Communication in Physical Sciences, 2023, 9(4): 1134-1156

A Comparative Analysis of the Nutritional Status of the Under-fives Based on Underweight and Stunting

Anthony Ekpo* and Jonathan Atsue Ikughur

Received: 29 April 2023/Accepted: 10 September 2023/Published: 19 September 2023

Abstract: *This study assessed the nutritional status of children under five years old by measuring underweight and stunting in Bolori II, Monguno, and Pulka, Borno State, Northeast Nigeria. The prevalence of underweight is 51.3% in Monguno and 33.7% in Pulka. According to the World Health Organization (WHO) severity thresholds (<10% low, 10–<20% medium, 20–<30% high, and ≥30% very high), severe underweight in Monguno is classified as high (24.6%), while Pulka is categorized as medium (11.7%). Severe stunting remains a significant concern, with rates of 22.9% in Bolori II, 30.4% in Monguno, and 25.3% in Pulka. Based on United Nations Children's Fund (UNICEF) and WHO prevalence thresholds, these stunting rates are classified as high in Bolori II and Pulka and very high in Monguno.*

Keywords: *Under-fives, Underweight, Stunting, Severity threshold, Prevalence, Low threshold, Medium Threshold, High Threshold, Anthropometry.*

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

Jonathan Atsue Ikughur
Department of Statistics, Federal University of Agriculture, Makurdi, Benue State, Nigeria.
Email: ikughur.jonathan@uam.edu.ng
https://orcid.org/0000-0003-1276-668X

1.0 Introduction

Child malnutrition remains one of the most persistent public health challenges worldwide and continues to undermine child survival, growth, cognitive development, and long-term socioeconomic productivity. Malnutrition encompasses deficiencies, excesses, or imbalances in energy and nutrient intake and is commonly assessed in children using anthropometric indicators such as stunting (low height-for-age), wasting (low weight-for-height), and underweight (low weight-for-age). These indicators reflect chronic, acute, and composite forms of undernutrition, respectively, and are recognized as reliable measures of children's nutritional status (World Health Organization [WHO], 2022). Undernutrition contributes substantially to childhood morbidity and mortality by increasing susceptibility to infectious diseases, impairing physical and cognitive development, reducing educational attainment, and diminishing future economic productivity (Black et al., 2013). Despite considerable global investments in nutrition programmes, undernutrition remains a major obstacle to achieving Sustainable Development Goal (SDG) 2 (Zero Hunger) and SDG 3 (Good Health and Well-being), particularly in low- and middle-income countries.

Globally, the burden of child undernutrition remains unacceptably high. The Joint Child Malnutrition Estimates released by UNICEF, WHO, and the World Bank indicate that approximately 149 million children under five years were stunted, 45 million were wasted, and 39 million were overweight in 2020 (UNICEF, WHO, & World Bank, 2021). Although gradual improvements have been recorded over the past two decades, progress has been uneven across regions, with Sub-Saharan Africa accounting for an increasing proportion of the global burden of child malnutrition due to rapid population growth, poverty, food insecurity, weak health systems, and recurrent conflicts (Development Initiatives, 2021).

Nigeria bears one of the highest burdens of childhood undernutrition globally. According to the Nigeria Demographic and Health Survey (NDHS), approximately 37% of children under five years are stunted, 22% are underweight, and 7% are wasted, with marked regional disparities that disproportionately affect northern Nigeria (National Population Commission [NPC] & ICF, 2019). The prevalence of undernutrition is particularly severe in conflict-affected states where prolonged insecurity has disrupted agricultural production, health services, education, water and sanitation infrastructure, and household livelihoods. Consequently, many families experience chronic food insecurity, poor dietary diversity, and limited access to essential maternal and child health services, thereby increasing children's vulnerability to malnutrition.

The humanitarian crisis in Northeast Nigeria has further exacerbated these nutritional challenges. Since the onset of insurgency in 2009, millions of people have been displaced across Borno, Adamawa, and Yobe States, creating one of Africa's most protracted humanitarian emergencies. Repeated displacement, destruction of livelihoods, restricted access to farmlands, disease outbreaks, inflation, and climate-related shocks have significantly reduced household food availability and access. Humanitarian reports indicate that millions of people in the BAY States continue to require emergency food assistance and nutrition interventions, while children under five remain the most vulnerable population due to their increased nutritional requirements and susceptibility to infectious diseases (United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2022; Food Security Information Network [FSIN] & Global Network Against Food Crises, 2022).

Several studies conducted in Nigeria have reported high levels of stunting, wasting, and underweight among children under five, identifying poverty, inadequate infant and young child feeding practices, maternal education, poor sanitation, infectious diseases, and food insecurity as major determinants (Akombi et al., 2017; Kandala et al., 2019). In conflict-affected settings, the prevalence of undernutrition is often considerably higher than national averages because humanitarian emergencies disrupt both food systems and health service delivery. SMART surveys conducted across internally displaced persons (IDP) camps and host communities in Borno State have consistently demonstrated elevated rates of acute and chronic malnutrition among children under five, emphasizing the continuing need for routine nutritional surveillance and evidence-based interventions (Nutrition Sector Nigeria, 2021).

Although numerous nutrition surveys have been undertaken in Northeast Nigeria, most have focused primarily on estimating the prevalence of acute malnutrition during humanitarian emergencies. Comparatively fewer studies have comprehensively examined underweight and stunting simultaneously across multiple conflict-affected locations using standardized anthropometric assessment methods. Furthermore, changing patterns of population displacement, camp closures, resettlement programmes, and fluctuations in humanitarian assistance necessitate updated evidence on the nutritional status of children residing in affected communities. Bolori II, Monguno, and Pulka have experienced different levels of conflict exposure, displacement dynamics, and access to humanitarian services, yet comparative evidence describing the burden and severity classification of underweight and stunting across these locations remains limited. This lack of current location-specific evidence constrains effective targeting, prioritization, and evaluation of nutrition interventions.

Therefore, the present study aimed to assess the nutritional status of children aged 6–59 months in Bolori II, Monguno, and Pulka in Borno

State using anthropometric indicators of underweight and stunting. Specifically, the study determined the prevalence and severity of underweight and stunting according to internationally recognized WHO and UNICEF classification thresholds and compared the nutritional situation across the three study locations.

The findings of this study provide important evidence for humanitarian agencies, public health practitioners, government institutions, and development partners involved in nutrition programming in Northeast Nigeria. By generating updated, location-specific estimates of childhood undernutrition, the study supports evidence-based planning, efficient allocation of scarce resources, improved targeting of nutrition interventions, and monitoring of progress toward national and global nutrition targets. The results also contribute to the growing body of literature on child nutrition in conflict-affected settings and provide a valuable baseline for future nutritional surveillance and programme evaluation in Borno State.

2.0 Materials and Methods

2.1 Sampling Technique

This study employed a cross-sectional anthropometric survey based on the Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology (SMART, 2020). A two-stage cluster sampling design using Probability Proportional to Size (PPS) was adopted to ensure that villages or wards with larger populations had a proportionately higher probability of selection, thereby enhancing the representativeness of the sample. In the first stage, clusters were selected using PPS sampling, while households within each selected cluster were chosen using the standard SMART household selection procedure.

Anthropometric measurements were obtained from eligible children aged 0–59 months residing in Bolori II, Monguno, and Pulka at the time of the survey. Trained and standardized field enumerators collected measurements of weight, height/length, mid-upper arm circumference (MUAC), and bilateral pitting edema in accordance with the SMART survey guidelines (SMART, 2020) and the WHO Child Growth Standards (WHO, 2006).

2.2 Sample Size Calculation

The required sample size for both the anthropometric and mortality surveys was determined using the Emergency Nutrition Assessment (ENA) for SMART software (Version 2020; updated January 11, 2020). The nutrition sample size was calculated based on the estimated prevalence of Global Acute Malnutrition (GAM), desired precision, design effect, average household size, proportion of children under five years of age, and anticipated household non-response rate. These parameters were obtained from the most recent SMART surveys and National Food Security Survey (NFSS) reports available for the respective study locations.

The anthropometric survey design parameters used for the sample size estimation are presented in Table 1. The resulting minimum numbers of households and children aged 0–59 months required for each study location were subsequently generated by the ENA for SMART software.

2.3 Study Area and Study Population

The study was conducted in Bolori II (Maiduguri Metropolitan Council), Monguno (Monguno Local Government Area), and Pulka (Gwoza Local Government Area) in Borno State, northeastern Nigeria. These communities have experienced prolonged humanitarian crises resulting from armed conflict, population displacement, and food insecurity.

