Communication in Physical Sciences 2020, 6(2): 953-969

Retrospective Analysis of Mortality and Morbidity Among Children Under Five in Three Local Government Areas of Borno State, Nigeria, 2018–2019

Anthony Ekpo

Received 24 July 2020/Accepted 26 December 2020/Published online: 30 December 2020

Abstract: *This study assesses the morbidity of the Under-fives (U5), the Under-five mortality and Crude mortality rates (U5MR and CMR) in three selected Local Governments Areas (LGAs) of Borno State, through determining the prevalence of diarrhea, Acute Respiratory Infection (ARI) and episodes of malaria, assessing the routine polio vaccination coverage among children aged 3 to 59 months, measles vaccination coverage among children aged 9 to 59 months and vitamin A supplementation coverage within the last 6 months prior to survey period among children aged 6 to 59. The crude and under-five mortality rates were assessed among children and the general population retrospectively (over the past three and a half months). In this study, 385, 528, and 610 households were interviewed in Bama, Dikwa, and Ngala, respectively. In all, 4, 46, and 117 deaths were reported, respectively, among all the approximately 911, 1333, and 1347 randomly surveyed individuals in the respective LGAs. Out of this number, 0 (0.0%) , 9 (19.6%) and 3(2.6%) deaths occurred among children less than 5years of age in the respective locations, the Crude Mortality Rate (CMR) and U5 (under-five) mortality rates were 0.47, 3.71and 9.34/10,000/day and 0.0, 3.07 and 1.12/10,000/day respectively in the three LGAs. They were calculated using the number of deaths during the recall period as the numerator and the midpoint population as the denominator. Their respective population pyramids are also presented.*

Keyword: *Under-fives (U5), Crude Mortality Rate (CMR), Morbidity, Retrospective, Recall-period, Mortality rate, midpoint population.*

Anthony Ekpo
Department of Mathematics, Statistics and Computer Science,
Federal University of Agriculture, Makurdi, Benue State, Nigeria.
Email:ekpo.anthony@uam.edu.ng
https://orcid.org/0000-0002-1896-6458

1.0 Introduction

Despite global progress, Nigeria's under-five mortality rate remains well above the Sustainable Development Goal 3 target of fewer than 25 deaths per 1,000 live births (Morakinyo & Fagbamigbe, 2017). In 2018, Nigeria accounted for 13% of global under-five deaths and 26% of such deaths in sub-Saharan Africa. Childhood morbidity is a major contributor to these figures. Globally, pneumonia, diarrhea, and malaria caused about 29% of under-five deaths in 2018. In Nigeria, nearly 90% of under-five deaths result from malaria, pneumonia, diarrhea, and three vaccine-preventable diseases: measles, pertussis, and meningitis. Infections and hypothermia also contribute to neonatal mortality. Beyond mortality, childhood morbidity significantly impairs physical and cognitive development, which largely occurs during this period. Nigeria has implemented strategies aligned with the World Health Organization and other child health agencies, leading to improvements (Lancet, 2017). The under-five mortality rate declined from 193 to 132 deaths per 1,000 live births between 1990 and 2018 (NDHS, April 2017–June 2019, National Primary Health Care Development Agency). However, under-five morbidity remains a significant challenge. Key factors include poor sanitation, unsafe drinking water, low maternal education, poverty, and air pollution. Regional differences in the prevalence of childhood illness may also hinder the effective implementation of interventions when generalized data are used.

Cairns *et al*. (2009) note that under-five mortality rates are of particular interest to public health professionals, as young children are often the focus of targeted interventions. These rates serve as a valuable index of mortality in humanitarian emergencies, given that young children are more susceptible to death than older children or adolescents and therefore exhibit higher mortality rates. In some emergencies, under-five mortality rates may increase before crude mortality rates, providing an earlier indication of deteriorating health conditions. The household census approach can be used to calculate under-five mortality rates; however, sample sizes are often insufficient to yield precise estimates.

A related set of approaches uses the 'indirect' method, developed in the 1960s, in which women in defined age groups answer standardized questions about the number of children ever born alive and the number surviving. This method does not collect information on dates of birth or death. Instead, fertility and mortality models are applied to estimate the timing of these events and the probabilities of survival to specific ages. However, these methods are not suitable for emergency contexts, as they rely on assumptions—such as stable mortality rates over time and independence between child and maternal survival—that are unlikely to hold in such situations.

The previous birth history (PBH) approach, widely used in development contexts, involves collecting the dates of children's births and deaths from a sample of women of reproductive age to construct life tables for the most recent five-year period. Although this method provides estimates centered on a date approximately two and a half years before the survey, recent adaptations have enabled more current estimates in humanitarian emergencies. The PBH approach reduces underestimation and manipulation by avoiding direct questions about deaths. Additionally, respondents have a direct relationship to the deceased, unlike other methods where any adult household member may report household deaths. Nevertheless, survivor bias remains a concern, as deaths cannot be reported if the mother is missing or deceased, which is particularly significant in settings with high maternal and under-five mortality. Few studies have validated the completeness of early childhood death data collected through the PBH approach. Despite these limitations, PBH remains the standard method in most large population-based surveys measuring infant and child mortality globally.

Borno State is in north-eastern Nigeria, with Maiduguri as its capital. It was formed in 1976 from the split of the North-Eastern State and included what is now Yobe State until 1991. The state is dominated by the Kanuri people, with smaller groups such as Lamang, Babur/Bura, and Marghi in the southern part of the state. Shuwa Arabs are primarily descendants of the Arab people. The emirs of the former Kanem-Bornu Empire have played a role in local politics for nearly 1,000 years. The current Kanemi dynasty gained control of the Borno Emirate in the early 19th century following the Fulani jihad led by Usman Dan Fodio. After Nigerian independence in 1960, Borno remained fairly autonomous until Nigeria's state count expanded to 12 in 1967. Local government reform in 1976 further reduced the power of the emirs of the former dynasty, and by the time of Nigeria's return to civilian rule in 1979, the emirs' jurisdiction had been restricted solely to cultural and traditional affairs. The emirs still exist and serve as advisers to the local government (Nigeria Demographic and Health Survey, 2008).

