



POLIO ERADICATION PROGRAMME IN NIGERIA: THE CURRENT SITUATION

L. Y. ADOGO^{1*}, L. H. MIBWALA¹ AND E. D. AKOR¹

¹Department of Biological Sciences, Faculty of Science and Technology, Bingham University, Karu, Nigeria.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author LYA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LHM and EDA managed the analyses of the study. Author EDA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Transmission of wild poliovirus (WPV) continues uninterrupted in only three countries (Afghanistan, Nigeria, and Pakistan). Nigeria is one of the remaining 3 endemic countries in the world that has never interrupted the transmission of the poliovirus compared to more than 125 countries since 1988 when the Global Polio Eradication Initiative was launched. The present study established the current situation of polio eradication in Nigeria. Nigeria has made tremendous strides towards eliminating polio and was declared polio free until August and September 2016, where four type 1 WPV (WPV1) cases were reported from northeastern Nigeria, Borno State, which is currently experiencing violent insurgency. The humanitarian crisis in the North-East, Circulating Vaccine-Derived Polioviruses transmission, resistance to accepting vaccination during scheduled campaigns among other factors have hindered the efforts of polio eradication in the country. However, sustained focus towards getting rid of all types of poliovirus by improving population immunity and enhancing disease surveillance will be needed to ensure it sustains the polio-free status in 2019.

Keywords: Nigeria; endemic countries; polio; immunization; surveillance.

1. BACKGROUND

Poliomyelitis, often called polio or infantile paralysis is an acute, viral, infectious disease spread from person to person, primarily via the fecal-oral route [1]. In Nigeria, the National Programme on Immunization (NPI) suffers recurrent setbacks due to many factors including ethnicity and religious beliefs [2]. Nigeria is made up of 36 states with its federal capital in Abuja. The virus can spread from person to person and can invade an infected person's brain and spinal cord causing paralysis [3]. The virus replicates in the nervous system and may cause significant neuronal loss. Polio is highly contagious and is classified into

three serotypes of Wild Polio Virus, type 1, type 2, and type 3 [4]. Each serotype differs from the other with a slightly different capsid protein [5]. All three are extremely virulent and produce the same disease symptoms [6]. Renne [7] also describes the perspectives on polio and immunization in Northern Nigeria during 2006.

Abimbola et al. [8] suggest that the global health community and the governments of Afghanistan, Pakistan, and Nigeria need to build trust and to prioritise polio eradication as part of routine health services rather than highlighting it as "the only" health problem.

*Corresponding author: Email: litex2525@gmail.com;

Although approximately 90% of polio infections cause no symptoms at all, affected individuals can exhibit a range of symptoms if the virus enters into the bloodstream [6]. Among 1% of cases, the virus enters into the central nervous system (CNS), preferentially infecting and destroying motor neurons, which leads to muscle weakness and acute flaccid paralysis. Different types of paralysis might occur, depending on the nerves involved; Spinal polio is the most common form, characterized by asymmetric paralysis that most often involves the legs, bulbar polio leads to weakness of muscles innervated by cranial nerves and bulbosplinal polio is a combination of bulbar and spinal paralysis [9].

Polio (poliomyelitis) mainly affects children under five years of age. One in 200 infections leads to irreversible paralysis. Among those paralyzed, 5% to 10% die when their breathing muscles become immobilized [10].

The World Health Assembly (WHA), the annual meeting of the Ministers of Health of all Member States of the World Health Organization (WHO), first committed to polio eradication when it adopted resolution 41.28 in 1988 calling for the worldwide eradication of the disease by the year 2000.

At that time, more than 125 countries were endemic with the disease and each year more than 350,000 children were paralyzed for life by polio. Since 1988, the Global Polio Eradication Initiative (GPEI) has reduced the global incidence of polio by more than 99%, three of six WHO Regions have been 'certified' polio-free (and one of the three wild poliovirus serotypes (type 2) has been eradicated since 1999 [11]. The polio eradication effort has become one of the largest public-private partnerships, successfully eliminating polio in all countries except three and these are Nigeria, Afghanistan, and Pakistan.

