

Baseline Assessment of Cvdvpv2 Transmission in the Lake Chad Basin: Cross-Border Complexities and Programmatic Drivers (2022–2025)

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ABSTRACT

ARTICLE DETAILS

Background: Despite Africa's certification as wild poliovirus-free by the World Health Organization, circulating vaccine-derived poliovirus type 2 (cVDPV2) continues to pose a significant public health threat in the Lake Chad Basin (LCB). Between 2022 and 2024, the region's contribution to the WHO African Region polio burden increased substantially, underscoring persistent transmission risks.

Methods: A mixed-methods retrospective assessment was conducted across five LCB countries – Nigeria, Niger, Chad, Cameroon, and Central African Republic. Data sources included acute flaccid paralysis and environmental surveillance systems, campaign performance indicators, and reports from polio eradication partners. Quantitative trend analysis and qualitative insights from key informant interviews were integrated.

Results: The LCB's contribution to the cVDPV2 burden in the WHO African Region increased from 22% in 2022 to 39% in 2024. While most countries in the region experienced a 63% decline in cases, LCB countries showed only a 13% reduction. Persistent transmission was associated with a combination of factors, including gaps in routine immunization and supplementary immunization activities, suboptimal surveillance sensitivity, insecurity limiting access to high-risk populations, and weak community engagement.

Conclusion: Interrupting cVDPV2 transmission in the Lake Chad Basin will require strengthened cross-border coordination, improved microplanning and accountability, and data-driven strategies to reach underserved populations. Addressing operational and structural vulnerabilities is critical to preventing further spread and achieving global eradication targets under the Global Polio Eradication Initiative

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INTRODUCTION

The global eradication of poliomyelitis remains one of the most ambitious public health initiatives, led by the Global Polio Eradication Initiative since its launch in 1988. Significant progress has been achieved, with wild poliovirus (WPV) cases reduced by over 99% worldwide (Kew et al., 2004). The World Health Organization African Region was certified free of indigenous WPV transmission in 2020, marking a historic milestone in the fight against polio (Nasir et al., 2016). However, this achievement has been undermined by the continued emergence and spread of circulating vaccine-derived poliovirus type 2 (cVDPV2), which now represents the primary source of poliovirus outbreaks in many parts of Africa (Eze et al., 2025).

cVDPV2 arises in settings with low population immunity where the attenuated virus in the oral polio vaccine (OPV) can genetically revert and regain neurovirulence, leading to sustained community transmission (Stern et al., 2017). Since the global withdrawal of type 2-containing OPV in 2016, immunity gaps have widened in several low-resource and conflict-affected settings, increasing susceptibility to cVDPV2 outbreaks (Macklin et al., 2020). These outbreaks are often difficult to control due to delayed detection, suboptimal immunization coverage, and operational challenges in implementing high-quality supplementary immunization activities (SIAs) (Kidanne et al., 2022).

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The Lake Chad Basin (LCB) comprising Nigeria, Niger, Chad, Cameroon, and Central African Republic, represents one of the most complex epidemiological settings for polio eradication globally. The region is characterized by porous international borders which facilitates cross-border transmission of infectious diseases (Wassilak et al., 2011). In addition, protracted insecurity linked to armed conflict and insurgency has resulted in large-scale population displacement, restricted access to health services, and the disruption of routine immunization systems (Wang et al., 2025).

Despite intensified eradication efforts, the LCB remained a persistent reservoir for cVDPV2 transmission in the World Health Organization African Region. Between 2022 and 2024, the region's contribution to the overall cVDPV2 burden increased substantially (Candido et al., 2025). This suggests that unique structural, operational, and contextual factors continue to drive transmission within the basin. Key challenges include weak routine immunization coverage, inconsistent quality of SIAs, surveillance gaps and insufficient community engagement leading to vaccine hesitancy or missed populations (Adamu et al., 2025). Cross-border coordination is also a critical yet under-optimized component of the polio response in the LCB. While frameworks for synchronized immunization campaigns and information sharing exist, their implementation is often hindered by differences in national policies, and limited real-time data exchange (Gostin & Katz, 2016). Furthermore, mobile and hard-to-reach populations, including nomadic groups and internally displaced persons, are frequently missed by conventional service delivery strategies, perpetuating immunity gaps and sustaining virus circulation (Ndiaye et al., 2014).

