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Prevalence of Malnutrition Among Children Under Five in Bolori II, Monguno, and Pulka Using Combined Mid-Upper-Arm Circumference and Weight-for-Height or Oedema Criteria

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Abstract: *Acute malnutrition remains a major public health challenge among children under five years of age in conflict-affected communities of North-East Nigeria. Accurate estimation of the burden requires the combined use of Mid-Upper Arm Circumference (MUAC), Weight-for-Height Z-score (WHZ), and bilateral oedema to identify all eligible cases. A community-based cross-sectional survey was conducted using the Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology in Bolori II, Monguno, and Pulka, Borno State. Children aged 6–59 months were selected through a two-stage cluster sampling technique. Anthropometric measurements, including MUAC, weight, height/length, and bilateral oedema, were collected and analyzed using ENA for SMART software based on the WHO Child Growth Standards. Based on MUAC, the prevalence of Global Acute Malnutrition (GAM) was 7.9% (95% CI: 5.6–11.1) in Bolori II, 18.4% (95% CI: 15.2–22.2) in Monguno, and 15.3% (95% CI: 11.1–20.8) in Pulka. Severe Acute Malnutrition (SAM) prevalence was 2.0%, 4.2%, and 2.6%, respectively. WHZ identified even higher levels of acute malnutrition, with GAM and SAM reaching 24.4% and 10.0%, respectively, in Monguno. Children aged 6–17 months consistently recorded the highest prevalence of moderate and severe acute malnutrition across all locations, while children aged 30–59 months had relatively few SAM cases. Girls showed a slightly higher prevalence of both GAM and SAM than boys. Combining MUAC, WHZ, and bilateral oedema substantially increased case detection, yielding GAM prevalences of 17.5%, 32.9%, and 21.9% and SAM prevalences of 4.9%, 11.8%, and 4.2% in Bolori II, Monguno, and Pulka, respectively. Only 18.8–26.7% of GAM cases and 2.5–11.4% of SAM cases were simultaneously identified by both MUAC and WHZ, demonstrating the limited overlap between the two indicators.Acute malnutrition remains critically high in the study areas, particularly in Monguno. The combined application of MUAC, WHZ, and bilateral oedema provides a more comprehensive estimate of malnutrition than either indicator alone and should be adopted for nutrition surveillance, programme planning, and Community Management of Acute Malnutrition (CMAM) in humanitarian settings.*

Keywords: *Acute malnutrition; MUAC; WHZ; Children under five; Borno State.*

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1.0 Introduction

Malnutrition remains one of the most significant public health challenges affecting children under five years of age worldwide, particularly in low- and middle-income countries where poverty, food insecurity, infectious diseases, and limited access to healthcare interact to compromise child growth and survival. According to the World Health Organization (WHO, 2024), malnutrition encompasses undernutrition (stunting, wasting, underweight, and micronutrient deficiencies), overweight, obesity, and diet-related non-communicable diseases. Among these forms, undernutrition continues to account for a substantial proportion of childhood morbidity and mortality, contributing to approximately 45% of deaths among children under five globally (WHO, 2024). The United Nations Children's Fund (UNICEF), WHO, and World Bank (2023) estimated that 148.1 million children under five years were stunted, 45 million were wasted, and 37 million were overweight worldwide, with Sub-Saharan Africa accounting for a disproportionately high share of these cases.

Nigeria bears one of the highest burdens of child malnutrition globally and contributes substantially to the global prevalence of stunting and wasting. The Nigeria Demographic and Health Survey (NDHS, 2023–24) reported that approximately 37% of Nigerian children under five are stunted, while 7% are wasted and 22% are underweight, reflecting persistent nutritional inequalities across geographical regions. The burden is particularly severe in Northern Nigeria, where chronic poverty, poor maternal education, inadequate infant and young child feeding practices, recurrent disease outbreaks, and prolonged insecurity have significantly worsened child nutritional outcomes (National Population Commission [NPC] & ICF, 2024).

The humanitarian crisis in North-East Nigeria, comprising Borno, Adamawa, and Yobe (BAY) States, has further exacerbated the nutritional vulnerability of children. Since the emergence of the Boko Haram insurgency in 2009, millions of people have been displaced, livelihoods disrupted, agricultural production reduced, and access to healthcare, water, sanitation, and education severely constrained. These factors have created one of the world's largest protracted humanitarian emergencies. According to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA, 2024), approximately 7.9 million people in the BAY States require humanitarian assistance, including millions of women and children who remain vulnerable to food insecurity, disease outbreaks, and acute malnutrition. Similarly, the Integrated Food Security Phase Classification (IPC, 2024) projected that millions of residents in North-East Nigeria continue to experience Crisis (IPC Phase 3), Emergency (IPC Phase 4), and Catastrophe (IPC Phase 5) levels of food insecurity, particularly during the annual lean season.

