Logistics Outsourcing in Tuberculosis Diagnosis, Prevention, and Control in Nigeria

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Abstract

Background: *The National Tuberculosis Program plan to eliminate Tuberculosis (TB) as a public health problem in Nigeria by 2050 and WHO 90-90-90 target of ending TB may be difficult to achieve without an efficient and effective sample referral system.*

Aims: *The aim of this study is to critically evaluate the outsourcing of sputum transportation logistics in TB diagnosis, prevention, and control in Nigeria.*

Materials and Method: *Information was obtained from all the TB testing laboratories in all the 36 states and the Federal Capital Territory in Nigeria. Data were extracted from the excel database used for tracking specimen transportation logistics, cleaned and analyzed using IBM-SPSS version 25.0.*

Result: *This study revealed a steady increase in the number of samples transported from collection centers to testing laboratories from 393 in March 2018 to 5211 in March 2019. Samples transported by 3PLs increased by 508.7% at month 7 (midway) and increased by 1,326% at month 13. Similarly, the number of results transported from testing laboratories back to collection centers increased by 1,121% and 3,166% respectively. Akwa Ibom state recorded the highest number of sample movements; (13.6%), followed by Benue (11.7%) and Lagos state (11.5%). Percentage of sputum results pick-up were above 50% and 69% overall. Sample rejection was low, at 0.25%, indicating effectiveness and efficiency in the system.*

Conclusion and Recommendation: *The study reported very good performance of 3PL services. However, the low sample transportation in some states requires further investigation and attention.*

Keywords: *Tuberculosis, Sputum, Sample Referral, Logistics, 3PL, Outsourcing.*

Introduction

Tuberculosis as a public health problem

Tuberculosis (TB) is an ancient disease that is unfortunately still a major public health problem in most developing countries such as Nigeria. The social stigma associated with this disease further compounds the problem (MOH, 2014). Prior to 2012, there was no national survey to determine the prevalence of TB disease in Nigeria but Nigeria's first National Tuberculosis Prevalence survey was concluded in November 2012 by the National TB and Leprosy Control program (MOH, 2013). The Ministry of Health in 2014 estimated yearly new occurrence of TB as 460,000 cases. TB has remained major public health problem in Nigeria for a very long time, However, TB was declared a national emergency in June 2006, this was followed by the development of an emergency plan for the control of the disease. Nigeria was ranked 4th among the 22 high TB burden countries in the world in the year 2014 (MOH, 2014).

According to WHO Estimates of TB and MDR-TB burden, the mortality and incidence of TB and HIV only in 2017 was 18 and 30 per 100,000 populations respectively while the TB treatment coverage was just 24% in Nigeria as shown in Table 1 (WHO, 2018).

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Table 1. Estimates of TB and MDR-TB burden as produced by WHO in consultation with countries

Estimates of TB burden*, 2017	Number (thousands)	Rate (per 100 000 population)
Mortality (excludes HIV+TB)	120 (70–180)	63 (36–96)
Mortality (HIV+TB only)	35 (21–52)	18 (11–27)
Incidence (HIV+TB only)	58 (37–85)	30 (19–44)
Incidence (MDR/RR-TB) **	24 (14–36)	12 (7.3–19)
TB case notifications, 2017		
Total cases notified	-	104 904
Total new and relapse	-	102 387
- % tested with rapid diagnostics at the time of diagnosis		41%
- % with known HIV status		95%
- % pulmonary		96%
- % bacteriologically confirmed among pulmonary		78%
Universal health coverage and social protection		
TB treatment coverage (notified/estimated incidence), 2017		**24% (17–38)**
TB patients facing catastrophic total costs, 2017		71% (68–73)
TB case fatality ratio (estimated mortality/estimated incidence), 2017		0.38 (0.2–0.59)

Source: (World Health Organisation, 2018)

The National TB program plans to eliminate TB as a public health problem by 2050 (<= 1/1,000,000 population) through several means including but not limited to early case detection through quality-assured bacteriology, standardized treatment with supervision and patient support, an effective supply and drug handling, monitoring and evaluation network, and impact measurement, scale-up collaborative TB/HIV activities, help improve health policies, workforce development, financing, supplies, service delivery, and information, upgrade laboratory networks and implement innovations that strengthen systems, and corporate and private providers through Public-Public and Public-Private Mix (PPM) approaches (MOH, 2013), the majority of these functions are related to logistics/transportation services.

