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Original Article

Individual and contextual factors associated with childhood stunting in Nigeria: a multilevel analysis

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Abstract

Stunting, a form of undernutrition, is the best measure of child health inequalities as it captures multiple dimensions of children's health, development and the environment where they live. The aim of this study was to quantify the predictors of childhood stunting in Nigeria. This study used data obtained from the 2008 Nigeria Demographic and Health Survey (NDHS). A total of 28 647 children aged 0–59 months included in NDHS in 2008 were analysed in this study. We applied multilevel multivariate logistic regression analysis in which individual-level factors were at the first level and community-level factors at the second level. The percentage change in variance of the full model accounted for about 46% in odds of stunting across the communities. The present study found that the following predictors increased the odds of childhood stunting: male gender, age above 11 months, multiple birth, low birthweight, low maternal education, low maternal body mass index, poor maternal health-seeking behaviour, poor household wealth and short birth interval. The community-level predictors found to have significant association with childhood stunting were: child residing in community with high illiteracy rate and North West and North East regions of the country. In conclusion, this study revealed that both individual- and community-level factors are significant determinants of childhood stunting in Nigeria.

Keywords: under nutrition, childhood stunting, multilevel analysis, under-five children.

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Background

Linear growth retardation, commonly regarded as stunting, is the best measure of child health inequalities as it captures multiple dimensions of children's health, development and the environment where they live (World Health Organisation 1995; Pradhan *et al*. 2003). Stunting is a form of under-nutrition in which the linear growth retardation is due to poor nutrition, infections and environmental problems, both prenatal and postnatal (Grantham-McGregor *et al*. 2007). Early occurrence of stunting is associated with poor cognitive, motor and socio-psychological development, and increased likelihood of mortality (Pelletier *et al*. 1993; Pelletier and Frongillo 2003). Children suffering from stunting are unable to reach their full growth potentials and often become stunted adolescents and adults later on (Martorell *et al*. 1994). The consequences of stunting in adulthood are often functional with its attendant reduced work capacity. (Spurr *et al*. 1977) Stunted women have increased likelihood of morbidity and mortality during childbirth for themselves and their babies (Habicht *et al*. 1973; Martorell *et al*. 1981; Royston & Armstrong 1989).

In 2004, it was reported worldwide that about one-third of pre-school children were stunted, although the global prevalence is on the decreasing trend from about 47% in 1980 to between 30–40% in 2004 with variations depending on geographic regions (de Onis *et al*. 2004). Most of the progress in stunting reduction that has been made in low- and middle income countries has been in Southeast Asia with little changes in Sub-Saharan African, which bear the brunt of the problem (de Onis *et al*. 2000). Research carried out in 1990 showed that in Nigeria, 43% of the under-fives were stunted (de Onis *et al*. 1993) while in 2008, the NHDS indicated that 41% of Nigerian children were stunted (NPC and ICF Macro 2009). Comparing these two studies, one would see that not much has changed in the trend and it should be obvious that stunting in the under-fives in Nigeria is still a major problem needing solution. From studies carried out internationally, it is evident that childhood stunting is linked to a number of environmental and socioeconomic factors such as poverty (Madzingira 1995; Phimmasone *et al*. 1996; Hong *et al*. 2006; Van de Poel *et al*. 2007). Having access to health care services was also found to be significant in determining nutritional status of children as the children who did not have access to health care facilities suffered mostly from childhood stunting (Muhe *et al*. 1996; Van de Poel *et al*. 2007; Monteiro *et al*. 2009). Some studies also associated childhood stunting to poor sanitary condition of the households (El Taguri *et al*. 2009; Medhin *et al*. 2010).

Previously published literatures on childhood stunting in Nigeria are limited. Most of them examined few determinants [either socioeconomic factors (Odunayo & Oyewole 2006), cultural factors (Esimai *et al*. 2001) or environmental factors on their own, or individual and community factors]; hence, effects of confounding factors were not sufficiently looked into. The studies on children's nutritional status in Nigeria were mostly carried out in urban areas with little attention being paid to rural areas (Akaninwor *et al*. 1996; Ajayi and Akinyinka 1999; Ojo *et al*. 2000; Abidoye & Ihebuzor 2001; Esimai *et al*. 2001; Ijarotimi & Ijadunola 2007) where about 70% of the population lives. The 2008 Nigeria Demographic and Health Survey (NDHS) has national representation covering both rural and urban settings; it is new and unexplored by researchers, specifically with respect to stunting in under-five children.

Therefore, the aim of this study was to examine individual- (child's factors, maternal/household factors) and community-level factors associated with childhood stunting in a single analytical framework to provide reliable and accurate information for policy-making and programme design that aims at addressing nutritional deficiencies in under-five children.

Methods

Study design

This is population-based cross-sectional study which used data obtained from 2008 NDHS.

