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Bayesian Space-Time Variations in Different Forms of Malnutrition Among Children Under-Five in Nigeria: A Spatiotemporal Analysis

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Abstract: ***Malnutrition among children remains a critical public health issue in Africa, particularly contributing to high infant mortality in Nigeria.***

This study aimed to analyze spatiotemporal variations in malnutrition among children under-five in Nigeria, utilizing data from the Nigeria Demographic and Health Survey (DHS) from 2008 to 2018.

A Bayesian space-time approach with the Gaussian intrinsic conditional autoregressive (iCAR) model, implemented through Integrated Nested Laplace Approximation (INLA), was employed to assess these variations.

The results indicated that stunting and underweight prevalence increased from 2008 to 2013 and decreased from 2013 to 2018, while wasting prevalence consistently rose from 2008 to 2018. Wasting also increased with age across different geopolitical zones. Undernutrition was more prevalent in male children, and significant regional disparities were observed. In 2018, the Southeast had the lowest stunting rate (19.0%), while the Northwest had the highest (57.6%). Wasting was most prevalent in the Northeast (9.6%) and least in the Southwest (4.3%). The Northwest also had the highest underweight prevalence (36.0%), with the Southeast reporting the lowest (10.9%). Key risk factors for undernutrition included gender, child's age, mother's age, mother's body mass index, education, wealth index, and religion.

The study concluded that Nigeria is unlikely to achieve a 40% reduction in stunting by 2025 but may meet the 5% reduction target in wasting set by the World Health Organization. The findings underscore the need for effective interventions, including nutritional and supplementary food programs, to improve the health of malnourished children in Nigeria.

Keywords: ***Undernutrition, Stunting, Underweight, wasting, malnutrition.***

Introduction

Malnutrition in children encompasses deficiencies, excesses, or imbalances in a child's intake of energy and nutrients. It includes two broad groups: undernutrition (stunting, wasting, and underweight) and over-nutrition (overweight, obesity, and micronutrient over-nutrition). Stunting, the most prevalent form of undernutrition, results from prolonged inadequate nutrition. According to WHO standards, children are stunted if their height-for-age z-score (HAZ) is less than -2 SD of the median. Globally, malnutrition is a significant issue, with 155 million children under 5 stunted, 45 million wasted, and 87.5 million underweight as of recent reports. In Sub-Saharan Africa, countries like Nigeria and Burundi have high malnutrition rates. Despite efforts like school feeding programs and community-based management of acute malnutrition, challenges remain due to high costs and lack of local production. World Health Organization (2021).

According to (UNICEF (2020) Malnutrition remains a significant public health concern, particularly among children under the age of five, with severe consequences for their health and development. Nigeria, one of the most populous countries in Africa, faces a substantial burden of both acute and chronic malnutrition. However, spatial and temporal patterns of malnutrition remain poorly understood, hindering effective intervention.

Bayesian space-time analysis allows for the identification of high-risk areas for malnutrition at national and sub-national levels. Understanding these spatial patterns can help policymakers prioritize resource allocation and interventions, ensuring that limited resources are directed to areas with the greatest need. Additionally, examining temporal dynamics allows for the identification of trends influenced by factors such as seasonal variations, socioeconomic changes, or interventions. This enables the design of time-specific interventions and optimization of resources. A comprehensive study on Bayesian space-time variations in malnutrition can strengthen Nigeria's health systems by improving preparedness, training healthcare workers, ensuring adequate supply chains for therapeutic food, and enhancing monitoring and surveillance systems (Waller and Gotway 2004).

Malnutrition among under-five children in Nigeria is a critical public health issue. Despite various studies, there is a significant gap in understanding the spatial and temporal variations using Bayesian space-time analysis. This study addresses this gap by investigating how stunting, wasting, and underweight are distributed across Nigeria's regions. Understanding these spatial patterns will help identify high-risk areas for targeted interventions. Additionally, examining temporal patterns can reveal trends influenced by seasonal variations, policy interventions, or socioeconomic changes (Blangiardo, M., & Cameletti, M. 2015). By identifying risk factors such as socioeconomic indicators, healthcare access, dietary patterns, and environmental factors, the research aims to inform targeted interventions and policy recommendations. Addressing these problems will provide valuable insights for policymakers and public health practitioners, guiding strategies to reduce malnutrition and improve health outcomes for under-five children in Nigeria. Therefore, this study examines spatio-temporal variations in different forms of malnutrition among under-five children in Nigeria, focusing on undernutrition with the use of Bayesian space-time approach and the Gaussian intrinsic conditional autoregressive (iCAR) model through Integrated Nested Laplace Approximation (INLA) (Rue et al. (2009).

Methodology

Data

The data for this research were derived from three waves of the Nigerian Demographic and Health Survey (DHS) which covered the entire population of Nigeria. The DHS gave approval to use the 2008,2013 and 2018 Survey Datasets for the research paper. These surveys were sponsored by the Federal Government of Nigeria, the United States Agency for International Development (USAID), the Global Fund, the Bill and Melinda Gates Foundation (BMGF), the United Nations Population Fund (UNFPA), and the World Health Organization (WHO). The DHS provides cross-sectional information on demographic and health indicators and was conducted in Nigeria in 2008, 2013, and 2018 by the National Population Commission of Nigeria. Thes surveys were conducted every five years. The data include information from 17,494 children aged 0-59 months in 2008, 22,689 children aged 0-59 months in 2013, and 10,334 children aged 0-59 months in 2018. The response variables considered in this study are forms of malnutrition: stunting, wasting, and underweight. The demographic and socio-economic factors associated with these forms of malnutrition include child age, gender, birth order, mother's age, mother's education, mother's BMI, wealth index, religion, place of residence, state, and region. Figure1 shows the administrative setting of Nigeria. Map of Nigeria. Source: (Gayawan et al., 2014).

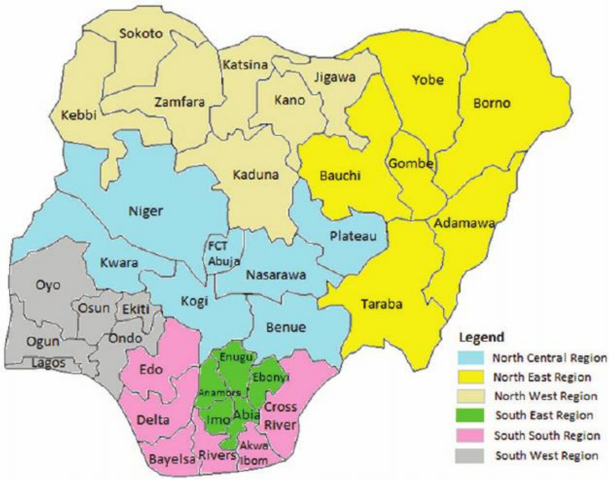


Fig.1 illustrates the administrative setting of Nigeria according to the Zones.

Bayesian Space-time Modelling.

This study utilizes Bayesian spatio-temporal modeling with the intrinsic conditional autoregressive (iCAR) model to account for both spatial and temporal dependencies in malnutrition data by capturing spatial dependencies between neighboring regions, assuming that data from a particular location depend on its own and neighboring locations' characteristics over time. A trivariate hierarchical binomial model is used to analyze stunting, wasting, and underweight in children. Bayesian modeling combines prior knowledge with observed data to estimate the posterior distribution of parameters, allowing for uncertainty quantification and flexible modeling of complex relationships.

The model's structure is as follows:

$$Y_{1ij} \sim \text{binomial}\ (n_{1ij}, \boldsymbol{\varpi}_{1ij})$$
$$Y_{2ij} \sim \text{binomial}\ (n_{2ij}, \boldsymbol{\varpi}_{2ij})$$
$$Y_{3ij} \sim \text{binomial}(n_{3ij}\ , \boldsymbol{\varpi}_{3ij})$$

Where Y_{1ij} , Y_{2ij} and Y_{3ij} represent the number of children with stunting, wasting and underweight respectively in state i in period j. The parameter $n_{1ij}, n_{2ij}, n_{3ij}$ denote the total number of children.

