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Epidemiological Pattern and Clinical Outcomes of Measles among Children Managed at Modibbo Adama University Teaching Hospital, Yola, North-East Nigeria: A Retrospective Study

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ABSTRACT

Measles is a vaccine-preventable disease that continues to cause substantial childhood morbidity and mortality in Nigeria, particularly in the north, where vaccination coverage remains suboptimal, population displacement is widespread, and access to healthcare is limited. Objectives: This study aimed to describe the epidemiological pattern, vaccination status, clinical complications, and outcomes of measles among children managed at Modibbo Adama University Teaching Hospital (MAUTHY), Yola, Adamawa State, North-East Nigeria. Methods: A retrospective cross-sectional study was conducted among 22 children aged 1 month to 17 years admitted with clinical measles between January and December 2025. Data were extracted from medical records using a structured form and analysed with IBM SPSS Statistics version 21; Fisher's exact test was used for categorical associations ($p < 0.05$). Results and Discussion: Children under five years accounted for 86.4% of admissions; children aged 1–4 years formed the largest age group (54.5%). Sex distribution was equal. Most children (81.8%) were unvaccinated or incompletely vaccinated. A marked seasonal peak occurred in March–April, accounting for 68.2% of cases and all deaths. Bronchopneumonia (90.9%), severe acute malnutrition (81.8%), and diarrhoea (68.1%) were the commonest complications. Six children died, yielding a case fatality rate of 27.3%; four deaths occurred within 24 hours of admission. No statistically significant association was detected between age group and outcome ($p = 1.000$). Conclusion: Measles imposes a severe, preventable burden on children in Adamawa State. Strengthening routine immunization, nutritional support, and early care-seeking behaviour are essential priorities.

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INTRODUCTION

Measles is a highly contagious acute viral illness caused by the measles virus (MeV), a negative-sense single-stranded RNA virus belonging to the genus *Morbillivirus*, family *Paramyxoviridae* (de Vries *et al.*, 2012). Transmission occurs primarily via respiratory droplets and aerosols, and the measles virus is among the most infectious of all human pathogens, with a basic reproduction number (R_0) of 12–18, implying that population-level vaccination coverage of at least 93–95% is required to achieve and sustain herd immunity (Moss, 2017). Compartmental modelling of measles transmission in Nigerian communities has similarly shown that the infection is driven towards a stable disease-free equilibrium only when the effective reproduction number is held below unity through sustained vaccination coverage (Ochi *et al.*, 2024). Despite the availability of a safe, effective, and affordable live attenuated vaccine since the 1960s, measles remains a leading vaccine-preventable cause of childhood mortality worldwide, disproportionately affecting children in sub-Saharan Africa and South Asia (Moss, 2017; World Health Organization [WHO], 2024).

Globally, measles caused an estimated 136,000 deaths in 2022, representing a 43% increase from 2021. This resurgence has been attributed largely to COVID-19 pandemic disruptions of routine immunization services, which left approximately 61 million children unvaccinated or under-vaccinated between 2020 and 2022 (Gaythorpe *et al.*, 2021; WHO, 2024). WHO has characterized the global resurgence as a predictable consequence of declining vaccination coverage (Mahase, 2025). In Africa, persistent immunity gaps, particularly among children under five years missed during the pandemic, have undermined progress toward regional measles elimination (WHO Regional Office for Africa, 2023).

Nigeria is the single largest contributor to the African measles burden, home to approximately one in six of all unvaccinated children globally and consistently recording the highest measles case counts in West Africa (Jean Baptiste *et al.*, 2021). The Nigeria Demographic and Health Survey (2018) documented first-dose measles-containing vaccine (MCV1) coverage at approximately 57% nationally, with considerably lower rates in northern states (National Population Commission [NPC] & ICF, 2019). The Nigeria Centre for Disease Control and Prevention (NCDC) reported a national measles case fatality rate (CFR) of approximately 0.8% among confirmed cases in 2025, with over 77% of confirmed cases having received no measles vaccine dose (NCDC, 2025).

Northern Nigeria is disproportionately affected owing to a convergence of structural risk factors: chronically suboptimal vaccination coverage; insecurity and large-scale displacement associated with the Boko Haram and Islamic State West Africa Province (ISWAP) insurgency; barriers to healthcare access in rural and conflict-affected communities;

and a high background prevalence of severe acute malnutrition (SAM), a potent amplifier of measles severity and mortality (Garba *et al.*, 2022; Olasoju *et al.*, 2024; Ori *et al.*, 2021; Osigwe *et al.*, 2020). Recurrent outbreaks have been documented across Sokoto (Ibrahim & Gana, 2016), Yobe (Eze *et al.*, 2020), Borno (Osigwe *et al.*, 2020), Bauchi (Ori *et al.*, 2021), Zamfara (Garba *et al.*, 2022), and Kebbi (Bala *et al.*, 2025).

Adamawa State, situated in the north-east geopolitical zone and bordering Borno, Yobe, and the Republic of Cameroon, faces comparable challenges. A situation analysis of children identified Adamawa among states with the lowest child immunization coverage in Nigeria (Adamawa State Government, 2020). Despite this context, published facility-based data characterizing the clinical profile and outcomes of measles in Adamawa State are entirely absent from the peer-reviewed literature. This study therefore aimed to: (1) describe the epidemiological characteristics of children admitted with measles to MAUTHY, Yola, during 2025; (2) document the clinical complications; (3) determine the CFR and examine factors associated with mortality; and (4) contextualize the findings within national, regional, and global evidence.

MATERIALS AND METHODS

Study Design

This was a retrospective cross-sectional study utilizing routinely collected medical record data to characterize the epidemiological and clinical profile of all measles admissions at a single tertiary centre over a defined 12-month period.