Data source/sampling technique

This study was be based on 28 647 under-five children included in the 2008 NDHS from which data from 18 286 households were taken. The main survey included 24 880 households from rural areas and 11 418 households from urban areas. The country was

Key messages

- This study revealed the importance of examining individual and community-level factors' influence on stunting as a measure of childhood nutritional status in Nigeria.
- Almost 8% of the variance in the odds of childhood stunting could be attributed to the community-level factors.
- Individual- (such as child's age, sex, breastfeeding duration and household's socioeconomic status) and community-level factors (such as literacy level and geopolitical region) were independently associated with childhood stunting, suggesting that interventions to reduce childhood stunting should focus more on high risk places as well as high risk groups of children.

divided by stratification into 36 states plus the Federal Capital Territory, which were further divided into 774 local government areas all within the six geopolitical zones to obtain a nationally representative sample (NPC & ICF Macro 2009). Domain was set up and each one consists of enumeration areas that was established by the general population and housing census conducted in 2006 (NPC & ICF Macro 2009). The sampling frame was made up of a list of all enumeration areas (clusters) (NPC & ICF Macro 2009). From each domain, a two-stage probabilistic sampling method was used for the clusters selection. The first stage involved choosing of 888 primary sampling units (PSUs), 602 in the rural and 286 in the urban areas with a probability proportional to the size (NPC & ICF Macro 2009). A second stage of sampling followed the first stage, which involved the systematic sampling of households from the selected enumeration areas (NPC & ICF Macro 2009).

Ethical consideration

Approval was granted for secondary analysis of existing data after the removal of all identifying information of the respondents by the Ethics Committee of the ICF Macro at Calverton in the United States in conjunction with the National Ethics Committee of the Federal Ministry of Health in Nigeria.

Study variable

Dependent variable

The dependent variable of this study was stunting (yes = 1 or no = 0). Stunting was defined as height for age z-score less than –2 standard deviations (HAZ < –2 SD) from the median of the reference population of World Health Organization (WHO Multicentre Growth Reference Study Group 2006; de Onis *et al.* 2009). It indicates skeletal growth reduction because of chronic under-nutrition.

Description of the independent variables

We included both individual- and community-level predictors of stunting. The coding for each explanatory variable is given in Table 1. Full definitions of some of the variables were also stated in the same table. We used the term community to describe clustering within the same geographical living environment. Communities were based on sharing a common PSU within the DHS data. The unit of analysis for the multilevel model was chosen for two reasons. First, in the DHS sample, PSU was used to define the clusters. Second, it has been shown that for most of the DHS conducted, the sample size per cluster met the optimum size with a tolerable precision loss. The bias introduced by using cluster averages based on about 25 women as a proxy for the PSU population averages is very small. (Kravdal 2006)

Statistical analysis

Descriptive analyses involved the use of numbers and percentage for categorical variables to show the distribution of the outcome variables by the predictor variables. Multivariate multilevel logistic regression was used to analyse factors associated with childhood stunting because of the hierarchical nature of the data set. Four models were constructed for the analysis. The first model, an empty model, was without any explanatory variable i.e. simple component of variance analysis. The second model controlled for the individual-level variables, the third model controlled for community-level variables while the fourth controlled for both the individual- and community-level variables simultaneously. P-value of <0.05 was used to define statistical significance.

Fixed effects (measures of association)

The fixed effects i.e. measures of association have their results presented as adjusted odds ratio (OR) with their corresponding 95% confidence intervals (CIs) and P-values.

Random effects (measures of variation)

Measures of random effects included intracluster correlation (ICC), median odds ratio (MOR) and proportional change in variance (PCV) (Merlo *et al.* 2005a,b). The ICC was calculated by the linear thresh-

Table 1. Variables definition

Independent variables	Description
Individual-level factors	
Child factors	
Age of child (months)	Categorized into (1) 0–11; (2) 12–23; (3) 24–35; (4) 36–47; and (5) 48–59.
Sex of child	Categorized into (1) female and (2) male.
Birthweight (g)	Categorized into (1) low < 2500 and (2) normal ≥ 2500.
Type of birth	Categorized into (1) single and (2) multiple birth.
Maternal/household factors	
Maternal age in years	Categorized into (1) 15–24; (2) 25–34; or (3) 35–49.
Educational level of mother	Categorized into (1) no formal education; (2) primary; (3) secondary; or (4) higher.
Breastfeeding (months)	Categorized into (1) <6; (2) 6–12; (3) 13–24; or (4) >24.
Immunization	Categorized into (1) incomplete or (2) complete.
Mother's body mass index (kg/m^2)	Categorized into (1) <18.5; (2) 18.5–24.9; or (3) ≥25.0.
Occupation	Categorized into (1) not working; (2) manual; or (3) white collar.
Birth interval (months)	Categorized into (1) ≥24 and (2) <24.
Number of under-fives	Categorized into (1) 1; (2) 2; (3) 3; or (4) ≥4.
Ethnicity	Categorized into (1) major or (2) minor.
Maternal health-seeking behaviour	Categorized into (1) (first quantile) (Least); (2) (second quantile); (3)(third quantile); (4) (fourth quantile); or (5) (fifth quantile) (Highest).
Type of family	Categorized into (1) monogamous or (2) polygamous.
Head of household	Categorized into (1) male or (2) female.
Wealth index	Categorized into (1) (first quintile) (Poorest); (2) (second quintile); (3) (third quintile); (4) (fourth quintile); or (5) (fifth quintile) (Richest)
Community-level factors	
Residence	Categorized into (1) rural or (2) urban.
Geographic region	Categorized into (1) North Central; (2) North East; (3) North West; (4) South East; (5) South South; or (6) South West.
Poverty rate	Proportion of households living below poverty level (wealth index below 20%, poorest quintile). Categorized into (1) Low or (2) High. Median value serves as the reference for the low and high groups.
Illiteracy rate	Proportion of people in the community with no formal education. Categorized into (1) Low or (2) High. Median value serves as the reference for the low and high groups.
Unemployment rate	Proportion of people who are unemployed in the communities. Categorized into (1) Low or (2) High. Median value serves as the reference for the low and high groups.
Proper sanitation	Categorized into (1) Yes or (2) No.
Safe water	Categorized into (1) Yes or (2) No.