Table 1: Anthropometric survey design parameters and assumptions for the study locations

Parameter	Bolori II[1]	Monguno[2]	Pulka[3]
Estimated prevalence of GAM (%)	19.1	15.8	15.7
Desired precision (±%)	3.5	3.5	3.5
Design effect (WHZ)	1.44	1.00	1.39
Children under five (%)	21.7	23.0	22.2
Average household size	6.5	4.2	5.1
Non-response households (%)	11.0	5.0	4.1
Households to be surveyed (n)	672	550	643
Children to be surveyed (n)	760	454	628

The assumptions adopted for estimating the sample size in Table 1 are summarized below.

Location	Basis for Assumptions
[1] Bolori II	Estimated GAM prevalence and design effect were obtained from the August 2021 SMART survey. The proportion of children under five years, average household size, and household non-response rate were also adopted from the same survey. The relatively higher non-response rate accounted for anticipated household refusals and exclusions associated with post-COVID-19 concerns.
[2] Monguno	GAM prevalence was based on the upper 95% confidence interval of the April 2019 SMART survey, which was consistent with findings from the November 2020 SMART survey. Design effect, household size, and non-response assumptions were similarly derived from these surveys.
[3] Pulka	All parameters, including GAM prevalence, design effect, household characteristics, and non-response rate, were adopted from the National Food Security Survey (NFSS) Round 10 Emergency Survey conducted in October 2021 for the Eastern Borno domain.

Note: GAM = Global Acute Malnutrition; WHZ = Weight-for-Height Z-score; HH = Household; ENA = Emergency Nutrition Assessment; SMART = Standardized Monitoring and Assessment of Relief and Transitions; NFSS = National Food Security Survey.

The target population comprised households with children aged 0–59 months residing in the selected study locations during the survey period. Population estimates were obtained from the International Organization for Migration (IOM) Displacement Tracking Matrix (DTM) Round 40. Bolori II recorded approximately 1,086 newly arrived households, representing an estimated 6,288 internally displaced persons (IDPs). Monguno had an estimated population of 243,827 individuals, including approximately 152,191

IDPs, 43,026 returnees, and 37,572 members of the host community. In Gwoza Local Government Area, where Pulka is located, the estimated population was 275,931 individuals, comprising approximately 148,778 IDPs, 87,423 returnees, and 16,309 host community members (IOM, 2022).

2.4 Data Collection

Data were collected using standardized nutrition survey questionnaires developed in accordance with the SMART methodology and programmed into the Open Data Kit (ODK) platform. The questionnaires were administered electronically using Android smartphones and tablet computers to facilitate real-time data entry, minimize transcription errors, and improve data completeness. Completed questionnaires were uploaded daily and subjected to quality checks by field supervisors.

Information collected included age, sex, presence of bilateral pitting edema, and anthropometric measurements. Children's ages were determined by interviewing mothers or caregivers and verified using birth certificates, immunization cards, or vaccination records whenever available.

Body weight was measured using a calibrated electronic mother–child digital scale with a precision of 0.1 kg. Recumbent length was measured for children younger than 24 months, whereas standing height was measured for children aged 24–59 months using a wooden measuring board with a precision of 0.1 cm. Mid-upper arm circumference (MUAC) was measured at the midpoint of the left upper arm using a standardized MUAC tape and recorded in millimetres. Bilateral pitting edema was assessed by applying thumb pressure to the dorsum of both feet for approximately five seconds and recording the presence or absence of persistent indentation according to WHO and SMART recommendations.

Anthropometric indices, including weight-for-age (underweight), height-for-age (stunting), weight-for-height (wasting), and MUAC status, were generated using the WHO Child Growth Standards (WHO, 2006).

2.5 Data Quality Assurance

Several quality assurance measures were implemented throughout the survey. All field personnel underwent standardized SMART training, including theoretical instruction, practical exercises, and anthropometric standardization tests before data collection commenced. Experienced nutrition supervisors monitored all field activities to ensure strict adherence to survey protocols.

Anthropometric equipment was calibrated daily before fieldwork, and duplicate measurements were performed whenever inconsistencies were observed. Supervisors conducted routine spot checks, household revisits, and daily reviews of completed questionnaires to ensure completeness, consistency, and accuracy. Age verification was performed using available official records whenever possible, while internal consistency checks within the ENA software facilitated early identification and correction of potential errors. Data quality reports generated by ENA for SMART were reviewed daily to monitor measurement reliability throughout the survey period.

2.6 Data Processing and Statistical Analysis

Data were cleaned, validated, and analyzed using ENA for SMART software (Version 2020), Microsoft Excel, and IBM SPSS Statistics (Version XX). Daily data cleaning procedures included verification of completeness, consistency checks, identification of duplicate records, and correction of data entry errors. Cleaning logs and exclusion logs were maintained throughout the analysis process.

Anthropometric indices were calculated according to the WHO Child Growth Standards (WHO, 2006). Biologically implausible values identified by the ENA software were excluded from the final analyses. Descriptive statistics, including frequencies, percentages, means, standard deviations, and 95% confidence intervals, were computed to summarize demographic characteristics and nutritional status. The prevalence of underweight, stunting, wasting, and acute malnutrition was classified using the WHO and UNICEF nutritional severity thresholds. All analyses were conducted at a 95% confidence level.

2.7 Ethical Considerations

Ethical approval for the study was obtained from the appropriate Institutional Research Ethics Committee before commencement of field activities (Approval No.: [Insert Approval Number]). Permission to conduct the survey was also obtained from relevant governmental authorities and community leaders in each study location.

Written or verbal informed consent was obtained from the parent or legal guardian 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 stage without penalty. To maintain confidentiality, no personal identifiers were included in the analytical dataset, and all collected information was securely stored and used solely for research purposes. Children identified with severe acute malnutrition or other serious health conditions during the survey were referred to the nearest health or nutrition facility for appropriate management in accordance with established humanitarian protocols.

3.0 Results and Discussion

3.1 Statistical Summary of Anthropometric Indicators

The prevalence of underweight and stunting among children aged 6–59 months was estimated using the proportion of children whose anthropometric indices fell below the World Health Organization (WHO) growth standards. Anthropometric status was first determined using Weight-for-Age Z-scores (WAZ) and Height-for-Age Z-scores (HAZ), calculated as equation 1

$$Z = \frac{X - \mu}{\sigma} \quad (1)$$

where X is the observed anthropometric measurement of a child, μ is the WHO reference median for children of the same age and sex, and σ is the corresponding standard deviation. Children with Z-scores between −2 and −3 standard deviations were classified as moderately undernourished, whereas children with Z-scores below −3 standard deviations were classified as severely undernourished. The prevalence of each nutritional indicator was estimated using equation 2

$$P = \frac{x}{n} \times \frac{100}{1} \quad (2)$$

where P represents prevalence (%), xxx denotes the number of children with the nutritional condition, and nnn represents the total number of children assessed within each study location.

Using this relationship, Table 2 shows that Bolori II recorded 272 underweight children, representing 34.4% of the surveyed population. Monguno recorded 292 underweight children, corresponding to 51.3%, while Pulka recorded 202 underweight children, representing 33.7% of the sampled children. These estimates indicate that more than one-third of children in each study area were underweight, with Monguno exhibiting the greatest burden of nutritional deficiency.

Similarly, Table 3 shows that 337 children (47.4%) in Bolori II were stunted, compared with 298 children (56.5%) in Monguno and 270 children (49.9%) in Pulka. These findings demonstrate that chronic malnutrition affected approximately one-half of all children surveyed across the three locations.

The precision of the prevalence estimates was assessed by calculating the standard error using equation 3

$$SE = \sqrt{\frac{P(1-P)}{n}} \quad (3)$$

where P is expressed as a proportion and n is the total sample size. The relatively small standard errors produced narrow confidence intervals, indicating satisfactory precision of the survey estimates despite the use of cluster sampling.

The corresponding 95% confidence interval for each prevalence estimate was determined using equation 4

$$CI = P + 1.96(SE) \quad (4)$$

where 1.96 represents the critical value of the standard normal distribution at the 95% confidence level. The confidence intervals reported in Tables 2 and 3 were generated by the ENA for SMART software after incorporating adjustments for the complex cluster sampling design and finite population correction.

