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H. K. Ibrahim

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ORIGINAL RESEARCH



Evaluation of food insecurity and child malnutrition among rural and urban farm households in Nigeria

H. K. Ibrahim ^{a,b}

^aDepartment of Agricultural Economics and Farm Management, University of Ilorin, Ilorin, Nigeria;

^bDepartment of Agricultural Economics, Extension and Rural Development, University of Pretoria, Hatfield, Pretoria, South Africa

ABSTRACT

This study examines the relationship between food insecurity and multidimensional child malnutrition using panel data from Nigeria's General Household Surveys. Employing a correlated random-effects logistic model, the analysis captures time-invariant household heterogeneity and urban–rural differences. The results showed that asset poverty and emergency coping strategies were associated with stunting and underweight in rural areas, while poor dietary diversity was associated with wasting. Asset poverty and poor diet diversity were associated with child overweight in urban settings, revealing a food insecurity–overweight paradox. High food expenditure and reliance on emergency coping strategies emerge as covariates of individual-level double burden malnutrition.

KEYWORDS

Farm households; food insecurity; child malnutrition; rural and urban locations; Nigeria

Introduction

The link between food security and nutrition is crucial for achieving the global health agenda.¹ In 2015, the Sustainable Development Goal (SDG) aimed to end hunger and malnutrition by 2030² and the 2016 UN Decade of Action worked to meet the nutrition targets.³ Despite the efforts to reduce hunger and malnutrition, sub-Saharan Africa and Nigeria, in particular, face a complex malnutrition challenge characterized by the coexistence of persistent undernutrition and emerging childhood overweight alongside persistent food insecurity.⁴ The prevalence of severe and moderate food insecurity among households has continued to rise, increasing from 11% to 34.7% in 2014–2016 to 22.6% and 73.9% in 2021–2023, respectively.⁵ However, the proportion of stunted children (those with low height for age) decreased from 37.7% in 2012 to 34.2% in 2022.⁵ In 2022, the proportion of Nigerian children who were wasted (low weight for height) and overweight was 6.5% and 2.2%, respectively, compared to 6.7% and 2.4% in 2012.⁵ These statistics underscore the double burden of malnutrition, where undernutrition and overnutrition coexist within

populations, households, and even individuals. While it is widely recognized that food security influences nutrition, the disparities that highlight the severity and context differences between food insecurity and nutritional outcomes remain under explored.

Food insecurity – the lack of consistent physical, social, and economic access to sufficient, safe, and nutritious food for an active and healthy life – has been identified as a direct determinant of child nutritional outcomes.⁶ Its effects are particularly complex in contexts like Nigeria, where rural and urban households experience disproportionate levels of food insecurity. Rural populations primarily serve as food producers, while urban areas are generally assumed to be food secure^{7,8} (Sonnino, 2016).⁹ Smallholder farmers, typically located in rural areas, are a major driving force behind domestic food production and play a critical role in ensuring food security in the country.⁸ However, rural households, which dominate Nigeria's food production sector with relatively small farms, often face structural barriers such as poor infrastructure, insecure land rights, low agricultural productivity, frequent conflicts, weather variability, low access to finance, and limited market integration, contributing to chronic undernutrition.¹⁰

Urban food security is a multifaceted issue marked by interconnected challenges and opportunities (Sonnino, 2016;⁹). The urban areas are often perceived as having better food security than rural areas due to the abundance of food markets, restaurants, and supermarkets.¹¹ However, this assumption is not always accurate and can be misleading.⁹ Although urban areas typically offer greater food availability through various channels, access to nutritious, affordable, and safe food is not equally distributed among all residents.¹¹ Urban households are increasingly affected by rising food prices, dependence on purchased food, and exposure to processed, calorie-dense diets, which can associate with both undernutrition and overweight. Ongoing population growth, regional migration, infrastructural decay and shifts in lifestyle, asset ownership, and dietary patterns continue to reshape the nutritional landscape.¹² These rural–urban contrasts make it essential to disaggregate analyses to capture context-specific pathways linking food insecurity to child malnutrition.

While earlier works (e.g.,^{13–16}) have linked dietary diversity or food access scales to child nutrition, the simultaneous association of varying levels of food insecurity and location differential on stunting, wasting, underweight, overweight, and stunted-overweight remains unknown. By applying disaggregated analyses and advanced econometric techniques, this study provides novel evidence on how food insecurity translates into diverse and double burden forms of child malnutrition in distinct geographic settings. Findings will not only inform national nutrition and food security policies but also contribute to global discussions on addressing the double burden of malnutrition in low- and middle-income countries. The discussion is relevant given the urgent need

to achieve SDG 2 Zero Hunger, which provides a deeper understanding of the local-level drivers of malnutrition.

This paper contributes to knowledge in three ways. Firstly, it presents a comparative, context-sensitive analysis of child malnutrition. In contrast to existing literature that often treats rural and urban populations as homogeneous or focuses on a single context, this research systematically compares both, addressing a gap in understanding the location specificity of food insecurity's effects. By generating evidence on the rural–urban dynamics of food insecurity and malnutrition, this study aligns with broader development programs aiming to improve nutrition-sensitive agriculture, strengthen social protection systems, and design interventions that are both context- and severity-sensitive. Secondly, unlike existing research that often treats food insecurity as a binary condition and overlooks disparities, this study adopted a multidimensional approach – measuring the severity of food insecurity and comparing indicators of food security effects on child nutrition. By incorporating varying levels of food insecurity, the analysis contributes to policy debates in Nigeria, where national nutrition strategies have often focused on food availability but have paid less attention to the severity of food insecurity using household-level multidimensional food security measures. Thirdly, this study produces reliable evidence that employs more robust econometric methods (Correlated Random Effect-regression models) to account for unobserved heterogeneity, aligning with methodological advances in applied empirical economics.

Reviewing the Complexities of Relating Malnutrition to Food Insecurity Across Time

Malnutrition remains one of the most pressing public health and development challenges worldwide, affecting both developing and developed nations. Food insecurity acts as a central determinant of child malnutrition, but its effects may vary by severity and context. It is multidimensional, encompassing food availability, access, utilization, and stability. At the household level, food insecurity manifests through low dietary diversity, poor food consumption scores, high food expenditure shares, and adoption of negative coping strategies. Each of these measures has been shown to influence child nutrition outcomes.^{13–19}

The coexistence of undernutrition and overweight has been increasingly documented in low- and middle-income countries.²⁰ Yet, within Nigeria, the overweight dimension remains underexplored, particularly in the context of food insecurity. Traditional analyses focus heavily on stunting, wasting, and underweight, often neglecting the emerging risks of overweight and obesity among children in food-insecure households.¹³ This is a critical gap because being overweight in early childhood has long-term implications for non-

communicable diseases and healthcare costs.²¹ Exploring how food insecurity empirically contributes to both undernutrition and overweight will help inform policies to address the full spectrum of child malnutrition.

Existing literature suggests that no single internationally recognized standard captures the complexity of household food insecurity.^{22,23} Most previous studies rely on one or two proxies of food insecurity, such as the Household Dietary Diversity Score (HDDS) or Household Food Insecurity Access Scale (HFIAS), to explain malnutrition (MN) outcomes.^{15,16} None of these standard measures can capture all the complexity of food insecurity; their integration into a single framework only partially explains malnutrition. Rather, simultaneous use of multiple food security indicators is necessary to fully understand the various pathways linking food security to child nutritional outcomes.²⁴ Using diverse indicators improves the comparability of estimates and provides a more comprehensive and nuanced assessment of how different facets of food insecurity affect child nutrition. Although Roba et al.¹⁵ employed several food security measures – such as the Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), and the Household Food Insecurity Access Scale (HFIAS) – the study did not comprehensively address the dual burden of malnutrition (undernutrition and overnutrition), nor did it examine how food insecurity varies across rural and urban settings.

Many existing studies on child malnutrition in Nigeria and Sub-Saharan Africa present national-level estimates without sufficient disaggregation by rural and urban households. While national surveys in Nigeria, such as the National Demographic and Health Survey (NDHS),²⁵ reported rural–urban different prevalence, few empirical analyses rigorously explore how the determinants of malnutrition differ between rural and urban contexts. These limit the understanding of context-specific pathways. For example, rural households often face chronic food insecurity linked to subsistence farming and structural poverty¹⁵ and urban households experience market-related vulnerabilities and nutrition transition risks.¹¹ Disaggregated analysis is therefore essential for designing location-sensitive interventions.