Ethical Considerations

Ethical approval was obtained from the Research Ethics and Review Committee of MAUTHY, Yola (Reference No: NHREC/MAUTHY/23/438). The study involved retrospective analysis of anonymized patient records without direct patient contact; individual consent was not required per the Declaration of Helsinki (2013 revision).

Study Area

The study was conducted at the Emergency Paediatric Unit (EPU) of Modibbo Adama University Teaching Hospital (MAUTHY), Yola, the capital of Adamawa State, in the north-east geopolitical zone of Nigeria. Yola is situated on the southern bank of the River Benue at approximately 9°14′ N and 12°28′ E (9.23° N, 12.46° E). Adamawa State was created on 27 August 1991 from the former Gongola State and occupies a land area of 36,917 km², making it the eighth largest of the 36 states of the Federation. It is bordered to the north-west by Borno State, to the west by Gombe State, and to the south-west by Taraba State, and shares an international boundary with the Republic of Cameroon to the east. The state comprises 21 Local Government Areas (LGAs) grouped into three senatorial districts. The 2006 national census enumerated 3,178,950 residents, and the state population was projected at 4,902,100 in 2021 (Adamawa State Bureau of Statistics, 2021).

Yola has a tropical wet-and-dry (savanna) climate of the Köppen Aw type, with a single rainy season from May to September/October and a dry season from October/November to April (Adamawa State Bureau of Statistics, 2021). Climatological records for the Yola synoptic station indicate a mean annual rainfall of approximately 870–880 mm, with August the wettest month at about 196 mm, while December to February are effectively rainless; a mean annual temperature of approximately 28 °C, with the hottest period in March and April, when daily maximum temperatures frequently exceed 35 °C; and a strongly seasonal relative humidity that falls below 20% during the Harmattan months of December to February and rises above 70% between July and September (Nigerian Meteorological Agency, 2025). This March–April window of maximum ambient temperature and minimum relative humidity coincides with the annual peak of measles transmission in the state and is therefore of direct relevance to the temporal findings reported below.

MAUTHY is a federal government-owned 350-bed tertiary institution functioning as the principal paediatric referral facility for Adamawa State. It receives referrals from the 21 LGAs of the state, from neighbouring Taraba and Borno States, and from cross-border communities in the Republic of Cameroon. The EPU is the point of entry for all paediatric emergencies and operates a 24-hour service staffed by consultant paediatricians, resident doctors, and nurses.

Study Population

The study population comprised all children aged 1 month to 17 years admitted to the EPU of MAUTHY with a primary clinical diagnosis of measles between 1 January and 31 December 2025.

Inclusion and Exclusion Criteria

Children were included in the study if they satisfied all of the following criteria: (i) aged 1 month to 17 years at the time of admission; (ii) admitted to the EPU of MAUTHY between 1 January and 31 December 2025; (iii) met the WHO standard clinical case definition for measles as set out below; and (iv) had a retrievable case record documenting, at minimum, age, sex, vaccination status, and treatment outcome.

Children were excluded if any of the following applied: (i) aged less than 1 month or 18 years and above; (ii) a febrile maculopapular rash that was attributed at discharge to an alternative diagnosis, such as rubella, scarlet fever, drug eruption, or Stevens–Johnson syndrome; (iii) seen and managed in the outpatient department without admission to the EPU; or (iv) case records that could not be retrieved, or that were too incomplete to permit classification of vaccination status or treatment outcome. Where a child had more than one admission episode within the study period, only the index admission was analysed, so that each record in the dataset represents a unique patient.

Case Definition

A clinical case of measles was defined according to the WHO standard case definition as fever (temperature ≥38.5 °C), generalized maculopapular rash, and at least one of: cough, coryza, or conjunctivitis (WHO, 2018). Laboratory confirmation by serology or reverse transcription polymerase chain reaction (RT-PCR) was not routinely available for all patients due to resource constraints.

Data Collection

Data were extracted from individual patient medical records using a structured extraction form. Variables collected included: age, sex, LGA of residence, vaccination status (fully vaccinated: two doses of measles-containing vaccine [MCV]; incompletely vaccinated: one MCV dose; unvaccinated: no MCV dose), clinical complications, duration of hospital stay, and treatment outcome (discharged alive or died). Vaccination status was ascertained from maternal and child health (MCH) immunization cards where available, or from caregiver verbal history.

Statistical Analysis

Data were entered and analysed using IBM SPSS Statistics version 21 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages; continuous variables as medians and interquartile ranges (IQR). The CFR was calculated as deaths divided by total admissions, multiplied by 100. Associations between categorical variables were assessed by Fisher's exact test. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

Demographic Characteristics

A total of 22 children were admitted with measles during the study period. The sex distribution was equal: 11 males (50.0%) and 11 females (50.0%). The median age was 3 years (IQR: 1–4 years). Children under five years accounted for 86.4% (19/22) of admissions. Infants below one year of age represented 31.8% (7/22) of the cohort, while children aged 1–4 years constituted the largest single subgroup at 54.5% (12/22). Children aged 5–9 years and those aged 10 years or older accounted for 9.1% (2/22) and 4.5% (1/22), respectively (Table 1).