Given these complexities, there is a need for a comprehensive and context-specific assessment of cVDPV2 transmission dynamics and response performance in the Lake Chad Basin. This study presents a retrospective analysis of polio epidemiology and programmatic interventions across the five LCB countries between 2022 and 2024. This study aims to identify persistent drivers of transmission by examining surveillance data, immunization campaign performance, and qualitative insights from key stakeholders.

Methods

Study Design and Setting

This study employed a convergent mixed-methods design, integrating quantitative epidemiological analysis, geospatial mapping, and qualitative inquiry to provide a comprehensive assessment of circulating vaccine-derived poliovirus type 2 (cVDPV2) transmission dynamics in the Lake Chad Basin (LCB) between 2022 and 2024. Mixed-methods approaches are particularly suited for complex public health challenges to allow triangulation of surveillance data with operational and contextual insights (Robinson, 2007).

The study was conducted across five countries in the LCB: Nigeria, Niger, Chad, Cameroon, and Central African Republic. These countries are linked by porous borders, shared ecological zones, and complex humanitarian settings characterized by population displacement and insecurity, which influence both poliovirus transmission and response effectiveness (Mendes et al., 2022).

Data Sources and Collection

Quantitative Data

Quantitative data were obtained from multiple sources to ensure completeness and validity. Acute flaccid paralysis (AFP) surveillance datasets from national surveillance systems were used as the primary source for poliovirus detection and reporting. These datasets included case-based information such as age, location, vaccination status, and laboratory confirmation results. AFP surveillance remains the gold standard for poliovirus detection globally due to its sensitivity in identifying potential poliomyelitis cases (Baguune et al., 2024).

In addition, cVDPV2 case reports and line lists from Polio Eradication Initiative (PEI) databases covering the period 2022–2024 were analyzed. These datasets included both confirmed cases and environmental isolates, allowing for a more comprehensive understanding of virus circulation patterns (Macklin et al., 2020). Vaccination campaign data, including supplementary immunization activity (SIA) reports, were also reviewed to assess campaign quality indicators such as administrative coverage, lot quality assurance sampling (LQAS) results, and the proportion of missed children (Adamu et al., 2025).

Qualitative Data

Qualitative data were collected through a combination of desk reviews and key informant interviews (KIIs). Desk reviews included program reports, outbreak investigation summaries, and operational updates from national ministries of health and partners supporting the Global Polio Eradication Initiative. These documents provided contextual information on program performance, response strategies, and implementation challenges (Hamisu et al., 2016).

Key informant interviews were conducted with purposively selected stakeholders involved in polio eradication activities at subnational and national levels. Participants included district immunization officers, local government area (LGA) health officials, surveillance focal persons, and partner agency staff. Purposive sampling was used to ensure representation from high-risk and security-compromised areas, where operational challenges are most pronounced (Palinkas et al., 2015). Interviews were guided by semi-structured questionnaires to explore themes such as surveillance performance, immunization delivery, cross-border coordination, and community engagement.

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Geospatial Data and Mapping

Geospatial analysis was conducted to visualize the spatial distribution of cVDPV2 cases and identify clustering patterns across the LCB. Shapefiles representing administrative boundaries and Lake Chad response zones were obtained from partner-supported geographic information system (GIS) repositories. Conflict data overlays were incorporated using publicly available datasets on insecurity and displacement to examine the relationship between transmission patterns and access constraints (Mendes et al., 2022). Spatial mapping techniques were used to identify high-risk areas, cross-border transmission corridors, and overlap between epidemiological hotspots and insecure or underserved regions. Such geospatial approaches are increasingly recognized as essential tools for targeting interventions in polio eradication programs (Smith & Emmett, 2016).

Data Analysis

Quantitative Analysis

Descriptive statistical analyses were conducted to assess temporal and geographic trends in cVDPV2 transmission. Key indicators included annual case counts, proportion of cases by country, and contribution of LCB countries to the overall burden in the World Health Organization African Region. Trends were analyzed over the study period (2022–2024) to identify changes in transmission dynamics and program performance (Bammeke et al., 2023).

