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Circulating Vaccine-Derived Poliovirus Type 2 (cVDPV2) Outbreak Response With Novel Oral Poliovirus Vaccine Type 2 (nOPV2), Sierra Leone's Experience

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ABSTRACT

Background: In March 2024, a circulating vaccine-derived poliovirus type 2 (cVDPV2) was isolated in environmental samples (ESs) collected at the Mabella Sawmill Bridge environmental surveillance (ES) site. The Ministry of Health and its partners responded to the outbreak by conducting a novel oral poliovirus vaccine type 2 (nOPV2) nationwide vaccination campaign among children aged 0–59 months. This study explores Sierra Leone's experience in terms of gaps identified, successes, and outcomes of the campaigns.

Methods: The study employed a descriptive secondary data analysis of the nOPV2 campaign, administrative, and lot quality assessment survey (LQAS). The LQAS is a cost-effective survey methodology used to classify "lots" (districts) as having met or not met the predefined target threshold for the nOPV2 post-vaccination campaign. Data were collected during the first round of the nOPV2 campaign in Sierra Leone in May 2024. Administrative data were extracted from the national nOPV2 campaign database, whereas the LQAS data were requested from the World Health Organization (WHO) server. Stata version 18 and Power BI were used to analyze the administrative and LQAS data.

Results: A total of 1,590,769 children aged 0–59 months were vaccinated against poliovirus in Sierra Leone. The supplementary immunization activity (SIA) coverage for the nOPV vaccination in Sierra Leone was 106% for the first round of the campaign. Moreover, of the 16 districts selected for the LQAS survey, 12 (75%) districts passed the study, and 4 (25%) districts failed the LQAS.

Conclusion: The first round of the nOPV2 vaccination campaign in Sierra Leone demonstrated significant success in reaching most of the target population, with robust preparatory and implementation strategies contributing to this achievement.

1 | Introduction

Circulating vaccine-derived polioviruses (cVDPVs) can arise from Sabin strain poliovirus serotypes 1, 2, and 3 found in the oral poliovirus vaccine (OPV) after extended person-to-person transmission [1]. When population vaccination immunity against polioviruses is suboptimal, sustained transmission can result in viral genetic changes that trigger a reversion to neurovir-

ulence and clinical disease identical to that caused by wild poliovirus [2]. However, OPV vaccines are considered safe and effective, and vaccine-associated paralytic poliomyelitis (VAPP) is rare, although severe adverse events following immunization do occur [3]. Vaccine-derived polioviruses (VDPVs) are divided into multiple categories: The viruses are first classified as cVDPVs when community circulation is confirmed (i.e., an outbreak) [4]. They are also called immunodeficiency-associated (iVDPVs) if isolated from individuals with primary immunodeficiency [5]. Lastly, ambiguous (aVDPVs) is a classification of exclusion when not associated with immune deficiency or community circulation when detected through acute flaccid paralysis (AFP) or environmental surveillance (ES) [6].

ES in Jigawa State, Nigeria first detected a single circulating vaccine-derived poliovirus type 2 (cVDPV2) emergence (named JIS-1) in January 2018. During the reporting period, the strain was later found in 12 other countries in the World Health Organization (WHO) regions [7]. The first half of 2019 saw the discovery of isolates genetically connected to JIS-1 from ES samples and AFP cases, first in Niger and then in Benin, Cameroon, and Ghana [8].

In 2020, 27 countries worldwide reported 959 human cases of cVDPV2 and 411 cVDPV2-positive environmental samples (ESs); 21 of these countries were in Africa, and the remaining 6 were in the Eastern Mediterranean, European Union, and Western Pacific regions [9]. Compared to 2019, when 366 cVDPV2 cases and 173 cVDPV2-positive ESs were recorded, there were more cVDPV2 cases and ESs in 2020 [10]. Since 2017, numerous genetically different cVDPV serotype 2 outbreaks have been reported in multiple African countries [11, 12]. The current epidemic of cVDPV2 affects about 21 countries: Angola, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Liberia, Mali, Niger, Nigeria, Republic of Congo, Senegal, Sierra Leone, South Sudan, and Togo. Outbreak response activities are being carried out in these countries [10]. In March 2024, Sierra Leone confirmed the presence of a poliovirus variant 3 in the Kambia district and a type 2 variant in sewage near the Mabella Sawmill Bridge in the Western Area Urban district [13].

In response to the latest cVDPV2 outbreak, the Expanded Program on Immunization(EPI) conducted a national novel oral poliovirus vaccine type 2 (nOPV2) campaign planned in the 16 districts to be synchronized with 5 countries in the West African subregion (Cote d'Ivoire, Guinea, Liberia, Burkina Faso, and Mali). The first round was conducted from May 10, 2024 to May 13, 2024.

The documented evidence of the success of immunization activity in Sierra Leone compared to many other immunization efforts is scant. Moreover, research that evaluates the quality of administrative data on polio vaccination against the lot quality assurance sampling (LQAS) performance tool, community acceptance of the nOPV2 campaign, and cross-border vaccination coverage is absent. Thus, such information is important to evaluate the success of the large-scale nOPV2 campaign activity in Sierra Leone.

