Reproductive Health

RESEARCH

Open Access

Individual, household, and community-level factors associated with high-risk fertility behaviour among Nigerian women: secondary analysis of the 2018 demographic and health survey data

Michael Ekholuenetale[1,2], Chimezie Igwegbe Nzoputam[3,4], Amadou Barrow[5,6*] and Amit Arora[7,8,9,10,11]

Abstract

Background High-risk fertility behaviour (HRFB) remains a significant public health concern in Nigeria, contributing to increase in maternal and child morbidity and mortality. The existence of HRFB presents significant barrier to accomplishing the Sustainable Development Goals. The objective of this study was to examine the prevalence and contextual factors of HRFB among Nigerian women.

Methods In this study, cross-sectional data with national representativeness from the 2018 Nigeria demographic and health survey (NDHS) were used. The sample was made up of 21,792 women aged 15–49 years selected from 1389 enumeration areas. A multilevel multivariable binary logistic regression model was utilised to examine the factors associated with HRFB.

Results The weighted prevalence of HRFB was 64% (95% CI 62–65%). Women having at least a secondary education had 14% (aOR = 0.86; 95% CI 0.77–0.98) reduction in the odds of HRFB when compared with women with at most a primary education. Muslim women had 20% (aOR = 1.20; 95% CI 1.06–1.36) increase in the odds of HRFB, when compared with the Christian women. Those who had 3–4 living children had 3.97 times higher odds of HRFB, when compared with women with no child (aOR = 3.97; 95% CI 2.92–5.40). Women aged 25–34 and 35–49 years had higher odds of HRFB when compared with women aged 15–24 years respectively. Women exposed to media use had 12% (aOR = 0.88; 95% CI 0.80–0.97) reduction in the odds of HRFB when compared with women not exposed to media use. The non-poor women had 12% (aOR = 0.88; 95% CI 0.79–0.99) reduction in the odds of HRFB when compared with poor women. Respondents from female-headed households had 21% reduction in the odds of HRFB when compared with those from households with male head (aOR = 0.79; 95% CI 0.69–0.92). The geographical region was significantly associated with HRFB among women.

Conclusion The high prevalence of HRFB among Nigerian women underscores the need for policies and programmes targeted to address the issue. Addressing socioeconomic factors, improving education and healthcare access, and promoting family planning could significantly reduce HRFB.

Keywords HRFB, Pregnancy, Birth interval, Reproductive health, Parity

*Correspondence:
Amadou Barrow
abarrow@utg.edu.gm
Full list of author information is available at the end of the article

Introduction

High-risk fertility behaviour (HRFB) continues to be a significant public health concern, particularly in low- and middle-income countries (LMICs), such as Nigeria. The HRFB is characterized by childbearing practices that increase maternal and child health risks, including early childbearing (before age 18), late childbearing (after age 34), short birth intervals (less than 24 months), and high parity (more than three children) [1–3]. These practices contribute substantially to maternal and child morbidity and mortality, impacting not only individual health outcomes but also broader socioeconomic development. These behaviours are particularly prevalent in sub-Saharan Africa, including Nigeria, where cultural, socioeconomic, and educational factors play a crucial role. In Nigeria, the fertility rate remains high, contributing to the rapid population growth and posing challenges to maternal and child health [4, 5].

Globally, there is a staggering burden of HRFB with resource-constrained settings affected disproportionately. In sub-Saharan Africa, including Nigeria, the prevalence of HRFB is particularly high, contributing to the region's elevated maternal mortality ratio of 542 deaths per 100,000 live births [6]. Nigeria, as the most populous country in Africa, faces significant challenges in addressing HRFB within the context of its national health policies and broader Sustainable Development Goals (SDGs). Specifically, SDG 3 which aims to reduce the global maternal mortality ratio to less than 70 per 100,000 live births by 2030, a target that necessitates addressing HRFB as a key contributing factor [7]. The Nigerian government has incorporated these goals into its national health strategy, emphasizing the need to promote safe motherhood practices and reduce HRFB [4, 8, 9].

Research has identified various factors associated with HRFB, including socioeconomic status, educational attainment, cultural norms, and access to healthcare services [10]. In Nigeria, these factors are often compounded by regional disparities, with rural areas typically experiencing higher rates of HRFB compared to urban centers. Additionally, religious beliefs and traditional practices play significant roles in shaping fertility behaviours, often promoting large family sizes, polygamy and early marriages, which can contribute to HRFB [8, 11, 12]. For instance, HRFBs has been linked to several factors such as family structure, women's decision-making power, access to family planning, and educational level [13, 14].

Despite the recognized importance of addressing HRFB, there remains a paucity of comprehensive, up-to-date data on its prevalence and associated factors in Nigeria. Previous studies have often been limited in scope and geographic coverage, leaving gaps in our understanding of the current situation across different regions and demographic groups within the country. Moreover, the dynamic nature of socioeconomic and cultural factors necessitates ongoing research to capture evolving trends and inform effective interventions [13, 15]. Socioeconomic characteristics such as education, wealth index, and community norms have been shown to significantly predict fertility behaviour and its associated risks [5, 9].

Given these knowledge gaps and the critical importance of addressing HRFB in Nigeria, this study aims to provide a comprehensive analysis of the prevalence and factors associated with HRFB among Nigerian women. By utilizing recent, nationally representative data, this study seeks to offer insights that can inform targeted policies and interventions. This study aimed to highlight the prevalence of HRFBs among Nigerian women and to identify the individual-, household-, and community-level factors that contribute to HRFB. This ultimately supports Nigeria's progress towards achieving the SDGs and improving the overall population health outcomes. The findings of this study will be crucial for policymakers, healthcare providers, and researchers to develop evidence-based strategies to mitigate HRFB and its adverse consequences on maternal and child health in Nigeria.

Methods

Data source

We used data from the 2018 Nigeria demographic and health survey (NDHS) individual woman questionnaire. In total, 21,792 women who are of reproductive age (15–49 years) made up the study's sample. The National Population Commission (NPC) has conducted this type of survey six times, with the most recent being the 2018 NDHS [16]. From August 14 to December 29, 2018, data were collected [16]. The sample was chosen using a stratified, multi-stage cluster design, with enumeration areas (EAs) serving as the sampling units for the first stage. A total of approximately 30 households were chosen from the complete list of households in each of the 1389 selected EAs, resulting in a 99% response rate.

Sampling technique

In the three-stage sampling stratification process used for the NDHS 2018, respondents were first divided into urban and rural housing strata, and then EAs were randomly chosen within each stratum. Following that, equal probability sampling was used to choose households within each EA for the survey. In order to ensure that the sample was representative of the general population, the three-stage sampling method was used when calculating survey weights. The Federal Republic of Nigeria's 2006 Population and Housing Census (NPHC), which

was carried out by the National Population Commission, served as the sampling frame for the 2018 NDHS. A stratified sample was chosen in two phases for the 2018 NDHS. The 36 states and the Federal Capital Territory were divided into urban and rural regions in order to stratify the country. There were 74 different sampling strata identified in total. The individual female data used for analysis in this study served as the source of the data. Information regarding the DHS sampling process has previously been reported [17].