Nigeria began its polio eradication campaign in 1988, using the fixed post and house to house strategies on days designated as National Immunization Days (NIDs) and become fully committed to the global goal of polio eradication by the year 2002. The number of confirmed Wild Polio Virus (WPV) cases in Nigeria has declined substantially, from a total of 122 cases in 2012 to 53 cases in 2013, down to 6 cases in 2014 and no case was reported in 2015. In 2015, Nigeria was removed from the list of polio endemic countries, by the World Health Organization [12]. But despite these achievements, Nigeria still remains one of the three countries where poliomyelitis is endemic as new cases have been reported subsequently. This review highlights the global burden of polio, the current situation and challenges of polio eradication in Nigeria.

2. POLIO AND ITS GLOBAL BURDEN

2.1 Wild Polio Virus Cases

The progress towards polio eradication worldwide from January 2016 to March 2018, in a report by Gardner et al. [13] which states that the continuous transmission of WPV occurred only in 3 countries; Afghanistan, Nigeria and Pakistan. Among all the 3 serotypes of WPV, type 1 remains the only confirmed circulating type [13]. As of 12th September 2018, the total number of WPV cases globally was 17 [14].

However, in October 2018, the 16th report produced by the Independent Monitoring Board (IMB) of the Global Polio Eradication Initiative (GPEI) revealed that progress towards interrupting polio transmission globally has stalled and may well have reversed and this is owing to the fact that the total number of wild poliovirus cases globally has increased. Twenty five (25) cases of WPV were reported in October 2018 whereas 13 cases were recorded for the same period (30 October) in 2017. The case count so far this year exceeds the total for the whole of 2017 [15].

The number of cases in Afghanistan has more than doubled: 19 in 2018 so far compared to 8 for the same period (30 October) in 2017. The number of wild poliovirus cases in Pakistan has increased since the same time in 2017; 6 compared to 5. In Pakistan, the percentage of positive poliovirus isolates drawn from environmental sampling is exactly the same as it was in 2017. The number of vaccine-derived poliovirus cases has increased from 63 on 30 October 2017 to 75 in the same period of 2018 [15].

2.2. Circulating Vaccine-Derived Polioviruses (cVDPV) cases

The circulation of vaccine-derived polioviruses continues to take on added significance in the world's approach to eradicate the wild poliovirus. Inadequate routine immunization levels coupled with subnational gaps in surveillance in high-risk countries continue to be the main risk factors for the emergence or continuing circulation of vaccine-derived polioviruses. In 2018, outbreaks due to circulating vaccine-derived poliovirus newly emerged or continued in the Democratic Republic of the Congo, the Horn of Africa, Niger, Nigeria, the Syrian Arab Republic and Papua New Guinea [16].

In the Democratic Republic of the Congo, three different circulating vaccine-derived poliovirus type 2 outbreaks are ongoing. By October 2018, 20 cases of cVDPV were reported [16,17]. The Horn of Africa is affected by outbreaks due to circulating vaccine-derived polioviruses; both type 2 and type 3.

Table 1. Wild poliovirus type 1 and circulating vaccine-derived poliovirus cases in endemic countries

Countries	Year-to-date 2019		Year-to-date 2018		Total in 2018		Onset of paralysis of most recent case	
	WPV	cVDPV	WPV	cVDPV	WPV	cVDPV	WPV	cVDPV
Afghanistan	2	0	6	0	21	0	12-Jan-2019	NA
Nigeria	0	0	0	0	0	34	NA	5-Dec-2018
Pakistan	4	0	0	0	12	0	20-Jan-2019	NA

(Source; GPEI, 2019)

