COVID-19 TESTING PERFORMANCE AND STRATEGIES FOR RAPID SCALE UP OF LABORATORY CAPACITY IN A PUBLIC HEALTH EMERGENCY IN A RESOURCE-CONSTRAINED SETTING: THE SARS-COV-2 NIGERIA RESPONSE EXPERIENCE

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Submission Date: 4th Nov., 2023
Date of Acceptance: 15th Dec., 2024
Publication Date: 31st Mar., 2025

ABSTRACT

Introduction: **Sufficient laboratory capacity is vital to containing infectious diseases outbreaks. This study was conducted to document the strategies adopted to scale up laboratory testing capacity during Nigeria's response to COVID-19 pandemic.**

Methods: **This cross-sectional descriptive study adopted a mixed method approach including desk reviews and key informant interviews (KIIs). The KIIs were conducted among actors of the COVID-19 response teams in states and federal ministries of health in Nigeria.**

Results: **At the beginning of the pandemic in Nigeria, testing performance was poor, but this improved over time. To manage the demand for testing, Nigeria adopted targeted testing with a focus on symptomatic contacts,alerts, and returning travelers from high-risk countries who were symptomatic during the quarantine period.. Strategies to enhance laboratory capacity and improve the turnaround time for results included leveraging on existing tuberculosis laboratory networks or building new laboratories where none existed; decentralization of sample collection and testing; staff health workers repurposing and hiring of volunteers; training and retraining of laboratory personnel; adoption of rapid diagnostic testing; and strengthening public-private partnerships. From an initial three laboratories with capacity to test for SARS-CoV-2 in February, 2020, the number of laboratories increased to 158 by March, 2022. Although laboratory capacity increased, logistics and supply chain disruption were still a challenge.**

Conclusion: **Investment in local manufacturing capacities of laboratory consumables such as RDTs and reagents would promote self-reliance and sustainability for a country as populous as Nigeria.**

Keywords: Laboratory capacity, The global health security agenda, Resource–constrained settings, Public health emergencies, COVID-19 pandemic

INTRODUCTION

The Global Health Security Agenda (GHSA) is an international cooperation that aims to address the global health security threats from infectious diseases.[1] More than ever before, the world has to contend with outbreaks of infectious disease agents which can be transmitted across continents within 24 hours due to the intensity of global travels for tourism, commerce and trade across countries. To combat and contain epidemic-prone infectious disease agents' spread, timely diagnosis is key.

Public health surveillance systems are effective if they can swiftly detect and notify cases, collect and consolidate data, conduct epidemiological, lead to clinical and laboratory confirmation of cases and have mechanisms for exchange of the information to inform public health action.[2] Diagnostic capacity is an important infrastructure of an efficient disease surveillance system and is pertinent to mitigating the spread of disease in line with the International Health Regulations.[2] The World Health Organization (WHO) recommends that countries make provision for enhancement of national laboratory capacity to support surveillance and improve accurate and rapid diagnosis through increase in laboratory medical equipment and training of medical laboratory professionals. In 2019, Nigeria became a GHSA partner country with commitment to improving the GHSA 2024 targets

and International Health Regulations (IHR) requirements.[3] The US Centers for Disease Control and Prevention (CDC) in collaboration with the Nigerian government and other international partners work towards the accomplishment of these targets by strengthening workforce development, surveillance, emergency response, and laboratory capacity.[3]

The 2019 WHO/Nigeria joint external evaluation of the IHR core capacities noted that out of the 50 indicators across 19 technical areas, Nigeria did not demonstrate sustainable capacity for any of the indicators, demonstrated capacity in 8% of indicators, developed capacity in 28%, limited capacity in 34% and demonstrated no capacity in 30% of the indicators. In the global health security index assessment, which reported a global average of 40.2/100, Nigeria scored 37.8 and was ranked 96th out of 195.[3] Specifically, the laboratory system capacity scored 50 which was below the average of 54.4.

Due to the limited core capacities, countries often rely on support from other countries within the continent and globally during disease outbreaks such as previous Ebola outbreaks. While the Ebola pandemic was limited to few countries in Africa such as Liberia and Sierra Leone, the COVID-19 pandemic presented a new challenge which affected all countries and thus affected the global cooperation.[4] COVID-19 is unequivocally, the largest pandemic in the last century [(5)] with over 700 million documented cases and over six million deaths, as at June 2023.[6] In the fight to contain the pandemic, nearly all countries required external support, yet this support was not easily forthcoming. The COVID-19 pandemic exposed the huge healthcare infrastructure deficit especially in the resource-constrained settings like some sub-Sahara African countries.[7] Compared with other parts of the world, the COVID-19 pandemic has not been as severe in the WHO Africa Region. Although, Africa is home to about 14 percent of the world's population, the region has accounted for only 1.2% and 2.5% of the reported cases and deaths, as at June, 2023.[6] This might have underplayed the potential impact of capacity gap in Africa during the COVID-19 pandemic.

