



NIGERIAN JOURNAL OF PAEDIATRICS

VOLUME 53 | NUMBER 2 | APRIL - JUNE 2026

<https://www.njpaediatrics.com>

PRINT: ISSN 0302-4660

ONLINE: ISSN 2814-2985

REVIEW **Respiratory Syncytial Virus Pneumonia Among Nigerian Children: Is it time to advocate for routine Respiratory Syncytial Virus Vaccine Inclusion into the National Programme on Immunisation?**
Peter Odion Ubuane

ORIGINAL ARTICLE **Factors Associated with Delayed Presentation of Sick Neonates at a Nigerian Tertiary Facility**
Oladehin Tolulope R, Taiwo Opeyemi D, Akindolire Abimbola E, Alao Michael B, Tongo Olukemi O

Comparative Study of the Nutritional Status of Children Aged 1-6 Years with Unoperated Congenital Heart Diseases in a Tertiary Hospital in Benin City
Ezeuko Lilian C, Nandom Benjamin M, Ezeuko Vitalis C

Pattern and Outcome of Diphtheria-Related Complications Among Hospitalised Children at Birnin Kebbi
Falaye Adejoke M, Tahir Ali A, Abubakar Mansur, Lawal Taslim O, Isezuo Khadijah O, Adeyemo Idayat A, *et al.*

Adiponectin and Altered Metabolic Signalling in Asymptomatic Malaria: A Community-Based, Cross-Sectional Study of Nigerian Children
Orimadegun Bose E, Adeolu Oluymisi J, Adediran Kofoworola I, Orimadegun Adebola E

Disclosure of Sickle Cell Disease Diagnosis to Children and Adolescents Aged 5-18 Years at the University of Benin Teaching Hospital, Benin-City, Nigeria
Oduvun Magdalene E, Ezeuko Lilian C

Seroprevalence of the Human Papillomavirus IgG Antibodies and the Associated Factors Among Female Adolescents in Gombe, North-Eastern Nigeria: A Pre-Vaccine Roll-Out Survey
Bello Abdulshaheed A, Jalo Iliya, Isaac Elon W, Manga Mohammed M, Aliu Rasaki, Farouk Halima U

A Comparative Study of Socio-demographic Characteristics and Risk Factors of Epilepsy Between Children with and without Co-existing Cerebral Palsy in Sokoto, Northwest Nigeria
Ahmed Hamidu, Ahmad Murtala M, Jiya Fatima B, Yusuf Abduganiyyu, Waziri Usman, *et al.*

Comparative Assessment of the Nutritional Status of Institutionalised and Non-Institutionalised Nigerian Children Using Anthropometric Parameters
Oji-Onuoha Stella N, Ughasoro Maduka D, Izuka Mildred O, Chukwudi Ndubuisi K, Oji Onuoha, Jibrin Alkasim M

Effect of COVID-19 Pandemic on Immunisation Programmes in Ibadan Metropolis, Southwest Nigeria
Ogunbosi Babatunde O, Alao Michael A, Alejoh Joy N, Adebayo Bosede E, Lagunju IkeOluwa A

CASE REPORT **Measles Keratitis in a Nigerian Child: Experience from a Rural Community**
Chukwukwe Ifeyinwa O, Ekwufulem Oluchi N, Okafor Amarachukwu F

Severe Hypertriglyceridaemia with Acute Kidney Injury in Paediatric Diabetic Ketoacidosis: A Case Report
Nwalorzie Chinomso, Ononiwu Uche, Oguzie Chioma

Acute Lymphoblastic Leukaemia Presenting as Pleural and Pericardial Effusions: A Case Report
Okosun Ofure A, Otumu Odianosen S, Ugadu Chukwuemeka O, Dawodu Osagie S

Neonatal Diabetic Ketoacidosis Mimicking Sepsis in a Nigerian Infant: A Case Report
Omachi Adah P, Eze Edith C, Abdullahi Usman, Mammud Abubakar, Abubakar Usman

CONFERENCE PROCEEDINGS **57th Annual General Meeting and Scientific Conference of the Paediatric Association of Nigeria, Abeokuta, Ogun State, Nigeria, 21st to 23rd January 2026**

7th Biennial General Meeting and Scientific Conference of the Nigerian Society for Paediatric Infectious Diseases, Abeokuta, Ogun State, Nigeria, 19th and 20th January 2026

EDUCATIONAL SERIES **SYNOPSIS: Measurement of Penile and Clitoral Sizes of Post-Neonatal Infants**
Oba-Daini Olubunmi O

CLINICAL QUIZ Briggs Datonye C

OFFICIAL JOURNAL OF THE PAEDIATRIC ASSOCIATION OF NIGERIA



Nigerian Journal of Paediatrics 2026 (June); Volume 53(2): 143-150.

