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Mother's education and nutritional status as correlates of child stunting, wasting, underweight, and overweight in Nigeria: Evidence from 2018 Demographic and Health Survey

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Abstract

Aim: This study examined the nexus between mother's education and nutritional status and their relationships with child stunting, wasting, underweight, and overweight. **Methods:** The data of 34,193 under-five (U-5) children from the 2018 Nigeria Demographic and Health Survey (NDHS) were analyzed using descriptive statistics, and binary and complementary log-logistic regression models. **Results:** The prevalence of child stunting, wasting, underweight, and overweight were 36.51%, 6.92%, 21.73%, and 2.05%, respectively. Compared to children born to mothers with at least secondary education, uneducated women's children (odds ratio (OR) = 1.55; 95% confidence interval (CI) = 1.32–1.82) and those of women with primary education (OR = 1.49; 95% CI = 1.28–1.72) were more likely to be stunted. Similarly, children born to uneducated women (OR = 1.51; 95% CI = 1.24–1.83) were more likely to be underweight than women with at least secondary education. The likelihood of child underweight (OR = 1.71; 95% CI = 1.45–2.01) and wasting (rate ratio (RR) = 1.82; 95% CI = 1.47–2.26) were higher among underweight mothers, respectively, than those with normal body mass index (BMI). The likelihood of child stunting (OR = 0.75; 95% CI = 0.67–0.84) and underweight (OR = 0.66; 95% CI = 0.57–0.77) were lower among obese/overweight mothers compared to those with normal BMI, but their children were more likely to be overweight (RR = 1.77; 95% CI = 1.27–2.48). **Conclusion:** Attainment of higher education by mothers should be promoted to prevent childhood nutritional imbalances, and sensitization on healthy dietary habits and lifestyles should be promoted among women, especially the overweight/obese, to reduce their risk of having overweight children.

Keywords

Mother's education, nutritional status, child malnutrition, Nigeria

Introduction

Childhood nutritional imbalance is an important indicator of quality of life which reflects the extent of vulnerability to infections (Endris et al., 2017; Uppal et al., 2005), and the risk of under-five mortality. Beyond this, increased exposure to nutritional imbalance at an early age (from the period of infancy to age 5) can cause a setback in a child's physical, mental, and cognitive development (Koletzko et al., 2015). Poor mental and cognitive development can lead to learning disability which can hinder children's chances of excelling in elementary school, stifle their academic progress, subvert their employability, and jeopardize their ability to set life goals let alone achieve them in adult life (Stewart et al., 2013).

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About 40% of under-5 children are affected by stunting and over 25% affected by wasting and overweight reside in Africa (UNICEF et al., 2021). Therefore, child malnutrition is quite rife among under-5 (U-5) children in Africa compared to other parts of the world (Global Nutrition Report, 2021; UNICEF, 2021). As such, Africa is lagging in improving child nutrition due to many factors including inadequate healthcare (Salm et al., 2021), and illiteracy (Kumeh et al., 2020). Given the bond between a mother and a child, which suggests that maternal characteristics can affect childhood health conditions, extant studies have shown that a mother's education has a positive effect on child health and in reducing the rate of child malnutrition globally (Abuya et al., 2012; Anwar et al., 2013; Fadare et al., 2019; Iftikhar et al., 2017; Makoka, 2013). Low maternal education may result in child wasting, stunting, and overweight or underweight among African children (Akombi et al., 2017). Also, it has been recommended that maternal underweight and overweight need to be addressed to reduce the varied dimensions of child nutritional imbalances (such as stunting and wasting) (Makoka, 2013). Any efforts to address child malnutrition require prioritizing maternal education and nutritional status (Abuya et al., 2012; Alderman and Headey, 2017).

There are consistent findings on the association between maternal education, nutritional status and childhood nutritional imbalance across studies in Africa (Makoka, 2013; Makoka and Masibo, 2015; Saaka, 2014; Yaya et al., 2020). For instance, in Ghana (Saaka, 2014), the link between women with low education with the nutritional imbalance of children has been observed, while in Uganda (Bbaale, 2014; Ickes et al., 2015) women's nutritional levels have been linked to their child's health, nutritional status, and wellbeing. Studies from Malawi showed that the level of maternal education affects child nutrition (Makoka, 2013; Makoka and Masibo, 2015). In South Africa, women's education tends to influence the nutritional status of children across various households (Yaya et al., 2020). Similar findings of the association between mother's education and U-5 nutritional status have been documented in several North African countries such as Egypt (Herbst et al., 2019; Zottarelli et al., 2007), Morocco, Algeria and Tunisia (Smith et al., 2003), and Libya (Adel et al., 2008).