With the population of about 215 million, Nigeria is Africa's most populous country.[8] The country's age structure is characterized as young population. Despite the country's strategic position in sub-Saharan Africa, health care delivery is grossly inadequate.[9] The public health facilities which provide care for the majority of the Nigerian population has limited infrastructural framework, personnel, medical equipment, and essential drugs.[9] The healthcare system in Nigeria has benefited from several reforms but it is yet to address some of these challenges.[9] The COVID-19 burden in Nigeria is noteworthy for being extremely underestimated due to its high population density. The low number of cases of COVID-19 recorded in Nigeria could be attributed to low testing.[10] but the swift government responses to the outbreak benefited from the country's experience in recent outbreaks such as the Lassa Fever and the Ebola outbreaks.

The first case of COVID-19 was reported in Nigeria on the 27th February, 2020, nearly three months after the first documented case in Wuhan, China. Like in many other resource-constrained settings, the capacity to test for the infection did not match up with the demands. Timely laboratory results reporting is essential to quick public health actions on strategies for containment of epidemics. The timeliness is often expressed in turnaround time and serves as a quality improvement indicator for laboratory effectiveness and efficiency. Challenges with poor capacity for sample collection and laboratory analysis, poor network for sample transportation and over-centralization of laboratory capacity, resulted in poor turnaround time (TAT) for SARS-CoV-2 test results. The TAT was as high as two weeks in some instances at the beginning of the response to the pandemic in Nigeria.[11]

Access to laboratory diagnosis for COVID-19 is important for early case identification and management, as well as breaking the transmission chain and suppressing the spread of the virus. Poor laboratory capacity or delays in obtaining test results hinders adequate public health response. About 85% of SARS-CoV-2 infections could have gone undetected in Africa.[12] An optimal response to the COVID-19 pandemic requires mitigating the challenges contributing to poor laboratory testing TAT to allow response workers make timely decisions.[13] This study was therefore, conducted to assess SARS-CoV-2 testing performance, the strategies adopted to scale up laboratory testing capacity, and to highlight challenges and lessons learnt in Nigeria's response to COVID-19 pandemic regarding testing strategies. This will provide guidance in preparedness for future responses to infectious diseases outbreaks and other public health emergencies of international concerns.

METHODS

This was a descriptive cross-sectional mixed methods study which included desk reviews and key informant interviews. The elements of the testing chain in Nigeria, that were assessed, included test types and their trajectory, testing and sample collection strategies, eligibility criteria for testing, and the laboratory network in the country.

The interviews were conducted among personnel who were active members of the COVID-19 response teams in States Ministry of Health (SMoH) and the Federal Ministries of Health (FMoH). These key actors included representatives from the various pillars of the national Emergency Operations Centre (EOC) including surveillance, laboratory and coordination pillars. and members of other pillars of the National Task Force such as the case management pillar. A total of 30 key informants from Oyo, Federal Capital Territory, Lagos, Plateau, Bayelsa, Rivers and Ebonyi states, participated in the study. Two data extraction tools were designed and piloted for the desk review. The first instrument was used to collect information on laboratory testing strategies, modalities, and capacity while the second was used to extract information on governance with respect to laboratory testing. The instruments were populated with relevant online resources and documents of the FMoH, SMoH and the Nigeria Centre for Disease Control (NCDC http://covid19.ncdc.gov.ng/).

A key informant guide was developed and used for the interview. It contained broad guides to discussions on laboratory-based surveillance, testing modalities and modifications, testing capacity and trend in TAT, laboratory quality control, challenges related to testing and recommendations on testing. The online resources were screened to ensure their suitability for addressing the aims and objectives of this study. The screened materials were subsequently downloaded and printed out for content appraisal.

For the document review, data were analyzed narratively. For comparison of testing performance between Nigeria and selected African countries, the COVID-19 data explorer in the live tool *Our World in Data* was used (https://ourworldindata.org/explorers/coronavirus-data-explorer). For the qualitative component, data analyses were performed using thematic approach and ATLAS.ti (version 8.4.3) software.

RESULTS

Performance of COVID-19 testing in Nigeria

Figure 1 shows poor relative testing per thousand population in Nigeria in comparison with selected African countries with similar demographics for the period March 2020 to June 2021. Senegal in West Africa and Uganda in East Africa reported higher testing per thousand population compared to Nigeria. However, tests conducted per confirmed COVID-19 case in Nigeria gradually increased from being the lowest in March, 2020 among four African countries to becoming the highest in June, 2021 (Figure 2).