Measurements of outcome variable

The outcome variable, HRFB, was calculated using four criteria: (a) women who were younger than 18 years old at the time of delivery; (b) women who were older than 34 years old at the time of delivery; (c) women who had more than three children; and (d) women who had a child born within a short time frame (less than 24 months). A woman was classified as having had HRFB if she had at least one of the indicators, which were categorised as 1 or "yes," and 0 or "no" otherwise [18–20].

Explanatory variables

Previous studies provided the basis for the factors this study examined [21–23]. Education: none or primary, secondary or higher; religion: Christianity, Islam, traditional or others; number of living children: 0, 1–2, 3–4, 5+; years spent in residence: < 5 years, 5+years; age (years): 15–24, 25–34, 35–49; marital status: not married, married; covered by health insurance: no, yes; exposed to media: no, yes; employment status: no, yes; socioeconomic disadvantaged status: low, medium, high; husband or partner's education level: none, primary, secondary, higher, don't know; household wealth: poor, non-poor; sex of household head: male, female; region: North-Central, North-East, North-West, South-East, South-South, South-West; residential status: urban, rural; community-level poverty: community level poverty was defined as the proportion of women who were below the middle class in wealth status and categorized into low, medium, high; community-level education: community level women's education was defined as proportion of women from community with at least primary education and categorized into low, medium, high; community-level ethnicity: ethnic diversity refers to the concentration of different ethnic groups in a community. It was defined as the proportion of women from different ethnic groups in the primary sampling unit. The value ranges from 0 to 100. A value of 0 (low) reflects a mono-ethnic community, whereas a value of 100 (high) reflects that the community is multi-ethnic in nature and this variable was categorized into mono-ethnic, multi-ethnic. The community-level poverty, education and ethnicity were constructed using principal component analysis technique respectively.

Analytical approach

Stata software version 17.0 (Stata Corporation, College Station, Texas, USA) was used for data analysis. Since the study included the multi-stage stratified cluster sample design, we employed the survey module's ('svy') function to account for sampling design (weighting, clustering, and stratification). Percentage was employed in the univariable analysis. A bivariate analysis chi-square test between each independent variable and the outcome variable (HRFB) was used to determine the significant variables to be included in the multivariable models. The fixed and random effects of the parameters connected to HRFB were investigated using the multilevel multivariable binary logistic regression. In order to assess multicollinearity, which is known to raise serious issues with the logit model, the variance inflation factor was employed [24].

We designed a three-level model for binary response reporting HRFB, at level 1 for individual women and level 2 for households from Enumeration Areas. We built five models. First, the amount of variance between the community and household levels was broken down into several components using an empty or unconditional model that lacked any explanatory factors. We utilised the null or empty model as the benchmark to calculate the extent to which household and community characteristics may account for the observed changes because it is crucial for comprehending the variations in the community and households. Furthermore, we utilised it to support the application of the multilevel statistical framework, as it recommended using single-level logistic regression in cases when the community variance in the empty model was not significant. The second model alone included elements at the individual level, the third model exclusively included factors at the household level, and the fourth model exclusively included factors at the community level. Ultimately, the fifth model (full model) simultaneously adjusted for variables at the individual, household, and community levels. The level of significance was determined at $p < 0.05$. To choose the best model from the five models, the Bayesian and Akaike Information Criteria were applied. A lower Akaike or Bayesian Information Criterion score denotes a better model fit [25].

Fixed and random effects

Adjusted odds ratios (aORs) along with their 95% confidence interval (CI) were used to report the outcomes of fixed effects (measures of association). The Intraclass Correlation (ICC) and Median Odds Ratio (MOR) were used to quantify the likely contextual effects [26].

With the use of ICC, we assessed the similarity between respondents living in the same household and community. The ICC is a measure of the clustering of odds of HRFB in the same household and community. It shows the percentage of the total variance in the likelihood of HRFB that is connected to the household and community level. The MOR estimates the probability of HRFB that may be assigned to the household and community by measuring the second or third level (household or community) variance as odds ratios. When the MOR is one, there is no variance in households or communities. Conversely, the higher the MOR, the more important are the contextual effects for understanding the probability of HRFB. The linear threshold was utilised to compute ICC using the Snijders and Bosker formula [27], MOR, on the other hand, measures the heterogeneity of unexplained clusters.

Ethical consideration

The de-identified public secondary dataset was used for this study. The respondents' informed consent was collected by NDHS in accordance with established ethical protocol. The authors were granted permission to use the data, which was collected by NDHS in accordance with ethical standards, therefore no further participants' agreement or consent was required. The details of DHS ethical guidelines can be found here: http://goo.gl/ny8T6X.

Results

Table 1 shows the distribution of respondents across selected characteristics. The majority of women were less educated (59.4%), Muslims (58.2%), had at least one child alive (98.8%), native of their place of residence (83.6%), aged 25–34 years (47.2%), married (97.2%), covered by health insurance (97.7%), exposed to media (61.1%), employed (68.0%), highly socioeconomically disadvantaged (42.3%), had husband/partner with at least primary education (63.7%), from non-poor (57.5%) and male headed households (89.5%), North West region (29.0%), rural residents (64.6%) and from multi-ethnic communities (99.9%) respectively, as shown in Table 1.

Four indicators were used to measure HRFB; these include: < 18 years at childbirth, > 34 years at childbirth, > 3 children birth order and < 24 months at preceding birth interval. A woman is said to have HRFB is she was reported to have at least one of these indicators. Figure 1 shows the weighted prevalence of HRFB was 64% (95% CI 62–65%), wherewith < 18 years at childbirth was 5% (95% CI 3–6%), > 34 years at childbirth was 18% (95% CI 17–20%), > 3 children birth order was 50% CI 48–51%) and < 24 months at preceding birth interval was 17.0% 95% CI 16–18%).

Table 1 Characteristics of respondents (n = 21,792)

Variable	Sample size (n)	Percent (%)
Education		
No education/primary	12,937	59.4
Secondary/Higher	8855	40.6
Religion		
Christianity	8929	41.0
Islam	12,687	58.2
Traditional/Others	176	0.8
Number of living children		
0	273	1.2
1–2	8339	38.3
3–4	6791	31.2
5 +	6389	29.3
Years spent in residence		
< 5 years	3578	16.4
5 + years	18,241	83.6
Age (years)		
15–24	5399	24.8
25–34	10,287	47.2
35–49	6106	28.0
Marital status		
Not married	605	2.8
Married	21,187	97.2
Covered by health insurance		
No	21,298	97.7
Yes	494	2.3
Exposed to media		
No	8470	38.9
Yes	13,322	61.1
Employment status		
No	6977	32.0
Yes	14,815	68.0
Socioeconomic disadvantaged status		
Low	6509	29.9
Medium	6058	27.8
High	9225	42.3
Husband/partner's education level		
No education	7141	35.0
Primary	2897	14.2
Secondary	7060	34.6
Higher	3039	14.9
Don't know	282	1.4
Household wealth		
Poor	9265	42.5
Non-poor	12,527	57.5
Sex of household head		
Male	19,512	89.5
Female	2280	10.5
Region		
North Central	3875	17.8
North East	4506	20.7