For example, the prevalence of underweight in Bolori II was estimated as 34.4% with a 95% confidence interval of 29.4–39.9%, while Monguno recorded 51.3% (46.5–56.1%) and Pulka recorded 33.7% (29.4–38.4%) (Table 2). Likewise, stunting prevalence was estimated as 47.4% (42.4–52.5%) in Bolori II, 56.5% (50.0–62.9%) in Monguno, and 49.9% (44.8–55.0%) in Pulka (Table 3). The relatively narrow confidence intervals indicate that the prevalence estimates are statistically reliable and provide a precise representation of the nutritional status of children in the three study areas. Where previous SMART survey results were available, changes in prevalence were quantified using equation 5

$$\%\Delta = \frac{P_{current} - P_{precious}}{P_{precious}} \times \frac{100}{1} \quad (5)$$

where $P_{current}$ and $P_{precious}$ denote the current and previous prevalence estimates, respectively. Applying this equation to Bolori II revealed that underweight prevalence declined from 43.1% in the previous SMART survey to 34.4% in the present assessment, representing an approximate 20.2% reduction. Similarly, stunting decreased from 55.6% to 47.4%, corresponding to a 14.7% reduction. Although these reductions suggest modest improvements in nutritional status, the prevalence remains considerably above internationally acceptable levels, indicating that chronic food insecurity and recurrent humanitarian crises continue to affect child growth.

Interpretation of the anthropometric indicators according to WHO public health thresholds further highlights the severity of the nutritional situation. Underweight prevalence equal to or exceeding 30% is classified as very high, while stunting prevalence of 40% or greater also represents a very high public health concern. Consequently, the prevalence of underweight recorded in Bolori II (34.4%), Monguno (51.3%), and Pulka (33.7%) all fall within the very high category. Similarly, the stunting prevalence of 47.4%, 56.5%, and 49.9% observed in Bolori II, Monguno, and Pulka, respectively, indicates that chronic malnutrition remains an extremely serious public health problem across all three study locations.

Comparison of the confidence intervals also provides insight into the relative nutritional burden among the study areas. Although the confidence intervals for Bolori II and Pulka overlap slightly, Monguno consistently recorded substantially higher prevalence estimates for both underweight and stunting. This finding is further supported by the larger proportions of severe underweight (24.6%) and severe stunting (30.4%) observed in Monguno (Tables 2 and 3), confirming that children residing in this location experienced the greatest nutritional disadvantage among the three study populations.

Table 2: Prevalence of Underweight based on Weight-for-Age Z-scores by Sex (6-59) in the three Locations of Bolori II, Monguno and Pulka.

Location	Prevalence of underweight (<-2 z-score)	Prevalence of moderate underweight (<-2 z-score and >=-3 z-score)	Prevalence of severe underweight (<-3 z-score)
Bolori II	(272) 34.4 % (29.4 - 39.9 95% C.I.)	(169) 21.4 % (17.4 - 26.0 95% C.I.)	(103) 13.0 % (10.0 - 16.8 95% C.I.)
Monguno	(292) 51.3 % (46.5 - 56.1 95% C.I.)	(152) 26.7 % (23.6 - 30.1 95% C.I.)	(140) 24.6 % (20.3 - 29.5 95% C.I.)
Pulka	(202) 33.7 % (29.4 - 38.4 95% C.I.)	(132) 22.0 % (18.5 - 26.0 95% C.I.)	(70) 11.7 % (9.1 - 14.9 95% C.I.)

Fig. 1: Bolori II Distribution of Weight-for-Age Z-score with WHO Reference curve

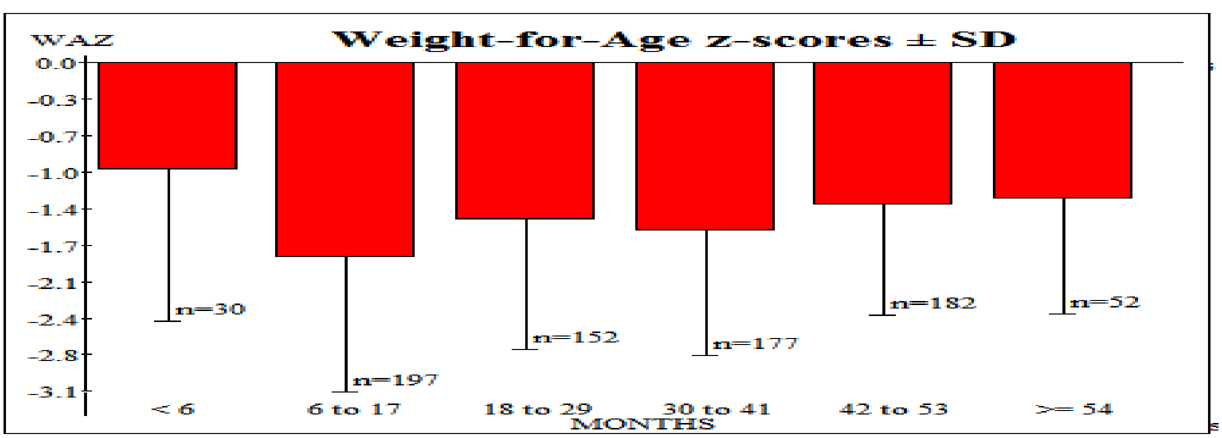

Fig. 2: Bolori II Weight-for-Age Z-score sample by Age

Fig. 3: Monguno Distribution of Weight-for-Age Z-score with WHO Reference curve

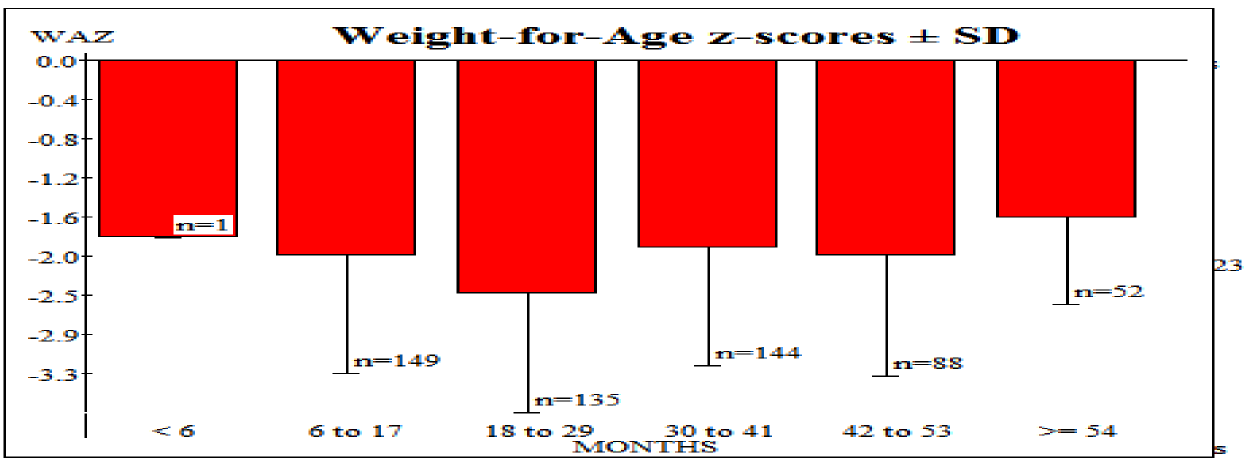

Fig. 4: Monguno Weight-for-Age Z-score sample by Age

Fig. 5: Pulka Distribution of Weight-for-Age Z-score with WHO Reference curve

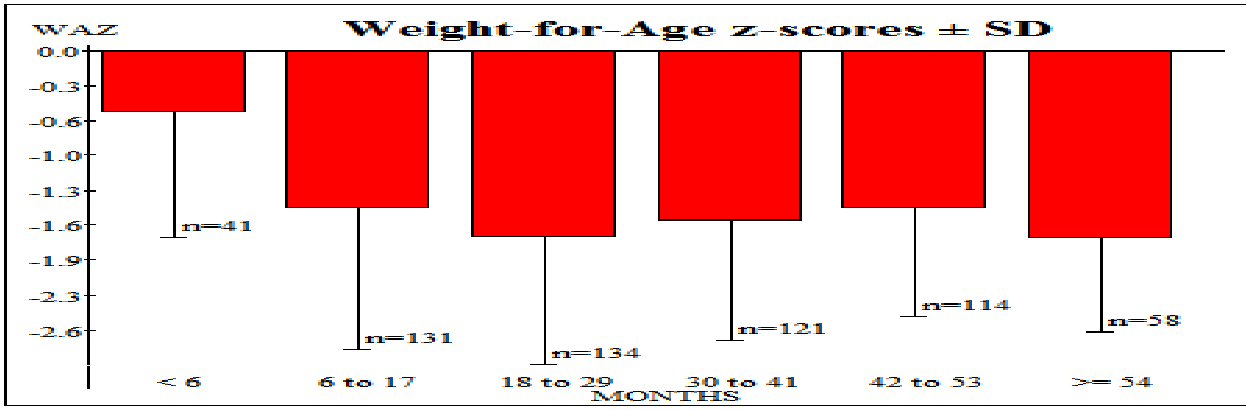

Fig. 6: Pulka Weight-for-Age Z-score sample by Age

Overall, the findings demonstrate a substantial burden of underweight across the three study locations, although considerable geographical variation was observed. Among the surveyed communities, Monguno recorded the highest prevalence of underweight, followed by Bolori II and Pulka. The observed differences reflect the heterogeneous impact of prolonged armed conflict, population displacement, food insecurity, and limited access to healthcare services across northeastern Nigeria.