Multiple multi-sectoral emergency humanitarian interventions, encompassing Health, Nutrition, and Water, Sanitation, and Hygiene (WASH) and funded by the Office of

U.S. Foreign Disaster Assistance (OFDA), were implemented for individuals affected by the humanitarian crisis in Borno State, north-east Nigeria (Nutrition and Food Security Surveillance, 2017). These interventions targeted three Local Government Areas: Bama (IDP Camp), Dikwa (Bulabulin, Fulatari, Masarmari camps), and Gamboru Host Community (Ward B and C). Hausa and Fulfulde are the predominant languages spoken by residents in these areas (Northeast, Nigeria, 2018). Nutritional surveillance activities in these locations enabled real-time monitoring and provided early warning of nutritional deterioration within the state (Ekpo & Udoumoh,, 2012, 2013). The primary objective of this study is to assess child morbidity by determining the prevalence of diarrhea, ARI and malaria, assess routine polio vaccination coverage among children aged 3 to 59 months, measles vaccination coverage among children aged 9 to 59 months and vitamin A supplementation coverage within the last 6 months prior to survey among children aged 6 to 59, and assess the crude and under-five mortality rates during the past three and a half months.

2.0 Materials and Methods

A retrospective mortality rate (RMR) is an epidemiological measurement used to estimate the number of deaths within a specific population over a past time frame, usually called the "recall period. It is primarily used in humanitarian emergencies or areas lacking formal death registration systems to gauge the severity of a crisis (Cairns *et al*. 2009).

Formula and Calculation

The U5MR and CMR are calculated by dividing the total number of deaths by the total population (adjusted for the length of the recall period), and is typically expressed as deaths per 10,000 people per day.

$$CMR = \frac{(Total\ Number\ of\ Deaths)}{Total\ Population \times Number\ of\ Recall\ Period} \times 10{,}000 \quad (1)$$

$$U5MR = \frac{(Total\ Number\ of\ Under-five\ Deaths)}{Total\ Population \times Number\ of\ Recall\ Period} \times 10{,}000 \quad (2)$$

Because official vital statistics are unavailable in many disaster or displacement settings, this rate is calculated via retrospective household surveys. Recall period is the duration investigated, typically ranging from 30 days to 6 months. (Angela *et al*., 2006)

2.1 Study area and population

This study was conducted in three LGAs of Bama, Dikwa, and Ngala in Borno State of Nigeria, located in areas of 5158.87 km2, 1836.89 km2, and 1519.82 km2, respectively. The three LGAs are considered one Domain based on their seemingly similar socio-economic, geographical, and cultural characteristics, thereby meeting the criteria for a homogeneous population. The State shares a border with the Republic of Niger to the north, Lake Chad (and the Republic of Chad) to the northeast, and Cameroon to the east; and to the south and west, it borders the Nigerian states of Adamawa, Gombe, and Yobe (Northeast, Nigeria, 2018). The mortality interview included all members of eligible households, randomly selected from the randomly selected clusters. A household comprises a man, one wife (even if he has more than two wives), her children, and any of their relatives living in the same house, sleeping together and eating from the same pot. A Simple Random Sample (SRS) procedure was used to select one wife when a household had multiple wives.

2.2 Study design, sample size and sampling procedure

A multi-stage cluster sampling survey following the EPI (2) method was be used in this survey

A multi-stage cluster sampling survey following the EPI (2) method was be used in this survey and was carried out by twelve (12) teams of trained enumerators/survey workers with three (3) teams in Bama, another three (3) teams in Dikwa and the remaining six (6) teams in Ngala, with one team per cluster within the three LGA for 5 days (27th July – 31st July 2018). The data collection exercise was carried out simultaneously in the three locations with adequate supervision. The three teams in Bama collected data on mortality component of the survey based on a 1.03/10000/day estimated death rate, a precision of 0.5/10000/day, 1.2 design effect and recall period of 90 days (27th April, 2018 - 28th July, 2018 i.e Shaban 11, 1439 – Dhul-Qudah 15, 1439 of the Islamic calendar). The resulting sample size was 2297 persons or 338 households based on an average household size of 7 members and a 3% non-response rate.

Table 1: Estimated Parameter for mortality

Parameters for Mortality	Value	Assumptions based on context
Estimated Death Rate /10,000/day	1.03	Based on the prevailing results from recent results of nutrition and mortality surveys conducted.
± Desired precision /10,000/day	0.5	SMART recommendations where death rates are very high (> 1.0), a precision of ± 0.4 or 0.5 may be sufficient.
Design Effect	1.2	The survey result of April 2016 revealed a design effect of 1.
Recall Period in days	90	Recommended period during emergencies (27 April, 2018 - 28 July, 2018)
Average HH Size	7	
% Non-response Households	3%	
Population to be included	2297	The calculations were made using ENA Software for SMART (July 9th, 2015 version of ENA).
Households to be included	338	The calculations were made using ENA Software for SMART (July 9th, 2015 version of ENA).

30 clusters were visited, with at least 76 households interviewed per cluster and a proportional number from each stratum, specifically at least 571 persons from stratum A, at least 364 persons from stratum B, and at least 1362 persons from stratum C. The study population comprised of the 34 identified settlements (Bulama/Camps) which have been demarcated into clusters in the identified wards and were distributed into three strata, i.e. Bama in Stratum A, Dikwa in Stratum B and Ngala in Stratum C with cluster sizes proportionately and hypothetically allocated for ease of cluster selection which must met the criteria for Simple Random Sampling (SRS) based on Probability Proportional to Size (PPS). All selected wards and settlements were accessible during the survey, except for households that were absent.

2.3 Cluster Selection

The 30 clusters used were randomly selected by assigning probability Proportional to Population Size (PPS), using ENA for SMART software. When a selected household is found to consist of one husband and several wives with their respective children, one of the wives with her children is selected at random. The mortality interview was administered first to this family, including any of the husband's relatives living with them at the time of the survey. Where there were no eligible children, the surveyors moved to the next house. Absent households or households with absent children were revisited once, at the end of the day (Manuel Sanchez-Montero *et al*, 2010).

