

## The Influence of Maternal Social Deprivation on Undernutrition in Children Under 5 Years in Northern and Southern Nigeria

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### ABSTRACT

**Background:** Undernutrition is a global public health issue that has far-reaching consequences on the health and development of individuals as well as economic and social impacts on communities and countries. Middle and low-income countries like Nigeria bear the highest burdens and Nigeria has an unequal distribution of this burden between the North and South. Maternal socioeconomic factors have been implicated in the burden of undernutrition. This study examines the regional differences in these factors as key determinants of the inequalities in the distribution of the burden of undernutrition.

**Subjects and Method:** We conducted a secondary data analysis of the child-recode data set from the cross-sectional 2018 Nigerian Demographic Health Survey (NDHS). NDHS participants were selected from all thirty-six states in Nigeria and the Federal Capital Territory (FCT) via a two-stage stratified cluster design. The child-recode data set includes 33,924 children aged 0 to 59 months. The dependent variables are weight for age, height for age, and weight for height. Independent variables of interest include the mother's education, mother's employment status, wealth quintile, and residence. Additional confounders included the age and sex of the child. Bivariate and multivariable logistic regression models were used to examine the association between region, maternal deprivation factors, and undernutrition.

**Results:** The unadjusted odds of being underweight (OR=2.80; 95% CI=2.53 to 3.10;  $p<0.001$ ), stunted (OR=3.09; 95% CI=2.84 to 3.37;  $p<0.001$ ), or wasted (OR=1.91; 95% CI=1.62 to 2.28;  $p<0.001$ ) were statistically significantly higher in children living in the North compared to children in the South. Across all 3 indices of undernutrition, the most consistent factors affecting childhood undernutrition were the mother's education (no formal education) and wealth quintile (poorest households). The regional differences in the prevalence of undernutrition persisted, after accounting for maternal deprivation factors that are more prevalent in the Northern parts of Nigeria.

**Conclusion:** Policies and programs to improve childhood undernutrition should be community-centered and focus on mitigating the inequities in important contributory factors. Further research to explore the role of childhood infections and environmental factors such as water, sanitation, and hygiene in the regional differences in undernutrition in Nigeria is needed.

**Keywords:** nutrition, social deprivation, Nigeria, children.

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## BACKGROUND

Undernutrition is one of the greatest global health problems. In 2014, 462 million people suffered from undernutrition globally (WHO, 2021). Undernutrition is energy and nutrient intake insufficient for the body's needs to sustain optimal health (Maleta, 2006). The indices of undernutrition include underweight (low weight for age), stunting (low height for age), and wasting (low weight for height). Undernutrition has far-reaching consequences on the health and development of individuals as well as economic and social impacts on communities and countries. It leads to increased risk of diseases, increased health care costs, reduced academic performance in children, reduced productivity in adulthood, and helps perpetuate the poverty cycle (Maleta, 2006; Agu et al., 2019).

Women, children, and adolescents are particularly susceptible to undernutrition. Globally, 149 million children under 5 years were stunted and 45 million were wasted in 2020 (WHO, 2021). Undernutrition is responsible for 45% of under-5 deaths with most of these deaths occurring in middle and low-income countries (WHO, 2021). In Nigeria, the most populous country in sub-Saharan Africa, the prevalence of stunting is 32%, making it the country with the second-highest burden of stunting globally (WHO, 2022). The rate of undernutrition is unevenly distributed in Nigeria with the highest rates of stunting in Northwest Nigeria at about 57% and the lowest in the Southeast at 18% (National Population Commission, 2019). The proportion of children who are wasted is almost two times as high in the Northeast (10%) and Northwest (9%) as in the other zones (4%–6%) (National Population Commission, 2019).

Many studies have also underscored the disparity in the prevalence of undernutrition between Nigeria's Northern and Southern regions (Adekanmbi, Uthman and

