

# The Impact of COVID-19 on the Distribution and Availability of Routine Immunization Vaccines at Last-Mile Facilities in Sokoto State, Nigeria

Loveth Metiboba<sup>1</sup>, Olufunke Femi-Ojo<sup>1</sup>, Sadiq Haruna Hassan<sup>1</sup>, Shehu Ahmad Tambuwal<sup>2</sup>, Mohammed-Faoso Adeniran<sup>1</sup>, Ahmadu Bello<sup>1</sup>, Glory Nwakaogor<sup>1</sup>

<sup>1</sup>eHealth Africa, Abuja, Nigeria

<sup>2</sup>State Immunization Officer, Sokoto State Primary Health Care Development Agency, Sokoto, Nigeria

Email: [glory.nwakaogor@ehealthafrica.org](mailto:glory.nwakaogor@ehealthafrica.org)

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## Abstract

**Background:** Globally, COVID-19 occurred without a preparedness plan, halting all public health interventions and restricting vaccines and other commodities from reaching health facilities. The dearth of evidence on the impact of the pandemic on routine immunization services necessitates this study. **Objective:** This study explored the impact of COVID-19 on the distribution and availability of RI vaccines at last-mile facilities in Sokoto State, Nigeria. **Methods:** The RI vaccine stock-out data were obtained from the project's stock performance database. An in-depth interview guide was used to elicit information on the impact of COVID-19 on VDD operations from 37 RI stakeholders purposively selected across the state to match the study's scope. We used paired t-tests to determine the significance of the mean difference between the stock-out events months before and post COVID-19. The qualitative data were coded inductively and analyzed thematically. **Results:** The majority (95%) of the respondents are males with an average work experience of 5 years. The main alterations to the VDD operations due to COVID-19 are the change of delivery schedule from biweekly to monthly and an increased delivery time by 29%. The mean difference of stock-out data 8 months before and post-COVID-19 is not statistically significant. The adaptations to the VDD operations include earlier delivery take-off time and acts of resilience and project ownership. **Conclusion:** The introduction of the Vaccine Direct Delivery (VDD) project in 2016 led to improved availability of Routine Immunization (RI) vaccines at last-mile facilities in northern Nigeria. Subsequently, RI vaccine stock-outs had reduced significantly where VDD had been introduced. COVID-19 evidently caused

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some changes to the VDD operations without undermining the impact of the project. This study further strengthens the importance of preparing flexible operational plans for projects to thrive during unprepared outcomes.

### **Keywords**

Routine Immunization, Vaccine Distribution Operations, COVID-19, Pandemic Preparedness

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## **1. Introduction**

Every country understands that immunization programs are a key element of national health and interference in the systemic immunization services can cause a negative effect on the health of the country (Lieu et al., 2017). The importance of Routine Immunization (RI) cannot be overemphasized as it is a key strategy towards attaining Sustainable Development Goal (SDG) 3, good health and well-being. Routine immunization plays a key role in significantly reducing preventable child mortality as vaccinations against childhood infectious diseases have inadvertently helped to reduce the mortality risk of two-thirds of children under five (Olusegun et al., 2012).

A report from the WHO estimated that about 2 - 3 million deaths globally every year have been prevented through immunization (WHO, 2018). The successes recorded in Routine Immunization have, in many ways, been linked to effective vaccine supply chain management. The vaccine supply chain is a key component of the health system, used to reach zero-dose children, enable delivery of services to underserved communities, ensure vaccine availability and potency, and maximize efficiency where possible (UNICEF, 2020a; KPMG, 2020).

In Nigeria, the National Primary Health Care Development Agency (NPHCDA) deploys the “push” distribution system to ensure consistent delivery of vaccines at the last mile. The “push” system is designed so that states deliver vaccines directly to LGAs.