The predominance of children under five years (86.4%) is consistent with the established epidemiological pattern of measles in northern Nigeria. Ori *et al.* (2021) documented that children aged 1–4 years constituted 66.0% of measles cases in Bauchi State, while Garba *et al.* (2022) reported a similar under-five predominance in Zamfara State. Bala *et al.* (2025) found that 72% of 9,819 suspected cases in Kebbi State occurred in children under five years, with a median age of 2 years, and Ibrahim *et al.* (2019), reviewing 131,732 cases from national case-based surveillance, reported the same age concentration. Beyond Nigeria, Idé *et al.* (2022) described an identical pattern in neighbouring Niger Republic, and Goodson *et al.* (2011) documented the persistence of an under-five-dominated age distribution across the African Region wherever routine coverage remains below the elimination threshold. The 2025 NCDC national surveillance data likewise reported that children aged 9–59 months accounted for nearly half of all confirmed cases nationally (NCDC, 2025). These convergent findings reflect the accumulation of susceptible individuals in under-vaccinated birth cohorts and the waning of maternally derived antibodies by 6–9 months, creating a window of maximum susceptibility in infancy (Moss, 2017; Jean Baptiste *et al.*, 2021). The equal sex distribution in this cohort is consistent with the absence of biological sex-differential susceptibility to measles, as documented in national surveillance analyses (Jean Baptiste *et al.*, 2021) and continental reviews (Goodson *et al.*, 2011); it contrasts with the slight male excess reported from Kebbi State (51% male) and Bauchi State (52% male), a difference most plausibly explained by chance in a cohort of this size rather than by any underlying biological mechanism.

The public health implication of this age distribution is that measles control in Adamawa State cannot be achieved through school-entry or catch-up strategies aimed at older children. Because the burden is concentrated in the first five years of life, and because 31.8% of admissions occurred in infants below the age at which MCV2 is scheduled, the operational priority must be timely delivery of MCV1 at nine months and MCV2 at 15 months, coupled with aggressive defaulter tracing. The finding also strengthens the case for maintaining the routine immunization schedule during humanitarian disruption, since each cohort that misses MCV1 becomes a reservoir of susceptibility that manifests clinically within one to two transmission seasons. Practically, this argues for integrating measles vaccination status screening into every paediatric contact, including outpatient, nutrition, and antenatal-linked services, so that missed opportunities for vaccination are systematically converted into doses delivered.

Table 1: Age Distribution of Measles Admissions, MAUTHY Yola, January–December 2025 (N = 22)

Age group	Frequency (n)	Percentage (%)
<1 year	7	31.8
1–4 years	12	54.5
5–9 years	2	9.1
≥10 years	1	4.5
Total	22	100.0

Note. Children under five years (<1 year and 1–4 years combined) = 19/22 (86.4%). Median age = 3 years (IQR: 1–4 years).

Vaccination Status

Most admitted children (81.8%; 18/22) were either unvaccinated (45.4%; 10/22) or incompletely vaccinated with one MCV dose (36.4%; 8/22). Only four children (18.2%) had received two complete doses of measles-containing vaccine prior to admission (Table 2).

These findings closely mirror the 2025 NCDC national surveillance data, which documented that 77.1% of confirmed cases nationally had received no measles vaccine dose (NCDC, 2025). Comparable proportions have been reported across northern Nigeria: Bala *et al.* (2025) found that 92% of suspected cases in Kebbi State were unvaccinated, and Jean Baptiste *et al.* (2021) reported that 70.8% of 153,097 confirmed cases nationally between 2008 and 2018 had received no dose, with 85.5% of the national caseload arising in the northern states. The Nigeria Demographic and Health Survey reported MCV1 coverage at only 57% nationally (NPC & ICF, 2019), and Sato *et al.* (2022) demonstrated a strong inverse correlation between vaccination coverage and measles incidence across Nigerian states. In Adamawa State, the 2020 situation analysis documented immunization coverage among the lowest in Nigeria, with significant proportions of children in rural LGAs and internally displaced person (IDP) communities unimmunized (Adamawa State Government, 2020). The ongoing Borno–Adamawa–Yobe (BAY) states insurgency has further disrupted routine immunization through facility closures, outreach worker displacement, and cold chain infrastructure damage (Olasoju *et al.*, 2024). Ibrahim and Gana (2016) demonstrated the fragility of immunity by documenting an outbreak in Sokoto State within three months of a supplementary immunization campaign, indicating that campaign coverage alone does not substitute for a functioning routine system. The four vaccinated cases in the present cohort (18.2%) may reflect primary vaccine failure (approximately 5% with one dose), secondary vaccine failure, cold chain lapses, or high-dose viral exposure in outbreak settings (Moss, 2017).

For public health practice, the finding that four in five admitted children were unvaccinated or incompletely vaccinated identifies the immunization system, rather than clinical case management, as the principal point of intervention. Every admission in this series represents a preventable event and therefore an audit signal: a child reaching a tertiary emergency unit with measles indicates a failure earlier in the chain of primary health care delivery. Three operational implications follow. First, the incompletely vaccinated fraction (36.4%) points to a dropout problem between MCV1 and MCV2 rather than to outright refusal, which is addressable through reminder systems, defaulter tracing, and second-dose delivery at every opportunity. Second, the presence of breakthrough disease among fully vaccinated children underlines the need for cold chain monitoring and vaccine potency assurance at the LGA level. Third, because measles vaccination coverage functions as a sensitive tracer for the performance of the wider Expanded Programme on Immunization, coverage gaps of this magnitude imply parallel susceptibility to other vaccine-preventable diseases in the same communities.

Table 2: Vaccination Status of Measles Admissions, MAUTHY Yola, 2025 (N = 22)

Vaccination status	Frequency (n)	Percentage (%)
Fully vaccinated (two MCV doses)	4	18.2
Incompletely vaccinated (one MCV dose)	8	36.4
Unvaccinated (no MCV dose)	10	45.4
Total	22	100.0

Note. MCV = measles-containing vaccine. Unvaccinated and incompletely vaccinated combined = 18/22 (81.8%). Status ascertained from MCH card or caregiver verbal history.