Food insecurity is widely recognized as one of the principal determinants of child malnutrition. The Food and Agriculture Organization (FAO), International Fund for Agricultural Development (IFAD), UNICEF, World Food Programme (WFP), and WHO (2024) emphasized that inadequate dietary intake, poor dietary diversity, recurrent infections, poverty, conflict, and climate-related shocks jointly contribute to childhood undernutrition. While insufficient food consumption directly affects weight gain, repeated episodes of diarrhoeal diseases, malaria, respiratory infections, and poor sanitation further impair nutrient absorption, thereby increasing the risks of stunting and wasting (Black et al., 2013; Victora et al., 2021). Chronic malnutrition manifests as stunting, characterized by impaired linear growth resulting from prolonged nutritional deprivation, whereas acute malnutrition is expressed as wasting, which reflects rapid weight loss associated with recent food shortages or illness. Severe acute malnutrition remains a leading cause of preventable childhood mortality when left untreated (WHO, 2024).

Several studies have documented the high prevalence of childhood malnutrition in Northern Nigeria. Ekpo and Udoumoh (2012) reported that malnutrition remains a leading contributor to childhood illness and mortality, while Ekpo and Ikughur (2021) highlighted inadequate dietary intake as one of its primary determinants. More recent studies have demonstrated that maternal education, household wealth, access to healthcare, sanitation, dietary diversity, breastfeeding practices, and household food security significantly influence child nutritional status in Nigeria (Akombi et al., 2017; Obasohan et al., 2020). Humanitarian assessments conducted in conflict-affected communities of Borno State similarly indicate persistently high rates of severe acute malnutrition among internally displaced children despite ongoing nutrition interventions (UNICEF, 2024).

Despite considerable investments by the Federal Government of Nigeria, United Nations agencies, and humanitarian partners through nutrition-sensitive and nutrition-specific interventions, childhood malnutrition remains persistently high across the North-East. Existing studies have largely focused on national estimates or individual determinants of malnutrition, while relatively few have comprehensively examined the current nutritional status of children within humanitarian settings in the BAY States using recent field-based evidence. Furthermore, the rapidly evolving humanitarian situation, characterized by displacement, camp closures, climate variability, and fluctuating food security conditions, necessitates updated assessments to guide evidence-based nutrition programming and policy decisions. This represents an important knowledge gap that requires continuous investigation.

Therefore, this study aims to assess the nutritional status and prevalence of malnutrition among children under five years of age in selected communities of North-East Nigeria. Specifically, the study evaluates the magnitude of stunting, wasting, and underweight among children and examines their distribution across the study locations. The findings are expected to provide current evidence for policymakers, humanitarian organizations, nutrition practitioners, and public health authorities in designing targeted interventions, strengthening nutrition surveillance systems, improving resource allocation, and supporting progress towards Sustainable Development Goal (SDG) 2 (Zero Hunger) and SDG 3 (Good Health and Well-being). Additionally, the study contributes to the growing body of literature on child nutrition in conflict-affected and humanitarian settings, thereby informing future research and evidence-based policy formulation.

2.0 Materials and Methods

2.1 Study Design

A community-based cross-sectional nutrition survey was conducted among children aged 0–59 months in selected conflict-affected communities of Borno State, North-East Nigeria. The survey employed the Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology, which is internationally recognized for estimating the prevalence of acute malnutrition and mortality in humanitarian settings (SMART, 2020). The study focused on three humanitarian locations—Bolori II (Maiduguri Metropolitan Council), Monguno (Monguno Local Government Area), and Pulka (Gwoza Local Government Area).

2.2 Study Area and Population

The study was conducted in Bolori II, Monguno, and Pulka, all located in Borno State, North-East Nigeria. These communities have experienced prolonged armed conflict, repeated population displacement, food insecurity, and disruption of essential health and nutrition services.

According to the International Organization for Migration (IOM) Displacement Tracking Matrix (DTM Round 40), Bolori II hosted approximately 1,086 newly displaced households, representing about 6,288 internally displaced persons (IDPs). Monguno had an estimated population of 243,827, comprising 152,191 IDPs, 43,026 returnees, and 37,572 host community members. Similarly, Gwoza Local Government Area, where Pulka is located, had an estimated population of 275,931, including 148,778 IDPs, 87,423 returnees, and 16,309 members of the host community (IOM, 2022).