Nigeria COVID-19 Response Strategy: high-risk testing

Due to limited testing capacity and availability of testing supplies, the country adopted a high-risk or targeted testing strategy.[14] This included testing of persons who experienced symptoms of COVID-19, testing symptomatic contacts of confirmed patients, returning travellers or persons of interest (travellers to high COVID-19 burden countries and their contacts), alerts from the community and health workers; all with pre-determined eligibility criteria. Other testing eligibility criteria included: testing as discharge criteria from quarantine/isolation.[14] Tests were conducted immediately the eligibility criteria were met. At the initial stage, all confirmed cases were managed at the isolation centres. Tests were repeated every 2/3 days until two negative results were obtained 48 hours apart. When evidence showed that viral RNA detected beyond 10 days was no longer infectious in September 2020, tests were repeated less frequently until one negative result was obtained. In the current guidelines, tests are not repeated and a confirmed case is discharged using the clinical discharge criteria.[15]

New arrivals from watchlist countries were to observe self-isolation and report for testing only when they were symptomatic. A negative test was also required to be discharged from quarantine or isolation.[16] Those eligible for free COVID-19 tests included symptomatic alerts and high-risk contacts, while all travellers were required to pay US$ 120 for a test. It was mandated that all incoming travellers carry out a polymerase chain reaction (PCR) test at an accredited laboratory within seven days of their arrival into Nigeria. The view of a respondent in the KII with respect to the initial criteria for testing at the onset of COVID-19 response in Nigeria is indicated below:

"For the people that meet the case definition…. high risk contact…… people travelling out and people coming in, especially people coming …. from other countries are being mandated to go unto the travel portal, get themselves registered select their testing labs and they get tested after they have isolated for some days when they come into the country. That is basically the testing modalities" (KII-15, Case Investigator and Surveillance Pillar Member, National EOC, FCT).

In collaboration with designated laboratories, the COVID-19 federal and state task forces provided testing for anyone who met the eligibility criteria, and individuals who tested positive were referred for institutional isolation at a hotel (returnee) or health facility during the early part of the pandemic February – May, 2020. Isolation started at four influenza sentinel sites (in Lagos, Abuja, Kano, and Anambra), expanding to government-owned facilities, and eventually to home-based isolation as cases increased.

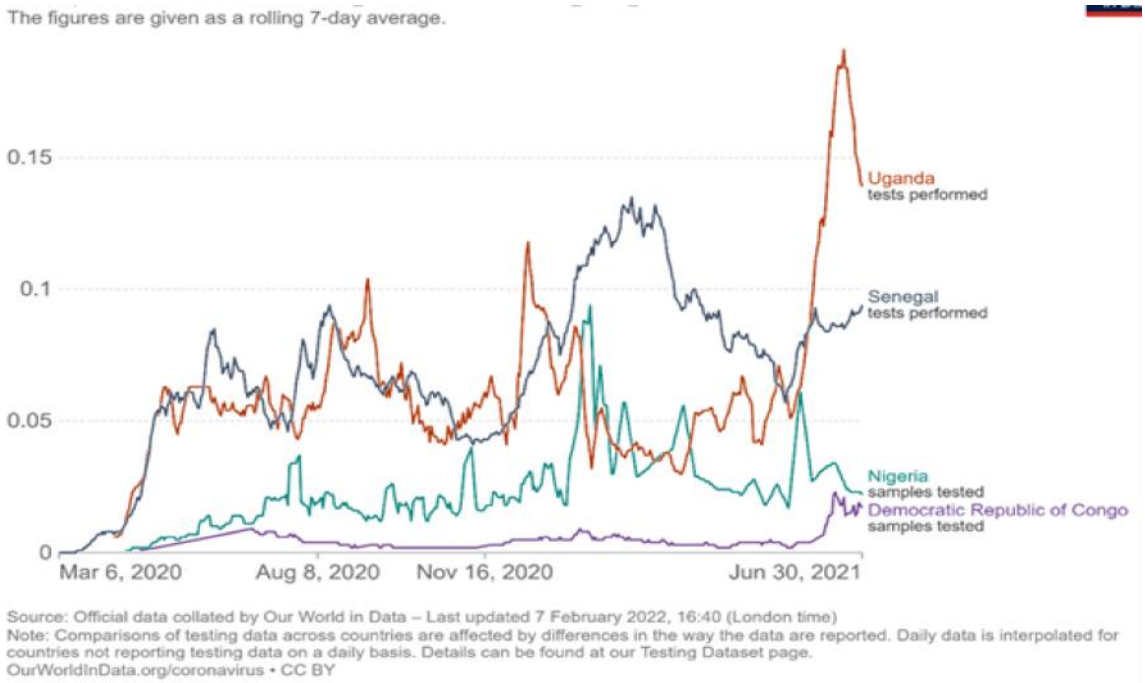

Figure 1: Trend in daily COVID-19 tests per thousand people in Nigeria and some selected African countries

As the pandemic response progressed by June 2020, confirmed cases were isolated at home or in a facility, and with more evidence, discharge from isolation centres were no longer based on negative PCR tests. Instead, officials used set discharge criteria:[17]

- Symptomatic cases can be discharged ten days after symptom onset, plus three days without symptoms
- Asymptomatic cases can be discharged 14 days after initial positive test, assuming they remain asymptomatic

A respondent in the KII corroborated the gradual changes in testing strategies that evolved from repeat testing to no repeat testing.

