ISSN: 2536-7153 SJMLS

Sokoto Journal of Medical Laboratory Science 2022; 7(2): 58 - 69

SJMLS-7(2)-007

# Evaluation of Nutritional Status using MUAC, BMI Percentile and Biochemical indicators among Internally Displaced Children attending IDPs Clinic within Maiduguri/ Jere, Borno State, Nigeria: An impact of the Boko Haram insurgency

Musa, A. H* [1], Abubakar A.A [1], Fatima Z.A [1], Mamza Y.P [1], Umar A.M [2]

Department of Medical Laboratory Science, Faculty of Allied Health Sciences, College of Medical Sciences, University of Maiduguri[1], Save The Children, Maiduguri, Borno State[2]

Author for Correspondence*: alharu2u.mls@unimaid.edu.ng/+234-703-120-0313/ORCID Number:0000-003-1087-1056. https://dx.doi.org/10.4314/sokjmls.v7i2.7

**Abstract**

The adverse effect of war and conflicts on the health of children is food and nutrition insecurity and poor health outcome with consequence of death before the age of 5 years and stunted growth due to malnutrition. Thus, we evaluated the nutritional status of children aged under 5 years in a Boko Haram war zone, Maiduguri. A cross sectional survey was conducted among 110 IDP children between the age of six (6) month and thirty-six (36) months. The Mid-upper arm circumference (MUAC), Body mass index (BMI) percentiles and Biochemical indicators (Serum protein, albumin and Calcium), were used to determine the nutritional status of these children. MUAC was measured using a simple colored plastic tape. BMI percentiles were analyzed. Biochemical parameters (Total protein, serum Albumin, and serum Calcium) were analyzed using Cobas C311 Hitachi/Roche Chemistry Auto analyzer. The mean ± SD for Age, Height, and Weight for boys and girls were 15.58±7.08, 0.67±0.10, 7.03±0.99 and 14.04±5.39, 0.64±0.11, 7.01±1.19 respectively. The Boys-Girls ratio was 1:29 with 43.6% boys (n=48) and 56.4% girls (n=62). Out of the 110 children, 50(45.5%) had diarrhoea, 36(32.7%) had vomiting, and 64(58.2%) had cough, 9 children had MUAC less than 11.0 cm (SAM), 85 had MUAC of 11.0 - 12.5cm (MAM) and 16 children had MUAC of between 12.6-12.9 cm (at risk for acute malnutrition). The result also showed that both boys and girls had mean BMI between 50$^{th}$ and 75$^{th}$ percentiles (normal weight). Biochemical analysis indicates that the children had normal serum total Protein (66.00±7.46g/L), Albumin (37.31±4.75g/L) and hypocalcemia (2.15±0.24mmol/L). However, Albumin, BMI and Weight were weakly correlated with MUAC and the relationship was significant at $p < 0.05$ but height was negatively correlated with MUAC and the relationship was not significant($p>0.05$). Malnutrition and diseases such as diarrhoea, vomiting and respiratory infections are the most common health outcome and mortality risk factors among the IDPs children less than 5 years. Thus, it is therefore imperative that government and the world at large should identify the root cause(s) of this conflict. It is also imperative that relevant stakeholders such as government agencies, non-governmental organizations, UN agencies, and local partners are involved in the formulation of policies that will guarantee provision of adequate nutrients and balanced diets for the children in the IDP camps.

**Keywords:** Malnutrition, children, status, body mass index, MUAC.

## Introduction

Malnutrition remains a major public health problem and a significant cause of mortality among children under five in low- and middle-income countries (LMICs), accounting for 45% of child deaths globally (Selimoglu *et al.*,2021). The adverse effect of War and Conflicts on the health of children have been well documented in several literatures. At least 240 million children live in countries affected by conflict. These children are at heightened risk of death before age 5, stunted growth due to malnutrition and so much more (Save the Children). In the last 20 years, conflicts or wars have occurred in about 37% of countries (Devakumar *et al.*, 2014) including Nigeria. In Nigeria, Boko Haram insurgency started in 2009 in Borno State (Dunn,2018). Since then, the sectarian violence continues in many parts of the state extending to neighboring states including Yobe, Adamawa and Kano (Oluwatosin, 2019). This insurgency has since affected neighboring countries including Niger, Chad and Cameroun. This has claimed thousands of lives leaving others

suffering and displaced. Displaced families have since been in camp as internally displaced persons (IDPs) and some are being taken care of by their relatives and philanthropist and orphanages. Infants and children exposed to conflicts has risk of morbidity and mortality due to diseases and malnutrition (Wagner *et al*., 2018). Several studies have found that exposure to conflicts has adverse effect on height (Yubraj *et al*.,2020) and nutritional status of children (Ghazi *et al*.,2014). The prolonged insurgency has caused food and nutrition insecurity which has become increasingly worse in areas affected and the consequence of which are that children affected by this conflict are facing a disproportionate burden of malnutrition and poor health outcomes (Carroll *et al*., 2017). Essentially malnourishment is a consequence of malnutrition (Lambardo, 2016), and therefore these children are at risk of stunted growth, mental retardation, gastro intestinal tract (GIT) infection, anaemia, diarrhoea and death before age 5 years. Children less than 5 years needs nutritious and balanced diet essential for the development of their brain and other vital organs (Mahak, 2019). With the help of Action Against Hunger, Save the Children's global health programs work and other NGOs including World Food Program (WFP), Christian Aid, etc. in collaboration with government agencies such as national emergency management agency (NEMA), Borno State emergency management agency (BOSEMA) have alleviated child hunger, reduced child undernutrition, improves child health. Thus, we evaluated the nutritional status among internally displaced children affected by the Boko Haram insurgence who attended internally displaced persons (IDPs) clinic within Maiduguri and Jere areas in Borno state, Nigeria.