In sub-Saharan Africa, apart from the documented effect of women's education on child nutritional imbalances (wasting, stunting, overweight, and underweight), variations in child nutritional imbalances also exist by age, income, residence, religion, and occupation (Abuya et al., 2012; Adedokun and Yaya, 2021; Fadare et al., 2019). Studies in Nigeria have revealed that women's education and nutritional status in urban and rural areas are associated with their children's nutritional status (Fadare et al., 2019; Olodu et al., 2019). The effect of women's education also varies between the northern and southern regions. An earlier study has discovered that child stunting is less prevalent among Christian women (Ukwuani and Suchindran, 2003). According to the Nigeria Demographic and Health Surveys (NDHS) report the burden of child malnutrition tends to be higher in the northern part of Nigeria than in the southern region (National Population Commission (NPC) and ICF Macro, 2014, 2004, 2009, 2019). This is not unconnected to the higher number of educated and socio-economically better women in the south than in the north.

Despite the existing evidence of the relationship between maternal education, nutritional status and childhood nutritional imbalance in Nigeria, little is known about the extent to which mother's education and nutritional status determine, and is consistent in determining, each standard indicator/form of childhood nutritional status separately. We argue that each form of childhood nutritional imbalance deserves to be studied separately and that the influences of mother's education and nutritional status may differ across the different forms of childhood nutritional imbalance. Hence, examining child nutritional imbalance in general or part of it—like most extant studies in Nigeria—conceals a lot of information about its dynamics and nuances. Such concealment runs the risk of promoting the assumption that all forms of childhood nutritional imbalance are determined by the same set of maternal factors. This hampers the effectiveness of interventions on childhood nutritional imbalance in Nigeria.

Given Nigeria's commitment to improving nutrition (in line with the second sustainable development goal), there is a need for more strategic and evidence-based interventions to tackle childhood nutritional imbalance in Nigeria. Therefore, we analyzed the 2018 NDHS by (a) decomposing childhood nutritional imbalance to its standard forms (such as child wasting, stunting, underweight, and overweight) and (b) examining the influence of mother's education and nutritional status on each form. The 2018 NDHS is the most recent data set on the subject matter and these study's findings are important as a justification to show progress attained in comparison to previous NDHS data on child stunting, wasting, underweight, and overweight, respectively among women of reproductive age. This study provides insights that will guide policymakers on the direction to chart to address these issues relying on the current information to make informed decisions.

Methods

Data source

The study analyzed data from the 2018 NDHS (www.measuredhs.com). The NDHS is implemented (among women and men aged 15–49 years) by the NPC and received financial and technical support from ORC Macro/ICF International through MEASURE DHS. The NDHS entailed a stratified two-stage cluster sampling design: stratified by location—rural and urban. The flow chart of the sampling approach is presented in Figure 1.

The NDHS is representative at the national, state and residential levels; therefore, it can be used to generate

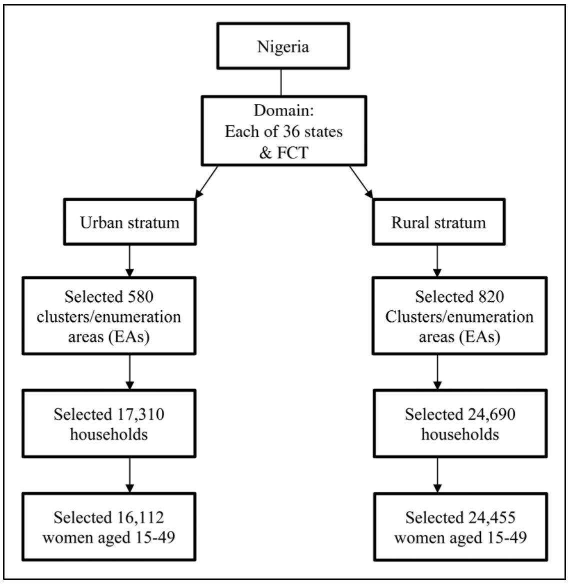

Figure 1. Flow chart of sampling approach by the Demographic and Health Survey program.

accurate and reliable estimates of demographic and health phenomena based on the following information collected in the survey on family planning, maternal and child health and nutrition, childhood mortality, malaria, female genital cutting, sexual activity, marriage, HIV/AIDS, and sexually transmitted diseases/infections (NPC and ICF, 2019). In this study, data on children born in the past 5 years (U-5), before the survey, among the women were considered. A total weighted sample of 34,193 kids' records was included in the analyses.

Measures

Outcome variables. The outcome variables were U-5 nutritional imbalance indicators, (1) stunting, (2) wasting, (3) underweight, and (4) overweight. Children's nutritional imbalance indicators were defined by comparing the computed standard deviations (Z-scores) of each child's height-for-age (stunting), weight-for-height (wasting) and weight-for-age (underweight and overweight) to the median of the WHO Child Growth Standards reference population (NPC and ICF Macro, 2019). Thus, children with height-for-age, weight-for-height and weight-for-height Z-scores that were <−2 standard deviations were regarded as moderately stunted, wasted, and underweight children, respectively. On the other hand, children with Z-scores >2 standard deviations were regarded as overweight (NPC and ICF Macro, 2019).