"For the testing modalities, initially we had PCR done and a repeat test before discharged from the isolation centers. Initially, it was a consecutive repeat test, and later it became one repeat test, later as investigations and researches improved, we got a better understanding of this and we recognized that there was no need to have a repeat test done looking at the infectious period" (KII-1, Surveillance Coordinator, National EOC, FCT)

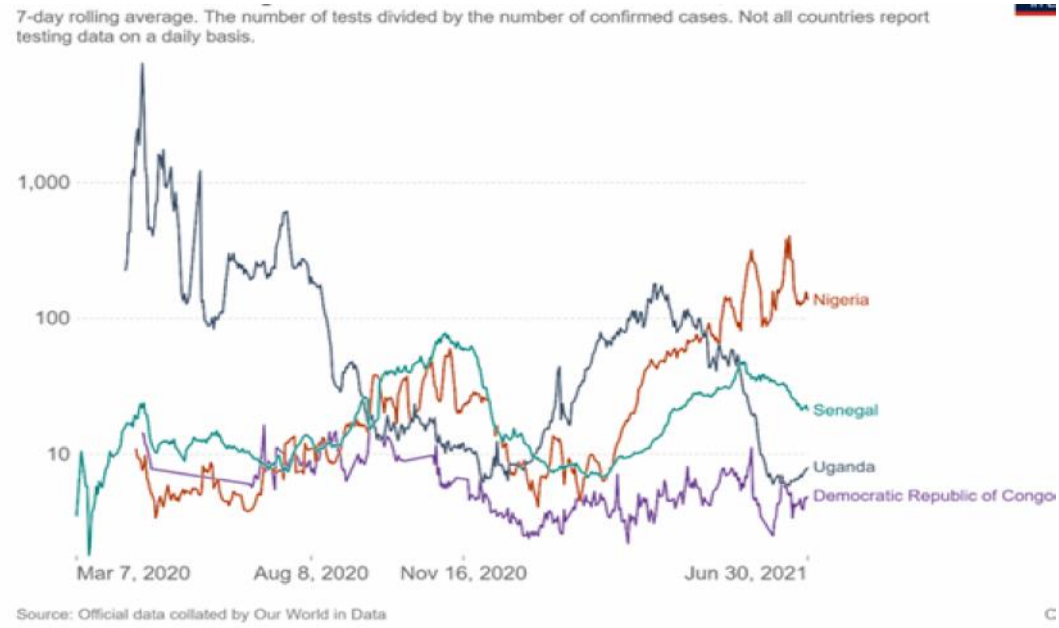

Figure 2: Trend in tests conducted per confirmed case of COVID-19 in Nigeria and selected African countries

Strategies for laboratory capacity growth

When the first case of COVID-19 was reported in Nigeria, only the polymerase chain reaction (PCR) test was available in the country. It was slow to obtain results, sometimes taking as long as two weeks.[18] About a month after, the GeneXpert was introduced by leveraging on the Tuberculosis laboratories network in the country.[19] These two testing modalities were used concurrently and later, point-of-care rapid testing was introduced for use in closed populations, for screening which would later be confirmed by the PCR test if positive.[20] A respondent in the key informant interview (KII) summarised the initial challenges of testing and TAT in Nigeria:

"Initially in the beginning we were testing with PCR so the PCR machines sometimes take a little bit of time to respond you know before you get your result back. But over time, I'll will say that we've improved. I think now currently we have ELISA which is also supporting the testing and now we have actually piloted a few RDTs [rapid diagnostic test of COVID-19]" (KII-2 Case Management Pillar Member, National EOC, FCT)

The Nigerian government was able to scale up the laboratory capacity rapidly (Figure 3). The trend line showing the growth rate of laboratory capacity in the country is described with the simple regression line y = 0.228t – 9995.2, indicating that a unit increase in days resulted in an increase in the number of new laboratories created by 0.228 unit. R^2 is 97%, implying that 97% variation in the number of COVID-19 laboratories was explained by time (t) (Figure 3). From an initial three laboratories in three states in February 2020, the number of laboratories increased to 13 in 10 different states by mid-April, then 28 laboratories in 18 different states by end of May and as at November, 2020 there were 69 public laboratories across the country.[21,22] By January 2021, there were 103 laboratories nationwide including both public and private laboratories. These increased to 150 laboratories by September, 2021 comprising 84 public laboratories, 58 fee paying laboratories and 8 corporate laboratories.[23] The private fee-paying laboratories added more tangible numbers in the following six months.