Therefore, our study generally examined the success of such activity in comparison to the Ministry of Health's many other immunization efforts. Specifically, it assessed the quality of administrative data against the LQAS performance, the community acceptance of the nOPV2 campaign, cross-border vaccination coverage, and the quality of the campaign's supervision.

2 | Materials and Methods

2.1 | Study Setting and Population

Sierra Leone is a country in West Africa with over 8 million people [13]. There are 328,710 surviving infants [14]. The country confirmed the cVDPV2 isolation through ES on January 8, 2024 [15]. An ES was collected in one of the five ES sites in Sawmill Bridge, Mabella, Freetown. The laboratory result was received on March 8, 2024, and it was positive for virus type 2, EPID No, ENV-SIL-WEA-WAU-MSB-MSB-24-001. These isolates were genetically linked to an outbreak in Nigeria. The outbreak was reported to the WHO headquarters (HQ) on March 9, 2024. It was declared a National Public Health Emergency on May 22, 2024. The Ministry of Health conducted the first nationwide supplementary immunization activity (SIA) with nOPV2 in May 2024 to reach eligible children with two doses, targeting 1,584,140 children aged 0–59 months.

2.2 | Study Design

This study employs descriptive secondary data analysis of the nationwide nOPV2 vaccination campaign conducted in response to the 2024 cVDPV2 outbreak in Sierra Leone.

2.3 | Pre-Campaign Activities

2.3.1 | Coordination of the Response

The country declared the cVDPV2 outbreak in March 2024. The Ministry of Health, in collaboration with its partners, set up an emergency operation center (EOC) to guide and coordinate the response. The EOC formed different response pillars, including surveillance, risk communication, case management, contact tracing, and vaccine pillars. The vaccine pillar was assigned to the EPI , which planned and coordinated the nOPV2 campaign in collaboration with its partners. The vaccination pillar formed six technical working groups (TWGs): leadership, coordination and finance, vaccine logistics and supply chain, service delivery training and human resources, monitoring and evaluation (M&E), advocacy communication and social mobilization, and vaccine safety surveillance. All pillars had their separate meeting, planning, and reporting to the incident manager at the EOC daily.

2.3.2 | Readiness Assessment

To assess the national program and district readiness for the campaign, there were five rounds of readiness assessment conducted at both the national and district levels. The country reviewed the WHO readiness assessment tool and adapted it to the country's context.

2.3.3 | Training

Training materials were developed for training healthcare workers on six topics. The included polio epidemiology, nOPV2 vaccine characteristics, management and supply chain, vaccination strategy and administration, roles and responsibilities of supervisors, performance monitoring, risk communication, social mobilization, and vaccine safety surveillance. The training was conducted at different levels, including National Training of Trainers (nTOT), district and chiefdom supervisors training, vaccine recorders, and vaccinators training. One week of integrated training was conducted for implementation, 2 days each for national, district, and chiefdom supervisors, and 1 day for vaccinators.

2.3.4 | Advocacy, Communication, and Social Mobilization

To minimize vaccine hesitancy and missed opportunities, robust community and stakeholder engagement meetings were held across all districts. Different media platforms, including radio, TV spots, and social media, were used to sensitize caregivers and create demand for the campaign. Rapid Refusal Resolution Teams (RRRTs) were set up in all districts to respond promptly to all vaccine refusal cases. Members of the RRRTs were drawn from key influencers within the community.

2.3.5 | Vaccination Teams

A total of 4043 vaccination teams were allocated to all 16 districts based on the approved budget, geography, and special population of the districts (special team) by the EPI program. The training was conducted for all staff and partners deployed for implementing and supervising the nOPV2 round one activity, including vaccinators, vaccine accountability monitors (VAMs), and supervisors. A total of 9102 vaccinators and mobilizers, 356 team supervisors, 230 chiefdom supervisors, 160 district supervisors, 84 national supervisors, and 10 regional supervisors participated. The trainings were conducted at the national, district, and chiefdom levels.

A total of 80 independent monitors and 20 LQAS surveyors were also trained to validate the campaign. The teams were allocated to the district and then to health facilities within their districts. Each vaccination team comprised a vaccinator, a recorder, and a social mobilizer. At least two teams were allocated to every health facility. Each vaccination team had a daily target of 100 vaccinated children for rural and 150 for urban.

2.4 | Intra-Campaign Activities

2.4.1 | Vaccine Management

The nOPV2 vaccine was distributed to all health facilities based on their target population identified in the health facility micro plan. Before the implementation, a cold chain assessment was done to determine the gaps in the requirements of the cold chain equipment (CCE). Health facilities without functional CCEs were supplied with vaccine cold boxes lined with adequately conditioned ice packs during the campaign. On the field, every team was assigned a vaccine carrier lined with coolant packs to keep the vaccine in the correct temperature range (+2°C to +8°C). VAMs were recruited to ensure every vaccine vial was accounted for. This was done to minimize vaccine-related nOPV2 outbreaks in the community.