Explanatory variables

The main explanatory variables were mother's level of education (no education, primary, and at least secondary) and maternal nutritional status (underweight: body mass index (BMI)< 18.5; normal: BMI (18.5–24.9); and overweight: BMI ≥25.0). Other variables, referred to as controls in the study, included age, current marital status (married and unmarried); employment status in the past 12 months (worked and didn't work); residence (urban and rural); religion (Christianity, Islam and Traditional/others); ethnicity (Hausa/Fulani/Kanuri/Beri Beri, Igbo, Yoruba, and Others); region (North Central, North East, North West, South East, South South, and South West regions); and wealth status which was recategorized to three groups from the original quintile to poor (poorest and poorer), middle, and richer (richer and richest). The selection of these variables was informed by previous studies (Abuya et al., 2012; Adedini et al., 2015; Adedokun and Yaya, 2021; Alkali et al., 2015; Amadu et al., 2021; Chowdhury et al., 2016; Fadare et al., 2019; John et al., 2015; Karlsson, 2018; Olodu et al., 2019; Omilola, 2010; Sserwanja et al., 2021; Ukwuani and Suchindran, 2003; Uthman, 2009).

Statistical analysis

Frequencies and percentages were used to describe the categorical variables. Multivariable binary logistic regression (MBLR) was used to model child stunting and underweight separately as a function of mother's nutritional status (BMI) and level of education while adjusting for their age, marital status, wealth, employment status, ethnicity, religion, residence, and region of residence. This model was fitted considering the binary nature of the outcome variables, $Y_i\{0,1\}$, where $Y_i = 1$ denotes the child stunting/underweight and 0 otherwise. The multivariable logistic regression model is expressed mathematically as:

$$Y \sim \text{Binomial}(p)$$
$$\ln\left(\frac{p}{1-p}\right) = \alpha + b_1X_1 + b_2X_2 + \cdots + b_nX_n, \quad (1)$$

where $\ln\left(\frac{p}{1-p}\right)$ = log of odds or logit; p = probability of outcome, for example, stunting; α = constant; $b's$ = regression coefficients; and X's = explanatory variables, for example, mother's level of education.

Furthermore, considering the low number of events of child wasting and overweight, multivariable complementary log–log regression (MClog-log) models were fitted to the data, separately for child wasting and overweight (while adjusting for age, marital status, wealth, employment status, ethnicity, religion, residence, and region of residence). MClog-log is an appropriate alternative to binary logistic regression when the proportion of one of the possible outcomes of an outcome is low (Alabi et al., 2019; StataCorp, 2015). The model is expressed as follows:

$$\log_e(-log_e - (1-p)) = \alpha + b_1X_1 + b_2X_2 + \cdots + b_nX_n, \quad (2)$$

where, $\log_e$ = natural log; p = probability of outcome, for example, wasting; α = Constant; $b's$ = regression coefficients; and X's = explanatory variables.

Table 1. Frequency and percentage distributions of mothers' characteristics.

Variables	Frequency	Percentage
U-5 Nutritional imbalance indicators		
Child stunting		
Stunted	4165	36.51
Not stunted	7242	63.49
Child wasting		
Wasted	793	6.92
Not wasted	10,664	93.08
Child underweight		
Underweight	2499	21.73
Not underweight	9001	78.27
Child overweight		
Overweight	234	2.05
Not overweight	11,223	97.95
Mothers' sociodemographic Characteristics		
Highest level of education		
No education	15,858	46.38
Primary	5,103	14.93
At least secondary	13,231	38.70
Body mass index		
Underweight	1,271	9.55
Normal	8280	62.21
Overweight or Obese	3759	28.24
Age		
15–19	1460	4.27
20–24	6683	19.55
25–29	9591	28.05
30–34	7792	22.79
35–39	5441	15.91
40–44	2337	6.83
45–49	887	2.59
Marital status		
Married	32,606	95.36
Unmarried	1587	4.64
Wealth status		
Poor	15,354	44.91
Middle	7043	20.60
Rich	11,795	34.50
Employment status		
Worked	24,413	71.40
Didn't work	9780	28.60
Residence		
Urban	13,170	38.52
Rural	21,023	61.48
Religion		
Christianity	12,304	35.99
Islam	21,706	63.48
Traditional/others	182	0.53
Ethnicity		
Fulani/Hausa/Kanuri/Beri Beri	16,689	48.81
Igbo	4328	12.66
Yoruba	3749	10.96
Others	9426	27.57
Region		
North Central	4619	13.51
North East	6213	18.17
North West	12,558	36.73
South East	3428	10.02
South South	2968	8.68
South West	4407	12.89

The regression coefficients from the MBLR and MClog-log were presented as adjusted odds ratios (OR) and adjusted incidence rate ratios (RR), respectively, together with their 95% confidence intervals. Inference were based on 5% level of significance. All the fitted models accounted for the complex nature of the survey design (i.e., the stratification and clustering) as well as the individual level weights.. The analyses were performed with Stata MP Version 14.0.