Table 1 (continued)

Variable	Sample size (n)	Percent (%)
North West	6309	29.0
South East	2365	10.9
South South	2174	10.0
South West	2563	11.8
Residential status		
Urban	7710	35.4
Rural	14,082	64.6
Community-level poverty		
Low	7357	33.8
Medium	7247	33.2
High	7188	33.0
Community-level education		
Low	7285	33.4
Medium	7253	33.3
High	7254	33.3
Community-level ethnicity		
Mono-ethnic	2	0.1
Multi-ethnic	21,790	99.9

Table 2 shows the weighted prevalence of HRFB was higher among the less educated women (73.6%), women who have lived 5+years in place of residence (67.4%), women aged 35–49 years (93.6%), married (64.3%), not exposed to media (71.0%), highly socioeconomically disadvantaged (71.7%), from poor households (70.1%), from North West geopolitical zone (72.2%), rural residents (67.0%), from community with low education (72.9%) and from mono-ethnic community (100.0%) respectively. The prevalence distribution of HRFB varied significantly across women's characteristics using Chi-square test.

Measures of variations (random effects) and model fit statistics

In Table 3, Model V (full model) was selected as the most suitable due to the least AIC and BIC values (16,154.60 and 16,424.02 respectively). The variations in the odds of HRFB across communities ($\sigma^2=0.04$) and households ($\sigma^2=0.05$) were estimated. Results from Median Odds Ratio became the evidence of community contextual factors shaping HRFB. It was estimated that if a women moved to another community or household with a higher probability of HRFB, the median increase in their odds of HRFB would be 1.21 or 1.25 with ICC of 1.0% or 2.0% respectively. MOR equal to unity, indicated no household variance given ICC of 0.0%.

Measures of associations (fixed effects)

Results from Table 4 shows that women with secondary/higher education had 14% (aOR=0.86; 95% CI 0.77–0.98) reduction in the odds of HRFB when compared with women with no formal/primary education. Muslim women had 20% (aOR=1.20; 95% CI 1.06–1.36) increase in the odds of HRFB when compared with the Christian women. Those who had 3–4 living children had 3.97 times higher odds of HRFB, when compared with women with no child (aOR=3.97; 95% CI

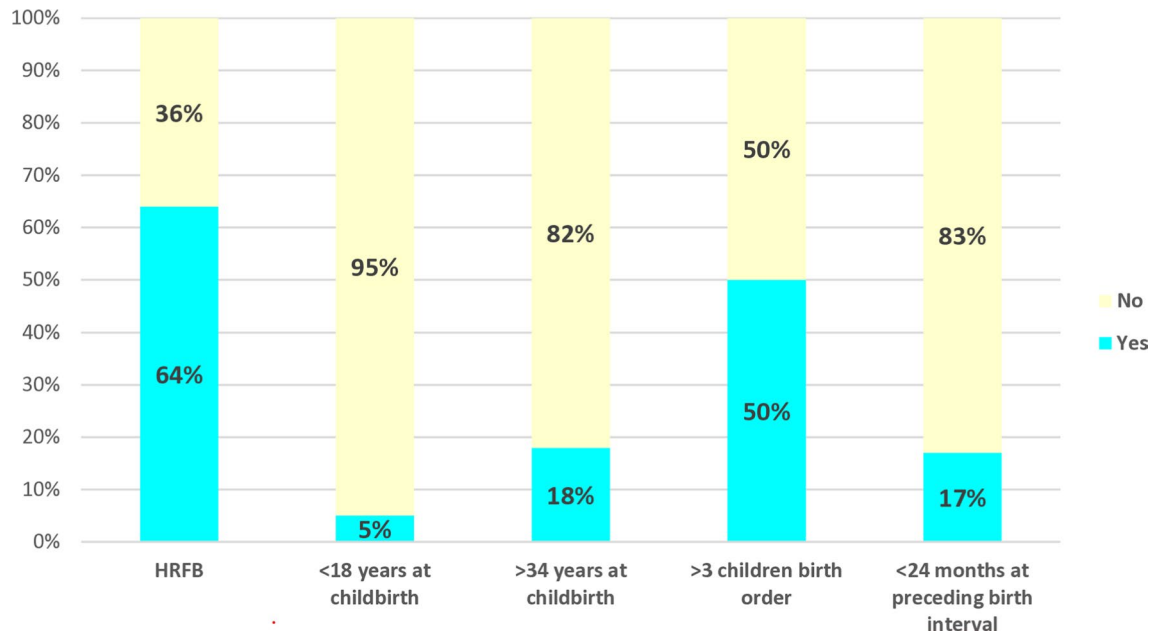

Fig. 1 Prevalence of high-risk fertility behaviour indicators among Nigerian women

Table 2 Prevalence of high-risk fertility behaviour across women's characteristics