$\boldsymbol{\varpi}_{1ij}, \boldsymbol{\varpi}_{2ij}, \boldsymbol{\varpi}_{3ij}$ represent the probabilities of malnutrition.

The logit of the prevalence for each outcome is modelled as:

$$logit(\pi_{1ij}) = \alpha_1 + \phi_{1i} + \gamma_{1j} + \vartheta_{1ij}$$

$$logit(\pi_{2ij}) = \alpha_2 + \phi_{2i} + \gamma_{2j} + \vartheta_{2ij}$$

$$logit(\pi_{3ij}) = \alpha_3 + \phi_{3i} + \gamma_{3j} + \vartheta_{3ij}$$

$$\vartheta \sim Normal\ (0, \sigma^2\vartheta),\ i = 1, \ldots, I\ and\ j = 1, \ldots, J$$

$$\phi \sim iCAR\ normal\ (0, \sigma^2\ \phi),\ \text{for}\ i = 1, \ \ldots, I$$

$$\gamma = (\gamma_1, \gamma_2 \ldots, \gamma_J) \sim iCAR\ normal\ (0, \sigma^2\gamma)$$

where α_k is intercept for each nutritional outcome and $\alpha = 1$. ϕ_{ki} is the spatial random effects which follows the Gaussian (iCAR) model. The spatially correlated random effect of the i th state (ϕ_i) is based on the sum of its weighted neighborhood values. Adjacency matrix of common boundaries (neighbors) of a given state was used for modelling this parameter, the term (γ_k) is a structured temporal effect, which is to follow the Gaussian (iCAR) model and also follow a second order random walk. ϑ_{kij} is a space-time interaction effect such that the ϑ parameter vector follows a Gaussian distribution with a precision matrix given by $\tau\vartheta R\vartheta$ where $\tau\vartheta$ is an unknown scalar, while $R\vartheta$ is a structured matrix that specifies the type of temporal and spatial dependence between the elements of ϑ.

Parameter estimation was performed using the Integrated Nested Laplace Approximation (INLA) technique, which approximates the posterior distribution by decomposing it into the marginal likelihood and conditional prior. This method, implemented in the R-INLA package, efficiently computes the posterior distribution using adaptive Gaussian quadrature and exploits the latent Gaussian structure. Inverse gamma distributions were adopted for the variance parameters suggested by Wakefield et al. (1994) to ensure model identifiability and robustness.

Exceedance Probability in Bayesian Spatio-Temporal Modelling

The relative risk of malnutrition (stunting, wasting, or underweight) in different states over time was accessed by calculating Exceedance Probabilities. The exceedance probability is the probability that the relative risk of a state i surpasses a specified threshold value c. This comparison is particularly useful for benchmarking against the World Health Organization (WHO) thresholds for malnutrition.

Let θ_{ij} denote the prevalence of stunting, wasting, or underweight in state i in period j. The threshold value c represents the WHO benchmark for these forms of malnutrition. The exceedance probability, $P(\theta_{ij} > c)$, indicates the likelihood that the malnutrition prevalence in a given state exceeds this threshold.

$P(\theta_{ij} > c) = 1 - P(\theta_{ij} \leq c)$

The exceedance probability decision rule:

In area with exceedance probability close to 1, it is very likely that the relative risk exceeds the threshold.

When exceedance probability is close to 0 it is very unlikely that the relative risk exceeds the threshold.

Results and Discussions

Descriptive Statistics of Temporal Changes in Stunting among Children Under -Five in Nigeria (2008,2013 and 2018)

Table 1 showed the prevalence of stunting among children under five years old in Nigeria. It showed a gradual decline over the study period from 2008 to 2018. This decline, however, was relatively modest in its pace. In 2008, the prevalence of stunting was 40.6%. This figure represents a significant burden of stunting among children under five at the beginning of the study period. In 2013, the prevalence decreased to 36.6%, indicating a reduction in stunting rates over the five-year span, while the prevalence saw a slight further decline to 36.5% in 2018. Although this marks a continued decrease, the reduction from 2013 to 2018 was minimal. The data reveals that different age groups experienced varying rates of stunting over the years. In 2008, children aged 12-35 months had the highest prevalence of stunting at 49.6%. Children aged 36-60 months followed with a prevalence of 44.5%. Children aged 0-11 months had the lowest prevalence at 26.0%. The results in 2013 showed that children aged 12-35 months continued to have the highest prevalence of stunting at 41.3%. Children aged 36-60 months had a prevalence of 40.8%. Children aged 0-11 months had a reduced prevalence of 19.5%. In 2018, children aged 12-35 months had a prevalence of 42.6%, maintaining the highest rate among the age groups. Children aged 36-60 months had a prevalence of 39.1%. Children aged 0-11 months had a prevalence of 20.3%. The data showed a general decline in stunting prevalence from 2008 to 2018. However, the pace of this decline slowed significantly in the later years, indicating that while progress was made, it was gradual.

The highest prevalence of stunting was consistently observed in children aged 12-35 months across all waves, indicating that this age group was the most impacted. The prevalence of stunting in children aged 0-11 months remained relatively lower and stable over the period. The prevalence of stunting in children aged 12-35 months decreased from 49.6% in 2008 to 42.6% in 2018. For children aged 36-60 months, the prevalence decreased from 44.5% in 2008 to 39.1% in 2018. In children aged 0-11 months, the prevalence decreased slightly from 26.0% in 2008 to 20.3% in 2018.

The temporal changes in stunting prevalence from 2008 to 2018 indicate a positive trend toward reducing stunting among under-five children in Nigeria. Despite the overall decline, the burden of stunting remained highest in the 12-35 months age group, highlighting a need for continued focus on this demographic to achieve more significant improvements in child nutrition and health. These findings align with studies that have shown children aged 24-59 months had the highest prevalence of stunting, with 53.3% (95% confidence interval: 52.0-54.6%) (Ezeh & Abir, 2021). Gayawan et al. (2019) revealed that the levels of stunting and underweight deteriorate as the children advance in age. There was more prevalence of undernutrition in male children compared with female children. This finding agrees with studies that the percentage of stunting, wasting, and underweight were considerably greater in male children compared to female children (Adesuyi & Kioko, 2021). The results also showed that the Northwest geopolitical zone had the highest prevalence of undernutrition. This study justifies the results of Nwosu and Ataguba (2020), which found that the Northwest geopolitical zone accounted for the highest proportion of stunting and wasting in 2013 and 2018, while the Southeast and South-South had the lowest proportions of stunting in 2013 and 2018, respectively. Kebbi state is a hotspot area for undernutrition. These findings agree with studies that have shown the percentage of children with stunting ranged from 11.5% in Anambra state to as high as 60% in Kebbi State (Adekanmbi et al., 2013). Biological factors (such as gender, child's age, mother's age, and mother's body mass index) and socioeconomic factors (such as education, wealth index, and religion) have been identified as significant risk factors for undernutrition in Nigeria.

Temporal Changes in Underweight among Children Under -Five in Nigeria from 2008,2013 to 2018

Table 2 showed the prevalence of underweight among children under five in Nigeria. It exhibited significant fluctuations over the study period from 2008 to 2018. In 2008, the prevalence was recorded at 23.2%. This figure increased to 28.8% in 2013, indicating a rising trend. However, a positive shift occurred by 2018, with the prevalence decreasing to 21.24%. The prevalence of underweight increased from 18.0% in 2008 to 21.9% in 2013, but then slightly decreased to 18.3% in 2018 among children aged 0-11 months. For children aged 12-35 months, prevalence increased from 26.9% in 2008 to 30.2% in 2013, and surged to 42.6% by 2018, showing a significant rise over the decade. Children aged 36-60 months experienced prevalence increased from 24.8% in 2008 to 26.7% in 2013, but then decreased to 20.3% in 2018. The data reveals a trend of increasing underweight prevalence in children aged 12-35 months from 2008 to 2018.