## Materials and Methods

### Study Area/Population

Three hospitals including Emergency Pediatric Units A (EPU A) of State Specialist Hospital Maiduguri, Mairi Clinic and Jiddari Polo Clinic were randomly selected for the study. These health facilities provide special care for the IDPs especially those children who are malnourished. Both EPU A, Mairi and Jiddari Polo clinics serve out patient and admits IDP children with severe acute malnutrition (SAM) and Moderate Acute Malnutrition (MAM) and also provide special care for them up to their revival.

### Sampling

Simple random sampling of the children in each clinic was conducted on both inpatients and outpatient. One hundred and ten (110) IDP children between the age of six (6) and thirty-six (36) months of both gender (Boys=48 and Girls=62 and) were recruited for this study.

### Informed consent

Informed consent to enable the children participate as subjects was sought from the parents and guardians of the children after the purpose for the study was explained to them.

### Ethical clearance

The ethical clearance for the study was obtained from the research and ethical committee of the ministry of Health, Borno State.

### Anthropometric/Sample collection

### Anthropometry:

Anthropometric measurements were also taken for each subject. This includes: BMI, Height, Weight, circumference of the mid-upper arm (MUAC).

### Blood sample collection

Five milliliters (5 ml) of blood specimen were collected aseptically from the superficial vein of left arm by venipuncture of each child for biochemical analysis. The blood was collected using a plain vacutainer and butterfly needle. The sample containers were appropriately labeled for each subject and the blood was allowed to clot at room temperature. The samples were centrifuged at 4000 revolutions per minute (rpm) for 5 minutes and serum separated into another appropriately labeled sample containers (cryovial) and stored frozen until the time of analysis.

### Statistical analysis

SPSS 20.0 package was used for all statistical analysis. All the data were expressed as Mean ± SD. Pearson correlation was used to compare between MAUC and BMI, $Ca^{2+}$, TP, and Albumin. BMI percentile was also analyzed using this package. A p value $<0.05$ was statistically considered significant for all statistical tests.

### Diagnostic procedures to determine malnutrition:

### Measurement of Mid-Upper Arm Circumference (MUAC):

### MUAC Measurement Procedure

The procedure was explained to the child's mother. The left hand of the child was removed from his or her cloth. He or she was made to stand straight and sideways to the measurer. Then the

child's left arm was bend at 90 degrees to the body. The mid-point of the upper arm was located and marked with a pen and the child's arm was allowed to relax hanging by his or her side. The MUAC tape window (0 cm) was then placed on the mid-point and the tape was wrapped around the outside of the arm with the right hand. The tape was then fed through the hole in the tape while keeping the right hand planted on the arm. The tape was then pulled until it fits securely around the arm while keeping the right hand steady on the child's arm. The measurement at the window of the MUAC tape was then read and recorded to the nearest millimeter (mm). If the circumference of the mid-upper arm is below 110 mm, it is a clear indication of malnutrition in your child (https :// ifrcgo.org/ ecv-toolkit/ action/measuring-mid).

**Blood Tests:** Specific blood tests such as Serum Total protein, albumin and Ca2+ levels, were included as routine blood tests for the diagnosis of the condition of malnutrition in kids.

**Serum Total Protein**

Serum total protein was estimated by Biuret Method (Chromy and Fisher,1997) which is the widely used method recommended by international Federation of Clinical Chemistry.

**Serum Albumin**

Serum Albumin was estimated by Bromocresol Green (BCG) method as described by Doumas *et al.* (1971)

**Serum Calcium**

Serum Calcium was estimated using O-cresolphthalein complexone method by Wamsley and Fowler (1981)

**Other Measurements**

**Height and Weight**

Standard measuring metal tapes and digital weighing scales were used to measure the height (to the nearest 0.1 centimeter) and weight (to the nearest decimal fraction) respectively of each child.

**Body Mass Index (BMI)**

The Body Mass Index (BMI) is a popular indicator of undernutrition. It is the weight of a person in relation to their height. It is determined by dividing the body weight in kilograms by the body height (in meters) squared of the child.

**Results**

One hundred and ten (110) IDP children aged six (6) to thirty-six (36) months attending IDPs clinics were recruited for this study. The Boys-Girls ratio was 1:29 with 43.6% boys and 56.4% girls. The study population (n =110) was drawn from State Specialist Hospital (n=36) 32.7%, Mairi IDPs clinic (n=57) 51.8% and Jiddari Polo IDPs clinic (n=17) 15.5%. The age range (in months) of the children are 6-12 months (n=49) 44.5%, 13-19 months (n=40) 36.4%, 20-26 months (n=16)14.5% and greater than 27 (n=5) 4.5%. Out of the 110 of children, 50(45.5%) had diarrhoea, 36(32.7%) had vomiting, and 64(58.2%) had cough (Table 1). Table 2 shows distribution of MUAC in cm according to gender, age, and BMI of the IDP children attending the IDP clinics. 9 of the children (2 boys and 7 girls) had MUAC less than 11.0 cm (SAM), 85 (40 boys and 45 girls) had MUAC of 11.0 - 12.5cm (MAM) and 16 children (boys 6 and girls 10) had MUAC of between 12.6-12.9cm (at risk for acute malnutrition). Six of the children aged 6-12 months (n=50) had MUAC less than 11.0cm,38 had MUAC of 11.0-12.5cm and 6 children had MUAC of 12.6-12.9cm. Children Aged 13 - 19months (n=39) had MUAC of <11.0cm (1 child), 29 children had MUAC of 11.0-12.5cm and 9 had MUAC of 12.6-12.9cm. children aged 20-26 months(n=16) had MUAC of <11.0cm (2 children), 13 had MUAC of 11.0-12.5cm and 1 had MUAC of 12.6-12.9cm. All the children aged 27-36 months (n=5) had MUAC of 11.0-12.5cm. The distribution also showed that 8 children with BMI <18.5kg/$m^2$ had MUAC of < 11.0cm, 64 had MUAC of 11.0-12.5cm and 8 had MUAC of 12.6-12.9cm. 13 children with BMI of 18.5-24.9 cm kg/$m^2$ had MUAC 11.0-12.5cm and only 1 child had MUAC of 12.6-12.9 cm. Five (5) Children with BMI of 25.0-29.9kg/$m^2$ had MUAC of 11.0-12.5cm and 6 had MUAC of 12.6-12.9cm. Both boys and girls had mean BMI between 50$^{th}$ and 75$^{th}$ percentiles (normal weight), both also had MUAC between 11.0-12.5cm which indicates Moderate Acute Malnutrition (MAM). The mean ± SD for Age, Height, and Weight for boys and girls were 15.58±7.08, 0.67±0.10, 7.03±0.99 and 14.04±5.39, 0.64±0.11, 7.01±1.19 respectively (Table 3). Table 4 shows the mean and standard deviations for Age, MUAC and BMI of the study