old according to the formula used by (Snijders & Bosker 1999) while MOR is a measure of unexplained cluster heterogeneity. The method used for calculating MOR and PCV had been described elsewhere (Larsen & Merlo 2005); (Merlo *et al*. 2005a,b).

The statistical analysis on the data was carried out with the use of Stata (xtmelogit routine) statistical software for Windows version 11.

Results

Descriptive analysis

Figure 1 shows the prevalence of childhood stunting as estimated from the data set, which indicated that 7322 (25.6%) of under-five children have stunted growth across the 37 states. The percentage of childhood stunting ranged from as low as 8.2% in Enugu state to as much as 36.7% in Sokoto state.

Table 2 is a descriptive analysis that shows that the prevalence of stunting was 35.0% in the age group 24–35 months while it was 14.2% in the age group 0–11 months, as reported. There is significantly higher prevalence of childhood stunting among under-five children who breastfed longer than usual, whose sex is male, did not complete immunization and those who were born with low birthweight. In the same vein, childhood stunting is highest in children born to mothers with low body mass index (BMI) status and

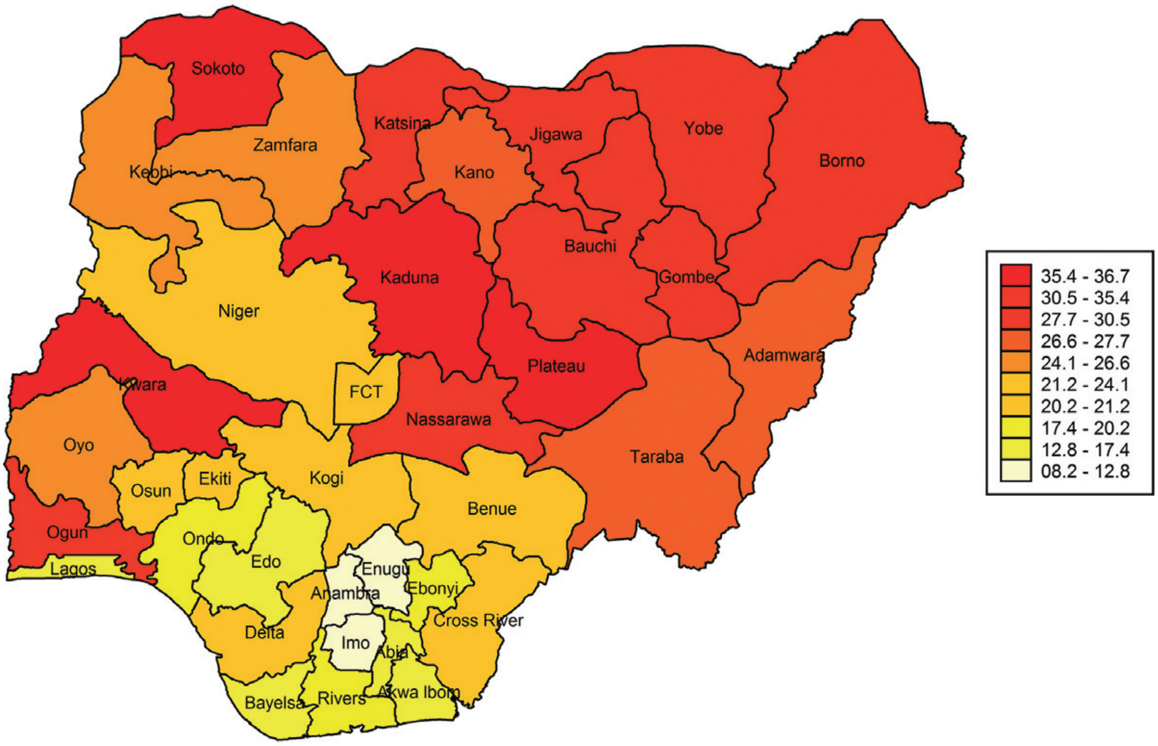

Fig. 1. Percentage of stunted children across the 37 states, Nigeria 2008. Source: Prevalence data generated from Nigeria DHS 2008.

whose mothers are not working. The prevalence is highest in the under-fives whose parents were the poorest with respect to wealth index status and those that had no formal education. Children born to young mothers (15–24 years) had the highest level of stunting. Furthermore, stunting was more prevalent with under-five children who reside in rural areas and communities with high poverty rate, unemployment rate and no access to safe drinking water.