The circulating vaccine-derived poliovirus type 2 was isolated from cases of acute flaccid paralysis as well as environmental samples in Mogadishu (Somalia) and from environmental samples in Nairobi (Kenya). In September 2018, 13 cases of cVDPV were reported. According to World Health Organization (WHO), In Nigeria, two separate outbreaks due to circulating vaccine-derived poliovirus type 2 were confirmed in 2018 [16,17]. In the Syrian Arab Republic, no new case of circulating vaccine-derived poliovirus type 2 had been detected by the end of September 2018, following confirmation of an outbreak in 2017. In Papua New Guinea, a circulating vaccine-derived poliovirus type 1 outbreak was confirmed in June 2018, as the virus was initially isolated from an acute flaccid paralysis case and two healthy community contacts [16]. However, in October 2018 twenty six (26) cases of cVDPV was reported [16,17]. The surest way to prevent circulation of vaccine-derived polioviruses in the future is to stop oral polio vaccine use rapidly, which can only occur after the successful eradication of wild polioviruses.

At the end of 2018, a total of 33 cases of WPV were recorded in Afghanistan and Pakistan while 34 cases of cVDPV were reported in Nigeria only. As of 20th February 2019, six cases of WPV were reported in Afghanistan and Pakistan as shown in Table 1.

3. THE CURRENT SITUATION OF POLIOMYELITIS IN NIGERIA

3.1 Wild Polio Virus Transmission

In Nigeria, ongoing endemic WPV1 transmission was confirmed in 2016 [18]; although WPV was not detected in 2017 or in 2018[19].

The number of reported cases of Wild Polio Virus has greatly declined. The highest number of WPV cases in the country was 1122 in the year 2006 which declined to 62 in 2011 as shown in Table 2. Similarly, a total of 122 cases in 2012 declined to 53 cases in 2013, 6 in 2014, and no cases in 2015, until August 2016, four (4) cases of WPV1 were confirmed in 3

local government areas in Borno State that occurred among some children in an Internally Displaced Peoples (IDP) camp; two (2) more cases were reported in September 2016. No cases of WPV were recorded in 2017 and 2018.

In 2018, the National Emergency Operations Centre (EOC) and Institute of Disease Modelling (IDM), jointly classified a total of 115 LGAs across 26 States plus the FCT as vulnerable and high-risk areas of the polio virus based on risk categorization algorithm (Fig. 1). These States were given special attention and focus in the Nigeria Polio Eradication Emergency Plan [20].

Twenty seven (27) of the 115 LGAs in Nigeria were reported to be at a high risk of Polio in 2017 and 39 in 2018. All the 23 LGAs in Borno state, 7 in Yobe, and 4 in Adamawa were identified as high risk areas because of the Security issues. States like Sokoto, Zamfara, Benue, Jigawa, Nasarawa, and Kaduna are under a different category due to a mix of security and other factor [20].

3.2 Circulating Vaccine-Derived Poliovirus

In 2012, 8 cases of (cVDPVs) were reported in states in Nigeria, this decreased in 2013 presenting only 5 cases, 30 cases in 2014, 1 case in 2015, 1 also in 2016, none in 2017. (Fig. 2). The reason for this decrease is that the Nigerian government expanded the number of the environmental surveillance sites from 56 in 14 states and 70 in 19 states including the Federal Capital Territory [20,21].

11 positive isolates of VDPV2 were recorded in 2017 from 4 states; 7 in Sokoto, 1 in Bauchi, 2 in Gombe, and 1 in Katsina. This VDPV2 was prevented by the implementation of a high-quality Monovalent Oral Polio Vaccine (mOPV2) Supplemental Immunization Activities (SIAs). This developed the resident's immunity against the type 2 virus. To advance the immunity of the residents, IPV was combined with mOPV2 in one addition the high risks LGAs in Sokoto in 2017 May [20].

An outbreak of circulating vaccine-derived poliovirus type 2 (cVDPV2) was confirmed in Sokoto State, Nigeria on the 5th of June 2018. From 30 January to 23 May 2018, 10 samples from the environment, collected from two locations all tested positive for genetically-related VDPV2 viruses. No associated cases of acute flaccid paralysis (AFP) have been detected with this cVDPV2. Nigeria is also affected by an ongoing separate cVDPV2 outbreak.