Table 1. Distribution of Sample Clusters by Stratum, Community/Ward, and Projected Population (2018)

Stratum A (Bama)

Political Ward	Community/Ward	Cluster	Projected Population (2018)	Code
Bama	IDP	B1	674	1
		B2	1,348	2
		B3	2,023	3
		B4	2,697	4
		B5	3,371	5
		B6	4,045	6
		B7	4,720	7
Total	**1**	**7**	**18,879**	

Stratum B (Dikwa)

Political Ward	Community/Ward	Settlement	Projected Population (2018)	Code
Dikwa	Bulabulin	D1	333	8
		D2	667	9
		D3	1,000	10
		D4	1,333	11
	Fulatari	D5	1,667	12
		D6	2,000	13
	Masarmari	D7	2,333	14
		D8	2,667	15
Total	3	8	12,000	

Stratum C (Ngala)

Political Ward	Community/Ward	Settlement	Projected Population (2018)	Code
Ngala	Gamboru B	N1	238	16
		N2	474	17
		N3	714	18
		N4	947	19
		N5	1,184	20
		N6	1,422	21
		N7	1,657	22
		N8	1,895	23
		N9	2,133	24
		N10	2,368	25
	Gamboru C	N11	2,605	26
		N12	2,841	27
		N13	3,079	28
		N14	3,317	29
		N15	3,552	30

		N16	3,789	31
		N17	4,022	32
		N18	4,263	33
		N19	4,500	34
Total	**2**	**19**	**45,000**	

Note: The table presents the allocation of the 34 survey clusters across the three study strata (Bama, Dikwa, and Ngala) based on the projected 2018 population. Cluster codes were assigned sequentially to facilitate sampling and field identification.

2.4 Training and supervision

A total of 45 trained survey workers in the area were invited to retrain. They all attended a three-day refresher training in their various locations (24th-26th July, 2018). The training dwelt on sampling principles, methodology of mortality measurements, data collection procedures in a mortality survey, and their possible biases. A written test together with a standardization test was administered at the end of the training, and on the basis of the results, twelve (12) teams were selected. The twelve teams comprised two measurers and one team leader, with at least one female team member who led in cases where men were restricted from entry. Three (3) teams were enumerated for three days in Bama; another three (3) teams were enumerated for three days in Dikwa; the remaining six teams were enumerated in Ngala for three days; and a team of three persons was kept in each location as a reserve.

2.5 Data collection

The variables of interest, such as age, sex, polio vaccinations, Vitamin A coverage, presence of ARI, malaria coverage, and diarrhea, were collected. A standardized mortality survey questionnaire, coded in ODK, was used for data collection and electronic entry. Daily data collected by each team were subjected to plausibility checks. Age: A child's age in years was determined from the birth date by interviewing the mother or an adult member of the household, mainly by asking for their age, because the event calendar was not available at the time of the survey; the use of the vaccination card reporting the child's birth date was also applied where possible. Episodes of diarrhea, Polio vaccination, Malaria and Vitamin A coverage, and ARI treatment: The child's mother or caregiver was asked verbally whether the child had been immunized against any of the diseases, and an immunization card was requested to confirm the child's immunization/health status.

The questionnaire, has questions such as the current household members present as at the time of the data collection, age of respondents, sex, persons that joined the household within the 90 days recall period, persons that left the household within the recall period, children that were born within the 90 days recall period, and persons that died within the recall period were collected using a standardize questionnaire.

2.6 Data entry and Analysis

Data entry and analysis of the mortality questionnaires was done using ENA for SMART software (updated version 2015). Ages of respondents were entered in years for mortality survey. Zero was entered for ages of respondents below 1 year old and 60 for column with adult as the age of the respondent (Measuring Mortality, Nutritional Status, and Food Security in Crisis Situations , 2006).

3.0 Results and Discussion

3.1 Retrospective Mortality

A total of 1,523 households were surveyed across the three Local Government Areas (LGAs), comprising 385 households in Bama, 528 households in Dikwa, and 610 households in Ngala. The survey covered a midpoint population of 911, 1,333, and 1,347 individuals in Bama, Dikwa, and Ngala, respectively

(Tables 3–5). During the 90-day recall period, 167 deaths were reported across the three LGAs, with only 4 deaths (2.4%) occurring in Bama, compared with 46 deaths (27.5%) in Dikwa and 117 deaths (70.1%) in Ngala. Among children under five years of age, no deaths were recorded in Bama, while nine deaths and three deaths occurred in Dikwa and Ngala, respectively.

The demographic characteristics of the study population are presented in Tables 3–5. In Bama, the surveyed population consisted of 444.5 males (48.8%) and 466.5 females (51.2%), indicating a nearly balanced sex distribution (Table 3). Children and adolescents below 18 years accounted for over half of the population, with the 5–11 years age group representing the largest proportion (211 individuals), followed by the 18–49 years economically productive age group (382.5 individuals). Household movement during the recall period was relatively limited, with 39 individuals joining and 23 leaving the surveyed households, while no births and only four deaths were recorded.

Similarly, Dikwa exhibited a slightly higher female population (685.5) than male population (647.5) (Table 4). The population structure was predominantly youthful, with children aged 0–14 years accounting for approximately 52.5% of the surveyed population. Two births and 46 deaths were recorded during the recall period, suggesting considerably higher mortality than observed in Bama. Ngala also displayed a youthful population structure with females (684) marginally exceeding males (663) (Table 5). However, unlike Bama and Dikwa, Ngala experienced substantial demographic changes during the recall period, including 132 new arrivals, 143 departures, 161 births, and 117 deaths, reflecting the highly dynamic nature of the population, which is characteristic of conflict-affected communities experiencing continuous displacement and migration.