Temporal (Seasonal) Distribution

Cases occurred across multiple months but with a markedly non-uniform distribution. A pronounced seasonal peak occurred in March and April, together accounting for 68.2% (15/22) of all admissions and all six deaths. Sporadic single cases were recorded in January, May, August, and October. No admissions were recorded in June, July, September, November, or December (Table 3 and Figure 1).

The March–April peak corresponds precisely with the established dry-season measles transmission pattern across northern Nigeria and the West African measles belt (Jean Baptiste *et al.*, 2021; Idé *et al.*, 2022). The NCDC consistently documents peak measles case notification in Nigeria during March–April (NCDC, 2025), and Ibrahim *et al.* (2019) identified March as the modal month in five years of national case-based surveillance. Bala *et al.* (2025) reported that 88% of Kebbi State cases occurred in the first half of each year, with March contributing 30.3% of the total. Multiple interacting mechanisms drive this seasonality: reduced Harmattan-season relative humidity prolongs airborne MeV viability; seasonal population movement associated with harvests and religious gatherings increases inter-community mixing; the school calendar concentrates young children in enclosed spaces; and the pre-harvest lean season worsens nutritional status, increasing susceptibility and disease severity (Jean Baptiste *et al.*, 2021; Ori *et al.*, 2021; Wolfson *et al.*, 2009). Comparable dry-season peaks have been documented in Bauchi (Ori *et al.*, 2021), Zamfara (Garba *et al.*, 2022), Sokoto (Ibrahim & Gana, 2016), Borno (Osigwe *et al.*, 2020), and Niger Republic (Idé *et al.*, 2022). It is notable, however, that Bala *et al.* (2025) observed a departure from this pattern in one study year, when transmission shifted to the last quarter, indicating that the dry-season peak, while highly reproducible, is not invariant and that surveillance must remain year-round.

The concentration of all six deaths within this two-month window carries a direct public health implication: measles mortality in Adamawa State is a predictable, calendar-linked event rather than a random occurrence, and is therefore amenable to anticipatory planning. Preparedness activities, including vaccine stockpiling, pre-positioning of vitamin A and antibiotics, reinforced infection prevention and control in paediatric wards, isolation bed reservation, and caregiver education, should be concentrated in the November-to-February interval, ahead of the transmission peak. Equally, health risk calendars used by the State Epidemiology Unit and by LGA disease surveillance and notification officers should formally designate March and April as a high-alert period for measles, so that outbreak thresholds trigger response within days rather than weeks. The absence of admissions in five months of the year should not be read as absence of transmission, but as a period in which case-finding and vaccination catch-up can be conducted with the least competition for health system capacity.

Table 3: Monthly Distribution of Measles Admissions, MAUTHY Yola, 2025 (N = 22)

Month	Number of cases (n)	Percentage (%)
January	1	4.5
February	3	13.6
March	7	31.8
April	8	36.4
May	1	4.5
August	1	4.5
October	1	4.5
Total	22	100.0

Note. Months not listed (June, July, September, November, and December) recorded zero admissions. Percentages may not sum to 100.0 owing to rounding.

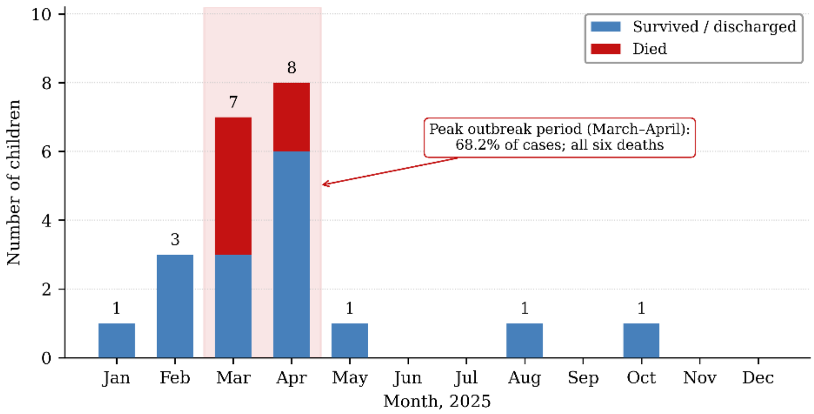

Figure 1: Epidemic curve of measles admissions by monthly distribution and outcome, MAUTHY Yola, January–December 2025 (N = 22). Blue bars represent children who survived and were discharged; red bars represent in-hospital deaths. Numbers above bars indicate total monthly case counts. The shaded area (March–April) denotes the peak outbreak period, accounting for 68.2% of all admissions and all six deaths

Clinical Complications

Bronchopneumonia was the most frequent complication, occurring in 90.9% (20/22) of patients, followed by severe acute malnutrition (SAM; 81.8%; 18/22), diarrhoea (68.1%; 15/22), encephalitis (9.0%; 2/22), croup (9.0%; 2/22), xerophthalmia (4.5%; 1/22), and subcutaneous emphysema (4.5%; 1/22) (Table 4 and Figure 2). Most children presented with concurrent multi-system complications.

The near-universal prevalence of bronchopneumonia (90.9%) reflects the profound immune amnesia induced by the measles virus, characterized by depletion of memory B and T cells, which renders affected children acutely susceptible to secondary bacterial infections for weeks to months after the acute illness (de Vries *et al.*, 2012; Moss, 2017). Pneumonia accounts for approximately 56–73% of measles-attributable deaths in sub-Saharan Africa (Wolfson *et al.*, 2009). The rate observed in this cohort substantially exceeds that reported from Nigerian population-based surveillance studies (Garba *et al.*, 2022; Ori *et al.*, 2021), and is closer to the complication burden described in earlier Nigerian hospital-based series, in which bronchopneumonia was likewise the dominant complication among admitted children. This divergence between community-based and facility-based estimates reflects the severe case mix at a tertiary referral centre, compounded by SAM co-morbidity, and illustrates why hospital series should not be interpreted as measures of population-level severity.