Challenges of TB diagnosis and control

The control and prevention of TB in contemporary times has many faces and challenges (MOH, 2014). A very important challenge in TB diagnosis, prevention and control is Sample rejection. Mehrotra *et al.* described the rejection of samples with the aim of proper processing of the samples and for providing a report of a high standard as good lab practices (Mehrotra, 2013). Kebede *et al.* explained that the fragile and fragmented specimen-referral networks within the health system are responsible for frequent rejection of transported samples because they were inadequate for analysis (Kebede *et al.*, 2016).

Also, availability of standard specimen- transport containers at referring sites, and the number of laboratory and postal service personnel trained are among the causes of unacceptably long turnaround times for laboratory results (Kebede *et al.*, 2016).

Both, the low TB case detection and cure rates, are serious challenges militating against the control of TB in Nigeria (Oyefabi *et al.*, 2017). It has been reported that the lack of laboratory facilities, poor logistics, and transportation as well as the poor sample handling procedure makes the laboratory diagnosis of infectious diseases difficult in many parts of the African continent (Parsons *et al.*, 2011). Another important challenge reported by Parsons *et al.* is that some people are asked to make repeated visits to the health care center for specimen delivery and collection of results. For many patients, the costs of repeated visits to health care facilities are prohibitive, this makes them drop out before finishing the processes (Parsons *et al.*, 2011). This is a serious challenge to TB prevention and control.

Gebreegziabher *et al.* identified some challenges of TB control as intermittent interruptions of laboratory reagents and anti-TB drug supplies, absence of trained and motivated health workers, poor TB data documentation, lack of adherence to TB treatment guideline, and lack of access to TB diagnostic tools at peripheral health institutions (Gebreegziabher, Yimer, & Bjune, 2016).

In 2018, Aruna *et al.* reported that health facilities are reporting TB cases to Nigeria's IDSR system very poorly, posing a serious threat to early detection, quality treatment, and ending the infection. Numerous problems, including dual TB reporting through two systems that are not integrated and non-reporting by the private sector, contribute to the poor reporting (Aruna *et al.*, 2018). They, however, recommended that IDSR should Integrate programs and share data to improve data collection, Engage the private sector: Provide vehicles for sample transport, among others (Aruna *et al*., 2018)**.** Another challenge in TB treatment is the inability to ensure the availability of drugs throughout the duration of treatment to ensure cure and to prevent the possible emergence of MDR TB (MOH, 2014).

In 2013, Ministry of Health identified some challenges of TB diagnosis to include poor logistics of sputum transportation and processing, delays in transmitting the laboratory results to the central data manager due to administrative and workload challenges in the laboratories (MOH, 2013). The MOH survey also identified the following challenges relating to the performance of the TB reference laboratory services: transportation, storage, sputum processing and data management (MOH, 2013). The recommendations to address these challenges include strengthening transportation system from peripheral to reference laboratories, strengthening infrastructural and human capacity of the reference laboratories, and strengthening the laboratory data management system (MOH, 2013). TB control in Nigeria can be best achieved through public-private partnership as revealed by the findings of this study.

Specimen collection and transportation logistics

Specimen collection is one of the pre-analytical processes that ensure to provide accurate, reliable and timely results to patients, but an improper collection of samples could delay patient results due to unnecessary specimen redraws and elongated corrective and preventive action activities (Shiferaw, Yismaw, & Getachew, 2018). This could dissatisfy customers in addition to time and resource wastage in the laboratory (Plebani, 2015). Therefore, the quality of the laboratory results is good only if the quality of specimen collection and transportation is appropriate (Shiferaw *et al*., 2018).

The transportation of tuberculosis (TB) specimens in a reliable and efficient manner are essential for effective TB patient care, allowing for faster diagnosis, initiation of treatment, and patient follow- up. For decades, health facility staff and sometimes even the patients themselves had to deliver TB specimens to the nearest laboratories. They were often faced with the complexity of transporting these valuable specimens in a safe and quality- assured manner and as a result, many TB patients failed to get a correct diagnosis and the much-needed treatment (USAID, 2018)**.**

The detection of TB and testing for drug-resistance are fundamental parts of providing accurate diagnosis and TB treatment. The transportation of TB specimens is an efficient method of increasing access to diagnostics in areas where testing is not currently available. This helps to prevent the need for patients to travel (with the associated costs) and leads to more equity in access to TB diagnosis and care. In addition, specimen transportation can often be more cost-effective than placing staff or procuring additional equipment to provide localized testing (USAID, 2018).