Multilevel analysis

Table 3 shows the results of multilevel models for both individual- and community-level factors. With all factors controlled for in the multilevel analysis, child's age was statistically significantly associated with the odds of childhood stunting. Male children were more likely to be stunted than female children (adjusted OR 1.18; 95% CI 1.10–1.26, $P < 0.001$). Children who are products of multiple births were 89% more likely to be stunted. Children born with low birthweight were 21% more likely to be stunted. Under-five children of mothers with the highest health-seeking behaviour index were 22% less likely to be stunted when compared with those from mothers with the least health-seeking behaviour. Children of mothers with low BMI (<18.5 kg/m^2) were 26% more likely to be stunted compared with the children of mothers with normal BMI. Generally, the odds of a child being stunted increases with increasing breastfeeding duration after 6 months. Children with shorter than usual birth interval were 19% more likely to be stunted. The odds of being stunted decreases with increasing wealth index level. When all the factors were controlled, the association between childhood stunting, mother's occupation and immunization status, number of under-five children, and household head were statistically not significant. When other factors were controlled for in the model, community-level illiteracy rate remained statistically significantly associated with childhood stunting. For communities with high illiteracy rate, the odds of a

Table 2. Prevalence of childhood stunting at various levels of independent variables

Variables and their values	Stunted $n = 7322$ (25.6%)	Not stunted $n = 21\,325$ (74.4%)	Missing values N (%)
Individual-level factors			
Child factors			
Age of child (months)			4289 (14.9)
0–11	820 (14.2)	4946 (85.8)	
12–23	1819 (37.0)	3102 (63.0)	
24–35	1584 (35.0)	2944 (65.0)	
36–47	1631 (33.9)	3180 (66.1)	
48–59	1468 (33.9)	2864 (66.1)	
Sex of the child			–
Male	3866 (26.5)	10 738 (73.5)	
Female	3456 (24.6)	10 587 (75.4)	
Type of birth			–
Single birth	7058 (25.5)	20 627 (74.5)	
Multiple birth	264 (27.4)	698 (72.6)	
Birthweight (grams)			664 (2.3)
Low < 2500	1210 (28.5)	3029 (71.5)	
≥2500	6000 (25.3)	17 744 (74.7)	
Maternal/household factors			
Mother's age (years)			–
15–24	1867 (25.8)	5382 (74.2)	
25–34	3617 (25.6)	10 494 (73.4)	
35–49	1838 (25.2)	5449 (74.8)	
Educational levels			–
No formal education	4287 (29.7)	10 131 (70.3)	
Primary	1681 (25.7)	4871 (74.3)	
Secondary	1181 (18.6)	5157 (81.4)	
Higher	173 (12.9)	1166 (87.1)	
Breastfeeding duration (months)			1679 (5.9)
<6	357 (7.6)	4365 (92.4)	
6–12	1217 (19.4)	5049 (80.6)	
13–24	5119 (33.3)	10 244 (66.7)	
>24	293 (47.5)	324 (52.5)	
Immunization			–
Incomplete	3805 (30.5)	8658 (69.5)	
Complete	3517 (21.7)	12 667 (78.3)	
Maternal health-seeking behaviour index in quantiles			1996 (7.0)
Fifth quantile(highest)	984 (18.8)	4241 (81.2)	
Fourth quantile	1188 (24.1)	3735 (75.9)	
Third quantile	1536 (27.0)	4148 (73.0)	
Second quantile	1446 (28.9)	3565 (71.1)	
First quantile (least)	1771 (30.5)	4037 (69.5)	
Mother's body mass index (kg/m^2)			680 (2.4)
<18.5	1129 (34.0)	2195 (66.0)	
18.5–24.9	5006 (26.6)	13 801 (73.4)	
≥25.0	1090 (18.7)	4746 (81.3)	
Mother's occupation			157 (0.6)
Not working	2387 (26.4)	6648 (73.6)	
Manual	2522 (26.6)	7615 (76.3)	
White collar	2370 (23.7)	6948 (73.4)	
Birth interval (months)			–
≥24	5880 (25.3)	17 392 (74.7)	
<24	1442 (26.8)	3933 (73.2)	
Number of children under-five			
One	24 (2.2)	1090 (97.9)	–