A cluster of cVDPV2 was identified in Yobe State from a stool sample from an AFP case with onset on

16 June 2018, and an environmental sample collected on 31 May 2018. The same cVDPV2 was detected in Gombe State from an environmental sample collected on 9 April 2018. Previously, the same cVDPV2 was detected in Jigawa State from an AFP case with onset of paralysis on 15 April 2018 and six environmental samples collected from 10 January through 2 May 2018 [16]. In September 2018, confirmation was received of international spread of the circulating vaccine-derived poliovirus type 2 from the epicentre in Jigawa to Niger, and outbreak response activities were immediately launched [16].

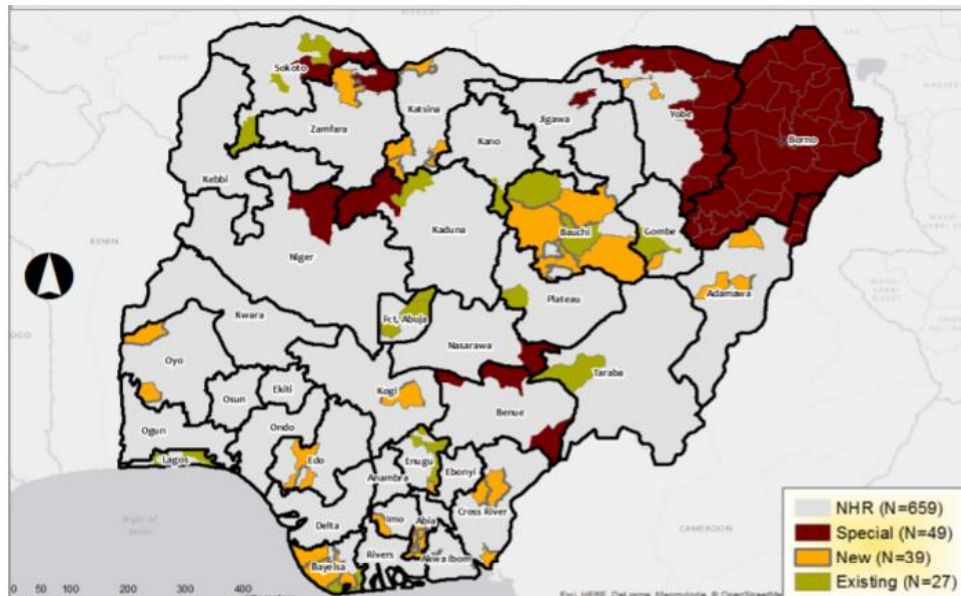


Fig. 1. Map showing high-risk local government areas in Nigeria in 2017 and 2018
(Source: NPHCDP, 2018)

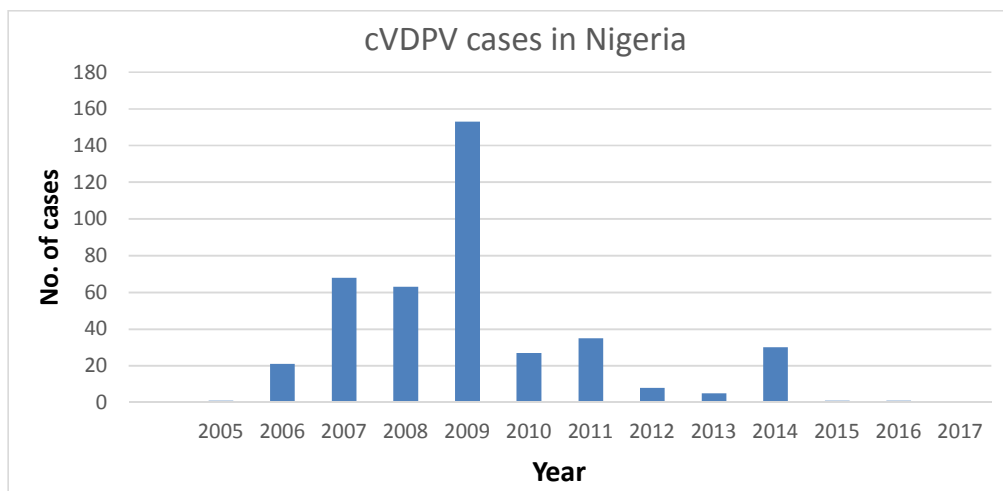


Fig. 2. Graph showing the trend of circulating vaccine derived polio virus cases in Nigeria from (2005-2017)