<https://dx.doi.org/10.63270/njp.v53i2.2000059>.

Pattern and Outcome of Diphtheria-Related Complications Among Hospitalised Children at Birnin Kebbi

Falaye Adejoke M¹, Tahir Ali A¹, Abubakar Mansur¹, Lawal
Taslim O¹, Isezuo Khadijat O², Adeyemo Idayat A¹, Olabisi Ismail
Y², Mansur Libata¹, Akpelu Enyida H²

Department of Paediatrics, Federal Teaching Hospital, Birnin Kebbi, Nigeria.

Department of Paediatrics, Usmanu Danfodiyo Teaching Hospital, Sokoto, Nigeria.

Correspondence

Dr Falaye Monsurat A. Department of Paediatrics, Federal Teaching Hospital, PMB 1126, Birnin Kebbi, Nigeria.

E-mail: falayeadejoke@gmail.com ; ORCID - <https://orcid.org/0009-0006-8342-4045>.

Abstract

Background: Diphtheria remains a re-emerging vaccine-preventable disease in Nigeria, contributing significantly to morbidity and mortality among children. Understanding the pattern and outcomes of diphtheria-related complications is essential for prevention and enhancing case management.

Objective: To describe the pattern and outcomes of diphtheria-related complications among hospitalised children at the Federal Teaching Hospital, Birnin Kebbi, Nigeria.

Methods: This descriptive, cross-sectional study analysed the data of 49 children diagnosed with diphtheria over 1 year. Information was collected using a structured proforma. Descriptive statistics and multinomial logistic regression analysis were used to assess associations between predictors and clinical outcomes.

Results: Fifty-one per cent of the patients were aged 5–10 years. Airway obstruction was the most common complication (49%), followed by myocarditis (16.3%) and acute kidney injury (12.2%). The overall mortality rate was 36.7%, with the highest mortality rate observed among the under-five group (20.4%) and those with incomplete immunisation. There was a statistically significant association between age, immunisation status, and clinical outcomes ($p < 0.05$), with children under five and those with incomplete immunisation having significantly lower odds of recovery.

Conclusion: Diphtheria continues to pose a significant threat to childhood survival in Birnin Kebbi, Nigeria, with incomplete immunisation and young age being major risk factors for poor clinical outcomes. Strengthening immunisation coverage and improving case management are crucial to reducing mortality and complications associated with diphtheria.

Keywords: *Acute Kidney Injury, Airway obstruction, Immunisation, Myocarditis, Vaccine-Preventable-Diseases*

Introduction

Diphtheria is an acute, potentially fatal, toxin-mediated infectious disease caused by *Corynebacterium diphtheriae*. Despite being vaccine-preventable, it remains a significant public health challenge in many low- and middle-

income countries, particularly in sub-Saharan Africa, including Nigeria.^{1,2} The disease primarily affects children and it is associated with considerable morbidity and mortality, especially in settings with low immunisation coverage, delayed presentation to the hospital, and limited access to diphtheria antitoxin.³ Since late 2022,

diphtheria cases in the African Region have surged, likely due to disruptions in routine immunisation caused by the COVID-19 pandemic and weakened health systems.