The study population consisted of children aged 0–59 months residing in selected households within the three study locations during the survey period.

2.3 Sampling Technique

The survey adopted a two-stage cluster sampling technique using Probability Proportional to Size (PPS) in accordance with the SMART methodology (SMART, 2020). During the first stage, clusters were selected proportional to their population size to ensure representativeness of the study population. During the second stage, households were systematically selected within each cluster.

All eligible children aged 0–59 months living in the selected households were included in the anthropometric assessment. Standardized procedures recommended by the SMART guidelines were followed for measuring weight, height or length, Mid-Upper Arm Circumference (MUAC), age, and bilateral oedema.

2.4 Sample Size Determination

The required sample size was calculated using ENA for SMART software (Version 2020). Sample size estimation was based on the expected prevalence of Global Acute Malnutrition (GAM), desired precision, design effect, proportion of children under five years, average household size, and anticipated household non-response rate. Previous SMART survey findings and Nutrition and Food Security Surveillance (NFSS) reports for each study location were used to determine these assumptions.

The sample size for the anthropometric survey was estimated using ENA for SMART software based on the expected prevalence of Global Acute Malnutrition (GAM), design effect, desired precision, household characteristics, and anticipated non-response rate, as summarized in Table 1.

Table 1. Parameters Used for Sample Size Determination

Parameter	Bolori II	Monguno	Pulka	Source/Assumption
Estimated GAM prevalence (%)	19.1	15.8	15.7	Previous SMART/NFSS surveys
Desired precision (%)	±3.5	±3.5	±3.5	SMART recommendation
Design effect	1.44	1.00	1.39	Previous SMART surveys

Children under five (%)	21.7	23.0	22.2	Previous SMART surveys
Average household size	6.5	4.2	5.1	Previous SMART surveys
Household non-response (%)	11.0	5.0	4.1	Previous SMART surveys
Required households	672	550	643	ENA for SMART
Expected children (6–59 months)	760	454	628	ENA for SMART

Source: ENA for SMART (Version 2020) using assumptions derived from previous SMART surveys and NFSS Round 10 (2021).

2.5 Data Collection

Data were collected using standardized SMART nutrition questionnaires programmed into Open Data Kit (ODK) and administered on Android smartphones and tablet devices by trained enumerators. Information collected included age, sex, weight, height or length, MUAC, and bilateral oedema.

The age of each child was obtained from birth certificates, immunization cards, vaccination records, or caregiver recall where official documents were unavailable. Weight was measured to the nearest 0.1 kg using calibrated electronic scales with a mother–child weighing function. Height or recumbent length was measured to the nearest 0.1 cm using a portable wooden measuring board. Children aged 24 months or older were measured standing, whereas younger children were measured lying down.

Mid-Upper Arm Circumference (MUAC) was measured on the left arm using standardized MUAC tapes and recorded to the nearest 1 mm. Bilateral pitting oedema was assessed by applying thumb pressure to the dorsum of both feet for approximately five seconds, with the presence or absence of oedema recorded according to WHO guidelines.

2.6 Data Quality Assurance

Several quality assurance measures were implemented throughout the study. Enumerators and supervisors underwent standardized SMART training before fieldwork. All anthropometric equipment was calibrated daily before use, and standardization tests were conducted to minimize inter-observer and intra-observer measurement errors.

Field supervisors reviewed completed questionnaires daily for completeness and consistency. Electronic data captured through ODK were synchronized daily, allowing real-time monitoring and validation. Anthropometric measurements with implausible values were verified immediately in the field whenever possible. Data cleaning procedures followed the SMART plausibility assessment protocols before statistical analysis.

2.7 Data Processing and Statistical Analysis

Data were exported from ODK and processed using ENA for SMART (Version 2020), IBM SPSS Statistics, and Microsoft Excel. Anthropometric indices, including Weight-for-Height Z-score (WHZ), Height-for-Age Z-score (HAZ), Weight-for-Age Z-score (WAZ), and MUAC classifications, were generated using the WHO Child Growth Standards (WHO, 2006).

Extreme anthropometric values outside WHO-recommended biological plausibility limits were excluded from analysis using the SMART plausibility criteria. Descriptive statistics, including frequencies, percentages, means, standard deviations, and 95% confidence intervals, were computed to summarize the nutritional status of the study population. Global Acute Malnutrition (GAM), Severe Acute Malnutrition (SAM), stunting, wasting, and underweight prevalence were estimated according to WHO classification criteria.

