

Diphtheria Resurgence in Nigeria: *Corynebacterium diphtheriae* resistance, Examining the Etiology, Vaccination Challenges, and Crisis Management

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ABSTRACT:

Diphtheria, a vaccine-preventable disease caused by *Corynebacterium diphtheriae*, has re-emerged as a public health concern in Nigeria. Since 2022, over 41,000 suspected cases have been reported across 37 states, with Kano, Yobe, Katsina, Bauchi, Borno, Kaduna, and Jigawa being the most affected. The disease primarily affects children aged 1–14 years, who account for nearly 64% of confirmed cases. Transmission occurs via respiratory droplets, direct contact, or contaminated surfaces. Alarmingly, only 19.7% of confirmed cases were fully vaccinated with a diphtheria toxoid-containing vaccine, underscoring Nigeria's low routine immunization coverage.

Efforts to contain the outbreak have included reactive vaccination campaigns and public health interventions promoting DTaP or Tdap vaccines, hand hygiene, and respiratory etiquette. However, challenges persist: poor immunization coverage, inadequate laboratory capacity, delayed case confirmation, and limited access to diphtheria antitoxin (DAT), which is critical for treatment. Additionally, unsafe caregiving practices such as unprotected contact with infected individuals and shared bedding among children, exacerbate transmission risks.

A coordinated response involving mass vaccination, enhanced surveillance, community engagement, and improved healthcare infrastructure are essential to curb the outbreak. Addressing these systemic gaps with urgency and diligence is indispensable to prevent further spread and safeguard vulnerable populations.

Key Words: Diphtheria, *Corynebacterium diphtheriae*, Nigeria, Vaccination Coverage, Public Health Response, Diphtheria Antitoxin, etiologic agent and resistance.

I. INTRODUCTION

Diphtheria, a vaccine-preventable bacterial infection, has been largely suppressed in many regions through effective immunisation campaigns. However, Nigeria has recently experienced a troubling resurgence of diphtheria outbreaks, leading to considerable morbidity and mortality. This resurgence is particularly concerning given the country's prior success in controlling the disease. This paper explores the resurgence of diphtheria in Nigeria, focusing on the resistance of *Corynebacterium diphtheriae* the etiologic agent alongside vaccination challenges and crisis management strategies that have influenced the outbreak trajectory.

Background

Diphtheria is primarily caused by *Corynebacterium diphtheriae* and occasionally by *Corynebacterium ulcerans*. It affects the upper respiratory tract and is highly contagious, spreading through respiratory droplets, contaminated surfaces, and vectors such as flies (Adegboye et al., 2023). Nigeria, with a population exceeding 200 million, faces persistent challenges in maintaining adequate vaccination coverage, especially in rural and underserved areas.

Between May 2022 and April 2023, Nigeria reported 1,439 suspected diphtheria cases, of which 557 (39%) were confirmed. These included laboratory-confirmed cases, epidemiologically linked cases, and those clinically compatible with diphtheria. The case fatality ratio among confirmed cases was approximately 13% (World Health Organization [WHO], 2023). Kano State alone accounted for 85% of the national case burden, highlighting regional disparities in

outbreak severity (Nigeria Centre for Disease Control [NCDC], 2023).

Historically, Nigeria achieved a significant reduction in diphtheria incidence during the 1990s and early 2000s. However, recent data indicate a more than 500% increase in reported cases between 2019 and 2022. Factors contributing to this resurgence include suboptimal vaccination coverage, weakened disease surveillance, and strained healthcare infrastructure. The COVID-19 pandemic further disrupted immunisation services, exacerbating the situation and triggering widespread outbreaks post-pandemic.

This overview sets the foundation for a detailed investigation into the multifaceted drivers of diphtheria's resurgence in Nigeria.

Aim

To investigate the resurgence of diphtheria in Nigeria by analysing the resistance patterns of *Corynebacterium diphtheriae*, vaccination challenges, and crisis management strategies.

Objectives

1. Identify the etiologic agent responsible for the current diphtheria outbreaks and assess its toxin-producing capabilities.
2. Evaluate vaccination coverage and identify barriers to effective immunisation across Nigeria.
3. Assess crisis management strategies deployed during the outbreak and their effectiveness in curbing disease spread.
4. Provide evidence-based recommendations to improve vaccination efforts and outbreak response mechanisms.