The very high SAM prevalence (81.8%) is the most clinically critical finding of this study. SAM impairs immunity through lymphoid atrophy, reduced complement activity, and diminished CD4+ T lymphocyte function (Wolfson *et al.*, 2009). Simultaneously, measles deepens malnutrition through anorexia, increased metabolic demand, protein-losing enteropathy, and vitamin A depletion, creating a bidirectional, self-amplifying cycle (de Vries *et al.*, 2012; Wolfson *et al.*, 2009). Wolfson *et al.* (2009) demonstrated that measles CFRs consistently exceed 20% in high-malnutrition settings, precisely the nutritional context of the BAY states humanitarian emergency, where SAM prevalence among children under five years exceeds 15–20% (United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2025).

Diarrhoea (68.1%) is the second most common direct measles-attributable cause of childhood mortality in Africa, mediated through viral enteropathy, secondary enteric infection by *Salmonella* spp., *Shigella* spp., and *Cryptosporidium* spp., and synergistic interaction with malnutrition causing rapid and lethal dehydration (de Vries *et al.*, 2012). Encephalitis (9.0%) is associated with a case fatality of 15–20% and permanent neurological sequelae in 25–35% of survivors (Moss, 2017). Xerophthalmia (4.5%) reflects measles-induced vitamin A depletion, risking corneal ulceration and blindness, and is preventable by prompt high-dose supplementation in accordance with WHO guidance (WHO, 2018). Subcutaneous emphysema (4.5%) is a rare but life-threatening complication of severe bronchopneumonia.

The public health implications of this complication profile are threefold. First, because bronchopneumonia and SAM co-occurred in the great majority of admissions, measles case management in this setting cannot be conceived as antiviral-free supportive care alone; it requires an integrated protocol combining empirical antibiotic therapy, high-dose vitamin A, and immediate therapeutic feeding. Second, the coexistence of a vaccine-preventable infection with a nutritional emergency means that immunization and nutrition programmes should be planned and evaluated jointly rather than as separate vertical streams; opportunities include routine mid-upper arm circumference screening at every immunization contact and measles vaccination status checks at every therapeutic feeding centre admission. Third, the presence of xerophthalmia in this cohort indicates that population-level vitamin A supplementation coverage remains incomplete in the catchment area, a deficiency that is both inexpensive and rapid to correct and that would be expected to reduce measles case fatality independently of any change in vaccination coverage.

Table 4: Clinical Complications among Measles Admissions, MAUTHY Yola, 2025 (N = 22)

Complication	Frequency (n)	Percentage (%)
Bronchopneumonia	20	90.9
Severe acute malnutrition	18	81.8
Diarrhoea	15	68.1
Encephalitis	2	9.0
Croup	2	9.0
Xerophthalmia	1	4.5
Subcutaneous emphysema	1	4.5

Note. Complications are not mutually exclusive; patients may have experienced concurrent multiple complications. Percentages are calculated as proportions of total admissions (N = 22).

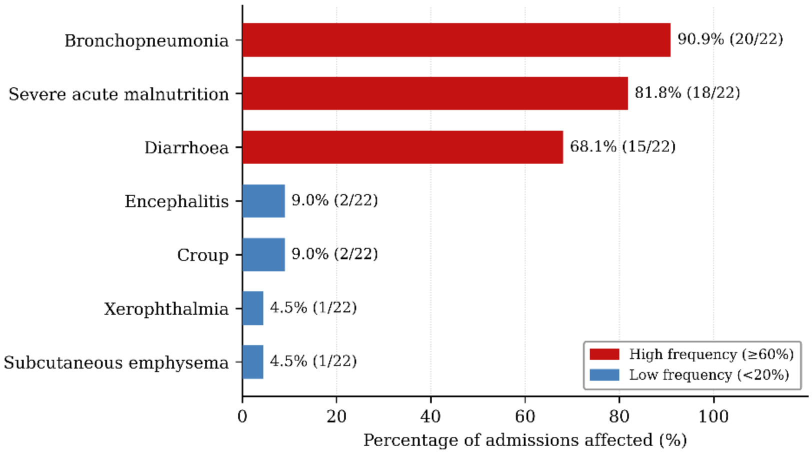

Figure 2: Prevalence of clinical complications among children admitted with measles, MAUTHY Yola, 2025 (N = 22). Horizontal bars indicate the percentage of patients affected by each complication, with the corresponding numerator and denominator shown alongside each bar. Red bars denote high-frequency complications (≥60% of admissions) and blue bars denote low-frequency complications (<20%); no complication fell within the intermediate 20–59% band. Complications are not mutually exclusive; individual patients may have experienced more than one complication simultaneously

Clinical Outcomes and Case Fatality Rate

Six children died, yielding an overall in-hospital CFR of 27.3% (6/22). Sixteen children (72.7%) were discharged alive. Age-specific CFRs were 28.6% (2/7) among infants aged less than 1 year and 33.3% (4/12) among children aged 1–4 years; no deaths occurred among children aged 5–9 years or among those aged 10 years and above (Table 5 and Figure 3). Fisher's exact test found no statistically significant association between age group and outcome ($p = 1.000$), though the small sample size substantially limits statistical power. Four of the six deaths (66.7%) occurred within 24 hours of admission, indicating advanced-stage disease at presentation. All six deaths occurred during the March–April seasonal peak.