2.8 Ethical Considerations

Ethical approval for the study was obtained from the appropriate institutional ethics review committee before commencement of field activities. Permission to conduct the survey was also obtained from relevant governmental authorities and community leaders.

Written or verbal informed consent was obtained from the parent or legal caregiver of every participating child before data collection. Participation was entirely voluntary, and respondents were informed of their right to withdraw from the study at any time without any consequences. All collected information was treated as confidential and anonymized during data management and reporting. Children identified with severe acute malnutrition or other medical complications during the survey were referred immediately to the nearest health or nutrition facility for appropriate management.

3.0 Results and Discussion

3.1 Prevalence of Acute Malnutrition Based on MUAC Cut-Offs and/or Bilateral Oedema

The nutritional status of children aged 6–59 months was assessed using the Mid-Upper Arm Circumference (MUAC) and the presence of bilateral pitting oedema in accordance with the World Health Organization (WHO) and SMART guidelines. MUAC remains one of the most widely accepted community screening tools because it is rapid, inexpensive, highly sensitive for detecting severe acute malnutrition (SAM), and suitable for large-scale humanitarian nutrition programmes.

The prevalence of Global Acute Malnutrition (GAM), Moderate Acute Malnutrition (MAM), and Severe Acute Malnutrition (SAM) across the three study locations is presented in Table 2.

Table 2: Prevalence of acute malnutrition based on MUAC cut off's (and/or oedema) and by sex in the three LGAs of MMC, Monguno and Gwoza

Location	GAM	MAM	SAM
Bolori II	(62) 7.9 % (5.6 - 11.1 95% C.I.)	(46) 5.9 % (3.8 - 9.0 95% C.I.)	(16) 2.0 % (1.1 - 3.8 95% C.I.)
Monguno	(109) 18.4 % (15.2 - 22.2 95% C.I.)	(84) 14.2 % (11.4 - 17.6 95% C.I.)	(25) 4.2 % (2.5 - 7.0 95% C.I.)
Pulka	(89) 15.3 % (11.1 - 20.8 95% C.I.)	(74) 12.8 % (9.2 - 17.5 95% C.I.)	(15) 2.6 % (1.4 - 4.6 95% C.I.)

Table 2 shows considerable variation in the prevalence of acute malnutrition among the three study locations. Monguno recorded the highest burden of acute malnutrition, with a GAM prevalence of 18.4% (95% CI: 15.2–22.2), followed by Pulka (15.3%; 95% CI: 11.1–20.8) and Bolori II (7.9%; 95% CI: 5.6–11.1). According to the WHO emergency thresholds for acute malnutrition, the GAM prevalence observed in Monguno represents a critical public health situation, while Pulka also remains at an alarming level requiring sustained nutrition interventions. In contrast, Bolori II exhibited a comparatively lower prevalence, although the GAM level still represents a significant public health concern requiring continuous surveillance.

A similar trend was observed for Moderate Acute Malnutrition (MAM), where Monguno recorded the highest prevalence (14.2%), followed by Pulka (12.8%) and Bolori II (5.9%). Severe Acute Malnutrition (SAM) was likewise highest in Monguno (4.2%), compared with Pulka (2.6%) and Bolori II (2.0%). The higher prevalence of both MAM and SAM in Monguno suggests more severe household food insecurity, prolonged displacement, poorer access to health services, and greater disruption of livelihood activities than in the other study locations.

Compared with previous SMART survey findings, Bolori II demonstrated a reduction in GAM from 9.2% to 7.9% and SAM from 3.8% to 2.0%, indicating gradual improvements in nutritional status. However, the observed reductions were not statistically significant (GAM: $p = 0.1414$; SAM: $p = 0.4737$), suggesting that although nutrition interventions may be yielding positive outcomes, the prevalence of acute malnutrition remains persistently high. This finding indicates that humanitarian assistance should be maintained to prevent relapse, particularly during periods of food shortages and disease outbreaks.

The observed geographical differences are likely attributable to variations in conflict intensity, displacement patterns, food availability, access to healthcare services, water and sanitation conditions, and household livelihood opportunities. Similar regional disparities have been reported in previous nutrition assessments conducted in conflict-affected areas of North-East Nigeria (UNICEF, 2024; OCHA, 2024), where insecurity continues to limit access to food and essential health services.

3.2 Distribution of Acute Malnutrition by Sex

The cumulative MUAC distributions by sex for Bolori II, Monguno, and Pulka are illustrated in Figs. 1–3, while the corresponding prevalence estimates are summarized in Table 2.