II. MATERIALS AND METHODS

Materials

- Epidemiological Data: Case counts, mortality rates, age distribution, and vaccination status from NCDC's Emergency Operations Centre (EOC).
- Laboratory Samples: Clinical and isolate samples analysed for confirmation of *C. diphtheriae*.
- Hospital Admission Records: Data on complications, mortality, and clinic-specific case loads.
- Surveillance Reports: Harmonised data from state-level surveillance pillars.
- Vaccination Records: Age-stratified immunisation data from national health databases.

Methods

- Descriptive Analysis: Summarising case counts, percentages, and outcomes.

- Epidemiological Metrics: Calculating attack rates and case fatality ratios.
- Temporal Trends: Analysing outbreak dynamics across epidemiological weeks.
- Comparative Analysis: Evaluating differences across states, age groups, and demographics.
- Data Harmonisation: Ensuring consistency and accuracy in reported data.

Significance

This study holds critical relevance for public health in Nigeria and beyond:

- Understanding resurgence dynamics: Clarifies the role of pathogen resistance and systemic vulnerabilities.
- Strengthening vaccination strategies: Offers insights to improve immunisation coverage and outreach.
- Enhancing outbreak response: Identifies gaps in crisis management and proposes actionable recommendations and improvements.
- Global health contribution: Adds to the body of knowledge on vaccine-preventable diseases in low-resource settings.
- Policy impact: Informs national health policy on surveillance, immunisation, and emergency preparedness.
- Etiologic confirmation: Reinforces that *Corynebacterium diphtheriae* remains the primary causative agent in current outbreaks.

III. LITERATURE REVIEW

Introduction

Diphtheria, an acute infectious disease caused by *Corynebacterium diphtheriae*, remains a pressing global health concern, particularly in low- and middle-income countries such as Nigeria. Despite the availability of effective vaccines and decades of public health interventions, the resurgence of diphtheria in Nigeria between 2022 and 2024 has raised significant alarm within the global health community (World Health Organization, 2023). This resurgence highlights the fragility of immunisation systems and the persistent challenges facing disease control in resource-limited settings.

Nigeria's complex socio-economic landscape and uneven healthcare infrastructure create a unique context for understanding the dynamics of diphtheria outbreaks. Although the diphtheria-tetanus-pertussis (DTP) vaccine is part of the national immunisation schedule, recurring outbreaks suggest critical gaps in vaccine coverage, surveillance, and public health preparedness

(Nigeria Centre for Disease Control, 2024). Between May 2022 and September 2024, over 36,000 suspected cases were reported across 37 states, with Kano, Katsina, and Yobe accounting for the majority. Alarming, only 22.6% of confirmed cases had received full vaccination, and children aged 1–14 years represented 63.2% of those affected (NCDC, 2024).

Causes of Diphtheria Outbreaks in Nigeria

The persistence and severity of diphtheria outbreaks in Nigeria stem from a multifaceted interplay of systemic, cultural, and logistical factors. Chief among these is low vaccination coverage, particularly in northern states where uptake of the DTP vaccine remains critically low (World Health Organization, 2023). Inadequate cold chain systems further compromise vaccine potency during storage and transportation, especially in remote and underserved areas.

Low health literacy also contributes significantly to vaccine hesitancy. Many communities lack awareness of the importance of routine immunisation, and misinformation about vaccine safety remains widespread. Cultural and religious beliefs often discourage immunisation, particularly in regions where traditional norms and religious doctrines conflict with public health messaging (Jega et al., 2024). These factors collectively contribute to high case fatality rates, especially among children under 15, placing additional strain on Nigeria's already overstretched healthcare system.

Government Response and Public Health Interventions

In response to the surge in cases, the Nigerian government launched a multi-pronged public health intervention. The establishment of the National Diphtheria Emergency Operation Centre (EOC), led by Amina Abbas, marked a significant shift in national coordination. The EOC implemented enhanced surveillance systems, rapid diagnostic testing, and real-time case tracking to facilitate early detection and containment (Jega et al., 2024).

Mass vaccination campaigns targeted high-risk populations, particularly in underserved regions. Community engagement was central to these efforts, with authorities partnering with local leaders, religious figures, and grassroots health workers to counter misinformation and rebuild public trust. International organisations such as the World Health Organization and the Nigerian Red Cross Society provided technical and logistical

support, strengthening national response capacity (WHO, 2023; Jega et al., 2024).