According to Faruna *et al.* (2019), sample transportation remains a challenge in resource-limited countries. In Nigeria transport was conducted through non-standard, parallel systems, leading to long turnaround times and lack of visibility (Faruna, Akintunde, & Odelola, 2019). This constitutes one of the major challenges of TB control in Nigeria.

In 2018, the Federal Ministry of Health (MOH) established a National Integrated Specimen Referral Network (NISRN) with the aim of achieving cost-effective, efficient, safe and secure referral system involving third-party logistics providers (3PLS) under the supervision of the Global Health Supply Program (GHSC-PSM). The NISRN took over the specimen transportation services from specimen collection centers to the testing laboratories due to the non-existence of a standard referral system in the country which had for a long time contributed to the high cost of sputum diagnosis, the long turnaround time of results especially from hard to reach areas. The responsibility of the 3PL includes result return from testing laboratories to the originating health facilities (Faruna *et al.*, 2019).

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Impact of third-party logistics in the TB sample referral system

A third-party logistics (3PL) provider is an external provider who manages, controls, and delivers logistics activities on behalf of a shipper (Alemnji, Nkengasong, & Parekh, 2011). A 3PL provider collects samples from collection centers and consolidates shipments in their distribution centers (Kebede *et al*., 2016). The consolidated shipments are then conveyed through alternative transportation routes to the testing laboratories (PEPFAR, 2015). The most frequently reported benefit of using a 3PL provider is that it allows a manufacturer to focus on its competencies (Kebede *et al*., 2016). The services of third-party logistics (3PL) provider had come to stay in the business circle because many companies and even managers had often found that they are overwhelmed with other essential services within the organizations (Faruna *et al*., 2019). Due to the concern of taking care of the employees, the management of finance, marketing strategies, ensuring the satisfaction of customers, many organizations currently employ the services of 3PLs for logistics services (Faruna *et al*., 2019). The major reasons why organizations engage the services of 3PLs include service improvement, cost reduction and the need to focus on the core functions (Adebambo, Omolola, & Victor, 2016).

This research, therefore, aims to assess the functional impact of the integrated referral system in the control of TB in Nigeria. It is believed that the established integrated system will be a right step in improving TB diagnosis as a measure of performance in line with the report of (Ju, Wang, Cheng, & Jia, 2019).

Researchers have established that 3PLs utilize of resources better compared to the uncoordinated methods of making use of facility staff to transport specimen and taking them away from their core duties of sample analysis (Kalinzi, 2017; Muthoni, 2016). With the commencement of NISRN operation, 3PLs provide dedicated transport services and are held accountable for timely pickup, transport, and delivery of specimens (Faruna *et al*., 2019). Before the start of operation of NISRN, the 3PLs were selected via a rigorous process of expression of interest, submission of bidding documents, proposal submission, and technical evaluations. This was followed by adequate training on specimen transportation management, from the point of collection to the testing laboratories, and the return of results to collection facilities (Faruna *et al*., 2019).

This study assesses the impact of Integrated 3PL Logistics in TB sample referral system.

Methodology

A retrospective study was carried out from March 2018 to March 2019. Information was obtained from all the TB diagnostic centers in all the 37 states of the federation and the Federal Capital Territory (FCT). Tracking records of transported specimens and results by all the logistics providers under NISRN operation from March 2018 to March 2019 were obtained from all the diagnostic centres. The total number of specimens rejected was also obtained from all the centers. Data extraction tool prepared by Axios international was used to capture information regarding specimen rejections and specimen transportation systems established at the reference laboratories. Data from bi-monthly quality indicator reports, which included specimen rejection and workload statistics, were also used. Data were extracted from the excel database prepared for tracking specimen transportation logistics, cleaned and were transferred to IBM-SPSS version 25.0 for analysis. The analysis done include descriptive statistics; like frequencies and proportions. The results were presented to show the impact of 3PLs in TB sample referral system in Nigeria.