Comparative analyses were performed to contrast trends in the LCB with those observed in other regions of Africa, highlighting disparities in outbreak control. Where available, surveillance performance indicators such as non-polio AFP (NPAFP) rates and stool adequacy were also reviewed to assess the sensitivity and quality of surveillance systems (Bessing et al., 2023).

Qualitative Analysis

Qualitative data from KIIs and desk reviews were analyzed using a thematic analysis approach. Interview transcripts and notes were coded inductively and deductively to identify recurring patterns and key themes related to cVDPV2 transmission and response challenges. Themes were subsequently grouped into broader domains, including health system factors, operational constraints, security-related barriers, and community-level determinants (Braun & Clarke, 2006).

Triangulation was applied by comparing qualitative findings with quantitative and geospatial data to enhance the validity and reliability of interpretations. This approach enabled the identification of converging evidence on key drivers of persistent transmission across the LCB (Fetters et al., 2013).

Geospatial Analysis

Spatial analyses were conducted to identify clustering of cVDPV2 cases and their relationship with geographic and contextual variables. Case distribution maps were generated to visualize hotspots and cross-border spread. Overlay analyses were used to examine the intersection of poliovirus transmission with insecurity, population displacement, and hard-to-reach settlements (Mendes et al., 2022).

These analyses supported the identification of priority areas for intervention and provided insights into how geographic and security-related factors influence both virus transmission and program reach.

RESULTS

Trends in cVDPV2 Burden in the Lake Chad Basin

Consistent with the quantitative analytical approach described in the Methods, descriptive trend analysis of surveillance and program data revealed a sustained and disproportionate burden of circulating vaccine-derived poliovirus type 2 (cVDPV2) in the Lake Chad Basin (LCB) between 2022 and 2024. Across the five study countries both absolute case counts and the proportional contribution to the regional burden increased over time.

Specifically, the LCB accounted for 234 cases (22%) in 2022, rising to 260 cases (35%) in 2023, before declining slightly to 204 cases (39%) in 2024. Although there was a modest reduction in absolute case numbers between 2023 and 2024, the proportional contribution of the LCB to the overall burden in the World Health Organization African Region continued to increase. These trends, along with country-specific distributions and spatial clustering of cases across border regions, are illustrated in **Figure 1**

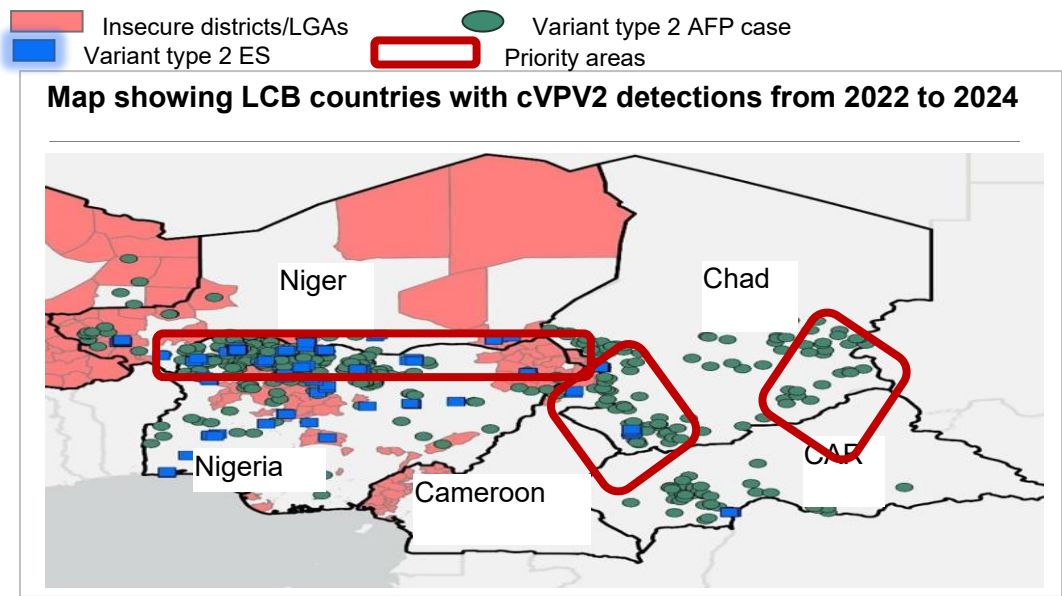


Figure 1: Trends and Geographic Distribution of cVDPV2 in the Lake Chad Basin (2022–2024)

Comparative analysis with non-LCB countries further showed this disparity. While other countries in the region achieved an estimated 63% reduction in cVDPV2 cases over the same period, LCB countries recorded only a 13% decline. These findings align with the hypothesis that structural and operational challenges unique to the LCB are sustaining virus circulation despite broader regional progress.

