



Review Article

Resurgence of Vaccine-Preventable Diseases in Nigeria: Epidemiological Trends, Immunization Gaps, and Public Health Implications

Emmanuel Tooohukwu Ogbodo ^{1*}, Timilehin Daniel Olufemi ², Yemisi Omobolanle Ajayi ³ and Chinwe Ofoegbu ⁴

¹Department of Media, School of Culture and Communication, Swansea University, Swansea, Wales, UK.

²Department of Physiotherapy, University College Hospital, Ibadan, Nigeria.

³Hematology and Clinical Chemistry Department, Cerba Lancet Africa, Lagos State, Nigeria.

⁴Department of Medical Laboratory Science, Centre for Population Health Initiatives, Port Harcourt, Nigeria.

*Corresponding author: tooemma4all@gmail.com

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Abstract

Despite decades of immunization programming and major disease-control achievements, Nigeria continues to experience recurrent outbreaks and persistent transmission of vaccine-preventable diseases (VPDs). This narrative review critically synthesizes contemporary evidence on the epidemiological patterns of major VPDs in Nigeria, the distribution and determinants of immunization gaps, and their public health implications. Evidence from epidemiological studies, population-based analyses, outbreak investigations, and authoritative surveillance and programmatic sources was integrated thematically. Recent measles, diphtheria, circulating vaccine-derived poliovirus type 2, yellow fever, and meningococcal disease activity demonstrates that national disease-control achievements coexist with substantial subnational susceptibility. The evidence indicates that this pattern is driven less by uniformly inadequate national coverage than by geographically and socially concentrated populations of zero-dose and under-immunized children. These immunity gaps reflect interacting vulnerabilities, including socioeconomic disadvantage, geographic inaccessibility, gender-related constraints, population mobility, insecurity, vaccine-confidence challenges, missed vaccination opportunities, unreliable service delivery, and weaknesses in primary healthcare and surveillance. Their consequences extend beyond preventable morbidity and mortality to repeated emergency vaccination campaigns, health-system resource demands, household and societal costs, and cross-border health-security concerns. This review argues that recurrent outbreaks should be interpreted as signals of underlying failures to establish and sustain equitable population immunity. An integrated immunization-resilience framework—Detect, Map, Reach, Build Trust, Vaccinate, Retain, Monitor, and Respond—is proposed to connect surveillance, targeted service delivery, community partnership, and routine immunization strengthening. Sustainable VPD control in Nigeria will require a transition from episodic outbreak response towards equity-oriented, data-driven, community-engaged, and resilient routine immunization capable of preventing the recurrent accumulation of susceptible populations.

1. Introduction

Vaccination is among the most consequential public health interventions of the modern era, substantially reducing illness, disability, and mortality from infectious diseases that once caused widespread childhood deaths. The benefits extend beyond direct protection of vaccinated individuals: when sufficiently high and equitable coverage is sustained, vaccination reduces opportunities for pathogen transmission and protects populations that cannot be fully immunized [1]. Yet these gains remain uneven. In 2024, approximately 14.3 million infants worldwide received no routine vaccine, while almost 20 million missed at least one dose of a diphtheria–tetanus–pertussis-containing vaccine. Global coverage with the third dose remained at 85%, and progress towards the Immunization Agenda 2030 targets remains inadequate [2]. Persistent coverage gaps are particularly consequential for highly transmissible infections, because national averages can obscure susceptible populations concentrated within specific geographic or socially marginalized communities.

Nigeria occupies a critical position in this unfinished immunization agenda. Its large and rapidly growing child population means that weaknesses in routine immunization translate into substantial absolute numbers of susceptible children. More importantly, vaccination coverage is markedly heterogeneous across the country. Recent geospatial analyses demonstrate persistent clustering of zero-dose and under-immunized children, with a disproportionate burden in several northern states. UNICEF estimated that Nigeria had approximately 2.1 million zero-dose children in 2024, alongside 2.8 million children who had not received measles vaccination. These estimates place Nigeria among the countries carrying the largest absolute burden of children unreached by routine immunization. The problem therefore extends beyond inadequate national coverage to inequalities in who is reached, where children live, and whether those who enter the immunization system complete recommended vaccine schedules [3]. Evidence from Nigeria further indicates substantial regional variation in the socioeconomic, logistical, health-system and community factors associated with immunization uptake [4].

This vulnerability exists alongside substantial achievements. Nigeria reported its last case of wild poliovirus in 2016 and was subsequently certified free of wild poliovirus in 2020, contributing decisively to certification of the WHO African Region. However, wild poliovirus elimination has not eliminated the broader threat posed by vaccine-preventable diseases (VPDs). Circulating vaccine-derived poliovirus remains a concern, while measles and diphtheria outbreaks have exposed persistent pockets of susceptibility. Epidemiological analyses have demonstrated an inverse relationship between measles vaccination coverage and measles incidence across Nigerian states, while recent diphtheria outbreaks have disproportionately affected incompletely vaccinated populations. These observations present an important public health paradox: why do VPDs persist or re-emerge despite decades of immunization programming, supplementary campaigns, and major disease-control achievements? [5, 6].

Existing evidence provides important but fragmented explanations. Studies have examined individual diseases, geographic inequalities, zero-dose populations, vaccine uptake, health-system constraints and outbreak responses, often as separate problems. What remains insufficiently integrated is how these factors interact to create and sustain population-level immunity gaps and how such gaps translate into recurrent outbreaks across different VPDs [4].

This narrative review therefore critically synthesizes evidence on the epidemiological trends of major VPDs in Nigeria, examines the immunization gaps and structural conditions underlying their persistence and resurgence, and evaluates the resulting public health implications. It further integrates these dimensions to identify shared vulnerabilities across diseases and proposes a framework for shifting from recurrent outbreak response towards more equitable and resilient immunization and prevention systems.