In contrast, there was a slight decrease in prevalence among children aged 0-11 months and 36-60 months by 2018 compared to 2013. These temporal changes highlight the need for targeted interventions, particularly for the age groups showing rising trends in underweight prevalence, to address the nutritional and health challenges faced by children in Nigeria. The findings of Oladunni and Olaniyan (2018) similarly reported fluctuations in underweight prevalence, noting that children aged 12-35 months experienced a rise in underweight rates over the years. They highlighted socioeconomic factors and inadequate dietary practices as contributing to these trends. Fagbamigbe et al. (2020) observed that underweight prevalence was particularly high among children aged 12-35 months, with significant variations observed over the study period. Their findings align with the need for age-specific interventions to address these nutritional challenges.

Temporal Trends in Wasting Prevalence among Children Under-Five in Nigeria from 2008,2013 to 2018

Table 3 shows the prevalence of wasting among children under five in Nigeria, which varied considerably over the study period from 2008 to 2018. In 2008, the prevalence of wasting was recorded at 13.9%. This figure increased to 18.4% in 2013, indicating a rise in wasting rates. However, significant progress was made by 2018, with the prevalence of wasting decreasing substantially to 6.8%.

Among children aged 0-11 months, the prevalence of wasting increased from 18.0% in 2008 to 24.7% in 2013, before decreasing to 10.2% in 2018. For children aged 12-35 months, the prevalence rose from 15.0% in 2008 to 17.8% in 2013, and then decreased to 8.2% in 2018. Children aged 36-60 months experienced a decrease in the prevalence of wasting from 11.9% in 2008 to 11.3% in 2013, and further declined to 3.4% in 2018. The data reveals a trend of initially increasing and then significantly decreasing wasting prevalence across all age groups from 2008 to 2018.

The most substantial reduction was observed between 2013 and 2018. These temporal changes indicate that while there was a rise in wasting prevalence up to 2013, effective interventions likely contributed to the substantial decrease by 2018. Continuous efforts are needed to sustain and further improve the nutritional status of children under five in Nigeria.

These findings align with those reported by Akombi et al. (2017), who emphasized the temporal changes in wasting prevalence in Nigeria, highlighting the increase until 2013 and the notable decrease by 2018. Similarly, Uthman et al. (2020) observed trends in Nigeria, showing a rise in wasting rates until 2013 and a significant decline by 2018, likely due to successful health and nutrition interventions.

Spatial Effect of Stunting among Under-Five Children in Nigeria between 2008,2013 and 2018

Figure 2 illustrates the geopolitical zone distribution of stunting among children under five in Nigeria from 2008 to 2018. The Southeast, Southsouth, Southwest, and Northcentral regions showed a decrease in stunting prevalence from 2008 to 2013, while the Northeast and Northwest regions recorded an increase. The Northwest had the highest prevalence of stunting in 2008, 2013, and 2018, followed by the Northeast and Northcentral regions.

Comparing data across the 36 states and FCT from 2008 to 2018, states with low prevalence in 2008 included Anambra (12.2%), Enugu (21.4%), and Abia (22.6%). By 2013, low rates were observed in Abia (8.4%), Enugu (11.2%), and Imo (13.0%), while in 2018, they were in Abia (10.6%), Anambra (14.1%), and Lagos (16.1%). Kebbi state had the highest prevalence of stunting across all periods, with 63.6% in 2008, 59.5% in 2013, and 67.0% in 2018. Other states with consistently high prevalence included Katsina and Jigawa. These trends highlight a persistent and growing burden of stunting in certain northern states, underscoring the need for targeted interventions.

These findings are consistent with studies conducted by Adekanmbi et al. (2013), who documented regional disparities in stunting prevalence in Nigeria, particularly in the northern regions. Additionally, Gayawan et al. (2019) found similar spatial patterns, noting that northern states like Kebbi, Katsina, and Jigawa have persistently high stunting rates over the years, reflecting socio-economic and environmental challenges that exacerbate child malnutrition.

Spatial Effect of Underweight among Under-Five Children in Nigeria between 2008, 2013 and 2018

Figure 3 illustrates the spatial distribution of underweight prevalence among children under five in Nigeria from 2008 to 2018. In 2008, the Northwest had the highest prevalence at 36.6%, followed by the Northeast at 33.0%, Northcentral at 23.4%, Southwest at 12.4%, Southsouth at 11.4%, and Southeast at 10.8%. In 2013, the Northwest again showed the highest prevalence at 45.4%, followed by the Northeast at 37.6%, Northcentral at 24.4%, Southwest at 14.0%, Southsouth at 13.2%, and Southeast at 11.0%. By 2018, the Northwest remained the highest at 35.7%, followed by Northcentral at 30.1%, Northeast at 29.3%, Southwest at 13.7%, Southsouth at 11.6%, and Southeast at 11.0%.

The data reveals a trend where the prevalence of underweight increased in the Northcentral region from 23.4% in 2008 to 30.1% in 2018, while it decreased in the Northwest, Northeast, Southwest, and Southsouth regions during the same period. The Southeast region remained stable. On a state level, low prevalence was observed in states such as Bayelsa, Enugu, and Ekiti in 2008, while high prevalence was seen in states like Yobe, Sokoto, and Bauchi. By 2018, states with high prevalence included Kebbi, Sokoto, and Yobe, while low prevalence was observed in Niger, Anambra, and Enugu.

These findings align with those of Gayawan et al. (2019), who highlighted significant regional disparities in underweight prevalence in Nigeria, with the northern regions, particularly the Northwest and Northeast, consistently exhibiting higher rates of underweight among children under five. Additionally, Akombi et al. (2017) observed similar spatial patterns, noting that northern regions have persistently high underweight prevalence, attributed to factors such as poverty, food insecurity, and limited access to healthcare services.

Spatial Effect of Wasting among Under-Five Children in Nigeria between 2008, 2013 and 2018

Figure 4 illustrates the regional distribution of wasting prevalence among children under five in Nigeria from 2008 to 2018. The Northwest consistently showed the highest prevalence, with estimates of 21.5% in 2008, 25.3% in 2013, and 9.6% in 2018. The Northeast followed closely, with prevalence rates of 20.5% in 2008, 21.1% in 2013, and 9.6% in 2018. The Northcentral region recorded 9.1% in 2008, 14.3% in 2013, and 5.3% in 2018. In the Southeast, prevalence was 8.8% in 2008, 12.3% in 2013, and 4.7% in 2018. The Southwest showed a significant reduction, from 8.6% in 2008 to 4.3% in 2018, surpassing the Southsouth, which had 7.1% in 2008 and 4.4% in 2018, making the Southwest the region with the lowest prevalence of wasting in 2018.

The trend of wasting prevalence across states varied considerably between 2008 and 2018. Jigawa had the highest prevalence in 2008 at 43.1%, followed by Bauchi at 41.0% and Kebbi at 35.2%. In 2013, Kaduna led with 39.3%, followed by Kano at 38.5% and Borno at 29.5%. By 2018, Sokoto had the highest prevalence at 19.4%, followed by Borno at 17.8% and Kebbi at 21.1%. States with the lowest prevalence of wasting also shifted over time, with Rivers at 4.3% in 2008, Kwara at 7.3% in 2013, and Bayelsa and Delta at 2.3% in 2018. Anambra and Enugu also recorded low prevalence rates at 2.4% and 2.9%, respectively, in 2018. Across all states, including the Federal Capital Territory (FCT) Abuja, there was a considerable reduction in wasting prevalence from 2013 to 2018.

