Exploring the Hierarchies: Multilevel Correlates of Child Mortality in Nigeria and Implications for Interventions

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Abstract

This study examined the multilevel correlates of childhood mortality among women (aged 15-49 years) in Nigeria using pooled data from the 2003, 2008 and 2018 Nigerian Demographic Health Surveys. This study considered 25,685 women who stated that they never lived outside their communities. Descriptive and multilevel regression analyses were performed. About 38% of the women reported losing at least a child. The individual-level correlates of childhood mortality were age, age at first birth, years of education, marital status, ethnicity, and wealth index. Household variables such as number of male children ever born (aIRR = 1.031; 95%CI = 1.026-1.036; p = 0.001), no bed net (aIRR = 1.052; 95%CI = 1.011-1.094; p = 0.012) and using biomass/charcoal (aIRR = 1.223; 95%CI = 1.013-1.475; p = 0.036) were positively associated with child mortality. Lower child mortality was observed in South South region (aIRR = 0.853; 95%CI = 0.767-0.949; p = 0.003), but it was higher in North East (aIRR = 1.143; 95%CI = 1.050-1.244; p = 0.002), North West (aIRR = 1.440; 95%CI = 1.318-1.574; p = 0.001) and South East (aIRR = 1.156; 95%CI = 1.028-1.300; p = 0.016) respectively. Higher childhood mortality associated positively with Community poverty (medium: aIRR = 1.107; 95%CI = 1.013-1.210; p = 0.024), low ownership of piped water (aIRR = 1.128; 95%CI = 1.047-1.215; p = 0.002) and problematic distance to health facility (aIRR= 1.046; 95%CI = 1.006-1.088; p = 0.025). There is a need for more interventions to tackle multilevel drivers of child mortality in Nigeria.

Keywords: Multilevel; Determinants; Childhood mortality; Nigeria

Introduction

Under-five (U-5) mortality rate reflects any country's level of socioeconomic development and population health (Yaya et al., 2017). It is fundamental for monitoring and evaluating population, healthcare intervention, programmes and policies (Kiross et al., 2021; Yaya et al., 2017). Despite the progress made over the last few years in reducing child mortality, from 12.6 million in 1990 to 5.4 million in 2017 (Roser et al., 2013; UN-IGME, 2020), child mortality remains high and threatens the attainment of the United Nation's sustainable development Goal

(SDG) 3.2 (UN-IGME, 2020). This goal is expected to save over 11 million U-5 many of whom live in sub-Saharan Africa (UN-IGME, 2020).

Nigeria has one of the highest U-5 mortalities, with 117 deaths per 1000 live births (UN-IGME, 2019). Hence, reducing child mortality is imperative; it requires more evidence-based interventions to set Nigeria on the path to achieving the SDG 3 target. Evidence suggests that at least one or a combination of individual, household and community-level factors play a critical role in childhood mortality (Adedini, 2013; Bello & Joseph, 2014; Kingsley et al., 2017; Olawuwo et al., 2018). For instance, women's age at first birth (among other factors) is associated with childhood mortality (Adepoju, 2015; Akinyemi et al., 2015; Samuel & Amoo, 2014; Yaya et al., 2017). Specifically, children born to younger mothers have been associated with a higher risk of mortality because they are often faced with physiological and financial empowerment challenges and are less experienced in childcare matters which can make child care extremely difficult (Adepoju, 2015; Akinyemi, Adebowale, Bamgboye, & Ayeni, 2015; Morakinyo & Fagbamigbe, 2017). Closely spaced birth intervals of less than two years also correlate with a higher risk of child mortality (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Ariyo & Jiang, 2021; Biradar et al., 2019; Ezeh et al., 2015; Salawu et al., 2021; Titilayo et al., 2017). Furthermore, the availability of community hospitals or maternal and child health services has been identified as a predictor of child survival (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Aregbeshola & Khan, 2018; Osita Kingsley Ezeh et al., 2015; Kiross et al., 2021; Morakinyo & Fagbamigbe, 2017).