Results

Descriptive statistics

Table 1 shows that stunting affected 36.51% of under-5 children; 6.92% of children experienced wasting while 21.73% were underweight and 2.05% were overweight. In terms of education, more than half of the mothers (53.63%) had at least primary education. About two-thirds of the mothers had normal BMI (62.21%). Nearly three-quarters of the mothers were <35 years old (74.66%). Most mothers were married (95.36%) while less than half (44.91%) were poor. Most mothers were employed (71.40%), rural residents (61.48%), Muslims (63.48%), and lived in the northern region (68.41%) respectively. Less than half of mothers were from the Fulani/Hausa/Kanuri/Beri Beri ethnic group (48.81%).

Relationships between mother's education, nutritional status, and childhood nutritional imbalance

Table 2 presents the covariate-adjusted results from the multivariable logistic regression models. According to the results, mothers' level of education and BMI were significantly associated with at least one of the indicators of childhood nutritional imbalance. However, there were inconsistencies in the relationships. To break this down further, mother's level of education and BMI were separately associated with child stunting and underweight, while only the mother's BMI was associated with child wasting and underweight, respectively.

Children born to mothers who had no education and those who had only primary education were 55% (OR = 1.55; 95% confidence interval (CI) = 1.32–1.82) and 49% (OR = 1.49; 95% CI = 1.28–1.72), respectively, were more likely to experiencestunting than those born to mothers who had at least secondary education. In the

Table 2. Multivariable logistic regression of childhood nutritional imbalance on explanatory variables.

	Stunting		Underweight		Wasting		Overweight	
Variables	OR	95% CI	OR	95% CI	RR	95% CI	RR	95% CI
Explanatory variables								
Level of education								
No education	1.55*	1.32–1.82	1.51*	1.24–1.83	1.08	0.77–1.50	0.75	0.45–1.27
Primary	1.49*	1.28–1.72	1.16	0.97–1.40	0.87	0.57–1.35	0.90	0.58–1.39
Secondary & above (RC)	1		1		1		1	
BMI								
Underweight	1.08	0.91–1.29	1.71*	1.45–2.01	1.82*	1.47–2.26	0.71	0.36–1.38
Normal (RC)	1		1		1		1	
Overweight/obese	0.75*	0.67–0.84	0.66*	0.57–0.77	0.68	0.52–0.89	1.77*	1.27–2.48
Control variables								
Age								
15–19 (RC)	1		1		1		1	
20–24	1.13	0.86–1.48	0.88	0.67–1.16	1.23	0.80–1.87	0.68	0.34–1.35
25–29	1.18	0.91–1.53	1.07	0.81–1.42	1.29	0.86–1.93	0.48*	0.25–0.96
30–34	1.11	0.85–1.46	0.96	0.71–1.30	1.15	0.75–1.76	0.48*	0.24–0.95
35–39	1.14	0.87–1.50	1.08	0.80–1.46	1.41	0.91–2.18	0.35*	0.17–0.73
40–44	1.20	0.88–1.63	0.86	0.60–1.22	0.74	0.44–1.25	0.57	0.25–1.28
45–49	1.26	0.90–1.78	1.11	0.74–1.68	1.30	0.71–2.40	0.73	0.23–2.33
Marital status								
Married	1.08	0.85–1.37	1.08	0.80–1.46	0.94	0.60–1.50	1.47	0.75–2.89
Unmarried (RC)	1		1		1		1	
Wealth status								
Poor	1.72*	1.46–2.02	1.75*	1.44–2.14	1.28	0.97–1.68	1.06	0.65–1.75
Middle	1.41*	1.20–1.65	1.30*	1.07–1.58	1.19	0.89–1.58	0.79	0.51–1.22
Rich (RC)	1		1		1		1	
Employment status								
Worked	1.06	0.94–1.20	0.97	0.85–1.11	1.04	0.85–1.27	0.88	0.63–1.23
Didn't work (RC)	1		1		1		1	
Residence								
Urban (RC)	1		1		1		1	
Rural	1.10	0.96–1.25	1.10	0.94–1.28	1.09	0.88–1.35	1.13	0.77–1.65
Religion								
Christianity	0.75*	0.62–0.91	0.82	0.65–1.03	1.06	0.76–1.47	1.09	0.65–1.85
Islam (RC)	1		1		1		1	
Traditional/others	0.93	0.54–1.61	0.76	0.46–1.26	0.59	0.16–2.14	0.77	0.17–3.54
Ethnicity								
Fulani/Hausa/Kanuri/Beri Beri (RC)	1		1		1		1	

(continued)

Table 2. (continued)