2.4.2 | Vaccination Strategy and Administration

The campaign was conducted across the 16 districts, delivering vaccines to eligible children and communities using house-to-house, fixed, and transit vaccination strategies. Although most eligible children were vaccinated in the households by the house-to-house teams, special or transit teams were assigned to border crossing points, lorry parks, marketplaces, places of worship, schools, and so forth, to ensure that children who were missed in the households were vaccinated. At the same time, fixed teams were assigned to the health facilities to vaccinate eligible children who would visit the health facilities for other interventions during the campaign period. Supervisors were allocated to monitor the day-to-day vaccination processes—four teams to a supervisor in rural areas and five teams to a supervisor in urban settlements. National, regional, district, chiefdoms, and team supervisors were deployed to monitor the vaccination exercise. Four days of supervision were conducted to monitor the implementation across all districts. Moreover, daily debriefings were conducted in all districts either from 7 a.m. to 9 a.m. or in the evening from 4:30 p.m. to 7 p.m. The meeting provides a platform for supervisors to discuss issues of the day and make action points with the responsible person to act on them before the next day's work. This serves as a corrective measure of the problem faced in the field while supervising the implementation, so that the intended goal is met by all districts. The national debriefing meeting starts at 8 p.m., where regional, national, and district representatives give updates from their district to the EPI program. To discuss the day's activity implementation and make action points or recommendations for the next day, a National Situation Room was formed to support and coordinate the activities at the national level. The heads of units were drawn to constitute the situation room.

2.4.3 | Data Collection and Reporting

During the nOPV2 campaign, administrative data were collected at different levels. The M&E TWG, in collaboration with Global Polio Eradication Initiative (GPEI) partners, designed and pretested the data collection and reporting tools. At the vaccination team level, vaccinators used tally sheets to record the number of children vaccinated for the day.

Administrative data were collected using tally sheets and an electronic-based Open Data Kit (ODK) to record the number of children vaccinated each day. The tally sheets consist of the number of children who received the nOPV2 in each age category, both zero-dose and one or more doses; refusals and revisits were used during the implementation phase. Thus, administrative coverages were available day by day. Aggregated

vaccination data are summarized by the team supervisors in the daily team vaccination summary sheet and submitted to the chiefdom supervisor. The chiefdom supervisors summarized the summaries from all health facilities within the chiefdom in the Daily Chiefdom Summary Form. The chiefdom supervisors submitted the daily summary form to the district M&E officer, who summarized the data by chiefdom in the district Excel-linked file. The Excel-linked file was uploaded to Google Drive so that the national M&E team and partners could access the data as they were entered at the district level. The linked file had a summary sheet and a data analysis sheet used at the national level to inform decision-making.

2.4.4 | Supportive Supervision

Supportive supervision exercises were conducted at all implementation levels during the campaign. At the team and health facility levels, one team supervisor was assigned to five teams. At the chiefdom level, each chiefdom had at least one chiefdom supervisor who supported all health facilities within his or her chiefdom. In addition to the district-level supervisors, there were three national supervisors assigned to each district. A supportive supervision checklist was developed by the WHO, which was uploaded to ODK for data collection. All supervisors used the ODK mobile app to collect data during the campaign.

2.5 | Post-Campaign Activities

2.5.1 | Lot Quality Assurance Survey

Definition: For the clustered LQAS survey, health districts in Sierra Leone were defined as "lots." Moreover, an individual vaccinated against polio is a child between 0 and 59 months who presents an indelible ink mark on the fingernail at the time of nOPV2 vaccination.

As our objective was a clustered LQAS for the nOPV2 vaccination, a 2-day survey was implemented after the mopping up, and the last day of the campaign was confirmed. For the nOPV2 antigen, 60 eligible individuals were interviewed per lot (district) for vaccination status, and each lot was divided into 6 clusters of 10. In each district, six chiefdoms were randomly selected. Communities (villages or neighborhoods) were randomly selected in each chiefdom. In each community, 10 (1 per household) children were surveyed [16].

Next, the first household in the cluster was randomly selected according to geographic random sampling: A map of the locality was drafted and divided into four smaller units according to existing landmarks (streets, rivers, and so forth) and randomly selected one sector that is the most central household to start the survey was randomly selected [17]. Moreover, during the campaign, independent monitors were employed to ascertain the quality of administrative data and ensure children missed during the campaign were vaccinated, especially in areas that vaccinators had covered. The independent monitors were instructed to participate in the daily vaccination campaign debriefing meetings at the district level and discuss daily findings with health officers and supervisors. In the selected household, caregivers were interviewed for the nOPV2 vaccination status of their children, and one eligible child was randomly selected per household. Children were checked for finger markings and household markings. The purpose of these meetings was to interpret all information from the field to guide supervisors and strengthen areas of attention.

2.5.2 | Planning the Clustered LQAS Surveys in the Field

The LQAS surveying team planned the nOPV2 post-vaccination campaign evaluation in collaboration with the EPI, the Ministry of Health, and the WHO. The campaign implementation team was fully aware of the purpose of the LQAS surveys. Independent surveyors were sent across all the selected 16 districts after the nOPV2 vaccination exercise to evaluate the quality of the administration data reported during the campaign.

Definition of key variables: The following operational definitions were used.

ZD: Zero-dose children were defined as those children aged between 0 and 59 months at the time of the survey who had not received any dose of the nOPV2.

The number of children targeted in the nOPV2 vaccination campaign in Sierra Leone was informed by a detailed microplanning at the community level, which involves house-to-house enumeration; this leads to the identification of more eligible children. For Sierra Leone, polio vaccination is estimated at 95% for herd immunity. This means that at least 95% of the target children aged 0–59 months need to be immunized to protect the entire community and prevent the virus from circulating.