As at 20th March 2022, there were a total of 158: 85 public, 64 private and 9 corporate laboratories with capacity to test for SARS-CoV-2.[24] The laboratories were fairly well distributed across the country, but two geographical regions (southwest and north-central) appeared to have almost half of the public laboratories as at November, 2020 probably because these regions were the epi-centres for COVID-19 infection in Nigeria.[24] The increase in testing sites also involved the private laboratory practitioners. Other strategies adopted to increase testing capacity included, conducting risk and needs assessment of molecular labs to identify gaps: providing technical and other support needed to achieve optimization and activation for testing: leveraging the existing Lassa Fever diagnostic laboratory testing platform: creating, supporting and strengthening of new and already existing tuberculosis laboratories with cartridges, equipment as well as providing technical capacity: the creation of molecular labs to further enhance testing.

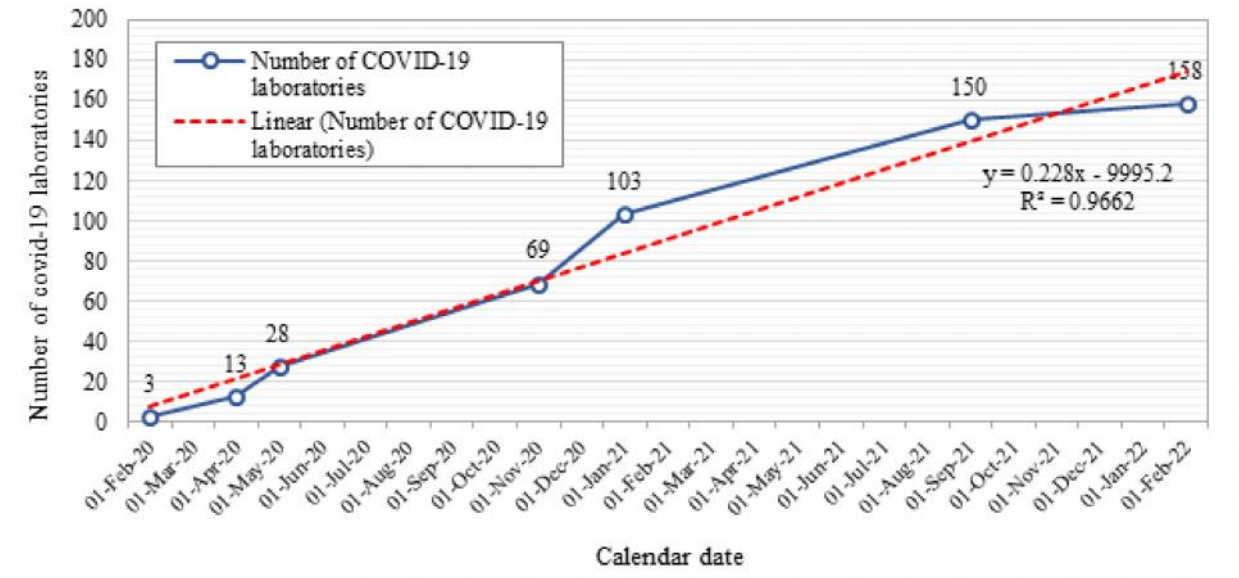

Figure 3: Trend in COVID-19 testing laboratory growth during two years of the pandemic in Nigeria

Strategies to manage demand and supply of laboratory testing
Although the testing capacity increased rapidly, the actual tests being conducted did not increase proportionately. Up until mid-April, 2020 fewer than 300 tests were conducted per day even though the capacity was up to 2500 tests per day. By the end of May, 2020 less than 1500 tests were being conducted per day even though the capacity had increased to 5000.[21,22,25] The gap was attributed to inadequate testing reagents due to delayed orders, airport closures, limited numbers of sample collection teams and sample collection centres as well as hesitancy among some eligible population to test.[21, 22] The gap in testing slowed down the contact tracing process considerably and several contacts were eventually lost to follow-up.

Increased demand for testing was caused in some cases by outbound travelers and fear of the infection by community members. This was managed by directing travelers to use private laboratories for testing, use of case definition for testing, strict adherence to eligibility criteria for testing, and risk communication through media engagement. The country also encountered other barriers to testing including: low-risk perception among the populace, lack of trust in government and her policies, and COVID-19 fatigue. The NCDC continued to engage the community members through heightened risk communication activities with media engagement, and the use of sub-national social mobilisers such as health educators, community informants, influencers, respected persons and organizations in the community.