Variables	Stunting		Underweight		Wasting		Overweight	
	OR	95% CI	OR	95% CI	RR	95% CI	RR	95% CI
Igbo	0.67	0.38–1.20	1.06	0.55–2.02	1.19	0.49–2.89	1.17	0.43–3.21
Yoruba	1.09	0.76–1.57	1.13	0.75–1.71	0.65	0.33–1.28	1.68	0.71–3.97
Others	0.83	0.67–1.02	0.68*	0.55–0.85	0.59*	0.44–0.80	1.26	0.68–2.36
Region								
North Central	0.58*	0.47–0.72	0.67*	0.54–0.82	0.84	0.64–1.11	0.56*	0.32–0.96
North East (RC)	1		1		1		1	
North West	1.27*	1.07–1.50	1.15	0.97–1.37	0.85	0.67–1.07	0.70	0.41–1.22
South East	0.73	0.41–1.30	0.59	0.32–1.09	0.48	0.19–1.21	0.64	0.25–1.59
South South	0.66*	0.51–0.86	0.79	0.58–1.08	0.77	0.47–1.24	0.36*	0.18–0.74
South West	0.60*	0.43–0.83	0.77	0.51–1.16	0.88	0.50–1.54	0.26*	0.11–0.59
Model diagnostics								
Model vs empty model (LR)	F (25, 1280) = 38.78; p = 0.001		F (25, 1280) = 26.82; p = 0.001		LR (25) = 214.71; p = 0.001		LR (25) = 56.97; p = 0.001	
Goodness-of-fit test	Hosmer–Lemeshow: F (9, 1296) = 1.25; p = 0.262		Hosmer–Lemeshow: F (9, 1296) = 1.10; p = 0.360					

*Significant at $p < 0.05$; BMI: body mass index; CI: confidence interval; LR: likelihood ratio; OR: adjusted odds ratio; RR: adjusted rate ratio; RC: reference category.

same vein, children born to uneducated mothers were 51% more likely to beunderweight children than children born to women whohad above primary education (OR = 1.51; 95% CI = 1.24–1.83).

Concerning mother's BMI, compared to mothers who had normal BMI, children born to overweight/obese mothers were 25% less likely to experiencestunting (OR = 0.75; 95% CI = 0.67–0.84). In contrast, while children born to underweight mothers were 71% more likely to be underweight (OR = 1.71; 95% CI = 1.45–2.01), children born to overweight/obsess mothers were 34% less likely to be underweight (OR = 0.66; 95% CI = 0.57–0.77) than children born to mothers who had normal BMI. Similarly, the likelihood of child wasting was 82% higher among underweight mothers than their counterparts with normal BMI (RR = 1.82; 95% CI = 1.47–2.26). Lastly, compared to mothers with normal BMI, children born to overweight/obese mothers were 77% more likely to be overweight (RR = 1.77; 95% CI = 1.27–2.48).

The model diagnostics, based on the results from the likelihood ratio and Hosmer–Lemeshow goodness-of-fits tests, show that each model was a good fit than an empty one.

Discussion

This study examined the relationship between maternal education, nutritional status and child nutritional imbalance in Nigeria based on the 2018 NDHS which is nationally representative data of women of reproductive age. The prevalence of child stunting in this study was 36.5%, this is less than the 38.8% reported by Li et al. (2020) among 35 low- and middle-income countries. Compared to this study, their estimated prevalence of child wasting and underweight were 6% and 5% higher, respectively. On the other hand, the prevalence of child overweight was 8%, this is less than the estimated rate by Duru et al. (2015) in rural communities in Imo state Nigeria.

The results from the multivariable analyses reveal that, although mother's education and nutritional status (using BMI) were significantly associated with childhood nutritional imbalance, there were inconsistencies in the relationships between mother's level of education, nutritional status, and each indicator of childhood nutritional imbalance. It is evident from the results that both explanatory variables were significantly associated with child stunting and underweight, respectively, while only mother's nutritional status (BMI) correlated with child wasting and overweight, respectively.

In terms of child stunting, we found that, having no education or primary education was associated with child stunting and underweight, respectively, than having at least secondary education. This aligns with the findings of Obayelu and Adeleye (2021). Higher education, beyond the primary level, correlates positively with higher income which in turn can improve the affordability of quality and nutrient-rich food for children (Abuya et al., 2012; Darteh et al., 2014; Hong, 2007; Semba et al., 2008).

We found that child wasting and underweight were more pronounced among underweight mothers than among mothers who had normal BMI. Studies have reported similar findings on the risk of childhood underweight and wasting among underweight mothers (Kang and Kim, 2019; Khan et al., 2019). The reverse was the case among overweight/obese mothers who were less likely to have stunted children. This link between maternal overweight/obesity and child stunting is widely supported by studies across the globe and has been linked to childhood undernutrition (Delisle, 2008; Popkin et al., 2012). Earlier studies have shown that as children affected by stunting transition to adolescence and adulthood, they become more susceptible to noncommunicable diseases (Hoffman et al., 2000; Sawaya et al., 2003).