Variable	< 18 years at childbirth, % (95% CI)	> 34 years at childbirth, % (95% CI)	> 3 children birth order, % (95% CI)	< 24 months at preceding birth interval, % (95% CI)	HRFB, % (95% CI)	P
Education						< 0.001*
No education/primary	6.3 (5.7–6.9)	21.1 (20.1–22.1)	61.7 (60.6–62.8)	17.6 (16.7–18.4)	73.6 (72.7–74.5)	
Secondary/Higher	2.8 (2.4–3.2)	14.2 (13.4–15.2)	31.9 (30.6–33.2)	16.2 (15.2–17.1)	48.7 (47.4–50.0)	
Religion						< 0.001*
Christianity	2.6 (2.2–3.0)	18.7 (17.8–19.7)	38.7 (37.4–40.0)	16.0 (15.1–17.0)	54.1 (52.7–55.3)	
Islam	6.3 (5.7–6.8)	18.0 (17.1–19.0)	56.3 (55.2–57.5)	17.6 (17.8–18.5)	69.3 (68.2–70.4)	
Traditional/Others	4.6 (2.1–9.5)	20.6 (14.3–28.6)	55.5 (42.7–67.5)	16.3 (11.0–23.5)	71.0 (60.1–79.9)	
Number of living children						< 0.001*
0	25.7 (20.6–31.5)	2.3 (1.0–5.3)	2.3 (1.0–5.2)	10.9 (7.1–16.3)	39.2 (32.8–46.0)	
1–2	11.5 (10.6–12.5)	3.6 (3.1–4.2)	4.6 (4.1–5.2)	14.2 (13.0–15.4)	30.8 (29.3–32.2)	
3–4	0.2 (0.1–0.3)	12.4 (11.4–13.4)	61.1 (59.6–62.6)	19.7 (18.6–20.8)	71.6 (70.3–72.9)	
5 +	0.0	45.0 (43.4–46.5)	100.0	18.2 (17.1–19.4)	100.0	
Years spent in residence						< 0.001*
< 5 years	7.4 (6.4–8.5)	10.1 (8.9–11.4)	22.2 (20.5–24.0)	16.3 (14.8–17.8)	43.8 (41.8–45.8)	
5 + years	4.4 (4.0–4.8)	19.9 (19.2–20.7)	55.0 (54.1–56.0)	17.1 (16.5–17.8)	67.4 (66.5–68.3)	
Age (years)						< 0.001*
15–24	19.7 (18.4–21.0)	0.0	6.5 (5.8–7.3)	15.2 (13.9–16.5)	37.7 (35.9–39.5)	
25–34	0.0	0.0	51.9 (50.5–53.4)	19.1 (18.2–20.0)	59.6 (58.2–60.9)	
35–49	0.0	66.5 (62.1–67.9)	84.4 (83.0–85.6)	15.0 (13.9–16.1)	93.6 (92.7–94.4)	
Marital status						0.449
Not married	16.6 (13.4–20.5)	4.7 (3.0–7.3)	6.8 (4.7–9.6)	5.0 (3.2–7.8)	29.1 (24.8–33.8)	
Married	4.6 (4.2–5.0)	18.6 (18.0–19.3)	50.6 (49.7–51.6)	17.3 (16.6–17.9)	64.3 (63.4–65.2)	
Covered by health insurance						0.026*
No	4.9 (4.6–5.4)	18.2 (17.6–18.9)	49.9 (49.0–50.8)	17.0 (16.3–17.6)	63.7 (62.8–64.6)	
Yes	1.4 (0.5–4.0)	21.3 (16.9–26.4)	37.2 (31.7–43.0)	18.4 (14.2–23.7)	57.0 (51.0–62.9)	
Exposed to media						< 0.001*
No	7.5 (6.8–8.3)	17.4 (16.4–18.5)	57.3 (56.0–58.6)	18.2 (17.2–19.3)	71.0 (69.8–72.2)	
Yes	3.3 (2.9–3.7)	18.9 (18.1–19.7)	45.0 (43.9–46.2)	16.3 (15.5–17.0)	59.0 (58.0–60.1)	
Employment status						< 0.001*
No	8.9 (8.1–9.7)	12.2 (11.3–13.2)	43.9 (42.5–45.3)	18.1 (16.9–19.3)	61.2 (59.7–62.6)	
Yes	3.0 (2.7–3.4)	21.1 (20.3–22.0)	52.3 (51.1–53.4)	16.5 (15.8–17.2)	64.6 (63.5–65.7)	
Socioeconomic disadvantaged status						< 0.001*
Low	1.7 (1.3–2.1)	19.5 (18.4–20.7)	37.8 (36.0–39.6)	15.7 (14.7–16.7)	53.3 (51.7–54.9)	
Medium	3.6 (3.0–4.2)	18.6 (17.4–19.8)	50.6 (48.8–52.3)	16.5 (15.4–17.6)	62.6 (60.7–64.5)	
High	8.0 (7.3–8.7)	17.2 (16.2–18.4)	58.0 (56.6–59.3)	18.2 (17.1–19.4)	71.7 (70.6–72.8)	
Husband/partner's education level						< 0.001*
No education	6.9 (6.3–7.7)	20.0 (18.7–21.4)	62.4 (61.0–63.8)	18.6 (17.4–19.8)	74.9 (73.7–76.0)	
Primary	4.7 (3.7–5.9)	22.0 (20.2–23.9)	58.7 (56.6–60.8)	17.8 (16.2–19.4)	71.3 (69.3–73.2)	
Secondary	3.2 (2.7–3.8)	16.0 (14.9–17.1)	42.0 (40.4–43.7)	16.6 (15.7–17.6)	56.3 (54.7–57.8)	
Higher	1.5 (1.1–2.1)	17.8 (16.0–19.7)	35.2 (32.7–37.8)	16.0 (14.3–17.7)	51.7 (49.2–54.1)	
Don't know	6.2 (3.8–10.1)	16.3 (12.0–21.7)	57.3 (51.8–62.6)	17.9 (11.9–26.0)	68.6 (61.5–74.8)	
Household wealth						< 0.001*
Poor	6.2 (5.6–6.8)	19.4 (18.4–20.4)	57.7 (56.4–58.9)	17.7 (16.8–18.7)	70.1 (68.9–71.3)	
Non-poor	3.9 (3.5–4.5)	17.6 (16.7–18.5)	44.0 (42.7–45.2)	16.5 (15.6–17.4)	58.9 (57.6–60.1)	
Sex of household head						< 0.001*
Male	4.9 (4.5–5.3)	18.2 (17.5–18.9)	50.7 (49.7–51.6)	17.3 (16.7–18.1)	64.5 (63.5–65.4)	
Female	4.6 (3.7–5.7)	19.6 (17.8–21.6)	40.0 (37.8–42.3)	13.7 (12.1–15.4)	54.5 (52.0–57.0)	
Region						< 0.001*

Table 2 (continued)

Variable	< 18 years at childbirth, % (95% CI)	> 34 years at childbirth, % (95% CI)	> 3 children birth order, % (95% CI)	< 24 months at preceding birth interval, % (95% CI)	HRFB, % (95% CI)	P
North Central	3.8 (3.1–4.6)	15.6 (14.3–17.1)	45.9 (43.6–48.1)	15.1 (13.6–16.7)	58.4 (56.2–60.6)	
North East	6.9 (5.9–8.0)	16.8 (15.5–18.2)	55.7 (53.8–57.6)	18.9 (17.4–20.6)	69.5 (67.6–71.3)	
North West	6.9 (6.1–7.7)	18.8 (17.4–20.2)	59.6 (58.0–61.2)	17.7 (16.5–19.0)	72.2 (70.7–73.7)	
South East	2.2 (1.7–2.9)	20.4 (18.7–22.3)	44.7 (42.0–47.3)	21.8 (20.1–23.7)	62.2 (60.2–64.1)	
South South	3.3 (2.4–4.5)	18.4 (16.4–21.8)	38.1 (35.6–40.7)	17.7 (15.9–19.6)	55.1 (52.5–57.7)	
South West	1.5 (1.1–2.1)	20.1 (18.4–21.8)	32.5 (30.1–35.0)	11.1 (9.9–12.5)	46.7 (44.4–48.9)	
Residential status						< 0.001*
Urban	2.4 (1.9–2.9)	19.8 (18.7–20.9)	43.7 (42.2–45.3)	16.5 (15.5–17.4)	58.2 (56.7–59.6)	
Rural	6.5 (6.0–7.1)	17.3 (16.5–18.2)	53.5 (52.4–54.6)	17.3 (16.5–18.2)	67.0 (66.0–68.1)	
Community-level poverty						< 0.001*
Low	7.0 (6.2–7.8)	18.8 (17.7–20.0)	57.0 (55.6–58.4)	17.4 (16.3–18.4)	70.4 (69.1–64.6)	
Medium	4.7 (4.1–5.4)	16.8 (15.7–17.9)	50.2 (48.3–52.0)	16.8 (15.7–18.0)	62.7 (60.8–64.6)	
High	3.0 (2.4–3.7)	19.4 (18.1–20.7)	41.9 (40.1–43.7)	16.8 (15.6–18.1)	57.7 (55.9–59.5)	
Community-level education						< 0.001*
Low	6.4 (7.6–9.2)	17.4 (16.3–18.6)	59.2 (57.8–60.5)	18.0 (17.0–19.1)	72.9 (71.7–74.2)	
Medium	4.1 (3.4–4.8)	18.5 (17.2–19.8)	53.9 (52.3–55.5)	17.0 (15.7–18.4)	65.3 (63.6–66.9)	
High	2.0 (1.6–2.4)	19.1 (18.0–20.2)	35.4 (33.9–36.9)	15.9 (14.9–16.9)	52.0 (50.6–53.4)	
Community-level ethnicity						< 0.001*
Mono-ethnic	0.0	50.0 (50.0–50.0)	50.0 (50.0–50.0)	100.0	100.0	
Multi-ethnic	4.9 (4.5–5.3)	18.3 (17.6–19.0)	49.6 (48.7–50.5)	17.0 (16.3–17.6)	63.5 (62.6–64.4)	