2. Review Approach

This narrative review used an unstructured, purposive approach to identify evidence relevant to the epidemiology of vaccine-preventable diseases (VPDs), immunization gaps, and persistent population susceptibility in Nigeria. A formal systematic search or exhaustive study-selection protocol was not undertaken. Instead, evidence was selected based on its relevance to the major thematic domains of the review, including the epidemiological patterns of major VPDs in Nigeria, vaccination coverage, zero-dose and under-immunized populations, determinants of immunization uptake, geographic and socioeconomic inequalities, health-system constraints, and outbreak preparedness and response. The review therefore did not aim to include all immunization studies conducted in Nigeria, but prioritized contemporary evidence directly relevant to these themes. Peer-reviewed epidemiological studies, population-based analyses, outbreak investigations, immunization studies, and relevant reviews were considered alongside authoritative surveillance, policy, and programmatic information from the World Health Organization (WHO), United Nations Children's Fund (UNICEF), Nigeria Centre for Disease Control and Prevention (NCDC), National Primary Health Care Development Agency (NPHCDA), Federal Ministry of Health and Social Welfare, and Gavi, the Vaccine Alliance.

Emphasis was placed on contemporary evidence describing VPD occurrence, vaccination coverage, zero-dose and under-immunized populations, geographic and socioeconomic inequalities, health-system constraints, vaccine confidence, conflict and displacement, and outbreak preparedness and response. Recent evidence was prioritized to characterize the current immunization landscape, while earlier publications and institutional documents were incorporated where necessary to establish historical trends, major immunization milestones, or changes in disease epidemiology.

Evidence was organized and interpreted thematically rather than summarized study by study. Particular attention was given to recurring patterns across diseases, differences between populations and geographic settings, inconsistencies among data sources, and limitations affecting interpretation of the available evidence. This approach was used to examine how immunization gaps and broader structural vulnerabilities interact to sustain VPD transmission and to identify implications for immunization policy, outbreak prevention, and future research in Nigeria.

3. Epidemiological Resurgence of Vaccine-Preventable Diseases in Nigeria

3.1. From historical progress to contemporary resurgence

Nigeria's VPD epidemiology since 2010 is characterized by substantial progress alongside recurrent outbreaks. The most prominent achievement was interruption of indigenous wild poliovirus transmission: the last detected case occurred in 2016, and Nigeria and the wider

WHO African Region were certified free of wild poliovirus in 2020. This achievement did not, however, signify uniformly high population immunity against other VPDs. Measles continued to circulate, yellow fever re-emerged in 2017 after two decades without a confirmed case, and large diphtheria outbreaks emerged from 2022 onwards. More recent circulating vaccine-derived poliovirus type 2 (cVDPV2) and meningococcal disease activity further demonstrates that national disease-control milestones can coexist with substantial subnational susceptibility. The epidemiological picture since approximately 2019 is therefore better characterized as heterogeneous disease control than as a uniform reversal of earlier gains [7].

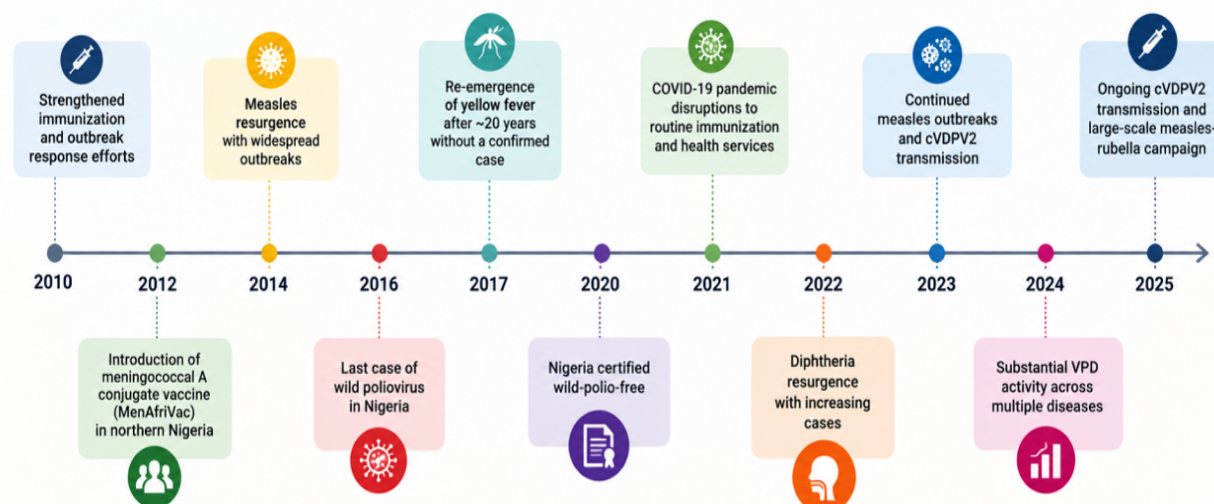


Figure 1: Epidemiological timeline of major vaccine-preventable disease resurgence and immunization milestones in Nigeria, 2010–2026

Figure 1 Epidemiological timeline of major vaccine-preventable disease resurgence and immunization milestones in Nigeria, 2010–2026. The timeline illustrates selected milestones in Nigeria’s immunization and VPD-control trajectory, including progress towards poliovirus elimination, the re-emergence and persistence of major VPD threats, disruptions associated with the COVID-19 pandemic, and subsequent vaccination and outbreak-response activities. The chronology highlights the coexistence of substantial disease-control achievements with recurrent outbreaks and persistent population immunity gaps.

3.2. Measles

Measles provides a particularly sensitive indication of immunity gaps because sustained interruption of transmission requires very high population immunity [8]. Nigerian surveillance data demonstrate persistent transmission with pronounced geographic heterogeneity. An analysis of state-level data from 2012–2021 found that recent outbreaks after 2019 were concentrated particularly in northeastern states, with Borno prominent among high-incidence settings; measles incidence was inversely associated with vaccination coverage [5]. In 2024, transmission remained geographically extensive. WHO reported 8,935 suspected cases between 1 January and 12 May, of which 4,633 were classified as confirmed by laboratory testing, epidemiological linkage or clinical compatibility; 302 of 774 districts had reached the epidemic threshold [9]. These patterns indicate that national coverage estimates conceal epidemiologically consequential pockets of susceptibility. Humanitarian settings are especially important: UNICEF reported that 62% of confirmed cases in its northeast humanitarian reporting were among children younger than five years and 74% were zero-dose children. Thus, contemporary measles epidemiology reflects not simply persistent transmission, but clustering of susceptibility among children and locations insufficiently protected by routine vaccination.