Despite ongoing challenges including delayed case reporting and gaps in surveillance infrastructure, the EOC's deployment of rapid response teams, contact tracing, and targeted resource allocation significantly curbed transmission and improved vaccine uptake. These efforts represent a critical step toward epidemic control and future outbreak preparedness. (Table 1:

The Epidemiological Landscape

Between May 2022 and September 2024, Nigeria recorded a total of 41,336 suspected diphtheria cases across 350 Local Government Areas (LGAs) in 37 states. Notably, 96.5% of these suspected cases were concentrated in seven northern states: Kano (23,784), Yobe (5,302), Katsina (3,708), Bauchi (3,066), Borno (2,902), Kaduna (777), and Jigawa (364) (Nigeria Centre for Disease Control, 2024).

Of the total suspected cases, 24,846 (60.1%) were confirmed through laboratory testing, epidemiological linkage, or clinical compatibility. These confirmed cases were distributed across 182 LGAs in 26 states. Children aged 1–14 years accounted for the majority of confirmed cases, representing 15,845 (63.95%) of the total.

Only 4,963 (20%) of the confirmed cases had received full vaccination with a diphtheria toxoid-containing vaccine. The outbreak resulted in 1,262 deaths, corresponding to a case fatality rate of 5.1% among confirmed cases (NCDC, 2024). (Figure 1)

Government and Health Agency Responses

The resurgence of diphtheria in Nigeria between 2022 and 2025 triggered an urgent nationwide public health response coordinated by the Federal Ministry of Health (FMoH) through the National Primary Health Care Development Agency (NPHCDA). This effort was supported by key international partners including the World Health Organization (WHO), United Nations Children's Fund (UNICEF), Gavi, the Vaccine Alliance, and Médecins Sans Frontières (MSF) (NCDC, 2024; WHO, 2023).

Central to the response was the vaccination campaign aimed at containing the outbreak and preventing further transmission. The NPHCDA emphasized the importance of the Pentavalent vaccine, which protects against five life-threatening diseases including diphtheria. It is administered at 6, 10, and 14 weeks of age, and can be given to children up to 4 years old if missed

during the routine schedule. Additionally, the Tetanus-diphtheria (Td) vaccine is recommended for children aged 4 to 14 years. Both vaccines are provided free of charge at primary healthcare centers nationwide (NPHCDA, 2023).

These immunization efforts are part of broader routine vaccination programs, reflecting the commitment of Nigerian health authorities to prevent future outbreaks and strengthen community immunity (UNICEF, 2024).

Challenges in Healthcare Access

Despite these efforts, access to healthcare services remains a significant challenge, particularly in rural and underserved regions. Nigeria faces a critical shortage of healthcare infrastructure and personnel, which exacerbates the impact of outbreaks like diphtheria. According to WHO data, Nigeria has only 2.3 doctors and 10.9 nurses per 10,000 people far below the global recommended ratio (WHO, 2024).

Dr. Tedros Adhanom Ghebreyesus, WHO Director-General, underscores the urgency of addressing these gaps:

“Access to healthcare is a fundamental right. We must ensure that every child, regardless of their location or economic status, has access to life-saving vaccines and medical care” (WHO, 2023).

UNICEF also highlights the importance of healthcare access in combating vaccine-preventable diseases. Henrietta Fore, former UNICEF Executive Director, stated:

“Immunization is one of the most effective public health interventions. Ensuring access to vaccines and healthcare services is essential in preventing diseases and protecting children's lives” (UNICEF, 2023).

Community Engagement and Public Health Education:

To ensure the success of vaccination campaigns, the NPHCDA and local health officials are working closely with community leaders and stakeholders. Public health education initiatives are vital for raising awareness about the importance of immunization and dispelling myths and misconceptions that hinder vaccine uptake (Intelpoint, 2025).

Parents are strongly encouraged to ensure their children receive the necessary vaccines to protect against diphtheria and other preventable diseases. Simultaneously, healthcare workers are being trained and mobilized to identify and report suspected cases promptly, enabling early treatment

and improved outcomes for affected individuals (NCDC, 2024).

Challenges:

What challenges were faced in the outbreak response and what were done to address them

What gaps were found and resolved? What gaps are still pending?