P was obtained from chi-square test

*Significant at $p < 0.05$

Table 3 Random effect estimates of individual-, household- and community-level factors associated with high-risk fertility behaviour (HRFB)

Random-effect	Model I	Model II	Model III	Model IV	Model V
Community-level					
Variance (95% CI)	0.25 (0.20–0.31)*	0.07 (0.04–0.14)*	0.18 (0.14–0.23)*	0.06 (0.04–0.10)*	0.04 (0.01–0.11)*
MOR	1.61	1.30	1.50	1.26	1.21
ICC	7.0%	2.0%	5.0%	2.0%	1.0%
Household-level					
Variance (95% CI)	0.20 (0.07–0.31)*	0.07 (0.01–13.18)	0.20 (0.06–0.62)*	0.12 (0.02–0.07)*	0.05 (0.01–37.91)
MOR	1.54	1.28	1.53	1.40	1.25
ICC	5.0%	2.0%	5.0%	4.0%	2.0%
Model fit statistics					
AIC	28,283.47	16,250.34	28,044.74	27,780.75	16,154.60
BIC	28,307.44	16,416.75	28,084.68	27,892.60	16,424.02
Sample size					
Community	1389	1388	1389	1389	1388
Household	19,236	18,124	19,236	19,236	18,124

Model I—baseline model with no explanatory variables, or empty null model (unconditional model)

Model II—solely taking into account individual-level factors

Model III—solely taking into account household-level factors

Model IV—solely taking into account community-level factors

Model V—full model adjusted for characteristics at the individual, household, and community levels

AIC: Akaike's Information Criterion; BIC: Bayesian Information Criterion; ICC: Intra-class correlation

* Significant at $p < 0.05$

Table 4 Fixed effect of individual-, household- and community-level factors associated with high-risk fertility behaviour (HRFB)

Variable	Odds ratio (95% CI)				
	Model I	Model II	Model III	Model IV	Model V
Education					
No education/primary		1.00			1.00
Secondary/Higher		0.85 (0.75–0.95)*			0.86 (0.77–0.98)*
Religion					
Christianity		1.00			1.00
Islam		1.20 (1.07–1.33)*			1.20 (1.06–1.36)*
Traditional/Others		1.08 (0.67–1.73)			1.04 (0.65–1.67)
Number of living children					
0		1.00			1.00
1–2		0.80 (0.60–1.07)			0.82 (0.62–1.09)
3–4		3.97 (2.92–5.41)*			3.97 (2.92–5.40)*
Years spent in residence					
< 5 years		1.00			1.00
5 + years		1.01 (0.92–1.12)			0.99 (0.89–1.09)
Age (years)					
15–24		1.00			1.00
25–34		1.16 (1.05–1.27)*			1.17 (1.06–1.29)*
35–49		6.69 (5.45–8.23)*			7.01 (5.69–8.63)*
Covered by health insurance					
No		1.00			1.00
Yes		0.84 (0.65–1.08)			0.79 (0.61–1.03)
Exposed to media					
No		1.00			1.00
Yes		0.87 (0.79–0.95)*			0.88 (0.80–0.97)*
Employment status					
No		1.00			1.00
Yes		0.98 (0.90–1.07)			1.04 (0.96–1.14)
Socioeconomic disadvantaged status					
Low		1.00			1.00
Medium		1.13 (1.01–1.27)*			1.06 (0.92–1.23)
High		1.37 (1.18–1.59)*			1.10 (0.89–1.37)
Husband/partner's education level					
No education		1.00			1.00
Primary		0.90 (0.79–1.04)			0.91 (0.79–1.05)
Secondary		0.74 (0.65–0.84)*			0.76 (0.67–0.87)*
Higher		0.62 (0.52–0.72)*			0.65 (0.55–0.77)*
Don't know		0.81 (0.58–1.13)			0.83 (0.59–1.16)
Household wealth					
Poor			1.00		1.00
Non-poor			0.62 (0.57–0.66)*		0.88 (0.79–0.99)*
Sex of household head					
Male			1.00		1.00
Female			0.68 (0.61–0.75)*		0.79 (0.69–0.92)*
Region					
North Central				1.00	1.00
North East				1.33 (1.19–1.48)*	1.26 (1.09–1.45)*
North West				1.54 (1.39–1.72)*	1.43 (1.24–1.65)*
South East				1.52 (1.34–1.74)*	1.42 (1.19–1.70)*

Table 4 (continued)

Variable	Odds ratio (95% CI)				
	Model I	Model II	Model III	Model IV	Model V
South South				1.12 (0.98–1.27)	1.18 (0.99–1.41)
South West				0.76 (0.68–0.86)*	0.71 (0.61–0.84)*
Residential status					
Urban				1.00	1.00
Rural				1.01 (0.92–1.09)	1.01 (0.89–1.16)
Community-level poverty					
Low				1.00	1.00
Medium				0.90 (0.82–0.98)*	0.99 (0.87–1.12)
High				0.95 (0.86–1.05)	1.06 (0.91–1.25)
Community-level education					
Low				1.00	1.00
Medium				0.85 (0.77–0.94)*	0.97 (0.83–1.13)
High				0.57 (0.50–0.65)*	0.97 (0.78–1.21)
Community-level ethnicity					
Mono-ethnic				1.00	1.00
Multi-ethnic				0.01 (0.00–1.38)	0.03 (0.00–1.37)

Model I—baseline model with no explanatory variables, or empty null model (unconditional model)

Model II—solely taking into account individual-level factors

Model III—solely taking into account household-level factors

Model IV—solely taking into account community-level factors

Model V—full model adjusted for characteristics at the individual, household, and community levels

* Significant at $p < 0.05$

2.92–5.40). Women aged 25–34 years and 35–49 years had higher odds of HRFB when compared with women aged 15–24 years respectively. Women exposed to media had 12% (aOR = 0.88; 95% CI 0.80–0.97) reduction in the odds of HRFB when compared with women not exposed to media use. The non-poor women had 12% (aOR = 0.88; 95% CI 0.79–0.99) reduction in the odds of HRFB when compared with the women. Women from female-headed households had 21% reduction in the odds of HRFB when compared with those from households with male head (aOR = 0.79; 95% CI 0.69–0.92). In addition, women with educated partners had reduction in the odds of HRFB when compared with those having partners with no formal education. The geographical region was significantly associated with HRFB among women.