Mudasiru, 2013; Akombi et al., 2017; Amare et al., 2018; Agu et al., 2019; Wariri et al., 2020). Maternal deprivation of some crucial socioeconomic factors such as education, occupation, income, and rural/ urban residence may be associated with undernutrition (Agu et al., 2019; Akombi et al., 2019; Owoo, 2020). These factors determine the level of food security, access, and utilization of healthcare services, public health resources, and water and sanitation. Maternal education has been shown by studies to improve the educational attainment, nutrition, and survival of their children (Gibson, 2001; Imoet al., 2017). Educated mothers tend to have better employment opportunities and therefore, higher socioeconomic class which in turn improves the mother's access to health information and awareness of healthy behaviors (Igbokwe et al., 2017). Therefore, maternal education is a key determinant of child health. Studies have also shown that poverty is a root cause of other indirect measures such as limited access to food and education (Gopalan, 2000). Rurality may also impact undernutrition through limited availability of and access to healthy foods because of poor infrastructure such as poor road networks. This is supported by several studies that have shown that undernutrition tends to be concentrated in rural areas (Oninla et al., 2007; Senbanjo et al., 2013; Ayogu et al., 2018). However, none of these studies to our knowledge have examined the regional differences in these factors as key determinants of the inequalities in the distribution of the burden of undernutrition.

This study aims to (1) assess the impact of geographical region on the prevalence of undernutrition in Nigeria, (2) examine the association between maternal social deprivation factors and undernutrition in Northern and Southern Nigeria, and (3) determine if there are regional differences in maternal social deprivation that may explain the

differences in the prevalence of undernutrition in Nigeria.

## SUBJECTS AND METHOD

### 1. Study Design

We analyzed the cross-sectional 2018 Nigerian Demographic and Health Survey (NDHS) data. The NDHS is a nationally representative household survey, in which households were interviewed by trained interviewers. Respondents were selected from all thirty-six states in Nigeria and the Federal Capital Territory (FCT) via a two-stage stratified cluster design. This survey was carried out in 1,389 clusters made up of 40,427 households. Data collected include indicators of fertility, reproductive health, maternal and child health, mortality, nutrition, and self-reported health behaviors among adults (National Population Commission, 2019).

### 2. Population and Sample

We used the child-recode data set of the NDHS, which includes 33,924 children aged 0 to 59 months as its unit of analysis. The child recode data set includes information on the child, the mother's pregnancy with the index child, postnatal care, as well as immunization, and health indices. Maternal information such as gender norms, demographic information, and anthropometric measures for each child are also included. Children between 0 and 59 months were chosen because they are most at risk of undernutrition and its attendant consequences. Children who were dead at the time of the survey were excluded ( $n=3,211$ ) as were children with missing data on the variables of interest (weight for age, height for age, weight for height, child's age in months, sex of the child, mother's education, mother's employment, household wealth quintile, place of residence;  $n=19,243$ ). The final analytic sample size was 11,470.

### 3. Study Variables

The dependent variable was personal hygiene. The independent variable was the role of the caretaker. The outcome variables were weight for age, height for age, and weight for height. Predictor variables include the mother's education, mother's employment status, wealth quintile, and residence. The confounders adjusted for were the age and sex of the child.

The outcome variables were weight for age dichotomized into underweight and not underweight, height for age dichotomized into stunted and not stunted, and weight for height dichotomized into wasted and not wasted. The variables were dichotomized using z-scores, which measure the number of standard deviations above or below the mean. Those children whose z-scores put them 2 or more standard deviations below the mean for age or height were classified as underweight, stunted, or wasted (Habyarimana et al., 2016; World Health Organization (WHO), 2022). Predictor variables are measures of maternal social deprivation which include: 1) Mother's education was operationalized as "mother's highest education level" = No education, primary, secondary, or higher; 2) Mother's employment status was operationalized as "respondent worked in the last 12 months?" = No, In the past year, currently working, and have a job but on leave in the past 7 days. This was recoded as 'Not employed' for those who answered 'No' or 'In the past year' and as 'Employed' for those mothers who responded either 'currently working' or 'have a job but on leave in the past 7 days'; 3) Wealth quintile = poorest, poorer, middle, richer, and richest; 4) Residence (rural or urban residence). The confounders adjusted for were the age and sex of the child.

**4. Operational Definition of Variables**  
**Weight for age** was classified in two categories, underweight and not underweight,

based on the World Health Organization Child Growth Standards. Underweight children were those whose weight, measured in kilograms, was two or more standard deviations below the mean for their age in months. Not underweight were children whose weight in kilograms was not two or more standard deviations below the mean for their age in months.

**Height for age** was measured in two categories, stunted and not stunted, based on the World Health Organization Child Growth Standards. Stunted children were those whose height in centimeters was two standard deviations below the mean for their age in months while not stunted children were those who were not classified as stunted.