IV. CONCLUSION

The thorough analysis conducted by the National Diphtheria Emergency Operation Centre (EOC) of the Diphtheria outbreak in Nigeria from 2022 to 2024 offers invaluable insights into the epidemiological landscape, vaccination status, and challenges encountered during the outbreak response. The proactive strategies implemented, including robust case management and vigilant surveillance, reinforce the necessity of a comprehensive public health approach in combating infectious diseases. Moreover, the wealth of data and findings presented in the EOC reports serves as a cornerstone for ongoing efforts to address Diphtheria outbreaks effectively and enhance public health outcomes in Nigeria. Moving forward, it is imperative that the EOC's activities remain focused on the outbreak's impact and safeguarding the well-being of the population. By prioritizing vaccination coverage through strengthening routine immunization, boosting surveillance capabilities and encouraging community engagement, Nigeria can navigate the complexities of Diphtheria transmission and progress towards the ambitious goal of disease elimination.

Critical review of the documents and data on the Diphtheria outbreak in Nigeria from 2022 to 2024 provides crucial insights into the etiologic agent to be still the same *Corynebacterium diphtheriae*, challenges faced, vaccination status and responsive steps taken by various levels and stakeholders, emphasising the importance of proactive case management and surveillance to address the outbreak efficaciously. The national strategic shift promises to overcome this menace !

V. RECOMMENDATIONS

Some recommendations need to be put in place to control and prevent diphtheria outbreaks in Nigeria, such as improving vaccination coverage particularly in rural areas, through targeted outreach programs and awareness campaigns, Strengthen Cold Chain System for effective vaccine storage and transportation to ensure

vaccine potency and safety. Enhance Health Literacy among the population, particularly in rural areas, through education and awareness campaigns, address cultural and religious beliefs that discourages vaccination through community engagement and education

It is advisable that all children receive the complete series of the diphtheria-tetanus-pertussis (DTaP) vaccine according to the recommended schedule, with adults getting booster shots every 10 years and pregnant women receiving the Tdap vaccine during each pregnancy. Good personal hygiene practices, such as regular handwashing and proper respiratory hygiene, should be promoted. Early detection is key; therefore, individuals should be aware of diphtheria symptoms, such as sore throat, fever, swollen glands, and a thick coating in the throat or nose. They should seek immediate medical attention if these symptoms arise. Infected individuals must be isolated to prevent the spread of the bacteria. Treatment involves administering diphtheria antitoxin and starting antibiotic therapy promptly, with supportive care provided in severe cases. Public health measures include reporting all diphtheria cases to local health authorities, conducting contact tracing, providing prophylactic antibiotics to close contacts, and implementing community vaccination programs in areas with low immunization rates. Additionally, raising public awareness about the importance of vaccination and educating healthcare providers on diphtheria management are essential for effective prevention and control of the disease.

Seroconversion study of the Penta vaccine is becoming imperative.

Competing interests

The authors affirm that they have no competing interests to declare. There are no conflicts of interest that could influence the objectivity or impartiality of the research findings presented in this study.

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Annexures:

Table 1: Distribution of diphtheria cases and deaths in Nigeria, May 2022 - April 2025

State	# Suspected case	# Confirmed case	% Confirmed cases	# Deaths among Confirmed cases	% of deaths among Confirmed Cases
Kano	23,784	17,770	75%	821	5%
Yobe	5,330	2,408	45%	109	5%
Bauchi	3,066	2,334	76%	104	4%
Katsina	3,708	1,088	29%	101	9%
Borno	2,902	1,036	36%	67	6%
Jigawa	364	53	15%	7	13%
Kaduna	777	44	6%	11	25%
Plateau	66	31	47%	15	48%
Sokoto	200	31	16%	5	16%
Zamfara	219	21	10%	0	0%
FCT	146	15	10%	7	47%
Gombe	216	7	3%	1	14%
Edo	20	6	30%	2	33%
Lagos	37	6	16%	5	83%
Adamawa	65	5	8%	4	80%
Nasarawa	104	3	3%	1	33%
Osun	16	3	19%	1	33%
Abia	25	2	8%	0	0%
Kebbi	70	2	3%	0	0%
Niger	11	2	18%	0	0%
Taraba	90	2	2%	0	0%
Cross River	1	1	100%	0	0%
Ekiti	36	1	3%	1	100%
Enugu	12	1	8%	0	0%
Imo	10	1	10%	0	0%
Ogun	6	1	17%	0	0%
Akwa Ibom	1	0	0%	0	0%
Anambra	1	0	0%	0	0%
Bayelsa	15	0	0%	0	0%