3.3. Diphtheria

The scale of Nigeria’s recent diphtheria resurgence is particularly striking. NCDC surveillance recorded 42,642 suspected cases from epidemiological week 19 of 2022 through week 10 of 2025, of which 25,812 were confirmed. Confirmed cases occurred in 184 local government areas across 26 states, but transmission was highly concentrated: Kano alone accounted for 18,108 confirmed cases, while substantial burdens were also reported in Bauchi, Yobe, Katsina and Borno. Children aged 1–14 years constituted 62.9% of confirmed cases. Only 19.3% of confirmed cases were documented as fully vaccinated with a diphtheria-toxoid-containing vaccine, and 1,319 deaths were recorded among confirmed cases [10]. The age and vaccination profiles are epidemiologically important because they indicate accumulated susceptibility extending beyond infancy. Analysis of 18,320 cases in Kano between 2022 and 2024 similarly identified a major peak in August 2023 and a smaller resurgence in early 2024, demonstrating prolonged rather than transient outbreak activity [11]. This prolonged transmission continued into 2026. By epidemiological Week 32 of 2026, NCDC had recorded 12,977 suspected cases, 10,476 confirmed cases and 406 deaths nationally, demonstrating that diphtheria remained an important ongoing VPD threat [12].

3.4. Poliomyelitis

Polio epidemiology requires a clear distinction between wild poliovirus and circulating vaccine-derived poliovirus. Nigeria's elimination of wild poliovirus represents a major and sustained achievement; subsequent cVDPV2 transmission does not constitute a return of indigenous wild poliovirus. Nevertheless, cVDPV2 circulation indicates the presence of populations with insufficient intestinal immunity to prevent sustained transmission of reverted vaccine-derived strains. WHO's progressively updated 2024 surveillance eventually attributed 94 of the 265 globally reported cVDPV2 cases to Nigeria, illustrating the country's continuing importance to global eradication efforts [13]. UNICEF humanitarian reporting separately documented 118 unvaccinated Nigerian children affected by vaccine-derived type 2 poliovirus across 15 states during 2024, with Kano, Sokoto and Katsina prominent. Differences between these figures reflect reporting periods and surveillance classifications and should not be treated as interchangeable estimates. Continued transmission into 2025 confirms that the epidemiological challenge has shifted from eliminating wild poliovirus to closing immunity gaps that permit cVDPV circulation [14].

3.5. Yellow fever

Yellow fever illustrates a different form of resurgence. After 21 years without a confirmed Nigerian case, the disease re-emerged in Kwara State in September 2017 and subsequently produced outbreaks across multiple regions. Between September 2017 and September 2019, 7,894 suspected and 287 laboratory-confirmed cases were reported, with outbreaks confirmed in 55 LGAs [15]. A broader national surveillance analysis covering 2017–2023 identified 16,777 suspected cases and 585 positive cases among 8,532 with laboratory result, while also demonstrating variation according to ecological zone, season, age and other epidemiological characteristics [16]. The geographic breadth and persistence of cases despite reactive and preventive vaccination campaigns indicate that yellow fever risk cannot be understood solely through national vaccine coverage; vector ecology and spatially heterogeneous population immunity are also relevant to transmission [15, 16].

3.6. Other continuing VPD burdens

Other VPDs reinforce this pattern of incomplete control. During the 2024–2025 meningitis season, NCDC recorded 1,858 suspected cerebrospinal meningitis cases and 156 deaths by epidemiological week 12 of 2025, with 126 laboratory-confirmed cases; *Neisseria meningitidis* serogroups C and W predominated among characterized infections [17]. Maternal and neonatal tetanus also remains unfinished business: as of 2026, Nigeria had not yet achieved nationwide validated maternal and neonatal tetanus elimination [18]. Compared with measles, diphtheria and meningitis, contemporary national evidence on pertussis incidence remains limited, constraining confident assessment of its recent temporal trajectory.

3.7. Cross-disease epidemiological synthesis

Across diseases, the dominant epidemiological feature is not uniform nationwide resurgence but persistent and recurrent transmission concentrated within susceptible populations and geographic pockets. Measles, diphtheria and cVDPV2 show particularly strong concentration among unvaccinated or incompletely vaccinated children, while northern and conflict-affected settings repeatedly appear in surveillance data. Yellow fever adds an ecological dimension, demonstrating that population immunity interacts with vector and environmental conditions. Collectively, these patterns caution against interpreting national vaccination averages or major elimination milestones as evidence of homogeneous protection. Nigeria's contemporary VPD burden is increasingly defined by the spatial clustering and accumulation of susceptible populations capable of sustaining transmission when pathogens are introduced or reintroduced. The major epidemiological patterns across these VPDs are synthesized in Table 1, highlighting differences in disease resurgence, affected populations, underlying immunity gaps, and their implications for disease control in Nigeria [5, 14].

4. Immunization Gaps and Inequities

4.1. National vaccination coverage and temporal trends

Nigeria's immunization profile is characterized by gradual improvement in some indicators but persistent gaps in both access to and completion of routine vaccination. These two dimensions can be distinguished using coverage with the first and third doses of diphtheria–tetanus–pertussis-containing vaccine (DTP1 and DTP3). DTP1 provides an indication of whether children enter the routine immunization system, whereas the difference between DTP1 and DTP3 identifies children who initiate but do not complete the primary series. Analysis of nationally representative household surveys found that DTP1 coverage increased from 64.8% in the 2018 Nigeria Demographic and Health Survey to 71.0% in the 2021 Multiple Indicator Cluster Survey/National Immunization Coverage Survey; MCV1 coverage increased from 53.4% to 61.1% over the same surveys [19]. These improvements are important, but coverage remains insufficient to prevent accumulation of susceptible children, particularly for measles, for which population protection requires very high and spatially consistent coverage. The continued occurrence of measles, diphtheria and cVDPV2 described above therefore needs to be interpreted not simply against national coverage estimates, but against the distribution of immunity within the population [5].