The CFR of 27.3% markedly exceeds published estimates at every comparator level. The NCDC reported a national CFR of approximately 0.8% in 2025 (NCDC, 2025); Ibrahim *et al.* (2019) documented a CFR of 0.62% (817 deaths among 131,732 cases) in national case-based surveillance data; Bala *et al.* (2025) reported an overall CFR of 1.2% (121/9,819) from Kebbi State surveillance, with a maximum LGA-level CFR of 8.4%; Ori *et al.* (2021) reported 1.15% (57/4,935) in Bauchi State; and WHO estimates West African measles CFRs at 4–6% under routine conditions, while acknowledging substantially higher rates in conflict-affected, high-malnutrition settings (WHO, 2024). The CFR in the present study therefore exceeds the WHO regional estimate approximately four- to five-fold and national population-level rates by more than thirty-fold. Importantly, Bala *et al.* (2025) explicitly attributed the divergence between their population-level CFR and the higher figures reported in Nigerian hospital-based reviews to the concentration of severe disease in facility denominators, a mechanism that applies directly to the present series.

Four complementary mechanisms explain this discrepancy. First, referral bias: MAUTHY receives predominantly the most severe cases, those that have failed to improve at primary and secondary care levels, systematically enriching the facility denominator with high-severity patients and inflating the CFR relative to population-level estimates (Wolfson *et al.*, 2009). Second, the very high SAM prevalence (81.8%) multiplicatively amplifies case fatality; Wolfson *et al.* (2009) demonstrated that measles CFRs consistently exceed 20% in high-malnutrition settings, confirming the biological plausibility of the observed rate. Third, delayed presentation, evidenced by four of six deaths occurring within 24 hours of admission, indicates that most fatal cases arrived moribund with established pneumonia or multi-organ dysfunction, reflecting long travel distances, financial barriers, and health-seeking delays (Osigwe *et al.*, 2020). Fourth, the outbreak-period concentration of all deaths in March and April suggests that the peak transmission season generates not only greater case volumes but also a more severe case mix. The absence of a statistically significant age–mortality association ($p = 1.000$) should be interpreted cautiously given the very small number of events (six deaths);

the study was underpowered to detect age-differential effects that are well established in the broader literature (Garba *et al.*, 2022; Ori *et al.*, 2021; Wolfson *et al.*, 2009). Indeed, Bala *et al.* (2025) found that cases who died were significantly more likely to be under five years of age (odds ratio 3.59, 95% CI: 2.50–5.19) and never vaccinated (odds ratio 3.35, 95% CI: 2.1–5.2), associations that the present cohort was too small to reproduce.

The public health implication of a case fatality rate of this magnitude is that measles in Adamawa State is currently behaving as it did in the pre-vaccine era for the subset of children who reach tertiary care. Because two-thirds of deaths occurred within the first 24 hours, gains from improved in-hospital care alone will be limited; the decisive intervention point lies upstream, in shortening the interval between symptom onset and arrival at a facility capable of managing complicated measles. This argues for investment in community-level recognition and referral, for removal of point-of-care financial barriers for paediatric emergencies, and for decentralized capacity to initiate oxygen, antibiotics, and vitamin A at secondary facilities before referral. It also argues for caution in the interpretation and public communication of facility CFRs: without an explicit statement of referral bias, a rate of this kind may be misread as evidence of poor clinical care rather than as a marker of late presentation and severe upstream system failure.

Table 5: Clinical Outcomes of Measles Admissions by Age Group, MAUTHY Yola, 2025 (N = 22)

Age group	Total (n)	Survived (n)	Died (n)	CFR (%)	Deaths ≤24 hrs (n)	p-value†
<1 year	7	5	2	28.6	2	1.000
1–4 years	12	8	4	33.3	2	1.000
5–9 years	2	2	0	0.0	0	—
≥10 years	1	1	0	0.0	0	—
Total	**22**	**16**	**6**	**27.3**	**4**	**—**

Note. CFR = case fatality rate. †Fisher's exact test comparing age group and treatment outcome; the association was not statistically significant (p ≥ 0.05). All deaths occurred during the March–April seasonal peak.

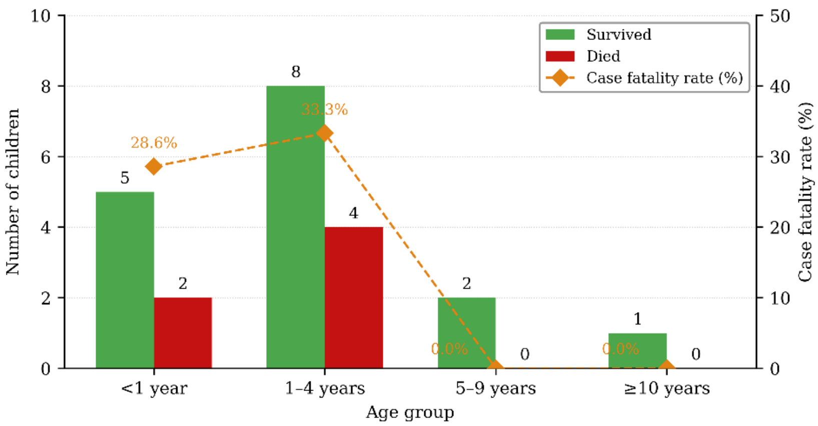

Figure 3: Clinical outcomes and case fatality rate (CFR) by age group among children with measles, MAUTHY Yola, 2025 (N = 22). Green bars represent survivors (left y-axis); red bars represent deaths (left y-axis). Orange diamonds connected by a dashed line indicate age-specific CFR percentage (right y-axis). No deaths occurred among children aged 5–9 years or among those aged 10 years and above. No statistically significant association between age group and treatment outcome was detected (Fisher's exact test: p = 1.000)

Limitations of the Study

Several limitations should be borne in mind. The study was conducted at a single tertiary referral centre, so the case mix is enriched for severe disease and the case fatality rate cannot be generalized to the community. The sample size was small, which limited statistical power to detect associations between age group and outcome. Case ascertainment relied on the WHO clinical case definition because laboratory confirmation was not routinely available, raising the possibility of misclassification with other febrile exanthems. Vaccination status was ascertained partly from caregiver recall where immunization cards were unavailable, which may introduce recall bias in either direction. Finally, because the design was retrospective and record-based, the completeness and accuracy of the data depended on routine clinical documentation, and no population denominator was available to permit calculation of incidence.