Most published nutrition studies have employed a cross-sectional design, rather than utilizing panel data, which offers greater information, variability, and efficiency.^{15,26} However, few studies by Chegere and Stage,¹⁷ Humphries et al.,²¹ and Harper et al.¹⁸ adopted longitudinal data to examine nutrition with limited aspects of food insecurity measures. Children's nutritional outcomes reflect a long-term cumulative process, which can complicate results in cross-sectional analyses that often lack strong theoretical grounding in food security measures.²⁷ Econometric issues such as time-varying unobserved heterogeneity, measurement errors, and simultaneity bias commonly affect cross-sectional designs, resulting in specification errors. However, these biases can be mitigated through longitudinal study designs, which help reveal subgroup differences and identify the most affected populations.²⁶ Much of the

Nigerian and regional literature relies on cross-sectional regression models (logit, probit, or OLS), which do not adequately address the unobserved heterogeneity at the household or community level. This raises concerns about omitted-variable bias and poor model specifications. More advanced approaches – such as the Correlated Random Effects (CRE) framework or Mundlak adjustments – allow for richer control of unobserved household characteristics while exploiting both within- and between-household variation. The limited applications of CRE regression in Nigerian food security–nutrition studies represent a methodological gap. The present study contributes to the literature by applying household-level multiple food security measures to capture each dimension of food security, disaggregating rural and urban households to reveal the location heterogeneity effects within Nigeria, and using advanced econometric techniques (CRE regression models) to better account for unobserved heterogeneity.

The paper is organized into five sections. The first section provides the introduction. The second reviews the complexities of the relationship between food security and nutrition. The third explains the material and method, including the data and estimation strategy. The fourth sections present the results and discussion, respectively. The final section concludes the paper.

Materials and Methods

This study utilized panel data from Nigeria's Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA), conducted by the National Bureau of Statistics (NBS) with support from the World Bank. The survey began in 2010 and initially covered 5,000 households. However, due to rural–urban migration, relocation, and mortality, the number of observations declined over time. The LSMS-ISA, also known as the General Household Survey (GHS), collected data across Nigeria's rural and urban areas to provide a comprehensive analysis of food security indicators and socioeconomic characteristics.²⁸ Although data were also collected across Nigeria's six geopolitical zones, this paper focused on geographical location – specifically rural and urban areas – since the food security and nutrition outcomes of agricultural households are not typically connected to geopolitical zones.¹ The survey captured information at both the production (post-planting) and harvesting (post-harvest) stages of agricultural activity, as well as at the household level. This study draws on data from 2,448 farming household heads that have children under the age of five (i.e., younger than 60 months) in their care, using three waves of the panel dataset (2012/13, 2015/16, and 2018/19). [Table 1](#) presents the measurements of the outcome and explanatory variables used in the analysis, including child anthropometric outcomes, food insecurity, and household socioeconomic characteristics as control variables (in [Table 1](#)).

Table 1. Definition of the variables of sampled households from Nigeria's GHS for data analysis.

	Indicator	Description	Unit
Child malnutrition (MN) within households	Stunting	Height-for-age z-scores	1 = less than -2 z-scores 0 = otherwise
	Wasting	Weight-for-height z-scores	1 = less than -2 z-scores 0 = otherwise
	Underweight	Weight-for-age z-scores	1 = less than -2 z-scores 0 = otherwise
	Overweight	BMI-for-age z-scores	1 = greater than +2 z-scores 0 = otherwise
	Stunted-overweight	Height-for-BMI (HBZ)	1 = less than -2 z-scores 0 = otherwise
Household food security measures (FIs)	Food Security Index (FSI)	Consolidate approach to reporting indicators of food security (CARI)	1 = Food secure 2 = Marginal food secure 3 = Mildly food insecure 4 = Severely food insecure
	Food expenditure share	Percentage of food expenditure in the total household income	1 = Low(<50%) 2 = Medium (50%-64%) 3 = High(65%-74%) & 4 = Very high(>74%)
	Household Dietary Diversity Scores (HDDS)	Measured the dietary quality using twelve food groups: cereal, white root & tuber, pulses & nuts, fat & oil, fruits, vegetables, eggs, meat, fish, milk, sweets and spices. One hundred and fifteen food items consumed in the last seven days were used to formulate the food groups and HDDS.	1 = Adequate(>35scores) 2 = Moderate(>21-≤35scores) 3 = Inadequate(≤21scores)
	Food Consumption Scores (FCS)	Measured the food nutritional values through assigned weights (in parentheses) of food groups, including staples (2), pulses (3), oils (3), fruits (1), vegetables (1), meat/fish (4), milk (4), and sugar (0.5). Each food group contains several food items consumed in households.	1 = Acceptable(≥6scores) 2 = Moderate(4-5scores) 3 = Poor (≤3scores)
	Asset ownership	Counting the assets owned by the household head. The indicator measures resilience to cope with sudden and long-term shocks.	1 = Most(≥10assets) 2 = Moderately(3-6assets) 3 = Least(<3assets)
	Livelihood Coping Strategy (LCS)	Measured the severity of livelihood stress after households adopted coping strategies	1 = Normal 2 = Stressed 3 = Crisis 4 = Emergency
	Sex	Sex of household head	1 = Female and 0 = Male
Household socioeconomic features (X)	Age	Age of household head	Years
	Household size	Number of family members in a household	Count
	Literate	Whether the household head can read and write	1 = Yes and 0 = Otherwise
	Plot count	Number of farm plots managed by the household	Count
	Cooperative	Whether a household head belongs to a society	1 = Yes and 0 = Otherwise
	Off-farm income	Off-farm income earned by the household head per month	Naira (₦)
	Remittance	Whether a household head received remittance from emigrated family members	1 = Yes and 0 = Otherwise
	Total Livestock Unit (TLU)	The number of livestock owned by the household head	Count

Source: General Household Survey²⁸.

Measurements of Outcome and Explanatory Variables

- Child anthropometric deficits serve as proxies for assessing nutritional outcomes among children.^{10,14} This study utilized data on the height, weight, age, and gender of children under 5 years old to calculate anthropometric z-scores (see Table 1). These include height-for-age z-scores (HAZ), weight-for-height z-scores (WHZ), weight-for-age z-scores (WAZ), BMI-for-age z-scores (BAZ), and Height-for-BMI (HBZ), computed using the World Health Organisation (WHO) growth reference standards with the *Zanthro* command in STATA.²⁹ BMI refers to Body Mass Index. Children with z-scores below -2 standard deviations from the WHO reference population were classified as stunted (if $HAZ < -2$), wasted (if $WHZ < -2$), or underweight (if, $WAZ < -2$). Children with BMI-for-age z-scores above $+2$ standard deviations (that is, $BAZ > +2$) were classified as overweight. The category stunted-overweight refers to children who are simultaneously stunted ($HAZ < -2$) and overweight ($BAZ > +2$). The double anthropometric indicator of height-for-BMI (i.e., stunted-overweight) describes a child who was both stunted and overweight. This represents an individual-level double burden case of malnutrition in a household. Children whose height-for-BMI was below minus two standard deviations ($-2SD$) from the median of the recommended reference population were stunted-overweight (shorter for their weight).²⁹ Based on this information, we determine whether a sampled household head has at least a malnourished (i.e., stunting, wasting, underweight, overweight, and stunted overweight²) child or not. The study only considered the incidence (not the intensity) of child malnutrition within the household, regardless of the number of children in the household. For example, if a child is stunted in a household, the household head was coded as 1; if not, the household head was coded as 0.
- This study computed six internationally accepted food security indicators (FIs) among the sampled household heads across the waves of survey (Table 1). The computed FIs include the following:
 - (i) Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) as direct indicators to evaluate food quality and access.³⁰ The HDDS reflects the variety of food groups consumed by a household. Low dietary diversity increases the risk of micronutrient deficiency, which is a proxy for low food utilization. The FCS is a composite index based on dietary diversity, food frequency, and the relative nutritional importance of different food groups. The dietary diversity (HDDS) and food consumption scores (FCS) are validated as proxies for food access.¹⁹
 - (ii) Food Expenditure Share (FES), asset ownership, and Livelihood Coping Strategies (LCS) as proxies for assess food security stability

and resilience.^{31–33} Asset ownership is used here as a proxy for household wealth. Asset-poor households are more vulnerable to economic and food production shocks, resulting in insufficient food access, poor sanitation, inadequate dietary diversity, and poor nutrition among household members.³³ The FES refers to the proportion of household income spent on food, often used as an indicator of economic stress.³² The high food expenditure shares reflect economic vulnerability and reduced capacity to afford balanced diets, while asset ownership reflects a household's capacity to produce/supply food or withstand shocks. The LCS reflected household adaptive responses to shocks (e.g., conflicts, economic crises, climate variability, and pandemics), which disrupt food stability.³⁰ Households shift from normal through the stress (e.g., reducing meal size and selling nonproductive assets) and the crisis (e.g., selling productive assets) to the emergency (e.g., begging or extreme food restrictions) livelihood coping strategies,³³ given a shock. The shock(s) occasioned in the time-horizon of the three-wave surveys include flood disaster, food price volatility, and insurgency in 2012/13^{34–36} economic recession, farmers-herders conflicts and climate variability in 2015/16³⁷; banditry/kidnapping, flooding, crop disease infestation (e.g., Armyworm), and border closure policy in 2018/19.^{38–40}

- (iii) A Food Security Index (FSI) is a composite indicator that reflects the availability, access, utilization, and stability of food within a household.³⁰ The FSI was constructed based on the Consolidated Approach to Reporting Indicators of Food Security (CARI), which incorporates key properties of food security. CARI comprises two main domains: current status and coping capacity. The coping capacity was derived from FES and LCS, while FCS represented the current status.³⁰ Lower FSI scores indicate greater food insecurity. The binary child MN indicators and the severity levels for each of these six food security measures considered in this study are presented in [Table 1](#).
- (iv) The choice of food security indicators (FIs) considered a VIF-test for its tendency to show whether predictors are linearly redundant in non-linear models. However, the VIF-test failed to show how much the coefficient variances are inflated in the non-linear likelihood framework. While the FIs construct was ordered categorical indices, we applied pre-estimation Spearman correlation (with the result in [Table 2](#)) to identify the monotonous relationships³ of FIs (in ranked or ordinal data). The weak or uncorrelated coefficients of FIs for data analysis assume low multicollinearity issues with our regression model estimates. Since the Spearman's highlighted monotonic associations does not translate to linear dependence, we shifted focus to

Table 2. Testing the spearman correlations between various food insecurity measures.