Table 2. Continued

Variables and their values	Stunted $n = 7322$ (25.6%)	Not stunted $n = 21\,325$ (74.4%)	Missing values N (%)
Two	1660 (22.8)	5633 (77.2)	
Three	3049 (27.5)	8039 (72.5)	
≥Four	2589 (28.3)	6563 (71.7)	
Ethnicity			166 (0.6)
Major	4319 (25.7)	12 519 (74.4)	
Minor	2954 (25.4)	8689 (74.6)	
Types of family			1456 (5.1)
Monogamous	4427 (24.5)	13 636 (75.5)	
Polygamous	2593 (28.4)	6535 (71.6)	
Head of household			–
Female	594 (22.3)	2074 (77.7)	
Male	6728 (25.9)	19 251 (74.1)	
Wealth index			–
Fifth quantile (richest)	592 (15.6)	3216 (84.5)	
Fourth quantile	1001 (21.0)	3754 (79.0)	
Third quantile	1454 (25.9)	4155 (74.1)	
Second quantile	1993 (29.0)	4878 (71.0)	
First quantile (poorest)	2282 (30.0)	5322 (70.0)	
Community-level factors			
Residence			–
Rural	5738 (27.3)	15 296 (72.7)	
Urban	1584 (20.8)	6029 (79.2)	
Regions			–
North central	1336 (26.5)	3710 (73.5)	
North east	1938 (29.6)	4621 (70.4)	
North west	2402 (30.2)	5545 (69.8)	
South east	327 (13.4)	2123 (86.6)	
South south	611 (18.4)	2716 (81.6)	
South west	708 (21.3)	2610 (78.7)	
Poverty rate			–
Low	3156 (21.9)	11 267 (78.1)	
High	4166 (29.3)	10 058 (70.7)	
Illiteracy rate			–
Low	3031 (21.1)	11 347 (78.9)	
High	4291 (30.1)	9978 (69.9)	
Unemployment rate			–
Low	3436 (23.9)	10 934 (76.1)	
High	3886 (27.2)	10 391 (72.8)	
Proper sanitation			–
Yes	3553 (24.7)	10 829 (75.3)	
No	3769 (26.4)	10 496 (73.6)	
Safe water			–
Yes	3286 (22.9)	11 056 (77.1)	
No	4036 (28.2)	10 269 (71.8)	

N, number of children; %, proportion (percentage).

child being stunted (OR 1.49; 95% CI 1.19–1.88, $P < 0.001$) increased by 49%. Children whose parents reside in the North East region were 35% more likely to be stunted when compared with those from the North central region.

Measures of variations

As shown in Table 4, with respect to the empty model (the null model), there was a significant variation in the odds of childhood stunting ($\tau = 0.282$, $P < 0.001$)

Table 3. Factors associated with childhood stunting identified by multilevel logistic regression, Nigeria 2008

Covariates	Model 1 empty			Model 2 individual			Model 3 community			Model 4 individual & community		
	OR	95% CI	*P*-value	aOR	95% CI	*P*-value	aOR	95% CI	*P*-value	aOR	95% CI	*P*-value
Individual-level factors												
Child factors												
Child's age (months)												
0–11				1.00						1.00		
12–23				2.24	(1.94–2.60)	<0.001				2.36	(2.04–2.74)	<0.001
24–35				2.01	(1.72–2.34)	<0.001				2.12	(1.82–2.48)	<0.001
36–47				1.99	(1.71–2.32)	<0.001				2.09	(1.79–2.44)	<0.001
48–59				1.97	(1.68–2.30)	<0.001				2.06	(1.76–2.41)	<0.001
Sex												
Female				1.00						1.00		
Male				1.17	(1.10–1.25)	<0.001				1.04	(1.10–1.26)	<0.001
Type of birth												
Single birth				1.00						1.00		
Multiple birth				1.84	(1.49–2.26)	<0.001				1.89	(1.52–2.32)	<0.001
Birthweight (g)												
≥2500				1.00						1.00		
Low <2500				1.21	(1.10–1.33)	<0.001				1.21	(1.10–1.33)	<0.001
Maternal/household factors												
Mother's age (years)												
15–24				1.00						1.00		
25–34				0.98	(0.90–1.07)	0.635				0.99	(0.92–1.09)	0.982
35–49				0.88	(0.80–0.97)	0.007				0.91	(0.82–0.99)	0.044
Birth interval (months)												
≥24				1.00						1.00		
<24				1.18	(1.08–1.28)	<0.001				1.19	(1.09–1.30)	<0.001
Maternal education												
No education				1.00						1.00		
Primary				0.98	(0.89–1.08)	0.707				0.98	(0.78–1.07)	0.267
Secondary				0.83	(0.74–0.94)	0.002				0.84	(0.64–0.97)	0.024
Higher				0.73	(0.58–0.92)	0.008				0.75	(0.35–0.86)	0.001
MHSBI												
First quantile (least)				1.00						1.00		
Second quantile				0.97	(0.88–1.08)	0.613				1.09	(0.94–1.26)	0.990
Third quantile				0.92	(0.82–1.03)	0.131				0.96	(0.85–1.24)	0.321
Fourth quantile				0.88	(0.78–0.99)	0.038				0.92	(0.82–1.10)	0.238
Fifth quantile (highest)				0.70	(0.60–0.80)	<0.001				0.83	(0.66–0.92)	<0.001