**Weight for height** was classified as wasted or not wasted using the World Health Organization Child Growth Standards. If a child was two or more standard deviations below the mean weight in kilograms for their height in centimeters they were classified as wasted while children who did not fit this classification of wasted were categorized as not wasted.

**The mother's education** was operationalized as the highest level of education attained for the mother. It included four categories: no education, primary school (ages 6–12), secondary school (ages 13–18), or higher education (over age 18).

**The mother's employment status** was classified as not employed or employed. Those not employed indicated not working in the last 12 months or working in the past year but not currently. Those employed indicated currently working or currently employed but on leave in the last 7 days.

**Wealth quintile** was measured at the household level in five categories. The household characteristics, assets, and access to goods and services put them into the poorest 20% of households, poorer (next 20% of households), middle (next 20% of house-

holds), richer (next 20% of households), and richest 20% of households.

**Residence** was classified as urban or rural based on urban areas having a minimum of 20,000 population along with legal and administrative criteria (Ofam, 2012).

**Age of the child** was the age of the child in months dichotomized into less than 24 months old and 24 months old or older.

**Sex of the child** was classified as male or female.

## 5. Study Instruments

Children's heights were recorded using stadiometers and their weights were measured using standard age-appropriate weighing scales respectively. The other variables were collected by questionnaire.

## 6. Data analysis

Data analysis was conducted in R version 4.0.3. We used frequencies, percentages, medians, and interquartile ranges to report the characteristics of the study population. We explored differences in these characteristics by region (North vs. South) using chi-squared tests. We used logistic regression to compute odds ratios (OR) to examine the association between each index of undernutrition and geographical region adjusting for the age and sex of the child. Two multivariable logistic models were then used to determine the association between maternal social deprivation factors and undernutrition with and without the region (North/South). We started with a model including only age and sex as predictors of undernutrition, then added maternal factors, and finally added North/South region. We compared the AIC for each model and selected the final model for each outcome based on lowest AIC. The final models all met the assumptions of independence, multicollinearity, and no unusual influence. However, the assumption of linearity was initially violated leading us to categorize the age variable into two groups:

a) Less than 24 months, and b) 24 months or more.

## 7. Research Ethics

The original study's survey procedure and instruments used in data collection received ethical approval from the National Ethics Committee of the Federal Ministry of Health of Nigeria and the Ethics Committee of the Opinion Research Corporation Macro International, Inc. (ORC Macro Inc., Calverton, MD, USA).

## RESULTS

### 1. Sample Characteristics

The median age of children in the study was 28 months (Table 1). Nearly half (49.3%) of the children were female while 50.7% were male. A majority, 6855 (59.8%) of the children, lived in the North and 4615 (40.2%) lived in the South. A larger number of participants resided in rural (61.1%) compared with urban areas (37.1%). Many of the mothers of the children in the study had no formal education (38.2%) and 16.8% had only a primary level of education. 20.1% of the children were from homes in the poorer quintile of wealth and 19.9% were from the poorest households. Of all the children sampled, 21.9% were underweight, 36% were stunted, and 6.8% were wasted. The prevalence of underweight, stunting, and wasting was higher in the North than in the South (Table 1).

### 2. Multivariable analysis

The unadjusted odds of being underweight (OR=2.80; 95%CI=2.53 to 3.10;  $p<0.001$ ), stunted (OR=3.09; 95% CI=2.84 to 3.37;  $p<0.001$ ), or wasted (OR=1.91; 95%CI=1.62–2.28;  $p<0.001$ ) were significantly higher in children living in the North compared to children in the South. Table 2 shows the effects of region and measures of maternal social deprivation on indices of undernutrition after adjusting for age and sex of the child.

Children living in the North had 38% (aOR=1.38; 95% CI 1.21 to 1.57;  $p<0.001$ ), 66% (aOR=1.66; 95% CI=1.49 to 1.85;  $p<0.001$ ), and 30% (aOR=1.30; 95% CI=1.06 to 1.61;  $p=0.017$ ) higher odds of being underweight, stunted, and wasted rather than appropriate height/ weight respectively compared to children in the South after adjusting for child age and sex.