These findings are consistent with those of Musa et al. (2018), who analyzed regional disparities in child malnutrition and found that northern regions, particularly the Northwest and Northeast, exhibited the highest levels of wasting. Musa et al. emphasized the impact of socioeconomic factors and limited access to healthcare in these regions. Furthermore, Okafor et al. (2019) highlighted the significant reduction in wasting prevalence in the Southwest and Southsouth regions by 2018, attributing this decline to improved public health interventions and better access to nutrition services. The study by Ogunlesi et al. (2020) also corroborated these trends, noting that states like Jigawa and Bauchi had persistently high wasting rates, while states in the South, such as Bayelsa and Delta, showed marked improvements in child nutritional outcomes by 2018.

Table 1-3: Temporal trend of Stunting, underweight and wasting among under-five children in Nigeria by age, Geo political zone, state and waves in 2008,2013 and 2018.

Stunting

Variable	Category	WAVE1 2008 N (%)	WAVE2 2013 N (%)	WAVE3 2018 N (%)
Age (months)	0-11	3843(26.0)	4921(19.5)	2199(20.3)
	12-35	6713(49.6)	8915(41.3)	4145(42.6)
	36-60	6937(44.5)	8852(40.8)	3989(39.1)
Geo Political zone	NC	3385(47.6)	4150(36.3)	1324(54.0)
	NE	4015(49.0)	3852(52.3)	1887(49.0)
	NW	3673(52.6)	5708(54.7)	2101(57.6)
	SE	1524 (23.8)	2075 (14.7)	1485 (19.0)
	SS	2076 (30.6)	2770 (20.7)	1102 (22.5)
	SW	2387 (32.2)	3060 (21.1)	1499 (23.2)
State	Abia	275 (22.6)	387(8.4)	225 (10.6)
	Adamawa	612 (43.0)	756 (34.5)	272 (38.2)
	Akw Ibom	330 (27.9)	434 (23.7)	224 (22.8)
	Anambra	319(12.2)	353(15.9)	383(14.1)
	Bauchi	693(51.2)	944(50.5)	388(57.2)
	Bayelsa	394(26.14)	629(24.5)	176(27.3)
	Benue	608(35.4)	501(20.4)	315(21.3)
	Borno	700(49.6)	366(28.4)	309(43.7)
	Cross River	419(30.6)	401(23.4)	141(24.8)
	Delta	318(34.9)	500(17 .2)	172(24.4)
	Ebonyi	501(32.5)	532(17.5)	403(24.8)
	Edo	267(37.1)	436(18.6)	130(17.7)
	Ekiti	371(32.9)	414(18.6)	222(21.6)
	Enugu	168(21.4)	446(11.2)	207(17.4)
	Gombe	603(52.2)	839(47.6)	331(49.2)
	Imo	261(24.14)	356(13.0)	267(18.7)
	Jigawa	645(53.3)	917(59.2)	343(63.9)
	Kaduna	671(52.5)	557(58.4)	377(48.3)

	Kano	833(46.1)	1482(49.2)	498(56.2)
	Katsina	679(59.2)	997(58.4)	403(59.8)
	Kebbi	335(63.6)	744(59.5)	315(67.0)
	Kogi	300(35.7)	324(22.5)	182(21.4)
	Kwara	376(49.73)	537(29.4)	204(29.4)
	Lagos	515(21.0)	732(15.2)	298(16.1)
	Nassarawa	438(42.5)	486(34.4)	259(34.0)
	Niger	497(45.5)	725(32.8)	403(27.3)
	Ogun	372(41.4)	431(23.2)	246(23.2)
	Ondo	351(31.6)	511(26.2)	195(21.5)
	Osun	371(32.6)	457(19.5)	213(22.5)
	Oyo	407(37.6)	515(26.0)	325(32.0)
	Plateau	487(59.1)	494(35.4)	242(45.5)
	Rivers	348(29.3)	370(15.1)	259(18.9)
	Sokoto	747(52.9)	980(51.6)	242(56.6)
	Taraba	732(43.4)	947(43.8)	275(41.8)
	Yobe	675(55.0)	713(50.5)	312(59.0)
	Zamfara	442 (55.0)	1028)56.0)	326(52.5)
	FCT Abuja	433 (31.9)	397(20.0)	251(22.3)
	Total	17493 (40.6)	22688(36.6)	10333(36.5)

Table 1. Temporal trend of stunting

Table 2. Temporal trend of underweight

Underweight				
Variable	**Category**	WAVE1 2008 N (%)	WAVE2 2013 N (%)	WAVE3 2018 N (%)
Age (months)	0-11	3843(18.0)	4921(21.9)	2199(18.3)
	12-35	6713(26.9)	8915(30.2)	4145(42.6)
	36-60	6937(24.8)	8852(26.7)	3989(20.3)
Geo Political zone	NC	3385(23.4)	4150(24.4)	1324(30.1)
	NE	4015(33.0)	3852(37.6)	1887(29.3)
	NW	3673(36.6)	5708(45.4)	2101(35.7)
	SE	1524 (10.8)	2074 (11.0)	1485 (11.0)
	SS	2076 (11.4)	2770 (13.2)	1102 (11.6)
	SW	2387 (12.4)	3060 (14.0)	(499 (13.7)
State	Abia	275 (10.6)	387 (11.4)	225 (14.8)
	Adamawa	612 (30.7)	756 (24.3)	272 (19.9)
	Akw Ibom	330 (13.5)	434(17.1)	224(10.7)
	Anambra	319(8.5)	353(6.4)	383(6.2)
	Bauchi	693(52.2)	944(41.4)	388(32.7)
	Bayelsa	394(5.3)	629(11.1)	176(14.2)
	Benue	608(12.5)	501(10.4)	315(13.7)
	Borno	700(28.7)	366(24.9)	309(29.8)
	Cross River	419(14.8)	401(15.7)	141(12.8)
	Delta	318(13)	500(17.4)	172(13.4)
	Ebonyi	501(14.4)	532(13.2)	403(14.6)
	Edo	261(10.5)	436(6.4)	130(12.3)
	Ekiti	371(8.6)	414(10.4)	222(12.6)
	Enugu	168(6.6)	446(7.6)	207(7.7)
	Gombe	603(28.9)	839(32.8)	331(30.2)
	Imo	261(10.0)	356(9.6)	267(11.6)
	Jigawa	645(50.5)	917(44.7)	343(42.3)
	Kaduna	671(22.5)	557(55.1)	377(22.6)
	Kano	833(31.3)	1482(56.5)	498(31.1)
	Katsina	679(37.9)	997(44.8)	403(37.5)
	Kebbi	335(35.2)	744(40.1)	315(47.9)
	Kogi	300(16.3)	324(14.7)	182(12.7)
	Kwara	376)27.1)	537(14.9)	204(12.8)

	Lagos	515(10.1)	752(11.6)	298(11.7)
	Nassarawa	438(15.3)	486(20.6)	259(20.5)
	Niger	497(31.8)	725(25.9)	403(4.9)
	Ogun	372(16.9)	431(18.1)	246(14.2)
	Ondo	351(11.1)	511(15.1)	195(12.8)
	Osun	371(12.4)	457(10.5)	213(12.2)
	Oyo	407(16.0)	515(18.8)	325(17.2)
	Plateau	487(18.5)	494(18.2)	242(18.2)
	Rivers	348(9.8)	370(11.6)	258(8.5)
	Sokoto	747(46.3)	980(37.5)	242(44.6)
	Taraba	275(19.3)	732(17.2)	947(24.6)
	Yobe	675(41.0)	713)(38.6)	312(40.7)
	Zamfara	442(18.6)	1028(37.0)	326(32.8)
	FCT Abuja	433(11.1)	397(12.3)	251(12.4)
	Total	17493(23.2)	22688(28.8)	10333(21.24)