	FSI	FES	HDDS	FCS	Assets owned	LCS
FSI	1.000					
FES	−0.603*(0.000)	1.000				
HDDS	0.603*(0.000)	−0.217(0.000)	1.000			
FCS	0.763*(0.000)	0.150(0.000)	0.690*(0.000)	1.000		
Assets owned	0.305*(0.000)	0.223*(0.000)	0.260*(0.000)	0.303*(0.000)	1.000	
LCS	−0.301*(0.000)	0.069*(0.001)	−0.039(0.056)	0.013(0.524)	−0.022(0.279)	1.000

Note: In parenthesis is standard error. Significant level: * $p < .05$. High correlation runs from ± 0.70 to ± 1.0 ; Moderate correlation runs from ± 0.30 to ± 0.69 ; Weak correlation runs from 0.00 to ± 0.29 ⁴¹.

Source: Author (2025).

the real structural issues in our FIs' constructs. The composite FSI was not used in the regression models due to its structure as a derivative of components of other FIs (i.e., many food security indicators are components of FSI). Including both the composite FSI and its parts in a regression model will create redundancy and instability. A common observation was also found between FCS and HDDS. While subjective weights are assigned to each food class to build the FCS, Kennedy et al.⁴² suggested that HDDS is a robust, easy-to-interpret, and reliable indicator for capturing nutrient adequacy. Therefore, this study considered the FES, HDDS, assets owned, and LCS as independent predictors in our regression model.

- We controlled for socioeconomic characteristics such as sex, age, household size, literacy, number of plots owned, cooperative membership, off-farm income, remittances, and total livestock units of the sampled households (Table 1).

Estimation Strategy

Our goal is to examine how a comprehensive set of indicators of household food insecurity (incidence and severity) is associated with child anthropometric outcomes over time (t). The panel-data framework is especially suited for this task, given that, the dataset at hand comprises repeated observations of households with children (i). The panel data framework accounts for unobserved household-level characteristics that may jointly influence FIs and the nutritional outcomes measured using child anthropometrics, MN_{it} , which equals one if household head i at time t has a child suffering from c malnutrition (stunted, wasted, underweight, overweight, or stunted-overweight), and zero otherwise. The model is represented as follows:

$$\text{logit}P(MN_{cit} = 1) = \beta_0 + FI_{qit}\beta_q + X_{it}\beta_x + u_i + \gamma_t + \varepsilon_{it} \quad (1)$$

In equation [1], where FI is a vector of q food insecurity measures (the four defined in Table 1) and X_{it} is a vector of socioeconomic the controls (in

Table 1 and survey year dummies). The u_i is an unobserved household-specific effect, γ_t is a survey year-specific effect, and ε_{it} is an idiosyncratic error term. Where this model is estimated as the standard Random Effects (RE) model, the estimates may be biased if unobserved household traits (e.g., caregiving practices, dietary habits, and long-run wealth) and seasonal shocks in ε_{it} correlate with the covariates in vector X or F .

The standard is to use the Fixed Effect (FE) estimator which removes all forms of arbitrary correlations between the error term and all factors in vector X and FI . However, it also prevents the estimation of time-invariant effects (such as rural/urban dummy) and drops as all households with no within-household variation in MN-indicators. Thus, we maintain the RE-model but implement the Correlated Random Effects (CRE) approach of Mundlak⁴³ and Chamberlain,⁴⁴ which relaxes the otherwise strong assumption of the RE-model. With where $\bar{X}_i$ denoting the household-level mean of each X_{it} across all survey waves, CRE augments the RE model with group-specific means of the time-varying covariates as indicated in [2]

$$\text{logit } P(MN_{cit} = 1) = \beta_0 + F_{qit}\beta_q + X_{it}\beta_x + \bar{X}_i\beta_{xi} + \bar{X}_t\beta_{xt} + u_i + \gamma_t + \varepsilon_{it} \quad (2)$$

In equation [2], β_x captures within-household (over time) effects, analogous to the FE estimator, β_{xi} captures between-household differences, β_{xt} represents between-year differences and γ_t year fixed effects satisfy the RE assumption conditional on $\bar{X}_i$, the remaining u_i satisfies the RE assumption conditional on $\bar{X}_i$. The CRE thus incorporates within and between variations while avoiding the incidental parameters problem of nonlinear FE models (such as *xtlogit* in Stata 17.0)⁴⁵.

Thus, we estimate the CRE-logit models as the primary specification for binary outcomes and clustered standard errors at household-level are not feasible due to the definition of our MN (i.e., binary outcome for the households regless of the number of children per household). The clustered standard errors at the year level are also not feasible due to only 3 years of data (few clusters). As a result, the reported standard errors are interpreted with caution. We report the Ordinary Wild Bootstraps (OWB) standard errors, which is a better option for data with fewer sub-clusters than observations.⁴⁶ Also, the year-fixed effects are included to account for common shocks across years. We also report FE-logit and RE-logit models as robustness checks. Given that, coefficients from logit models are on the probability scale, and we report the coefficients ($\exp(\beta)$) in average marginal effects (AMEs) from the CRE-logit model for ease of interpretation. AMEs show the change in predicted probability associated with a one-unit change in a covariate or a movement from 0 to 1 for a binary indicator of a given category of FI as measured by one of the q indices.

The implication of the simultaneous inclusion of all four indices of FI in the model is that we estimate the effects of a given FI dimension (via a given indicator) while controlling for potential effects of other dimensions. But this approach could introduce multicollinearity, and thus, misspecification biases in the estimates. We use the VIF test and Spearman correlation to verify that no such influences are present in our estimates. For the effects β_q to be identified, a discussion of the exogeneity or instrumentation of FI indicators is warranted. The CRE allows correlation between regressors and permanent household traits. It removes bias coming from time-invariant unobserved heterogeneity such as long-run caregiver quality, inherent household dietary preferences, permanent wealth, or culture and fixed location factors, which do not change across survey waves. CRE handles this by including the household mean and year mean (i.e., linear trend) of each time-varying regressor. It, however, does not completely deal with reverse causality and confounding that change over time beyond three survey periods. If such confounding exists (and it almost certainly does in this context), CRE does not identify causal effects. It only improves the precision and structure of associations between FI and MN outcomes.

Thus, we are unable to rule out that (i) imprecise measurement of FI indicators and nutritional shocks to children could cause food reallocation decisions – i.e. measurement errors and reverse causality; (ii) long-term seasonal shocks (due to natural disasters – diseases and environmental hazards) or intrahousehold food allocation decisions – among other time-varying unobserved phenomena – could vary over time as well as influence both FI and child MN-outcomes; and (3) neither are we even able to rule-out systematic differences across households in their food practices, caregiving norms, long-term economic vulnerability, or health environments, among other time-invariant phenomena. Rather, as presented above, we mitigate the identification challenges via (a) Household-level correlated random effects (CRE), (b) Rich set of controls, (c) Temporal variation via the panel structure which reduces confounding from stable household traits, and (d) Sensitivity checks across CRE, FE, and RE models where consistency of qualitative results increases confidence in the robustness of estimates. The FE-logit which eliminates all time-invariant unobservable and RE-logit leverages both within- and between-household variation under stronger assumptions. These notwithstanding, as good as our results are, they may not be interpreted as causal effects.

Results and Discussion

Table 3 presents the descriptive statistics of the variables for socioeconomic features, child malnutrition status, and food security of the sampled household heads across locations. Fewer than 30% of household heads resided in

Table 3. Descriptive summary of variables among the sampled household heads across location.