Between the year 2000 and 2024, the World Health Organisation (WHO) recorded 75,789 suspected cases, with the majority occurring during 2023–2024, when approximately 57,000 suspected cases and 2,000 deaths were reported across several affected countries, including Nigeria, Guinea, and Niger. In 2025, eight African nations reported 17,491 suspected cases and 896 deaths, indicating widespread regional transmission. Nigeria emerged as a major epicentre, with Kano State reporting a record 18,320 cases and a case fatality rate of 4.5%. The outbreak in Nigeria, alongside those in Guinea and Niger, highlighted the impact of low vaccination coverage and fragile healthcare systems. Other countries in West Africa and the Sahel, such as Chad and Mali, also experienced significant outbreaks of the disease.^{3,4}

Globally, diphtheria has become rare in high-income countries due to sustained vaccination coverage; however, outbreaks persist in parts of Africa and Asia.⁵ In Nigeria, factors contributing to the menace include poor routine immunisation uptake, insecurity-related population displacement, vaccine hesitancy, weak health systems, and inadequate surveillance.⁶ Reports from the Nigeria Centre for Disease Control indicate that children generally bear the greatest burden of infection and mortality.⁵

Disease severity is largely determined by systemic dissemination of diphtheria toxin. Local airway obstruction from pseudomembrane formation may occur, while systemic toxicity can lead to life-threatening complications such as myocarditis, acute kidney injury, and peripheral neuropathy, which are major predictors of mortality.⁵ Data on the pattern and outcomes of diphtheria-related complications in Nigeria

remain limited, particularly in the northwestern region.^{4, 5} This study, therefore, examined the pattern and outcomes of diphtheria-related complications among children hospitalised at the Federal Teaching Hospital, Birnin Kebbi. The findings may inform improved clinical management and public health interventions.^{5,7}

Methods

Study area

The study was conducted at the Federal Teaching Hospital, Birnin Kebbi, a tertiary healthcare institution in Birnin Kebbi, the capital of Kebbi State, northwest Nigeria.^[8] Kebbi State spans a landmass of 36,985 km². It is bordered by the Republics of Niger and Benin, and the Nigerian states of Niger, Zamfara, and Sokoto. With a projected 2024 population of over 4.4 million, the State has a predominantly young demography and is home to various ethnic groups, including the Fulani and Hausa, predominantly, and others. The hospital is well-equipped with a capacity of over 300 beds and staffed by highly qualified healthcare professionals.⁸

Study design

This was a descriptive, retrospective, hospital-based study.

Study population

The study population consisted of children aged 1–15 years who were admitted to the paediatric wards of the Federal Teaching Hospital, Birnin Kebbi, with a diagnosis of diphtheria over one year (1 January to 31 December 2024). Cases of diphtheria were diagnosed clinically, based on a thorough throat examination which showed a thick, greyish-white, adherent pseudomembrane on the tonsils, pharynx, or larynx, with or without cervical lymphadenopathy described as a “bull neck”, dysphagia, hoarseness, or respiratory distress.

Both bacterial culture and PCR testing were performed to confirm the diagnosis. Diphtheria antitoxin (DAT) was administered where available; however, access was inconsistent during the study period due to supply limitations, and not all eligible patients received DAT. Intravenous (IV) Crystalline penicillin was administered to affected children, while close contacts received prophylactic oral erythromycin. Myocarditis was diagnosed using electrocardiography (ECG) and echocardiography. Continuous ECG monitoring was not used during the period of study due to financial constraints, and some patients were lost to follow-up. Airway obstructions were managed by an otorhinolaryngologist and an anesthesiologist according to standard protocols for the management of diphtheria-related complications.

Inclusion and exclusion criteria

Children aged 1–15 years with a clinical diagnosis of diphtheria, admitted to the Federal Teaching Hospital, Birnin Kebbi, during the study period with complete medical records, were included in the study.

Children with incomplete clinical records, those referred after resolution of complications, and suspected diphtheria cases lacking adequate clinical documentation were excluded from the study.

Ethical considerations

The study protocol was approved by the Ethics and Research Committee of the Federal Teaching Hospital, Birnin Kebbi (FTH/BK/HP/045/P/517/VOL.IX/041). Given the retrospective nature of the study and the use of anonymised data, informed consent was waived, but patient confidentiality was strictly maintained, and data were de-identified before analysis.

Sample size determination

All eligible cases within the study period were recruited consecutively. A total of 49 children met the inclusion criteria, and their records were analysed, whereas 12 children had incomplete data and were excluded from the study.

Data collection

Data were extracted from patients' medical records using a structured proforma. Information obtained included socio-demographic characteristics, immunisation status, clinical features, type of complications and clinical outcomes.