The population pyramids further illustrate the demographic composition of the three LGAs (Figures 1–3). The population pyramid for Bama (Figure 1) exhibits a broad base with progressive narrowing toward the older age groups, representing an expansive population typical of developing and humanitarian settings characterized by high fertility and a predominantly young population. The largest population shares occurred among children aged 0–4 years and 5–9 years, while very few individuals were observed above 65 years of age. The relatively symmetrical distribution between males and females across most age groups suggests the absence of significant sex-selective population loss. The narrow apex further reflects low life expectancy and limited survival into old age, a demographic pattern commonly associated with populations experiencing prolonged socioeconomic hardship.

A similar demographic profile was observed in Dikwa (Figure 2), although the pyramid displays a slightly wider female population within the reproductive age groups (20–34 years), indicating greater representation of women of childbearing age. The extremely broad base demonstrates sustained high fertility, while the sharp decline in population beyond 50 years suggests elevated mortality and reduced survival among older adults. This age structure is consistent with populations affected by chronic insecurity, food shortages, and restricted access to healthcare services.

The Ngala population pyramid (Figure 3) also exhibits an expansive structure with a remarkably broad base dominated by children younger than 15 years. Compared with Bama and Dikwa, the pyramid displays greater fluctuations within the adult age groups, particularly between 25–49 years, likely reflecting repeated population displacement, migration, and household fragmentation resulting from the protracted insurgency. The pronounced reduction in older age groups further highlights poor survival among elderly populations. Overall, the three population pyramids demonstrate that all study locations possess youthful populations with high dependency ratios, placing substantial pressure on already overstretched humanitarian and health resources.

The crude mortality rate (CMR) and under-five mortality rate (U5MR) are summarized in Tables 6–8. Bama recorded the lowest mortality burden, with a CMR of 0.47 deaths per 10,000 persons per day (95% CI: 0.07–3.04) and no recorded under-five deaths, resulting in a U5MR of 0.00 deaths per 10,000 children per day (Table 6). These values remain well below internationally recognized emergency thresholds of 1 death per 10,000 persons per day for the general population and 2 deaths per 10,000 children under five per day for children, indicating relatively stable mortality conditions during the survey period.

In contrast, Dikwa recorded a CMR of 3.71 deaths per 10,000 persons per day (95% CI: 0.82–15.33) and a U5MR of 3.07 deaths per 10,000 children per day (95% CI: 0.47–17.72) (Table 7). Both indicators exceeded internationally accepted humanitarian emergency thresholds, suggesting the presence of a severe public health crisis. Elevated mortality among children under five is particularly concerning because it often reflects deteriorating nutritional status, infectious disease transmission, inadequate immunization coverage, poor water and sanitation conditions, and limited access to essential healthcare services.

Ngala experienced the highest mortality burden among the three LGAs, with a CMR of 9.34 deaths per 10,000 persons per day (95% CI: 2.55–29.18), approximately 20 times higher than that observed in Bama (Table 8). Although the U5MR of 1.12 deaths per 10,000 children per day remained below the emergency threshold, the exceptionally high crude mortality indicates that mortality was concentrated predominantly among older children and adults. The markedly elevated CMR likely reflects the cumulative effects of prolonged conflict, repeated displacement, food insecurity, infectious diseases, disrupted livelihoods, and inadequate access to healthcare services.

Sex-specific mortality rates are presented in Tables 9–11. In Bama, females recorded a slightly higher mortality rate (0.69 per 10,000 persons per day) than males (0.24 per 10,000 persons per day) (Table 9), although the wide confidence intervals suggest no statistically meaningful difference. In Dikwa, male mortality (4.15 per 10,000 persons per day) marginally exceeded female mortality (3.29 per 10,000 persons per day) (Table 10), which may reflect greater male exposure to insecurity, occupational hazards, and conflict-related risks. Conversely, in Ngala, female mortality (10.69 per 10,000 persons per day) was higher than male mortality (7.95 per 10,000 persons per day) (Table 11). This pattern may be attributable to reduced access to maternal and reproductive healthcare, heightened vulnerability among women during displacement, and increased caregiving responsibilities under humanitarian conditions. Nevertheless, the overlapping confidence intervals indicate that these sex differences should be interpreted cautiously.

Overall, the mortality findings demonstrate considerable heterogeneity across the three LGAs. While Bama exhibited mortality levels below emergency thresholds, Dikwa and particularly Ngala experienced mortality rates indicative of an ongoing humanitarian emergency. These findings are consistent with reports from humanitarian agencies indicating that conflict-affected communities in northeastern Nigeria continue to experience elevated mortality due to food insecurity, population displacement, limited healthcare access, and recurrent disease outbreaks. The youthful population structures observed in Figures 1–3, together with the elevated mortality rates documented in Tables 6–11, underscore the urgent need for strengthened humanitarian interventions, including expanded primary healthcare services, nutritional support programmes, disease surveillance, immunization campaigns, and improved maternal and child health services to reduce preventable deaths among vulnerable populations.

Table 3: Demographic distribution of respondents in Bama LGA

Years	Popup.	Male	Female	Joined	Left	Births	Deaths
0-4	185.5	94.5	91	1			
5-11	211	120.5	90.5	4	2		2
12-17	81.5	44.5	37	2	1		
18-49	382.5	144.5	238	27	16		2
50-64	41	34.5	6.5	3	3		
65-120	9.5	6	3.5	2	1		
Total	911	444.5	466.5	39	23	0	4

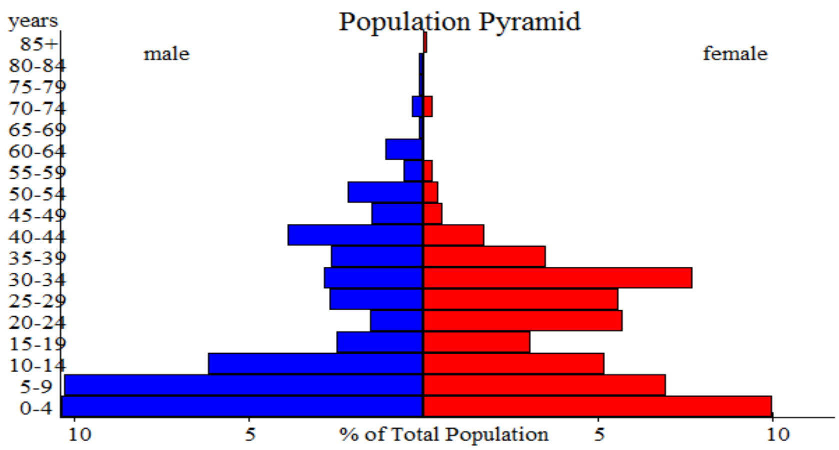

Figure 1: Population pyramid of 30 cluster sites in Bama LGA (n =911)