Women who experience child death face psychological devastation (Shifa et al., 2018), guilt and social stigma (Barr, 2004). Also, women with such experience tend to have higher fertility (Adugna, 2018; Kabir et al., 2001; Syamala, 2001). This drive for higher fertility is quite risky for women under 18 years or over 34 years (Hammarberg et al., 2017; National Population Commission (NPopC) & ICF Macro, 2019). Therefore, it is quite important to examine child mortality rate among women in Nigeria. Although, there is a growing body of literature on child mortality in Nigeria (Adedini, 2013; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Akinyemi et al., 2017; Aregbeshola & Khan, 2018; Yaya et al., 2017), many have focused on a pairwise combination of individual, household and community-level determinants of child mortality or whether a child is alive or dead. However, little is known about the magnitude of child mortality in terms of the number of deceased children among women as well as the underlying individual-, household- and contextual- or community-level determinants.

This study investigated the individual-, household- and community-level determinants of childhood mortality (measured as the number of deceased children) among women of reproductive age in Nigeria. This study also focused on women of reproductive age who had never left their communities. This was needed to link women's immediate community factors—and estimate (more reliably) their marginal effects—to their child mortality experience. Findings from this study provided additional evidence for driving more effective community-based child survival interventions in Nigeria.

Methods

Data source

This study was based on pooled data from the 2003, 2008 and 2018 Nigeria Demographic and Health Survey (NDHS). The 1991 and 2013 NDHS was not considered because they lack some variables of interest in

this study, also, the latter has no question on the number of years a woman has lived in her residence. The surveys were implemented by the National Population Commission of Nigeria (NPopC) with financial and technical support from ORC Macro/ICF International through MEASURE DHS. DHS used a stratified two-stage cluster sampling design stratified by location-rural and urban. The information collected includes family planning, maternal and child health and nutrition, childhood mortality, malaria, female genital cutting, sexual activity, marriage, HIV/AIDS, and sexually transmitted diseases/ infections (National Population Commission - NPopC & ORC Macro, 2004, 2009, 2019).

Pooled data were analysed to enhance the external validity of statistical inferences (Friedenreich, 1993; Smith-Warner et al., 2006). Besides, the NDHS is quite uniform in terms of sampling design and variable-naming across the survey rounds, and there are no established connections between households selected in previous and subsequent surveys. The NDHS 2003, 2008 and 2018 surveys contained 7,620, 33,596 and 41,821 women of reproductive age, 15-49 years. This study considered 25,685 women who stated that they had lived all their lives in their communities.

Measures

Outcome variable

The outcome variable was "childhood mortality" measured as the total number of deceased under-five children. In line with a previous study in Nigeria, this variable was computed by subtracting "the number of surviving children" from "the total children ever born" to a woman (Yaya et al., 2017).

Explanatory variables

The selection of the individual, household and community-level explanatory variables was guided by previous studies (Adedini, 2013; Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Adeolu et al., 2016; Gayawan & Turra, 2015; Kingsley et al., 2017; Nyaramba, 2017; Pérez-Mesa et al., 2020; Yaya et al., 2017). The individual-level variables were current marital status, employment status, religion, ethnicity, ever use of contraceptive, the number of male children ever born, while household-level variables are ownership of bed net, electricity, wealth index, type of cooking fuel, ownership of piped water and ownership of flush toilet, ownership of piped water.

Apart from the place and region of residence, the community-level variables in this study were derived by aggregating women's individual or household characteristics at the cluster level. For example, individual women at the lowest wealth index were aggregated to form the proportion of women at the lowest wealth quintile in a community (cluster level). Previous studies have used this technique to derive multilevel factors (Adedini, 2013; Okunlola et al., 2020; Ononokpono et al., 2013, 2014; Solanke & Rahman, 2018). The community-level variables were later categorised into tertiles, low (25%), middle (50%), and high (75%) proportions. The variables were community-level diversity, education, poverty (lowest wealth index), contraceptives use, piped water ownership, toilet ownership and distance to a health facility. Ethnic diversity, measured as the proportion of women of different ethnic extractions in the community, was dichotomised into low (50%) and high density (50%) in line with a previous study (Ononokpono et al., 2016).