Strategies to decentralize sample collection and testing
To improve sample collection, the FMoH encouraged the decentralization of sample collection through the establishment of multiple sample collection centers. The Minister of Health mandated all teaching hospitals in the country to collect COVID-19 samples from eligible population as the need arose. Sample rejection in the laboratory was an initial challenge. The sample rejection rate in the laboratory was reduced significantly with the training and retraining of more staff in sample collection. There were also dedicated vehicles to convey samples from the sample collection sites to ensure that they get to the laboratories on the same day. The TAT improved to a maximum of 24 hours. Coupled with increased sample collection sites, the NCDC worked hard in ensuring that each state had a standard laboratory which could serve as a sample

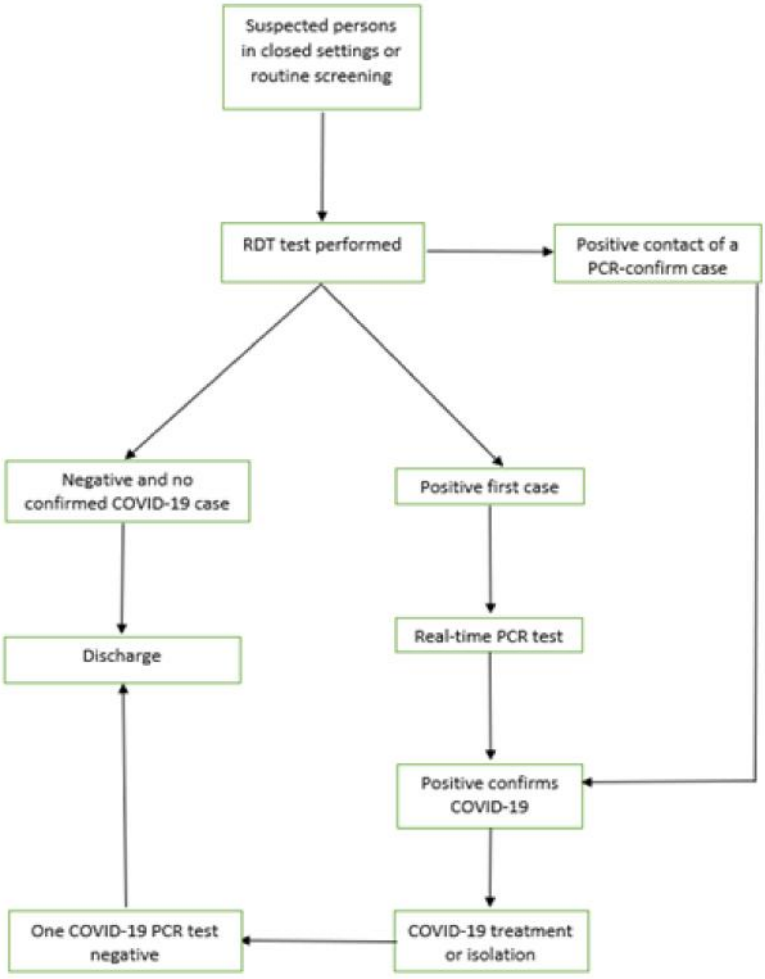

Figure 4: COVID-19 Rapid diagnostic testing algorithm in closed settings in Nigeria

processing point thereby, reducing the sample transportation time and logistic challenges. The process and challenges were described by KII respondents:
"…So, with time the turnaround time improved considerably after establishment of sample collections sites and after establishment of labs in the state which led to the improvement of the turnaround time compared to when samples had to be transported to the nearby state or another state" (KII-1, Surveillance Coordinator, National EOC, FCT).

TAT is still a challenge. Test that should be within 2/3 days but are delayed till 2 weeks and by the time you have test results coming after 2 weeks, the person is no longer infectious even if the person was positive (KII-4, Surveillance Pillar Member, State EOC, SS)

Strategies to ramp up human capacity in response to increasing laboratory capacity
As the laboratory capacity to test for SARS-CoV-2 increased, more staff were trained in sample collection, data collection and management, and laboratory testing. Healthcare workers were repurposed for some of these processes and volunteers were also recruited for better efficiency. Some respondents highlighted these strategies:
"We have two ways for testing- the walk-in and drive-in. For the walk-in, everything remains the same. For the drive-in when we started, it takes maximum of seven minutes for the preparation and sample collection. Efficiency and effectiveness improved over the time. As we increased in capacity, human resources employed more people into sample collection and data collection. This increased human capacity, increased number of clients to be attended to, reduces waiting time and output" (KII-6, Laboratory Team Lead, State EOC, SW).