Case definition and diagnostic criteria

A case of diphtheria was defined as any child aged 1–15 years and hospitalized with a compatible clinical presentation (acute onset of sore throat, fever, or malaise, and a thick, greyish-white adherent pseudomembrane on the tonsils, pharynx, or larynx, with or without cervical lymphadenopathy described as a “bull neck”, dysphagia, hoarseness, or respiratory distress), with or without laboratory confirmation.⁶

Study variables

Independent variables included age, sex, residence, and immunisation status (complete, incomplete - any child who did not receive all scheduled doses of diphtheria-containing vaccine as per the national immunisation schedule and unknown).

The dependent variables included the types of complication, clinical outcome (recovered, died, or Signed Against Medical Advice {SAMA})

Data analysis

Data were entered and analysed using IBM SPSS version 25 software. Descriptive statistics were used to summarise variables like age group and sex, while the Chi-Square test was used to assess associations between categorical variables. Statistical significance was set at $p < 0.05$. A multinomial logistic regression analysis was done to determine the association between each

independent variable of significance and clinical outcome.

Results

Socio-demographic characteristics

A total of 49 children were studied. The age range was 1–15 years. Children aged 5–10 years constituted the largest group (25; 51.0%), followed by those under five years (13; 23.6%). There were 27 (55.1%) females in the population studied.

Table I: Age distribution

Age group	Frequency	Percentage
< 5 years	13	26.5
5–10 years	25	51.0
> 10 years	11	22.5
Total	49	100.0

More than half of the patients (26; 53.1%) were resident in the rural areas.

Immunization Status

Nineteen (38.8%) of the children were fully immunised, while 26 (53.1%) had incomplete immunisation and 4 (8.1%) were not immunised, as shown in Figure 1.

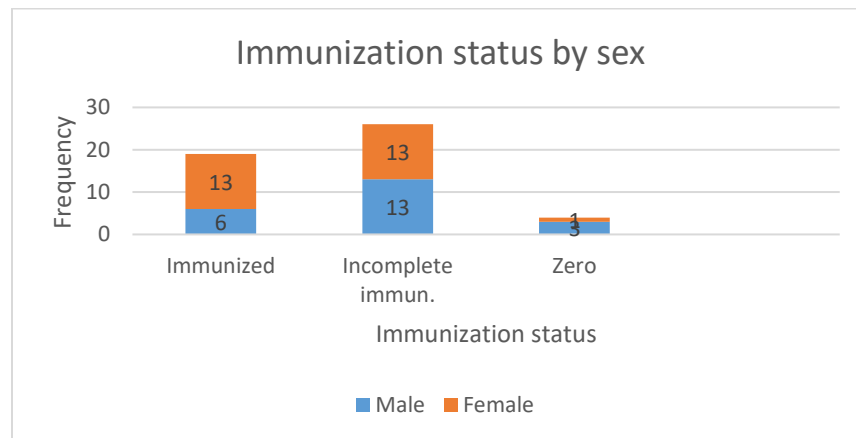


Figure 1: Immunisation status according to sex

Pattern of diphtheria complications among different age groups

Airway obstruction was the most common complication (24; 49%), followed by myocarditis

(8; 16.3%), Acute Kidney Injury (AKI) and pneumonia (6; 12.2%) and neurologic complications (5; 10.3%) as shown in Table II below.

Table II: Frequency of complications and associated mortalities across the different age groups

Complications	<5yrs	5-10 years	>10years	Total
Airway Obstruction	12 (6)	9 (2)	3 (0)	24 (8)
Acute Kidney Injury	1 (1)	4 (3)	1 (0)	6 (4)
Pneumonia	1 (1)	3 (1)	2 (1)	6 (3)
Myocarditis	2 (1)	4 (1)	2 (0)	8 (2)
Neuropathy	3 (1)	1 (0)	1 (0)	5 (1)
Total	19 (10)	21 (7)	9 (1)	49 (18)

Figures in parentheses are the number of deaths in the respective group

In the <5 years age group, airway obstruction was the most prevalent complication with the highest number of deaths while acute kidney injury recorded the highest number of deaths in the 5-10 years group. The only death in the >10 years group had pneumonia, as shown in Table II.