Statistical analysis

All categorical variables were described with frequency and percentages, while medians and inter-quartile ranges were presented for quantitative variables. Due to the hierarchical structure of the NDHS and over-dispersion in the outcome variable, multilevel negative binomial regression models were used to identify the individual, household, and community-level correlates of childhood mortality in Nigeria. The regression model also included an exposure variable, which was the total number of children ever born (per woman). Several models were fitted in the order of complexity, starting with a null model (model with no predictors). Model 2 included the individual-level variables, while Model 3 contained only the household level variables. In Model 4, community-level variables were considered. The last model (Model 5) was a full model that included all variables. Model estimates for fixed effects were presented as adjusted Incidence risk ratios (aIRR) together with their 95% confidence interval. Log-likelihood tests of the models were performed to assess the goodness of fit of the multilevel regression models. Variance partitioning coefficient (VPC) was used to assess the proportion of the variation in the total number of deceased children attributed to community-level factors following the approach of Leckie, Browne, Goldstein, Merlo, and Austin (2020). VPC ranges from 0 to 1 (the higher, the better).

Results

Background characteristics of the respondents

Table 1 presents the characteristics of the study sample. The median age of women, age at first birth and years of education were 32 (Q1 =25, Q3 = 40), 18 (Q1 = 16, Q3 = 21) and 0 (Q1 = 0, Q3 = 9) respectively while median number of male children ever born was 4 (Q1 = 2, Q3 = 6). About 38% of women reported losing at least a child. Most women (89%) were married. More than half of women (68%) were employed and practised Islamic religion (62%), respectively. More than one-quarter (35%) women were from the Hausa/Fulani ethnic group. Slightly above one-quarter (26%) of the women ever used contraceptives, and about half (53%) had bed nets. Half of the women had electricity (48%) and were in poor households (47%). More than three-quarters (72%) used biomass outdoor, 96% had no piped water, and 85% did not have a flush toilet. Overall, 97% of women were from less diverse communities in terms of ethnic composition, 69% and 63% resided in the northern region and rural areas, respectively. Less than half of women lived in communities characterised by a high lack of education (45%), high poverty (40%) and high non-users of contraceptives (42%), respectively. Most women (81%) lived in communities where the proportion of piped water owners was low. About 67% of women stated that proximity to health facilities was not problematic.

Table 1 Individual, household and community level characteristics

Variables	n	%
Individual-level		
Number of deceased children, median (Q1, Q3)		0 (0, 1)
Current age, median (Q1, Q3)		32 (25, 40)

Age at first birth, median (Q1, Q3)		18 (16, 21)
Number of male children ever born, median (Q1, Q3)		4 (2, 6)
Years of education, median (Q1, Q3)		0 (0, 9)
Deceased children		
None	15,809	61.55
At least 1	9,876	38.45
Marital status		
Never married	885	3.44
Married	22,931	89.28
Widowed	917	3.57
Divorced	951	3.70
Employment status		
Employed	17,580	68.44
Unemployed	8,105	31.56
Religion		
Christian	9,369	36.52
Islam	15,948	62.17
Others	334	1.30
Ethnicity		
Hausa/ Fulani	9,100	35.43
Igbo	1,525	5.94
Yoruba	2,370	9.23
Others	12,690	49.41
Ever use of contraceptive		
Ever use	6,647	25.88
Never-use	19,038	74.12
Household-level		
Ownership of bed net		
Have	13,596	52.93
Don't have	12,089	47.07
Electricity		
Have	12,418	48.35
Don't have	1,267	51.65
Wealth Index		
Poorest	6,080	23.67
Poorer	6,052	23.56
Middle	5,433	21.15
Richer	4,670	18.18
Richest	3,449	13.43
Type of cooking fuel		