Table 3. Continued

Covariates	Model 1 empty			Model 2 individual			Model 3 community			Model 4 individual & community		
	OR	95% CI	*P*-value	aOR	95% CI	*P*-value	aOR	95% CI	*P*-value	aOR	95% CI	*P*-value
Mother's BMI (kg/m^2)												
18.5–24.9				1.00						1.00		
<18.5				1.27	(1.15–1.39)	<0.001				1.26	(1.14–1.39)	<0.001
≥25.0				0.79	(0.71–0.85)	<0.001				0.79	(0.72–0.87)	<0.001
Mother's occupation												
Not working				1.00						1.00		
Manual				1.02	(0.93–1.11)	0.720				1.03	(0.94–1.12)	0.557
White collar				1.00	(0.90–1.08)	0.768				1.03	(0.94–1.14)	0.452
Breast feeding (months)												
<6				1.00						1.00		
6–12				2.13	(1.83–2.48)	<0.001				2.14	(1.84–2.49)	<0.001
13–24				2.66	(2.24–3.17)	<0.001				2.52	(2.12–3.00)	<0.001
>24				3.74	(2.90–4.83)	<0.001				3.52	(2.73–4.55)	<0.001
Immunization												
Complete				1.00						1.00		
Incomplete				1.05	(0.98–1.13)	0.158				1.06	(0.95–1.17)	0.284
Number of under-fives												
≥Four				1.00						1.00		
Three				0.93	(0.54–1.55)	0.726				0.84	(0.51–1.42)	0.888
Two				0.92	(0.54–1.54)	0.736				0.83	(0.49–1.41)	0.778
One				0.85	(0.50–1.43)	0.529				0.78	(0.46–1.32)	0.745
Ethnicity												
Major				1.00						1.00		
Minor				0.97	(0.89–1.06)	0.506				0.99	(0.89–1.10)	0.873
Family type												
Monogamy				1.00						1.00		
Polygamy				1.12	(0.93–1.21)	0.056				1.10	(0.96–1.19)	0.123
Household head												
Male				1.00						1.00		
Female				0.97	(0.85–1.10)	0.602				1.01	(0.89–1.16)	0.832
Wealth index												
Fifth quantile (richest)				1.00						1.00		
Fourth quantile				1.20	(1.04–1.39)	<0.001				1.21	(1.04–1.41)	0.014
Third quantile				1.52	(1.30–1.78)	<0.001				1.51	(1.27–1.79)	<0.001
Second quantile				1.64	(1.39–1.92)	<0.001				1.58	(1.31–1.91)	<0.001
First quantile (poorest)				1.71	(1.45–2.03)	<0.001				1.64	(1.33–2.01)	<0.001

Community-level factors						
Residence						
Urban	1.00			1.00		
Rural	1.21	(0.91–1.36)	0.099	1.27	(0.94–1.42)	0.336
Region						
North central	1.00			1.00		
North west	1.13	(1.02–1.23)	<0.001	1.26	(1.14–1.29)	<0.001
North east	1.28	(1.22–1.46)	0.024	1.35	(1.27–1.43)	0.036
South east	0.45	(0.38–0.54)	<0.001	0.49	(0.39–0.56)	<0.001
South south	0.66	(0.57–0.77)	<0.001	0.76	(0.78–0.89)	<0.001
South west	0.86	(0.74–0.99)	0.040	0.97	(0.72–1.00)	0.044
Poverty rate						
Low	1.00			1.00		
High	1.01	(0.93–1.08)	0.921	1.05	(0.89–1.10)	0.524
Illiteracy rate						
Low	1.00			1.00		
High	1.37	(1.06–1.76)	<0.001	1.49	(1.19–1.88)	<0.001
Unemployment rate						
Low	1.00			1.00		
High	1.00	(0.95–1.06)	0.964	0.95	(0.81–1.11)	0.521
Proper sanitation						
Yes	1.00			1.00		
No	1.05	(0.99–1.12)	0.091	1.21	(0.89–1.35)	0.528
Safe water						
Yes	1.00			1.00		
No	1.06	(1.00–1.13)	0.046	1.08	(0.74–1.15)	0.087

aOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index; MHSBI, maternal health-seeking behaviour index.