As presented in Table 2, the prevalence of underweight in Bolori II was 34.4% (95% CI: 29.4–39.9), comprising 21.4% moderate underweight and 13.0% severe underweight. In Monguno, the prevalence increased markedly to 51.3% (95% CI: 46.5–56.1), with 26.7% moderately underweight and 24.6% severely underweight children. Pulka recorded an overall underweight prevalence of 33.7% (95% CI: 29.4–38.4), including 22.0% moderate and 11.7% severe underweight.

According to the WHO nutritional severity classification, the prevalence of underweight exceeding 30% represents a very high public health concern (WHO, 2010). Consequently, all three study locations fall within the category of very high underweight prevalence, indicating a critical nutritional situation requiring immediate intervention. Furthermore, the proportion of children with severe underweight was exceptionally high in Monguno (24.6%), almost double that observed in Bolori II (13.0%) and Pulka (11.7%), suggesting a greater burden of chronic food deprivation and repeated episodes of illness among children residing in Monguno.

The findings indicate that although Bolori II showed a reduction in overall underweight prevalence compared with previous SMART survey estimates (43.1%), the current prevalence remains substantially above internationally acceptable thresholds. Although this reduction suggests some improvement in nutritional conditions, the prevalence remains indicative of a persistent humanitarian nutrition crisis. The improvement may reflect sustained humanitarian nutrition interventions, increased availability of therapeutic feeding programmes, improved vaccination coverage, and expanded access to primary healthcare services implemented in internally displaced persons (IDP) settlements over recent years. Nevertheless, the persistence of one-third of children being underweight demonstrates that these interventions have not been sufficient to eliminate the underlying determinants of malnutrition.

Monguno exhibited the poorest nutritional status among the three locations. More than one out of every two children was underweight, while approximately one-quarter suffered severe underweight. These findings highlight the cumulative effects of prolonged conflict, repeated displacement, disruption of agricultural production, insecurity restricting humanitarian access, poor dietary diversity, inadequate infant feeding practices, and recurrent infectious diseases. Previous studies have consistently demonstrated that children living in conflict-affected settings experience significantly higher rates of undernutrition than those in relatively stable communities due to the combined effects of food insecurity, poor sanitation, interrupted health services, and poverty (Black *et al*., 2013; Akombi *et al*., 2017). The present findings therefore reinforce existing evidence regarding the detrimental nutritional consequences of humanitarian emergencies in northeastern Nigeria.

Although Pulka recorded a lower prevalence of underweight than Monguno, the burden remains alarmingly high. Approximately one in every three children was underweight, indicating that food insecurity and inadequate child nutrition remain major public health concerns. The slightly lower prevalence observed in Pulka may be attributable to relatively improved humanitarian assistance, differences in displacement dynamics, or better access to nutrition programmes compared with Monguno. However, the prevalence still exceeds both national and international targets for child nutrition and warrants continued nutritional surveillance and intervention.

The graphical distributions further support these observations. The WAZ distribution curves for Bolori II, Monguno, and Pulka (Figs. 1, 3, and 5) are all shifted noticeably to the left of the WHO 2006 reference curve. Such leftward displacement indicates that the average body weight of children in the surveyed populations is substantially lower than expected for healthy children of the same age. The degree of leftward shift is greatest in Monguno, intermediate in Bolori II, and least pronounced in Pulka, closely mirroring the prevalence estimates reported in Table 2.

In addition to the leftward displacement, the observed distributions are considerably wider than the WHO reference distribution. This broader spread suggests substantial heterogeneity in children's nutritional status within each community, indicating that while some children approach normal nutritional status, a considerable proportion experience moderate to severe nutritional deficits. Such variability is typical of humanitarian settings where access to food, healthcare, sanitation, and livelihood opportunities differs considerably among displaced households.

The age-specific WAZ plots (Figs. 2, 4, and 6) reveal an important pattern in the progression of undernutrition. Underweight prevalence increases progressively with age, with the greatest nutritional deficits observed among children aged 54–59 months. Very few children younger than six months exhibited severe nutritional deficits, whereas markedly lower WAZ values were observed among older preschool children. This trend suggests that nutritional deterioration accumulates over time as children transition from exclusive breastfeeding to complementary feeding and become increasingly exposed to recurrent infections, poor dietary quality, environmental contamination, and household food insecurity.

The progressive decline in nutritional status with increasing age has been documented in several studies conducted in Sub-Saharan Africa. During the first six months of life, breastfeeding provides substantial nutritional protection. However, after this period, children frequently receive complementary foods that are inadequate in both quantity and quality, particularly in resource-constrained and conflict-affected communities. Repeated diarrhoeal disease, malaria, respiratory infections, intestinal parasitic infections, and poor water, sanitation, and hygiene (WASH) conditions further impair nutrient absorption and increase metabolic demands, thereby accelerating weight loss and growth faltering (Victora *et al*., 2021; Black *et al*., 2013).

Another notable observation from Figs. 2, 4, and 6 is that the largest numbers of children with markedly depressed WAZ values occur within the age groups between approximately 18 and 59 months. This finding reflects prolonged cumulative nutritional stress rather than isolated episodes of acute food shortage. Children surviving repeated cycles of illness and inadequate dietary intake gradually lose weight relative to their age, resulting in the high prevalence of moderate and severe underweight observed in the present study.

The prevalence estimates reported here are considerably higher than the national average underweight prevalence of approximately 22% reported in the Nigeria Demographic and Health Survey (NPC & ICF, 2019). The substantially higher prevalence in the present study reflects the unique vulnerability of conflict-affected populations in Borno State. Similar findings have been reported from other humanitarian settings where armed conflict, forced displacement, disruption of health services, and reduced agricultural productivity have contributed to exceptionally high levels of childhood undernutrition (Development Initiatives, 2021; UNICEF, WHO, & World Bank, 2021).

The results also underscore the importance of sustained nutritional surveillance using SMART methodology. Although improvements have been observed in some locations, particularly Bolori II, the persistently high prevalence of underweight demonstrates that emergency nutrition interventions should continue to prioritize preventive and therapeutic programmes. Integrated approaches combining supplementary feeding, promotion of optimal infant and young child feeding practices, routine growth monitoring, immunization, improved water and sanitation services, food security interventions, and strengthened primary healthcare delivery are essential for reducing the burden of undernutrition in these conflict-affected communities.

Overall, the findings indicate that underweight remains a severe public health problem among children aged 6–59 months in Bolori II, Monguno, and Pulka. The pronounced leftward shifts of the WAZ distributions (Figs. 1, 3, and 5) together with the progressive deterioration of nutritional status among older children (Figs. 2, 4, and 6) provide compelling evidence of sustained nutritional deprivation. These results emphasize the urgent need for location-specific humanitarian nutrition interventions, particularly in Monguno, where both overall and severe underweight prevalence reached the highest levels observed in this study.

3.2 Prevalence of Stunting Based on Height-for-Age Z-Scores (HAZ)

The prevalence of stunting among children aged 6–59 months in Bolori II, Monguno, and Pulka is presented in Table 3, while the corresponding Height-for-Age Z-score (HAZ) distributions relative to the WHO Child Growth Standards are illustrated in Figs. 7, 9, and 11. The age-specific HAZ distributions are presented in Figs. 8, 10, and 12. Height-for-age is a well-established indicator of chronic malnutrition, reflecting prolonged nutritional deprivation and recurrent exposure to infectious diseases during early childhood (WHO, 2006). Unlike wasting, which reflects acute nutritional deficiencies, stunting develops gradually and is often associated with irreversible impairments in physical growth, cognitive development, educational attainment, and future economic productivity (Victora et al., 2021).