subjects. Boys with mean age of 15.58±7.08 have MUAC of 11.66±0.62 and BMI of 16.22±5.46 while Girls have mean age of 14.04±5.39, MUAC of 11.64±0.070 and BMI of 18.17±7.94. Table 5 shows the descriptive statistics and correlation between MUAC and serum Albumin, Total Protein, and Calcium. The result shows weak correlation. However, only Albumin was significantly correlated ($p<0.05$) with MUAC. Table 6 shows descriptive statistics and correlation between MUAC and BMI, Height and weight. Both BMI and weight were weakly correlated with MUAC and the relationship was significant at $p < 0.05$ but height was negatively correlated with MUAC and the relationship was not significant (as also shown in figures 1, 2 and 3). Table 7 showed descriptive statistics and correlation between age and BMI, Height and weight. Age correlated weakly and significantly ($p<0.05$) with BMI and weight.

**Table 1. Demographic, anthropometric characteristics and prevalence of risk factors associated with malnutrition among IDP children attending the IDPs clinics**

| Variables | Frequency(n) | Prevalence (%) |
|---|---|---|
| **Gender** | | |
| Boys | 48 | 43.6 |
| Girls | 62 | 56.4 |
| Total | 110 | 100.0 |
| **Age range(months)** | | |
| 6-12 | 49 | 44.5 |
| 13-19 | 40 | 36.4 |
| 20-26 | 16 | 14.5 |
| | 5 | 4.5 |
| Total | 110 | 100.0 |
| **Health Outcome** | | |
| SAM | 9 | 8.2 |
| MAM | 85 | 77.3 |
| At risk for acute malnutrition | 16 | 14.5 |
| **Diarrhea** | | |
| Yes | 50 | 45.5 |
| No | 60 | 54.5 |
| Total | 110 | 100.0 |
| **Vomiting** | | |
| Yes | 36 | 32.7 |
| No | 74 | 67.3 |
| Total | 110 | 100.0 |
| **Cough** | | |
| Yes | 64 | 58.2 |
| No | 46 | 41.8 |
| Total | 110 | 100.0 |
| **Location** | | |
| State specialist Hospital | 36 | 32.7 |
| Mairi IDPs Clinic | 57 | 51.8 |
| Jiddari Polo IDPs Clinic | 17 | 15.5 |
| Total | 110 | 100.0 |

**Table 2. Distribution of MUAC in cm according to Sex, Age, and BMI among internally displaced (IDP) children attending IDPs clinic within Maiduguri and Jere, Borno state**

| Variables | MUAC in cm | | | |
|---|---|---|---|---|
| | SAM (10.5-10.9) | MAM (11.0-12.3) | At risk for acute malnutrition (12.5-12.9) | TOTAL |
| Gender | | | | |
| Boys | 2 | 40 | 6 | 48 |
| Girls | 7 | 45 | 10 | 62 |
| **Total** | **9** | **85** | **16** | **110** |
| Age in months | | | | |
| 6-12 | 6 | 38 | 6 | 50 |
| 13-19 | 1 | 29 | 9 | 39 |
| 20-26 | 2 | 13 | 1 | 16 |
| 27-36 | 0 | 5 | 0 | 5 |
| **Total** | **9** | **85** | **16** | **110** |
| BMI in $Kg/m^2$ | | | | |
| <18.5 | 8 | 64 | 8 | 80 |
| 18.5-24.9 | 0 | 13 | 1 | 14 |
| 25.0-29.9 | 0 | 8 | 8 | 16 |
| **Total** | **8** | **85** | **17** | **110** |

*SAM (Severe Acute Malnutrition) = MUAC < 11.0 CM, MAM (Moderate Acute Malnutrition) = MUAC of between 11.0cm and 12.5cm, At Risk for Acute malnutrition = MUAC of between 12.5cm and 13.5cm, Well Nourished = MUAC of over 13.5cm (www.motherchildnutrition.org/early-malnutrition-detection/detection-referral-children-with-acute-malnut)*

**Table 3. Percentiles, Mean and Standard deviations of anthropometric measures for Height, Weight, BMI and nutritional status relative to gender of the internally displaced (IDP) children attending IDPs clinic within Maiduguri and Jere, Borno state**

| Gender | Calculated Percentiles | | | | | | | Mean ± SD |
|---|---|---|---|---|---|---|---|---|
| | $5^{th}$ | $10^{th}$ | $25^{th}$ | $50^{th}$ | $75^{th}$ | $90^{th}$ | $95^{th}$ | |
| **Boys** | | | | | | | | |
| BMI ($Kg/m^2$) | 10.61 | 11.36 | 12.26 | 14.54 | 19.35 | 26.01 | 28.47 | 16.22 ± 5.46 |
| Age (month) | 6.45 | 7.00 | 10.25 | 14.00 | 18.00 | 23.00 | 36.00 | 15.58±7.08 |
| Height (m) | 0.50 | 0.50 | 0.62 | 0.70 | 0.75 | 0.81 | 0.84 | 0.67 ± 0.10 |
| Weight (Kg) | 5.72 | 5.80 | 6.50 | 6.95 | 7.75 | 8.11 | 9.12 | 7.03 ± 0.99 |
| **Girls** | | | | | | | | 18.17 |
| BMI ($Kg/m^2$) | 10.16 | 11.62 | 13.30 | 15.49 | 19.13 | 30.22 | 34.62 | ±7.94 |
| Age (month) | 7.15 | 8.00 | 9.00 | 12.00 | 19.00 | 21.00 | 23.70 | 14.04 ± 5.39 |
| Height (m) | 0.40 | 0.45 | 0.56 | 0.65 | 0.72 | 0.80 | 0.84 | 0.64 ± 0.11 |
| Weight (Kg) | 5.20 | 5.33 | 6.20 | 7.15 | 7.90 | 8.27 | 8.87 | 7.01 ± 1.19 |