Clinical outcomes

The clinical outcomes included full recovery in 51.0%, death in 36.7% and premature voluntary

discharge (signing against medical advice) in 12.2%. High mortality was associated with the <5 years group, incomplete immunisation status, non-administration of DAT and presence of airway obstruction. In the latter, only 12.5% had the required interventions done (two had tracheostomy, and one had endotracheal intubation) as shown in Table III.

Table III: Relationship between clinical outcomes and selected characteristics of the subjects

Age group	Recovery	Death	SAMA	Statistics
<5yrs	3 (6.1)	10 (20.4)	0 (0.0)	
5-10yrs	14 (28.6)	7 (14.3)	4 (8.2)	$\chi^2 = 13.85$
>10yrs	8 (16.3)	1 (2.0)	2 (4.1)	$p = 0.0078$
Total	25 (51.0)	18 (36.7)	6 (12.3)	
Sex				
Male	11 (22.5)	8 (16.3)	3 (6.1)	$\chi^2 = 0.073$
Female	14 (28.5)	10 (20.4)	3 (6.1)	$p = 0.964$
Total	25 (51.0)	18 (36.7)	6 (12.3)	
Immunization status				
Complete	18 (36.8)	1 (2.0)	1 (2.0)	$\chi^2 = 23.04$
Incomplete	5 (10.2)	16 (32.7)	4 (8.2)	$p = 0.000124$
Zero	2 (4.1)	1 (2.0)	1 (2.0)	
Total	25 (51.0)	18 (36.7)	6 (12.2)	
DAT administration				
Yes	13 (26.5)	4 (8.2)	1 (2.0)	$\chi^2 = 5.18$
No	12 (24.5)	14 (28.5)	5 (10.2)	$p = 0.075$
Total	25 (51.0)	18 (36.7)	6 (12.2)	
Complications				
Airway obstruction	15 (30.6)	8 (16.3)	1 (2.0)	$\chi^2 = 7.74$
Acute Kidney Injury	1 (2.0)	4 (8.2)	1 (2.0)	$p = 0.459$
Pneumonia	2 (4.1)	3 (6.1)	1 (2.0)	
Myocarditis	4 (8.2)	2 (4.1)	2 (4.1)	
Neuropathy	3 (6.1)	1 (2.0)	1 (2.0)	
Total	25 (51.0)	18 (36.7)	6 (12.3)	

SAMA – Signed Against Medical Advice (Premature voluntary discharge)

There were statistically significant associations between age, immunisation status and outcome ($p < 0.05$), with under-five children having the

highest mortality. On the other hand, no statistically significant association was observed

between sex, DAT administration, pattern of complication and clinical outcomes ($p > 0.05$).

Table IV: Multinomial logistic regression showing associations between independent variables and clinical outcome

Predictor / Comparison (vs reference)	OR (95 % CI) Recovery vs Death	for p-value	OR (95 % CI) SAMA vs Death	for p-value
Age: <5 yrs vs >10 yrs	0.04 (0.003–0.43)	0.009	0.03 (0.001–0.93)	0.046
Age: 5–10 yrs vs >10 yrs	0.25 (0.03–2.42)	0.23	0.29 (0.02–4.24)	0.36
Immunization: incomplete vs complete	0.02 (0.002–0.17)	<0.001	0.25 (0.01–4.92)	0.36
Immunisation: zero vs complete	0.11 (0.005–2.55)	0.17	1.00 (0.02–50.4)	1.00
DAT: no vs yes)	0.26 (0.07–1.03)	0.055	1.43 (0.13–15.97)	0.77

Age and immunisation status were strong predictors of outcomes, with children under five years old having significantly lower odds of recovery compared with older age groups. Immunisation status was strongly protective, as children with incomplete vaccinations had a lower chance of recovery than fully immunised children. The administration of DAT suggested a borderline-significance protective effect, as children who did not receive DAT had lower recovery odds, whereas the association with premature discharge (SAMA) was not significant.