Results

This study focuses on assessing the efficiency of 3PLs in TB sample referral system. Within 13 months of into NISRN operation, 26,746 sputum samples were transported by 3PL service providers to reference laboratories across Nigeria. During this period, 18, 392 results were also picked from these reference centers, this represents 69% of all sputum samples transported for the test (Table 2).

Figure 1 shows the total samples transported by 3PL providers to all reference laboratories and the results collected from all the centers since the inception of NISRN (March 2018 to March 2019). The figure shows a steady increase in both specimen and results transported to and for reference laboratories. The number of transported samples rose from 393 in March 2018 to 1999 (508.7%) in September (7

months and mid-way from the inception) and later to 5,211 in March 2019, representing an increase of 1,326% increment over a period of 13 months. Also, the number of results picked up rose from 113 in March 2018 to 1,267 (1,121.3%) and later to 3,578 (3, 166.4%) in March 2019. The percentage result picked up was highest in December 2018 (1604/1755; 91.4%).

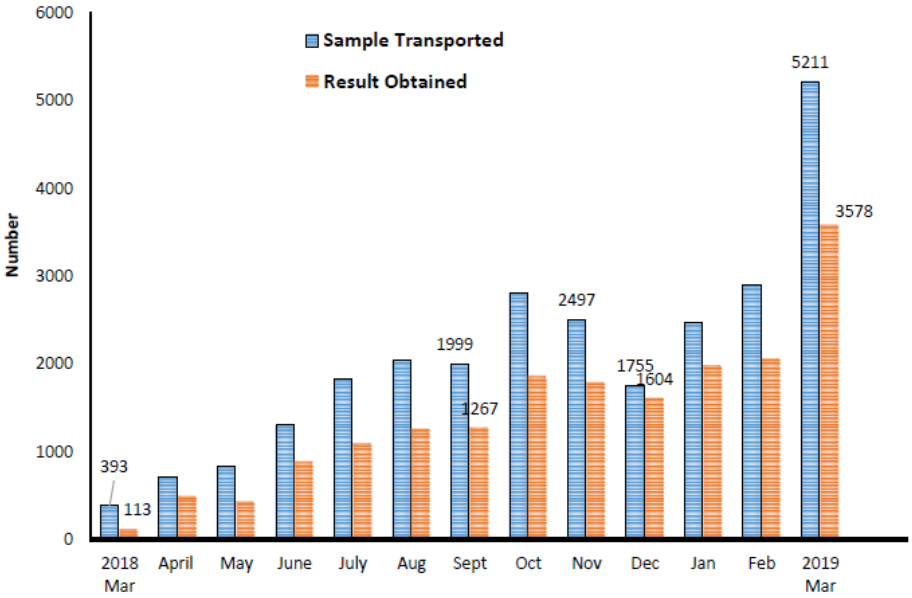

Figure 1. Transportation of sample and results to and fro reference laboratories in

Table 2 shows the number of specimens transported within 13 months across Nigeria. The highest number of samples (3633; 13.6%) was transported in Akwa Ibom state, followed by Benue (3131; 11.7%) and Lagos state (3078; 11.5%). Five percent of the total samples were transported within Cross River and Rivers states, 14 states recorded less than 1% of total samples transport while no sample was transported in Yobe and Imo states respectively. Percentage sputum results pick-up was above 50% in most states except Bauchi, Kano, Katsina, Osun, Oyo, and Gombe states, where pick-up level was below 50%.

Table 2. Sample transported and results obtained from referral centers in 13 months

SN	State	Total Samples	% sample transported	Total Results	% Sputum Result
1	Akwa Ibom	3633	13.58%	2864	79%
2	Benue	3131	11.71%	2310	74%
3	Lagos	3078	11.51%	2004	65%
4	Kaduna	2559	9.57%	1289	50%
5	Cross River	1338	5.00%	1250	93%
6	Rivers	1329	4.97%	816	61%
7	Edo	1197	4.48%	955	80%
8	Nasarawa	1097	4.10%	636	58%
9	Taraba	991	3.71%	859	87%
10	Kebbi	964	3.60%	667	69%
11	FCT, Abuja	906	3.39%	600	66%
12	Bauchi	851	3.18%	368	43%
13	Kano	850	3.18%	348	41%
14	Niger	672	2.51%	640	95%