Table3.Temporal trend of wasting

Wasting				
Variable	**Category**	WAVE1 <u>2008</u> N (%)	WAVE2 <u>2013</u> N (%)	WAVE3 <u>2018</u> N (%)
Age (months)	0-11	3843(18.0)	4921(24.7)	2199(10.2)
	12-35	6713(15.0)	8915(17.8)	4145(8.2)
	36-60	6937(11.9)	(8852)11.3	3989(3.4)
Geo Political zone	NC	3385 (9.11)	4150(14.3)	1324(5.3)
	NE	4015(20.5)	3852(21.1)	1887(9.6)
	NW	3673(21.5)	5708(25.3)	2101(9.5)
	SE	1524 (8.8)	2074 (12.3)	1485 (4.7)
	SS	2076 (7.1)	2770 (11.6)	1102 (4.4)
	SW	2387 (8.6)	3060 (10.5)	1499 (4.3)
State	Abia	275 (8.94)	387 (11.4)	225 (7.11)
	Adamawa	612 (21.1)	756 (15.0)	272 (4.4)
	Akw Ibom	330 (13.3)	434(11.5)	224 (4.9)
	Anambra	319(6.0)	353(16.7)	383(2.4)
	Bauchi	693(41.0)	944(23.8)	388(9.8)
	Bayelsa	394(6.4)	629(5.6)	176(2.3)
	Benue	608(5.6)	501(7.6)	315(9.2)
	Borno	700(13.0)	366(29.5)	309(17.8)
	Cross River	419(5.7)	401(12.2)	141(5.7)
	Delta	318(6.0)	500(19.6)	172(2.3)
	Ebonyi	501(8.2)	532(11.3)	403(5.2)
	Edo	261(7.5)	436(10.1)	130(5.4)
	Ekiti	371(4.6)	414(9.0)	222(3.6)
	Enugu	168(16.7)	446(10.0)	207(2.9)
	Gombe	603(17.3)	839(15.7)	331(7.9)
	Imo	261(8.8)	356(13.5)	267(6.4)
	Jigawa	645(43.1)	917(18.1)	343(9.0)
	Kaduna	671(10.3)	557(39.3)	377(5.3)
	Kano	833(18.0)	1482(38.5)	498(7.4)
	Katsina	679(20.3)	997(24.0)	403(9.2)
	Kebbi	335(35.2)	744(19.5)	315(12.1)
	Kogi	300(7.0)	324(11.6)	182(3.7)
	Kwara	376(12.0)	537(7.3)	204(3.9)
	Lagos	515(9.13)	752(11.2)	298(5.7)
	Nassarawa	438(5.7)	486(10.9)	259(6.6)
	Niger	497(18.9)	725(18.6)	403(5.2)
	Ogun	372(7.0)	431(10.4)	246 (4.9)
	Ondo	351(6.0)	511(7.6)	195(3.1)
	Osun	71 (12.4)	457(12.9)	213(4.7)
	Oyo	407(12.0)	515(11.3)	325(3.7)
	Plateau	487(5.3)	494(10.1)	242(2.9)

	Rivers	348(4.3)	370(12.3)	258(5.4)
	Sokoto	747(24.9)	980(18.6)	242(19.4)
	Taraba	73(9.4)	947(7.9)	275(4.0)
	Yobe	675(21.3)	713(22.6)	312(12.5)
	Zamfara	442(10.6)	1028(15.7)	326(8.9)
	FCT Abuja	433(9.5)	397(12.6)	251 (3.6)
	Total	17493(13.9)	22688(18.4)	10333(6.8)

Figure 2: Maps of Nigeria showing the yearly spatial effects for stunting.

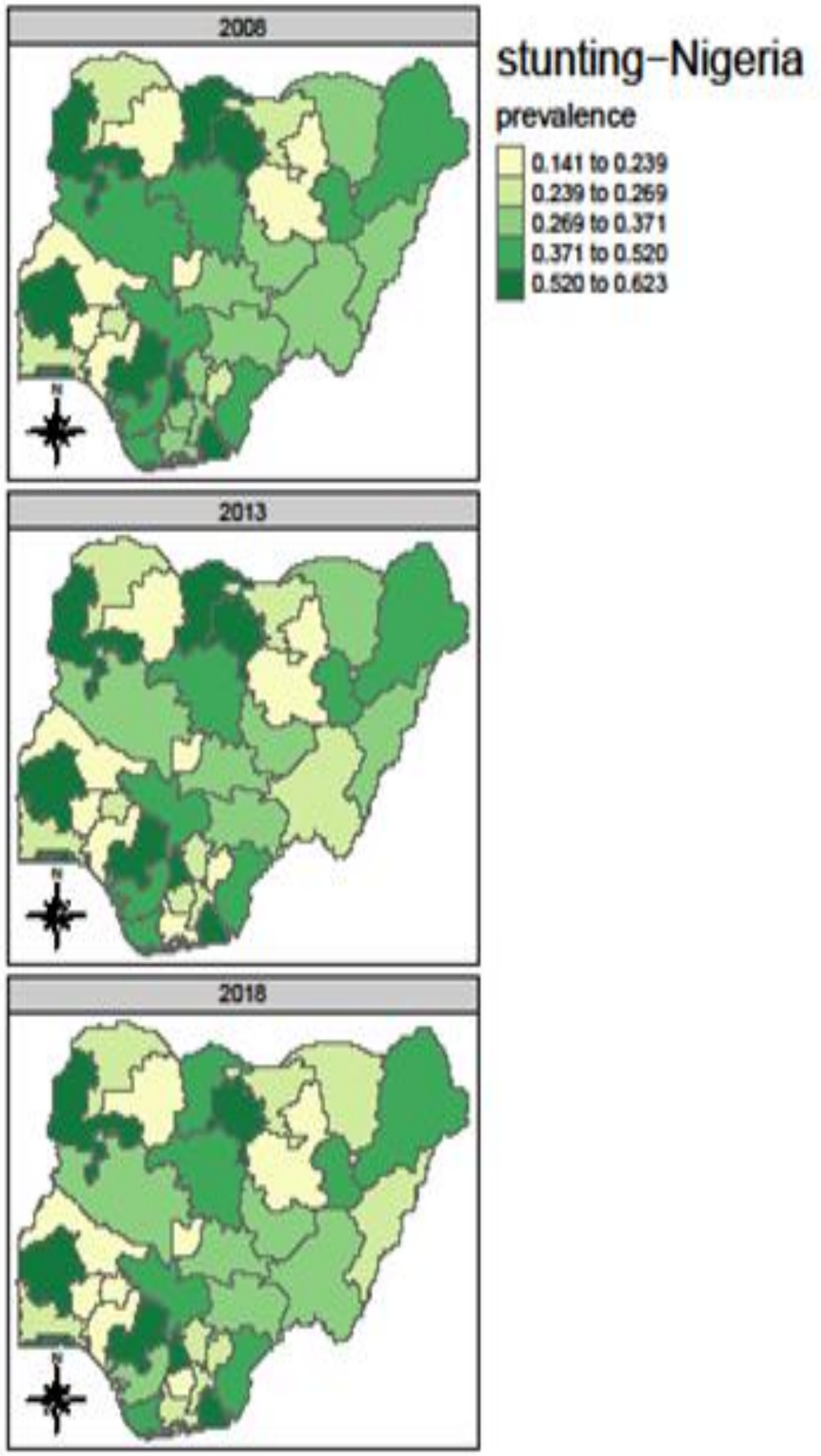


Figure 3: Maps of Nigeria showing the yearly spatial effects for underweight.