Discussion

This paper investigated the prevalence of HRFBs and their associated factors in Nigerian women. Previous studies have shown that most sub-Saharan African women practice fertility behaviours that are high-risk, and these practices have been observed to be associated with adverse outcomes for both mother and the child [1, 20, 28–30]. The findings from this study indicated that 64% of women reported HRFB. Specifically, 5% of these women had their first childbirth before their 18th birthday, 18% had theirs after age 34 years, approximately 50% had more than 3 children, and 17% had a birth interval less than 24 months. Significant variations were observed across the six geopolitical zones of the country, with varying distributions of the HRFB. It was observed that the prevalence of HRFB ranged from 46.7% (the least HRFB) in the South West geopolitical zone to 72.2% (highest HRFB) in the North West geopolitical zone. The Northeastern and Northwestern geopolitical zones of Nigeria are the most hit zones by the insurgence, Boko Haram, Islamic state of West Africa Province (ISWAP) and Bandits activities, clusters of internally displaced persons (IDPs) camps, and these two zones has the highest prevalence of HRFB of 69.5% and 72.2% respectively. The disruption in settlements and social behaviours may have influenced the sexual and reproductive health practices. The high prevalence of HRFB among Nigerian women aged 15–49 years, observed in this study is in tandem with other studies previously conducted in other Sub-Saharan African countries [9, 14, 20, 29].

Based on our findings, the Northern women had higher odds of HRFB, when compared with their Southern counterparts. Previous studies have reported poorer

maternal health indices in the Northern part of Nigeria, when compared with the Southern region [31–33]. Northern women in Nigeria could exhibit higher odds of HRFB due to sociocultural, educational, and economic disparities with the southern women. In the North, early marriage, often driven by cultural norms and religious practices, leads to early childbearing and higher parity. Limited access to education reduces contraceptive use and knowledge about birth spacing. Additionally, lower healthcare infrastructure and restricted autonomy among women contribute to inadequate reproductive health services. Conversely, southern women are more likely to have higher educational attainment and access to healthcare facilities, enabling informed family planning. These factors may collectively heighten fertility risks among Northern women. In addition, Islamic women reported higher odds of HRFB. It is clear why women of Islamic faith have reported higher HRFB, when compared with the Christian women. One of the reasons could be because the Northern region with higher odds of HRFB is predominantly of Islamic faith [33]. Another reason could be because of low attendance of formal education for the Northern girl-child [34]. Women's socioeconomic status is also poorer in the Northern part of Nigeria with predominantly Islamic background [33]. The older women had higher odds of HRFB. This could be as a result of the years of exposure to childbearing. Older women are more likely to have higher number of children if they married early, as well as more likely to be involved in childbearing after aged 34 years which is another indicator of HRFB.

Women with exposure to media use had reductions in the odds of HRFB when they were compared with their counterparts who had no exposure to media use. Women exposed to media could have reduction in the odds of HRFB due to improved access to health information and awareness [35–37]. Media platforms, including radio, television, and social media, disseminate messages promoting family planning, safe reproductive practices, and the importance of birth spacing. Exposure to such information empowers women with knowledge about contraceptives, maternal health risks, and the benefits of smaller family sizes. This awareness could facilitate informed decision-making regarding fertility. Additionally, media often challenges harmful cultural norms and enhances women's autonomy by broadening their perspectives. Furthermore, our findings show that women with secondary or higher education had reduction in the odds of HRFB, when compared with those having no formal or primary education. Educated women are less likely to engage in HRFB due to increased knowledge, autonomy, and access to healthcare [3]. Education empowers women with knowledge about sexual and reproductive health, and the adverse effects of early childbearing and high parity. It fosters critical thinking, enabling women to make informed decisions about contraceptive use and birth spacing. Educated women are more likely to delay marriage and prioritize career or personal development, thereby reducing HRFB. Furthermore, they are better positioned to access and utilize healthcare services.

Moreover, being from a non-poor household reduced the odds of HFRFB among Nigerian women, when compared with those from poor households. Women from rich households could have better access to healthcare, education, and resources. The access to funds could enable these women to afford sexual and reproductive health services thereby reducing HRFB. Wealthier households often prioritize health, education, empowering women with knowledge about reproductive health. Moreover, rich women are more likely to have autonomy in fertility decisions and access to media that promotes awareness. These factors can be considered in the design and adoption of reproductive health programmes by policymakers and stakeholders in healthcare system. Good policies that are aimed to empowering women educationally and socioeconomically will help women in proper decision making as regards their sexual and reproductive health practices. Previous studies from other countries have reported similar findings such as reduction in the odds of HRFB among women from non-poor households and those who are educated [1, 14, 29]. According to this study, HRFB was lower among Nigerian women who were residing in wealthier homes at the time of the survey.

In line with previous studies [1, 9, 14], spousal's education was associated with HRFB. In this study, we found that women who have educated partners had reduction in the risk of HRFB. This could be due to the fact that educated partners could have better knowledge for health, social and economic decision-making power to support women, thereby reducing the odds of HRFB. A previous study conducted among women in Democratic Republic of Congo [29], show that there were associations between socioeconomic status and HRFB. Other studies from Eastern African countries [9] and among reproductive-aged women in Ethiopia [20], also are in agreement with the finding of our study. Furthermore, our findings revealed that women from female headed households had lower odds of HRFB, when compared with their counterparts from male headed households. Women from female-headed households could have greater autonomy and decision-making power. In these households, women often control reproductive choices, including the use of contraceptives and birth spacing, without external pressures to conform to traditional norms. Female heads of households are more likely to

prioritize education and health for themselves and their children, reducing early marriages and high parity. In addition, they are often exposed to social networks promoting reproductive health awareness and this can impact on HRFB reduction.

Our findings corroborate with previous reports regarding HRFB, adding to the body of knowledge. This sets the stage for plausible comparisons for future works, because we conducted a thorough testing of the relationships between the women's characteristics and HRFB using hierarchical statistical modelling approach. Policymakers can use the findings from this study to develop targeted interventions among the vulnerable women. This is one of the foremost studies that concentrated on the nationally pooled data on HRFB among reproductive-aged Nigerian women. The findings will also enhance the knowledge of the patterns of HRFB. This is crucial in designing health interventions to reduce the inequalities that exist between and within geopolitical zones, socioeconomic status, religious backgrounds, across age categories, exposure to media use amongst others. Indeed, our results showed how the Northern part of Nigeria is of a great concern regarding high prevalence of HRFB.