Household head features (unit)	Total	Rural	Urban	Mean diff.
Sex (female %)	0.0421(0.004)	0.050(0.005)	0.018(0.005)	0.033*(0.009)
Age(year)	33.428(0.522)	39.947(0.536)	34.174(0.976)	5.773*(1.083)
Household size(number)	8.036(0.079)	8.383(0.092)	7.010(0.141)	1.000*(0.179)
Literate(%)	0.440(0.010)	0.226(0.017)	0.513(0.012)	-0.286*(0.022)
Plot number	1.879(0.035)	2.310(0.040)	0.606(0.043)	2.000*(0.073)
Cooperative(%)	0.080(0.005)	0.047(0.005)	0.176(0.015)	-0.129*(0.012)
Off-farm income(₦)	21223.08 (1717.659)	13360.96 (1939.698)	44913.4 (3484.387)	31552 (3919.955)
Remittance(%)	0.112(0.006)	0.100(0.007)	0.150(0.014)	-0.050*(0.015)
Total Livestock Unit(number)	8.000(0.436)	11.000(0.569)	1.000(0.113)	10.000*(0.980)
HH has a malnourished child				
Stunted child	0.508(0.010)	0.573(0.012)	0.451(0.020)	0.122*(0.023)
Wasted child	0.605(0.010)	0.617(0.011)	0.589(0.020)	0.028*(0.023)
Underweight child	0.511(0.010)	0.513(0.012)	0.504(0.020)	0.009(0.063)
Overweight child	0.580(0.010)	0.553(0.011)	0.620(0.020)	-0.067*(0.003)
Stunted-overweight child	0.606(0.010)	0.603(0.011)	0.614(0.020)	-0.011(0.053)
HH food expenditure share				
Low food expenditure share	0.345(0.010)	0.402(0.011)	0.175(0.015)	0.227*(0.022)
Medi food expenditure share	0.171(0.008)	0.170(0.009)	0.175(0.015)	-0.005(0.018)
High food expenditure share	0.131(0.007)	0.094(0.007)	0.238(0.017)	-0.144*(0.015)
V. high food expenditure share	0.354(0.010)	0.334(0.011)	0.413(0.020)	-0.079*(0.022)
HDDS				
Adequate	0.180(0.008)	0.151(0.008)	0.267(0.018)	-0.116*(0.018)
Moderate	0.387(0.010)	0.365(0.011)	0.451(0.020)	-0.085*(0.023)
Inadequate	0.433(0.010)	0.484(0.012)	0.283(0.018)	0.201*(0.023)
HH Asset owned				
High	0.138(0.007)	0.168(0.009)	0.048(0.009)	0.120*(0.016)
Medium	0.137(0.007)	0.157(0.009)	0.076(0.011)	0.082*(0.016)
Low	0.725(0.009)	0.675(0.011)	0.877(0.013)	-0.202*(0.020)
LCS				
Normal	0.020(0.003)	0.024(0.004)	0.007(0.003)	0.018*(0.006)
Stress	0.114(0.006)	0.120(0.008)	0.098(0.012)	0.022(0.015)
Crisis	0.104(0.006)	0.119(0.008)	0.060(0.010)	0.059*(0.014)
Emergency	0.762(0.009)	0.737(0.010)	0.836(0.015)	-0.099*(0.020)
Total observation	2447	1828	619	

Note: In parentheses is the standard error. HH represents household. Significant level: * $p < .05$, Nov 2018, Central Bank of Nigeria's exchange rate: US\$1= ₦306.30.

Source: Authors (2025).

urban areas. Female-headed households were underrepresented in Nigeria's General Household Surveys, which were primarily designed to gather food and agricultural data from household heads, predominantly male, due to the country's patrilineal system. The proportion of female household heads in rural areas was three percentage points higher than in urban areas. This pattern reflected Nigeria's rural demographic structure, where male out-migration for nonfarm employment increases the share of female household heads.⁴⁷ The average age of sampled household heads was 33 years, with an average household size of eight. Both age and household size averages were higher among rural households compared to their urban counterparts, consistent with agrarian family structures characterized by higher fertility and extended family living arrangements. Larger household sizes are widely documented as risk factors for food insecurity and child malnutrition in Nigeria and SSA, particularly when dependency ratios are high.⁴⁸

The sampled household heads cultivated an average of two plots of land and earned roughly ₦21,223 (about \$68.12) per month from off-farm activities. Rural households, on average, managed one additional plot but earned ₦31,553 (\$103) less from off-farm work compared to their urban counterparts. Half of the sampled household heads were literate, with rural literacy rates being 29% lower than those in urban areas. Twelve percent of households received foreign remittances, with urban households benefiting five percentage points more than rural ones. Households owned an average of eight total livestock units (TLU), with rural households owning more (10 units) than urban households. Only eight percent of sampled household heads were members of a cooperative, with five percent of rural and 18% of urban households participating in such groups, reflecting better access to formal institutions, financial groups, and social networks in urban areas than in rural areas.

More than 50% of households had at least one stunted child, with significantly higher prevalence in rural areas. Households with wasting incidences were alarmingly high in both rural and urban areas, with only little rural-urban differences. Similar patterns have been documented during short-term shocks in terms of recent food price inflation, disease outbreaks, and climate stress in Nigeria and the Sahel.⁴⁹ While there were no variations in underweight and stunted-overweight incidences among rural and urban households, overweight was slightly higher among urban farm households than those in rural areas. Fewer than seven percent of rural households had an overweight child than the urban households, suggesting a higher consumption of energy-dense, nutrient-poor (or sugar- and salt-rich) foods in urban areas, which may contribute to overweight.⁵⁰ The significantly higher prevalence of overweight children in urban households, alongside stunting and wasting, highlighted Nigeria's emerging double burden of malnutrition. The prevalence of stunted-overweight in a household signaled to the coexistence of both stunting and overweight in a child.

Nearly two-thirds of households spent a high portion of their budgets on food, reflecting food insecurity as high food prices reduce the purchasing power of low-income consumers.³² Urban households were disproportionately represented in the high and very high food expenditure share categories, indicating greater vulnerability to economic stress rather than food adequacy, particularly in market-dependent urban settings.⁵¹ Approximately 40% of rural households, by contrast, were more concentrated in the low expenditure category, reflecting partial reliance on own food production. Household dietary diversity was significantly poorer in rural areas, where nearly half (48%) of households fall into the inadequate category. This mirrored evidence showed that rural diets are often dominated by staples with limited intake of animal-source foods, fruits, and vegetables.⁷ Urban households performed better on average but still exhibited substantial diet quality deficits, reinforcing the idea

that income alone does not ensure nutrition security. Low asset ownership was overwhelmingly concentrated in urban areas, reflecting the limited capacity of urban households to accumulate productive assets. This was critical for understanding urban food insecurity, as asset poverty reduces households' ability to smooth consumption during shocks.⁵² About 76% of the households adopted emergency coping strategies, while at least 10% households adopted stress and crisis coping strategies, making them vulnerable to food insecurity. The majority of households, especially urban areas, reported relying on emergency coping strategies, indicating widespread livelihood stress. The greater use of emergency coping in urban areas may temporarily protect food consumption but it undermines long-term resilience and exacerbates vulnerability to malnutrition.²³

Table 4 presents the descriptive statistics of the variables for socioeconomic features, child malnutrition status, and food security of the sampled household heads across survey years (2012–2018). The descriptive statistics revealed the structural and nutritional changes over time, reflecting Nigeria's evolving FIs and socioeconomic conditions. The results of the Likelihood Ratio (LR) χ^2 (a non-regression-based test) that test for the equality of mean of each variable across years of data were presented in column 5 of Table 4. Statistically significant intertemporal differences (LR χ^2 tests) were observed across most household features, food security, and nutrition indicators, underscoring the importance of a short-term dynamic, panel-based analytical approach. The share of female-headed households remained low and statistically stable across survey waves, consistent with national evidence that household headship patterns change slowly over time. In contrast, the mean age of household heads increases significantly by 2018/19, suggesting demographic aging and reduced entry of younger household heads into agriculture. Similar aging trends have been documented in Nigeria and are often linked to youth out-migration and declining agricultural attractiveness.⁵³

Household size raised markedly between 2012/13 and 2018/19. Larger households increase dependency ratios and strain food resources, a pattern consistently associated with food insecurity and child malnutrition in Nigeria.⁴⁸ This demographic pressure provided a structural explanation for worsening nutrition outcomes observed later in the period. Literacy rates improved significantly by 2018/19, reflecting gradual gains in educational attainment. However, cooperative membership declined sharply, indicating a weakening institutional engagement among farming households. Nigerian studies showed that declining cooperative participation reduces access to credit, extension, and risk-sharing mechanisms, thereby increasing vulnerability to food shocks.⁵⁴ Off-farm income declined significantly over time, indicating a reduced livelihood diversification. This trend mirrored national evidence linking economic recessions, conflict, and labor market contraction to falling rural nonfarm earnings.⁵⁵ Reduced off-farm income limits

households' capacity to smooth consumption during food price spikes.⁵⁶ Remittance receipts increased dramatically by 2018/19, reflecting intensified migration as a coping response to economic hardship. The sharp decline in livestock ownership and the rising share of households in the low-asset category indicate widespread asset erosion.