Table 2. Progress of poliomyelitis cases in Nigeria from 2000-2018

YEAR	WPV	CVDPVs
2000	28	0
2001	56	0
2002	202	0
2003	355	0
2004	782	0
2005	830	1
2006	1122	21
2007	285	68
2008	798	63
2009	388	153
2010	21	27
2011	62	35
2012	122	8
2013	53	5
2014	6	30
2015	0	1
2016	4	1
2017	0	0
2018	0	7

4. CURRENT CHALLENGES OF POLIO ERADICATION IN NIGERIA

Despite the monumental success of relevant stakeholders in the health, security, political and financial sector, several challenges has allowed the poliovirus transmission to thrive in the country. These challenges include;

4.1 Inaccessibility in Security Compromised States and IDPs

During the past 8 years, Borno State in northeastern Nigeria has been at the center of an insurgency that has affected other Nigerian states including Adamawa, Gombe, and Yobe and the neighbouring Lake Chad Basin countries of Cameroon, Chad, and Niger. Insecurity in this region has led to a major humanitarian emergency, with forced displacement of an estimated 2.1 million persons within Nigeria and 200,000 refugees seeking shelter in other countries [22]. Security concerns over Boko Haram's presence prevented vaccinators from reaching multiple Northern villages over the last several years, and consequently, up to 200,000 children in these areas may have never received any polio vaccine [23]. Even with increasing military advancement and efforts towards the liberation of insecure areas, unreachability remains one of the major challenges in these States [24].

The major challenge in the Nigerian program is accessing children, particularly in completely inaccessible areas. At the height of the insurgency in

2015, 60% of settlements were inaccessible for implementation of vaccination and surveillance activities. Close to 6,000 settlements across 15 LGAs have not been reached by the program in Borno State. Out of the 27 LGAs in Borno State, two of them Marte and Abadam remained inaccessible as at the end of 2017.

Northern Nigeria is also home to large nomadic groups (the Fulani people) that constantly move with livestock to find grass and water [23]. These populations are difficult to track and even more difficult to vaccinate, as OPV doses are supposed to be administered at regular intervals over several weeks [25]. Furthermore, both displaced persons and nomadic farmers regularly cross national borders, which could allow Nigerian polio strains to spread into other African countries [23]. Surveillance in these areas is equally a challenge. One hundred and seventy-eight (178) islands in the Lake Chad basin, believed to be inhabited by Nigerian populations have also not been accessed, posing a potential threat for continued circulation [20].

Other challenges include the possibility of missing children from inaccessible areas, lack of cold chain facilities in recently liberated LGAs and insufficient routine immunization providers.

4.2 Population Immunity Gaps

Population immunity profile analysis indicates a number of areas with low type 1 immunity, posing a risk for continued transmission of wild polio virus particularly in North Eastern Nigeria, and Kebbi State in the North West.

Based on coverage survey data by (Multiple Indicator Cluster Survey/ National Immunization Coverage Survey 2016), routine immunization coverage performance is very low across several states. Oral Polio Vaccine (OPV3) coverage ranged from 7% in Sokoto and Yobe to 75% in Lagos; with a national average of 33%.

Routine administrative data by December 2017, indicated 16 (43%) of states achieved OPV3 coverage above 80%, 19 (51%) had coverage between 50-79%, and 2 (6%) were less than 50%. While for Inactivated Poliovirus (IPV12) (32%) have coverage 80% or more; 21 (57%) have coverage between 50% and 79.9%, and 4 (11%) have coverage less than 50%. The disparity between reported and survey data remain a concern inaccurate monitoring of progress. Furthermore, the immunity profile for OPV3 coverage of non-polio acute flaccid paralysis (AFP) cases in 2017 depicts low coverage in Akwa Ibom (84%) and Borno (89%). The VDPVs detected in Sokoto,

Katsina, Gombe and Bauchi in 2017 further indicated gaps in population immunity [26, 20].