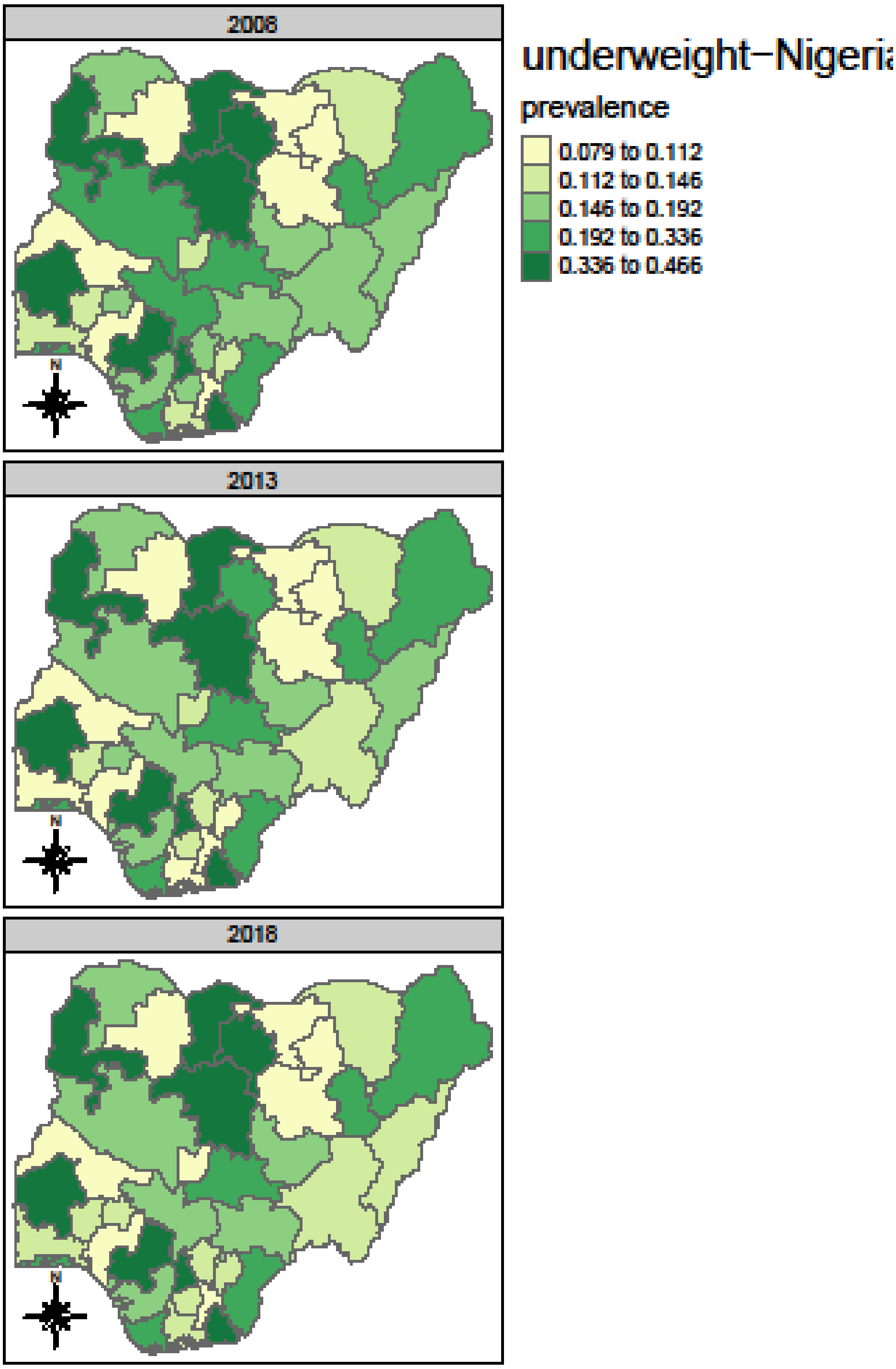
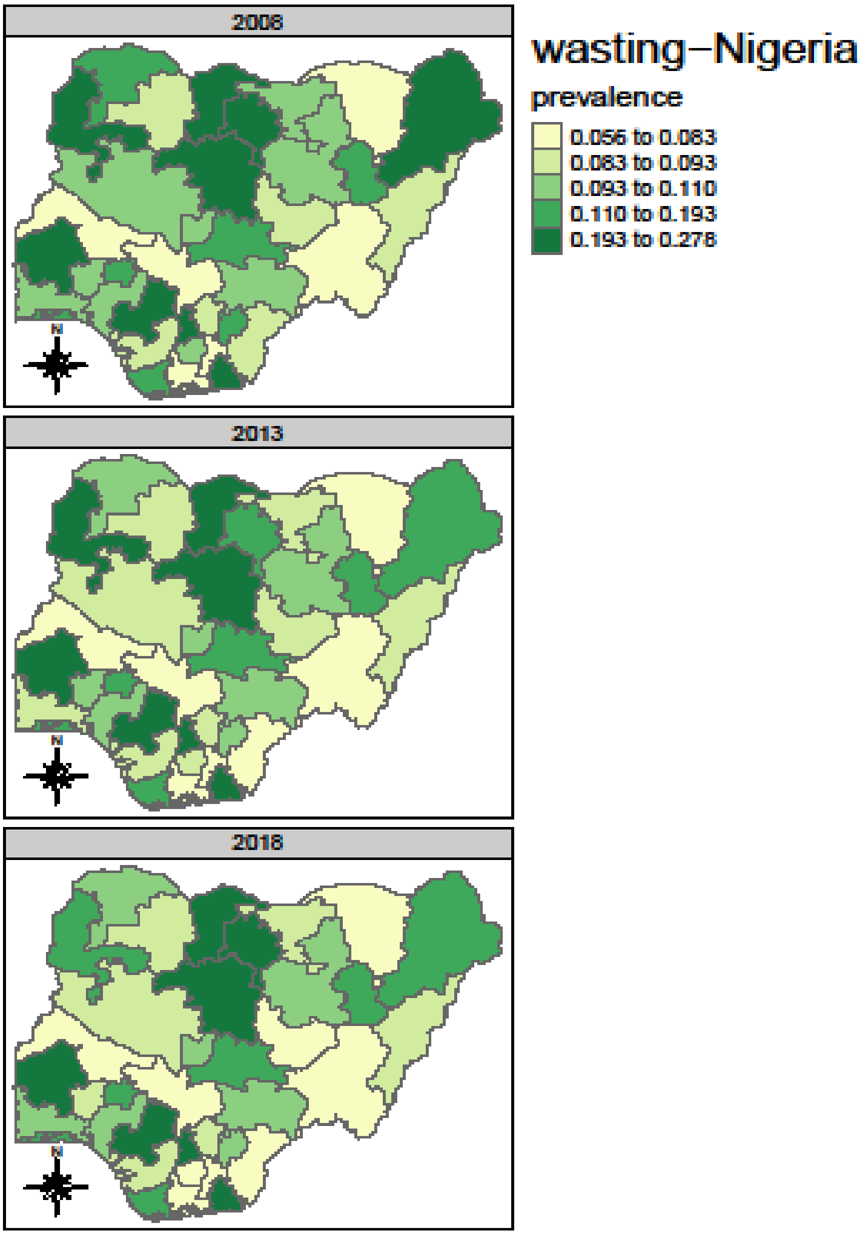


Figure 4: Maps of Nigeria showing the yearly spatial effects for wasting.



The result of specific linear effects of stunting

Table 4 shows the odds ratio for the specific linear effects of stunting among under five children in Nigeria. The odds of having stunting were not significant among children under five living in urban areas (OR: 0.948, CL: 0.897, 1.001) compared with children living in rural areas. The odds of having stunting among children of mothers with primary education (OR: 0.935, CL: 0.883, 0.990) and secondary education (OR: 0.741, CL: 0.693, 0.792) were significant compared to children of mothers with no education. Similarly, children of mothers with higher education were 50.8% less likely to be stunted (OR: 0.492, CL: 0.435, 0.556), and the odds were significant compared with children of mothers with no education.

For the wealth index, the odds of having stunting among children of poorer mothers were 10.3% less likely (OR: 0.897, CL: 0.847, 0.949) and the odds were significant compared to the children of the poorest mothers. Likewise, the odds of having stunting among children of middle-class mothers were 21.4% less likely (OR: 0.786, CL: 0.737, 0.839), and the odds were significant compared to the poorest mothers. The findings also showed that the children of richer mothers were 40% less likely to be stunted (OR: 0.600, CL: 0.555, 0.648), and the odds were significant compared with children of the poorest mothers. The odds of having stunting among children of the richest mothers were 50.2% less likely (OR: 0.498, CL: 0.451, 0.550) and the odds were significant compared with the poorest mothers.