CONCLUSION

This retrospective study demonstrates that measles remains a severe and preventable cause of childhood morbidity and mortality at MAUTHY, Yola, Adamawa State, North-East Nigeria. In-hospital case fatality was concentrated among children under five years who presented during the dry-season peak with advanced bronchopneumonia and severe acute malnutrition, and it substantially exceeded national population-level estimates. The predominance of unvaccinated and incompletely vaccinated children identifies inadequate immunization coverage as the primary upstream driver of the burden observed. The coexistence of severe acute malnutrition with measles in most admissions highlights the dual burden of infectious disease and undernutrition that defines paediatric healthcare in the north-eastern Nigerian humanitarian context, while the clustering of deaths within the first day of admission reflects the critical contribution of late presentation and delayed care-seeking. Taken together, these findings provide the first facility-level baseline evidence on measles for Adamawa State health authorities and establish the case for a prospective, multi-centre, population-denominator-linked measles surveillance programme across northern Nigeria.

i. Achieve and sustain MCV1 and MCV2 coverage above the herd immunity threshold across all LGAs in Adamawa State, prioritizing rural and IDP-affected communities, through expanded routine immunization, cold chain strengthening, and integration of vaccination into humanitarian response platforms.
ii. Conduct pre-season targeted supplementary immunization activities (SIAs) between November and February, prior to the established March–April dry-season transmission peak.
iii. Strengthen measles surveillance with real-time case notification to the Adamawa State Epidemiology Unit and the NCDC, and establish sentinel laboratory confirmation capacity at MAUTHY.
iv. Mandate high-dose vitamin A supplementation (two doses 24 hours apart, per WHO protocol) for all children admitted with measles at MAUTHY and across Adamawa State health facilities.
v. Integrate routine SAM screening (mid-upper arm circumference measurement) for all children admitted with measles, with immediate linkage to therapeutic feeding programmes and nutritional rehabilitation services.
vi. Train community health workers in early recognition of measles symptoms to facilitate prompt care-seeking and referral before advanced complications are established, thereby reducing the proportion of patients arriving with advanced disease.
vii. Improve access to vaccination through mobile immunization teams, outreach to IDP camps and religious gatherings, and cold chain infrastructure investment across Adamawa State.
viii. Conduct a prospective, multi-centre, population-denominator-linked measles surveillance study across northern Nigeria to generate robust age-specific CFR data and to identify independent clinical predictors of in-hospital mortality.

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REFERENCES

Adamawa State Bureau of Statistics. (2021). *Adamawa at a glance*. Adamawa State Bureau of Statistics. Available on: https://adsbs.ad.gov.ng/about/adamawaataglance Accessed on: 27 August 2026.

Adamawa State Government. (2020). *Adamawa State situation analysis of children*. Adamawa State Planning Commission.

Bala, H. A., Yahaya, M., Barau, N., Surajudeen, L., Abdullateef, I. R., & Amaza, C. R. (2025). Descriptive characterization of measles in Kebbi State, Nigeria, 2013–2017. *Journal of Interventional Epidemiology and Public Health, 8*, 12. Available on: https://www.afenet-journal.net/content/article/8/12/full Accessed on: 27 August 2026.

de Vries, R. D., Mesman, A. W., Geijtenbeek, T. B. H., Duprex, W. P., & de Swart, R. L. (2012). The pathogenesis of measles. *Current Opinion in Virology, 2*(3), 248–255. https://doi.org/10.1016/j.coviro.2012.03.005

Eze, U., Adewuyi, O., & Abubakar, M. (2020). Investigation of the 2019 measles outbreak in Yobe State, North-East Nigeria. *International Journal of Infectious Diseases, 101*(Suppl. 1), 319. https://doi.org/10.1016/j.ijid.2020.09.832

Garba, F., Usman, R., Umeokonkwo, C., Okolocha, E., Yahaya, M., AbdulQadir, I., Oyeladun, O., Dada, A., & Balogun, M. (2022). Descriptive epidemiology of measles cases in Zamfara State, Nigeria, 2012–2018. *Journal of Interventional Epidemiology and Public Health, 5*, 21. Available on: https://www.afenet-journal.net/content/article/5/21/full Accessed on: 27 August 2026.