4.3 Surveillance Gaps

Despite the appreciable surveillance performance, gaps still exist, especially at sub-national levels. As at the end of December 2017, 9 LGAs in four states were not able to achieve the two key surveillance indicators. During the reporting period, the minimum requirement (10%) of non-polio enterovirus rate was not achieved in 7 states. A total of 11 polio-compatible cases have so far been classified by the National Polio Expert Committee [27].

Other identified surveillance gaps include sub-optimal data quality, inadequate active surveillance, sub-optimal quality of active surveillance leading to missed AFP cases, less than 20% of health facilities being focal sites, knowledge gaps among clinicians and community informants, limited geographical accessibility for field activities in some areas in the northeast and southern parts of the country due to insecurity and inadequate documentation of surveillance activities in many states [20].

4.4 Anti-vaccination Rumors

There was a surge in resistance to vaccination in the fourth quarter of 2017 following rumours that linked a monkeypox outbreak to vaccination. The rumours started in the south east zone and spread to the rest of the country [28]. Several states were affected negatively including some high-risk states like Borno, Yobe and Adamawa, that was evidenced by independent monitoring results of the polio IPDs in October and November.

4.5 Vaccine Accountability

The use of monovalent oral polio vaccine (mOPV)2 vaccine in responding to the cVDPV2 outbreak required strict accounting of the vaccine used. However, the country experienced challenges in accounting for those vaccines. Use of sub-standard improvised stock management tools and inadequate follow up by health workers especially at LGA and ward levels, led to difficulty in generating the correct information. States submitted incomplete and poor vaccine accountability reports late. Some teams wasted vaccines deliberately and there were poor cold chain management practices during implementation as well as when returning the balance of vaccines and used vials to the ward. Using mOPV2 for outbreak response after the withdrawal of trivalent oral polio vaccine (tOPV) has the risk of potential cVDPV2 outbreaks especially in areas where there is low population immunity [20].

4.6 Risk of Complacency

The most recent IMB report highlighted fatigue as one of the growing threats to the polio eradication effort. In Nigeria, the prolonged duration of non-detection of WPV in several states (outside Borno) has created a sense of complacency that the “job is finished” resulting in challenges to the program: wavering political support, reduced counterpart funding, and ‘fatigue’ [29].

5. THE WAY FORWARD

In spite of the various challenges faced in the country, several innovations tailored toward addressing the challenges face in polio eradication have reported remarkable successes. Considerable progress has been made to overcome these challenges through the application of incentives, financial support from donor agencies, improving immunization systems in key geographies; introduction of new, affordable IPV options for managing long-term poliovirus risks; risk mitigation strategies and renewed high level political will.

At the end of 2018, WPV still remained endemic in three countries thereby indicating a failure to eradicate polio globally using the Polio Eradication and Endgame Strategic Plan Working Draft of 2013-2018 and the Nigeria polio eradication emergency plan in Nigeria. In view of this the Global Polio Eradication Initiative developed the *Global Polio Surveillance Action Plan, 2018 – 2020* to help endemic, outbreak and high-risk countries measure and enhance the sensitivity of their surveillance systems. With this and other strategies put in place, GPEI will work to close all remaining gaps and rid the world of polio [30]. On the other hand, the following measures will need to be put in place to ensure total elimination of polio in Nigeria.