**Underweight= BMI < $5^{TH}$ Percentile, Normal weight= BMI between $5^{TH}$ and $85^{TH}$ percentile Overweight= BMI >$85^{th}$ and <$95^{th}$ percentile, Obese = BMI ≥ $95^{TH}$ percentile (Mushtaq et al,2012).*

**Table 4. The mean and standard deviations for Age, MUAC and BMI of the internally displaced (IDP) children attending IDPs clinic within Maiduguri and Jere, Borno state**

| Subjects | Age (Mean±SD) | MUAC (Mean±SD) | BMI (Mean±SD) |
|---|---|---|---|
| Boys | 15.58±7.08 | 11.66 ± 0.62 | 16.22±5.46 |
| Girls | 14.04±5.39 | 11.64 ± 0.70 | 18.17±7.94 |

***SAM (Severe acute Malnutrition) = MUAC < 11.0 cm, MAM (Moderate acute Malnutrition) = MUAC of between 11.0cm and 12.5cm, At Risk for Acute malnutrition = MUAC of between 12.5cm and 13.5cm, Well Nourished = MUAC of over 13.5cm (www.motherchildnutrition.org/early-malnutrition-detection/detection-referral-children-with-acute-malnut).*

**Table 5. Descriptive statistics and Correlation between MUAC and albumin, Total Protein and Calcium among internally displaced (IDP) children attending IDPs clinic within Maiduguri and Jere, Borno state**

| Variables | (Mean±SD) | Pearson's correlation(r) | p- value |
|---|---|---|---|
| MUAC (cm) | 11.65±0.67 | | |
| Albumin (g/L) | 37.31±4.75 | 0.192 | 0.044 |
| Total protein (g/L) | 66.00±7.46 | 0.130 | 0.175 |
| Calcium (mmol/L) | 2.15±0.24 | 0.182 | 0.056 |

*Reference values:*
*Serum Total Protein (TP) = 50 – 80g/L, Serum Albumin (Alb) = 35 – 50g/L*
*Serum Calcium ($Ca^{2+}$) = 2.2 – 2.7 mmol/L*

**Table 6. Descriptive statistics and Correlation between MUAC and BMI, Height, Weight among internally displaced (IDP) children attending IDPs Clinic within Maiduguri and Jere, Borno State**

| Variables | (Mean±SD) | Pearson's correlation(r) | p- value |
|---|---|---|---|
| MUAC (cm) | 11.65±0.67 | | |
| BMI ($Kg/m^2$) | 17.32±7.00 | 0.283 | 0.003 |
| Height (m) | 0.66±0.11 | - 0.040 | 0.681 |
| Weight (Kg) | 7.02±1.11 | 0.352 | 0.000 |