Discussion

This study highlights the continued burden of diphtheria and its complications among children in north-western Nigeria. The predominance of cases among children aged 5–10 years is consistent with findings from recent Nigerian studies, suggesting waning immunity or incomplete booster doses among school-aged children.⁹ Similar age distributions have been reported during outbreaks of diphtheria in Kano, Katsina, and Yobe States of northern Nigeria, between 2021 and 2024.^{7,9}

The slightly higher proportion of females observed in this study contrasts with some Nigerian studies reporting male predominance,^{7,9} but aligns with reports from parts of sub-Saharan

Africa where no clear sex difference has been established.¹⁰ The absence of a significant association between sex and outcome further supports the view that biological sex does not substantially influence diphtheria prognosis.^{7,9}

More than half of the children were from rural areas, underscoring persistent rural-urban disparities in immunisation coverage and access to healthcare. Studies from northern Nigeria and Ethiopia have similarly documented higher diphtheria burden in rural communities, attributed to limited primary healthcare services and poor vaccine uptake.^{9,13–15}

Incomplete immunisation was a major finding in this study, with over half of the children hospitalised with diphtheria lacking full vaccination. This aligns with recent Nigerian reports indicating declining routine immunisation coverage, particularly in conflict-affected and underserved areas. Inadequate immunisation has been consistently associated with severe disease and complications.^{5,12,13}

The present study also observed that airway obstruction was the predominant complication among children with diphtheria, particularly in the youngest patients. This pattern likely reflects delayed presentation to the hospital and extensive pseudomembrane formation in the throat, leading to rapid upper-airway compromise. The high number of deaths associated with airway

obstruction underscores its role as an immediate life-threatening complication. Interestingly, this pattern differs from larger northwest Nigerian cohorts, where cardiac complications and neuropathy were more common.^{10,12,15} The difference may stem from the Birnin Kebbi cohort capturing children with more advanced local disease, whereas larger cohorts may have included patients who survived the early obstructive phase and subsequently manifested toxin-mediated cardiac and neurological problems. Although 40% of the subjects were eligible for surgical intervention for acute respiratory obstruction, only 6% received it. This was due to some patients passing away before the procedure could be performed, while others were unable to afford the surgery due to financial constraints.

Systemic complications - myocarditis, neuropathy and acute kidney injury - were less frequent compared with airway obstruction but carried a significantly higher risk of mortality. The few cases of acute kidney injury were associated with the highest crude fatality, echoing findings from other Nigerian studies that link renal dysfunction to increased odds of death and highlight elevated creatinine as an independent predictor of mortality. These results support routine cardiac, neurologic and renal monitoring for all hospitalised children with diphtheria, even when airway symptoms predominate.^{5-7,14,15}

The lack of an association between DAT administration and outcome should be interpreted with caution. In addition to late presentation and small sample size, DAT administration in this cohort was influenced by intermittent availability in the hospital, introducing potential selection bias. Consequently, the observed effect may not reflect its true therapeutic benefits. WHO recommends early DAT administration in suspected cases of diphtheria because delayed neutralisation of circulating toxin reduces the

effectiveness of the antitoxin. The present study, therefore, reflects operational realities, including ongoing shortages of DAT in many African countries, rather than evidence against its value.^{4,9,14}

The overall case-fatality rate of 36.7 %, though high, is lower than rates recorded during some Nigerian outbreaks. Mortality was closely tied to younger age and incomplete immunisation status, indicating that host vulnerability and lack of immunity are major determinants of survival, while sex had no prognostic relevance.⁵⁻⁷ The proportion of children discharged against medical advice may reflect socioeconomic challenges, health beliefs, and financial constraints, which remain significant barriers to optimal care in many Nigerian settings.^{5,7,9,14}

Limitation

The hospital-based design and small sample size limit generalizability. The limited and inconsistent availability of diphtheria antitoxin during the study period may have impacted treatment allocation and outcomes, potentially introducing bias in the evaluation of its effectiveness

Conclusion

The study highlights that diphtheria continues to pose a severe threat in north-western Nigeria, with school-aged children most affected. Still, mortality is highest among younger patients and those lacking complete vaccination. Airway obstruction predominates as the most fatal complication, while toxin-mediated issues such as myocarditis, neuropathy and acute kidney injury are less common but are still associated with deaths. Given an overall high case-fatality rate, there is a need for widespread vaccination, early recognition in peripheral clinics and prompt supportive care to avert further deaths.