Total population of children aged 0–59 months targeted for the nOPV2 vaccine in Sierra Leone = 1,581,359.

Number of children aged 0–59 months who received the nOPV2 vaccine = 1,590,769.

$$\text{nOPV2 vaccination coverage} = \frac{1,590,769}{1,582,359} \times 100$$

nOPV2 vaccination coverage = 101%

The target nOPV2 vaccination coverage to achieve herd immunity = 1,582,359 × 95%

Targeted number of children for the nOPV2 vaccination = 1,503,241

Lot quality assurance survey target for the nOPV2 campaign:

Districts = 12
Chiefdoms = 6
Household per cluster = 10
Number of households per districts = 6 × 10
Number of households per districts = 60
Total target = number of districts × number of households
Total target = 12 × 60
National target = 720 children per households

Each district should have a coverage of 60 children per households.

The LQAS rule states that:

1. <4 missed children: shows high SIA performance.
2. ≥4 missed children: shows suboptimal SIA performance.
   - 4–8 missed children: moderate SIA performance
   - 9–19 missed children: poor SIA performance
   - ≥20 missed children: very poor SIA performance

Caregivers' awareness of the nOPV2 campaign:

Average children reached by each vaccinator per day = 125
Number of days per round = 4 days
Number of vaccination teams = 356
Targeted number of caregivers for the nOPV2 campaign = number of teams × average children reached × number of days
Targeted number of caregivers for the nOPV2 campaign = 356 × 125 × 4
Targeted number of caregivers for the nOPV2 campaign = 178,000

However, each district has its targeted number of caregivers due to variation in population.

Vaccination indicators: <4 children missed during the nOPV2 campaign are characterized as high SIA performance, and no action is required, as districts in this category are considered to have achieved high-quality campaign performance, and ≥4 children missed were categorized as suboptimal SIA performance.

2.6 | Data Analysis

The administrative data were analyzed using STATA version 18 and Power-Bi software, and statistical calculation for the clustered LQAS data were analyzed using Excel. We entered the campaign data and analyzed it with Excel. To take corrective action on the basis of objective information, during the campaign, any individual not presenting proof of vaccination is considered unvaccinated, that is, those without finger markings. Moreover, children in the streets and schools were not sampled during the LQAS activity. The impact of the measures taken following the outcomes of the clustered LQAS on nOPV2 administrative coverage was analyzed. Districts' nOPV2 administrative data with LQAS findings were compared. The community acceptance of the nOPV2 campaign, cross-border vaccination coverage, and the quality of supervision of the campaign were also assessed. Data were represented on graphs and tables.

3 | Results

3.1 | Demographic Data, Community Awareness, and Acceptance of the nOPV2 Vaccination Campaign

The nOPV round 1 vaccination campaign targeted 1,503,241 children across the country. The campaign reached 1,590,769 (106%) of the targeted children in Sierra Leone. The majority, 77.74% (1,236,631), were children aged 12–59 months, and 354,138 (22.26%) were children aged 0–11 months, respectively. The results highlight a considerable awareness of the nOPV2 campaign, with 86% of caregivers aware of the nOPV2 campaign before the implementation. However, there is a gap in information with districts like Western Area Rural and Western Area Urban as shown in Table 1.

TABLE 1 | Age distribution of children vaccinated and caregivers informed about the novel oral poliovirus vaccine type 2 (nOPV2) vaccination by districts.

Variable	Sub-variable	Frequency (n = 1,590,769)	Percent
Age (months)	0–11 months	354,138	22.26
	12–59 months	1,236,631	77.74
		Frequency (n = 178,00)	
National coverage of caregivers informed about the polio campaign	Caregivers informed	153,080	86
	Caregivers not informed	24,9200	14

3.2 | Administrative Data and Cross-Border nOPV2 Vaccination Coverage by Districts

Thirteen of the sixteen districts achieved a vaccination coverage of ≥95% for administration rates, such as Koinadugu 129%, Falaba 117%, Kailahun 109.1%, Bonthe 105%, Port Loko 103.6%, Pujehun 102.3%, Moyamba 101.5%, Bombali 100.6%, Kono 100.3%, Karene 98.5%, Kenema 96.9%, Western Area Rural 95%, and Tonkolili 94.7%. Furthermore, low coverage, <95%, is seen in Western Area Urban 92.9%, Kambia 75.3%, and Bo 75.3%, respectively. A total of 3589 children were vaccinated across border districts in Sierra Leone: 2.30% of children aged 0–59 months were vaccinated in Karene, 1.96% were vaccinated in Kambia, 0.32% in Falaba, 0.21% in Kailahun, 0.19% in Kenema, 0.10% in Pujehun, 0.07% in Kono, and 0.05% in Koinadugu, respectively as illustrated in Figure 1.