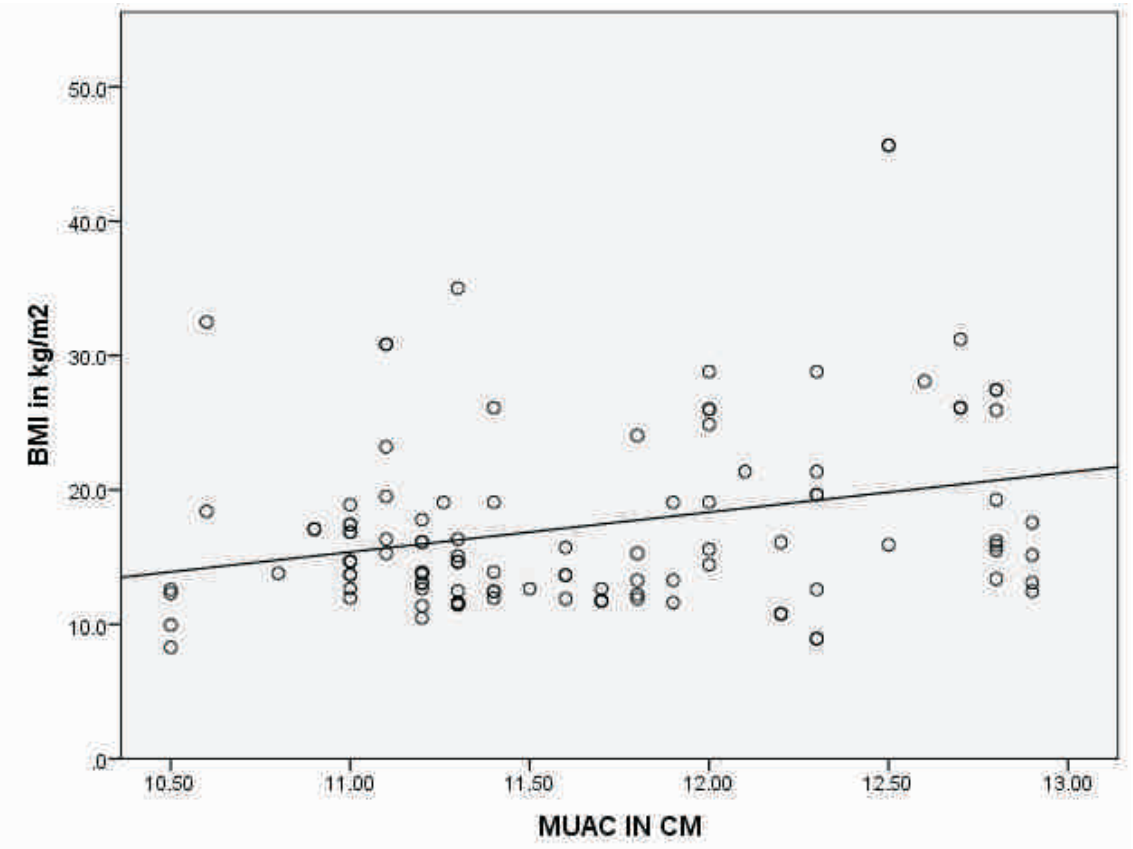


Figure 1.A Scatterplot between CM and BMI INKg/m2

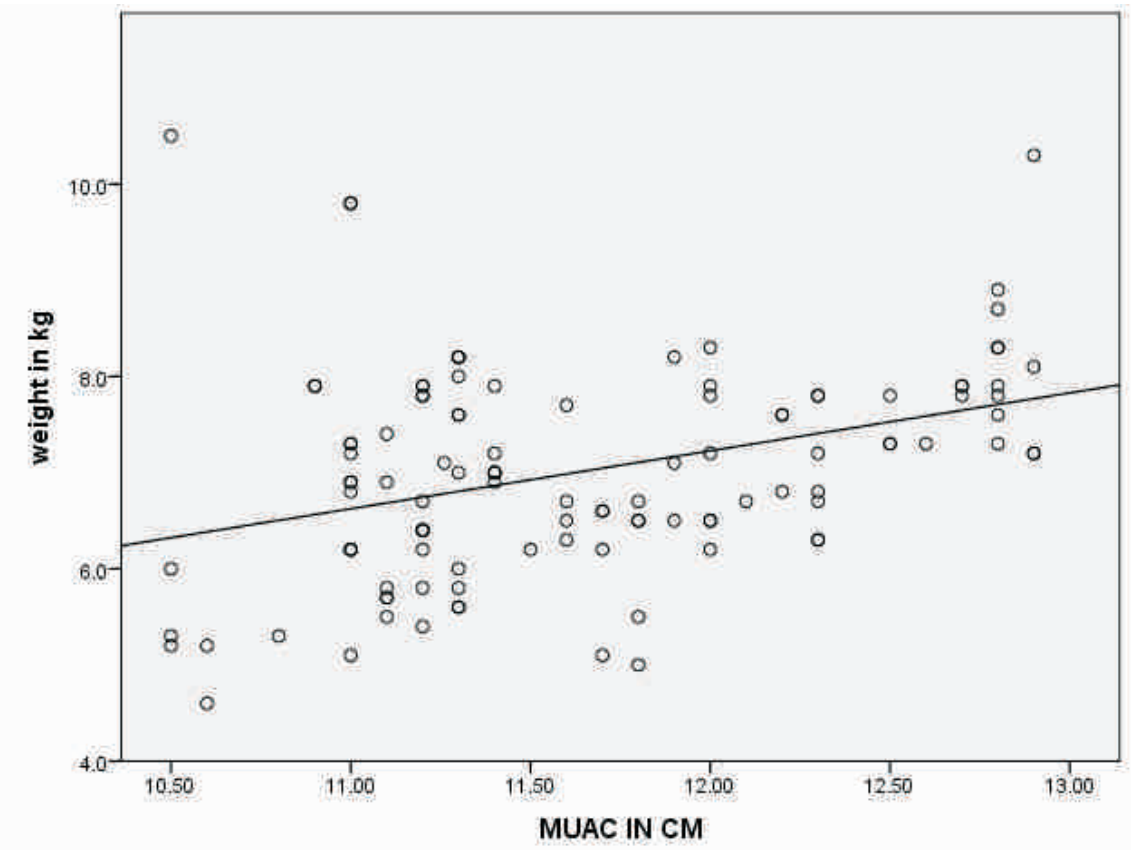


Figure 2. A Scatterplot Between MUAC in cm and weight in kg

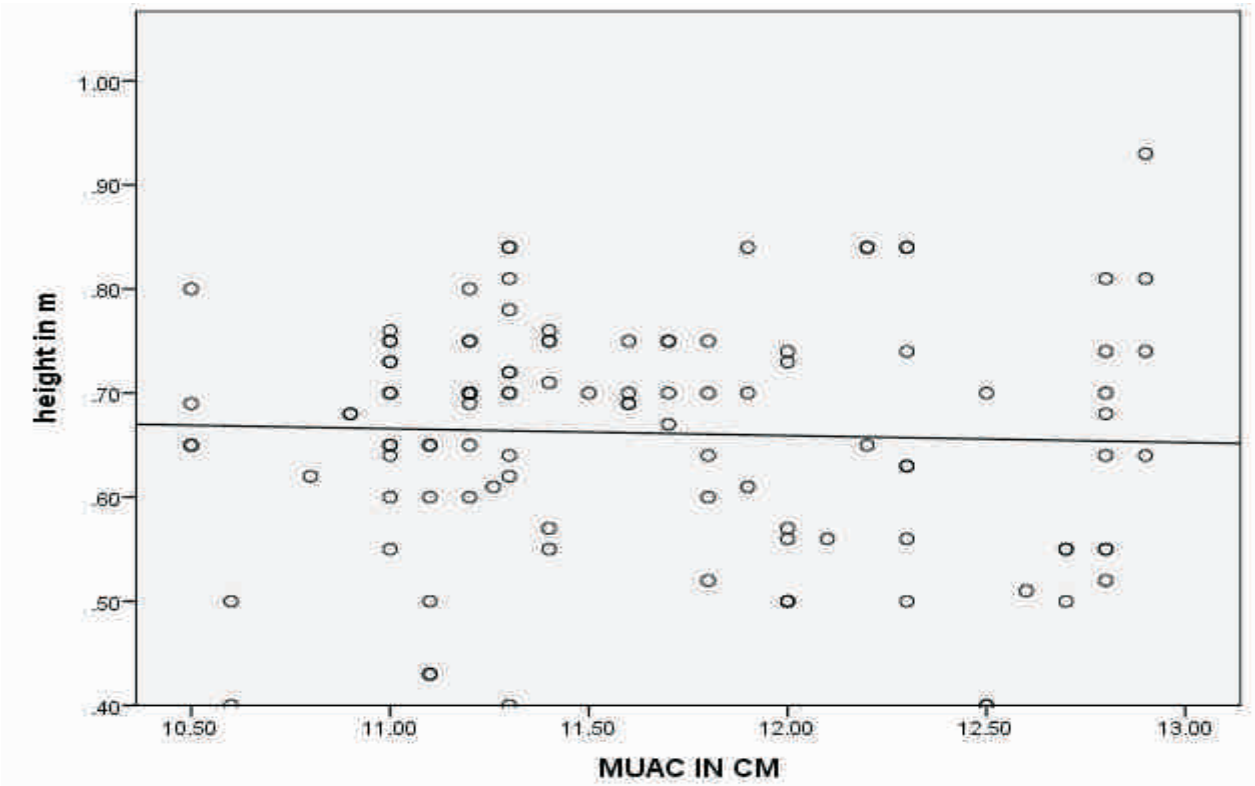


Figure3. Scatterplot Between MUAC in cm and Height in m

**Discussion**

In conflict or war zone area many people were forced to leave their homes and become refugees outside their towns, countries as a result of destruction of their homes, of agricultural infrastructure, attacks on health care facilities, destruction and contamination of sources of drinking water resulting in poor sanitation and hygiene, malnutrition, and infectious disease out breaks (Carroll *et al.*, 2017). Thus, we evaluated the health and nutritional status of children aged 5 and under in a Boko Haram war zone, Maiduguri. A cross sectional survey was conducted among 110 children victims of Boko Haram insurgence who were attending three IDP clinics. Through anthropometric measures and other diagnostic procedures, the nutritional status of these children was determined (Bloss *et al.*,2004). Anthropometry is a key tool in the assessment of nutritional status across age groups and population (Duggan,2010; Gorstein and Akré ,1988; Vijayaraghavan,1987). The anthropometric measures were used in calculating both BMI and MUAC, which provides a simple and convenient values for assessing nutritional status (Bhattacharya, 2019; Addo *et al.*, 2017). BMI was measured and only the percentile method was used for assessment of growth and nutritional status (El shafie *et al.*, 2021). MUAC was used to assess protein-energy malnutrition in the children (Jelliffe and Jelliffe,1969). This method has been used in field settings it was simple and in identifying young children with undernutrition and who are at elevated risk of near-term mortality, especially under emergency situations such as famine or refuge crises (Addo *et al.*, 2017; WHO, 2013). The biochemical parameters serum protein, albumin was used to assess the visceral protein stores (Matarese, 2002). Albumin has traditionally been used as marker of nutritional status (Keller, 2019). In this study, nutritional status of internally displaced children aged between six (6) months and thirty-six (36) months were evaluated using MUAC, BMI percentiles and biochemical indicators. The Boys-Girls ratio was 1:29 with boys-girls proportion of 43.6% and 56.4% respectively. The study population (n=110) was drawn from three health facilities including State Specialist Hospital (EPU A) Maiduguri (n=36) 32.7%, Mairi IDPs clinic (n=57) 51.8% and Jiddari Polo

IDPs clinic (n=17) 15.5%. Clinical and physical examinations show that 50(45.5%) of these children had diarrhoea, 36(32.7%) had vomiting and 64(58.2%) had cough (Table 1). This finding was in agreement with report of Kandala *et al.* (2011) who reported respiratory infection and diarrhoea in age-matched population of children in Democratic Republic of Congo (DRC). Similar study was also reported by Edem *et al.* (2015) where 40.7% of the children had diarrhoea diseases. This may be due to the compromised immune system as a result of undernutrition, impaired GIT functions such as GIT dysfunction, increased intestinal permeability, malabsorption and also may be due to poor drinking water and lack of hygiene condition of the IDP camps (Selimoglu *et al.