The prevalence of stunting, wasting, and underweight increased markedly by 2018/19, signaling a deterioration in child nutrition outcomes. The simultaneous rise in overweight and stunted-overweight children highlights Nigeria's growing double burden of malnutrition. This reflected nutrition transitions toward overweight as well as stunted-overweight from the consumption of nutrient-poor foods across survey periods. The dramatic shift toward the very high food expenditure share category by 2018/19 (over 95%) reflects severe economic stress and food price inflation. Consistent with

Table 4. Descriptive summary of variables among the sampled household heads across survey years.

Variables	2012/13	2015/16	2018/19	LR Chi2 test
Household features				
Sex(female %)	0.039(0.007)	0.042(0.007)	0.045(0.007)	0.385
Age(year)	32.121(0.895)	31.156(0.915)	36.966(0.892)	244.746*
Location(1 = rural)	0.748(0.015)	0.749(0.015)	0.745(0.015)	0.0360
Household size(number)	7.255(0.115)	8.412(0.122)	8.440(0.163)	374.793*
Literate(%)	0.408(0.017)	0.386(0.017)	0.526(0.018)	37.3624*
Plot number	1.435(0.048)	1.536(0.050)	2.663(0.072)	256.707*
Cooperative(%)	0.087(0.010)	0.104(0.011)	0.048(0.007)	18.588*
Off-farm income(₦)	29764(3856)	20045(3078)	14033(1411)	658.430*
Remittance(%)	0.012(0.004)	0.027(0.006)	0.301(0.016)	427.091*
Total Livestock Unit(number)	12.813(0.862)	11.882(0.917)	0.168(0.043)	737.298*
HH has a malnourished child				
Stunting	0.499(0.018)	0.527(0.018)	0.678(0.016)	61.547*
Wasting	0.544(0.017)	0.598(0.017)	0.703(0.016)	45.266*
Underweight	0.429(0.018)	0.466(0.018)	0.638(0.017)	81.775*
Overweight	0.518(0.018)	0.614(0.017)	0.691(0.016)	51.298*
Stunted-overweight	0.517(0.018)	0.613(0.017)	0.688(0.016)	49.822*
HH food expenditure share				
Low food expenditure share	0.604(0.017)	0.411(0.017)	0.020(0.005)	2.0e + 03*
Medium food expenditure share	0.213(0.014)	0.294(0.016)	0.006(0.003)	
High food expenditure share	0.135(0.012)	0.233(0.015)	0.023(0.005)	
Very high food expenditure share	0.048(0.007)	0.063(0.008)	0.951(0.008)	
HDDS				
Adequate	0.109(0.011)	0.192(0.014)	0.240(0.015)	71.774*
Moderate	0.358(0.017)	0.408(0.017)	0.395(0.017)	
Inadequate	0.533(0.017)	0.400(0.017)	0.366(0.017)	
HH Asset owned				
High	0.195(0.014)	0.115(0.011)	0.104(0.011)	54.754*
Medium	0.159(0.013)	0.154(0.013)	0.098(0.010)	
Low	0.647(0.017)	0.730(0.016)	0.798(0.014)	
LCS				
Normal	0.034(0.006)	0.013(0.004)	0.011(0.004)	28.939*
Stress	0.100(0.011)	0.132(0.012)	0.110(0.011)	
Crisis	0.133(0.012)	0.092(0.010)	0.088(0.010)	
Emergency	0.733(0.016)	0.762(0.015)	0.791(0.014)	
Observation	816	816	816	

Notes: In parentheses is the standard error. HH represents household. Significant level for equality of group-mean using the likelihood ratio (LR chi2 test): * $p < .05$, November 2018, Central Bank of Nigeria's exchange rate: US\$1= ₦306.30.

Source Author (2025).

Engel's law, this pattern indicated declining real incomes rather than improved food access.⁵⁷ Dietary diversity improved at households over time, with reductions in inadequate HDDS. However, these gains were insufficient to prevent worsening malnutrition, suggesting that improvements in food variety are offset by declining food affordability, health services, and caregiving quality. The growing reliance on emergency coping strategies underscored intensifying livelihood stress. While such strategies may temporarily protect consumption, they undermine long-term resilience and are associated with asset depletion and nutritional vulnerability.³⁰

Figure 1 presents the pairwise correlations among child nutritional outcomes within households. The results offered important descriptive insights into the coexistence and overlap of multiple forms of malnutrition. The Pearson correlation was mathematically equivalent to the point-biserial correlation (or Phi coefficient – ϕ_{ij}) when one variable is binary and coded as 0/1. The results indicated that there were moderate to strong correlations between stunting, wasting, and underweight within households. This pattern suggested that children exposed to chronic undernutrition were also likely to experience acute nutritional stress and low body mass. In Nigeria, studies demonstrated that households with stunted children frequently also reported wasted or underweight children, reflecting overlapping deprivation rather than isolated nutritional failures.⁵⁸ At the conceptual level, underweight acts as a composite indicator, capturing both chronic (stunting) and acute (wasting) nutritional deficits. The observed correlations therefore reinforce WHO guidance that

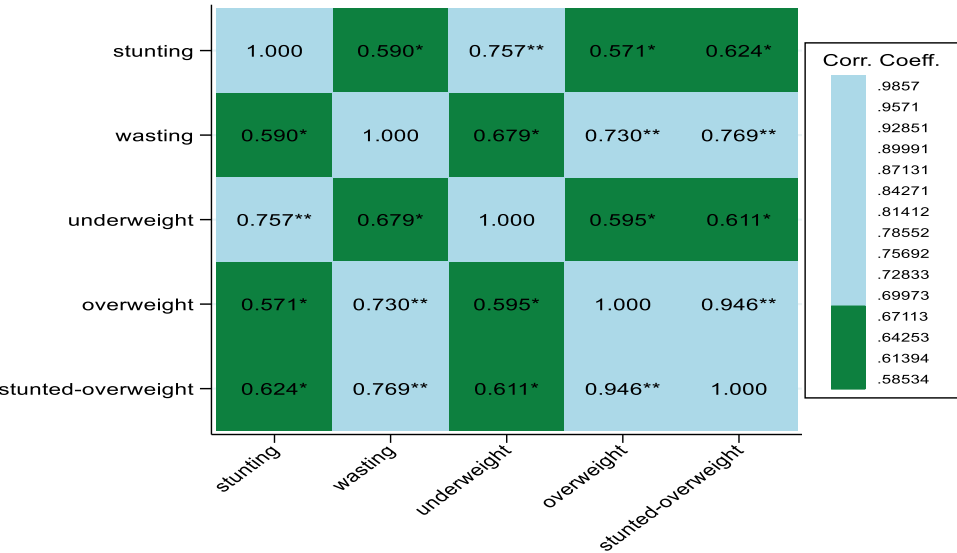


Figure 1. Results of pairwise correlations between households with child nutritional outcomes. Note: Significant level: * $p < .05$ and ** $p < .01$. High correlation runs from ± 0.70 and ± 1.0 ; Moderate correlation from ± 0.30 and ± 0.69 . Source: Author (2023).

underweight prevalence often mirrors combined stunting – wasting burdens in low-income settings.²⁹

The presence of significant correlations across malnutrition indicators highlighted the nutritional risk in a household. The correlations observed were therefore consistent with the household production of nutrition framework, which viewed child nutrition as the outcome of joint household decisions and constraints rather than individual-level choices. The correlation matrix also revealed a significant association between stunting and overweight within households, pointing to the emerging double burden of malnutrition. Empirical studies showed that stunted children may become overweight when exposed to energy-dense, nutrient-poor diets, particularly in urbanizing contexts.²⁰ At the household level, this reflected dietary polarization, where limited resources were allocated to cheap, calorie-dense foods that promote weight gain without supporting linear growth.⁵⁹ The correlation results demonstrated that child malnutrition in Nigeria is multidimensional in the household heads, with significant overlap between chronic, acute, and emerging forms of malnutrition. The coexistence of stunting, wasting, underweight, and overweight within households reflects shared structural constraints and evolving food environments, consistent with contemporary Nigerian and SSA evidence.^{20,58}

The CRE Logit Regression Results of Food Insecurity Level on Child Malnutrition

This study considered CRE-logit (*xtlogit*) by including Mundlak (group means) for time-varying regressors to control for correlation between (household and year) unit effects and regressors, and we interpreted the results with caution as year-level clustering of standard errors was not feasible due to the small number of clusters (i.e., 3 years of data). We reported the Ordinary Wild Bootstrap standard errors, which is a better option to address heteroskedasticity errors in the model. However, the inclusion of household and year fixed effects in the CRE framework strengthens predictive interpretation by accounting for time-invariant household heterogeneity.