"Occasionally, there could be overwhelming collections so that there are backlog that the (TAT) that is the turnaround time was getting longer than 48 hours. But usually, they employ volunteers and some other group of people and they were able to turn it round" (KII-11, Head of Coordination, State EOC, SW)

SARS-CoV-2 rapid diagnostic test kits
The WHO approved two antigen RDTs under the Emergency Use Authorization (EUA) in September 2020. Accordingly, the NCDC approved these RDTs for use in Nigeria after they were validated and found to meet minimum standards.[20] The RDTs were recommended for use in congregate settings such as schools, in hospital for triaging and among health workers (Figure 4). Although, RDTs had some limitations, it was quite cheaper, had a faster turnaround time and required less technical expertise.

By the end of September, 2021 RDT use accounted for about 15% of the 3 million cumulative tests conducted.[26] This implied a considerable increase in the use of RDT for testing compared to earlier periods. An RDT local manufacturing agenda (SARS-COV-2 Isothermal Molecular Assay) was piloted by the Nigerian Institute for Medical Research (NIMR) but this was set aside due to additional infrastructural needs and because all RDTs manufactured locally failed validation testing.[27,28] Thus, Nigeria relied entirely on imports for her RDT procurements.

Laboratory Quality Assurance
Test quality was assured by the internal quality assurance (QA) officer whose duty was to ensure that the quality of samples collected were maintained.[29] Each laboratory was also attached to a QA reference laboratory with annual inter-laboratory QA program in place. QA also involved the use of negative extraction controls, positive templates control, no template control and negative template control. Members of staff were also trained and retrained on good laboratory techniques and participated in the inter-laboratory network QA program.[29] As confirmed by key informants, the quality assurance is being coordinated by the national reference laboratory.
"The quality control of testing lab is done by national reference laboratory. This is actually at the hub of NCDC which is in charge of establishing testing and ensuring quality of each of these laboratories" (KII-2, Case Management Pillar Member, National EOC, FCT)

"The Quality control of labs testing was done by NCDC before the accreditation of the Laboratories" (KII-3, Head of Coordination Pillar, State EOC)

Private sector involvement strategies
The country's response benefited from strong public-private support and collaboration. The NCDC and partners from private organizations, civil society and academic institutions supported response ranging from donation of personal protective equipment to training personnel in emergency operation centres. Additionally, the Jack Ma foundation donated testing kits to Nigeria. A private laboratory in Nigeria was named as one of the regional repository and bioinformatics centres by the WHO and Africa CDC to provide sequencing, data analysis and other technical support services to Nigeria and to neighbouring countries and countries in the sub-regions.[30]

The private laboratories were completely responsible for testing travelers at a fee of about $120.[31] This strategy diverted a huge part of the testing demand from the public laboratories and enabled the laboratories to focus on the high-risk population which were more important for surveillance purposes. The private laboratories worked closely with the airport

surveillance in conducting mandatory pre-boarding testing and also in certifying returnees SARS-CoV-2 negative after isolation.[32]

Through robust technical, administrative, and financial support, partners such as the WHO, the Coalition Against COVID19 (CACOVID), amongst several others, have contributed towards ensuring health security in the country.

DISCUSSION

An adequate and efficient laboratory system is an important component of any public health surveillance system for optimal response to an infectious disease outbreak.[33] At the beginning of the COVID-19 pandemic, most African countries had non-existent testing capacity. Only two African countries, Senegal (Pasteur Institute), and South Africa had the capacity to conduct a PCR test for SARS-CoV-2.[34] Over the following six months through one year, African countries including Nigeria responded adequately in expanding capacity for testing. Within six to nine months, Nigeria improved her capacity from three to 69 laboratories which were fairly distributed across the country's vast geopolitical landscape. The decentralisation strategy impacted positively on the TAT which reduced to a maximum of 24 hours from an initial TAT running into several days. Whereas these improvements were realised over time, it is important for countries to make investments in laboratory capacities as part of the preparedness efforts to enable a quick response and limit the diversion of resources from other disease programmes and interruption of other disease services.[35]

At the beginning of the outbreak response in Nigeria, test results were delayed for as long as two weeks. The existing laboratories were few and skewed in distribution, raising equity issues. By the time these delayed test results were out, conducting contact tracing was only academic and establishing linkages in case definition was lost in many cases.

Interestingly, as at the time the testing capacity improved, testing demands did not match up with the available capacity.[11] At first, there were challenges with reagents and supplies which were mostly imported.[11] Restrictions placed on both international and local flights and human mobility distorted the supply of health items needed to fight the outbreak.[11] Free testing was still based on high-risk strategy and at no point did Nigeria adopt mass screening except in closed populations.[11] This impacted on the daily test carried out, test conducted per 1000 population and tests conducted per confirmed case. Test positivity, or the proportion of COVID-19 tests that are positive, can be used as a marker to indicate how widespread infection is and whether sufficient testing is being carried out.[(36)] The WHO recommends that a test positivity rate of less than 5% is an indication that a country has the spread of COVID-19 under control.[12] For Nigeria and many African countries, the test positivity rates were well over 10% as at June, 2021.[12] This may be partly explained by the testing strategies adopted. For example, most persons tested in Nigeria were high-index suspected cases who met the inclusion criteria.