3.3 | Evaluation of the nOPV2 Campaign Through the LQAS

A total of 96 clusters across the 16 districts were sampled for the LQAS survey (Figure 2); of the 16 districts, 12 districts were selected (Bo, Bombali, Bonthe, Falaba, Kailahun, Kambia, Karene, Kenema, Kono, Moyamba, Pujehun, and Tonkolili districts); 75% passed the survey with no missed children out of the 60 children sampled in each district, whereas 4 districts (Western Area Urban, Western Area Rural, Port Loko, and Koinadugu districts) accounts for 25% that were rejected for low vaccination coverage by the LQAS rule due to exceeding the threshold of more than four (>4) unvaccinated children that shows a suboptimal performance in those lots. A total of 48 children out of the 720 children for each household nationwide were left unvaccinated across the 16 districts sampled, with the majority, 27 (56%) of the children not vaccinated because vaccination teams did not visit the house, 11 (23%) of the children vaccinated were not finger marked, and 10 (21%) of the children were absent from home, respectively. Out of the 10 children absent for the nOPV2

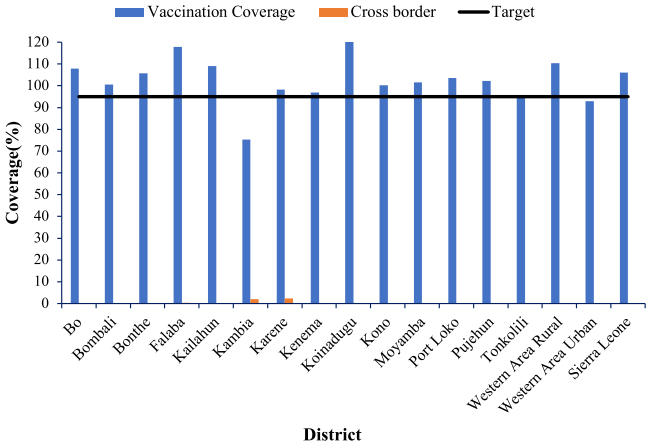

FIGURE 1 | Novel oral poliovirus vaccine type 2 (nOPV2) coverage per district, Sierra Leone, 2024. This graph illustrates the individual districts and cumulative percentage of children aged 0–59 months who received the nOPV2 vaccine across the 16 districts of Sierra Leone. Vaccination coverage for each district was calculated as the total number of children aged 0–59 months verified as vaccinated with nOPV2 during the campaign and divided by the estimated target population within the respective district, multiplied by 100%.

vaccination reported by the lot quality assessment survey (LQAS), 3 (30%) of the children were absent because they were taken to the farm by their caregivers, 2 (20%) were taken to the market, 2 (20%) traveled with their parents, 2 (20%) of the children went to the playground, and 1 (10%) were based on other activities embarked by their caregivers as shown in Table 2.

3.4 | The Number of Children Still Missed After Revisiting and Community Awareness of the nOPV2 Vaccination

A total of 113 children were missed for the nOPV2 vaccination during the first round. Of the 113 children missed, 48 were in Kambia district, 18 in Falaba, 16 in Kailahun, 7 in Koinadugu, 7 in Port Loko, 5 in Moyamba, and 2 in the Western Urban Area. Furthermore, no missed child is seen in districts, such as Bo, Bombali, Karene, Kenema, Kono, Pujehun, Tonkolili, and Western Area Rural. Moreover, in terms of community awareness of the nOPV2 vaccination, results show a considerable awareness of the nOPV2 campaign, with 153,080 (86%) out of the 178,000 targeted caregivers being aware of the nOPV2 campaign before the implementation. However, there is a gap in information with districts, such as Western Area Rural and Western Area Urban. As shown in Figure 3, understanding vaccine awareness gaps and communication pathways among caregivers in Urban Sierra Leone, a mixed-method study design should be employed, which will give a clear picture of why vaccination awareness is a problem.

4 | Discussions

The outcome of the first round of the nOPV2 vaccination campaign in Sierra Leone demonstrates a major success in the quest to vaccinate children against poliovirus. The campaign effectively exceeded the target of 1,503,241 eligible children receiving the polio vaccine. These findings are dissimilar with those in Cameroon that had challenges with low coverage (85%–90%), in part due to logistical and community challenges and similar to the overall coverage achieved with nOPV2 in India [6, 18]. This shows the effectiveness of the vaccination strategies used in reaching eligible children during the campaign. In a bid to achieve higher coverage and leave no child behind, the EPI employed strategies like robust pre-vaccination readiness assessments across all districts with continuous media and community engagements. The house-to-house and mobile or fixed or transit vaccination strategies prove pivotal in reaching more children. Moreover, incorporating cross-border vaccination strategies across all border districts influenced the number of children reached during the campaign.