Figure 2 presents the statistically significant average marginal effect of food security indicators on child nutrition outcomes. The results (in Box A.) revealed the statistically significant relationship between child stunting and food insecurity among sampled households. Households with a very high food expenditure share (FES) showed a statistically significant relationship with the likelihood of child stunting. Households with a very high food expenditure share had a 13% higher probability of being associated with stunting relative to the low FES (reference group). In urban areas, the relationship is much stronger, and children in households with very high FES were significantly associated with a high risk of stunting, reflecting severe economic vulnerability. Children in households with an inadequately

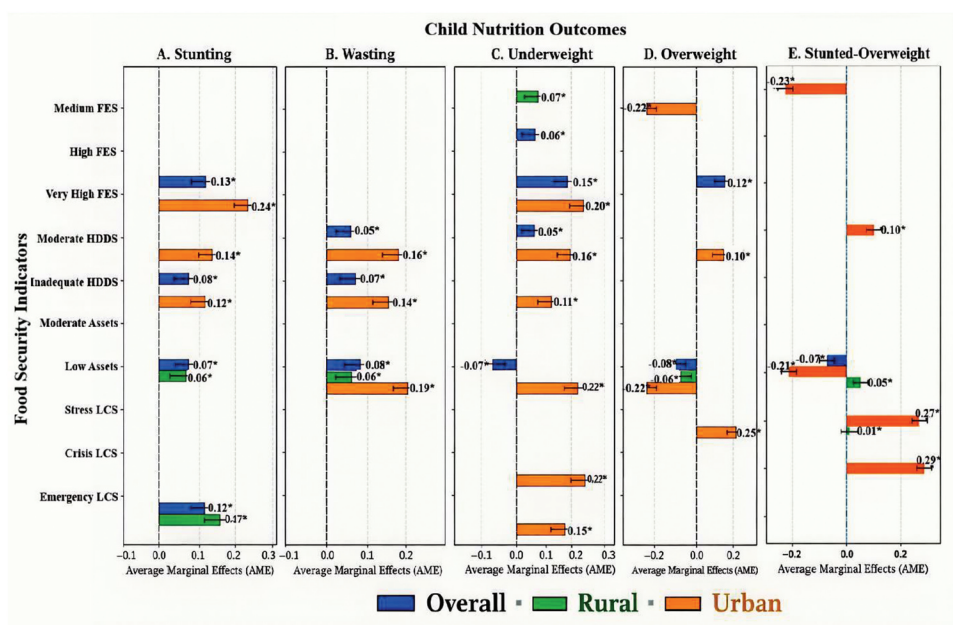


Figure 2. CRE-Average marginal effects of food security indicators on child nutrition Outcomes. Note: Wild Bootstraps Standard errors in parentheses, Significant level: $*p < .05$. Low FES is the reference category for FES levels; Adequate HDDS is the reference category for HDDS levels; High Asset is the reference category for Asset levels and Normal LCS is the reference category for LCS levels. Source: Author (2026).

diversified diet (vs. an adequate diet diversity) were significantly associated with a high risk of stunting by eight percentage points. In urban areas, both moderate and inadequate dietary diversity were 14% and 12% significantly related to stunting risk, respectively, relative to adequate HDDS. Households in the low asset category were seven and six percent significantly more associated with stunted children in the overall and rural samples. Households adopting emergency coping strategies were 12% and 17% significantly more associated with stunted children in the overall and rural samples.

Figure 2's results (in Box B.) also revealed that there was a statistically significant relationship between child wasting and food insecurity among sampled households. Overall, children in households with moderate and inadequate dietary diversity were significantly correlated with a higher risk of wasting by five to seven percentage points relative to adequate dietary diversity. In urban areas, both moderate and inadequate dietary diversity compared to adequate HDDS were 16% and 17% significantly related to stunting risk, respectively. Children in low asset households compared to high asset households were 8, 6, and 19 more associated with wasting across overall, rural, and urban samples.

Figure 2 (in Box C.) presents the statistically significant relationship between child underweight and food insecurity among sampled households. Relative to the reference “low” FES group, children in overall sampled households with very high FES had a 15%-point higher marginal probability of underweight risk. The relationship was especially large in urban areas, where very-high-FES urban households had a 20%-point higher marginal probability of child underweight. Moderate and high FES were six percent and seven percent also associated with underweight likelihood in the pooled and rural samples. In relation to adequate HDDS, the moderate diet diversity was 16% significantly associated with urban underweight likelihood, which is greater than a five percentage-point higher marginal probability of underweight among rural sampled households. Similarly, an inadequate diet (vs. adequate) showed 11% more significant co-variation with child underweight. Household wealth (proxied by asset ownership) showed a mixed relationship. The children in the low-asset households surprisingly had a relationship with lower likelihood of being underweight, with a seven percentage-point higher marginal probability of the risk compared to the high-asset households. In urban areas, the low-asset group had 22% points of child underweight. That is, urban poverty was strongly correlated with underweight, while rural contexts are more complex. We found that the estimates of “crisis” and “emergency” coping family categories were 5% statistically significant association with underweight risk by 22% and 15% in urban households.

The results (in Box E.) of Figure 2 present the statistically significant relationship between child overweight and food insecurity among sampled households. Children in households under extreme budgetary stress (very high FES vs low FES) were 12% more likely to be overweight. In urban settings, food budget strain (medium FES vs low FES) was significantly associated with 22% lower overweight risk. Household dietary diversity had weaker associations. Using adequate diversity as a reference, moderate diet diversity was significantly linked to higher overweight in urban areas by 10% percentage points, reflecting that moderately diverse diets in urban poor settings still include calorie-dense items. Asset wealth showed the expected inverse relation. Compared to “high”-asset households, the “low”-assets category (poorest households) had (8%, 6% & 22%) significantly lower association with the marginal probability of child overweight among rural, urban, and overall sampled households, respectively. Urban households with “stress”-level coping (the mildest form of deprivation) strategies were 25% significantly associated with overweight risk. Figure 2 (in Box F.) presents the statistically significant relationship between child stunted-overweight and food insecurity among sampled households. Medium-FES households relative to the low-FES group showed a non-monotonic relationship with stunted-overweight – dual burden risk in children, especially in urban areas. Children from households with lower diversity (vs adequate diversity) tended to be significantly

correlated with higher dual-burden risk, particularly in urban areas. Asset ownership (a proxy for wealth) showed a striking urban–rural divide with double burden nutrition. In rural areas, children in the low-asset households (vs high -asset group) had a five percentage-point higher marginal probability of the DBM likelihood. By contrast, in urban areas, the poorest asset category was 21% more associated with lower DBM risk. In the overall (combined) sample, the poorest assets showed a seven percent likelihood of association with lower DBM risk, but this masks the diverging location differences. The “stress” coping (minor adjustments like eating less preferred foods) was correlated with DBM risk substantially. In urban and rural Nigeria, stress-coping households had about 27% and one percent more associated with the high marginal probability of a child being stunted-overweight. The households who cope with “crisis”-based strategies (borrowing, selling assets) were 29% more associated with DBM risk in urban children.

The Robustness Check

We evaluate whether the main CRE estimates (summarized in [Table 5](#)) are robust across alternative estimators (in [Figs. A1 and A2](#)) and specifications. This paper has at least two explicitly robustness checks (FE-logit and RE-logit) for all model specifications for indicators of FS and MN in the main

Table 5. Summaries of significant associations between food security and child malnutrition (CRE models).

Food-security indicator	Malnutrition Indicators				
	Stunting	Wasting	Underweight	Overweight	Stunted-Overweight
Food Expenditure Share (FES)					
*Reference Category: Low FES					
Medium FES	–	–	↑ Rural	↓ Urban	↓ Urban
High FES	–	–	↑ Urban	–	–
Very high FES	↑ Urban, ↑ Overall		↑ Urban, ↑ Overall	↑ Overall	–
Dietary Diversity Scores (HDDS)					
*Reference Category: High HDDS					
Moderate HDDS	↑ Urban	↑ Urban, ↑ Overall	↑ Urban, ↑ Overall	↑ Urban	↑ Urban
Inadequate HDDS	↑ Urban, ↑ Overall	↑ Urban, ↑ Overall	↑ Urban		
Assets (Low asset ownership)					
*Reference Category: High assets					
Moderate assets	–	–	–	–	–
Lowest assets	↑ Rural, ↑ Urban	↑ Rural, ↑ Urban	↑ Urban, ↓ Overall	↓ Rural, ↓ Urban, ↓ Overall	↑ Rural, ↓ Urban, ↓ Overall
Livelihood Coping Strategies					
Reference Category: Normal					
Stress Coping				↑ Urban	↑ Urban
Crisis Coping			↑ Urban		↑ Urban
Emergency	↑ Rural, ↑ Overall		↑ Urban		

Source: Author (2026).

text. A summary of findings from these alternative specifications includes the following: (1) signs of coefficients remain stable across CRE, FE, and RE; (2) magnitudes of the estimates for the levels of FS indicators differ for LCS and assets in urban samples, and (3) there were no qualitative changes for HDDS or FES. Across all models, the key associations – poor diet diversity, high food expenditure share, and coping strategies in urban households – remain robust. The Wald and LR statistics indicate strong overall model significance. We found consistency in results across CRE, FE, and RE logit models, strengthening the confidence in the interpretation and inferences. However, some results in the FE/RE models may be counter-intuitive or contradict our expectations. The divergence could be associated with our inability to adequately address identification issues like reverse causality (e.g., food insecurity and malnutrition), which may require valid instruments for estimating the Instrumental Variable (IV) model. Therefore, the coefficients from our models were interpreted with caution as conditional associations, capturing short-term nutritional vulnerability rather than long-run welfare outcomes.