The high-risk testing strategy had a potential for missed cases of SARS-CoV-2 infection but Nigeria was able to maximise efficient use of resources targeted at clients who were more likely to be exposed. Thus, the strategy enabled the country to cope with limited testing capacity as at the time the infection was introduced to the country. Although, the testing capacity was ramped up in Nigeria, the actual proportion of the population tested did not appear to match up with other countries within Africa and globally. For example, the proportion of the population tested as at 31 March, 2021 was less than 1% in Nigeria compared to 16.5% in South Africa, 17.8% in UK and 37.8% in UAE.[37] The high-risk based testing strategy adopted in Nigeria coupled with the challenges of contact tracing, may have restricted the quantity of tests carried out compared to these countries.

While some African countries were able to commence local RDT production, Nigeria was unsuccessful in mainstreaming local RDT for local use. The RDT in use locally were therefore, imported. The NCDC produced a guideline for local use of RDT in closed population basically for screening purposes in congregate settings, in hospital for triaging, in prison and among health workers. Lack of local production led to delays in supplies of orders by the government and organisations. Furthermore, supply chain management and frequent expiry were challenges experienced with the use of imported RDT.

RDTs are cheaper and provide a faster TAT compared to the PCR, albeit with lower sensitivity and specificity.[38] RDTs have proven useful in scaling up SARS-CoV-2 laboratory testing capacity in Nigeria especially in closed population. The proportion of tests conducted with RDTs in Nigeria was observed to gradually increase as the pandemic progressed and was up to 15% by the end of September, 2021.[26]

Implications and Key Learnings

The risk-based testing strategy was adopted in Nigeria and was designed to reduce demand. This testing approach may have contributed to underestimating

the true burden of COVID-19 disease as demonstrated by the serological surveys conducted in October, 2020 which reported a SARS-CoV-2 prevalence of more than 20%, reflecting a case load of nearly 200 times what was officially captured.[39] Extending COVID-19 testing to all contacts of a confirmed case would help identify asymptomatic cases, interrupt transmission and give a better sense of the disease burden but comes at a high cost which a low-resource setting like Nigeria may not be able to afford and sustain.

The COVID-19 pandemic brought to the fore the huge infrastructural deficiencies in standard laboratories in the country. The few well-equipped laboratories in the country before the pandemic were located far from the reach of the local health authorities which warranted a decentralization strategy from the federal level to states and local governments, thereby, facilitating improved local capacity and access.

Decentralization of testing and sample collection was enhanced by public-private partnerships through leveraging existing labs and establishing new ones. The private sector provided adequate access to testing for travelers and reduced pressure on public resources. A stronger laboratory network now exists in the country and if appropriately maintained, should provide better capacity to handle future outbreaks.

Adoption of RDTs improved access and TAT but local production met with several challenges. There were no readily accessible local or regionally produced RDTs. Access relied on importation or donations from other regions such as Europe or Asia, which may result in delays and stock outs. This raises global equity concerns in access to testing supplies.

CONCLUSION

The strategies adopted to ramp up COVID-19 testing capacity in Nigeria as a case study of resource constrained setting was based on efficient control of demand and supply. The high-risk criteria-based testing controlled demands. Existing infrastructures from other disease areas were optimised to grow capacity. Decentralisation of laboratories and sample collection sites also enhanced test penetration especially in hard-to-reach areas. Human capacity was ramped up through training, especially in sample collection and RDT testing which required low technical capacity but with far-reaching impact. Investment in local manufacturing capacities of laboratory consumables such as RDTs and reagents would promote self-reliance and sustainability for a country as populous as Nigeria. The lessons learnt would guide future response to infectious diseases threats while some infrastructural and technical growth can be mainstreamed into the routine healthcare system.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from research participants. Ethical clearance and approval were obtained from the Nigerian National Health Research Ethics Committee NHREC/01/01/2007.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Funding

This work was supported in whole or in part, by the Bill & Melinda Gates Foundation [Opportunity ID: INV-019313]. The views, and content of this publication are those of the authors and do not necessarily reflect the views, opinions, or policies of the Bill & Melinda Gates Foundation.

Authors' contribution

OIF and RW were involved in the study conceptualization and drafting of the protocol. All authors were involved in the review of the study protocol, planning, data collection, data analysis, interpretation and drafting of the study report. SB developed the first draft of the manuscript. All authors reviewed and approved the final version of the manuscript.

Acknowledgements

The authors acknowledge the Gates ventures and the Bill & Melinda Gates Foundation teams for technical review of the study report versions: William Wang, Anne Liu, Rebecca Bartlein and William Sambisa for technical review of the study report versions.

Competing interests

Authors have nothing to disclose

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