Table 1: Epidemiological profile of major vaccine-preventable diseases in Nigeria

Vaccine-preventable disease	Recent epidemiological pattern	Populations/settings disproportionately affected	Principal immunity or prevention gap	Public-health significance
Measles	Persistent transmission with recurrent outbreaks and substantial geographic heterogeneity; extensive outbreak activity continued in 2024	Young children, particularly zero-dose children; northeastern and humanitarian settings	Inadequate and spatially uneven measles vaccine coverage, with clusters of unvaccinated children	Highly sensitive marker of population immunity gaps; outbreaks reveal susceptible communities concealed by national coverage estimates [5].
Diphtheria	Large, prolonged resurgence from 2022 onward, with cases reported across multiple states and particularly high burden in Kano	Children aged 1–14 years; unvaccinated and incompletely vaccinated populations; several northern states	Accumulated susceptibility resulting from absent or incomplete diphtheria-toxoid-containing vaccination	High morbidity and mortality; demonstrates that susceptibility can accumulate beyond infancy when routine vaccination is incomplete [11]
Poliomyelitis / cVDPV2	Wild poliovirus transmission interrupted, but cVDPV2 circulation has persisted, including substantial activity during 2024–2025	Unvaccinated and under-immunized children; several northern states and hard-to-reach populations	Insufficient population immunity permitting sustained circulation of vaccine-derived poliovirus	Threatens polio-eradication gains and demonstrates that wild-polio elimination does not eliminate risks created by immunity gaps [13].
Yellow fever	Re-emerged in 2017 after approximately two decades without a confirmed case, followed by outbreaks across multiple regions	Populations in areas with inadequate immunity and ecological conditions conducive to transmission	Spatially heterogeneous vaccine-derived immunity interacting with vector exposure	Demonstrates interaction between vaccination gaps, population susceptibility and ecological determinants of transmission [15, 16].
Meningococcal meningitis	Continuing seasonal outbreaks, including substantial suspected disease and mortality during the 2024–2025 meningitis season	Populations within meningitis-prone areas, particularly northern Nigeria	Incomplete population protection against circulating meningococcal serogroups	Produces preventable mortality and neurological sequelae and places recurrent seasonal pressure on surveillance and outbreak-response systems [20].
Maternal and neonatal tetanus	Elimination remains incomplete; Nigeria had not achieved validated maternal and neonatal tetanus elimination as of 2026	Mothers and newborns in populations with inadequate vaccination and maternal/newborn health-service access	Persistent gaps in maternal immunization and associated maternal/newborn health interventions [18]	Remains an important cause of preventable maternal and neonatal mortality and highlights persistent gaps in maternal immunization and access to safe maternal and newborn health services [18, 21].

4.2. The zero-dose challenge

The persistence of this problem is particularly important when considered alongside vaccination dropout. Longitudinal analysis of Nigerian household surveys from 2003 to 2018 found substantial reductions in zero-dose, under-immunized and dropout prevalence in most geopolitical zones, demonstrating that progress is possible. More recent evidence, however, indicates that gains have not been evenly sustained. An ecological analysis covering 2018–2024 found that DTP1 coverage in the North-West declined from 37.3% to 33.4%, while zero-dose prevalence increased from 25.7% in 2021 to 47.4% in 2024. In contrast, DTP1 coverage remained above 90% in the South-East, where zero-dose prevalence was approximately 4% in 2024. Notably, DTP1-to-DTP3 dropout in the North-West decreased from 38.7% in 2018 to 14.3% in 2024. The juxtaposition is informative: completion among children who successfully enter the vaccination pathway may improve even while large numbers of children remain unreached at its beginning [3, 4].

4.3. Geographic inequalities

National averages therefore conceal pronounced spatial inequalities. Analyses spanning multiple Nigerian household surveys consistently identify higher levels of zero-dose and incomplete vaccination in northern than southern zones and in rural compared with urban populations [22]. Recent geospatial analysis of surveys conducted between 2003 and 2023/2024 identified persistent concentrations of missed DTP vaccination in northern Nigeria, with Kebbi, Sokoto, Zamfara and parts of Niger, Kwara, Borno, Yobe, Taraba and Kogi among areas with a high probability of zero-dose prevalence exceeding 10%. These patterns overlap with settings affected by poverty, remoteness, population mobility or insecurity, although their relative contribution varies considerably across locations. UNICEF's state-level analysis similarly demonstrates that the distribution of zero-dose children does not correspond uniformly with the number of available health facilities, suggesting that physical service presence alone cannot explain geographic disparities. Conflict-affected and hard-to-reach populations present an additional challenge because insecurity can interrupt fixed and outreach services while simultaneously constraining surveillance and population access [23].

4.4. Socioeconomic and demographic inequalities

Immunization inequalities also follow a marked social gradient. Maternal education is among the most consistently reported correlates of childhood vaccination in Nigeria. In the 2021 MICS, 70.6% of children aged 12–23 months whose mothers had tertiary education were fully vaccinated, compared with only 21.2% among children whose mothers had no formal education. Zero-dose prevalence showed the inverse pattern, increasing from 1.9% among children of mothers with tertiary education to 31.3% among those whose mothers had no education. Household wealth is also associated with immunization status, although its influence differs across geographic settings. Analysis of Nigerian DHS data found that improvements in maternal education and household wealth contributed to reductions in zero-dose and under-immunized populations, particularly in rural settings, but explained much less of the change in vaccination dropout. These findings caution against treating socioeconomic disadvantage as a single causal explanation; education, household resources, residence and local health-system conditions intersect rather than operate independently [5, 24].

4.5. Access versus utilization

The distinction between being reached and remaining engaged is therefore central to interpreting Nigeria's immunization gap. A child who never receives DTP1 reflects failure at the point of initial access, whereas a child who receives DTP1 but not DTP3 reflects failure to complete an established vaccination pathway. These outcomes can arise from different combinations of supply- and demand-side constraints. Geographic inaccessibility, insecurity, service interruptions and inadequate outreach can prevent first contact, while repeated travel requirements, indirect costs, missed opportunities, caregiver perceptions and service experience can influence continuation. The coexistence of high zero-dose prevalence with declining DTP1–DTP3 dropout in some northern settings demonstrates why these problems should not be conflated. Nigeria's immunization challenge is consequently not reducible to low aggregate coverage: it comprises unequal access, incomplete continuity and the concentration of both disadvantages within particular populations. Understanding the mechanisms that produce these patterns requires examination of the individual, household, community, health-system and structural conditions considered in the next section [4].