Place of residence had no statistically significant relationship with undernutrition. Factors that increased the odds of being underweight rather than appropriate height/ weight were having a mother without formal education (aOR=2.81; 95% CI=2.18 to 3.66;  $p<0.001$ ), or with primary (aOR=1.55; 95% CI=1.19 to 2.04;  $p<0.001$ ) or secondary education (aOR=1.33; 95% CI 1.04 to 1.70;  $p=0.022$ ) only; unemployed mother (aOR=1.11; 95% CI=1.00 to 1.23;  $p=0.040$ ), and being from a poorest (aOR=2.09; 95% CI=1.68 to 2.62;  $p<0.001$ ), poorer (aOR=1.70; 95% CI=1.37 to 2.10;  $p<0.001$ ), or middle (aOR=1.51; 95% CI=1.24 to 1.86;  $p<0.001$ ) wealth quintile household compared to a high wealth quintile household.

Factors that increased the odds of being stunted rather than appropriate height/ weight were having a mother without formal education (aOR=3.20; 95% CI=2.58 to 4.00;  $p<0.001$ ), or with primary (aOR=2.31; 95% CI=1.85 to 2.89;  $p<0.001$ ) or secondary education (aOR=1.64; 95% CI=1.34 to 2.02;  $p<0.001$ ) only compared to secondary education; and being from a poorest (aOR=2.46; 95% CI=2.03 to 2.97;  $p<0.001$ ), poorer (aOR=2.17; 95% CI=1.81 to 2.60;  $p<0.001$ ), middle (aOR=1.83; 95% CI=1.55 to 2.16;  $p<0.001$ ), or richer (aOR=1.32; 95% CI=1.12 to 1.56;  $p=0.001$ ) wealth quintile household compared to a high wealth quintile household.

Children who were from the poorest wealth quintile households had 76% higher odds of being wasted than being appropriate

height/weight than children from the richest households (aOR=1.76; 95% CI=1.24 to 2.51; p=0.002). Children whose mothers had no formal education had 53% (aOR=1.53; 95%

CI=1.05 to 2.26; p=0.031) higher odds of being wasted than being appropriate height/weight compared to children whose mothers had higher education.

**Table 1: Demographic and nutrition-related characteristics of 11,470 children by region of Nigeria (NDHS, 2018)**

Variables	South (N=4,615)		North (N=6,855)		Total (N=11,470)	
	<b>Age of child in months</b> Median (IQR)	28.0	29.0	27.0	30.0	28.0
<b>Sex of child</b>						
Female	2241	48.6	3413	49.8	5654	49.3
Male	2374	51.4	3442	50.2	5816	50.7
<b>Rural or urban residence</b>						
Urban	2658	57.6	1801	26.3	4459	38.9
Rural	1957	42.4	5054	73.7	7011	61.1
<b>Level of education of mother</b>						
No education	281	6.1	4105	59.9	4386	38.2
Primary	907	19.7	1023	14.9	1930	16.8
Secondary	2756	59.7	1349	19.7	4105	35.8
Higher education	671	14.5	378	5.5	1049	9.1
<b>Number of persons in the household</b> Median (IQR)	5.00	3.00	7.00	5.00	6.00	4.00
<b>Number of children under 5 in the household</b> Median (IQR)	2.00	1.00	2.00	1.00	2.00	2.00
<b>Household wealth quintile</b>						
Richest	1376	29.8	560	8.2	1936	16.9
Richer	1470	31.9	946	13.8	2416	21.1
Middle	1090	23.6	1441	21.0	2531	22.1
Poorer	486	10.5	1820	26.6	2306	20.1
Poorest	193	4.2	2088	30.5	2281	19.9
<b>Mother's employment status</b>						
Not employed	819	17.7	2661	38.8	3480	30.3
Employed	3796	82.3	4194	61.2	7990	69.7
<b>Child's weight for age</b>						
Not underweight	4044	87.6	4915	71.7	8959	78.1
Underweight	571	12.4	1940	28.3	2511	21.9
<b>Child's height for age</b>						
Not stunted	3625	78.5	3715	54.2	7340	64.0
Stunted	990	21.5	3140	45.8	4130	36.0
<b>Child's weight for height</b>						
Not wasted	4406	95.5	6286	91.7	10692	93.2
Wasted	209	4.5	569	8.3	778	6.8

**Table 2. Maternal social deprivation and undernutrition in children in North and South Nigeria (NDHS 2018, n =11,470)**

Characteristic	Wasting		Stunting		Underweight	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
<b>Region</b>						
North	1.30 (1.06–1.61)	0.017	1.66 (1.49–1.85)	< 0.001	1.38 (1.21–1.57)	<0.001
South	1		1		1	
<b>Residence</b>						
Rural	1.05 (0.86–1.27)	0.556	1.02 (0.92–1.12)	0.850	1.05 (0.93–1.18)	0.437
Urban	1		1		1	