Children of Christian mothers were 51.1% less likely to be stunted (OR: 0.489, CL: 0.444, 0.538), and the odds were significant compared with children of mothers who practiced traditional religion. There were also 43.7% less likely to be stunted among children of mothers who practiced Islam (OR: 0.563, CL: 0.512, 0.618) compared with children of mothers who practiced traditional religion, and the odds were significant.

The odds of stunting among 2nd and 3rd birth order children were 0.3% more likely to be stunted (OR: 1.003, CL: 0.945, 1.067), and the odds were not significant compared with 1st birth order children. Stunting among 4th birth order children was 11.5% more likely, and the odds were significant (OR: 1.115, CL: 1.040, 1.195) compared to 1st birth order children. The odds of having stunting among female children were 21.3% less likely (OR: 0.787, CL: 0.757, 0.818) compared to male children, and the odds were significant.

While the odds of having stunting among children of mothers aged 24-35 were 14.4% less likely (OR: 0.856, CL: 0.802, 0.914), and the odds were significant compared with the reference age, while the odds of having stunting among children of mothers aged 36 and above were 20.2% less likely (OR: 0.798, CL: 0.735, 0.865) compared to the children of mothers aged 15-23 years, and the odds were significant. The odds of having stunting among children of normal BMI mothers were 17.2% less likely (OR: 0.828, CL: 0.778, 0.881) compared with children of underweight mothers, and the odds were significant.

Children of overweight mothers were 33.1% less likely to be stunted (OR: 0.669, CL: 0.618, 0.723), and the odds were significant compared with children of underweight mothers. Children of obese mothers were 42.3% less likely to be stunted (OR: 0.577, CL: 0.517, 0.644) compared to children of underweight mothers, and the odds were significant.

The result of specific linear effects of underweight.

Table 5 shows the odds ratio of specific linear effects of underweight for under five children in Nigeria. The odds of having underweight children were significant among children living in urban residences (OR: 1.066, CL: 1.001, 1.135) compared with children living in rural areas.

The odds of having underweight children among the children of mothers with primary education (OR: 0.830, CL: 0.778, 0.885) and secondary education (OR: 0.730, CL: 0.675, 0.788) were significant compared to the children of mothers with no education, while the odds of having underweight children among the children of mothers with higher education were 50.7% less likely (OR: 0.493, CL: 0.423, 0.572) compared to mothers with no education, and the odds were significant.

For the wealth index, children of poorer mothers were 12.9% less likely to be underweight compared to the children of the poorest mothers (OR: 0.871, CL: 0.822, 0.924), and the odds were significant. Similarly, children of middle-class mothers were 21.2% less likely to be underweight (OR: 0.788, CL: 0.734, 0.845) when compared with children of the poorest mothers, and the odds were significant.

The odds of underweight among children of richer mothers were 33.7% less likely (OR: 0.663, CL: 0.608, 0.723) compared with children of the poorest mothers, and the odds were significant. Similarly, the odds of underweight among children of the richest mothers were 41% less likely (OR: 0.590, CL: 0.526, 0.661) compared with children of the poorest mothers, and the odds were significant. Underweight among children of Christian mothers was 54.5% less likely (OR: 0.455, CL: 0.411, 0.505) compared with children of mothers who practiced traditional religion, and the odds were significant. Similarly, the odds of having underweight children of mothers who practiced Islam were 46.5% less likely (OR: 0.535, CL: 0.484, 0.591) compared to the children of mothers who practiced traditional religion, and the odds were significant.

While the odds of having underweight children among 2nd and 3rd birth order children were not significant (OR: 0.957, CL: 0.894, 1.024) compared to 1st birth order children. However, the odds of having underweight children among 4th birth order children were significant (OR: 1.091, CL: 1.008, 1.180) compared to 1st birth order children. The odds of having underweight among female children were 17% less likely (OR: 0.830, CL: 0.795, 0.866) compared with male children, and the odds were significant.

Children of mothers aged 24-35 years were 6.7% less likely to be underweight (OR: 0.933, CL: 0.872, 0.998) compared to children of mothers aged 15-23 years, and the odds were significant. Similarly, the children of mothers aged 36 and above were 12% less likely to be underweight (OR: 0.880, CL: 0.804, 0.962) when compared with children of mothers aged 15-23 years, and the odds were significant. The odds of having underweight children among children of mothers with normal BMI were 35.8% less likely (OR: 0.642, CL: 0.442, 0.525) compared with children of underweight mothers, and the odds were significant. Similarly, the odds of having underweight among children of overweight mothers were 51.8% less likely (OR: 0.482, CL: 0.442, 0.525) compared to children of underweight mothers, and the odds were significant. The odds of having underweight children among children of obese mothers were 61.3% less likely (OR: 0.387, CL: 0.338, 0.441) when compared with children of underweight mothers, and the odds were significant.

The result of specific linear effects of wasting.

Table 6 shows the odds ratio of specific linear effects of wasting for under five children in Nigeria. The odds of having wasting among children under five living in urban areas were not significant (OR: 1.096, CL: 1.017, 1.181) compared with children living in rural areas. The odds of having wasting among children of mothers with primary education (OR: 0.837, CL: 0.772, 0.906), secondary education (OR: 0.740, CL: 0.673, 0.813), and higher education (OR: 0.564, CL: 0.477, 0.666) were significant compared to the children of mothers with no education.

For the wealth index, the children of poorer mothers were less likely to be wasted compared to the children of the poorest mothers (OR: 0.910, CL: 0.847, 0.979), and the odds were significant. Likewise, the children of middle-class mothers were 17% less likely to be wasted (OR: 0.830, CL: 0.761, 0.905), and the odds were significant in reference to the poorest mothers. Similarly, the children of richer mothers were 17.3% less likely to be wasted (OR: 0.827, CL: 0.745, 0.918) compared with children of the poorest mothers, and the odds were significant, while the odds of having wasting among children of the richest mothers were not significant (OR: 0.904, CL: 0.791, 1.032) compared with the poorest mothers.

Children of Christian mothers were 63% less likely to be wasted (OR: 0.370, CL: 0.331, 0.421), and the odds were significant compared with children of mothers who practiced traditional religion. Similarly, children of mothers who practice Islam were 57.8% less likely to be wasted (OR: 0.422, CL: 0.376, 0.474) compared with children of mothers who practiced traditional religion, and the odds were significant. While, the odds of having wasting among 2nd and 3rd birth order children were not significant (OR: 0.932, CL: 0.861, 1.011) compared to 1st birth order children. Similarly, wasting among 4th birth order children was not significant (OR: 0.917, CL: 0.836, 1.007) compared to 1st birth order children.

The odds of wasting among female children were 15.1% less likely (OR: 0.849, CL: 0.806, 0.894) compared to male children, and the odds were significant. The odds of having wasting among children of mothers aged 24-35 years were 4.5% more likely to be wasted (OR: 1.045, CL: 0.965, 1.130) compared to children of mothers aged 15-23 years, and the odds were not significant, while children of mothers aged 36 years and above were not significant (OR: 0.954, CL: 0.856, 1.065) compared with children of mothers aged 15-23 years.

The odds of wasting among children of mothers with normal BMI were 23.2% less likely (OR: 0.768, CL: 0.712, 0.828) compared with children of underweight mothers, and the odds were significant. Similarly, the odds of wasting among children of overweight mothers were 34% less likely (OR: 0.660, CL: 0.600, 0.731) compared to the children of underweight mothers, and the odds were significant, while children of obese mothers were 47.2% less likely to be wasted (OR: 0.528, CL: 0.451, 0.617) when compared with children of underweight mothers, and the odds were significant.

Table 4. The odds ratio (OR) for the fixed effects estimates and their 95% credible intervals for stunting.