5. Why Are VPDs Resurging? A Multilevel Analysis

The persistence and resurgence of vaccine-preventable diseases (VPDs) in Nigeria cannot be attributed to a single deficit in vaccine supply, caregiver knowledge, or service utilization. Rather, the immunity gaps described above emerge from interacting determinants operating at individual, household, community, health-system, and broader structural levels. Importantly, these determinants do not operate uniformly across Nigeria. Their relative importance varies between states, communities, population groups, and stages of the immunization pathway.

5.1. Individual and caregiver-level determinants

Caregiver knowledge and perceptions influence whether vaccination is initiated and completed. In Nigeria, incomplete understanding of immunization schedules can coexist with concerns about vaccine safety, fear of adverse events, misconceptions, and low perceived susceptibility to VPDs. UNICEF has previously identified lack of awareness as an important communication-related barrier to completion of routine immunization, alongside mistrust, fear, service-delivery problems, lack of time, and distance to vaccination sites. These findings suggest that apparent vaccine refusal should not automatically be interpreted as ideological opposition to vaccination. Caregivers may accept vaccination in principle yet fail to complete schedules because they misunderstand dose requirements, anticipate adverse effects, encounter inconvenient services, or assign greater urgency to competing responsibilities. Previous interactions with healthcare services may further reinforce either confidence or disengagement. Consequently, vaccine confidence and practical access are often intertwined rather than independent determinants [4].

5.2. Household and socioeconomic determinants

Household resources determine how easily willingness to vaccinate can be translated into action. Although childhood vaccines are provided through public immunization programmes, access may still involve transportation, travel-time and other opportunity costs. These burdens may be particularly consequential for socioeconomically disadvantaged households and those living far from vaccination services. Maternal education may also influence knowledge of vaccination and the ability to navigate health services, while household wealth and place of residence further shape the likelihood of completing childhood immunization [25].

Gender is particularly relevant in this respect. A 2025 NPHCDA–UNICEF analysis identified interconnected gender-related constraints, including women’s limited economic resources, unequal decision-making power, educational disadvantage, and sociocultural expectations surrounding responsibility for children’s healthcare. Women may carry primary responsibility for obtaining immunization while lacking independent control over transport expenditure, time, or decisions concerning healthcare utilization. Gender should therefore not be treated simply as a maternal characteristic; it can shape the distribution of resources and authority required to access vaccination services [26].

5.3. Community-level determinants

Community environments can amplify or mitigate household-level barriers. Information about vaccination circulates through family networks, peers, religious and traditional leaders, health workers, and increasingly digital communication channels. Rumours and misinformation may reduce confidence, particularly where trust in government or formal healthcare institutions is already weak. Religious affiliation itself, however, should not be treated as a sufficient explanation for low uptake. What matters epidemiologically is how local leadership, historical experiences, institutional trust, social norms, and information networks influence vaccination decisions within particular contexts.

Mobility presents an additional challenge. Nomadic groups, seasonal migrants, displaced populations, and families moving between settlements may not fit vaccination systems organized around stable residence and scheduled facility attendance. Community engagement is therefore not merely a mechanism for persuading hesitant caregivers; it can also identify missed populations, adapt service delivery to local mobility patterns, and establish trusted channels through which vaccination programmes operate [27].

5.4. Health-system determinants

Demand for vaccination cannot produce high coverage if services are unreliable. Nigerian evidence identifies vaccine availability, logistics, service organization, missed opportunities and the quality of routine delivery as important influences on immunization uptake. Weaknesses in vaccine management and cold-chain practice can compromise service reliability, while broader analyses of zero-dose and missed-dose children show that inconvenient delivery arrangements, inconsistent service availability and missed vaccination opportunities can prevent eligible children from receiving recommended doses. These findings illustrate how supply-side failures can reinforce demand-side barriers: when caregivers invest time and resources in reaching vaccination services but encounter unavailable or poorly organized services, continued engagement may become more difficult [4, 25, 26].

Missed opportunities within health facilities compound this problem. Nigerian studies have documented vaccine-eligible children leaving health facilities without receiving indicated vaccination, demonstrating that contact with the health system does not necessarily translate into immunization. Workforce constraints, inconvenient session schedules, cold-chain and logistics limitations, weak documentation, and inconsistent use of vaccination status during clinical encounters can therefore contribute to incomplete coverage. At programme level, weaknesses in denominators, vaccination records and surveillance data can also obscure pockets of low coverage until disease transmission exposes them [28].

5.5. Structural and geopolitical determinants

The effects of these health-system limitations are magnified by insecurity, displacement, remoteness and population mobility. Evidence from Borno State shows that insecurity can restrict access to settlements, disrupt campaign implementation and complicate efforts to reach eligible children. Internal displacement can likewise impede planned vaccination activities when population movement changes where target populations are located and how they can be reached. These challenges are especially important for routine and supplementary immunization strategies that depend on accurate microplanning, predictable access and repeated contact with children. Structural and geopolitical conditions therefore shape the capacity of immunization programmes to reach populations consistently and to prevent the accumulation of susceptibility [20, 23].

5.6. COVID-19 and accumulated immunity gaps

The COVID-19 pandemic intensified existing vulnerabilities by disrupting routine health services, restricting mobility, redirecting health-system resources, and delaying vaccination in many settings. Its role in Nigeria should nevertheless be interpreted as an **amplifier rather than the origin** of contemporary immunization gaps. Regional inequalities, zero-dose populations, stock-outs, missed opportunities, insecurity, and vaccine-confidence challenges were documented before 2020. The pandemic consequently added susceptible children to populations in which immunity gaps had already accumulated, potentially increasing the conditions for subsequent outbreaks.