Strengths and limitations

This study utilised nationally representative data from the 2018 NDHS, making its findings of plausible comparison. It revealed socioeconomic disparities in HRFB and identified the contributory factors. These results provide policymakers with a chance to improve the delivery of counseling, health information and programmes to address the observed HRFB inequalities, by focusing on these identified factors. However, the cross-sectional nature of the study design cannot establish a cause-and-effect relationship between exploratory variables and HRFB; rather, it signifies correlation. HRFB was evaluated based on self-reported data, potentially introducing recall or social desirability bias. Moreover, the assets-based wealth index, used as a proxy for household economic status, may not always provide accurate results compared to direct measurements of income and expenditure where such data are available or can be collected reliably.

Conclusion

There was high prevalence of HRFBs among Nigerian women. HRFB was reported in about two-thirds of women. We also identified the contextual factors associated with HRFB. Addressing socioeconomic factors, improving education and healthcare access, and promoting family planning could significantly reduce HRFB. Stakeholders in healthcare system should support women to participate in programmes and interventions that emphasize social behaviour change through health education, particularly those that promote the use of contraceptives and the ideal spacing between pregnancies.

Acknowledgements
The authors appreciate the demographic and health survey (DHS) for the approval and access to the original data.

Author contributions
ME contributed to the conceptualization, study design and conducted data analysis. ME, CIN, AB, AA contributed to initial manuscript preparation, review of literature, wrote the results, discussed the findings and critically reviewed the manuscript for its intellectual content. The authors read and approved the final manuscript.

Funding
This research received no grant from any funding agency in the public, commercial or not-for-profit sectors.

Availability of data and materials
Data for this study were sourced and available here: https://dhsprogram.com/data/dataset/Nigeria_Standard-DHS_2018.cfm?flag=1.

Declarations

Ethics approval and consent to participate
This study is a secondary data analysis of the DHS which is publicly available, and approval was granted for its use. Written consent was obtained from mothers/caregivers and data were recorded anonymously at the time of data collection during the DHS. The Nigerian DHS is conducted according to the local Nigerian research ethics requirements. Data for this analysis were accessed via the publicly available DHS data sets, with access granted through the DHS programme. As this was a secondary data analysis, further research ethics approval was not required; however, in accordance with DHS regulations, all data extracted from the NDHS for the purpose of this study were handled as confidential and survey respondents remained unidentified. This study conforms to the principles of the Declaration of Helsinki.

Consent for publication
Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Epidemiology and Medical Statistics, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria. [2]Faculty of Science and Health, School of Health and Care Professions, University of Portsmouth, Hampshire, Portsmouth PO1 2UP, UK. [3]Department of Medical Biochemistry and Molecular Biology, School of Basic Medical Sciences, University of Benin, Benin City, Nigeria. [4]Department of Public Health, Center of Excellence in Reproductive Health Innovation, College of Medical Sciences, University of Benin, Benin City, Nigeria. [5]Department of Public & Environmental Health, School of Medicine & Allied Health Sciences, University of The Gambia, Kanifing, The Gambia. [6]Department of Epidemiology, College of Public Health & Health Professions, University of Florida, Gainesville, FL, USA. [7]School of Health Sciences, Western Sydney University, Campbelltown Campus, Locked Bag 1797, Penrith, NSW 2751, Australia. [8]Health Equity Laboratory, Campbelltown, NSW 2560, Australia. [9]Translational Health Research Institute, Western Sydney University, Locked Bag 1797, Penrith, NSW 2751, Australia. [10]Discipline of Child and Adolescent Health, Sydney Medical School, Faculty of Medicine and Health, The University of Sydney, Westmead, NSW 2145, Australia. [11]Oral Health Services, Sydney Local Health District and Sydney Dental Hospital, NSW Health, Surry Hills, NSW 2010, Australia.

Received: 30 August 2024 Accepted: 20 January 2025
Published online: 03 February 2025