*, 2021). This study also shows that 9 children (2 boys 7 girls) had MUAC less than 11.0cm indicative of severe acute malnutrition (SAM), 85 had MUAC of between 11.0 and 12.5cm indicative of moderate acute malnutrition (MAM) and 16 children (6 boys and 10 girls) had MUAC between12.6 and 12.9cm indicative that the children are at risk of acute malnutrition. The study also showed that most children of the age range of 6 - 12 had MAM (38) compared to few once with SAM (6) and those ones at risk of acute malnutrition. This may be due to the fact that children of this age group of 6-12 months rely on others for food, have increased caloric requirement, inadequate breast feeding, and increased susceptibility to infection as evidenced from the health outcome (diarrhoea and vomiting) (Table 1 and 2). Age range 27-36 had the least number of children with undernutrition category of MAM. This may be due to the fact that this older age group are stronger and more developed to accept supplementary foods and thus less susceptible to diseases (Table 2). Our study equally showed that those children with BMI <18.5kg/m$^2$(underweight) are mostly those with MAM compared to those with SAM and those that are at risk of acute malnutrition. The preponderance of these children with MAM and BMI of <18.5kg/m$^2$ indicates that there was no enough food supplement or proper feeding. It may also be indicative of the health outcome of the children (diarrhoea and vomiting) which may cause GIT dysfunction, malabsorption and consequently undernutrition (Table 2). Table 3 shows nutritional status relative to gender of the children using statistics and anthropometric measures and BMI percentiles. The result showed that BMI for both male and female fall between 50$^{th}$ and 75$^{th}$ percentiles. This means that most of the children had BMI between 50 and 75% of the children and therefore have normal body weight (BMI between 5$^{th}$ and 85$^{th}$ percentile – normal weight) (Mushtaq *et al.*, 2012). Table 4 shows the mean & SD for age, MUAC, BMI of the IDP children. The mean age for the Boys was 15.58±7.08 in month compared to the mean of the girls which was 14.04±5.39. The boys had mean MUAC and BMI of 11.66±0,62 and 16.22±5.46 respectively and the girls had mean MUAC and BMI of 11.64±0.70 and 18.17±7.94 respectively. This means both boys and girls averagely had normal MUAC (>11.0 cm). Table 5 shows descriptive statistics and correlation between MUAC and Albumin, Total Protein and calcium. This study shows that the study population had normal serum protein 66g/L (50 – 80g/L) and serum Albumin 37g/L (35 – 50g/L). This result indicates that the children had normal biochemical indicators for nutrition. However, the serum Calcium is lower 2.15mmol/L (2.2 – 2.7 mmol/L) which is in agreement with the report of Mishra *et al.* (2009), and that of Lakshmi *et al.* (2016) where 35% of the study population was reported to have hypocalcemia. Arup *et al.* (2017) also reported hypocalcaemia in malnourished in children. The hypocalcaemia seen in these subjects may be due to poor calcium intake over a long period of time or malnutrition. The result shows weak correlation between MUAC and all the biochemical indicators but the relation between MUAC and Albumin was significant (p=0.04). However, the relationship between MUAC and the other parameters were not significant (p>0.05). Table 6 shows descriptive statistics and correlation between MUAC and other anthropometric measures but only BMI and weight showed significant relation between MUAC and BMI and weight (as also indicated in Figures 1-3).