5.7. Interacting vulnerabilities and outbreak emergence

Taken together, these findings challenge explanations that attribute VPD resurgence to a single cause such as hesitancy, poverty, conflict, or weak vaccine supply. The more plausible interpretation is a multilevel accumulation of vulnerability. Poverty can increase the cost of reaching services; gender relations can constrain the caregiver’s capacity to act; misinformation can weaken motivation; unreliable services can erode trust; insecurity can interrupt outreach; and population mobility can prevent completion of multidose schedules. When these conditions converge geographically, they generate clusters of zero-dose and under-immunized children in which susceptibility accumulates over successive birth cohorts. Introduction or continued circulation of a sufficiently transmissible pathogen can then convert those underlying

immunity gaps into outbreaks. VPD resurgence in Nigeria is therefore best understood not as an isolated failure of vaccination demand or supply, but as the epidemiological expression of interacting social, health-system, and structural vulnerabilities. The interacting determinants identified across the evidence can be organized into a multilevel pathway in which barriers operating at individual, household, community, health-system, and structural levels generate and sustain population immunity gaps Table 2. Importantly, these determinants require different but complementary responses rather than a single intervention focused exclusively on vaccine demand or supply [5, 29].

Table 2: Multilevel determinants of immunization gaps and VPD resurgence in Nigeria and corresponding programmatic responses

Level	Key determinants	Mechanism contributing to immunity gaps	Potential programmatic responses
Individual/caregiver	Limited knowledge of vaccination schedules; safety concerns; fear of adverse events; misconceptions; low perceived disease risk	Delayed vaccination, failure to initiate vaccination, or incomplete multidose schedules	Clear schedule communication; reminder and recall systems; context-specific risk communication; respectful counselling during healthcare encounters [29]
Household and socioeconomic	Poverty; transportation and opportunity costs; maternal educational disadvantage; limited household resources; gendered decision-making constraints	Caregivers may be willing to vaccinate but unable to meet the financial, temporal or decision-making requirements of repeated service use	Reduce indirect access costs; bring vaccination closer to communities; integrate immunization with other maternal and child health services; address gender-related access barriers [25, 26]
Community	Misinformation; weak institutional trust; social norms; influence of community information networks; population mobility	Reduced confidence or acceptance; delayed uptake; difficulty maintaining vaccination schedules among mobile populations	Sustained community engagement; partnership with trusted local leaders; locally adapted communication; vaccination strategies responsive to population mobility [27, 29]
Health system	Vaccine-supply and logistics constraints; missed vaccination opportunities; workforce limitations; inconvenient service organization; weak documentation	Unreliable or poorly organized services can prevent vaccination at contact, interrupt multidose schedules and reduce continued engagement	Strengthen vaccine logistics and cold chain; check vaccination status routinely; improve service organization, workforce capacity, follow-up and immunization records [4, 28, 29]
Structural and geopolitical	Insecurity; conflict; displacement; remoteness; hard-to-reach settlements; migration and population movement	Restricted access, disrupted outreach and changing population locations can impede repeated contact and leave susceptible populations unreached	Adapt microplanning and outreach to insecure, displaced and mobile populations; use locally feasible delivery strategies and update target-population information [23, 27]
Cross-cutting data and governance	Weak population denominators; fragmented immunization and surveillance information; delayed identification of low-coverage pockets; financing constraints	Immunity gaps may remain undetected or poorly localized, limiting timely preventive action	Strengthen LGA-level monitoring; integrate epidemiological, immunization and demographic data; use geospatial targeting and outbreak information to improve routine programmes [3, 30]

6. Public Health and Health-System Implications

6.1. Morbidity, mortality and disability

The resurgence of vaccine-preventable diseases (VPDs) in Nigeria has consequences extending beyond the number of cases recorded during individual outbreaks. Severe disease and preventable mortality remain immediate concerns, particularly among young children and populations with limited access to timely care. The recent diphtheria resurgence illustrates this burden, with substantial mortality documented during the prolonged outbreak in Kano and nationally reported deaths among confirmed cases. Poliovirus transmission carries an additional risk of preventable paralytic disease, reinforcing the importance of maintaining sufficiently high population immunity. More broadly, the health burden of VPD resurgence should be understood in terms of mortality, acute illness and preventable disability rather than incidence alone. These consequences can be amplified where malnutrition, delayed presentation or restricted healthcare access increase vulnerability to severe outcomes [1, 8, 11].

6.2. Health-system consequences

VPD outbreaks also impose demands on health systems that extend beyond treatment of individual patients. Outbreak confirmation requires case detection, specimen collection, laboratory testing, contact tracing and intensified surveillance. Confirmed transmission can subsequently trigger reactive vaccination campaigns, community mobilization, enhanced surveillance and deployment of additional personnel and supplies. These activities are necessary for outbreak control but require financial, laboratory and workforce resources that could

otherwise support routine primary healthcare. Repeated emergency responses may be particularly disruptive where routine immunization services are already constrained. The result can be a counterproductive cycle in which underlying immunity gaps generate outbreaks, outbreaks require resource-intensive campaigns, and attention to emergency control competes with the routine systems needed to prevent subsequent outbreaks [31]. These pressures occur within health systems already managing other substantial infectious-disease challenges, including antimicrobial-resistant infections; evidence from African diabetic foot ulcers, for example, demonstrates a considerable burden of multidrug-resistant organisms and adverse clinical outcomes, further underscoring the importance of resilient laboratory, surveillance, and infection-management capacity [32].

6.3. Economic and societal consequences

The economic burden of VPD resurgence operates at household, health-system, and broader societal levels. Families affected by outbreaks may incur transportation and treatment expenses while also losing income or productive time when caregivers must seek care or remain with sick children. Severe disease and disability can extend these costs beyond the acute episode through rehabilitation needs, prolonged caregiving, interrupted education, and reduced future productivity. Such consequences may be particularly important for economically disadvantaged households, for whom even relatively modest healthcare and transportation costs can intensify existing vulnerability [33, 34].