Table 4. Results from random intercept model – measure of variation

Measures of variation	Model 1*	*P*-value	Model 2†	*P*-value	Model 3‡	*P*-value	Model 4§	*P*-value
Community-level								
Variance (SE)	0.282 (0.025)	<0.001	0.176 (0.024)	<0.001	0.163 (0.023)	<0.001	0.155 (0.021)	<0.001
Explained variation (%)	Reference		37.6		42.4		46.0	
ICC (%)	7.9		5.1		4.8		4.6	
MOR	1.66		1.50		1.49		1.46	
Model fit statistics								
DIC (–2 log likelihood)	32 055		22 538		22 487		22 466	

SE, standard error; ICC, intracluster correlation; MOR, median odds ratio; DIC, deviation information criterion. *Model 1 is the empty model, a baseline model without any determinant variable. †Model 2 is adjusted for individual-level factors. ‡Model 3 is adjusted for community-level factors. §Model 4 is final model adjusted for both individual- and community-level factors.

across the communities. The ICC indicated by the estimated intercept component variance showed that 7.9% of the variance in the odds of childhood stunting could be attributed to the community-level factors. The variations in childhood stunting across communities remained statistically significant, even after adjusting for individual and community-level factors (full model). As determined by percentage change in variance, the full model accounts for about 46.0% in the odds of childhood stunting across the communities.

Results of the MOR also confirmed evidence of community-dependent phenomenon modifying childhood stunting. The MOR for stunting was 1.66 in the empty model; this relatively low MOR suggests that the clustering effect was moderate. The unexplained community heterogeneity in stunting decreased to an MOR of 1.46 when individual- and community-level factors were added to the empty model. Thus, there are very little variations between communities in the predisposition for being stunted.

Discussion

This study examined individual- and community-level factors as significant determinants of childhood stunting using nationally representative survey data. It confirms the importance of community variations with respect to childhood stunting. Both individual- and community-level factors in the final model accounted for about 46% of the variations observed for stunting. Children of age group 12–24 months have the highest odds, which subsequently declined after 24 months. This finding supports the findings of two previous studies conducted by Kabubo-Mariara *et al*. (2009) and Shrimpton *et al*. (2001), which revealed a rapid fall in children's height from birth to 24 months; although stunting processes after 24 months still continue, but at a much slower rate. This could be as a result of weaning and lower breast milk intakes, which make them prone to childhood stunting.

The result of this study indicated that the sex of a child is a strong determinant of stunting in under-five children. Previous literature has reported an inconsistent association between the sex of the child and childhood stunting. While some studies have reported that male children were more likely to be stunted, others found that female children were more likely to be stunted. However, one recent meta-analysis of DHS from 16 sub-Saharan countries found that male children were more likely to be stunted in most of the countries studied (10 out of 16) (Wamani *et al*. 2007). In this study, we found male children had higher odds of being stunted compared with female children. Previous studies in neonatology and in cohorts of preterm under-fives showed both morbidity and mortality to be consistently higher in males than females in early life even after adjusting for gestational age and body size, and this being more pronounced in the preterm under-fives (Chen *et al*. 1993; Kilbride & Daily 1998; Elsmen *et al*. 2004). An alternative explanation could be as a result of preferential treatment of females as a result of a high value placed on women for agricultural labour in some cultures and this supports the findings of other studies.(Cronk 1989;

Sevedberg 1996). Findings of this current study is consistent with the findings of other previous studies (Madzingira 1995; Reed *et al*. 1996; Hong *et al*. 2006; Kabubo-Mariara *et al*. 2009), which found that children of multiple births are more likely to be stunted than those of single births. This could be attributed to inadequate breastfeeding, low birthweight and competition for nutritional intake, which happen more in children of multiple births than those of single births.

The findings of this study support those of other similar studies, which indicated that maternal education has positive effect on childhood stunting (Hong *et al*. 2006; Odunayo & Oyewole 2006; Pongou *et al*. 2006; Wamani *et al*. 2006; Ijarotimi & Ijadunola 2007; Van de Poel *et al*. 2007; Semba *et al*. 2008; El Taguri *et al*. 2009; Kabubo-Mariara *et al*. 2009; Monteiro *et al*. 2009). Mothers with formal education may be knowledgeable of what to do to prevent childhood stunting from occurring or lessen the degree if it occurs. Maternal health-seeking behaviour index in this study was found to have positive effect on childhood stunting, which is consistent with findings of other similar studies that examined the predictors of childhood stunting (Pongou *et al*. 2006; Uthman 2009). Mother's BMI in this study revealed a significant association with childhood stunting; this suggests that under-fives whose mothers have low BMI are more likely to suffer from childhood stunting. Similar finding has been documented in some studies (Bhargava 1999; Uthman 2009). However, one may argue that the mother's height will be a better parameter for assessing this association; to the best of our knowledge, we did not find any literature to support this. Prolonged breastfeeding, particularly beyond infancy (>12 months), in this study was associated with childhood stunting. This finding could be attributed to the fact that most households are poor in developing countries and are unable to feed the children with adequate and quality complementary foods. Hence, they continue to practice solely exclusive breastfeeding beyond 12 months without supplementation with complementary foods (Larrea and Kawachi 2005; Hong 2007; Van de Poel *et al*. 2007). There is also the possibility that some of the children that are breastfed for longer than normal duration refused other foods apart from breast milk as evidenced by a study conducted in Ghana (Brakohiapa *et al*. 1988).