1. To circumvent the problem of access in areas where security is a challenge, increased access to vaccination in these areas can be achieved through strategies such as;
 - (i) Hit and run method which entails conducting the National Immunization Days (NIDs) over a shorter period (e.g., 1-2 days) instead of 3 days to a week should be carried out.
 - (ii) Firewalling method entails that vaccinations will be given at border crossing points, using fixed posts as well as in bordering communities as part of intensified outreach services.
 - (iii) Deployment of permanent health teams; Teams including discreet old women who have served as traditional birth attendants with many years of experience, resident

- within the community and providing services as deliveries, reproductive health counselling for married women and care of infants and children should be used.
- (iv) The use of transit vaccinations introduced by the Nigerian Primary Health Care Development Agency for children in Markets, Motor parks, Highways, Hospitals etc in Northern Nigeria should be sustained.
 - (v) Collaborations between the Nigerian army and Civilian Joint Task Force whose forces are trained accordingly should be strengthened.
2. The Chad basin is believed to be inhabited by Nigerian populations that have also not been accessed, posing a potential threat for continued circulation. Thus, collaboration within the Lake Chad basin should be further strengthened to facilitate joint planning across the countries for synchronized SIAs and cross border vaccinations.
 3. More effort is needed to increase demand for routine immunization in high-risk areas especially children in IDP camps. Routine immunization in polio high-risk LGAs should be enhanced. With the low routine Immunization coverage, the risk for outbreaks remains.
 4. As Nigeria moves closer to interruption of poliovirus transmission, surveillance gaps should be prioritized with a view to implementing effective measures to address the gaps. There is a need to build the required confidence that the surveillance system in the country can be relied upon to timely detect any poliovirus circulation. Systematic high-quality surveillance of AFP cases in security-compromised areas should be conducted regularly. Environmental surveillance collection sites should be increased.
 5. There should be a rapid response team to counter any rumour or fake news that will interfere with the progress of polio eradication in the country.
 6. Health workers, Immunization Outlets, maintenance of the cold chain of the oral polio vaccine should be observed, the government needs to provide sufficient funds for the health workers and immunization teams, in order for them to carry out their work.
 7. Vaccine management and accountability should be strengthened at all levels. The activities of Emergency Operation Centers (EOC) which was established to hold all state and local actors accountable for their role and increase vaccination coverage should be intensified.

8. There should be a rapid response to counter any rumour of fake news that will interfere with the progress of polio eradication both at LGA, State and National levels.

6. CONCLUSION

The drive to eliminate polio from Nigeria is of strategic importance to Nigerians, the Nigerian Primary Health Care Development Agency and the Global Polio Eradication Initiative. Nigeria has also achieved giant strides since the Polio Eradication program began in the country, therefore, the prospects for polio eradication in Nigeria are high but the current challenges such as governance, population immunity and surveillance gaps, inaccessibility to security compromised States and IDP camps among other factors require urgent, sustained and focused attention so as to shorten the journey from now to eradication time.

Nigeria has overcome several unique challenges over the past several decades to finally eliminate polio from the country, but a strong vigil towards early detection and effective response to any reemergence of wild virus circulation, and stopping all vaccine-derived viruses will be crucial to the maintenance of its polio-free status. With all hands on deck, just as Nigeria was polio free in 2015, Nigeria can also be forever free of polio.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Cohen JJ. Harrison's Principles of Internal Medicine (16th ed.). Enteroviruses and Reoviruses. McGraw-Hill Professional. 2004; Chapter 175:1144.
2. Ophori EA, Tula MY, Azih AV, Okojie R, Ikpo PE. Current trends of immunization in Nigeria: prospect and challenges. *Tropical Medicine and Health*. 2014;42(2):67-75.
3. Centres for Disease Control and Prevention DC. Assessment of risks to the global polio eradication initiative (GPEI) strategic plan 2010-2012). Global Immunization Division and Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia USA. 2019;1-7.
4. World Health Organization. Circulating Vaccine Derived Polio type 2; 2018. Available:www.Who.int/csr/don/8-august-2018-polio-nigeria/en/