In tandem with previous studies in the United Kingdom (Crozier et al., 2010), Denmark (Nohr et al., 2008), Unite States (Sewell et al., 2006), and Uganda (Sserwanja et al., 2021), our study revealed that the likelihood of overweight children was higher among overweight/obese mothers. Although, according to a study in the United States, such a relationship may be explained by the mediating effect of birth anthropometry (such weight, length, head circumference, ponderal index, small-for-gestational age, or large-for-gestational age), the effect from the study was quite small (Stevens et al., 2021). Nevertheless, this cited study has provided some evidence that future studies can examine in Nigeria to understand and address the mechanisms that link child overweight to maternal overweight/obesity.

Limitations of the study

This study is not without some limitations. We established a noncausal relationship between maternal education, nutritional status and child malnutrition due to the cross-sectional nature of the NDHS in which the data on the explanatory and outcome variables were collected at the same period, thus there is no temporal precedence. Other sociocultural factors that may affect a child's nutritional status were not considered in this study because those latent constructs were not captured in the survey. For instance, some studies suggest that some sociocultural practices such as taboos and norms play important roles in women's food consumption patterns which may also affect their children's feeding and nutritional status. Nevertheless, this study painted a more current and representative picture, and extended the frontier of knowledge on the influence of mother's education and nutritional status on childhood nutritional imbalance. Insights from this study are not only generalizable to Nigeria but also useful for maternal and child health programs aimed at improving maternal and child nutrition in the country.

Conclusion

This study concludes that mother's education and nutritional status are significant correlates of childhood nutritional imbalance in Nigeria. However, there was no consistency in their relationships with each indicator of childhood nutritional imbalance as both factors correlated with child stunting and underweight, respectively, while only mother's BMI correlated with child wasting and overweight, respectively. Nevertheless, higher educational attainment should be massively promoted among mothers across Nigeria. This will not only improve their knowledge of maternal and child health, it can also improve their access to income-generating opportunities that canincrease their ability to afford their nutritional needs and children's. To eliminate child stunting, women with normal BMIs should be a target for intervention. Efforts to eradicate child underweight and wasting and overweight should be directed toward underweight mothers, while overweight or obese women should be encouraged to adopt healthy diets and lifestyles to reduce the risk of their children being overweight.

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Author contributions

Conceptualization: SAL; methodology: SAL and DAO; statistical analysis: DAO; writing original draft: DAO and SAL; critical review and editing: OAA and IAA.

Availability of data and materials

The NDHS data analyzed in this study is freely obtainable from the DHS Program: https://dhsprogram.com/data/availabledatasets.cfm.

Ethics

The NDHS data analyzed in this study is freely obtainable from the DHS Program (https://dhsprogram.com/data/available-datasets.cfm). Before data collection, the NDHS protocol was approved by the National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board.

Declaration of conflicting interests

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References

Abuya B, Ciera J and Kimani-Murage E (2012) Effect of mother's education on child's nutritional status in the slums of Nairobi. *BMC Pediatrics* 12: 80.

Adedini SA, Odimegwu C, Imasiku EN, et al. (2015) Ethnic differentials in under-five mortality in Nigeria. *Ethnicity & Health* 20(2): 145–162.

Adedokun ST and Yaya S (2021) Factors associated with adverse nutritional status of children in sub-Saharan Africa: Evidence from the Demographic and Health Surveys from 31 countries. *Maternal & Child Nutrition* 17(3): e13198.

Adel ET, Marie-Françoise R-C, Salaheddin MM, et al. (2008) Nutritional status of under-five children in Libya; a national population-based survey. *Libyan Journal of Medicine* 3(1): 13–19.

Akombi BJ, Agho KE, Hall JJ, et al. (2017) Stunting, wasting and underweight in sub-Saharan Africa: A systematic review. *International Journal of Environmental Research and Public Health* 14(8): 863.

Alabi O, Odimegwu CO, De-Wet N, et al. (2019) Does female autonomy affect contraceptive use among women in northern Nigeria? *African Journal of Reproductive Health* 23(2): 92–100.

Alderman H and Headey DD (2017) How important is parental education for child nutrition? *World Development* 94: 448–464.

Alkali YS, Ambe JP, Sabin M, et al. (2015) Socio-economic status, lifestyle and childhood obesity in Gombe. *Nigerian Journal of Paediatrics* 42(2): 107–110.

Amadu I, Seidu A-A, Duku E, et al. (2021) The joint effect of maternal marital status and type of household cooking fuel on child nutritional status in sub-Saharan Africa: Analysis of cross-sectional surveys on children from 31 countries. *Nutrients* 13(5): 1541.

Anwar S, Nasreen S, Batool Z, et al. (2013) Maternal education and child nutritional status in Bangladesh: Evidence from demographic and health survey data. *Pakistan Journal of Life and Social Sciences* 11(1): 77–84.

Bbaale E (2014) Maternal education and child nutritional status: Evidence from Uganda. *African Journal of Economic and Management Studies* 5(1): 52–74.

Chowdhury MRK, Rahman MS, Khan MMH, et al. (2016) Risk factors for child malnutrition in Bangladesh: A multilevel analysis of a nationwide population-based survey. *The Journal of Pediatrics* 172: 194–201.e1.