Table 4: Demographic distribution of respondents in Dikwa LGA

Years	Popup.	Male	Female	Joined	Left	Births	Deaths
0-4	315.5	157	158.5	3		2	9
5-9	243.5	128	115.5	2	4		5
10-14	140.5	81	59.5	2	1		10
15-19	70.5	33	37.5	1	1		5
20-24	92	17	75	2			2
25-29	97.5	23.5	74	4			3
30-34	113	32	81	1	1		3
35-39	58.5	33	25.5		1		3
40-44	69.5	47.5	22	1			
45-49	31.5	23.5	8	1			1
50-54	46	34	12				1
55-59	4	2	2				

60-64	26	18	8	1			1
65-69	7	5	2				
70-74	10	8	2				3
75-79	1		1				
80-84	6	5	1				
85-120	1		1				
Total	1333	647.5	685.5	18	8	2	46

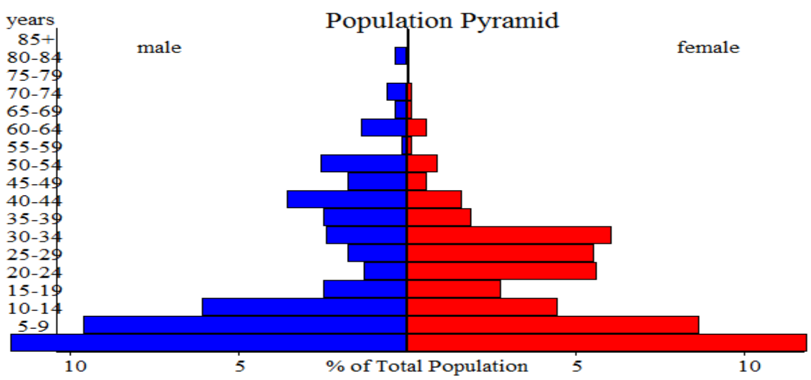

Figure 2: Population pyramid of 30 cluster sites in Dikwa LGA (n =1333)

Table 5: Demographic distribution of respondents in Ngala LGA

Years	Popup.	Male	Female	Joined	Left	Births	Deaths
0-4	287	146	141	3		161	3
5-9	249	125	124	5	12		7
10-14	154.5	88	66.5	4	7		4
15-19	84	37	47	7	6		2
20-24	86	15.5	70.5	7	6		5
25-29	101	32	69	10	7		9
30-34	104	35.5	68.5	15	19		15
35-39	65.5	38.5	27	26	27		25
40-44	72.5	47.5	25	5	5		3
45-49	25.5	18	7.5	19	20		16
50-54	49.5	32.5	17	10	11		9
55-59	5	3	2	4	5		5
60-64	33.5	21.5	12	5	6		5
65-69	9.5	6.5	3	5	6		4
70-74	12.5	9.5	3	2	3		2
75-79	1	1		1	1		1
80-84	5	4	1	3	1		1
85-120	2	2		1	1		1
Total	1347	663	684	132	143	161	117

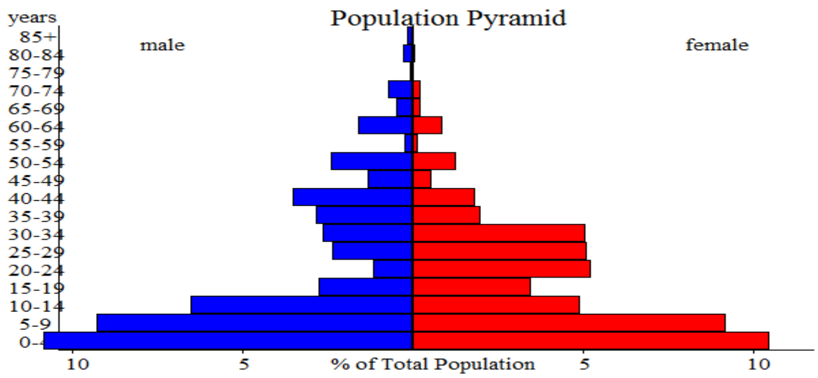

Figure 3: Population pyramid of 30 cluster sites in Ngala LGA (n =1347)

Table 6: Crude and U5 mortality rates in the cluster sites in Bama LGA over a recall period of 90 days (27th April, 2018 - 28th July, 2018)

Rates	N	Mortality/10000/day	95% Conf. Interval
CMR	4	0.47	0.07-3.04
U5MR	0	0.00	0.00 – 0.00

Table 7: Crude and U5 mortality rates in the cluster sites in Dikwa LGA over a recall period of 90 days (27th April, 2018 - 28th July, 2018)

Rates	N	Mortality/10000/day	95% Conf. Interval
CMR	46	3.71	0.82-15.33
U5MR	9	3.07	0.47-17.72

Table 8: Crude and U5 mortality rates in the cluster sites in Ngala LGA over a recall period of 90 days (27th April, 2018 - 28th July, 2018)

Rates	N	Mortality/10000/day	95% Conf. Interval
CMR	117	9.34	2.55-29.18
U5MR	3	1.12	0.34-3.69

Table 9: Mortality rates by sex in the cluster sites in Bama LGA over a recall period of 90 days (27th April, 2018 - 28th July, 2018)

Sex	Mortality/10000/day	95% Conf. Interval
Male	0.24	(0.02-3.52)
Female	0.69	(0.10-4.77)

Table 10: Mortality rates by sex in the cluster sites in Dikwa LGA over a recall period of 90 days (27th April, 2018 - 28th July, 2018)

Sex	Mortality/10000/day	95% Conf. Interval
Males	4.15	(0.96-16.33)
Females	3.29	(0.67-14.83)

Table 11: Mortality rates by sex in the cluster sites in Ngala LGA over a recall period of 90 days (27th April, 2018 - 28th July, 2018)

Sex	Mortality/10000/day	95% Conf. Interval
Males	7.95	(2.58-22.14)
Females	10.69	(2.51-36.29)

3.2 Morbidity and Coverage

The morbidity and intervention coverage among children aged 6–59 months are presented in Tables 12–17. The assessment focused on the occurrence of common childhood illnesses, including diarrhoea, acute respiratory infections (ARI), and malaria, as well as the coverage of Vitamin A supplementation and polio vaccination. These indicators provide valuable insight into the burden of childhood diseases and the effectiveness of preventive healthcare services in the conflict-affected communities of Bama, Dikwa, and Ngala.