As illustrated in Figs. 1–3, girls consistently exhibited a slightly higher prevalence of acute malnutrition than boys across the three study locations. The cumulative distribution curves indicate a greater proportion of female children with MUAC measurements below the nutritional cut-off points, particularly within the severe and moderate malnutrition categories.

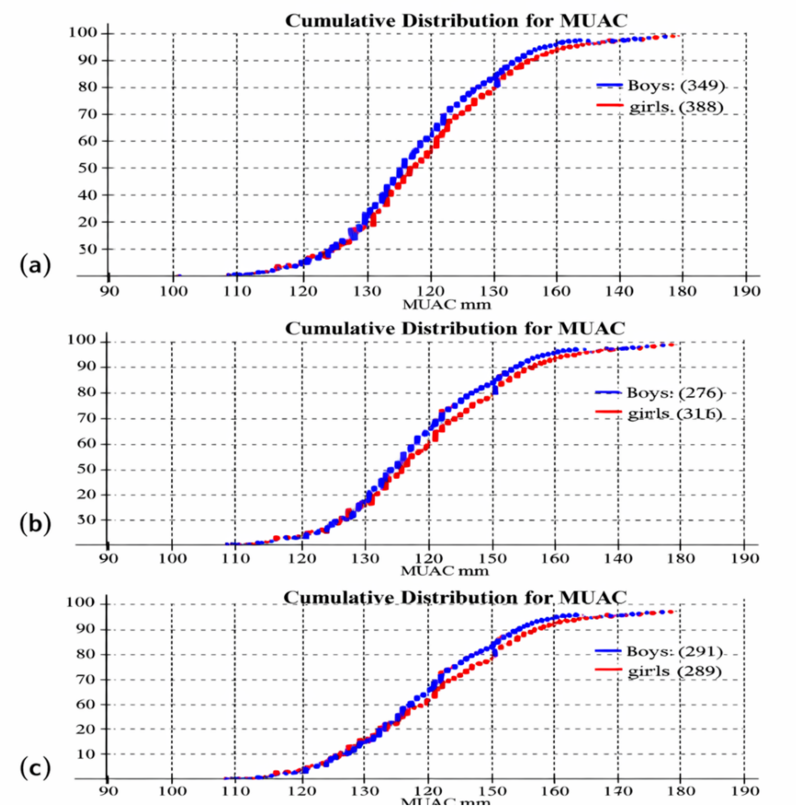

Fig. 1: Bolori II Cum. distribution for MUAC (0-59) by sex, and

(b) Fig. 2: Monguno Cum. distribution for MUAC (0-59) by sex

(c) Fig. 3: Pulka Cum. distribution for MUAC (0-59) by sex

This pattern was most evident in Monguno and Pulka, where overall malnutrition prevalence was highest.

The findings suggest that female children may have experienced greater nutritional vulnerability during the survey period. Previous SMART surveys conducted within the study area have reported similar observations, while several studies have shown that MUAC tends to identify proportionately more female children with acute malnutrition than Weight-for-Height Z-score (WHZ). This difference has been attributed to sex-related variations in body composition, muscle mass, fat distribution, and arm circumference during early childhood (Myatt et al., 2006; Grellety & Golden, 2016). Consequently, reliance on MUAC alone may identify a somewhat different population of malnourished children compared with WHZ, reinforcing current WHO recommendations that both indicators should be used together in humanitarian nutrition programmes.

Although the sex differences observed in this study were relatively small, the consistently higher prevalence among girls highlights the importance of maintaining equitable nutrition screening and treatment programmes that ensure both male and female children receive timely identification and management.

As shown in Figures 1, 2, and 3, this study found that the prevalence of GAM is higher among girls than boys. The same trend is observed in SAM cases based on MUAC. Previous surveys in the area reported similar findings. Additionally, many studies indicate that MUAC is more sensitive in detecting cases among younger female children (6-29 months) compared to males or older children (30-59 months).

3.3 Age-Specific Distribution of Acute Malnutrition

The prevalence of acute malnutrition according to age group is presented in Table 3, while the graphical age distribution based on MUAC is shown in Figs. 4–6.

As shown in Table 3, children aged 6–17 months exhibited the highest prevalence of both moderate and severe acute malnutrition across all three study locations. In Bolori II, 13.4% of children within this age group were moderately malnourished, while 4.5% were severely malnourished.