This model has reduced the challenges of vaccine visibility and availability of potent vaccines for immunization (George et al., 2016). Following the adoption of the push system by the federal government, several states were still lagging in the delivery of the vaccine to children, resulting in children growing up with missed vaccinations or being unvaccinated due to the lack of available vaccines in most health facilities across these states, as well as recorded problems of excess vaccine wastage in most facilities across the states. This necessitated the Vaccine Direct Delivery (VDD) project with the aim of outsourcing vaccine distribution to health facilities to third-party logistics (3PL) providers to ensure stock availability of vaccines in every equipped health facility (Aina et al., 2017).

## **2. The Vaccine Direct Delivery Project**

The VDD project aims to provide an effective and efficient distribution of vaccines

and dry commodities from state cold stores to health facilities. The Sokoto State Government contracted eHealth Africa (eHA) to manage the delivery of vaccines and dry goods from the state/zonal cold store to ward-level health facilities; the contract also covers the collection of waste materials from health facilities and their return to the state cold store (reverse logistics). Delivery operations are typically conducted on a bi-weekly or monthly basis to health facilities equipped with ward-level solar-powered refrigerators. The project commenced in 2014 and has been implemented in northern states such as Kano, Bauchi, Zamfara, and is currently being implemented in Sokoto state. The VDD targets the essential ten (10) vaccines: BCG, Measles, Yellow Fever, OPV, IPV, PCV, Tetanus, HBV, Men A, and Pentavalent. Only health facilities that can maintain vaccine refrigeration receive direct intervention from VDD. Other health facilities without refrigeration can indirectly benefit from the VDD, as they receive vaccines from facilities that do.

In partnership with the State government, the project has recorded significant improvements in health commodity transportation in Nigeria by reducing late deliveries, inefficiencies in routine operations, and high stockout rates (Sato et al., 2021). eHealth Africa designed a logistics tool that allows offline data collection via a mobile app and a web dashboard for analysis and planning. The donors of the VDD project in Sokoto State are the Bill and Melinda Gates Foundation (BMGF), Dangote, and the Sokoto state government.

The COVID-19 pandemic has created an opportunity to assess the operations of the VDD project and determine any changes that have occurred due to the pandemic. In view of this, the study objectives were focused on:

1. Identifying the impact of COVID-19 on VDD operations in Sokoto State.
2. Determining the impact of COVID-19 on RI vaccine availability at last-mile facilities in Sokoto state and
3. Understanding the adaptations of VDD operations since the inception of COVID-19 in Sokoto state.

### 3. Methods

This research was conducted in Sokoto State, which is situated in the North-Western part of Nigeria, at longitude 13.0059° N, 5.2476° E, and occupies 25,973 square kilometers. The State shares its borders with the Niger Republic to the North, Zamfara State to the East, Kebbi State to the South-East, and the Republic of Benin to the West. Sokoto State has a population of 6.2 million, with 1,505,988 under-5 (male 50.5%, Female 49.7%). Since 2020, at least two hundred and sixty (260) health facilities have been visited monthly under the VDD project.

This study employed a mix of qualitative and quantitative research methods. The quantitative data were from the project stock performance database, while the qualitative data were gathered through the Key In-depth Interview guide to understand the operations of the VDD project during the COVID-19 pandemic period. This provided the opportunity to determine how COVID-19 has impacted

the distribution of routine immunization vaccines to last-mile facilities through the VDD project in Sokoto state. A purposive sampling was utilized to identify 37 RI stakeholders. The category of stakeholders interviewed consisted of the state government RI decision makers (2), the trained vaccine delivery officers (5), the VDD project management team members (3), and the heads of health facilities (27) across Sokoto State. The inclusion criteria were based on the staff of the facilities where the VDD project took place, and routine immunization activities are carried out. The staff from other facilities (non-VDD project sites) were not included in the study. The interview sessions were facilitated by trained and experienced research assistants and supervised by the Quality Assurance personnel. The interviews were done face-to-face with strict adherence to COVID-19 preventive guidelines provided by the Nigeria Center for Disease Control (NCDC) (NCDC, 2021). The study did not attempt to address any form of seasonal variations in vaccine demand, nor did it consider or control for variations when comparing the two 8-month periods, as seasonality could have confounded the stockout comparison.