Characteristic	Wasting		Stunting		Underweight	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
<b>Education</b>						
No Education	1.53 (1.05–2.26)	0.031	3.20 (2.58–4.00)	< 0.001	2.81 (2.18–3.66)	< 0.001
Primary	0.95 (0.64–1.43)	0.843	2.31 (1.85–2.89)	< 0.001	1.55 (1.19–2.04)	< 0.001
Secondary	1.02 (0.72–1.47)	0.858	1.64 (1.34–2.02)	< 0.001	1.33 (1.04–1.70)	0.022
Higher	1		1		1	
<b>Wealth Quintile</b>						
Poorest	1.76 (1.24–2.51)	0.002	2.46 (2.03–2.97)	< 0.001	2.09 (1.68–2.62)	< 0.001
Poorer	1.33 (0.95–1.89)	0.107	2.17 (1.81–2.60)	< 0.001	1.70 (1.37–2.10)	< 0.001
Middle	1.37 (1.00–1.90)	0.051	1.83 (1.55–2.16)	< 0.001	1.51 (1.24–1.86)	< 0.001
Richer	1.17 (0.86–1.59)	0.379	1.32 (1.12–1.56)	0.001	1.19 (0.98–1.46)	0.081
Richest	1		1		1	
<b>Employment</b>						
Not Employed	0.91 (0.77–1.07)	0.248	1.02 (0.93–1.11)	0.783	1.11 (1.00–1.23)	0.040
Employed	1		1		1	

## DISCUSSION

This study examines the effects of maternal social deprivation and living in the North vs. living in the South on undernutrition in children under 5 years in Nigeria. Controlling for common factors associated with undernutrition, our study shows evidence that living in the North increases a child's odds of being undernourished compared to living in the South. We also confirmed that maternal social deprivation is associated with undernutrition in children. All the indices of maternal deprivation except rural residence significantly increased the odds that a child is undernourished. Across all 3 indices of undernutrition, the most consistent factors affecting childhood undernutrition were the mother's education (no formal education) and wealth quintile (poorest households). There were lower odds of undernutrition with each higher level of education. Children whose mothers had a lower level of education were more likely to be undernourished than children of mothers with a higher level of education. The odds of being undernourished also increased as the wealth quintile decreased.

There are disparities in the nutritional status of children across Nigeria. These disparities affect mostly those who are from the

poorest households and the uneducated and are exacerbated by geography. The factors we accounted for, poverty, lack of education, and unemployment, were more prevalent among mothers in the North compared to the South (Gayawan et al., 2017). Parents who are poor may not be able to afford nutritious food for their children. Poverty may lead to undernutrition through the lack of adequate food, exposure to infections, and poor access to health care services (Nandy et al., 2005; Manyong et al., 2021). Likewise, uneducated parents may not be able to make informed decisions regarding the provision of nutritious foods from available food options. Also, parents who are educated are more likely to be gainfully employed and financially empowered (Igbokwe et al., 2017). Educated parents are also more likely to have access to information to make healthy food decisions for their children and allocate the household income and food resources to favor children (Igbokwe et al., 2017).

The higher burden of undernutrition in the North compared to the South may also be due to the growing security issues in the northern part of Nigeria which has led to an economic decline and increase in rates of poverty (World Bank Group, 2015) Cultural

practices and beliefs may also have a bearing on the burden of undernutrition. For instance, some homes may have intra-familial food allocation practices that favor adults over children, and this may be rooted in culture (Mock et al., 1994). These practices may prohibit children from eating some foods which they ideally require to have a balanced diet (Oninla et al., 2007). Cultural practices may also determine the timing of, and type of foods introduced at weaning (Agu et al., 2019).

Findings from the present study are consistent with other studies that have found associations between maternal deprivation and undernutrition (Fotso and Kuate-Defo, 2005; Senbanjo et al., 2013; Akombi et al., 2017; Agu et al., 2019; Hasan et al., 2020). However, unlike some other studies, this present study found no association between rural residence and undernutrition (Oninla et al., 2007; Senbanjo et al., 2013; Imam et al., 2021). The finding of increased odds of undernutrition in children between 2 to 5 years compared to children less than 2 years is unexpected as several studies have shown and focused on the higher burden in those less than 2 years (Akombi et al., 2019; Imam et al., 2021). However, Oninla et al. (2007) also demonstrated an increased risk of undernutrition with increasing age in their study (Oninla et al., 2007).