In addition, findings of this study revealed that under-five children from less wealthy households have greater odds of being stunted than under-fives from the wealthy households. Similar results were documented in previous studies carried out in different developing countries, which gives further proof that poverty is a significant predictor of childhood stunting (Hong *et al*. 2006; Odunayo & Oyewole 2006; Pongou *et al*. 2006; Hong 2007; Van de Poel *et al*. 2007; Hien & Kam 2008; Semba *et al*. 2008; Kabubo-Mariara *et al*. 2009; Monteiro *et al*. 2009; Ramli *et al*. 2009). Levels of socioeconomic status of a household are vital as it often determines the availability of good and nutritious foods for the growth and development of children. Moreover, under-five children from poorer households in most developing countries like Nigeria where a publicly funded health care system is not practised would lack access to good and basic health care services when they fall ill.

Using multilevel method of analysis for this study allowed variations in childhood stunting among different communities to be fully accounted for by contextual effects (area or neighbourhood of residence effects) rather than compositional effects (individual characteristics effects), although the variations among different communities with respect to the odds of having childhood stunting were found to originate mainly from variations in individual-level factors. These findings are consistent with most studies that have tried to differentiate contextual effects from compositional effects (Frohlich *et al*. 2002; Subramanian *et al*. 2003) and supports a major role for community-level phenomenon as a strong influence on childhood stunting. This study therefore supports the growing body of evidence advocating that community-level factors, on their own, exert a significant influence on individual-level factors (Macintyre *et al*. 1993; Pickett and Pearl 2001).

Study strengths and limitations

One of the strengths of this study is the representativeness of the data from the multistage sampling technique used, which makes the findings of the study to be relevant to the study population and also generalizable if applied to similar populations. An important strength of the study is it being population-based study with a large sample size and a participants' response rate of over 98%. Another important strength of this study is the small amount of missing data in virtually all the variables used apart from the child's age group category. In addition, another important strength of this study is using multilevel analysis in this study has made it possible to reveal other factors beyond individual-level factors that were responsible for the variations in childhood stunting; which the typical one-level model would not be able to reveal. Lastly, the NDHS data set, being the best data available in Nigeria and is used by both national and international agencies, gives credibility to the worthiness of this study.

An important limitation of this study is the cross-sectional nature of the study, which cannot be used as a good measure of causal relationship. Hence, strong conclusions cannot be drawn with respect to the aetiology of childhood stunting. The selection of multilevel units in this study could be a source of selection bias. We included only two levels (children – level 1 and community – level 2). The multilevel analysis can be performed at more finite levels, namely child (level 1), maternal (level 2) and community (level 3). However, the DHS was not designed for such stratification. Another limitation of this study is the difficulty in obtaining income and expenditure data for measuring wealth status in developing countries like Nigeria; therefore, an asset-based index is the only feasible alternative for measuring household wealth status. Lastly, there is an absence of dietary consumption data and other health care indicators such as morbidity data to substantiate the findings.

Policy implications

The findings from this study have some relevant policy implications. There is a clear need for intervention to reduce economic inequalities and ultimately poverty among the populace. Adult literacy programmes with special focus on child's health and nutrition should be organized particularly for women in communities with a high illiteracy rate as a short-term solution aimed at increasing low literacy level in Nigeria. In addition, governments of developing countries should ensure that female children are given appropriate formal education as a long-term measure. All of these will ultimately help equip uneducated mothers with knowledge on how to prevent stunting from occurring. Any intervention by governmental and non-governmental organizations that aim at improving under-five children's nutritional status should consider regions with a high rate of childhood stunting so as to avert under-coverage of the regions that deserve it. Nutritional intervention programmes like the therapeutic feeding and nursery school feeding programmes should be established and be directed specifically towards higher risk groups such as male under-fives, children born to non-educated or less-educated mothers, children who are products of multiple birth, and children who reside where there is a high illiteracy rate. This will at least lessen the degree of linear growth retardation in those who are already experiencing childhood stunting. Furthermore, interventions directed at subsidizing consumptions particularly for under-five children should be instituted by both governmental and non-governmental agencies in Nigeria and other developing countries. Establishment of public service fees especially health service fees for the less wealthy and poor in the society who are unable to pay for services would also be of tremendous help at lessening the degree of growth retardation in the sufferers. Moreover, provision of free health care for pregnant mothers, new mothers and young children, as being carried out in Sierra Leone, can serve as important policy alternative. Lastly, future studies should be conducted, which can be used for establishing causal relationships and will also include morbidity factors.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

VTA was involved in the conception of the study. VTA carried out data extraction. VTA conducted statistical analysis with contributions from OAU and GAK. VTA drafted the paper with contributions from OAU and GAK. All authors read and approved the final manuscript.

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