5. Katz SL, Gershon AA, Krugman S, Hotez PJ. Krugman's infectious diseases of children. St. Louis: Mosby. 2004;81–97.
6. Ryan KJ, Ray CG. Sherris medical microbiology. 2004;535–7.
7. Renne E. Perspectives on polio and immunization in Northern Nigeria. *Social Science & Medicine*. 2006;63(7):1857-1869.
8. Abimbola S, Malik AU, Mansoor GF. The final push for polio eradication: addressing the challenge of violence in Afghanistan, Pakistan, and Nigeria. *PLoS Medicine*. 2013;10(10): e1001529.
9. Atkinson W, Hamborsky J, McIntyre L, Wolfe S. Poliomyelitis: Epidemiology and prevention of vaccine-preventable diseases. 2009;231–44.
10. World Health Organization. World Health Organization Fact sheet N°114; 2012.
11. Global Polio Eradication Initiative. Polio Eradication and Endgame Strategic Plan Working Draft of 23 January 2013-2018.
12. World Health Organization. WHO removes Nigeria from polio-endemic list. Geneva, Switzerland: World Health Organization; 2015. Available: <http://www.who.int/mediacentre/news/releases/2015/nigeria-polio/en/>
13. Gardner TJ, Diop OM, Jorba J, Chavan S, Ahmed JA, Anand A. Surveillance systems to track progress toward polio eradication—worldwide, 2016–2017. *MMWR Morb Mortal Wkly Rep*. 2018;67:418–23.
14. Crowley P, Athalia C, Frank M, Naveed S, Fredrick W, Katie H. Review of polio endemic countries. 2018;10:50-70.
15. Independent Monitoring Board of the Global Polio Eradication Initiative. How to cut a long story short. Sixteenth Report; 2018.
16. World Health Organization. Polio Eradication Report by the Director-General. 144th session. Provisional agenda item 5.3; 2018.
17. Global Polio Eradication Initiative/ World Health Organization. Polio this week as of 20 February 2019.
18. Bolu O, Nnadi C, Damisa E, Eunice D, Fiona B, Anisur S, Roodly WA, Philip B, Richard B, Jeffrey H, Aboyowa E, Gatei wa N, Joseph CF, Hongmei L, Saheed G, Mohammed S, Richard F, Ndadilnasiya W, Cara CB, John V, Eric W, Usman A. Progress toward poliomyelitis eradication—Nigeria, 2017. *MMWR Morb Mortal Wkly Rep*. 2018;67:253–6.
19. Farrah K, Deblina DS, Arshad Q, John FV, Cara CB, Jaume J, Steven GFW. Progress toward polio eradication — Worldwide. *MMWR Morb Mortal Wkly*. 2018;18;524–528.
20. Nigerian Primary Health Care Development Agency. Nigeria polio eradication emergency plan. 2018;5-20.
21. Nigerian Primary Health Care Development Agency. Nigeria polio eradication emergency plan. 2012;2-4.
22. United Nations Office for the Coordination of Humanitarian Affairs. Relief Web: Nigeria: humanitarian dashboard. New York, NY: United Nations Office for the Coordination of Humanitarian Affairs; 2016. Available: <https://reliefweb.int/report/nigeria/nigeria-humanitarian-dashboard-january-december-2016>
23. McNeil DG Jr. Polio response in Africa to be fast, difficult and possibly dangerous. *Health*; 2016.
24. Abdullahi M, Abdulrahim I, Abalaka M. Polio in Nigeria; the journey so far. LAMBERT academic publishing GmbH and CO. KG Heinrich-Bocking-Street. 2012;1-25.
25. Centers for Disease Control and Prevention. "Polio Vaccination"; 2016. Available: <http://www.cdc.gov/vaccines/vpd-vac/polio/default.htm>.
26. Global Polio Eradication Initiative. Annual Report 2017. Geneva, Switzerland: World Health Organization. (WHO/Polio/18.01; 2018.
27. Global Polio Eradication Initiative. (2018). Polio Eradication and Endgame Strategic Plan 2013-2018.
28. 16th Independent Monitoring Board Meeting. Progress in Polio Eradication Initiative in Nigeria: Challenges and Mitigation Strategies. London; 2017.
29. Roberts L. Polio reappears in Nigeria, triggering massive response. News. [Accessed 15 October 2016] DOI: 10.1126/science/aah7197
30. Global Polio Eradication Initiative. Nowhere to hide; New action plan to close gaps in polio detection. Global Polio Surveillance Action Plan, 2018-2020.