Table 3: Prevalence of acute malnutrition based on MUAC cut off's (and/or oedema) by severity and Age in the three LGAs of MMC, Monguno and Gwoza

Location	Age	Total	Severe wasting (< 115 mm)		Moderate wasting (>= 115 mm and < 125 mm)		Normal (> = 125 mm)		Oedema	
			No.	%	No.	%	No.	%	No.	%
Bolori II	6-17	201	9	4.5	27	13.4	165	82.1	0	0.0
	18-29	157	1	0.6	5	3.2	151	96.2	0	0.0
	30-41	183	1	0.5	8	4.4	174	95.1	2	1.1
	42-53	187	0	0.0	6	3.2	181	96.8	1	0.5
	54-59	54	0	0.0	0	0.0	54	100.0	1	1.9
	Total	782	11	1.4	46	5.9	725	92.7	4	0.5
Monguno	6-17	154	12	7.8	44	28.6	98	63.6	1	0.6
	18-29	141	5	3.5	28	19.9	108	76.6	1	0.7
	30-41	153	1	0.7	9	5.9	143	93.5	3	2.0
	42-53	92	1	1.1	3	3.3	88	95.7	1	1.1
	54-59	52	0	0.0	0	0.0	52	100.0	0	0.0
	Total	592	19	3.2	84	14.2	489	82.6	6	1.0
Pulka	6-17	129	7	5.4	30	23.3	92	71.3	0	0.0
	18-29	139	5	3.6	28	20.1	106	76.3	2	1.4
	30-41	125	0	0.0	11	8.8	114	91.2	1	0.8
	42-53	113	0	0.0	5	4.4	108	95.6	0	0.0
	54-59	57	0	0.0	0	0.0	57	100.0	0	0.0
	Total	563	12	2.1	74	13.1	477	84.7	3	0.5

Similarly, Monguno recorded the highest burden among this age group, with 28.6% classified as moderately malnourished and 7.8% as severely malnourished. Pulka demonstrated a comparable pattern, where 23.3% and 5.4% of children aged 6–17 months experienced moderate and severe acute malnutrition, respectively.

Children aged 18–29 months also showed relatively high levels of acute malnutrition across the three locations, although the prevalence was generally lower than that observed among children aged 6–17 months. In contrast, the prevalence of severe acute malnutrition declined substantially among children aged 30–41 months, 42–53 months, and 54–59 months, where very few cases of SAM were identified.

The age-specific trends illustrated in Figures 4–6 further demonstrate that acute malnutrition was concentrated predominantly among children younger than 30 months. The cumulative distributions reveal that younger children consistently recorded lower MUAC measurements than older children, indicating greater nutritional vulnerability during infancy and early childhood.