At the health-system level, recurrent outbreaks require resources for epidemiological investigation, laboratory confirmation, intensified surveillance, emergency vaccine deployment, risk communication, community mobilization, and supplementary immunization activities. Although these interventions are essential for controlling transmission, repeated emergency responses carry substantial opportunity costs because financial and human resources committed to outbreak control cannot simultaneously support other routine health priorities. This distinction is important in Nigeria, where the same primary healthcare system is expected to maintain routine immunization while responding to recurrent disease threats.

Robust national estimates quantifying the aggregate economic burden of recurrent VPD outbreaks in Nigeria remain limited, making precise monetary comparisons inappropriate. Nevertheless, the available epidemiological pattern supports an important policy consideration: preventing immunity gaps through sustained routine immunization is fundamentally different from repeatedly mobilizing resources after transmission has become established. Economic evaluations comparing the long-term costs and outcomes of strengthening routine immunization with those of recurrent outbreak response would therefore provide valuable evidence for future resource allocation and immunization policy [33].

7. From Reactive Outbreak Control to Immunization Resilience: An Integrated Framework

The evidence synthesized in this review suggests that recurrent VPD outbreaks in Nigeria cannot be sustainably controlled through reactive vaccination campaigns alone. Campaigns remain indispensable for interrupting transmission and rapidly closing immunity gaps, but their protective effect may be temporary when the conditions that continually generate zero-dose and under-immunized populations remain unchanged. Nigeria therefore requires a transition from episodic outbreak control towards immunization resilience, defined here as the capacity of the immunization system to identify susceptibility, reach underserved populations, maintain vaccine uptake across successive birth cohorts, detect emerging transmission, and respond without compromising routine service delivery [35].

Figure 2 Integrated framework for transitioning from reactive vaccine-preventable disease outbreak control to immunization resilience in Nigeria. The framework illustrates how structural vulnerabilities and barriers to immunization contribute to zero-dose and under-immunized populations, population immunity gaps, pathogen circulation, outbreaks, reactive vaccination campaigns, and temporary disease control. The proposed resilience pathway—Detect, Map, Reach, Build Trust, Vaccinate, Retain, Monitor, and Respond—seeks to interrupt this recurring cycle by strengthening the identification, reach, uptake, continuity, and monitoring of immunization. Sustainable financing, a skilled workforce, reliable vaccine supply and cold chain support the transition towards sustained population immunity and reduced outbreak risk.

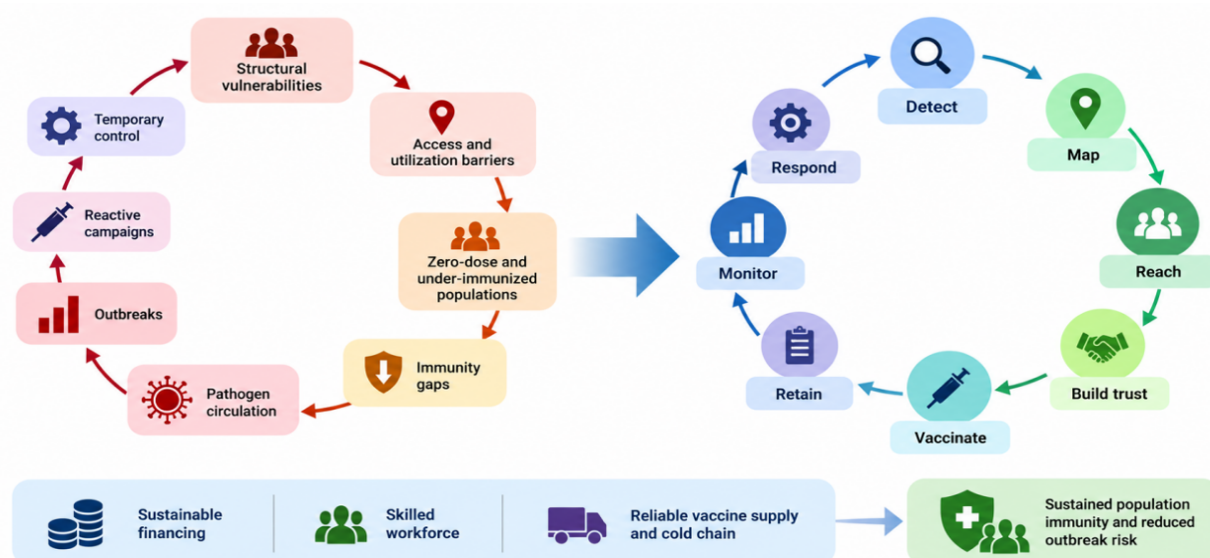


Figure 2: Integrated framework for transitioning from reactive vaccine-preventable disease outbreak control to immunization resilience in Nigeria

We propose an integrated framework organized around eight connected functions: Detect → Map → Reach → Build Trust → Vaccinate → Retain → Monitor → Respond. Detection begins with identifying both disease transmission and populations inadequately reached by vaccination. Surveillance data should therefore be interpreted alongside immunization records and population information rather than waiting for outbreaks to reveal immunity gaps. Mapping converts these data into geographically actionable information by locating zero-dose children, under-immunized communities, mobile populations and recurrent outbreak areas. Geospatial analysis and local microplanning can support more precise allocation of outreach teams, vaccines and other resources [23, 30].

Identification must subsequently translate into access. Reach emphasizes adapting delivery to the circumstances of populations poorly served by conventional facility-based immunization, including remote settlements, displaced populations, nomadic communities and underserved urban populations. Outreach, mobile vaccination and integration of immunization with other primary healthcare services can reduce missed opportunities for contact. However, physical availability alone does not guarantee uptake. Build Trust therefore recognizes community partnership as an operational component of immunization rather than an adjunct communication activity. Engagement with caregivers, community representatives, religious and traditional leaders, and frontline health workers can help identify locally specific concerns, counter misinformation and improve the acceptability of services [26, 29].

Vaccinate represents reliable delivery once contact is established. This requires adequate vaccine availability, functional cold chains, trained personnel and consistent service schedules. **Retain** addresses the distinction identified earlier between reaching a child once and ensuring completion of multidose schedules. Default tracing, reminder systems, vaccination-status checks during healthcare encounters and integration with maternal and child health services can reduce loss between successive doses.