Gaythorpe, K. A. M., Abbas, K., Huber, J., Karachaliou, A., Thakkar, N., Woodruff, K., Li, X., Echeverria-Londono, S., Ferrari, M., Jackson, M. L., McCarthy, K., Perkins, T. A., Trotter, C., & Jit, M. (2021). Impact of COVID-19-related disruptions to measles, meningococcal A, and yellow fever vaccination in 10 countries. *eLife, 10*, e67023. https://doi.org/10.7554/eLife.67023

Goodson, J. L., Masresha, B. G., Wannemuehler, K. A., Uzicanin, A., Cochi, S. L., & Reef, S. E. (2011). Changing epidemiology of measles in Africa. *The Journal of Infectious Diseases, 204*(Suppl. 1), S205–S214. https://doi.org/10.1093/infdis/jir129

Ibrahim, B., & Gana, G. (2016). Outbreak of measles in Sokoto State, Northwestern Nigeria, three months after a supplementary immunization campaign. *Australasian Medical Journal, 9*(1), 21–26. https://doi.org/10.4066/AMJ.2016.2697

Ibrahim, B. S., Usman, R., Mohammed, Y., Ahmed, Z. D., Okunromade, O., Abubakar, A. A., & Nguku, P. M. (2019). Burden of measles in Nigeria: A five-year review of case-based surveillance data, 2012–2016. *Pan African Medical Journal, 32*(Suppl. 1), 5. https://doi.org/10.11604/pamj.supp.2019.32.1.16169

Idé, H., Yanogo, P., Barry, D., Togola, O., Adehossi, E., & Meda, N. (2022). Epidemiological profile of measles in Niger: Analysis of measles case-based surveillance data from 2010 to 2019. *Pan African Medical Journal, 43*, 18. https://doi.org/10.11604/pamj.2022.43.18.33443

Jean Baptiste, A. E., Masresha, B., Wagai, J., Luce, R., Oteri, J., Dieng, B., Bawa, S., Ikeonu, O. C., Chukwuji, M., Braka, F., Sanders, E. A. M., Hahné, S. J. M., & Hak, E. (2021).

Trends in measles incidence and measles vaccination coverage in Nigeria, 2008–2018. *Vaccine, 39*(Suppl. 3), C89–C95. https://doi.org/10.1016/j.vaccine.2021.03.095

Mahase, E. (2025). WHO warns that measles is back as the virus spreads across Europe, America, and Afghanistan. *British Medical Journal, 388,* r528. https://doi.org/10.1136/bmj.r528

Moss, W. J. (2017). Measles. *The Lancet, 390*(10111), 2490–2502. https://doi.org/10.1016/S0140-6736(17)31463-0

National Population Commission & ICF. (2019). *Nigeria Demographic and Health Survey 2018*. NPC and ICF. Available on: https://dhsprogram.com/pubs/pdf/FR359/FR359.pdf Accessed on: 27 August 2026.

Nigeria Centre for Disease Control and Prevention. (2025). *Measles situation report, week 52, 2025*. NCDC. Available on: https://www.ncdc.gov.ng Accessed on: 27 August 2026.

Nigerian Meteorological Agency. (2025). *State of the climate in Nigeria 2025*. Nigerian Meteorological Agency. Available on: https://nimet.gov.ng/socn. Accessed on: 27 August 2026.

Ochi, P. O., Agada, A. A., Nworah, I. B., Nworah, D. A., & Goni, A. N. (2024). Local and global stability analysis of measles epidemic model at disease-free equilibrium. *FUDMA Journal of Sciences, 8*(1), 369–379. https://doi.org/10.33003/fjs-2024-0801-2219

Olasoju, T. I., Olasoju, M. I., Daggash, B. B., Abaye, B. B., Enumah, C., Isah, S., Bolori, M. T., & Adebowale, O. O. (2024). Measles outbreak in Lambu Internally Displaced Persons' Camp, Maiduguri, Borno State, Nigeria, 2017. *Journal of Interventional Epidemiology and Public Health, 7*(2), 25. Available on: https://www.afenet-journal.net/content/article/7/25/full Accessed on: 27 August 2026.

Ori, P. U., Adebowale, A., Umeokonkwo, C. D., Osigwe, U., & Balogun, M. S. (2021). Descriptive epidemiology of measles cases in Bauchi State, 2013–2018. *BMC Public Health, 21*, 1311. https://doi.org/10.1186/s12889-021-11063-6

Osigwe, U., Usuwa, I., Bamgboye, E., Bomoi, I., Umeokonkwo, C., & Balogun, M. (2020). Epidemiology of measles in a security-compromised setting: A retrospective analysis of surveillance data in Borno State, Nigeria, 2007–2017. *International Journal of Infectious Diseases, 101*(Suppl. 1), 340. https://doi.org/10.1016/j.ijid.2020.09.896

Sato, R., Makinde, O. A., Daam, K. C., & Lawal, B. (2022). Geographical and time trends of measles incidence and measles vaccination coverage and their correlation in Nigeria. *Human Vaccines & Immunotherapeutics, 18*(6), 2114697. https://doi.org/10.1080/21645515.2022.2114697

United Nations Office for the Coordination of Humanitarian Affairs. (2025). *Nigeria 2025 humanitarian needs and response plan*. OCHA. Available on: https://humanitarianaction.info/plan/1274 Accessed on: 27 August 2026.

Wolfson, L. J., Grais, R. F., Luquero, F. J., Birmingham, M. E., & Strebel, P. M. (2009). Estimates of measles case fatality ratios: A comprehensive review of community-based studies. *International Journal of Epidemiology, 38*(1), 192–205. https://doi.org/10.1093/ije/dyn224

World Health Organization. (2018). Measles vaccines: WHO position paper, April 2017. *Weekly Epidemiological Record, 92*(17), 205–228. Available on: https://www.who.int/docs/default-source/immunization/position_paper_documents/measles/measles-PP-2017.pdf Accessed on: 27 August 2026.

World Health Organization. (2024). *Immunization data: Provisional measles and rubella data*. WHO. Available on: https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/surveillance/monitoring/provisional-monthly-measles-and-rubella-data Accessed on: 27 August 2026

World Health Organization Regional Office for Africa. (2023). *Measles and rubella surveillance data in the African Region*. WHO Regional Office for Africa. Available on: https://www.afro.who.int Accessed on: 27 August 2026.