**Conclusion**

This study has summarily documented nutritional and health status among IDP children less than 5 years in a Boko Haram war zone,

Maiduguri. Malnutrition and diseases such as diarrhoea, vomiting and respiratory infections are the most common health outcome among the IDPs children less than 5years. They are mostly affected by malnutrition because of their inability to have sufficient and adequate nutrients needed for healthy growth and development. This study revealed that most of the children 85(77.3%) have moderate acute malnutrition and few ones 99(8.2%) having severe acute malnutrition and 16(14.5%0 who are at risk of acute malnutrition. Thus, it is therefore imperative that government and the world at large should identify the root cause(s) of this conflict. It is also imperative that relevant stakeholders such as government agencies, non-governmental organizations, UN agencies, and local partners are involved in the formulation of policies that will guarantee provision of adequate nutrients and balanced diets for the children in the IDP camps.

**Acknowledgement**

We want to thank Borno State Ministry of Health for granting us permission to collect our research samples and data from the IDP children. We also want to appreciate all the parents/guardians/ caregivers of the IDP children for consenting to and participating in this research work.

**Conflict of Interest**

There was no conflict of interest.

**Funding**

Self-sponsored

**References**

Adedeji Bethel Oluwatosin, Adebayo Tosin & Udo, Emem Michael. (2019). Malnutrition among Internally Displaced Persons Children: A Consequence of Armed Conflicts in Nigeria. *Journal of Global Peace and Conflict*; **7(2)**:31-38.

Arup Ratan Pau, Md Abdur Razzaque Mia, Nahid Bintay Ansary, Suttam Kumar Biswas, Md Mahamudur Rahman and Manisha Paul Tumpa (2017). Serum Potassium and Calcium Level in Malnourished Children of Bangladesh. *Community Based Medical Journal;* ***06(01)***:12-16. doi: 10.3329/cbmj.v6i1.54662

Bhattacharya, A., Pal, B., Mukherjee, S., Roy, S.K. (2019). Assessment of nutritional status using anthropometric variables by multivariate analysis. *British Medical Council Public Health. 5;**19(1)**:1045.* doi: 10.1186/s12889-019-7372-2.

Bloss, E., Wainaina, F., Bailey, R.C. (2004). Prevalence and predictors of underweight, stunting, and wasting among children aged 5 and under in western Kenya. *Journal of Tropical Pediatricks;**50(5)**: 260-270. doi*: 10.1093/tropej/50.5.260.

Carroll, G.J., Lama, S.D., Martinez-Brockman, J.L., Pérez-Escamilla, R. (2017). Evaluation of Nutrition Interventions in Children in Conflict Zones: A Narrative *Review. Advanced Nutrition;**8(5)**:770-779.* doi: 10.3945/an.117.016121.

Chromy, V. and Fischer, J. (1977). Photometric determination of total protein in lipemic serum. *Clinical Chemistry; **23**:754.*

Crystal Lombardo (2016). Difference Between Malnutrition and Malnourishment.

Delan Devakumar, Marion Birch, David Osrin, Egbert Sondorp and Jonathan CK Wells (2014). The intergenerational effects of war on the health of children. *British Medical Council Medicine;* ***12***:57 http://www.biomedcentral.com/1741-7015/12/57.

Doumas, B.T., Watson, W.A. and Biggs, H.G. (1971). *Clinical Chemistry Acta*;**31**: 87-96.

Duggan, MB. (2013). Anthropometry as a tool for measuring malnutrition: impact of the new WHO growth WHO. Guideline: updates on the management of severe acute malnutrition in infants and children. Geneva (Switzerland): World Health Organization. Guideline: updates on the management of severe acute malnutrition in infants and children. Geneva (Switzerland): World Health Organization.