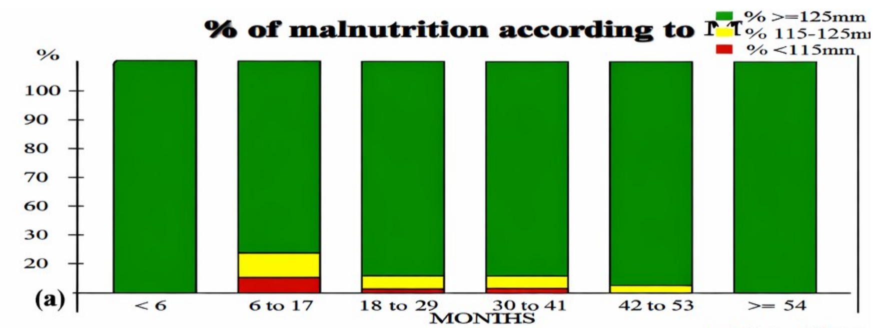

Fig. 4: Bolori based on MUAC (0-59) by age

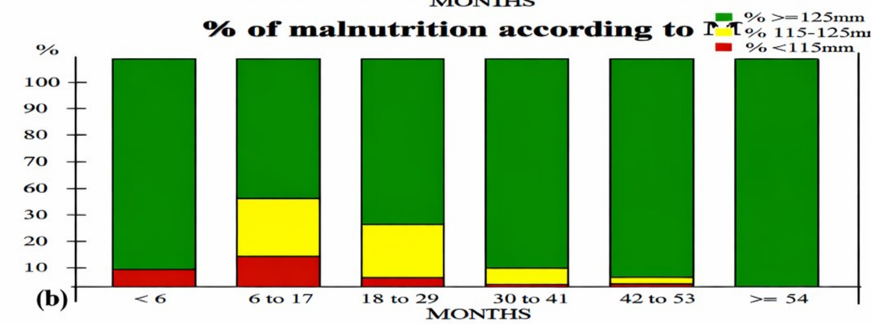

Fig. 5: Monguno based on MUAC (0-59) by age

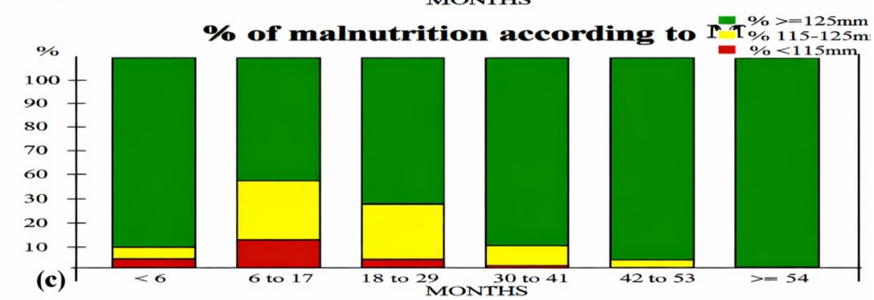

Fig. 6: Pulka based on MUAC (0-59) by age

This pattern is biologically plausible because children between 6 and 24 months undergo rapid physical growth while simultaneously transitioning from exclusive breastfeeding to complementary feeding. In many humanitarian settings, complementary foods are frequently inadequate in both quality and quantity, while repeated episodes of diarrhoea, malaria, respiratory infections, and poor sanitation further compromise nutritional status. Consequently, this age group is widely recognized as the period of greatest susceptibility to acute malnutrition (Black et al., 2013; Victora et al., 2021).

The significantly lower prevalence among older children suggests improved dietary adaptation, maturation of immune function, and increased resilience against common childhood illnesses as age advances. These findings reinforce the need for nutrition interventions that prioritize children younger than two years through improved breastfeeding promotion, complementary feeding practices, micronutrient supplementation, immunization, and infection prevention.

3.4 Combined Assessment of Acute Malnutrition Using MUAC, WHZ, and Bilateral Oedema

The combined prevalence of acute malnutrition determined using MUAC, Weight-for-Height Z-score (WHZ), and bilateral oedema is presented in Table 4.

As shown in Table 4, combining multiple diagnostic criteria substantially increased the estimated burden of acute malnutrition compared with using MUAC alone. In Bolori II, the combined assessment identified 144 GAM cases (17.5%), compared with only 30 cases (3.6%) detected using MUAC alone. Likewise, Monguno recorded 195 GAM cases (32.9%), while Pulka identified 139 cases (21.9%), representing the highest overall caseloads among the three locations.

A similar trend was observed for Severe Acute Malnutrition. The combined assessment identified 40 SAM cases (4.9%) in Bolori II, 70 cases (11.8%) in Monguno, and 27 cases (4.2%) in Pulka. These estimates substantially exceeded those identified using MUAC alone, demonstrating that reliance on a single anthropometric indicator would underestimate the true burden of acute malnutrition.

Interestingly, WHZ alone detected a greater number of GAM and SAM cases than MUAC alone in all three locations. For example, in Monguno, WHZ identified 86 GAM cases compared with 51 cases identified using MUAC. Similarly, WHZ identified 45 SAM cases, whereas MUAC alone detected only 11 cases. These findings indicate that each anthropometric indicator identifies partially different groups of malnourished children.

The overlap between MUAC and WHZ was relatively modest, particularly in Bolori II and Pulka, indicating that many children fulfilled only one diagnostic criterion. This observation supports previous studies demonstrating poor concordance between MUAC and WHZ because each reflects different aspects of body composition and nutritional deficits (Grellety & Golden, 2016; Myatt et al., 2006). Consequently, exclusive reliance on either MUAC or WHZ would fail to identify a significant proportion of children requiring nutritional rehabilitation.

Although bilateral oedema accounted for a relatively small proportion of cases (0.5–1.0%), its presence remains clinically important because nutritional oedema is a defining feature of complicated severe acute malnutrition associated with high mortality risk. Therefore, oedema assessment should continue to form an integral component of community nutrition screening programmes.

Overall, the findings demonstrate that the combined use of MUAC, WHZ, and bilateral oedema provides the most comprehensive estimate of acute malnutrition and should remain the preferred approach for estimating programme caseloads and planning humanitarian nutrition interventions. The particularly high prevalence observed in Monguno highlights the urgent need for strengthened Community Management of Acute Malnutrition (CMAM) services, improved food security interventions, enhanced infant and young child feeding programmes, and sustained humanitarian support across conflict-affected communities in North-East Nigeria.