Authors' Contributions: FAM, IKO, OIY and TAA conceived and designed the study. FAM, LTO and AM analysed and interpreted the data. AIA, IKO and AEH drafted the manuscript. FAM, ML, and LTO revised the manuscript to ensure sound intellectual content. All authors approved the final version of the manuscript.

Conflicts of Interest: None declared.

Financial support: The authors did not receive any financial support for the research or for the preparation of the manuscript.

Accepted for publication: 25th May 2026.

References

1. World Health Organization. Diphtheria vaccines: WHO position paper – 2020. *Wkly Epidemiol Rec.* 2020;95(3):25–34.
2. Mokrousov I, Narvskaya O. *Corynebacterium diphtheriae*: clinical disease and public health relevance. *Clin Microbiol Rev* 2021;34(4):e00082-20. <https://doi.org/10.1128/CMR.00082-20>
3. Sadoh AE, Sadoh WE, Ibadin MO. Re-emergence of diphtheria in Nigeria: a call for improved immunization coverage. *Niger J Paediatr* 2021;48(2):67–72. World Health Organization. Diphtheria in the African Region, 2023-2024. Available at: <https://www.who.int/news-room/fact-sheets/detail/diphtheria> [Accessed 16 Apr 2026].
4. Usamatu A, Iseh KR, Amutta SB, Abdullahi M, Adeyeye FM, Yabo US, *et al*. Diphtheria mortality in Northwestern Nigeria: A review of ninety-eight consecutive cases. *Res Sq* [Preprint] 2025. <https://doi.org/10.21203/rs.3.rs-7132993/v1>
5. Médecins Sans Frontières (MSF). Diphtheria. In: *Clinical guidelines – diagnosis and treatment manual* [Internet]. Paris: Médecins Sans Frontières; 2025. Available from: <https://medicalguidelines.msf.org/viewport/CG/english/diphtheria-16689456.html>. Accessed 18 April 2026.
6. Alege A, Ibrahim OR, Ibraheem RM, Aladesua O, Lugga AS, Yahaya YY, *et al*. Clinical presentation and predictors of hospital mortality of diphtheria in Nigeria, July 2023 to April 2024: A single-center study. *BMC Infect Dis* 2024;24:10401. <https://doi.org/10.1186/s12879-024-10401-4>
7. Federal Medical Centre, BK. About us Birnin Kebbi. <https://fmcbirninkebbi.gov.ng/home> 2025.
8. Adegboye OA, Alele FO, Pak A, Castellanos ME, Abdullahi MAS, Okeke MI, *et al*. A resurgence and re-emergence of diphtheria in Nigeria, 2023. *Ther Adv Infect Dis* 2023 8;10:20499361231161936. <https://doi.org/10.1177/20499361231161936>
9. Ahmad AA, Musa BM, Onyemochi A, Pattern of diphtheria infection in children during an outbreak in Kano, Nigeria. *BMC Infect Dis.* 2021;21:1098. <https://doi.org/10.1186/s12879-021-06814-4>
10. Adamu AA, Essoh TA, Adebawale AS. Routine immunization coverage and determinants in rural northern Nigeria. *Pan Afr Med J* 2020;37:197. <https://doi.org/10.11604/pamj.2020.37.197.24012>
11. Hassan A, Abdullahi K, Mohammed S. Upper airway obstruction in paediatric diphtheria: experience from a tertiary hospital in Sudan. *Afr J Paediatr Surg.* 2022;19(2):85–90. https://doi.org/10.4103/ajps.AJPS_98_21
12. Mbanga D, Ngama M, Ndjitoyap Ndam EC. Severe diphtheria and outcomes among hospitalized children in Chad. *Int J Infect Dis* 2023;128:85–91. <https://doi.org/10.1016/j.ijid.2023.01.012>
13. Abubakar A, Yusuf H, Ibrahim A. Clinical outcomes of pediatric diphtheria in low-resource hospitals: a multi-center African study. *Pan Afr Med J* 2020;36:214.
14. Ali M, Ahmed A, Hirsi I, Omar N, Elmi-Abdi M. Severe pediatric diphtheria with myocarditis in Somalia: a case report. *East Afr Med J.* 2024;101(2):87–92.