereby reducing the effectiveness of DOTs centers. Also, Ukwaja et al.[25] stated that the absence of proper record-keeping systems and limited access to electronic databases negatively impacted the monitoring and evaluation of TB control programs in Nigeria. Ekeke et al.[8] reported that stock-outs of anti-TB drugs were a common occurrence in Nigeria, leading to treatment delays and poor treatment outcomes. Shortage of reagents was also noticed by Odumeet al.[15] who reported the scarcity of reagents in Nigeria's laboratory will lead to a backlog in TB testing, delayed treatment initiation, and invariably affect the treatment success rate of TB. Adamu and McGill,[5] also identified a general problem associated with the Laboratories of the DOTs center covered by their study to include shortage of reagents/materials epileptic or erratic supply of electricity. Despite having stand-by generators in most of the centers, fueling the generators is a major bottleneck.

These challenges can lead to sub-optimal case management, delayed treatment initiation, poor treatment adherence, inefficient data management, and delayed diagnosis, ultimately hampering the effectiveness of TB control efforts.

On the effect of COVID-19 on the effectiveness of DOTs centers, COVID-19 has also been found to have a direct and indirect effect on the effectiveness of DOTs centers in the control of TB (Table 3). The COVID-19 pandemic affects the world healthcare system by leading to the closure of many health facilities and in turn stopping routine screening and treatment. The implementation of infection prevention and control measures for COVID-19, such as physical distancing, quarantine, and lockdowns have impacted the delivery of TB services.[31]

This study showed that over 80% of the DOTs centers revealed that COVID-19 locked down affects service delivery, this is similar to the findings of a study by Oleribe et al.[18] who reported challenges in the procurement and distribution of TB medications during the COVID-19 pandemic. This study also noted that over 90% of the DOTs centers recorded a low outpour of patients during COVID-19 lockdown; however, 96.2% of the centers didn't lose a single patient to COVID-19 during this period. This result is consistent with the findings of Agboghoroma et al.[2] and Oladimeji et al.[16] which show that during the COVID-19 pandemic, there was a reduction in the number of TB cases diagnosed, treatment interruptions, and decreased treatment success rates.
The low outpour of the patients was in consistent with the findings of Sanni et al.[22] which stated that fear of exposure to COVID-19 and concerns about the safety of healthcare facilities contributed to a decline in TB case detection rates in Nigeria during the pandemic, which may have affected treatment success outcomes.
On measures to ensure compliance and drug supply during the COVID-19 lockdown, this study found that 65.40% deliver drugs to TB patients at home (Figure 1). This is to mitigate the negative effects of COVID-19 on TB treatment success as the COVID-19 outbreak's frightening rate of disease spread throughout Nigeria and the world, nearly every sector has been put to the test.[38] The Nigerian government and healthcare authorities have implemented various strategies to

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provide uninterrupted service delivery to TB patients which include; the integration of TB and COVID-19 services to ensure continuity of care, the provision of telemedicine and virtual consultations, and the strengthening of infection prevention and control measures in healthcare facilities.[2] Proper storage conditions, good hygiene, and distribution practices should always be adhered to at both DOTs Centers, Pharmacies, and Medical stores.[12] Additionally, public health campaigns and community engagement efforts have been launched to address misconceptions and fears surrounding TB and COVID-19, aiming to encourage TB patients to seek timely medical care.[22] Also, the conduction of follow-up service is statistically significantly associated with treatment success rate (Table 5).

Implication of the study

This study has identified influencing DOTs effectiveness as such by utilizing strategies to optimize DOTs implementation, it can lead to enhanced tuberculosis control, improved treatment outcomes, reduced treatment failure, decreased drug resistance, and reduction of morbidity and mortality. The study's results can guide policy decisions, ensuring that tuberculosis control programs are data-driven and effective. The study can strengthen research capacity in Niger state, fostering a culture of evidence-based decision-making in healthcare and ultimately contributing to the achievement of international targets in tuberculosis control.

Strengths and Limitations of the Study

Studying the effectiveness of DOTs centers in Niger State can provide valuable insights into the effectiveness of tuberculosis control measures. Research has identified areas for improvement in the delivery of tuberculosis services, thus, enabling targeted interventions. Efficient use of resources can be promoted, reducing waste and maximizing the impact of investments in tuberculosis control.

Conducting research in resource-poor settings like Niger State has been a challenge due to limited infrastructure, funding, and personnel. Tuberculosis-related stigma and cultural beliefs as well as ensuring informed consent, confidentiality, and participant privacy made it very difficult for data collection and study participation.

Declarations

Informed consent: All participants were informed about the aims and objectives of the study, their freedom of participation and the anonymity of their participation. Only those centers that gave informed consent to partake in the study were recruited. The data obtained was handled with the utmost confidentiality.

Authors' Contribution: Adamu SU researched literature and conceived the study; Adamu MB reviewed and edited the manuscript; Ojetokun MB was involved in protocol development, gaining ethical approval, patient recruitment, and data analysis. All authors contributed to the final version of the manuscript

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