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15	Bayelsa	599	2.24%	323	54%
16	Zamfara	567	2.12%	411	72%
17	Anambra	561	2.10%	504	90%
18	Plateau	431	1.61%	367	85%
19	Kogi	369	1.38%	290	79%
20	Katsina	335	1.25%	154	46%
21	Osun	278	1.04%	122	44%
22	Sokoto	227	0.85%	137	60%
23	Ondo	136	0.51%	82	60%
24	Oyo	131	0.49%	55	42%
25	Gombe	102	0.38%	40	39%
26	Enugu	97	0.36%	61	63%
27	Jigawa	93	0.35%	65	70%
28	Delta	81	0.30%	67	83%
29	Adamawa	50	0.19%	38	76%
30	Abia	44	0.16%	39	89%
31	Kwara	28	0.10%	19	68%
32	Borno	8	0.03%	7	88%
33	Ogun	7	0.03%	0	0%
34	Ekiti	4	0.01%	4	100%
35	Ebonyi	2	0.01%	1	50%
36	Yobe	0	0.00%	0	0%
37	Imo	0	0.00%	0	0%
Total		**26,746**	100.00%	**18,392**	69%

Figure 2 shows a sample rejection rate within 13 months of this study. There were only 68 cases of rejection, which represents 0.25% of the total (26,746) sputum samples transported across the country. Katsina state recorded the highest number of rejected samples (25 of 335; 10.4%), followed by Lagos (23 of 3078; 0.75%), Akwa Ibom (6 of 3633; 0.17%) states and FCT (5 of 906; 0.55%) while the states with lower number of referred samples did not experience sample rejection.

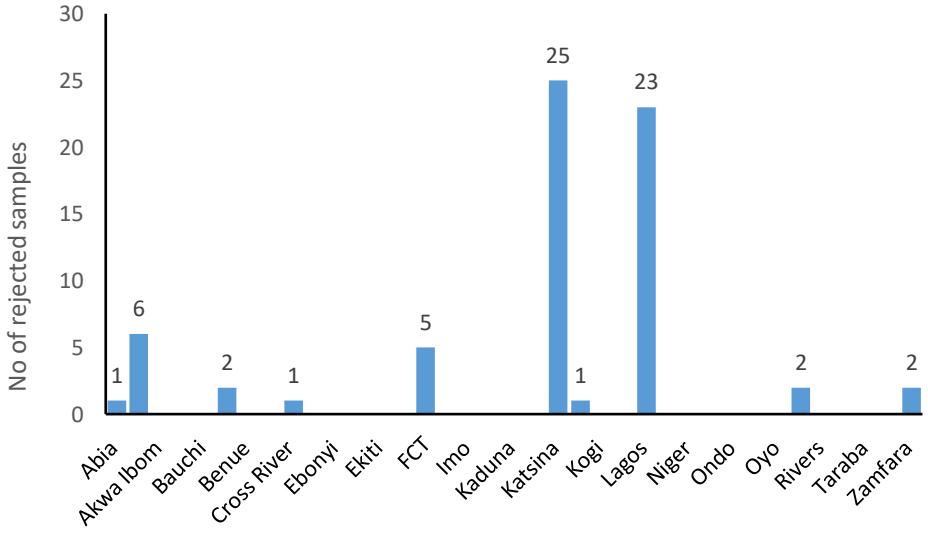

Figure 2. Sample rejection rate in all states in 13 months

Discussion

Nigeria is ranked number seven among the 30 high TB burden countries and second in Africa. Also, Nigeria is among the 14 high TB burden countries, TB-HIV and Multi-drug resistant TB (Global Health Education, 2018; Oguntade, 2018). It is estimated that the number of HIV negative persons that have TB in Nigeria each year is 407,000. In addition, there are an estimated 63,000 HIV positive people that get TB each year and an estimated 115,000 HIV negative persons die from TB in Nigeria each year and an estimated 39,000 HIV positive people also die (Global Health Education, 2018).

In 2013, the National TB program plans to eliminate TB as a public health problem by 2050 (MOH, 2014) but it has been said that achieving the reduction in TB incidence rate for attainment of the 90-90-90 target to strategically end TB will be a mirage, if something drastic is not done (Global Health Education, 2018). This goal cannot be achieved without an efficient and effective sample referral system. In March 2018, the established NISRN, using 3PL providers, took over the sample transportation logistics in Nigeria to transport specimens from collection centers to testing laboratories.