Stunting prevalence remained critically high across all three study locations, indicating a persistent burden of chronic malnutrition among children aged 6–59 months. In Bolori II, the overall prevalence of stunting was 47.4% (95% CI: 42.4–52.5), comprising 24.5% moderate stunting and 22.9% severe stunting. Monguno recorded the highest burden, with 56.5% (95% CI: 50.0–62.9) of children classified as stunted, including 26.2% with moderate stunting and 30.4% with severe stunting. In Pulka, the overall prevalence of stunting was 49.9% (95% CI: 44.8–55.0), of which 24.6% were moderately stunted and 25.3% were severely stunted. These findings indicate that approximately one out of every two children in the study areas experienced impaired linear growth, with severe stunting accounting for nearly half of all stunting cases, particularly in Monguno, underscoring the substantial public health burden of chronic undernutrition in these conflict-affected communities.

Table 3: Prevalence of stunting according to height-for-age z-scores, disaggregated by sex (ages 6–59 months), in the three Locations; Bolori II, Monguno, and Pulka

Location	Prevalence of stunting (<-2 z-score)	Prevalence of moderate stunting (<-2 z-score and >=-3 z-score)	Prevalence of severe stunting (<-3 z-score)
Bolori II	(337) 47.4 % (42.4 - 52.5 95% C.I.)	(174) 24.5 % (21.5 - 27.7 95% C.I.)	(163) 22.9 % (18.9 - 27.5 95% C.I.)
Monguno	(298) 56.5 % (50.0 - 62.9 95% C.I.)	(138) 26.2 % (21.6 - 31.3 95% C.I.)	(160) 30.4 % (26.4 - 34.6 95% C.I.)
Pulka	(270) 49.9 % (44.8 - 55.0 95% C.I.)	(133) 24.6 % (21.5 - 28.0 95% C.I.)	(137) 25.3 % (21.2 - 30.0 95% C.I.)

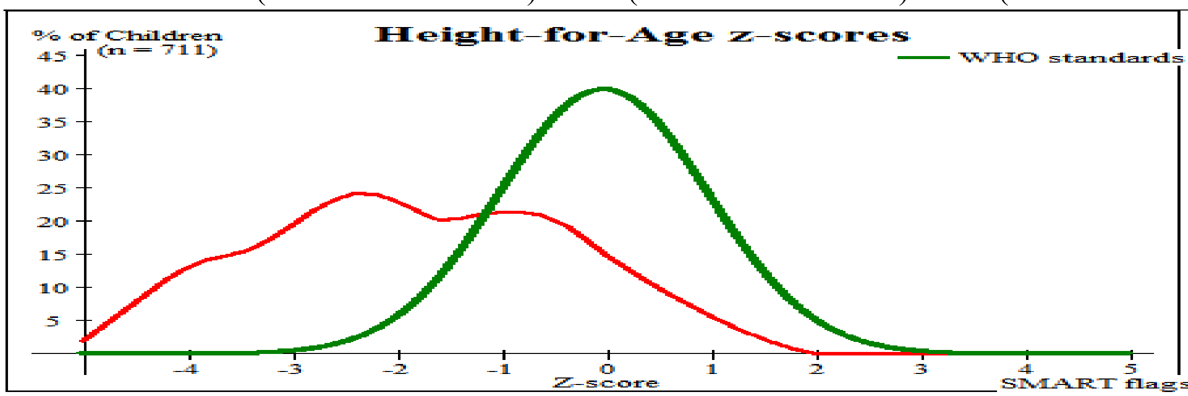

Fig. 7: Bolori II Distribution of Height-for-Age Z-score with the WHO Reference curve

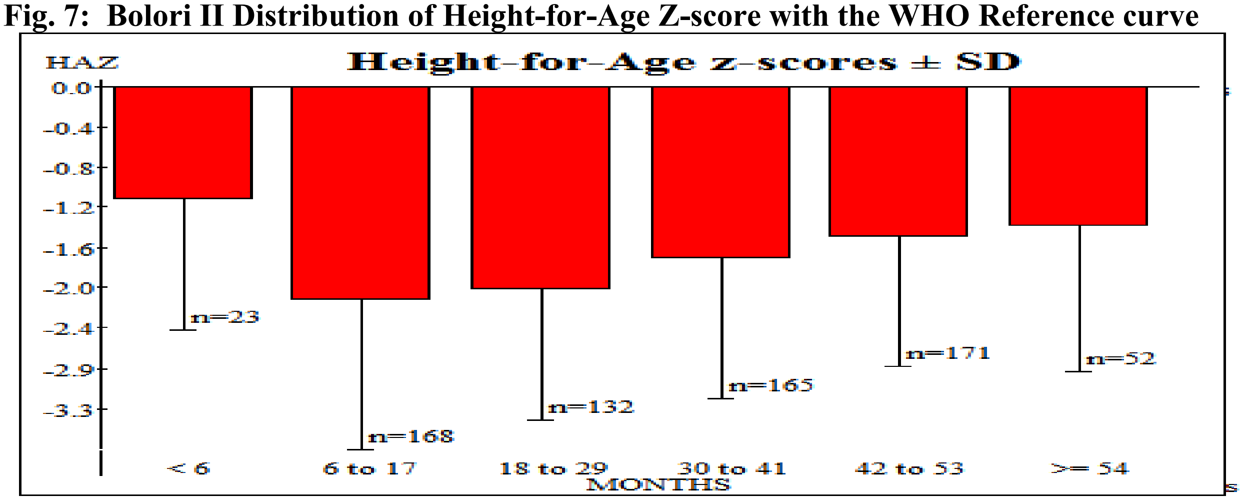

Fig. 8: Bolori II Height-for-Age Z-score with sample by Age

Figure 9: Monguno Distribution of Height-for-Age Z-score with the WHO Reference curve