References

1. Seifu BL, Tebeje TM, Asgedom YS, Asmare ZA, Asebe HA, Kase BF, et al. Determinants of high-risk fertility behavior among women of reproductive age in Kenya: a multilevel analysis based on 2022 Kenyan demographic and health survey. BMC Public Health. 2023;23:2516. https://doi.org/10.1186/s12889-023-17459-w.
2. Singh P, Singh KK. Trends, patterns and predictors of high-risk fertility behaviour among Indian women: evidence from National Family Health Survey. BMC Public Health. 2024;24:626. https://doi.org/10.1186/s12889-024-18046-3.
3. Woldeamanuel BT, Gessese GT, Demie TG, Handebo S, Biratu TD. Women's education, contraception use, and high-risk fertility behavior: a cross-sectional analysis of the demographic and health survey in Ethiopia. Front Glob Womens Health. 2023;4:1071461. https://doi.org/10.3389/fgwh.2023.1071461.
4. Ibrahim J, Adamou N, Olorukooba A, Omole N. Assessment of fertility behaviors among women of reproductive age in a rural community, northwest Nigeria. Int J Med Health Dev. 2022;27:24. https://doi.org/10.4103/ijmh.IJMH_55_20.
5. Obiyan OM, Akinlo A, Ogunjuyigbe PO. Maternal socioeconomic status and fertility behaviour in Nigeria: evidence from a cross sectional nationally representative survey. Eur Sci J. 2019. https://doi.org/10.19044/esj.2019.v15n31p207.
6. World Health Organization. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; 2023.
7. United Nations. Sustainable Development Goals (2016–2030). 2030. 2016https://www.un.org/sustainabledevelopment/sustainable-development-goals/. Accessed 18 Aug 2019.
8. Adebola OG, Ewemooje OS, Adebola FB. Predictors and differences in fertility level among Nigerian women of reproductive age: a function of subgroup social norms fertility behaviour. Hum Fertil. 2023;26:1114–28. https://doi.org/10.1080/14647273.2022.2137859.
9. Tamirat KS, Tesema GA, Tessema ZT. Determinants of maternal high-risk fertility behaviors and its correlation with child stunting and anemia in the East Africa region: a pooled analysis of nine East African countries. PLoS ONE. 2021;16: e0253736. https://doi.org/10.1371/journal.pone.0253736.
10. Adedini SA, Odimegwu C, Bamiwuye O, Fadeyibi O, Wet ND. Barriers to accessing health care in Nigeria: implications for child survival. Glob Health Action. 2014. https://doi.org/10.3402/gha.v7.23499.10.3402/gha.v7.23499.
11. Tessema ZT, Azanaw MM, Bukayaw YA, Gelaye KA. Geographical variation in determinants of high-risk fertility behavior among reproductive age women in Ethiopia using the 2016 demographic and health survey: a geographically weighted regression analysis. Arch Public Health. 2020;78:74. https://doi.org/10.1186/s13690-020-00456-5.
12. Bolarinwa OA, Hajjar JM, Alawode OA, Ajayi KV, Roberts AT, Yaya S. Multiple high-risk fertility behaviours and children under five mortality survivors among ever-married women of reproductive age in Nigeria. Arch Public Health. 2023;81:175. https://doi.org/10.1186/s13690-023-01192-2.
13. Fayehun O, Sanuade OA, Ajayi AI, Isiugo-Abanihe U. Ethnicity, sex composition of living children, and unrealized fertility in Nigeria. Popul Stud. 2020;74:351–61. https://doi.org/10.1080/00324728.2020.1779333.
14. Seidu A-A, Ahinkorah BO, Anjorin SS, Tetteh JK, Hagan JE, Zegeye B, et al. High-risk fertility behaviours among women in sub-Saharan Africa. J Public Health. 2023;45:21–31. https://doi.org/10.1093/pubmed/fdab381.
15. Adebowale SA, Adeoye IA, Palamuleni ME. Contraceptive use among Nigerian women with no fertility intention: interaction amid potential causative factors. Afr Popul Stud. 2013;27:127. https://doi.org/10.11564/27-2-435.
16. National Population Commission (NPC) Nigeria, ICF. Nigeria demographic and health survey 2018. Abuja, Nigeria and Rockville, Maryland, USA: NPC and ICF; 2019 pp. 3–27. https://dhsprogram.com/pubs/pdf/FR359/FR359.pdf. Accessed 17 June 2024.
17. Corsi DJ, Neuman M, Finlay JE, Subramanian S. Demographic and health surveys: a profile. Int J Epidemiol. 2012;41:1602–13. https://doi.org/10.1093/ije/dys184.
18. Amir-ud-Din R, Naz L, Rubi A, Usman M, Ghimire U. Impact of high-risk fertility behaviours on underfive mortality in Asia and Africa: evidence from demographic and health surveys. BMC Pregnancy Childbirth. 2021;21:344. https://doi.org/10.1186/s12884-021-03780-y.
19. Aboagye RG, Donkoh IE, Okyere J, Seidu A-A, Ahinkorah BO, Yaya S. Association between sexual violence and multiple high-risk fertility behaviours among women of reproductive age in sub-Saharan Africa. BMC Public Health. 2024;24:432. https://doi.org/10.1186/s12889-023-17444-3.
20. Tessema ZT, Tamirat KS. Determinants of high-risk fertility behavior among reproductive-age women in Ethiopia using the recent Ethiopian Demographic Health Survey: a multilevel analysis. Trop Med Health. 2020;48:93. https://doi.org/10.1186/s41182-020-00280-1.
21. Ekholuenetale M, Benebo FO, Idebolo AF. Individual-, household-, and community-level factors associated with eight or more antenatal care contacts in Nigeria: evidence from demographic and health survey. PLoS ONE. 2020;15: e0239855. https://doi.org/10.1371/journal.pone.0239855.
22. Ekholuenetale M, Barrow A, Benebo FO, Idebolo AF. Coverage and factors associated with mother and newborn skin-to-skin contact in Nigeria: a multilevel analysis. BMC Pregnancy Childbirth. 2021;21:603. https://doi.org/10.1186/s12884-021-04079-8.
23. Ekholuenetale M, Benebo FO, Barrow A, Idebolo AF, Nzoputam CI. Seroprevalence and determinants of human immunodeficiency virus infection among women of reproductive age in Mozambique: a multilevel analysis. Infect Dis Ther. 2020. https://doi.org/10.1007/s40121-020-00336-z.
24. Midi H, Sarkar SK, Rana S. Collinearity diagnostics of binary logistic regression model. J Interdiscip Math. 2010;13:253–67. https://doi.org/10.1080/09720502.2010.10700699.
25. Spiegelhalter DJ, Best NG, Carlin BP, van der Linde A. Bayesian measures of model complexity and fit. J R Stat Soc Ser B Stat Methodol. 2002;64:583–639. https://doi.org/10.1111/1467-9868.00353.
26. Larsen K, Merlo J. Appropriate assessment of neighborhood effects on individual health: integrating random and fixed effects in multilevel logistic regression. Am J Epidemiol. 2005;161:81–8. https://doi.org/10.1093/aje/kwi017.
27. Stawski RS. Multilevel analysis: an introduction to basic and advanced multilevel modeling (2nd Edition). Struct Equ Model Multidiscip J. 2013;20:541–50. https://doi.org/10.1080/10705511.2013.797841.
28. Aragaw FM, Chilot D, Belay DG, Merid MW, Kibret AA, Alem AZ, et al. Spatial distribution and determinants of high-risk fertility behavior among reproductive-age women in Ethiopia. Trop Med Health. 2023;51:14. https://doi.org/10.1186/s41182-023-00506-y.
29. Dimbuene ZT, Tessema ZT, Sonne SEW. High-risk fertility behaviours among women of reproductive ages in the Democratic Republic of the Congo: prevalence, correlates, and spatial distribution. PLoS ONE. 2023;18: e0283236. https://doi.org/10.1371/journal.pone.0283236.
30. Seidu F, Mogre V, Yidana A, Ziem JB. Utilization of growth monitoring and promotion is highest among children aged 0–11 months: a survey among mother-child pairs from rural northern Ghana. BMC Public Health. 2021;21:910. https://doi.org/10.1186/s12889-021-10980-w.
31. Okoli C, Hajizadeh M, Rahman MM, Khanam R. Geographical and socioeconomic inequalities in the utilization of maternal healthcare services in Nigeria: 2003–2017. BMC Health Serv Res. 2020;20:849. https://doi.org/10.1186/s12913-020-05700-w.
32. Meh C, Thind A, Ryan B, Terry A. Levels and determinants of maternal mortality in northern and southern Nigeria. BMC Pregnancy Childbirth. 2019;19:417. https://doi.org/10.1186/s12884-019-2471-8.
33. Mobolaji JW, Fatusi AO, Adedini SA. Ethnicity, religious affiliation and girl-child marriage: a cross-sectional study of nationally representative sample of female adolescents in Nigeria. BMC Public Health. 2020;20:583. https://doi.org/10.1186/s12889-020-08714-5.
34. Odozi JC, Uwaifo OR. Evolution of inequality in Nigeria: a tale of falling inequality, rising poverty, and regional heterogeneity. J Econ Race Policy. 2023;6:297–309. https://doi.org/10.1007/s41996-023-00129-9.
35. Dutta MJ. Health information processing from television: the role of health orientation. Health Commun. 2007;21:1–9. https://doi.org/10.1080/10410230701283256.
36. Acharya D, Khanal V, Singh JK, Adhikari M, Gautam S. Impact of mass media on the utilization of antenatal care services among women of rural community in Nepal. BMC Res Notes. 2015. https://doi.org/10.1186/s13104-015-1312-8.
37. Zamawe COF, Banda M, Dube AN. The impact of a community driven mass media campaign on the utilisation of maternal health care services

in rural Malawi. BMC Pregnancy Childbirth. 2016. https://doi.org/10.1186/s12884-016-0816-0.

Publisher's Note