The Results' Discussion for the Relationship Between Food Insecurity and Child Malnutrition

We estimate correlated-random-effects (CRE) logistic models and random- and fixed-effects models with extensive controls (including household and year-fixed effects). We discuss the main significant CRE results as summarized in [Table 5](#) by nutrition outcomes across the food security indicators in the overall sample, and rural/urban subsamples.

Stunting: Persistent Poverty and Poor Diets

Our findings indicate that chronic undernutrition (stunting) is closely linked to long-term economic deprivation and limited diet quality, with important urban-rural contrasts. In urban areas, children in households with very high food expenditure shares (FES) – a proxy for extreme poverty – are much more associated with stunting. High FES reflects that most of a family's limited income is spent on food, leaving little for nutrient-rich foods.⁶⁰ This is compounded by poor dietary diversity: nationally, only about 56% of Nigerian women meet minimum dietary diversity,²⁵ suggesting many children consume monotonous, low-quality diets. In other words, urban poor families often pay heavily for food but still cannot afford a varied diet, consistent with Engel's Law and evidence from other contexts linking high food budgets and low diet quality to stunting.

By contrast, asset poverty in rural areas emerges as a key correlation of stunting. Rural households depend on subsistence farming with limited yields and have fewer livelihood assets, so income poverty directly limits both food

quantity and diversity.⁶¹ Morgan and Fanzo⁶⁰ note that rural Nigeria experiences higher undernutrition. In our data, the poorest rural families – those lacking land, income, or social capital – had especially high stunting risk, reflecting chronic food gaps and inadequate nutrient intake over time.

Additionally, households resorting to emergency coping strategies (e.g., skipping meals and borrowing food) had higher predicted stunting in the overall and rural samples. This pattern aligns with literature that resource-poor families frequently reduce meal quality and frequency during shocks.⁵⁰ Recurrent food shortages and unstable consumption patterns likely exacerbate growth faltering. In sum, stunting in Nigeria appears to be related to sustained poverty and persistently poor diets – especially among urban families with limited purchasing power and rural households with low assets – in line with broader evidence that low dietary diversity and high food cost burdens are fundamental causes of chronic undernutrition.

Wasting: Acute Shocks and Diet Instability

Acute undernutrition (wasting) in our study showed a different pattern: it was not strongly linked to high FES but was correlated with poor diet quality and asset poverty across regions. This suggests that wasting is associated with short-term shocks to food access rather than chronic food-budget stress. Consistent with Headey and Ruel's,⁶² analysis, major negative economic shocks can sharply reduce children's dietary diversity and precipitate wasting. In other words, when a family's income or food supply drops abruptly (due to illness, price hikes, or other crises), children's diet diversity falls, connecting with acute weight loss.

Our finding that wasting rises with asset poverty in all areas likewise fits global patterns: the poorest households have the least buffer against shocks. Even without very high FES, asset-poor families (often rural) cannot smooth consumption or access sufficient food during crises, making children vulnerable to acute undernutrition. In Nigeria's context, rural asset-poor families often consume largely homegrown staples; a bad season or market disruption means immediate scarcity. This matches evidence that rural Nigerians frequently experience seasonal or crisis-related wasting, whereas urban poor face more chronic undernutrition.⁶³ In short, wasting here appears as an indicator of transient food insecurity – linked to abrupt dietary declines (low HDDS) and poverty – rather than long-term income stress.

Underweight: Combined Associations of Stressors

Underweight (a composite of chronic and acute undernutrition) reflects situations where both quantity and quality of diet are compromised. We find that underweight children are most associated with households under intense food stress (very high FES) and under low diet diversity, especially in urban settings. This implies that severe budget constraints plus poor diet

correlated with underweight, echoing the drivers of both stunting and wasting. Notably, underweight risk was associated with urban households employing crisis or emergency coping strategies. This suggests that in cities, sudden consumption cuts (e.g., skipping meals when money runs out) connect with children being underweight. and and Fanzo,⁶⁰ describe how urban poor families often use distress-coping (going hungry, borrowing food) even in the absence of large shocks, which would directly translate to acute and chronic deficits.

The role of assets in underweight was complex as asset poverty appeared somewhat protective because the very poorest families tend to under consume calories in a way that masks weight deficits on this composite measure. However, in urban areas, low assets were associated with a higher underweight risk. This likely reflects that urban asset-poor families lack both income and self-produced food, making them particularly susceptible to under nourishing crises. By contrast, the poorest rural households, while food insecure, may rely on minimal subsistence staples, connecting more with stunting than the acute weight loss captured by underweight. These patterns suggest underweight is associated with both chronic deprivation and acute shocks, with city dwellers facing especially volatile food conditions that manifest in underweight when families cope badly with stress.

Overweight: The Food-Insecurity-Obesity Paradox

Perhaps most striking is the food insecurity–overweight paradox we observe. In urban Nigeria, the risk of child overweight was highly linked to households with very high FES (i.e., severe food stress), whereas it is lower in the moderate-FES group. In addition, moderate dietary diversity is associated with urban overweight, and having few assets is strongly protective against overweight. These counterintuitive findings align with the nutrition transition framework, which describes that Nigerian diets are becoming more diverse but also richer in refined carbohydrates and processed foods.⁶⁰ Poor urban families under financial strain may turn to inexpensive, energy-dense foods (refined grains, oils, sugary snacks) that provide calories but little nutrition. This can connect with an excess weight gain even as diets lack quality.

Such patterns have been documented elsewhere: Engel's Law implies that both extreme poverty and rising affluence can yield poor diets. In Nigeria, processed foods are increasingly consumed by even middle- and low-income urban households, and sedentary lifestyles are on the rise.⁶⁴ Overweight and obesity are now major public health problems in Nigeria and other LMICs, even while undernutrition persists.⁶⁰ Under chronic food insecurity, some children may overeat when food is available (a form of cyclical deprivation and feasting) or experience stress-induced metabolic changes – both mechanisms proposed in the literature to explain the obesity risk under food insecurity. Thus, our findings suggest that economic stress in an obesogenic

environment can increase overweight risk, reversing the usual poverty–under-nutrition linkage. This underscores that income alone does not determine child overweight; rather, the nature of the food system (cheap processed foods) plays a crucial role.

Stunted – Overweight: The Urban Double Burden

Finally, the coexistence of stunting and overweight in the same child (“double burden”) emerged predominantly in urban settings and among households with moderate resources plus stress. In cities, medium-FES households and those using coping strategies had the highest predicted risk of concurrent stunting and overweight. This pattern likely reflects a life-course effect: children experiencing early growth restriction (due to poor diets in infancy) later gain excess weight when exposed to cheap high-calorie foods. As Morgan & Fanzo note, the interaction of early undernutrition and the nutrition transition has fueled the double burden of malnutrition.⁶⁰ In other words, a child who is growth-stunted may have metabolic adaptations that predispose to adiposity when diets later include refined carbs and fats.

The urban concentration of this phenotype suggests food environment factors: even moderately poor urban families may give children some diverse foods but still rely heavily on sugars and fats. By comparison, some rural poor families may remain relatively undernourished without gaining excess weight (their limited diet of staples tends to blunt obesity). This context-specific pattern is consistent with prior evidence that the dual burden often appears in populations undergoing dietary transition.⁶⁵ Notably, in our data, urban asset poverty reduced double-burden risk (as poorest kids tended to have only undernutrition), whereas in rural areas, asset poverty slightly increased it (perhaps reflecting a mix of chronic undernutrition and the rising availability of refined staples). In sum, the stunted-overweight outcome seems to arise where households straddle deprivation and the modern diet – a hallmark of the ongoing nutrition transition in Nigeria’s cities.⁶⁰

Implications for Policy and Practice

These findings have several policy implications. First, nutrition interventions must go beyond calories and target diet quality. Ensuring access to affordable nutrient-dense foods (fruits, vegetables, and proteins) is critical, particularly for poor urban households. For example, food subsidy programs or cash transfers could be designed to make healthy foods more accessible than ultra-processed alternatives. Second, urban food environments require regulation: policies such as taxing sugary snacks, mandating clear labeling, and limiting marketing of unhealthy foods could help counter the obesity risk among the food-insecure households. Third, social protection and safety nets should be strengthened to prevent harmful coping behaviors. For instance, scaling up school feeding or emergency food aid in urban areas could reduce the need for

families to skip meals or rely on the cheapest calories. Fourth, rural interventions should focus on agricultural and livelihood support. Improving farm productivity, crop diversity, and storage can enhance food availability and dietary diversity in the countryside, directly addressing the root of rural stunting.