Crozier SR, Inskip HM, Godfrey KM, et al. (2010) Weight gain in pregnancy and childhood body composition: Findings from the Southampton Women's Survey. *The American Journal of Clinical Nutrition* 91(6): 1745–1751.

Darteh EKM, Acquah E and Kumi-Kyereme A (2014) Correlates of stunting among children in Ghana. *BMC Public Health* 14(1): 1–7.

Delisle HF (2008) Poverty: The double burden of malnutrition in mothers and the intergenerational impact. *Annals of the New York Academy of Sciences* 1136(1): 172–184.

Duru CB, Oluoha UR, Uwakwe KA, et al. (2015) Prevalence and sociodemographic determinants of malnutrition among under-five children in rural communities in Imo State, Nigeria. *American Journal of Public Health Research* 3(6): 199–206.

Endris N, Asefa H and Dube L (2017) Prevalence of malnutrition and associated factors among children in rural Ethiopia. *BioMed Research International* 2017. Hindawi.

Fadare O, Amare M, Mavrotas G, et al. (2019) Mother's nutrition-related knowledge and child nutrition outcomes: Empirical evidence from Nigeria. *PLoS ONE* 14(2): e0212775.

Global Nutrition Report (2021) Country nutrition profiles. Available at: https://globalnutritionreport.org/resources/nutrition-profiles/africa/ (accessed 12 November 2021).

Herbst CH, Elshalakani A, Kakietek J, et al. (Eds.) (2019) *Scaling up nutrition in the Arab Republic of Egypt: Investing in a healthy future*. World Bank Publications.

Hoffman DJ, Roberts SB, Verreschi I, et al. (2000) Regulation of energy intake may be impaired in nutritionally stunted children from the shantytowns of Sao Paulo, Brazil. *The Journal of Nutrition* 130(9): 2265–2270.

Hong R (2007) Effect of economic inequality on chronic childhood undernutrition in Ghana. *Public Health Nutrition* 10(4): 371–378.

Ickes SB, Hurst TE and Flax VL (2015) Maternal literacy, facility birth, and education are positively associated with better infant and young child feeding practices and nutritional status among Ugandan children. *The Journal of Nutrition* 145(11): 2578–2586.

Iftikhar A, Bari A and Iqbal Bano QM (2017) Impact of maternal education, employment and family size on nutritional status of children. *Pakistan Journal of Medical Sciences* 33(6): 1401.

John C, Ichikawa T, Abdu H, et al. (2015) Maternal overweight/obesity characteristics and child anthropometric status in Jos, Nigeria. *Nigerian Medical Journal* 56(4): 236.

Kang Y and Kim J (2019) Risk factors for undernutrition among children 0–59 months of age in Myanmar. *Maternal & Child Nutrition* 15(4): e12821.

Karlsson O (2018) Religion and child health in sub-Saharan Africa: Religious affiliation and community-level religious composition. In: *Population Association of America annual conference, Denver, CO, USA*, 2018.

Khan S, Zaheer S and Safdar NF (2019) Determinants of stunting, underweight and wasting among children < 5 years of age: Evidence from 2012-2013 Pakistan demographic and health survey. *BMC Public Health* 19(1): 358.

Koletzko B, Bhatia J, Bhutta ZA, et al. (Eds.) (2015) *Pediatric Nutrition in Practice*. Karger Medical and Scientific Publishers.

Kumeh OW, Fallah MP, Desai IK, et al. (2020) Literacy is power: Structural drivers of child malnutrition in rural Liberia. *BMJ Nutrition, Prevention & Health* 3(2): 295.

Li Z, Kim R, Vollmer S, et al. (2020) Factors associated with child stunting, wasting, and underweight in 35 low-and middle-income countries. *JAMA Network Open* 3(4): e203386–e203386.

Macro I and Commission NP (2014) Nigeria Demographic and Health Survey 2013. Available at: https://dhsprogram.com/publications/publication-fr293-dhs-final-reports.cfm

Makoka D (2013) *The Impact of Maternal Education on Child Nutrition: Evidence from Malawi, Tanzania, and Zimbabwe*. Calverton, Maryland: ICF International. Available at: http://dhsprogram.com/pubs/pdf/WP84/WP84.pdf.

Makoka D and Masibo PK (2015) Is there a threshold level of maternal education sufficient to reduce child undernutrition? Evidence from Malawi, Tanzania and Zimbabwe. *BMC Pediatrics* 15(1): 96.

National Population Commission - NPC and ICF Macro (2014) *Nigeria Demographic and Health Survey 2013*. Available at: https://dhsprogram.com/publications/publicationfr293-dhs-final-reports.cfm.

National Population Commission - NPC and ICF Macro (2019) *Nigeria Demographic and Health Survey 2018 - Final Report*. Abuja, Nigeria: NPC and ICF. Available at: http://dhsprogram.com/pubs/pdf/FR359/FR359.pdf.