The aim of this study is to critically evaluate the efficiency of 3PLs in the TB specimen referral system from March 2018 to March 2019. A total of 26,746 sputum samples was transported by 3PL service providers from collection centers to testing laboratories across while 18, 392 (69%) results were returned.

Within the first 7 months of operation of the 3PLs, the number of samples transported from collection centers to testing laboratories monthly was increased by over 500% and increased by over 1,300% in at the end of the first year of operation. Likewise, the number of monthly results transported from testing laboratories was increased by over 1200% midway and later increased to over 3,100% per month. Though the findings of this study form a baseline for future studies since there had not been any study in this area in Nigeria, a similar study that critically evaluated the performances of 3PLs in viral load testing recorded an increase in the number of samples handled within 6 months from 16% to 44% (Faruna *et al*., 2019). According to the WHO, Nigeria is among the ten countries that account for 64% of the global gap in TB case finding (Global Health Education, 2018). A major challenge with TB in Nigeria is the low TB case finding for both adults and children (Global Health Education, 2018). In 2017 only 104,904 TB cases were detected out of an estimated 407,000 of all TB cases expected to be detected in 2017; this indicates a treatment coverage of just 25.8% (Desmon, 2018; GOV.UK, 2018; Ogbo *et al*., 2018; WHO, 2018).

This result of this study undoubtedly shows the capability and efficiency of the 3PLs and it is an indication of the right direction in achieving the 2050 goal and 90-90-90 target. This is also one of the ways that the Ministry of Health has made considerable progress as part of the National Strategic Plan for Tuberculosis Control which aims to provide Universal Access to Prevention, Diagnosis, and Treatment by 2020 in line with its commitments to the World Health Organization (WHO) (Oguntade, 2018). Several previous findings have discussed the benefits of transport logistics outsourcing to 3PLs due to their efficiency and capabilities (Adegboyega *et al.*, 2017; Aliyu *et al.*, 2017; Joloba *et al*., 2016; Kebede *et al*., 2016; Shiferaw, Yismaw, & Getachew, 2018; USAID, 2018).

This study revealed a large number of specimen movement in some states with high population and are centers of high commercial activities like Lagos, Akwa Ibom, Benue, Cross Rivers, and Kaduna state while some recorded a very low number; though states such as Kano, Katsina, Plateau, and Sokoto states recorded less than 5% of the total samples transported. The trends observed might be due to the influx of people to economically stable states to access quality health care, security challenges in some state, most especially in the northern parts of Nigeria and may be due to variation in TB prevalence in some states. For example, the prevalence of TB in Akwa Ibom state, which recorded the highest sample referrals in this study was reported over a period of 11 years to be 37.5% in 2005, 2006 (30.9%), 2007 (26.2%), 2008 (23.1%), 2009 (23.0%), 2010 (20.5%), 2011 (16.6%), 2012 (20.5%), 2013 (22.9%), 2014 (21.8%) and 2015 (44.6%) respectively while 13% was reported from Kaduna and 37% for Enugu state (Kooffreh *et al.*, 2016). However, the prevalence of TB in some states cannot be ascertained due to the limited information. Also in the first TB prevalence conducted in Nigeria by the Ministry of Health in 2012, it was discovered among those that sought any form of care, the majority consulted the general hospital (37%) and chemist (28%), while only 14% sought care from the PHC system which is supposedly the entry point into the health care system in Nigeria (MOH, 2013). This justifies the

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assumption that a high number of samples recorded in some states might be due to the need for quality healthcare in urban settings.

This study recorded a very low sample rejection of 0.25%. This is an indication of effective handling of samples by the 3PL service providers. Currently, no information on sputum sample rejection rates in Nigeria due to the previous non-standard, parallel sample transportation and collection systems. However, similar studies outside Nigeria have reported sample rejection rates in some similarly integrated system. For examples, sputum sample rejection rate was reported to be 3.3% in India in 2013 (Mehrotra, 2013) while 4.4% was reported in Ethiopia in 2018 (Shiferaw *et al*., 2018). These rejection rates are far more than the <1% seen in Nigeria.

Conclusion

This study is a baseline study that critically evaluates the outsourcing of TB sample transportation logistics in TB diagnosis, prevention, and control in Nigeria. The study reported very good performance of the 3PL services. However, the low sample transportation in some states requires further investigation and attention. Also, the sample rejection rate of 10.4% discovered in Katsina state also requires attention.

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