Country-Level Epidemiological Patterns

Country-specific analysis of AFP surveillance and cVDPV2 case datasets revealed heterogeneous transmission dynamics across the five LCB countries. Table 1 illustrates the country-specific trend of detections. Nigeria consistently reported the highest number of cases throughout the study period, increasing from 130 cases in 2022 to 167 cases in 2023, before declining to 118 cases in 2024. Despite this decline, Nigeria remained the primary contributor to the regional burden. Chad recorded the second-highest burden, with relatively stable transmission (51 cases in 2022, 58 in 2023, and 42 in 2024). Niger demonstrated a fluctuating pattern, with a marked decline from 38 cases in 2022 to 7 cases in 2023, followed by a resurgence to 40 cases in 2024. Cameroon maintained relatively low case counts (2 in 2022, 13 in 2023, and 4 in 2024). Central African Republic showed a gradual decline from 14 cases in 2022 to 15 in 2023, followed by zero reported cases in 2024, indicating possible interruption of transmission.

Table 1: Country-Specific Detections (2022–2024)

Country	2022	2023	2024
Nigeria	130	167	118
Niger	38	7	40
Chad	51	58	42
Cameroon	2	13	4
CAR	14	15	0

Geospatial Distribution and Transmission Corridors

In line with the geospatial methods applied, mapping of case distributions revealed clear clustering of cVDPV2 detections along insecure and hard-to-reach border regions. High-burden areas were consistently identified in Northern Borno State in Nigeria, Diffa Region in Niger and Hadjer-Lamis Province in Chad. These areas correspond to known humanitarian and conflict-affected zones characterized by population displacement, limited health service access, and restricted movement for vaccination teams. Spatial overlay analyses further demonstrated a strong convergence

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between cVDPV2 hotspots and areas affected by insecurity. This supports the observed association between access constraints and persistent transmission.

Cross-border clustering patterns were also evident, particularly along shared borders between Nigeria–Niger and Chad–Cameroon which suggests active transmission corridors facilitated by population mobility and gaps in synchronized immunization efforts.

Discussion

This study provides a comprehensive assessment of circulating vaccine-derived poliovirus type 2 (cVDPV2) transmission dynamics in the Lake Chad Basin (LCB) between 2022 and 2024, highlighting the region's persistent and disproportionate contribution to the polio burden in the World Health Organization African Region. Despite broader regional progress toward poliovirus containment, the findings demonstrate that the LCB remains a critical reservoir of transmission, driven by a complex interplay of epidemiological, operational, and contextual factors.

The observed increase in the proportional contribution of LCB countries to the regional cVDPV2 burden reflects a concerning divergence from overall continental trends. While other African countries achieved substantial reductions in cases, the relatively modest decline within the LCB reflects persistent transmission dynamics that are consistent with findings from other fragile and conflict-affected settings (Bigouette et al., 2021). Similar patterns have been documented in regions where health system disruptions and insecurity undermine immunization coverage and surveillance performance, thereby sustaining poliovirus circulation (Geiger et al., 2024).

A central finding of this study is the strong association between insecurity, population displacement, and ongoing transmission. Geospatial clustering of cases along border regions such as northern Borno in Nigeria, Diffa in Niger, and Hadjer-Lamis in Chad aligns with existing evidence that conflict-affected areas serve as persistent reservoirs for poliovirus (Mendes et al., 2022). In such contexts, restricted access to communities, destruction of health infrastructure, and large-scale displacement contribute to immunity gaps and hinder timely outbreak response (Bigna, 2016). These findings reinforce prior research demonstrating that insecurity is one of the most significant barriers to polio eradication in endemic and high-risk regions (Patel et al., 2020).