The line of inquiries in the key informant interview (KII) guide included demographics, operations of VDD before the pandemic, operations of VDD during the pandemic, impact of COVID-19 on the VDD operations, the experiences of RI vaccine stockout in VDD facilities, and lastly, the adaptations made to VDD operations due to COVID-19. With the respondent's consent, interview sessions were recorded for ease and robustness of transcription. The audio-recorded interviews were transcribed into text, ensuring all the information given by respondents was quoted verbatim. Relevant words, phrases, and sentences were labeled with codes to identify important qualitative data types and patterns. Through the desk review and VDD stock performance database, the data on vaccines and antigens stockout at delivery points were collated from 8 months before COVID-19 (July 2019-February 2020) and 8 months into the pandemic in Nigeria (March 2020-October 2020). With Microsoft Excel, we used a bar chart to show the average time (in hours) it took the delivery officers to complete RI vaccine delivery in a day before and after the advent of COVID-19 in Sokoto state, and SPSS software (version 20.0) package, that is, the paired t-test to analyze the statistical significance between the mean difference of vaccine stockout experiences before and after the pandemic.

Ethical approval was obtained from the Sokoto State Primary Health Care Development Agency Research Ethics Committee with reference number SSPHCDA/N/GC/038.VOL.1 Dated: 10th May 2021.

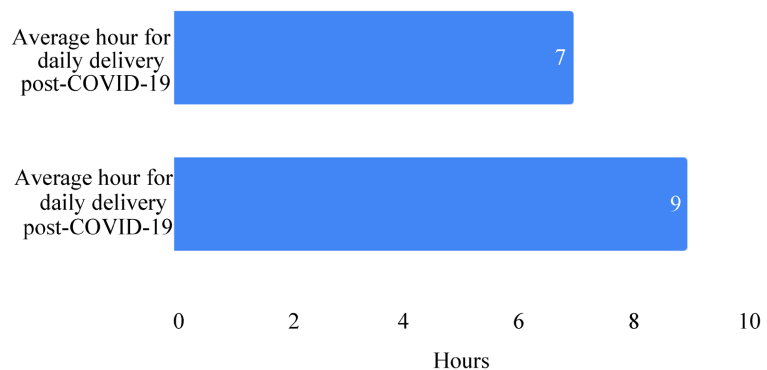
#### 4. Results

In this study, the respondents were disaggregated by male (95%) and female (5%). As of the period of this study, the average years of work experience for all categories of respondents is 5 years. The vaccines and its accompanying items that are mostly distributed through the VDD project includes Bacille Calmette-Guérin

(BCG), Pentavalent, Oral Polio Vaccine (OPV), Inactivated Polio Vaccine (IPV), Meningitis vaccines, tetanus toxoid, Measles Vaccine (MV), Yellow Fever (YF), hepatitis B vaccine, pneumococcal conjugate vaccine, YF diluent, MV Diluent, BCG Diluent, auto disposable 0.05 ml syringe, auto disposable 0.5 ml syringe, reconstitution syringes of 2 ml and 5 ml, safety boxes, droppers, and immunization cards. In this study, it was found that the quantity of RI vaccines to be distributed by the delivery officers was still dependent on the stock schedules from the state government. On average, the RI delivery officers visit 260 facilities for vaccine delivery in Sokoto State each month. In addition, the average number of RI vaccine doses delivered per month from March 2020 to December 2021 was 257,515.