3.2.1 Morbidity and Coverage in Bama LGA

The results for Bama LGA are presented in Tables 12 and 13. Malaria was the most frequently reported childhood illness, affecting 90.9% of children aged 6–59 months (95% CI: 63.9–98.3), followed by Vitamin A supplementation coverage at 89.2% (95% CI: 39.7–99.0). Diarrhoea and ARI were reported among 64.2% and 61.2% of the children, respectively (Table 12). Although these illnesses remained common, the high proportions of children reported to have received treatment or intervention suggest relatively good utilization of available child health services within the study area.

Among children aged 9–59 months, polio vaccination coverage reached 88.3% (95% CI: 60.5–97.4), while Vitamin A supplementation remained similarly high at 89.2% (95% CI: 39.9–99.0) (Table 13). These findings indicate that routine immunization and nutritional programmes were largely maintained despite the humanitarian challenges affecting the area. The relatively high coverage may reflect sustained efforts by government agencies and humanitarian partners to implement outreach immunization campaigns and integrated child health interventions within internally displaced persons (IDP) camps and host communities.

The relatively high prevalence of malaria compared with diarrhoea and ARI is not unexpected, given the endemic nature of malaria in northeastern Nigeria. Seasonal rainfall, inadequate environmental sanitation, overcrowded settlements, and limited access to insecticide-treated nets likely contributed to continued malaria transmission. Nevertheless, the comparatively high intervention coverage observed in Bama may partly explain the low crude and under-five mortality rates reported earlier (Tables **6** and **9**), suggesting that essential health services remained relatively functional during the study period.

Table 12: Child's disease morbidity/coverage among children 6 to 59 months in Bama LGA over last six months

Disease	Received/Episode/Treated	N	%	95% Conf. Interval
Diarrhea	Yes card not seen (Confirmation from mother)	149	64.2 %	52.0 - 74.8
	No	83	35.8 %	25.2 - 48.0
ARI	Yes card not seen	142	61.2 %	18.1 - 91.9

	(Confirmation from mother)			
	No	90	38.8 %	8.1 - 81.9
Malaria	Yes card not seen (Confirmation from mother)	211	90.9 %	63.9 - 98.3
	No	21	9.1 %	1.7 - 36.1
Vitamin A	Yes card not seen (Confirmation from mother)	207	89.2 %	39.7 - 99.0
	No	25	10.8 %	1.0 - 60.3

Table 13: Coverage among children 9 to 59 months in Bama LGA over last six months

Disease	Received/Episode/Treated	N	%	95% Conf. Interval
Polio	Yes card not seen (Confirmation from mother)	196	88.3 %	60.5 - 97.4
	No	26	11.7 %	2.6 - 39.5
Vitamin A	Yes card not seen (Confirmation from mother)	198	89.2 %	39.9 - 99.0
	No	24	10.8 %	1.0 - 60.1

Table 14: Child's disease morbidity/coverage among children 6 to 59 months in Dikwa LGA over last six months

Disease	Received/Episode/Treated	N	%	95% Conf. Interval
Diarrhea	Yes card not seen (Confirmation from mother)	127	45.2 %	16.8 - 77.1
	No	154	54.8 %	22.9 - 83.2
ARI	Yes card not seen (Confirmation from mother)	125	44.5 %	20.5 - 71.3
	No	156	55.5 %	28.7 - 79.5
Malaria	Yes card not seen (Confirmation from mother)	162	57.7 %	16.1 - 90.6
	No	119	42.3 %	9.4 - 83.9
Vitamin A	Yes card not seen (Confirmation from mother)	227	80.8 %	54.8 - 93.6
	No	54	19.2 %	6.4 - 45.2

Table 15: Coverage among children 9 to 59 months in Dikwa LGA over last six months

Disease	Received/Episode/Treated	N	%	95% Conf. Interval
Polio	Yes card not seen (Confirmation from mother)	231	97.1 %	86.1 - 99.4
	No	7	2.9 %	0.6 - 13.9
	Yes card not seen	184	77.3 %	45.2 - 93.4

Vitamin A	(Confirmation from mother)			
	No	54	22.7 %	6.6 - 54.8

Table 16: Child's disease morbidity/coverage among children 6 to 59 months in Ngala LGA over last six months

Disease	Received/Episode/Treated	N	%	95% Conf. Interval
Diarrhea	Yes card not seen (Confirmation from mother)	411	46.9 %	35.5 - 58.6
	No	466	53.1 %	41.4 - 64.5
ARI	Yes card not seen (Confirmation from mother)	596	68.0 %	52.6 - 80.2
	No	281	32.0 %	19.8 - 47.4
Malaria	Yes card not seen (Confirmation from mother)	608	69.3 %	55.9 - 80.1
	No	269	30.7 %	19.9 - 44.1
Vitamin A	Yes card not seen (Confirmation from mother)	567	64.7 %	47.3 - 78.8
	No	310	35.3 %	21.2 - 52.7

Table 17: Coverage among children 9 to 59 months in Ngala LGA over last six months

Disease	Received/Episode/Treated	N	%	95% Conf. Interval
Polio	Yes card not seen (Confirmation from mother)	754	94.3 %	89.3 - 97.0
	No	46	5.8 %	3.0 - 10.7
Vitamin A	Yes card not seen (Confirmation from mother)	518	64.8 %	47.6 - 78.8
	No	282	35.3 %	21.2 - 52.4

3.2.2 Morbidity and Coverage in Dikwa LGA

The childhood morbidity profile in Dikwa is summarized in Tables 14 and 15. Malaria remained the most commonly reported illness, affecting 57.7% of children, followed by diarrhoea (45.2%) and ARI (44.5%) (Table 14). Compared with Bama, Dikwa recorded lower treatment coverage for all three major childhood illnesses, indicating comparatively poorer access to healthcare services or reduced healthcare utilization.