4.1 | Quality of Administrative Data Against the LQAS Performance

Sierra Leone's EPI achieved 106% nOPV2 vaccination coverage, exceeding the campaign's national target. This increase in coverage was impacted by the migration of caregivers from neighboring countries like Guinea and Liberia for economic purposes. After the first round of the nOPV2 campaign, an LQAS survey was done to assess vaccination coverage in 16 districts, which were purposely selected to ascertain the quality of administrative data reported nationwide. The number of districts with a high vaccination coverage of ≥95% reported for the administrative data for the nOPV2 campaign was 13 out of the 16 districts, which represents 81.25% of the districts that achieved the set vaccination coverage target. These findings are similar to studies done in Nepal, Nigeria, and Indonesia [10, 12, 19]. Furthermore, the LQAS findings revealed that out of the 13 districts with high vaccination coverage, 4 of those districts, Koinadugu, Port Loko, Western Area Urban, and Western Area Rural, exceeded the threshold of more than 4 unvaccinated children and did not pass the LQAS criteria. These findings show some discrepancies with the nOPV2 administrative data with districts identified with high vaccination coverage during the first round of the campaign; this is because most of these districts engage in economic activities that involve the movement of people, which can facilitate the movement of unvaccinated children by their parents and hence can negatively impact the outcome of the LQAS findings in these districts. Western Area Rural indicates a very poor SIA performance and should conduct a comprehensive mopping up in the entire district as part of the strategies employed by the WHO. Moreover, Western Area Urban and Port Loko indicate a poor SIA performance, and hence, those districts should conduct a comprehensive mopping up across those health areas within 1 week after the LQAS has been completed. Moreover, Bo and Tonkolili districts show high SIA performance, which required no action to be taken; these findings are consistent with the administrative data reported for these districts. Moreover, districts like Koinadugu show moderate SIA performance, which needs quality improvement in subsequent campaigns [20]. LQAS findings show that most of the children were unvaccinated because they did not show any evidence of finger marking. This was so because during the campaign, vaccination teams were supplied with faulty markers, which resulted in some children without finger markings. Furthermore, the LQAS results revealed that most of the children were missed

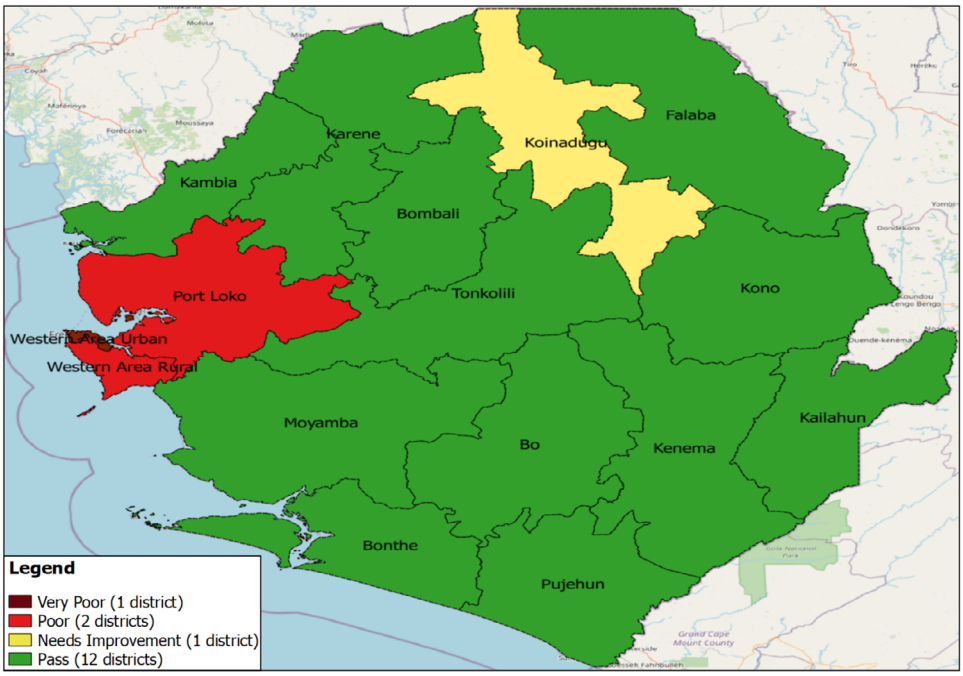

FIGURE 2 | Map of Sierra Leone showing the administrative districts where lot quality assessment survey (LQAS) was conducted, May 2024. The LQAS is a cost-effective survey methodology used to classify "lots" (districts) as having met or not met the predefined target threshold for the nOPV2 post-vaccination campaign. All 16 districts in Sierra Leone were evaluated. Districts shaded green were the districts that passed the LQAS survey whereas other colors represent districts that did not passed the LQAS survey.

TABLE 2 | Number of unvaccinated children by districts and reasons for a child not vaccinated, Sierra Leone 2024.

		Number of unvaccinated children ($n = 48$)				Reason for a child not vaccinated		
Lot	**Clusters**	**House not visited**	**No finger marking**	**Child absent**	***N* (%)**	**Variable**	**Frequency**	**Percent**
Bo	6	1	0	0	1 (2)	Farm	3	30
Bombali	6	0	0	0	—	Market	2	20
Bonthe	6	0	0	0	—	Travel	2	20
Falaba	6	0	0	0	—	Playground	2	20
Kailahun	6	0	0	0	—	Others	1	10
Kambia	6	0	0	0	—			
Karene	6	0	0	0	—			
Kenema	6	0	0	0	—			
Koinadugu	6	2	1	1	4 (8)			
Kono	6	0	0	0	—			
Moyamba	6	0	0	0	—			
Port Loko	6	7	0	3	10 (21)			
Pujehun	6	0	0	0	—			
Tonkolili	6	0	1	0	1 (2)			
Western Area Rural	6	7	2	1	10 (21)			
Western Area Urban	6	10	7	5	22 (46)			