Clean fuel	1,716	6.73
Biomass/ charcoal	3,054	11.98
Biomass outdoor	18,561	72.82
Other pollutant cooking fuel	2,158	8.47
Ownership of piped water		
Have	992	3.86
Don't have	24,693	96.14
Ownership of flush toilet		
Have	3,885	84.87
Don't have	21,800	15.13
Community-level		
Type of place of residence		
Urban	8,444	32.87
Rural	17,241	67.13
Ethnic diversity		
Low diversity	25,054	97.54
High diversity	631	2.46
Region		
North Central	3,061	11.92
North East	4,771	18.57
North West	9,812	38.20
South East	2,169	8.45
South South	2,579	10.04
South West	3,293	12.82
No-education level		
Low level of no-education	6,091	23.72
Medium no education	7,994	31.12
High level of no-education	11,600	45.16
Poverty level		
Low	6,533	25.43
Medium	8,903	34.66
High	10,249	39.90
Low contraceptive use		
Low	6,550	25.50
Medium	8,131	31.66
High	11,004	42.84
Piped water ownership		
High	4,817	18.75
Low	20,868	81.25
Electricity ownership		

Low	9,746	37.95
Medium	9,406	36.62
High	6,533	25.43
Toilet ownership		
Low	12,977	50.53
Medium	6,296	24.51
High	6,412	24.96
Distance to the health facility		
Not a big problem	16,524	67.37
Big problem	8,002	32.63

Q1 = First Quartile; Q3 = Third Quartile

Relationship between Individual, household, and community-level characteristics and childhood mortality

The results from the models' goodness of fit are presented in Table 2. The results show that models with explanatory variables were better than the null model. The full model (Model 5) has the smallest log-likelihood and thus, has the best fit. VPCs were computed for each model, showing the proportion of variation in childhood mortality due to between-cluster differences. The proportion decreased drastically from 4.8% (in the null model) to 0.6% (in Model 5). Although not shown, a decrease in the marginal effect was observed for women's current age, religion, contraceptives use, male children ever born and ownership of bed net from Model 2 to Model 5. Other variables, including "current marital status" fluctuated.

Model 5 (in Table 3), presents the full model investigating the association between individual level, household level, community-level factors and childhood mortality. A unit increase in women's age was associated with a 1.8% increase in rate of childhood mortality (aIRR = 1.018, 95% CI: 1.015-1.020, p = 0.001). Childhood mortality rate decreased by 3% in response to a year increase in women's age at first birth (aIRR = 0.971, 95% CI: 0.966-0.976, p = 0.001). Higher years of education was associated with 1% reduction in child mortality rate (aIRR = 0.989, 95% CI: 0.983-0.995, p = 0.001). Compared to never-married women, divorced/ separated women were assoscited a higher child mortality rate (aIRR = 1.399, 95% CI: 1.136-1.723, p = 0.002). Childhood mortality rate decreased by 18% and 16% among Igbo (aIRR = 0.819, 95% CI: 0.705-0.953, p = 0.010) and Yoruba women (aIRR = 0.836, 95% CI: 0.708-0.986, p = 0.034), respectively while childhood mortality rate among other ethnic groups increased by 8% (aIRR = 1.081, 95% CI: 1.021-1.145, p = 0.008) compared to Hausa/Fulani women. There was 8% increase in the childhood mortality rate among (aIRR = 1.084, 95% CI: 1.034=1.136, p = 0.001) women who never used contraceptives than those who ever used.

For the household characteristics, increase in number of male children ever born was associated with 3% increase in the childhood mortality rate (aIRR = 1.031, 95% CI: 1.026-1.036, p = 0.001). Women living in households without bed nets were associated with 5% increase in child mortality rate than those who had (aIRR = 1.052, 95% CI: 1.011-1.094, p = 0.012). childhood mortality rate reduced by 11%, 21% and 32% among women in middle (aIRR = 0.889, 95% CI: 0.834-0.947, p = 0.001), richer (aIRR = 0.795, 95% CI: 0.730-0.866, p = 0.001)

and richest (aIRR = 0.680, 95% CI: 0.592-0.780, p = 0.001) wealth groups respectively than their poorest counterparts. Compared to women who used clean fuel, childhood mortality rate increased by 22% among women who used biomass/charcoal (aIRR = 1.223, 95% CI: 1.013-1.475, p = 0.036).