Benue	1	0	0%	0	0%
Delta	2	0	0%	0	0%
Ebonyi	1	0	0%	0	0%
Kogi	40	0	0%	0	0%
Kwara	1	0	0%	0	0%
Ondo	2	0	0%	0	0%
Oyo	16	0	0%	0	0%
Rivers	2	0	0%	0	0%
total	41336	24874	60.1%	1262	5.1%

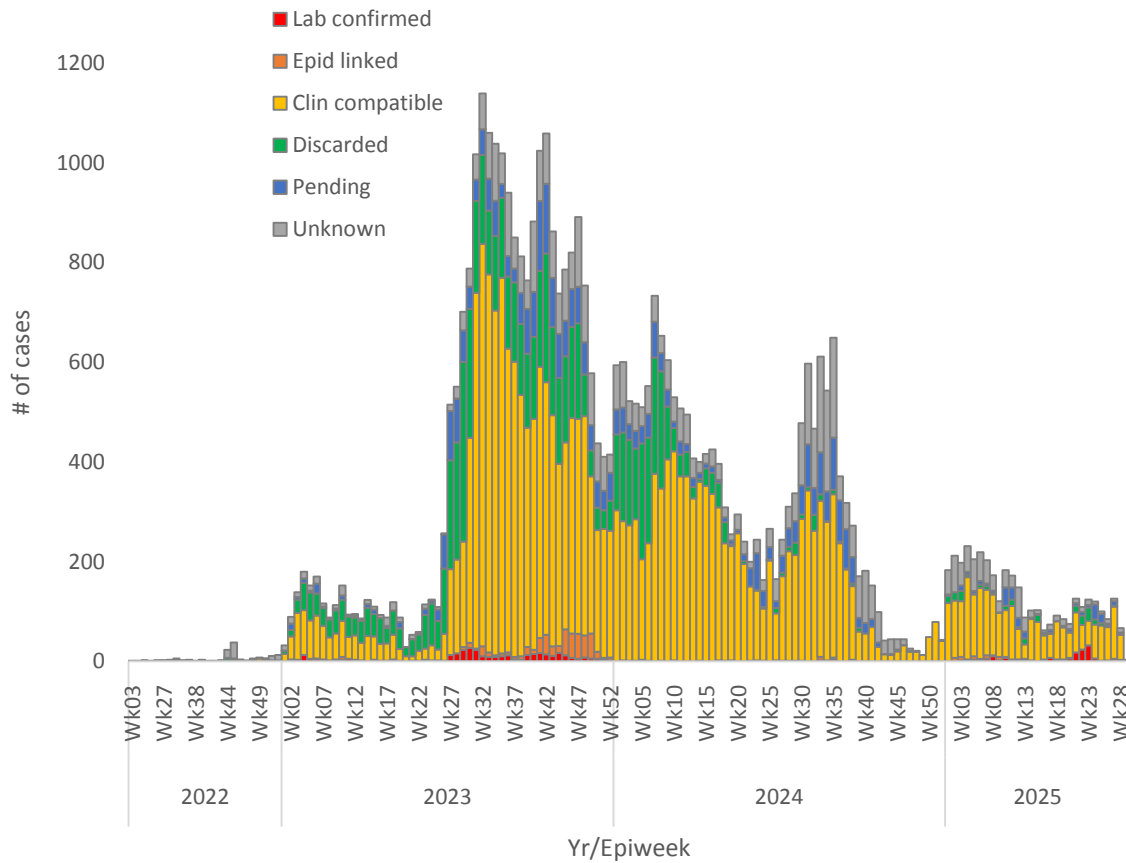