Edem, M.A., Tette, Eric K. Sifah and Edmund T. Nartey (2015). Factors affecting malnutrition in children and the uptake of interventions to

prevent the condition. *British Medical Council Pediatrics*; **15**:189 DOI 10.1186/s12887-015-0496-3

El Shafie, A.M., El-Gendy, F.M., Allahony, D.M., Hegran, H.H., Omar, Z.A., Samir, M.A., Kasemy, Z.A., El-Bazzar, A.N., Abd El-Fattah, M.A., Abdel Monsef, A.A., Kairallah, A.M., Raafet, H.M., Baza, G.M., Salah, A.G., Galab, W.S., Alkalash, S.H., Salama, A.A., Farag, N.A. and Bahbah, W.A. (2021). Development of LMS and Z Score Growth References for Egyptian Children from Birth Up to 5 Years. *Frontiers of Paediatrics;* **8**:598499. doi: 10.3389/fped.2020.598499

Ghazi, H.F., Isa, Z.M., Shah, S.A., Qader, M.A.A., Hasan, T.N. & Al-Abed, A. A.A. (2014). The relationship between the neighborhood safety and nutritional status of children in Baghdad City, Iraq. *Journal of Nutrition and Metabolism*:32–37. https://doi.org/10.1155/2014/686934

Gillian Dunn (2018). The impact of the Boko Haram insurgency in Northeast Nigeria on childhood wasting: a double-difference study. *Conflict and Health;* 12:6 DOI 10.1186/s13031-018-0136-2.

Gorstein, J. and Akré, J. (1988). The use of anthropometry to assess nutritional status. World Health Statistics Quaterly;**41(2)**:48-58. https://ifrcgo.org/ecv-toolkit/action/measuring-mid https://visionlaunch.com/difference malnutritionmalnourishment https://www.savethechildren.org/us/charity-stories/What-is-malnutrition-in-children

Jelliffe & Jelliffe (1969). The arm circumference as public health index of protein-calorie malnutrition of early childhood: current conclusions. *Journal of Tropical Pediatrics*; **15**: 253–260 (monograph 8).

Kandala - Ngianga-Bakwin, K., Tumwaka, P.M., Jacques, B.O.E., Kikhela, P.D. N. and Francesco, P.C. (2011). Malnutrition among children under the age of five in the Democratic Republic of Congo (DRC): does geographic location matter? *BMC Public Health;* **11**:261 http://www.biomedcentral.com/1471-2458/11/261.

Keller, U. (2019). Nutritional Laboratory Markers in Malnutrition. *Journal of Clinical Medicine*; ***8*(6)**:775. https://doi.org/10.3390/jcm8060775.

Lakshmi, M. and Sreenivas, S.K. and Pavitra, N.A. and Sudheendra, N. (2016). Study of biochemical and nutritional indicators in severe acute malnutrition: A prospective observational study. *The Indian Journal of Child Health;* **3**:314-316.

Mahak Arora **(**2019). Malnutrition in Children: Causes, Symptoms & Remedies. FirstCry Parenting.

Matarese, L.E., Steiger, E., Seidner, D.L. and Richmond, B. (2002). Body composition changes in cachectic patients receiving home parenteral nutrition. *Journal of Parenteral and Enteral Nutrition*; **26**; 366-371. DOI: 10.1177/0148607102026006366

Mishra, S.K., Bastola, S.P., Jha, B. (2009). Biochemical nutritional indicators in children with protein energy malnutrition attending Kanti Children Hospital, Kathmandu, Nepal. Kathmandu *University Medical Journal (KUMJ)*;**7(26)**:129-34. doi: 10.3126/kumj. v7i2.2705.

Mushtaq, M.U., Gull, S., Mushtaq, K., Abdullah, H.M., Khurshid, U., Shahid, U., Shad, M.A., Akram, J. (2012). Height, weight and BMI percentiles and nutritional status relative to the international growth references among Pakistani school-aged children. *BMC Pediatrics*; **12**:31. doi: 10.1186/1471-2431-12-31.

O Yaw Addo, John H Himes, and Babette S Zemel (2017). Reference ranges for mid upper arm circumference, upper arm muscle area, and upper arm fat area in US children and adolescents aged 1–20 years. *American Journal of Clinical Nutrition*; **105**:111–120.

Save the Children. 4 Causes of Malnutrition in Children.

Selimoglu, M.A., Kansu, A., Aydogdu, S., Sarioglu, A.A., Erdogan, S., Dalgic, B., Yuce, A. and Cullu Cokugras, F. (2021). Nutritional Support in Malnourished Children with Compromised Gastrointestinal Function: Utility of Peptide-Based Enteral Therapy. *Frontiers of Pediatrics;***9**: 610275. doi: 10.3389/fped.2021.610275.

Standards and reference (2010). *Annals of Tropical Paediatrics*;**30(1)**:1-17. doi: 10.1179/146532810X12637745451834.

Vijayaraghavan, K. (1987). Anthropometry for

assessment of nutritional status. *Indian Journal of Pediatrics;* **54:** 511–520. doi.org/10.1007/BF02749045.

Wagner, Z., Heft-Neal, S., Bhutta, Z.A., Black, R.E., Burke, M., & Bendavid, E. (2018). Armed conflict and child mortality in Africa: A geospatial analysis. *The Lancet*; **392 (10150)**: 857–865. doi.org/10.1016/S0140-6736(18)31437-5.

Walmsley, T.A and Fowler, R.T. (1981). *Clinical Chemistry; **27***:1782

www.motherchildnutrition.org/early-malnutrition-detection/detection-referral-children-with-acute-malnut.

Yubraj Acharya, Nancy Luke, Saman Naz, Dhiraj Sharma (2020). Exposure to conflict-related violence and nutritional status of children in Iraq. SSM - Population Health.

**Citation:** Musa, A.H., Abubakar, A.A., Fatima, Z.A., Mamza, Y.P., Umar, A.M. Evaluation of Nutritional Status using MUAC, BMI Percentile and Biochemical indicators among Internally Displaced Children attending IDPs Clinic within Maiduguri/ Jere, Borno State, Nigeria: An impact of the Boko Haram insurgency**. *Sokoto Journal of Medical Laboratory Science; 7(2):58 - 69*.** https://dx.doi.org/10.4314/sokjmls.v7i2.7