Importantly, these strategies must adopt a “double-duty” approach. Rather than treating undernutrition and overweight as separate problems, programs should be integrated. For example, maternal and child nutrition programs can incorporate guidance on healthy dietary patterns to simultaneously combat stunting and prevent excess weight. Public health messaging should emphasize balanced diets even when budgets are tight. Finally, broader food system reforms are needed: policies that transform Nigeria’s food supply (such as investing in local fruits and vegetables, or regulating food imports and processing standards) would help shift the entire environment toward healthier options. Each implication above ties directly to our findings on how specific dimensions of food insecurity relate to each malnutrition outcome.

Limitations

Several limitations warrant cautious interpretation. The study faced an identification challenge, such as reverse causality and long-time-varying unobserved factors, so causal pathways cannot be confirmed; we can only describe associations. Measures like FES, HDDS, and coping strategies are based on household reports and may suffer from recall or reporting bias. The asset poverty has protective effects for underweight, overweight, and urban double-burden outcomes. However, the asset indicator may not capture all aspects of poverty or food access (for example, it omits seasonal variations and informal income). We also lack data on children’s physical activity, which could influence overweight outcomes. Furthermore, cultural factors and intrahousehold food distribution (who eats first) are not directly measured. Finally, our urban–rural comparisons may mask important within-urban and within-rural heterogeneity (differences between regions, or between slum vs. non-slum urban neighborhoods). Future longitudinal research with detailed dietary and behavioral data would help validate and refine these findings.

Conclusion and Recommendations

This study provides robust empirical evidence that household food insecurity is a multidimensional covariate of child malnutrition in Nigeria, shaping not only traditional outcomes such as stunting, wasting, and underweight, but also overweight and the individual-level double burden of malnutrition. Our key findings suggest that stunting is associated with long-term structural deprivation and diet quality deficits; wasting reflects short-term shocks, illness, and seasonal deprivation; underweight reflects

multiple insecurities operating simultaneously; overweight presents a food-insecurity paradox which indicates high consumption of energy-dense, low-quality diets among food-stressed urban populations; and lastly, double burden of malnutrition is contained in the results on stunted-overweight, reflecting nutrition transition and reliance on processed food environments. Our study unearths the following cross-cutting themes: (1) Dietary diversity (HDDS) is the most consistent predictor across MN outcomes; (2) Urban malnutrition is associated with market dependence indicators, high food prices, processed foods, and coping responses; (3) Rural malnutrition is associated with asset poverty, structural deficits, and chronic livelihood vulnerability; and (4) The double burden of malnutrition is accelerating in urban areas where insecurity coexists with access to cheap, calorie-dense foods. Our results are coherent and reveal an internally consistent pattern linking multiple dimensions of food insecurity (FES, HDDS, Assets, and LCS) to the five child malnutrition outcomes (stunting, wasting, underweight, overweight, stunted-overweight) – that is, a credible urban–rural divergence in how food insecurity manifests across malnutrition outcomes.

Nigeria's child malnutrition landscape was therefore best understood as a complex interaction between asset poverty, household coping behavior, and rapidly changing food systems. The findings highlighted the urgent need for integrated context-specific, double-duty nutrition policies to address multiple forms of malnutrition simultaneously. These interventions may include farm-based diversification measures, school meal programs, healthy street foods/food assistance, maternal-child nutrition services, nutrition education, and fortification programs. The coordinative actions could be implemented across agriculture, social protection, health, and food system governance, with explicit recognition of the emerging double burden of malnutrition. Our study's methodological contribution – focused on whether the incidence of child malnutrition is associated with multidimensional food insecurity using econometric techniques – requires a more robust model to address identification challenges and determine the severity of child malnutrition within households for future research.

Notes

1. The geopolitical zones in Nigeria include North-Central, North-East, North-West, South-East, South-South, and South-West zones. The division of Nigeria into six geopolitical zones was not done through constitutional provision but rather as a political and administrative arrangement. The zoning systems was introduced during military regime of General Sani Abacha in the mid-1990s to manage Nigeria's ethnic, political, and regional diversity more effectively.⁶⁶ The zoning system is not aligned with grouping households with similar residential properties that influence their food availability, accessibility, and utilization.

2. While the WHO growth standards include a BMI chart beginning at birth, the authors acknowledge that using the BMI-for-age growth chart is not recommended for children younger than 2 years. The BMI in infancy is based on recumbent length rather than stature and, there has been little research on what BMI calculated from length means in infancy and the consequences of high or low BMI in infancy.^{10,29}
3. Monotonous relationship means two variables consistently move in the same or opposite directions.

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ORCID

H. K. Ibrahim  <http://orcid.org/0000-0002-6101-5041>

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Author contributions

CRedit: **H. K. Ibrahim:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing.

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Appendix

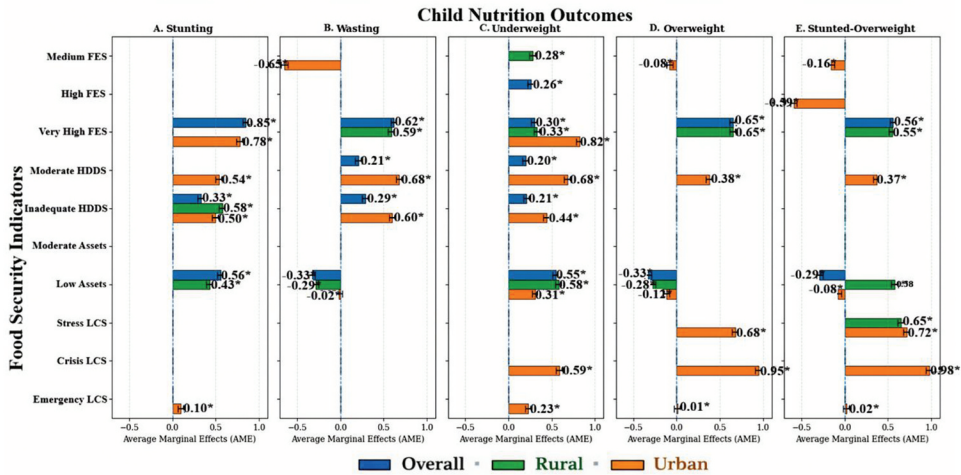


Figure A1. RE-Average marginal effects of food security indicators on child nutrition outcomes. Note: Wild Bootstraps Standard errors in parentheses, Significant level: $*p < .05$. Low FES is the reference category for FES levels; Adequate HDDS is the reference category for HDDS levels; High Asset is the reference category for Asset levels and Normal LCS is the reference category for LCS levels. Source: Author, (2026).

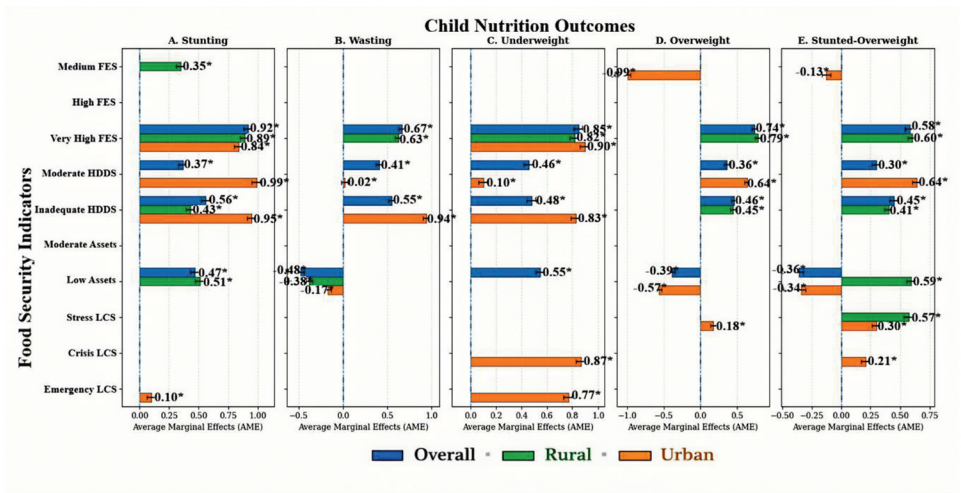


Figure A2. FE-Average marginal effects of food security indicators on child nutrition outcomes. Note: Wild Bootstraps Standard errors in parentheses, Significant level: $*p < .05$. Low FES is the reference category for FES levels; Adequate HDDS is the reference category for HDDS levels; High Asset is the reference category for Asset levels and Normal LCS is the reference category for LCS levels. Source: Author, (2026).