#### 4.1. Impact of COVID-19 on RI Vaccine Distribution to Last-Mile Facilities

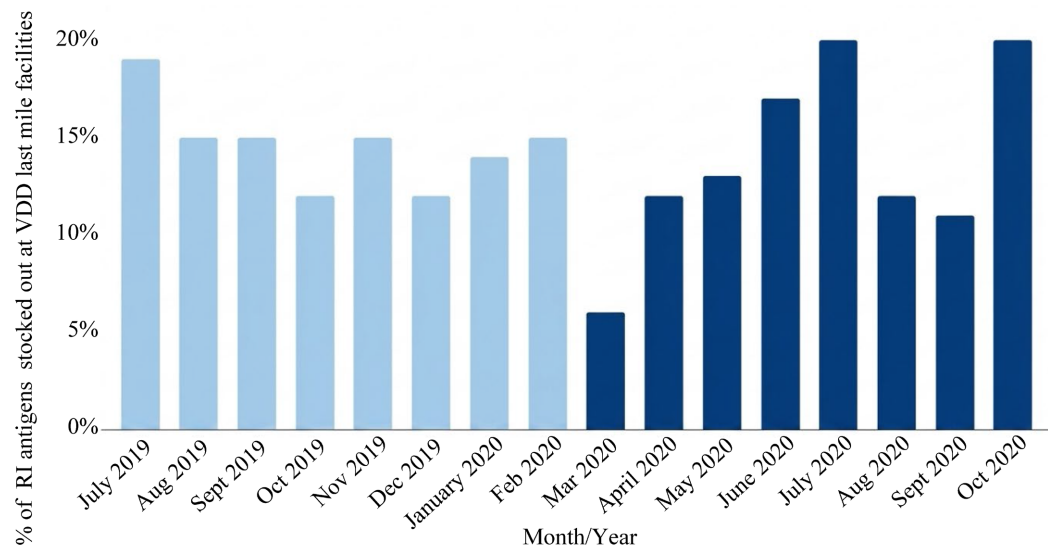
One of the major findings from this study is the changes in the VDD project operations due to COVID-19. This study identified the alterations to the VDD operations of RI vaccine distribution in Sokoto State. The average time to complete a daily delivery schedule has increased by 29%, i.e., the VDD delivery period has increased by 2 hours since the pandemic started (**Figure 1**). The prolonged delivery period due to COVID-19 increased the risk of having the delivery officers exposed to security concerns. In addition, the delivery schedule changed from bi-weekly to monthly. When respondents were asked why the schedules were changed to monthly, it was made clear that this was one of the measures put in place to reduce the risk of having the delivery officers and RI decision makers exposed to vulnerable events that could promote their exposure to COVID-19.



**Figure 1.** Average amount of time (hours) to complete vaccine delivery per day in Sokoto.

#### 4.2. Impact of COVID-19 on RI Vaccine Availability and Uptake at Last-Mile Facilities

The review of the trend vaccine stock performance database, specifically, vaccine stock-out experiences at the point of a new round delivery at the facility in Sokoto State, suggests a consistent pattern in vaccine stock-out experiences. That is, the advent of the COVID-19 pandemic had caused no significant impact on the availability or stock-out of vaccines at the last-mile facilities in Sokoto state (**Figure 2**).



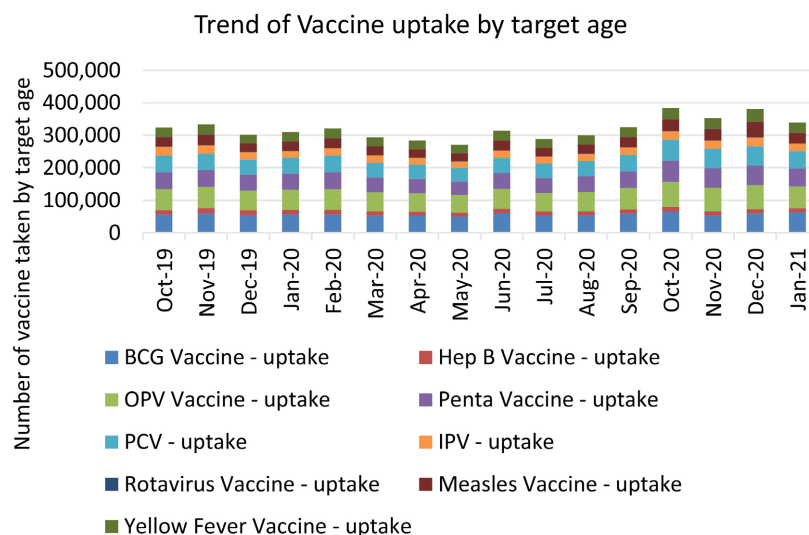
**Figure 2.** Trend analysis of the percentage of antigens out of stock at the point of vaccine delivery (Pre-COVID-19 era, July 2019; COVID-19 era: March 2020-Oct 2021).