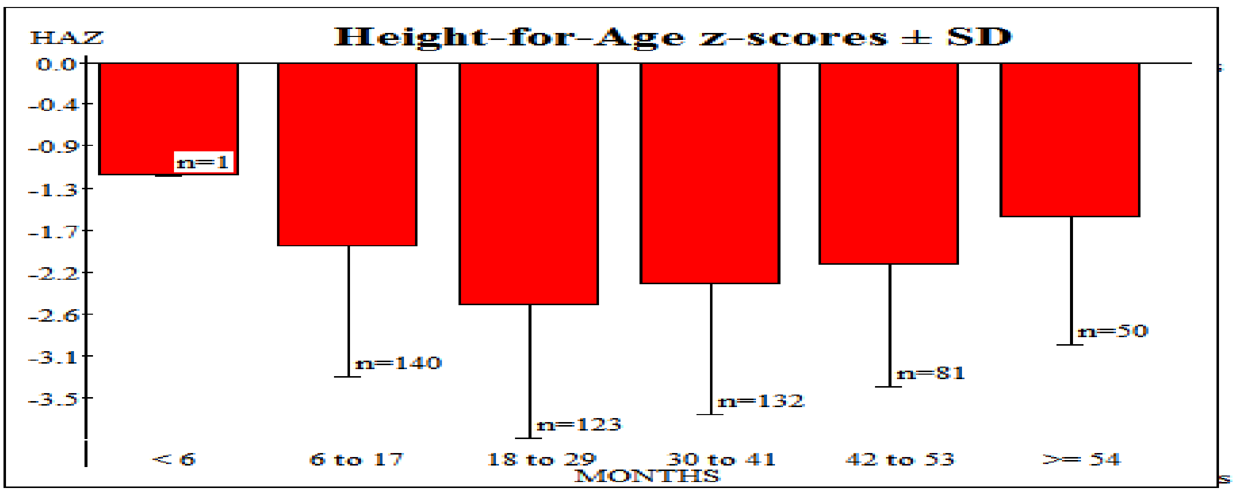

Figure 10: Monguno Height-for-Age Z-score with sample by Age

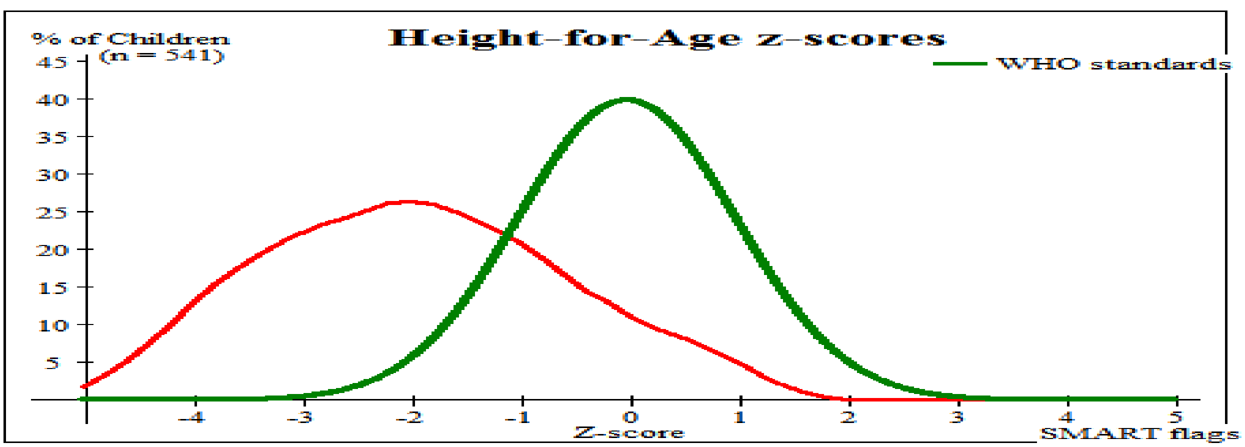

Figure 11: Pulka Distribution of HAZ compared to the WHO Reference curve and HAZ sample by Age

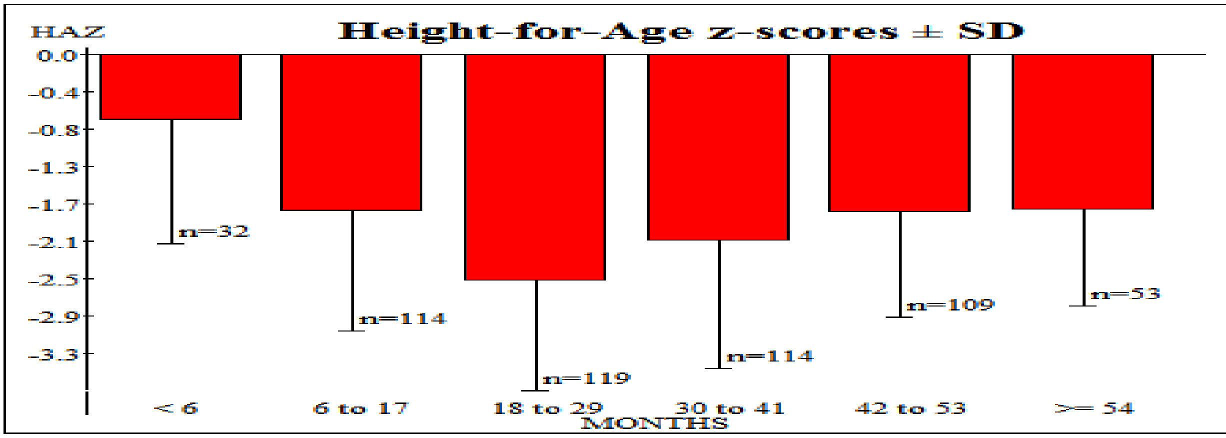

Fig. 12. Distribution of Height-for-Age Z-scores by Age among Children Aged 6–59 Months in Pulka.

As shown in Table 3, the prevalence of stunting According to the WHO and UNICEF public health classification, a stunting prevalence of 30% or greater constitutes a very high public health concern (WHO, 2010; UNICEF, WHO, & World Bank, 2021). Therefore, all three study locations fall within the category of very high chronic malnutrition, indicating that nearly one-half or more of all children have experienced prolonged nutritional deprivation during the critical periods of growth and development. The exceptionally high prevalence observed in Monguno further emphasizes the cumulative impact of persistent humanitarian crises on child nutrition.

Comparison with previous nutritional assessments suggests modest improvements in Bolori II, where stunting declined from approximately 55.6% reported in earlier SMART surveys to 47.4% in the present study. Although this reduction indicates gradual progress, the prevalence remains well aboveinternationally acceptable thresholds and continues to represent a major public health challenge. Sustained humanitarian assistance, expanded supplementary feeding programmes, improved vaccination coverage, and enhanced access to maternal and child healthcare services may have contributed to this improvement. Nevertheless, the persistence of nearly one in every two children being stunted indicates that the underlying determinants of chronic malnutrition remain largely unresolved.

Monguno recorded the poorest linear growth outcomes among the three study areas. More than one-half of all surveyed children were stunted, while approximately one-third experienced severe stunting. These findings likely reflect the prolonged effects of food insecurity, repeated displacement, disruption of agricultural production, inadequate dietary intake, poor infant and young child feeding practices, recurrent infectious diseases, and limited access to quality healthcare. Chronic exposure to these adverse conditions during the first 1,000 days of life has profound consequences for skeletal growth, resulting in permanent deficits in adult stature and cognitive development (*Black et al*., 2013; *Victora et al*., 2021).

Similarly, Pulka exhibited an extremely high prevalence of chronic malnutrition. Although slightly lower than Monguno, almost one-half of all children were stunted, while one-quarter suffered severe stunting. The similarity in stunting prevalence between Pulka and Bolori II suggests that despite variations in humanitarian access and displacement patterns, children in these communities continue to experience persistent nutritional deficiencies over extended periods. Chronic food insecurity, suboptimal dietary diversity, inadequate maternal nutrition, and repeated childhood illnesses are likely contributors to the observed growth retardation.

The HAZ distribution curves shown in Figs. 7, 9, and 11 provide additional evidence supporting these findings. In all three study locations, the observed HAZ distributions (red curves) are substantially shifted to the left of the WHO Child Growth Standards reference distribution (green curves). This pronounced leftward displacement indicates that children in the surveyed populations are considerably shorter for their age than healthy reference populations. Among the three locations, Monguno demonstrates the greatest leftward shift, followed by Pulka and Bolori II, corresponding closely with the prevalence estimates presented in Table 3.

In addition to the leftward displacement, the HAZ distributions exhibit wider dispersion than the WHO reference curves, indicating considerable variability in children's growth patterns within each community. Such heterogeneity is characteristic of populations affected by prolonged humanitarian emergencies, where household access to adequate nutrition, healthcare, sanitation, and livelihood opportunities differs substantially across communities and even within individual settlements.

The age-specific HAZ distributions (Figs. 8, 10, and 12) further illustrate that stunting becomes progressively more pronounced as children grow older. Minimal growth deficits are observed among infants younger than six months, whereas increasingly lower HAZ values are evident among children between 18 and 59 months. The greatest concentration of severe stunting occurs among children aged 54–59 months, indicating that chronic nutritional deprivation accumulates throughout early childhood.

This age-related progression reflects the cumulative nature of linear growth failure. During infancy, exclusive breastfeeding provides a degree of nutritional protection. However, after the introduction of complementary foods, children become increasingly exposed to nutritionally inadequate diets, repeated infections, poor environmental sanitation, intestinal parasitic diseases, and household food insecurity. These factors progressively impair skeletal growth, resulting in irreversible stunting by the time children approach five years of age (*Victora et al*., 2021). Once established after the age of two years, stunting is difficult to reverse, emphasizing the importance of preventive interventions during pregnancy and the first two years of life.

The age distribution plots (Figs. 8, 10, and 12) also indicate that severe linear growth retardation is concentrated among older preschool children. The largest numbers of children with markedly depressed HAZ values occur within the age categories extending beyond 18 months, particularly between 54 and 59 months. This observation suggests prolonged exposure to adverse nutritional and environmental conditions rather than isolated episodes of acute malnutrition. It also supports previous evidence that chronic undernutrition is a cumulative process that worsens when adequate nutritional rehabilitation is unavailable during early childhood.

The prevalence of stunting observed in the present study is substantially higher than the national average of approximately 37% reported in the Nigeria Demographic and Health Survey (NPC & ICF, 2019). This disparity highlights the disproportionate burden of chronic malnutrition experienced by conflict-affected populations in northeastern Nigeria. Similar patterns have been reported in humanitarian settings across Sub-Saharan Africa, where armed conflict, forced displacement, disruption of health services, inadequate infant feeding practices, and household food insecurity contribute to exceptionally high levels of childhood stunting (*Akombi et al*., 2017; *Black et al*., 2013).