The heterogeneous epidemiological patterns observed across LCB countries further highlight the importance of localized dynamics within a broader interconnected system. For instance, the resurgence of cases in Niger following a temporary decline suggests either reintroduction through cross-border transmission or improvements in surveillance sensitivity. Conversely, the apparent interruption of transmission in Central African Republic by 2024, while encouraging, should be interpreted cautiously given the risk of silent transmission in areas with limited surveillance coverage (Macklin et al., 2020). These findings are consistent with global evidence indicating that cVDPV2 outbreaks are often characterized by episodic resurgence and geographic spread, particularly in regions with high population mobility (Stern et al., 2017).

Immunization gaps emerged as a critical driver of persistent transmission. Both quantitative indicators and qualitative findings point to suboptimal routine immunization (RI) coverage and inconsistent quality of supplementary immunization activities (SIAs). This aligns with global analyses showing that low population immunity remains the primary risk factor for the emergence and spread of cVDPV2 (Stockman, 2010). The withdrawal of type 2-containing oral polio vaccine (OPV2) in 2016, while necessary for eradication efforts, has further exacerbated immunity gaps in settings where RI systems are weak (Macklin et al., 2020). In the LCB, these gaps are compounded by operational challenges, including missed settlements, inadequate microplanning, and limited accountability mechanisms during campaign implementation.

Surveillance performance also plays a pivotal role in shaping transmission dynamics. Although AFP surveillance systems are established across LCB countries, qualitative findings indicate persistent challenges in reaching insecure and hard-to-access areas. This raises concerns about potential under-detection of cases and delayed response to outbreaks. Global standards emphasize the importance of maintaining high non-polio AFP (NPAFP) rates and stool adequacy to ensure surveillance sensitivity; however, these indicators are often difficult to achieve in fragile settings (Bessing et al., 2023). The risk of “silent transmission” in such contexts underscores the need for enhanced environmental surveillance and innovative approaches to case detection.

Cross-border transmission remains a defining feature of cVDPV2 epidemiology in the LCB. The spatial clustering of cases along international borders and the observed synchronization of outbreaks across neighboring countries highlight the limitations of country-specific approaches to outbreak control. Although cross-border coordination mechanisms exist under the Global Polio Eradication Initiative framework, their effectiveness is often constrained by differences in national priorities, logistical challenges, and limited real-time data sharing (Owoaje et al., 2020). Strengthening these mechanisms is essential, as global experience has shown that synchronized immunization campaigns and coordinated surveillance are critical for interrupting transmission in multi-country epidemiological blocks (Patel et al., 2020).

The findings of this study have important implications for global polio eradication efforts. First, they underscore the need for context-specific strategies tailored to fragile and conflict-affected settings. Standard approaches to immunization and surveillance may be insufficient in the LCB, where insecurity and population mobility require adaptive and flexible delivery models. Second, the results highlight the importance of integrating polio eradication activities with broader health system strengthening efforts, particularly in

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improving routine immunization coverage and community engagement. Third, the study reinforces the urgency of addressing cross-border transmission through enhanced regional coordination and data-driven decision-making.

Finally, this study contributes to the growing body of evidence that achieving global polio eradication will depend not only on technological and biomedical interventions but also on the ability to address underlying social, political, and structural determinants of health. Without targeted efforts to overcome these challenges in high-risk regions such as the Lake Chad Basin, the goal of interrupting all poliovirus transmission may remain elusive

CONCLUSION

This study highlights the persistent and disproportionate burden of circulating vaccine-derived poliovirus type 2 (cVDPV2) in the Lake Chad Basin (LCB) despite significant progress toward global polio eradication. The findings demonstrate that the LCB has become an increasingly concentrated reservoir of cVDPV2 transmission, with only modest reductions in case counts compared to substantial declines observed elsewhere in Africa. Persistent transmission is driven by a convergence of factors.

Importantly, the study reveals that cVDPV2 epidemiology in the LCB is inherently transnational, with clear evidence of cross-border transmission corridors and synchronized outbreaks across neighboring countries. This reflects the limitations of country-specific approaches and highlights the need for coordinated regional strategies. Without targeted and context-specific interventions, the LCB will continue to pose a significant threat to achieving global eradication goals under the Global Polio Eradication Initiative.

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