Compared to women in North Central region, childhood mortality rate increased by 14% in North East (aIRR = 1.143, CI: 1.050-1.244, p = 0.002), 44% in North West (aIRR = 1.440, CI: 1.318-1.574, p = 0.001) and 16% in the South East (aIRR = 1.156, CI: 1.028-1.300, p = 0.016), while the rate decreased by 15% in South South region (aIRR = 0.853, CI: 0.767-0.949, p = 0.003). Among the women living in communities with medium level of poverty, childhood mortality rate increased by 11% (aIRR = 1.107, CI: 1.013-1.210, p = 0.024) than communities with low poverty. In communities with high non-users of contraceptive, child mortality rate decreased by 11% (aIRR = 0.894, CI: 0.820-0.975, p = 0.010). In communities with low proportion of piped water owners, childhood mortality rate increased by 13% (aIRR = 1.128, CI: 1.047-1.215, p = 0.002) than their counterparts in communities with higher proportion of piped water owners. In communities where distance to health facility was problematic, rate of childhood mortality rate was 5% higher (aIRR = 1.046, CI: 1.006-1.088, p = 0.025) than communities where distance was not a problem.

Table 2 Model goodness of fits

Models	Description	Log likelihood	p†	VPC
Model 1	Null	1807.87	<0.0001	0.048
Model 2	Individual-level only	765.65	<0.0001	0.016
Model 3	Household-level only	757.56	<0.0001	0.016
Model 4	Community-level only	554.58	<0.0001	0.011
Model 5	Full model	379.50	<0.0001	0.006

†Based on the Log-likelihood ratio test versus negative binomial regression; VPC: Variance Partition Coefficient

Table 3 Results from multilevel regression of children mortality (Model 5)

Variable	aIRR	95% CI		p-value
Individual-level				
Current age	1.018*	1.015	1.020	0.001
Age at first birth	0.971*	0.966	0.976	0.001
Years of education	0.989*	0.983	0.995	0.001
Marital status				
Never married	Ref			
Married	1.094	0.904	1.323	0.356
Widowed	1.166	0.950	1.432	0.142
Divorced/Separated	1.399*	1.136	1.723	0.002
Employment status				

Employed (RC)	Ref			
Unemployed	1.001	0.965	1.040	0.939
Religion				
Christian (RC)	Ref			
Islam	1.052	0.973	1.138	0.202
Others	1.032	0.884	1.206	0.690
Ethnicity				
Hausa/ Fulani (RC)	Ref			
Igbo	0.819*	0.705	0.953	0.010
Yoruba	0.836*	0.708	0.986	0.034
Others	1.081*	1.021	1.145	0.008
Ever use of contraceptive				
Ever use	Ref			
Never-use	1.084*	1.034	1.136	0.001
Household-level				
Number of male children ever born	1.031*	1.026	1.036	0.001
Ownership of bed net				
Have	Ref			
Don't have	1.052*	1.011	1.094	0.012
Electricity				
Have	Ref			
Don't have	1.007	0.950	1.067	0.819
Wealth Index				
Poorest	Ref			
Poorer	0.984	0.941	1.028	0.465
Middle	0.889*	0.834	0.947	0.001
Richer	0.795*	0.730	0.866	0.001
Richest	0.680*	0.592	0.780	0.001
Type of cooking fuel				
Clean fuel	Ref			
Biomass/ charcoal	1.223*	1.013	1.475	0.036
Biomass outdoor	0.983	0.820	1.178	0.853
Other pollutant cooking fuel	1.021	0.848	1.230	0.824
Ownership of piped water				
Have	Ref			
Don't have	1.087	0.970	1.219	0.152
Ownership of flush toilet				
Have	Ref			
Don't have	0.931	0.853	1.016	0.109
Community-level				