Vitamin A supplementation among children aged 6–59 months was 80.8% (95% CI: 54.8–93.6), which was lower than the coverage reported in Bama. However, polio vaccination coverage among children aged 9–59 months was exceptionally high at 97.1% (95% CI: 86.1–99.4), representing the highest coverage among the three LGAs (Table 15). Vitamin A supplementation among children aged 9–59 months was 77.3%, indicating that approximately one-quarter of eligible children had not received the intervention during the preceding six months.

Despite the excellent performance of the polio vaccination programme, the moderate treatment coverage for common childhood illnesses may have contributed to the elevated crude mortality rate (3.71 deaths/10,000/day) and under-five mortality rate (3.07 deaths/10,000/day) observed in Dikwa (Table 7). These findings suggest that although vertical immunization programmes remained effective, access to comprehensive child healthcare services, including prompt diagnosis and treatment of malaria, diarrhoea, and respiratory infections, remained inadequate. Similar observations have been reported in conflict-affected humanitarian settings, where immunization campaigns often achieve high coverage through donor-supported outreach activities, while routine curative health services remain constrained by insecurity, shortages of health personnel, and limited availability of essential medicines.

3.2.3 Morbidity and Coverage in Ngala LGA

The morbidity profile for Ngala LGA is presented in Tables 16 and 17. Malaria affected 69.3% of children aged 6–59 months, making it the most prevalent childhood illness, followed closely by ARI (68.0%) and diarrhoea (46.9%) (Table 16). Compared with Bama and Dikwa, Ngala exhibited a substantially higher burden of respiratory infections, indicating increased exposure to overcrowded living conditions, poor shelter, inadequate ventilation, and environmental factors associated with displacement camps.

Vitamin A supplementation among children aged 6–59 months was 64.7%, representing the lowest coverage among the three LGAs. Similarly, Vitamin A coverage among children aged 9–59 months remained unchanged at 64.8% (Table 17). In contrast, polio vaccination coverage remained high at 94.3%, indicating that mass immunization activities continued to reach the majority of eligible children despite the humanitarian crisis.

The lower Vitamin A coverage in Ngala is of particular public health concern because Vitamin A plays a critical role in strengthening immune function, reducing the severity of childhood infections, and lowering mortality among children under five years of age. The coexistence of high malaria and ARI prevalence with relatively lower nutritional intervention coverage may have contributed to the exceptionally high crude mortality rate (9.34 deaths/10,000/day) reported in the area (Table 8). The findings highlight important deficiencies in routine child survival interventions despite successful implementation of vaccination campaigns.

3.3 Comparative Discussion

Comparison of the three LGAs reveals notable differences in childhood morbidity and health service coverage. Malaria remained the predominant childhood illness across all locations, with prevalence ranging from 57.7% in Dikwa to 90.9% in Bama, confirming its continued status as the leading cause of childhood morbidity in northeastern Nigeria. Acute respiratory infections were particularly common in Ngala (68.0%), whereas diarrhoeal disease affected approximately half of children across all three LGAs. These findings are consistent with previous studies conducted in humanitarian emergencies, which identify malaria, respiratory infections, and diarrhoeal diseases as the principal causes of illness and mortality among displaced children.

Intervention coverage varied considerably across the LGAs. Bama demonstrated consistently high coverage for Vitamin A supplementation and polio vaccination, reflecting relatively better access to child health services. Dikwa achieved the highest polio vaccination coverage (97.1%), demonstrating the effectiveness of targeted immunization campaigns implemented by governmental and humanitarian organizations. However, treatment coverage for common childhood illnesses remained comparatively lower, corresponding with the elevated mortality rates observed in the LGA. Ngala presented the greatest public health challenges, combining a high burden of childhood illnesses with the lowest Vitamin A supplementation coverage, despite maintaining high polio vaccination rates.

Overall, the findings demonstrate that successful immunization campaigns alone are insufficient to reduce childhood morbidity and mortality in humanitarian settings. While polio vaccination coverage exceeded 88% in all three LGAs (Tables 13, 15, and 17), substantial burdens of malaria, diarrhoea, and ARI persisted, particularly in Dikwa and Ngala. These results underscore the need for integrated child survival strategies that combine routine immunization with strengthened case management of childhood illnesses, improved nutrition programmes, enhanced water, sanitation and hygiene (WASH) interventions, and expanded access to primary healthcare services. Such integrated approaches are essential for reducing preventable childhood illnesses and mortality in conflict-affected populations of northeastern Nigeria.

4. 0 Conclusion

4.1. Mortality component

The result of this survey showed that the CMR and U5MR in the study populations from 27th April, 2018 - 28th July, 2018 were 0.47/10000/day and 0.00/10000/day in Bama, 3.71/10000/day and 3.07/10000/day in Dikwa, and 9.34/10000/day and 1.12/10000/day in Ngala respectively, giving an indication that more health and perhaps livelihoods interventions need concentrate in Dikwa and Ngala.

The cause of death, however, was outside the scope of this study. Figures 1, 2, and 3 show the age and sex structure of the study population as population pyramids by 5-year age intervals, and Tables 9, 10, and 11 present the demographic characteristics of the study population. The shape of the pyramid is determined by high birth and death rates in the respective locations, with a broad base and rapid tapering off in the older age groups.