Figure 1: Epidemiological Landscape

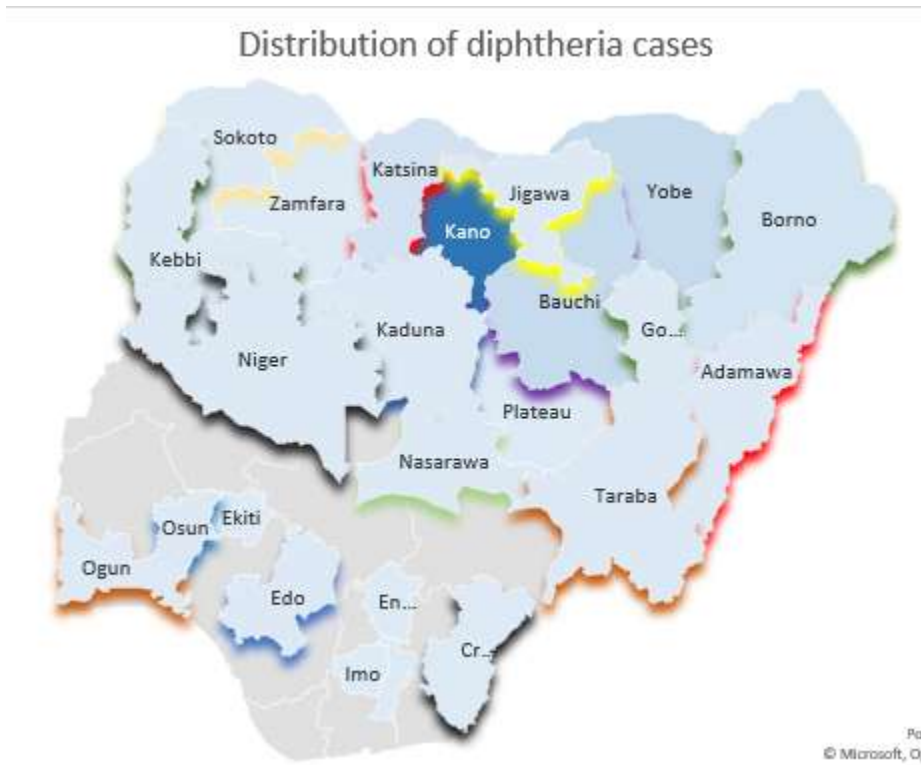


Figure 2: Distribution of Diphtheria cases by State

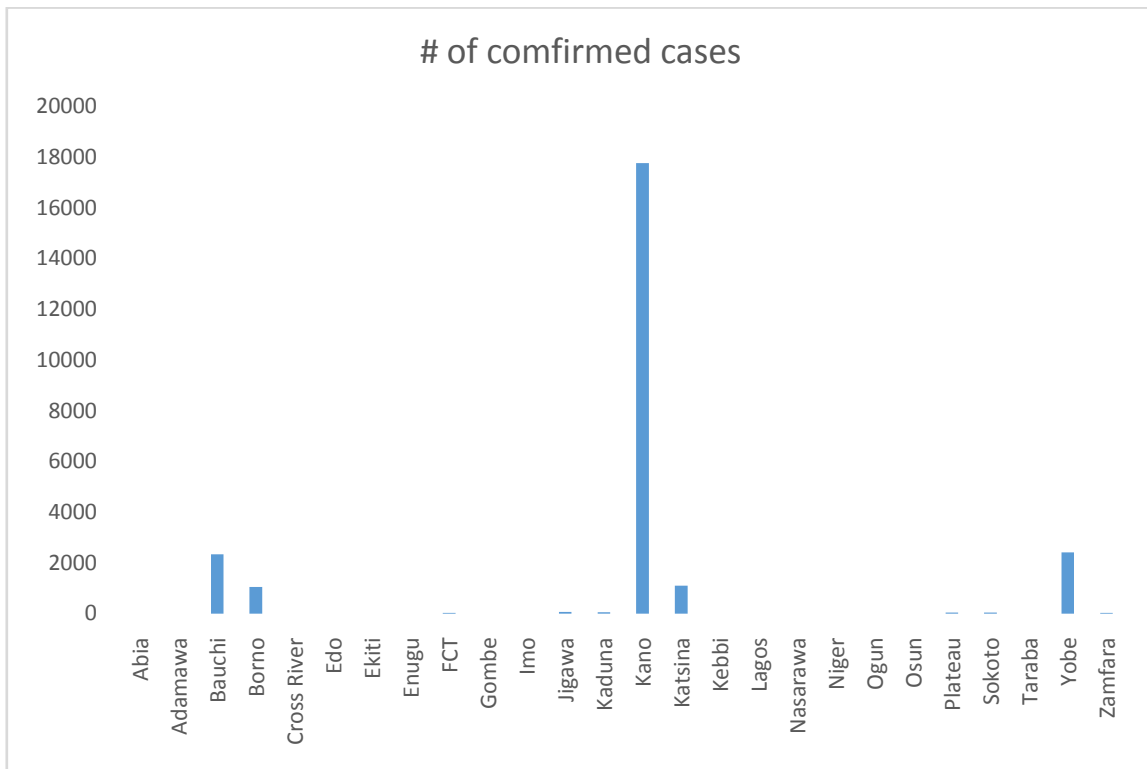


Figure 3 : Graphic representation of confirmed cases of Diphtheria in Nigeria