Another study conducted in Bangladesh also found geographical disparities in undernutrition and in the distribution of maternal deprivation factors like poor education and poverty (Hasan et al., 2020). This highlights the social divide between the rich and the poor and how this may have adverse consequences on the health of children. Some studies have also found differences in odds of undernutrition by age groups, with children between two and five years more likely to be undernourished than those less than 2 years (Akombi et al., 2019; Imam et

al., 2021). This may be explained by a shift in focus and attention from an older child by a mother, after the birth of a younger sibling, leaving the older child relatively neglected (Oninla et al., 2007). Given the higher social deprivation in the North in the factors we examined, and the findings from Bangladesh, perhaps additional related social and economic factors not measured are contributing to the geographic differences we identified.

The findings in this study underscore the importance of policies aimed at reducing undernutrition to target mothers as well as children. Such policies should aim at improving maternal deprivation factors as well as empowering women financially and should focus on the most vulnerable groups such as households with low income and low educational achievement. There is a need to close the economic gap between regions in Nigeria. This can be done by redistributing resources and spreading development to the poorest areas. Infrastructural development and reduced taxation on industries located in these areas may encourage the migration of other companies to these areas, which will help improve the economic outlook of these areas and empower their residents. It is also imperative that programs to reduce undernutrition are tailored to regions rather than a one-size-fits-all national program that may not take into cognizance the peculiarities of the region in which it is being implemented.

The implications for practice are those of planning and implementation of programs targeted at undernutrition. These programs should consider maternal literacy and family income in their design. Food programs should also teach in an easily understandable manner, how to access the most nutritious foods on a limited budget. It is also important to provide integrated health care with collaborations between clinical and public health professionals. Diagnosis of malnutrition in

primary care facilities where growth monitoring first highlights this issue, and subsequent treatment should be followed by referral to appropriate community services. This is to ensure that both children and their parents receive necessary aid to mitigate risk and subsequent relapse. Since most children in Nigeria begin schooling at age of 2–3 years, school-based food programs may be utilized to mitigate undernutrition from this age with success.

There are a few drawbacks to this study. First, the cross-sectional nature of this study does not permit making a causal inference. Secondly, wealth was not measured directly but was estimated using a proxy. This is because wealth is often difficult to measure in developing countries like Nigeria due to improper documentation of income and expenditure. Therefore, the use of a proxy measure like assets is often sufficient to estimate wealth.

Despite these limitations, the study has some notable strengths including the large sample size which would increase the power of the study and enable the generalization of the study results to the entire population. Also, this study is useful in highlighting the huge disparities in maternal factors between regions and identifying the most important factors affecting childhood undernutrition.

In conclusion, this study confirms the role of maternal deprivation in childhood undernutrition. It also confirms that there are significant differences in undernutrition by geography, even after accounting for maternal deprivation factors that are more prevalent in the Northern parts of Nigeria. Policies and programs targeted toward the improvement of childhood undernutrition should be community-centered and focus on mitigating important factors. Investing in maternal education, employment, and financial empowerment may be instrumental in reducing the rates of childhood undernutri-

tion in areas deemed most at risk. The government should also be encouraged to tighten security in the North which will allow economic improvement and alleviate poverty. Programs currently being implemented in the North to address undernutrition should be evaluated to measure impact as well as to determine possible areas of modification and improvement. Programs that have been evaluated and found effective in reducing the burden of undernutrition in the South may be adapted for implementation in the North. Future directions for research include assessing the role of environmental factors like inadequate water and sanitation, diarrhea, and other infections in childhood in the regional differences in undernutrition in Nigeria. Differences in these factors between North and South may account for the higher rates of undernutrition among children in the North. This is necessary for the focusing of relevant interventions and policies according to the region of need.

#### **AUTHOR CONTRIBUTION**

NJO conceptualized the study, conducted the literature review and analyses, wrote the first draft of the full manuscript, and revised multiple drafts. JKH provided guidance during the initial stages of data management and analysis and revised multiple full drafts for clarity and accuracy, especially in the data management and analysis sections.

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#### **CONFLICT OF INTEREST**

The authors declare that the study was conducted in the absence of any commercial

or financial relationships that could be construed as a potential conflict of interest.

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