National Population Commission - NPopC and ICF Macro (2004) *Nigeria Demographic and Health Survey 2003*. Available at: http://dhsprogram.com/pubs/pdf/FR148/FR148.pdf.

National Population Commission (NPopC) and ICF Macro (2009) *Nigeria Demographic and Health Survey 2008*. National Population Commission, ICF Macro.

Nohr EA, Vaeth M, Baker JL, et al. (2008) Combined associations of prepregnancy body mass index and gestational weight gain with the outcome of pregnancy. *The American Journal of Clinical Nutrition* 87(6): 1750–1759.

Npc and ICF Macro (2014) *Nigeria Demographic and Health Survey 2013*. Available at: https://dhsprogram.com/publications/publication-fr293-dhs-final-reports.cfm

Obayelu OA and Adeleye OR (2021) Explaining child nutritional status in rural Nigeria: Socioeconomic dimensions. *Journal of Hunger & Environmental Nutrition* 16(6): 829–846.

Olodu MD, Adeyemi AG, Olowookere SA, et al. (2019) Nutritional status of under-five children born to teenage mothers in an urban setting, south-western Nigeria. *BMC Research Notes* 12(1): 116.

Omilola B (2010) *Patterns and Trends of Child and Maternal Nutrition Inequalities in Nigeria*. Citeseer.

Popkin BM, Adair LS and Ng SW (2012) Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews* 70(1): 3–21.

Saaka M (2014) Relationship between mothers' nutritional knowledge in childcare practices and the growth of children living in impoverished rural communities. *Journal of Health, Population, and Nutrition* 32(2): 237–248. Available at: https://pubmed.ncbi.nlm.nih.gov/25076661.

Salm L, Verstraeten R, Nisbett N, et al. (2021) Exploring the drivers of malnutrition in West Africa from health and social science perspectives: A comparative methodological review. *Methodological Innovations* 14(3): 205979912110514.

Sawaya AL, Martins P, Hoffman D, et al. (2003) The link between childhood undernutrition and risk of chronic diseases in adulthood: A case study of Brazil. *Nutrition Reviews* 61(5): 168–175.

Semba RD, de Pee S, Sun K, et al. (2008) Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: A cross-sectional study. *The Lancet* 371(9609): 322–328.

Sewell MF, Huston-Presley L, Super DM, et al. (2006) Increased neonatal fat mass, not lean body mass, is associated with maternal obesity. *American Journal of Obstetrics and Gynecology* 195(4): 1100–1103.

Smith LC, Ramakrishnan U, Ndiaye A, et al. (2003) The importance of women's status for child nutrition in developing countries: International food policy research institute (IFPRI) research report abstract 131. *Food and Nutrition Bulletin* 24(3): 287–288.

Sserwanja Q, Mutisya LM, Olal E, et al. (2021) Factors associated with childhood overweight and obesity in Uganda: A national survey. *BMC Public Health* 21(1): 1–9.

StataCorp (2015) *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP.

Stevens DR, Neelon B, Roberts JR, et al. (2021) Mediation of the association between maternal pre-pregnancy overweight/obesity and childhood overweight/obesity by birth anthropometry. *Journal of Developmental Origins of Health and Disease* 12(1): 71–78.

Stewart CP, Iannotti L, Dewey KG, et al. (2013) Contextualising complementary feeding in a broader framework for stunting prevention. *Maternal & Child Nutrition* 9: 27–45.

Ukwuani FA and Suchindran CM (2003) Implications of women's work for child nutritional status in sub-Saharan Africa: A case study of Nigeria. *Social Science & Medicine* 56(10): 2109–2121.

UNICEF (2021) The State of Food Security and Nutrition in the World 2021. Available at: https://data.unicef.org/resources/sofi-2021/ (accessed 12 November 2021).

UNICEF, WHO and World Bank (2021) Levels and Trends in Child Malnutrition: UNICEF/WHO/The World Bank Group Joint Child Malnutrition Estimates: Key Findings of the 2021 Edition. Available at: https://www.who.int/publications-detail-redirect/9789240025257 (accessed 4 October 2022).

Uppal M, Kumari K and Sidhu S (2005) Clinical assessment of health and nutritional status of scheduled caste pre-school children of Amritsar. *The Anthropologist* 7(3): 169–171.

Uthman OA (2009) Patterns, distribution, and determinants of under-and overnutrition among women in Nigeria: A population-based analysis. *Journal of Public Health* 17(5): 289–299.

Yaya S, Odusina EK, Uthman OA, et al. (2020) What does women's empowerment have to do with malnutrition in sub-Saharan Africa? Evidence from demographic and health surveys from 30 countries. *Global Health Research and Policy* 5(1): 1–11.

Zottarelli LK, Sunil TS and Rajaram S (2007) Influence of parental and socioeconomic factors on stunting in children under 5 years in Egypt. *EMHJ-Eastern Mediterranean Health Journal* 13(6): 1330–1342.