**Table 1.** Mean difference of vaccine stockout experiences in VDD facilities, Sokoto state.

Statistical Elements	Pre-COVID-19: COVID-19
Mean Difference	-0.739
Standard Deviation (SD)	6.1121
Standard Error Mean (SE)	2.1609
95% CI Lower Bound	-4.3598
95% CI Upper Bound	5.8598
t-Statistic	0.347
Degrees of Freedom (df)	7
<i>p</i> -Value	0.739
Sig. (2-Tailed)/ <i>p</i> -Value	>0.05

The paired t-test analysis shows that there is no statistical significance between the mean difference of vaccine stockout experiences before and after the pandemic. The stockout data 8 months before COVID-19 is not different from the stockout data 8 months into the COVID-19 period.

To further validate this, the paired t-test result shows no statistical significance in the mean difference of vaccine stockout experiences prior to and after the pandemic. The stockout data 8 months before COVID-19 is not different from the stockout data 8 months into the COVID-19 period (**Table 1**). The vaccine uptake by the target age group indicated that the vaccines taken before and after COVID-19 aligned with the stock data, indicating a spiral downward in May 2020 (**Figure 3**).



**Figure 3.** Trend analysis of vaccine uptake by target age (Pre-COVID-19 era, October 2019; COVID-19 era: Mar 2020-Jan 2021).

### 4.3. Adaptations Made to the VDD Operations during COVID-19

The identified changes in VDD operations due to COVID-19, such as the extended delivery period and reduced number of delivery rounds per month, were managed by the project management team by being flexible with the project operations and plans. The VDD project team reported having reviewed the operations plan to suit the realities of the pandemic. The adaptations to the VDD operations include earlier delivery take-off time and adherence to COVID-19 guidelines. Furthermore, this study revealed the delivery officers' resilient and diligent attributes. When the delivery officers were asked to describe how consistently the vaccine was delivered during the pandemic, it was gathered that the delivery officers had taken ownership of the project, and they understood the implications of vaccine stockouts at last-mile facilities.

### 4.4. Resilience and Project Ownership among Delivery Officers

Interviews with Health Delivery Officers suggest that resilience and project ownership were central to the continuity of VDD operations during the COVID-19 period. While Nigeria. Revised the delivery model itself largely remained intact, officers described absorbing additional operational strain through longer workdays, stricter infection prevention measures, and more cautious interaction with health facilities and communities. One of the delivery Officers captured this clearly when he stated: "I will finish, but unlike before, I used to come back from the field around 2 to 3 pm, but now it's about 5 to 6 pm, and I still do it well." This reflects a willingness to continue meeting delivery targets despite more demanding field conditions. Another respondent also emphasized the officers' confidence in and commitment to the delivery model, explaining that "we can use the same process in delivering the RI vaccines to deliver the Covid-19 vaccines." These examples substantiate the finding that delivery officers showed both resilience in adapting

to pandemic-related pressures and a strong sense of ownership over maintaining uninterrupted vaccine delivery.

## 5. Discussion

The advent of COVID-19 posed a threat to the pre-existing vaccines that had gained acceptance and commendable uptake (Mansour et al., 2021; Shet et al., 2022). As an essential service, routine immunization is expected to continue even during the pandemic period; hence, the need for vaccines to be readily available. This is largely due to the high risk of increased vaccine-preventable diseases during interruptions in vaccination services (WHO, 2020; GFF, 2020). This study examined the impact of COVID-19 on the distribution of routine immunization vaccines to last-mile facilities and the availability of these vaccines at last-mile facilities in Sokoto State, Nigeria. In addition, this study reports project management adaptations to the alterations caused by the pandemic. Findings from this study revealed that COVID-19 had caused major changes to the operations of the project, VDD. The increased duration of time for daily delivery of vaccines at last-mile facilities was significant enough to heighten the risk of the delivery officers being exposed to security issues. In addition, the likelihood of having potent vaccines delivered at last-mile sessions was threatened by the extended delivery hours. This was mitigated by adherence to best practices for vaccine storage and transport (VSHT, 2024). In addition, it was found that the delivery officers monitored the temperature of the vaccines whilst in transit using a temperature monitoring device called LogTag.