The coexistence of high underweight and high stunting prevalence across all three locations demonstrates that the nutritional challenges extend beyond temporary food shortages. Underweight reflects both acute and chronic nutritional deficits, whereas stunting primarily reflects long-term deprivation. The concurrence of these indicators therefore suggests sustained inadequacy in food availability, dietary quality, healthcare access, water and sanitation services, and maternal nutrition over several years. Consequently, interventions focused solely on emergency food distribution are unlikely to produce sustained improvements unless accompanied by comprehensive multisectoral programmes addressing maternal nutrition, infant and young child feeding practices, disease prevention, immunization, household food security, safe water, sanitation, hygiene, and poverty reduction.

The present findings have important implications for humanitarian nutrition programming in Borno State. Given the exceptionally high prevalence of chronic malnutrition, priority should be placed on strengthening community-based growth monitoring, expanding supplementary and therapeutic feeding programmes, improving maternal nutrition services, promoting exclusive breastfeeding and appropriate complementary feeding, enhancing routine immunization, and improving access to clean water and sanitation facilities. Nutrition-sensitive interventions that strengthen household livelihoods and food production will also be essential for reducing long-term dependence on humanitarian assistance and preventing recurrent growth faltering among vulnerable children.

Overall, the findings demonstrate that chronic malnutrition remains a critical public health problem among children aged 6–59 months in Bolori II, Monguno, and Pulka. The pronounced leftward displacement of the HAZ distributions relative to the WHO reference curves (Figs. 7, 9, and 11), together with the progressive deterioration in height-for-age observed among older children (Figs. 8, 10, and 12), provides compelling evidence of prolonged nutritional deprivation in these conflict-affected communities. Although modest improvements have occurred in some locations, particularly Bolori II, the persistently high prevalence of stunting underscores the urgent need for sustained, integrated, and location-specific nutrition interventions aimed at preventing irreversible growth failure and improving child survival and development in northeastern Nigeria.

3.3 Public Health Implications

The present study provides important evidence of the nutritional status of children aged 6–59 months residing in three conflict-affected communities in Borno State, northeastern Nigeria. Using standardized anthropometric measurements based on the SMART methodology and WHO Child Growth Standards, the study demonstrated that both underweight and stunting remain major public health concerns in Bolori II, Monguno, and Pulka. Although slight improvements in some nutritional indicators were observed compared with previous SMART assessments, the prevalence of undernutrition remains far above internationally accepted public health thresholds, highlighting the persistent effects of armed conflict, displacement, food insecurity, and limited access to essential health and nutrition services.

The results consistently identified Monguno as the most nutritionally vulnerable location. The prevalence of underweight (51.3%) and stunting (56.5%) exceeded those observed in Bolori II and Pulka, while severe underweight (24.6%) and severe stunting (30.4%) were also highest in Monguno (Tables 2 and 3). The corresponding WAZ and HAZ distributions (Figs. 3 and 9) exhibited the greatest leftward displacement relative to the WHO reference curves, providing graphical confirmation of the severe nutritional deficits observed among children in this location. These findings suggest that the cumulative effects of prolonged displacement, insecurity, disruption of agricultural production, limited livelihood opportunities, poor dietary diversity, and restricted humanitarian access have contributed substantially to the deterioration of child nutritional status.

Although Bolori II and Pulka recorded slightly lower prevalence rates than Monguno, the nutritional situation in these communities remains critical. Approximately one-third of children in both locations were underweight, while nearly one-half were stunted (Tables 2 and 3). These findings indicate that improvements achieved through humanitarian nutrition interventions have been insufficient to restore normal child growth patterns. The WAZ and HAZ distribution curves (Figs. 1, 5, 7, and 11) remain markedly shifted to the left of the WHO standards, confirming that nutritional deficits remain widespread throughout the surveyed populations.

One of the most important observations emerging from the study is the difference between acute and chronic manifestations of undernutrition. While underweight prevalence ranged from 33.7% to 51.3%, stunting prevalence ranged from 47.4% to 56.5%, indicating that chronic nutritional deprivation is considerably more prevalent than acute nutritional deficits. This pattern suggests that children have experienced prolonged exposure to inadequate nutrition and repeated infectious diseases rather than isolated episodes of food shortage. Chronic undernutrition is particularly concerning because its consequences extend far beyond childhood and are largely irreversible after the first two years of life (*Victora et al*., 2021).

The age-specific analyses presented in Figs. 2, 4, 6, 8, 10, and 12 further demonstrate that nutritional deterioration increases progressively with age. Children younger than six months generally exhibited relatively normal anthropometric status, whereas progressively lower WAZ and HAZ values were observed among children older than 18 months, with the greatest nutritional deficits occurring between 54 and 59 months. This finding is consistent with the biological progression of childhood undernutrition. During early infancy, breastfeeding provides substantial nutritional protection; however, following the introduction of complementary foods, children in resource-limited settings often receive diets that are nutritionally inadequate in both quantity and quality. Combined with repeated episodes of diarrhoeal diseases, respiratory infections, malaria, intestinal parasitic infections, and poor environmental sanitation, these conditions progressively impair growth and weight gain (*Black et al*., 2013). The leftward shifts observed in both the WAZ and HAZ distributions represent another important finding of this study. Under normal conditions, the anthropometric distribution of a healthy child population closely approximates the WHO reference curve. In contrast, the present study demonstrates a systematic displacement of both distributions toward lower Z-scores in all three study locations. This shift reflects population-wide nutritional deficiencies rather than isolated cases of severe malnutrition. Furthermore, the broader distribution curves observed in the study populations indicate substantial variability in nutritional status, suggesting inequalities in household food security, socioeconomic conditions, healthcare access, caregiving practices, and exposure to humanitarian assistance.

The findings of this study are consistent with previous reports from conflict-affected regions of Nigeria and other humanitarian settings. The Nigeria Demographic and Health Survey reported national prevalences of approximately 22% for underweight and 37% for stunting (NPC & ICF, 2019), considerably lower than those observed in the present study. Similarly, the UNICEF, WHO, and World Bank Joint Child Malnutrition Estimates continue to identify Sub-Saharan Africa as one of the regions with the highest burden of childhood undernutrition globally (UNICEF, WHO, & World Bank, 2021). The substantially higher prevalence reported in the present study reflects the exceptional vulnerability of internally displaced populations affected by prolonged armed conflict and humanitarian crises.

Several interacting factors are likely responsible for the high prevalence of undernutrition observed across the three study areas. First, prolonged insecurity has disrupted agricultural production, reducing household food availability and dietary diversity. Second, repeated population displacement has weakened household livelihoods and increased dependence on humanitarian assistance. Third, inadequate maternal nutrition and suboptimal infant and young child feeding practices may contribute to poor child growth. Fourth, limited access to healthcare services, safe drinking water, sanitation, and hygiene increases the incidence of infectious diseases that further compromise nutritional status. Finally, widespread poverty and rising food prices have reduced household purchasing power, making it increasingly difficult for families to provide nutritionally adequate diets for young children. From a public health perspective, the coexistence of widespread underweight and stunting demonstrates that emergency food assistance alone is unlikely to eliminate childhood undernutrition in these communities. Effective interventions should adopt a multisectoral approach integrating nutrition-specific and nutrition-sensitive programmes. Nutrition-specific interventions should include community-based management of acute malnutrition (CMAM), supplementary feeding programmes, growth monitoring and promotion, micronutrient supplementation, routine immunization, and counselling on optimal infant and young child feeding practices. Nutrition-sensitive interventions should strengthen household food security through livelihood support, agricultural recovery programmes, social protection initiatives, improved maternal education, and expanded access to safe water, sanitation, and primary healthcare services.

The findings also emphasize the importance of maintaining routine nutritional surveillance in conflict-affected communities. Periodic SMART surveys provide valuable evidence for identifying vulnerable populations, monitoring programme effectiveness, and guiding humanitarian resource allocation. Given the dynamic nature of population displacement and food insecurity in northeastern Nigeria, continuous surveillance is essential for detecting emerging nutritional crises and evaluating progress toward national and global nutrition targets. Despite its strengths, the study has some limitations. The cross-sectional design provides only a snapshot of nutritional status and does not permit causal inference regarding the determinants of undernutrition. Seasonal variations in food availability and disease occurrence may also influence anthropometric outcomes. Furthermore, although internationally standardized SMART procedures were used to minimize measurement error, some degree of recall bias in determining children's ages may have occurred where birth records or immunization cards were unavailable. Nevertheless, the use of standardized anthropometric techniques, rigorous quality control procedures, and WHO growth standards enhances the reliability and comparability of the findings.