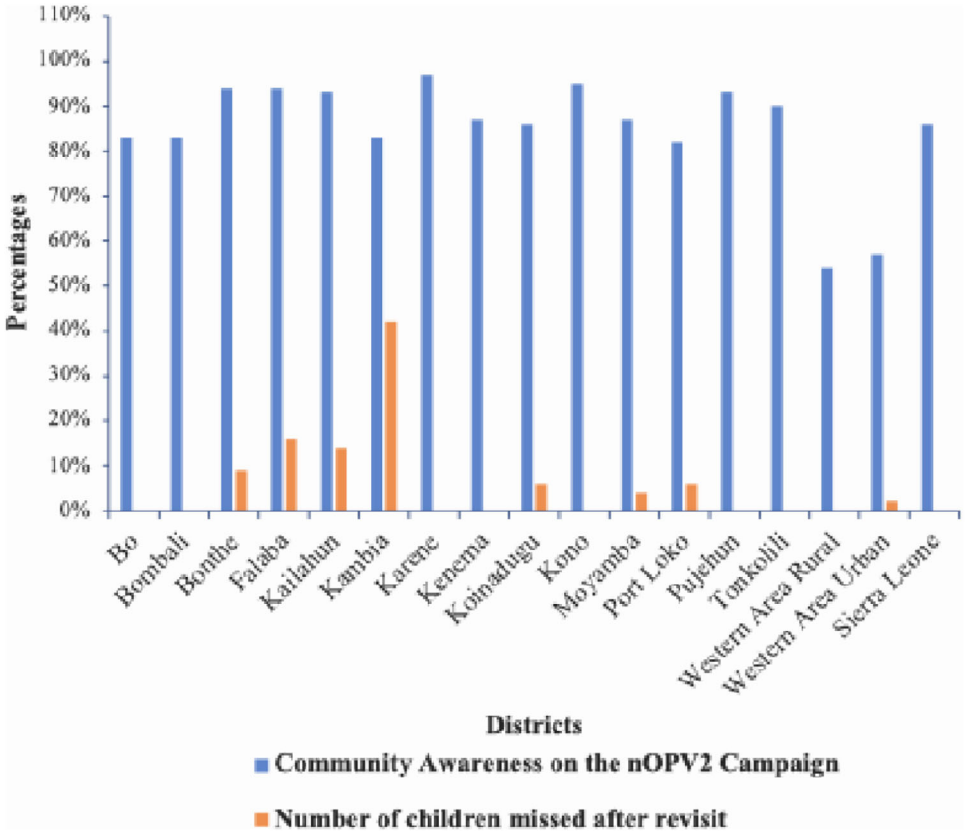

FIGURE 3 | Number of children missed after revisit and community awareness of the novel oral poliovirus vaccine type 2 (nOPV2) vaccination campaign. This figure summarizes findings from the post-nOPV2 vaccination in Sierra Leone, 2024. It shows the number of children aged 0–59 months who were missed for vaccination even after revisits of vaccination teams during the mopping-up days, alongside the percentage of community awareness about the nOPV2 campaign.

because their caregivers carried them along to their farms and market, some traveled with parents to other destinations, causing their absence, and some of the children were on the playground during the house-to-house vaccination session, which caused missing out from the vaccination. Our findings are similar to those of a study done in numerous countries, including Pakistan and Nigeria [13–15]. Out of the 16 districts selected nationwide for the LQAS assessment, the campaign achieved a 75% pass mark, which shows a higher quality in the SIA vaccination result and represents the true nature of the vaccination coverage achieved in each district during the campaign. These findings are similar with Nigeria's experience, where high-performing areas reached ≥75% LQAS pass marks due to strong supervision and community participation [21]. However, districts falling below this threshold often faced logistical or training gaps highlighting the need for targeted improvements in future SIAs.

4.2 | The Community Awareness and Acceptance of the nOPV2 Campaign

Nationally, more than three fourths of caregivers were aware of the nOPV2 vaccination campaign before the implementation. This was achieved following the pre-vaccination strategies adopted by the EPI, which involves conducting periodic readiness assessments at 8, 6, 4, 2, and 1 week. The national nOPV2 vaccination readiness assessment findings revealed that caregivers in Western Area Urban and Rural show a low awareness of the nOPV2 campaign, which is contrary to studies done in Ethiopia and Pakistan [17, 22]. This disparity occurred because in urban areas, a misleading impression of protection could make people less interested in vaccination programs, and emphasis on other health problems could make people forget about the nOPV2 campaign [23]. Healthcare providers may give priority to rural areas if they believe urban areas are already adequately covered, and they may disregard important indicators due to the overabundance of information in cities. In rural locations, stronger community links and more direct communication can also lead to better awareness, hence reducing the amount of information about the campaign in cities. Overall, 113 children in Sierra Leone were missed from taking the nOPV2 vaccination during the first round after revisits were made, similar to a study done in Pakistan and Nigeria [20, 24]. Kambia district has the highest number of missing children after revisits, followed by Falaba, Kailahun, Koinadugu, and Port Loko. The higher refusal rate shown by these districts depicts a low acceptance of the nOPV2 vaccine. Despite the high awareness of the nOPV2 vaccination campaign in these districts, refusal rates are stubbornly high, inconsistent with findings from Pakistan [25], a phenomenon puzzling to public health providers. This discrepancy suggests deeper rooted factors beyond mere lack of knowledge. Likely, a combination of historical mistrust, cultural beliefs, and practical access barriers is at play.