Despite the pandemic, which lacked emergency preparedness or a response plan, the occurrences of vaccine stockouts at last-mile facilities maintained the trend that had been pre-COVID. This is consistent with a UNICEF study that found that more than 44% of respondents across all four survey rounds reported no stockout of any vaccine (MoH, & UNICEF Indonesia, 2021). As Sharma et al. (2021) reported concerns and agitations among facilities experiencing vaccine stockouts because of COVID-19, this study also found that RI stakeholders had heightened concerns of experiencing an upsurge of stockouts at last-mile facilities in Sokoto State (Sharma et al., 2021; UNICEF, 2020b). However, there was no significant increase in vaccine stockout events across all facilities exposed to VDD intervention. This was associated with the consistent delivery of the RI vaccines during the pandemic through the VDD interventions. However, the delivery period changed from twice a month to once a month. Having life-saving vaccines available at the last-mile despite the pandemic is a commendable feat that was achieved through the resilience of the project team and the flexibility of the project operation plans. These findings corroborate the report from the Sabin Vaccine Institute, where there were continued RI services in Kaduna State, Nigeria, through some adaptation measures such as deepened commitment and resilience amongst RI stakeholders (WHO, 2021).

Another finding from this study showed that the uptake of immunization services also declined sharply, especially in the month of May 2020. The consistency

of the findings on decreased immunization uptake in Sokoto State validates the global reports of pandemic-related disruption of essential health services (Mansour et al., 2021). A study conducted across 170 countries to assess the impact of COVID-19 on RI services reported a decline in the number of administered doses of some life-saving vaccines, such as diphtheria-pertussis-tetanus-containing vaccine (DTP3) and first dose of measles-containing vaccine (MCV1), in the first half of 2020 (Shet et al., 2022). The Vaccine Industry Consultation has also reported that basic immunization coverage dropped by 3% in 2020, leaving 3.7 million more children under vaccinated than in 2019 (WHO, 2021). The reduction in vaccine coverage during the peak of COVID-19 in Nigeria was reported to be one of the factors that caused the trend of RI vaccine stock-out experiences during the pandemic to be consistent with the trend before COVID-19.

### Limitations

The limitation of this study is the quality of the secondary data reviewed. The effect was reduced by holding a quality check review session with the project team.

## 6. Conclusion

In summary, our results suggest that the advent of COVID-19 altered the delivery operations of RI vaccines to last-mile facilities. Amidst the pandemic, the implications of severing the delivery operations of these life-saving vaccines at the last-mile facilities were prevented through the flexible operational plans and resilient project stakeholders.

Our study findings highlight the need for routine immunization supply chain stakeholders to deploy intervention strategies that are sensitive to emergency preparedness and response plans. This study further shows the value of having all intervention stakeholders discharge their responsibilities with a sense of ownership, as this was found to be a motivating factor to working effectively.

## Authors Contributions

LM: Conceptualization, Funding acquisition, Methodology, Validation, Writing: review & editing. OF: Investigation, Methodology, Project Administration, Software. SHH: Methodology, Project Administration, Software, Writing: Original Draft Preparation. SAT: Data Curation, Writing-Review & Editing, Methodology, Project Administration. MA: Investigation, Methodology, Project Administration, Software. AB: Data Curation, Methodology, Project Administration, Software. GN: Data Curation, Visualization, Writing: Original Draft Preparation, Writing: Review & Editing.

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## Conflicts of Interest

The authors declare no conflict of interest.

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