Place of residence				
Urban	Ref			
Rural	1.056	0.991	1.126	0.093
Ethnic diversity				
Low diversity	Ref			
High diversity	0.987	0.796	1.224	0.903
Region				
North Central	Ref			
North East	1.143*	1.050	1.244	0.002
North West	1.440*	1.318	1.574	0.001
South East	1.156*	1.028	1.300	0.016
South South	0.853*	0.767	0.949	0.003
South West	0.884	0.767	1.019	0.088
No-education level				
Low	Ref			
Medium	0.928	0.854	1.007	0.074
High	1.089	0.937	1.181	0.387
Poverty level				
Low	Ref			
Medium	1.107*	1.013	1.210	0.024
High	1.089	0.969	1.224	0.151
Non-use of contraceptive				
Low	Ref			
Medium	0.934	0.866	1.006	0.072
High	0.894*	0.820	0.975	0.011
Piped water ownership				
High	Ref			
Low	1.128*	1.047	1.215	0.002
Electricity ownership				
Low	Ref			
Medium	1.041	0.977	1.109	0.211
High	0.999	0.910	1.096	0.977
Toilet ownership				
Low	Ref			
Medium	0.945	0.888	1.006	0.077
High	1.029	0.945	1.120	0.516
Distance to the health facility				
Not a big problem	Ref			
Big problem	1.046*	1.006	1.088	0.025

*Significant at $p<0.05$; aIRR = Adjusted Incidence Rate Ratio; Ref = Reference Category

Discussion

Although childhood mortality rate has been declining in Nigeria in recent years, it remains consistently high and continues to portend negative implications for socio-economic development and population health in the country. Utilising pooled data from NDHS 2003 to 2018, this study investigated the individual-, household-, community-level determinants of childhood mortality in Nigeria.

This study showed that 38% of all the women in this study had experienced childhood mortality. This differs from the 30% reported by Yaya et al. (2017), although their study focused on married women (and men). There was a positive association between childhood mortality rate and women's current age, but the reverse was observed for women's age at first birth and years of education. These suggest that higher age at first birth and years of education is protective against childhood mortality, unlike older maternal age. These findings are consistent with previous studies (Adeolu et al., 2016; Friede et al., 1988; Mondal et al., 2009). Concerning education, child mortality rate was lower among women with at least secondary education than the uneducated ones (Yaya et al., 2017). Based on existing evidence, education can enable adherence to and the utilisation of quality health practices and services (Buor, 2003).

Marital status, ethnicity and contraceptive use were significant correlates of childhood mortality, respectively. Women who were divorced/ separated experienced higher childhood mortality than the never-married. This finding contradicts that of Adedini (2013) but is consistent with Aregbeshola and Khan (2018) and Akinyemi et al. (2017) that found being married is protective of child mortality. The authors argued that being unmarried could jeopardise a child's health because it can rob a child of adequate fatherly care. Moreover, the burden of childcare and seeking means of livelihood at the same time may overwhelm a mother and lead her to compromise on better childcare practices. Compared to women from Hausa/Fulani ethnic group, childhood mortality rates were lower among women from Igbo and Yoruba ethnic groups respectively. This is attributable to high level of education, better socio-economic features and cultural differences among Igbos and Yorubas (unlike Fulanis/Hausas). Women who had never used contraceptive experienced a higher rate of childhood mortality. This echoes previous findings that contraception ensures adequate birth spacing, which in turn lowers the risk of childhood mortality (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Biradar et al., 2019; Ezeh et al., 2015; Salawu et al., 2021).