Determining the prevalence of GAM and SAM using combined WHZ and MUAC cut-offs (and/or edema) is the best way to estimate the actual caseload, as many cases cannot be identified by a single criterion.

4.0 Conclusion

This study assessed the prevalence and distribution of acute malnutrition among children aged 6–59 months in three conflict-affected communities of Borno State using Mid-Upper Arm Circumference (MUAC), Weight-for-Height Z-score (WHZ), and bilateral oedema. The findings revealed substantial geographical variations in nutritional status across the study locations. Monguno recorded the highest burden of acute malnutrition, followed by Pulka, while Bolori II exhibited comparatively lower prevalence. Although Bolori II showed reductions in both Global Acute Malnutrition (GAM) and Severe Acute Malnutrition (SAM) compared with previous SMART survey estimates, these reductions were not statistically significant ($p > 0.05$), indicating that acute malnutrition remains an important public health concern despite ongoing humanitarian interventions.

Table 4: Detailed numbers for combined GAM and SAM

Criteria	GAM Prevalence per Location			SAM Prevalence per location		
	Bolori II	**Monguno**	**Pulka**	**Bolori II**	**Monguno**	**Pulka**
MUAC Criterion alone	30 (3.6%)	51 (8.6%)	58 (9.1%)	10 (1.2%)	11 (1.9%)	9(1.4%)
WHZ Criterion alone	82 (10.0%)	86 (14.5%)	50 (7.9%)	24 (2.9%)	45 (7.6%)	12 (1.9%)
MUAC and WHZ Criteria	27 (3.3%)	52 (8.8%)	27 (4.2%)	1 (0.1%)	8 (1.3%)	2 (0.3%)
Oedema	5 (0.6%)	6 (1.0%)	4 (0.6%)	5 (0.6%)	6 (1.0%)	4 (0.6%)
Total	**144(17.5%)**	**195(32.9%)**	**139(21.9%)**	**40(4.9%)**	**70(11.8%)**	**27(4.2%)**

The study further demonstrated that female children were slightly more affected by both GAM and SAM than their male counterparts, a pattern consistent with previous SMART surveys and studies reporting greater sensitivity of MUAC in identifying malnutrition among young girls. Age-specific analysis revealed that children aged 6–17 months were the most vulnerable to both moderate and severe acute malnutrition across all study locations, whereas children older than 30 months experienced considerably fewer cases of severe acute malnutrition. These findings underscore the heightened nutritional vulnerability during the complementary feeding period and highlight the need for targeted interventions focusing on children under two years of age.

The combined assessment using MUAC, WHZ, and bilateral oedema identified substantially more cases of acute malnutrition than either MUAC or WHZ alone. While MUAC and WHZ each detected unique groups of malnourished children, their overlap was relatively limited, demonstrating that reliance on a single anthropometric indicator would underestimate the true burden of acute malnutrition. The combined diagnostic approach therefore provides a more comprehensive estimate of programme caseloads and strengthens the identification of children requiring therapeutic or supplementary nutrition services.

Overall, the findings indicate that acute malnutrition remains a critical public health challenge in the conflict-affected communities of North-East Nigeria, particularly in Monguno and Pulka. Strengthening Community Management of Acute Malnutrition (CMAM) programmes, improving household food security, promoting optimal infant and young child feeding practices, expanding nutrition surveillance, and ensuring sustained humanitarian assistance are essential to reducing the burden of malnutrition. Future nutrition assessments should continue to employ the combined use of MUAC, WHZ, and bilateral oedema to improve case detection, programme planning, and resource allocation for vulnerable populations.

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Declarations

Ethics Approval and Consent to Participate

The survey was conducted in accordance with the ethical principles for research involving human participants. Approval to conduct the survey was obtained from the relevant authorities prior to data collection. Written or verbal informed consent was obtained from the parents or legal guardians of all participating children before enrolment in the study. Participation was voluntary, and the confidentiality and anonymity of all respondents were maintained throughout the study.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request. The publisher reserves the right to make the data publicly available in accordance with the journal's data-sharing policy.

Competing Interests

The authors declare that they have no competing interests or conflicts of interest.

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Authors' Contributions

Anthony Ekpo conceived and designed the study, supervised data collection, performed the statistical analyses, interpreted the results, and drafted the manuscript. Jonathan Atsue Ikughur contributed to the study design, data analysis, interpretation of findings, critical revision of the manuscript, and approval of the final version for publication. Both authors read and approved the final manuscript.