The final two functions create a continuous feedback mechanism. Monitor requires timely surveillance of vaccination coverage, dropout, vaccine availability and VPD occurrence at sufficiently disaggregated levels to detect emerging pockets of susceptibility. **Respond** entails rapid outbreak investigation and targeted vaccination when transmission occurs, but response data should feed back into mapping and routine programme improvement rather than ending when an outbreak subsides.

Four enabling domains underpin the entire pathway: equity, primary healthcare, data and surveillance, and community partnership. Sustainable financing, workforce capacity and reliable vaccine supply are cross-cutting requirements for these domains. More broadly, experience from infectious-disease control demonstrates the importance of sustained partnerships, equitable resource allocation, local capacity development, and long-term financing in maintaining disease-control gains [36]. The framework therefore reframes outbreaks as signals of where routine protection has failed, not simply emergencies requiring temporary suppression. Nigeria's 2025 measles-rubella campaign illustrates the scale that coordinated delivery can achieve: UNICEF reported vaccination of 59.4 million children, while integrated interventions reached approximately 651,400 zero-dose children aged 1–2 years. The strategic challenge is to convert such campaign capacity into sustained routine protection. Immunization resilience ultimately depends on preventing susceptible populations from repeatedly accumulating between campaigns, thereby shifting the system from recurrent crisis response towards continuous prevention [37].

8. Knowledge Gaps and Future Research Priorities

Despite substantial surveillance and immunization research in Nigeria, important evidence gaps limit understanding of where vaccination-derived population protection is inadequate or deteriorating, why specific communities remain unreached, and which interventions produce sustained improvements. A central priority is the development of longitudinal, subnational analyses linking vaccination coverage with subsequent VPD incidence. National and state-level averages can conceal substantial local heterogeneity; consequently, analyses at local government area (LGA) or finer spatial resolution are needed to determine whether persistent zero-dose and under-immunized clusters predict subsequent outbreaks and how these relationships change over time. Existing geospatial studies demonstrate the value of fine-scale mapping, but stronger linkage among immunization, demographic, geospatial, and disease-surveillance data is needed for prospective identification of populations at greatest risk [3, 5, 22].

Research should also distinguish more clearly between failure to initiate vaccination and failure to complete multidose schedules. Evidence from Nigeria indicates that zero-dose, under-immunized, and dropout populations do not necessarily share the same determinants, and socioeconomic factors may influence these outcomes differently. Future studies should therefore evaluate initial access and subsequent continuation as related but distinct components of the immunization pathway rather than combining them into a single measure of incomplete vaccination [25, 38].

Important evidence gaps also remain for populations that may be inadequately represented in conventional household surveys or facility-based data. Nomadic populations, internally displaced people, mobile families, populations affected by insecurity, hard-to-reach rural settlements, and underserved urban communities may experience distinctive barriers to vaccination. Research should examine how mobility, displacement, insecurity, and geographic isolation affect vaccination access and continuity while evaluating delivery strategies specifically adapted to these populations [23, 27, 29].

Implementation research is needed to determine which combinations of interventions produce durable improvements in routine immunization. Nigerian evidence describes numerous barriers and potential responses, but comparatively less evidence establishes whether strategies such as outreach and mobile delivery, integration with primary healthcare, reminder and follow-up systems, community engagement, supply-chain strengthening, and locally adapted communication produce sustained improvements after intensive campaigns or time-limited interventions end. Comparative evaluations should assess not only doses delivered but also equity, multidose-series completion, feasibility, cost, scalability, and persistence of effect [4, 28, 29].

Further research is also required on vaccine confidence and community partnership. Misinformation, institutional trust, previous service experiences, and practical barriers to access can interact, making it difficult to distinguish attitudinal barriers from failures of service delivery. Mixed-methods and community-engaged studies could clarify how these mechanisms vary across states and population groups and determine which forms of engagement improve both vaccine acceptance and continued use of routine immunization services [4, 26, 29].

The economic evidence base should also be strengthened. Existing Nigerian evidence demonstrates that measles can expose households to catastrophic health expenditure, but robust national estimates comparing the economic consequences of recurrent VPD outbreaks with sustained investment in routine immunization remain limited. Future economic evaluations should assess household expenditure, health-system costs, caregiver productivity losses, and the longer-term value of preventing outbreaks through resilient routine immunization [33].

Finally, future research would benefit from stronger integration of immunization, disease-surveillance, demographic, and geospatial information. Linking these data at sufficiently disaggregated levels could enable programmes to identify emerging susceptibility before outbreaks occur, while integration with responsive epidemiological modelling may further support timely interpretation of surveillance data and evidence-informed public health decision-making [3, 5, 30, 39].

9. Conclusion

The resurgence and persistence of vaccine-preventable diseases in Nigeria cannot be adequately understood through national vaccination coverage estimates alone. Major achievements, including interruption of wild poliovirus transmission and the capacity to conduct vaccination campaigns at considerable scale, coexist with recurrent measles, diphtheria, cVDPV2, yellow fever and other VPD threats. This apparent contradiction becomes clearer when population immunity is examined at subnational and community levels. National averages can conceal geographically concentrated clusters of zero-dose and under-immunized children in which susceptibility accumulates across successive birth cohorts.

These immunity gaps are not produced by a single barrier. They emerge through interactions among socioeconomic disadvantage, unequal access to primary healthcare, incomplete vaccination schedules, service and supply constraints, population mobility, insecurity, gendered household circumstances, and variable confidence in vaccination and health institutions. Consequently, outbreak control that closes immunity gaps temporarily without addressing the conditions that recreate them is unlikely to provide durable protection.

Nigeria's central challenge is therefore to move from repeated cycles of outbreak detection and emergency response towards sustained immunization resilience. This requires identifying susceptible populations before outbreaks expose them, strengthening routine primary healthcare, using disaggregated surveillance and immunization data for local action, maintaining reliable vaccine delivery, and building durable partnerships with communities. An equity-oriented, data-driven and community-engaged immunization system would shift the objective from repeatedly controlling VPD resurgence to preventing the accumulation of susceptibility that makes resurgence possible.

Article Information

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