Overall, the study demonstrates that undernutrition remains a critical humanitarian and public health challenge among children aged 6–59 months in Bolori II, Monguno, and Pulka. The persistently high prevalence of underweight and stunting, together with the marked leftward shifts in the WAZ and HAZ distributions relative to the WHO reference curves, provides compelling evidence of sustained nutritional deprivation. Among the three locations, Monguno remains the most severely affected community and should therefore receive priority attention in future nutrition programming. Sustained investment in integrated nutrition, health, food security, and livelihood interventions will be essential to improve child nutritional status, reduce preventable childhood morbidity and mortality, and support long-term recovery in conflict-affected communities of northeastern Nigeria.

4.0 Conclusion

This study assessed the nutritional status of children aged 6–59 months in Bolori II, Monguno, and Pulka, Borno State, using Weight-for-Age Z-scores (WAZ) and Height-for-Age Z-scores (HAZ) based on the WHO Child Growth Standards. The findings demonstrate that childhood undernutrition remains a major public health problem across all three conflict-affected communities despite ongoing humanitarian interventions.

The prevalence of underweight ranged from 33.7% to 51.3%, with Monguno recording the highest burden of both overall (51.3%) and severe (24.6%) underweight. Similarly, stunting affected 47.4%–56.5% of children, while severe stunting ranged from 22.9% to 30.4%, again with Monguno exhibiting the greatest burden. According to WHO and UNICEF public health thresholds, these prevalence rates represent a very high level of public health concern, indicating persistent chronic nutritional deprivation among children under five years of age.

The graphical analyses further corroborated these findings. The Weight-for-Age and Height-for-Age Z-score distributions were consistently shifted to the left of the WHO reference curves, demonstrating that children in the three study locations generally weighed less and were shorter than expected for their age. Furthermore, age-specific analyses revealed progressive deterioration in nutritional status with increasing age, with the greatest burden of severe underweight and severe stunting occurring among children aged 54–59 months. This pattern suggests cumulative nutritional deficits arising from prolonged inadequate dietary intake, repeated infectious diseases, poor complementary feeding practices, and persistent household food insecurity.

Although Bolori II showed modest improvement compared with previous SMART survey findings, the prevalence of both underweight and stunting remains considerably above national and international targets. The exceptionally poor nutritional status observed in Monguno highlights the disproportionate effects of prolonged armed conflict, repeated population displacement, disruption of livelihoods, and restricted access to healthcare and humanitarian services. Pulka also continues to experience an unacceptably high burden of chronic undernutrition, emphasizing that improvements remain insufficient across the entire study area.

Overall, the findings underscore the urgent need for sustained, integrated, and location-specific interventions that address both the immediate and underlying determinants of child malnutrition. Beyond emergency food assistance, priority should be given to strengthening community-based management of acute malnutrition, improving maternal and child nutrition services, promoting optimal infant and young child feeding practices, enhancing immunization coverage, expanding access to safe water and sanitation, improving household food security, and restoring sustainable livelihoods. Continuous nutritional surveillance using the SMART methodology should also be maintained to monitor trends, evaluate programme effectiveness, and guide evidence-based humanitarian planning.

Addressing childhood undernutrition in conflict-affected communities of northeastern Nigeria will require coordinated action involving government agencies, humanitarian organizations, development partners, and local communities. Such collaborative efforts are essential for reducing preventable childhood morbidity and mortality, improving child growth and cognitive development, and advancing Nigeria's progress toward the Sustainable Development Goals, particularly SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-being).

4.0 Conclusion

In conclusion, survey results from the study areas are firstly summarized in Table 2, where percentage of underweight children (weight-for-age z-score, WAZ) aged 6–59 months in Bolori II is now 34.4% (29.4–39.9, 95% CI), down from 43.1% (38.1–48.3, 95% CI), showing a meaningful improvement (p-value = 0.2019). In Monguno, the current rate is 51.3% (46.5–56.1, 95% CI), while in Pulka it is 33.7% (29.4–38.4, 95% CI).

According to World Health Organization (WHO) severity levels (<10% low, 10–<20% medium, 20–<30% high, 30% or more very high), severe underweight is high in Monguno at 24.6% (20.3–29.5, 95% CI), and medium in Bolori II and Pulka at 13.0% (10.0–16.8, 95% CI) and 11.7% (9.1–14.9, 95% CI), respectively. The Weight-for-Age z-score (WAZ) distribution curves (in red), compared with the World Health Organization (WHO) 2006 reference curve (in green), shown in Figures 1, 3, and 5, show a leftward shift. This means there is a high rate of underweight children in Monguno and a medium rate in Bolori II and Pulka compared to the standard population. Further analysis shows that underweight is most common among children aged 54–59 months in all three locations, as seen in Figures 2, 4, and 6.

Finally, the Height-for-Age Z-score (HAZ) distribution curve (in red), compared with the World Health Organization (WHO) 2006 reference curve (in green) shown in Figures 7, 9, and 11, shows a leftward shift, indicating a more stunted population than the normal group. Further analysis shows a severe growth delay, mostly among children aged 54-59 months, as seen in the age-sample sections (n = 54, 50, and 53 for Bolori II, Monguno, and Pulka, respectively), as shown in Figures 8, 10, and 12.

5.0 References

Akombi, B. J., Agho, K. E., Hall, J. J., Merom, D., Astell-Burt, T., & Renzaho, A. M. N. (2017). Stunting, wasting and underweight in Sub-Saharan Africa: A systematic review. *International Journal of Environmental Research and Public Health*, 14, 8, pp. 863. https://doi.org/10.3390/ijerph14080863

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, 382, 9890, pp. 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Development Initiatives. (2021). *2021 Global Nutrition Report: The State of Global Nutrition*. Development Initiatives.

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).* Proceedings of the 59th World Statistics Congress, International Statistical Institute. https://2013.isiproceedings.org

International Organization for Migration (IOM). (2022, March). *Displacement Tracking Matrix (DTM) Round 40: List of Sites Assessed in the BAY States, Nigeria.* International Organization for Migration.

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

National Population Commission and ICF.

United Nations Office for the Coordination of Humanitarian Affairs (OCHA). (2021, June). *Urgent Assistance Needed in North-East Nigeria to Avert Serious Food and Nutrition Crisis.* United Nations Office for the Coordination of Humanitarian Affairs.

United Nations Office for the Coordination of Humanitarian Affairs (OCHA). (2022, June). *Nigeria Humanitarian Situation Report (Quarter 3) and Press Release.* United Nations Office for the Coordination of Humanitarian Affairs.

UNICEF, World Health Organization, & World Bank. (2021). *Levels and Trends in Child Malnutrition: UNICEF/WHO/World Bank Joint Child Malnutrition Estimates.* UNICEF.

Victora, C. G., Christian, P., Vidaletti, L. P., Gatica-Domínguez, G., Menon, P., & Black, R. E. (2021). Revisiting maternal and child undernutrition in low-income and middle-income countries. *The Lancet*, 397, 10282, pp. 1388–1399. https://doi.org/10.1016/S0140-6736(21)00390-0

World Health Organization. (2006). *WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development.* World Health Organization.

World Health Organization. (2010). *Nutrition Landscape Information System (NLIS) Country Profile Indicators: Interpretation Guide.* World Health Organization.

You, D., Hug, L., Ejdemyr, S., Idele, P., Hogan, D., Mathers, C., Gerland, P., New, J. R., & Alkema, L. (2015). Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *The Lancet*, 386, 10010, pp. 2275–2286. https://doi.org/10.1016/S0140-6736(15)00120-8

Declarations

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.

Ethical Approval and Consent to Participate

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and followed the Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology for nutrition surveys. Ethical approval for the survey was obtained from the appropriate institutional and/or humanitarian ethics review authority before commencement of the study. Permission to conduct the survey was also obtained from the relevant government authorities and community leaders in the study areas. Written or verbal informed consent was obtained from the parents or legal guardians of all participating children before data collection. Participation was entirely voluntary, and respondents were informed of their right to decline participation or withdraw from the study at any stage without any consequences. All data were treated confidentially and analyzed anonymously to protect participants' privacy.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this manuscript.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Authors' Contributions

Anthony Ekpo conceptualized and designed the study, supervised data collection, performed the statistical analyses, interpreted the results, and prepared the original manuscript draft. Jonathan Atsue Ikughur contributed to the study design, data validation, statistical analysis, interpretation of the findings, manuscript revision, and critical review of the final version. Both authors read and approved the final manuscript and agree to be accountable for all aspects of the work.