4.3 | Cross-Border nOPV Vaccination Coverage

Effective cross-border vaccination coverage with the nOPV2 vaccine was implemented to reach more eligible children, especially children traveling in and out of the country. This is important for achieving global polio eradication goals. During the nOPV2 cross-border vaccination campaign, a total of 3589 children were vaccinated in cross-border districts, constituting a vaccination coverage of 0.21%. High cross-border vaccination coverage is seen in the Karene and Kambia districts with the nOPV2 due to their location along the Guinea border, which experiences significant cross-border movement. Our findings are similar to a study in China [26]. This necessitates focused vaccination efforts to prevent polio spread. Targeted campaigns, collaboration with Guinea, strong community engagement, and enhanced surveillance in these regions contribute to higher vaccination coverage. This strategic vaccination strategy acts as a preventive shield, preventing the virus from gaining a foothold in previously polio-free areas, minimizing the likelihood of polio outbreaks, and ultimately contributing to the global eradication effort.

4.4 | The Quality of the Round 1 nOPV2 Campaign Supervision in Sierra Leone

The quality of the nOPV2 campaign supervision in Sierra Leone hinges on numerous factors, such as timely reporting of vaccination data, promoting data accuracy, completeness, and data integrity of nOPV2 vaccination data. Moreover, the campaign achieved high vaccination coverage, which was influenced by the strategic campaign implementation ranging from selecting competent health personnel, informed training, cold chain management, logistics, and supply chain efficiency, monitoring and surveillance systems, community engagement, and communication strategies, as well as examining the incidence of polio cases within the population. This is a concerted effort by the Ministry of Health, District Health Management Teams (DHMTs), and Partners. The strides made by the EPI in strengthening vaccination supervision in the country underscore the importance of quality, reliable, and accurate vaccination outcomes that reflect expected results. These findings are similar to Nigeria's success in using real-time monitoring and independent assessments to enhance campaign accuracy [27]. Both countries demonstrate that robust supervision systems are critical to achieving expected results, though contextual adaptations (e.g., community-led vs. tech-driven approaches) may vary.

4.5 | Study Limitations

The nationwide implementation of the polio campaign ensures the representativeness of data across all districts, thus increasing the study's findings' relevance to all Sierra Leonean children under five. However, the incomplete and inconsistent data reported by supervisors during the polio campaign created a huge gap in achieving high-quality supervision data. Moreover, in terms of the vaccination protocols, vaccination teams failed to document administrative data correctly as per the vaccination guidelines set for the campaign; this may result in incomplete, inaccurate, or inconsistent recording of administrative data, which has an impact on the LQAS. Similarly, the LQAS survey might not cover the full variability in vaccination coverage or the campaign implementation because only six clusters are selected in each district, which cannot substantiate the exact outcome of the polio campaign.

4.6 | Recommendations

After conducting the LQAS survey, the following actions are recommended to address issues around missed children.

- A total of 4–8 children missed from vaccination: Needs quality improvement in subsequent campaigns, thereby assessing pre-campaign and intra-campaign monitoring results (preparedness validation, training monitoring, and social mobilization).
- A total of 9–19 missed children missed from vaccination: Initiate conducting a comprehensive mopping up across the concerned health areas within 1 week after the LQAS is completed immediately. Furthermore, all program gaps should be identified and addressed during the assessment before the next SIA.
- More than 20 missed children from vaccination: Initiate conducting a comprehensive mop-up in the entire district within 1 week after the LQAS is completed. Moreover, for mid-term actions, ensure microplans are fully updated for all health facilities in the district, validate, and revalidate before the next SIA.

5 | Conclusion

The first round of the nOPV2 vaccination campaign in Sierra Leone demonstrated significant success in reaching most of the target population, with robust preparatory and implementation strategies contributing to this achievement. However, gaps in coverage and challenges, such as missed households and inadequate marking of vaccinated children highlight areas for improvement. Continuous monitoring, targeted interventions in low coverage districts, and enhanced community engagement will be essential in achieving and sustaining high vaccination coverage in future campaign rounds.

Author Contributions

Desmond M. Kangbai: conceptualization, manuscript acquisition, methodology, writing review and editing, visualization. **Edwin N. Sesay**: conceptualization, manuscript acquisition, methodology, formal analysis, writing review and editing, visualization. **Andrew K. Kemoh**: conceptualization, manuscript acquisition, methodology, formal analysis, writing review and editing, visualization. **Sallu Lansana**: conceptualization, manuscript acquisition, methodology, formal analysis, visualization. **Nella Clemens-Kangbai**: conceptualization, manuscript acquisition, methodology. **Hassan Benya**: manuscript acquisition, writing review and editing, visualization. **Peter B. James**: writing review and editing. **Aminata Nunie**: writing review and editing. **Amanda Clemens**: writing review and editing. **Joyce M. Kallon**: writing review and editing. **Edna G. Samuels**: writing review and editing. **Michael Jones**: writing review and editing. **Braima Patrick Kanneh**: writing review and editing. **Andrew Alfred Nyakeh Jimmy**: writing review and editing. **Mohamed**

T. M. Kallay: writing review and editing. **Tom Sesay**: writing review and editing. All authors have read and agreed to the published version of the manuscript. All authors agree to be accountable for all aspects of the work in this article.

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Ethics Statement

The study was not considered human subject research; hence, Institutional Review Board (IRB) statement is not applicable.

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data underlying this article were provided by and are the property of the Ministry of Health of Sierra Leone. The data will be shared upon reasonable request with the ministry's permission.

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