In terms of household factors, childhood mortality was positively associated with an increase in male children. A study from Nigeria revealed that childhood mortality is more pronounced among male children (Olawuwo et al., 2018). Hence, life expectancy tends to be higher among female children than male children due to genetic factors (Muhuri & Preston, 1991). Also, even when there is equality in immunisation uptake among male and female children, mortality is still higher among male children (Basu, 1989; Koenig & D'Souza, 1986). Therefore, having more male children comes with a huge burden of care that is necessary to reduce a woman's exposure to child mortality. Wealth status was negatively associated with childhood mortality rate. This aligns

with other studies (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Adepoju, 2015; Edeme, Ifelunini, & S, 2015; Ezeh et al., 2015; Gayawan & Turra, 2015; Yaya et al., 2017). Women from wealthy households can afford and cater for children's nutritional and health needs. Also,Higher childhood mortality rate was found among women in households with biomass/charcoal. Children in such households are exposed to fumes and hazardous smoke and which can damaged their respiratory systems and increase their risk of dying (Lee et al., 2020; Roberman et al., 2021).

Concerning community level factors, compared to the North Central region, childhood mortality rate was higher in the North East, North West Nigeria and South East regions, respectively, while the reverse was observed in South South. These findings are due to the high rate of poverty (Khan & Cheri, 2016), insurgency and terrorist attacks(Ekhator-Mobayode & Abebe Asfaw, 2019), and childhood comorbidities (such diarrhea, acute respiratory and stunting) (Gayawan et al., 2022) in North East, North West. The evidence regarding the South East region is consistent with that of Yaya et al. (2017). Yet, it is surprising because the region (alongside South South region) has a higher proportion of educated women than North Central (National Population Commission (NPopC) & ICF Macro, 2019), and high childhood vaccination uptake (Adegboye et al., 2014; National Bureau of Statistics and United Nations Children's Fund, 2017). This study's finding may be due to regional differentials in socio-economic and health-related attributes—as revealed in previous studies (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Antai, 2011; Kravdal, 2004; Ladusingh & Singh, 2006; Pradhan et al., 2003; Say & Raine, 2007; Wall, 1998)— in terms of maternal education, economic development, hygiene practice, community education, distribution and use of health facilities.

Community poverty level was associated with childhood mortality. This aligns with other studies from Nigeria (Adedini, 2013; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015). Child mortality rate was higher among women in moderately poor communities. Again, this finding emphasises the protective effect of wealth against childhood mortality. In communities with a high proportion of non-users of contraceptive, childhood mortality rate was higher, than in communities with a low proportion of non-users of contraceptives. Women in non-users' communities may be adopting more effective childcare measures. In contrast, it is possible that their counterparts using contraceptive may use it inconsistently, thereby underutilising the benefits of contraception to ensure adequate childbirth spacing and lowering childhood mortality risk. Communities with high proportion of households without piped water were associated with a higher rate of childhood mortality. Adequate supply of clean and safe water indicates level of infrastructural development in any community. Access to piped water reduces incidence of diseases and poor child health outcomes (Wolf et al., 2018). On the other hand, access to facilities may not be sufficient because proximity to such facilities may pose a big problem to the survival of a child. For instance, in this study, the rate of child mortality was higher among women who admitted that distance to health facilities was a problem.

Limitations

This study was based on pooled cross-sectional data that lacked temporal precedence to establish causality. Secondly, beyond the division of Nigeria into 36 states (and federal capital), the country is divided into 774 local governments. Therefore, the use of PSU as a proxy for measuring community factors in this study may cause many women to be misclassified into the wrong local governments. This may have implications for inferring

about the contribution of between-cluster differences to variation in childhood mortality in this study. Thirdly, some potential confounders, such as socio-cultural practices, were not considered. Fourthly, age at child death and the cause of death were not examined in this study. Despite these limitations, this study contributed to generated insights, especially with respect to the magnitude of childhood mortality and associated multilevel factors in Nigeria. Unlike in previous studies, the consideration of women who had never left their communities in this study enables us to link the child mortality experience to the exact communities in which the women lived all their lives to generate more reliable estimates.

Conclusion and Implication for Policy

This study established that individual and household factors accounted for the larger proportion of the variation in child mortality among women of reproductive age in Nigeria, but pointed out some significant community-level factors. The identified multilevel factors can serve as useful inputs in the development of more effective child survival interventions toward the SDG target of a reduction in U-5 mortality rate to at least 25 deaths (per 1000 live births) by the year 2030.

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