4.2 Diseases morbidity/coverage

The results for episodes of diarrhea among children aged 6 to 59 months in Bama showed that 64.2% (52.0–74.8; 95% CI) had episodes, as reported by their mothers/caregivers, and 35.8% (25.2–48.0; 95% CI) did not. 61.2% (18.1 – 91.1; 95% CI) claimed to have been treated for ARI, while 38.8% (8.1 – 81.9; 95% CI) claimed there hadn't been any incident of ARI in their household. For malaria, 90.9% (63.9-98.3; 95% CI) claimed that their child received treatment for malaria in the last six months, while 9.1% (1.7 – 36.1; 95% CI) claimed their child did not receive the treatment. Up to 89.2% (39.7 – 99.0; 95% CI) claimed that their child received a vitamin A capsule in the last six months, whereas 10.8% (1.0 – 60; 95% CI) claimed otherwise.

Similarly, in Dikwa LGA, 45.2% (16.8–77.1; 95% CI) of the children had episodes of diarrhea according to their mothers/caregivers, and 54.8% (22.9–83.2; 95% CI) did not. 55.5% (28.7 –79.5; 95% CI) claimed to have been treated for ARI, while 57.7% (16.1 – 90.6; 95% CI) claimed there hadn't been any incident of ARI in their household. For malaria, 57.7% (16.1-90.6; 95% CI) claimed that their child received treatment for malaria in the last six months while 42.3% (9.4 – 83.9; 95% CI) claimed their child did not receive the treatment and up to 80.8% (54.8 – 93.6; 95% CI) claimed that their child received vitamin A capsule in the last six months whereas 19.2% (6.4 – 45.2; 95% CI) claimed otherwise.

Again, for Ngala LGA, 46.9% (35.5–8.6; 95% CI) of the children had episodes of diarrhea according to their mothers/caregivers, and 53.1% (41.4–64.5; 95% CI) did not. 68.0% (52.6 – 80.2; 95% CI) claimed to have been treated for ARI, while 32.0% (19.8 – 47.4; 95% CI) claimed there hadn't been any incident of ARI in their household. For malaria, 69.3% (55.9-80.1; 95% CI) claimed that their child received treatment for malaria in the last six months while 30.7% (19.9 – 44.1; 95% CI) claimed their child did not receive the treatment and about 64.7% (47.3 – 78.8; 95% CI) claimed that their child received vitamin A capsule in the last six months whereas 35.3% (21.2 – 52.7; 95% CI) claimed otherwise.

Among the children who are 9-59 months old in Bama LGA, polio immunization was confirmed to have been received by 88.3% (60.5 – 97.4; 95% CI) of the children but with no card to show, while 11.7% (2.6 – 39.5; 95% CI) had not been immunized according to their mothers, whereas 89.2% (39.9 – 99.0; 95% CI) claimed that their child has received Vitamin A capsule within the last six months.

In Dikwa, polio immunization was confirmed to have been received by 97.1% (86.1 – 99.4; 95% CI) of the children but with no card to show, while 2.9% (0.6 – 13.9; 95% CI) had not been immunized according to their mothers, whereas 77.3% (45.2 – 93.4; 95% CI) claimed that their child has received Vitamin A capsule within the last six months whereas 22.7% (6.6 – 54.8; 95% CI) claimed otherwise.

Finally, in Ngala, polio immunization was confirmed to have been received by 94.3% (89.3 – 97.0; 95% CI) of the children but with no card to show, while 5.8% (3.0 – 10.7; 95% CI) had not been immunized according to their mothers, and 64.8% (47.6 – 78.8; 95% CI) claimed that their child has received Vitamin A capsule within the last six months while 35.3% (21.2 – 52.4; 95% CI) claimed otherwise.

References

Cairns, K. L., Woodruff, B. A., Myatt, M., Bartlett, L., Goldberg, H., Roberts, L., & Checchi, F. (2009). Cross-sectional survey methods to assess retrospectively mortality in humanitarian emergencies. *Disasters, 33*(4), 503–521.

Ekpo, A., & Udoumoh, E. F. (2012). *Cluster surveillance of malnutrition prevalence and hunger pattern in Kazaure Local Government Area of Jigawa State, Nigeria (2010–2012).* Census and Statistics Department, Hong Kong. https://www.statistics.gov.hk/wsc/CPS106-P4-S

Ekpo, A., & Udoumoh, E. F. (2013). *Trends of cluster malnutrition prevalence and hunger pattern in Kazaure Local Government Area of Jigawa State, North-Eastern Nigeria (2010–2012).* International Statistical Institute Proceedings. https://2013.isiproceedings.org

Famine Early Warning Systems Network (FEWS NET). (2011). *Nigeria food security outlook: May to September 2011.* https://www.fews.net/nigeria

GBD 2016 Mortality Collaborators. (2017). Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970–2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet, 390*(10100), 1084–1150. https://doi.org/10.1016/S0140-6736(17)31833-0

Measuring mortality, nutritional status, and food security in crisis situations: SMART methodology (Version 1). (2006). Standardized Monitoring and Assessment of Relief and Transitions (SMART) Initiative.

Morakinyo, O. M., & Fagbamigbe, A. F. (2017). Neonatal, infant, and under-five mortalities in Nigeria: An examination of trends and drivers (2003–2013). *PLoS ONE, 12*(8), e0182990. https://doi.org/10.1371/journal.pone.0182990

National Population Commission (NPC) [Nigeria], & ICF. (2009). *Nigeria Demographic and Health Survey 2008: Preliminary report.* National Population Commission and ICF.

National Population Commission (NPC) [Nigeria], & ICF. (2019). *Nigeria Demographic and Health Survey 2018.* National Population Commission and ICF.

National Population Commission (NPC) [Nigeria], & ICF. (2019). *Nigeria Demographic and Health Survey 2018: Key findings.* National Population Commission and ICF.

Nutrition in Emergency Working Group. (2018). *Northeast Nigeria nutrition in emergency bulletin* (June 2018).

Rose, A. M. C., Grais, R. F., Coulombier, D., & Ritter, H. (2006). A comparison of cluster and systematic sampling methods for measuring crude mortality. *Bulletin of the World Health Organization, 84*(4), 290–296.

Conflict of interest

The authors declared no conflict of interest

Ethical Considerations

Not applicable

Funding

The author declared no external source of Funding

Data Availability

Data shall be made available upon request