	Stunting		
Variables	**OR**	**LCI**	**UCL**
Place of residence			
Rural (ref)	1.000		
Urban	0.948	0.897	1.001
Education			
No Education (ref)	1.000		
Primary	0.935	0.883	0.990
Secondary	0.741	0.693	0.792
High Education	0.492	0.435	0.556
Wealth Index			
Poorest (ref)	1.000		
Poorer	0.897	0.847	0.949
Middle	0.786	0.737	0.839
Richer	0.600	0.555	0.648
Richest	0.498	0.451	0.550
Religion			
Traditionalist (ref)	1.000		
Christian	0.489	0.444	0.538
Islam	0.563	0.512	0.618
Birth order			
Ist birth (ref)	1,000		
2^{nd} & 3^{rd} birth	1.003	0.945	1.067
4^{th} birth	1.115	1.040	1.195
Sex			
Male (ref)	1.000		
Female	0.787	0.757	0.818
Mothers 'age (years)			
15-23(ref)	1.000		
24-35	0.856	1.031	0.802
>36	0.798	0.735	0.865
Mother BMI			
Underweight (ref)	1.000		
Normal	0.828	0.778	0.881
Overweight	0.669	0.618	0.723
Obesity	0.577	0.517	0.644

Table 5. The odds ratio (OR) for the fixed effects estimates and their 95% credible intervals for underweight.

	Underweight		
Variables	**OR**	**LCI**	**UCL**
Place of residence			
Rural (ref)	1.000		
Urban	1.066	1.001	1.135
Education			
No Education (ref)	1.000		
Primary	0.830	0.778	0.885
Secondary	0.730	0.675	0.788
High Education	0.493	0.423	0.572
Wealth Index			

Poorest (ref)	1.000		
Poorer	0.871	0.822	0.924
Middle	0.788	0.734	0.845
Richer	0.663	0.608	0.723
Richest	0.590	0.526	0.661
Religion			
Traditionalist (ref)	1.000		
Christian	0.455	0.411	0.505
Islam	0.535	0.484	0.591
Birth order			
Ist birth (ref)	1.000		
2^{nd} & 3^{rd} birth	0.957	0.894	1.024
4^{th} birth	1.091	1.008	1.180
Sex			
Male (ref)	1.000		
Female	0.830	0.795	0.866
Mothers 'age (years)			
15-23(ref)	1.000		
24-35	0.933	0.872	0.998
>36	0.880	0 .804	0.962
Mother BMI			
Underweight (ref)	1.000		
Normal	0.642	0.442	0.525
Overweight	0.482	0.442	0.525
Obesity	0.387	0.338	0.441

Table 6. The odds ratio (OR) for the fixed effects estimates and their 95% credible intervals for wasting.

	Wasting		
Variables	**OR**	**LCI**	**UCL**
Place of residence			
Rural (ref)	1.000		
Urban	1.096	1.017	1.181
Education			
No Education (ref)	1.000		
Primary	0.837	0.772	0.906
Secondary	0.740	0.673	0.813
High Education	0.564	0.477	0.666
Wealth Index			
Poorest (ref)	1 .000		
Poorer	0.910	0.847	0.979
Middle	0.830	0.761	0.905
Richer	0.827	0.745	0.918
Richest	0.904	0.791	1.032
Religion			
Traditionalist (ref)	1.000		
Christian	0.370	0.331	0.421
Islam	0.422	0.376	0.474
Birth order			
Ist birth (ref)	1.000		
2^{nd} & 3^{rd} birth	0.932	0.861	1.011
4^{th} birth	0.917	0.836	1.007
Sex			
Male (ref)	1.000		
Female	0.849	0.806	0.894
Mothers 'age (years)			
15-23(ref)	1.000		
24-35	1.045	0.965	1.130
>36	0.954	0.856	1.065
Mother BMI			
Underweight (ref)	1.000		
Normal	0.768	0.712	0.828
Overweight	0.660	0.600	0.731
Obesity	0.528	0.451	0.617

3.10 The exceedance probabilities for stunting

From Table 7, the prevalence in line with 2025 WHO target threshold with exceedance probabilities of 40% reduction in stunting in Nigeria from wave 2 (2013) to wave 3 (2018) showed that it is very unlikely that the reduction in prevalence of stunting exceed 40%.th.The finding agree with the studies that shown rates of progress and predicted that there will be 127 million stunted children by 2025, that is, 27 million more than the threshold target or a reduction of only 26%(de Onis et al. 2013). The finding also agrees with a study, the predicted prevalence of stunting in 2025 will be 34.9%, two percentage points lower than the 2018 prevalence (Adeyemi et al. 2022).

Table 7 Exceedance probability estimate for stunting.

Stunting	Region	Exceedance probability 40%
	NC	0.04845023
	NE	0.10511991
	NW	0.00000000
	SE	0.00000000
	SS	0.00000000
	SW	0.00000000

3.11 The exceedance probabilities for wasting

Table 8 showed that the prevalence in line with WHO target threshold with exceedance probability of 5% reduction in wasting in Nigeria from wave 2 (2013) to wave3 (2018), the result showed that (0.999) it is very likely that prevalence of wasting exceeds 5% reduction by 2025.

Table 8 Exceedance probability estimate for wasting by region.

Wasting	Region	Exceedance probability 5%
	NC	0.9999998
	NE	0.9999998
	NW	0.9999997
	SE	0.9999997
	SS	0.9999997
	SW	0.9999998

Conclusion

Malnutrition remains a critical public health challenge in Nigeria, significantly affecting the growth and development of children under five years of age. Despite various efforts to address this issue, many children continue to suffer from undernutrition, characterized by stunting, wasting, and underweight. These conditions not only impede physical growth but also have long-term consequences on cognitive development, educational attainment, and overall well-being. The root causes of malnutrition in Nigeria are multifaceted, involving a combination of inadequate dietary intake, poor maternal health, socio-economic disparities, and regional conflicts that exacerbate food insecurity.

The study provided a comprehensive analysis of undernutrition in Nigeria from 2008 to 2018, focusing on the prevalence of stunting, wasting, and underweight. The results indicated that the prevalence of these conditions varied over time, with an initial increase from 2008 to 2013, followed by a decrease from 2013 to 2018. However, wasting exhibited a worsening trend as children aged across various geopolitical zones. Male children were found to have a higher prevalence of undernutrition compared to female children.

Geopolitical zone variations were observed: in 2018, the Southeast recorded the lowest stunting rate (19.0%), while the Northwest had the highest stunting rate (57.6%). Similarly, the Northeast reported the highest rate of wasting (9.6%), whereas the Southwest recorded the lowest rate (4.3%). The Northwest had the highest prevalence of underweight children (36.0%), while the Southeast had the lowest prevalence (10.9%). At the state level, Kebbi State emerged as a hotspot for undernutrition. The study identified several risk factors for undernutrition, including biological factors such as gender, child's age, mother's age, and mother's body mass index, as well as socio-economic factors such as education, wealth index, and religion. Based on the findings, it is unlikely that Nigeria will achieve a 40% reduction in stunting by 2025, but it is very likely to achieve a 5% reduction in wasting.

Recommendations

The Government should formulate policies to improve maternal healthcare, especially in the Northern region where undernutrition among children is more prevalent. There should be a support community initiative to educate pregnant women on nutrition, particularly targeting traditional religion worshippers and other religious groups. Address inequalities in living standards through wealth creation programs, ensuring that even the poor can access medical services. The government should provide free medical services for pregnant women at the grassroots level. Promote adult education campaigns among women to mitigate the impact of maternal education on undernutrition, a significant socio-economic risk factor. Implement nutritional and supplementary food interventions to improve the conditions of stunted, wasted, and underweight children, addressing long-term national impacts and contributing to the achievement of the World Health Organization's sustainable development goals by 2025. The Government should enhance protection of lives and property, especially in the Northern region's rural areas where Boko Haram crises have disrupted livelihoods, primarily farming, leading to food insecurity.

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