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Maternal High-Risk Birth Behaviour in Nigeria: A Multilevel Multinomial Analysis of the 2021 Multiple Indicator Cluster Survey Data

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Abstract

Maternal high-risk birth behaviours (MHRBBs) has been linked to adverse maternal and child health outcomes. MHRBBs have been measured using three indicators; the maternal age at first birth (< 18 years and > 34 years), shorter and longer birth intervals (< 24 months and > 59 months), and a higher number of live births (4 birth orders or higher) order. This study examined the prevalence of MHRBBs and examined their contextual determinants among ever married women (15-49 years) in Nigeria. This was with the view to provide valuable insights into how individual and contextual determinants are associated with high-risk birth behaviour in Nigeria. A secondary dataset from a population-based cross-sectional study design was extracted from the 2021 Nigeria UNICEF Multiple Indicator Cluster Survey (MICS) and used for this study. A weighted sample size of 24,241 women who had a recent birth within the 5 years preceding the 2021 MICS was analysed. Charts and percentage distributions were used to describe the data. The associations between contextual determinants and high-risk birth behaviours were determined using Pearson's chi-square test, and a multilevel multinomial logistic regression analysis was carried out to identify predictors of high-risk birth behaviours in Nigeria. The adjusted odds ratio (AOR) with 95% confidence interval (CI) was presented at a $p<0.05$ level of significance. Two-fifths (40%) of births were identified as having no risk, one-third (34%) had a single risk, and more than a quarter (26%) had multiple risk factors. There were more Northern women with multiple risks (29%) than their Southern counterparts (22%). Women aged 35+ are about 14 times experiencing single risk (RRR=13.79, $p<0.001$, CI [11.22-16.94]) compared to the lesser age group. Also, the chances of experiencing single and multiple risks reduce as the education level increases, Women who are using contraceptives have higher chances of experiencing single risk (RRR=1.26, $p<0.001$, 95% CI [1.11-1.42]) and multiple risks (RRR=1.56, $p<0.001$, CI [1.30-1.88]) than their counterparts who are not using contraceptives. The study has established a strong relationship between individual, household and community-level factors and maternal high risk behaviours. Thus, policymakers and stakeholders should design interventions that take into account the factors that predispose women to have high-risk birth behaviours particularly women who reside in areas with a high proportion of high-risk birth behaviours.

Keywords: High-risk, behaviour, single-risk, multiple-risk, maternal, multilevel, Nigeria

Introduction

Maternal high-risk birth behaviours (MHRBBs) refer to birth behaviours that place a woman at increased risk during pregnancy and childbirth. It involves women's reproductive choices that significantly increase the possibility of undesirable health outcomes for both the mother and child. MHRBBs are concerned with mothers

giving birth at a young (under 18 years) or advanced age (over 34 years); having a short birth interval (less than 24 months apart) or too close birth interval (greater than 59 months), and having a high number of children (5 or higher birth order) [Budu et al., 2023, Howlader et al., 2022, Amir-Ud-Din *et al.,* 2021; Pai & Shekhar, 2021, Salawu et al., 2021, World Health Organization [WHO], 2019, Gurmu & Dejene, 2017]. A birth behaviour that includes two or more of these high-risk birth behaviours is classified as multiple high-risk birth behaviours (MHRBBs) [Amir-Ud-Din *et al.*, 2021].

Extant literature [Bolarinwa et al., 2023; Aragaw et al., 2023, Salawu et al., 2021] have shown that women's HRBBs pose a serious public health concern in sub-Saharan African countries particularly in Nigeria where many mothers who engaged in the high-risk birth behaviour have a significant influence on the high rates of maternal and infant mortality [Bolarinwa *et al.,* 2023; Salawu et al., 2021]. For instance, according to the Nigeria Demographic and Health Survey (NDHS), the Nigeria Infant Mortality Rate (IMR) for the 5 years before the 2018 NDHS survey was 67/1,000 (95%CI: 63-72) live births while Maternal Mortality Ratio (MMR) for the 7 years before the survey was 512 (95%CI: 447-578) deaths per 100,000 live births [National Population Commission (NPC) [Nigeria] and ICF 2019]. These estimated rates of IMR and MMR resulted from high-risk birth behaviour. For instance, four out of every five (80%) of currently married women in Nigeria have the likelihood a high-risk birth [NPC [Nigeria] and ICF 2019]. In addition, in the 5 years before the 2018 NDHS, out of 63% of infants who were at higher odds of dying from avoidable risks, 40% fell into a single high-risk birth category while 23% fell into a multiple high-risk category [NPC [Nigeria] and ICF 2019].

In addition, studies have shown that HRBBs such as early or late motherhood, shorter and longer birth intervals and higher birth order are associated with higher odds of adverse maternal and child health outcomes such as pregnancy-induced hypertension, anaemia, pregnancy-related complications, preterm births, acute undernutrition, low birth weight, unsafe abortion and higher likelihood of caesarean deliveries [Kahn *et al.,* 2021; Tadesse *et al.,* 2020; Finlay & Norton, 2017; Gurmu & Tariku, 2017]. For instance, women who begin childbearing at an early age (less than 18 years) have a greater risk of having pre-term birth, low birth weight, stillbirths, and infant death among others [Ahinkorah, 2021; Amir-Ud-Din *et al.,* 2021; Gurmu &Tariku, 2017, Oyefara, 2013]. They also have a high propensity to have more children in quick succession probably leads to high parity. A study by Rutstein et al., [2014] reported that children born to young mothers less than 18 years have a 20% greater risk of dying in their first year of life while those born to mothers above 35 years have a 50% greater risk of dying in their first year of life. Furthermore, studies have established a significant and U-shape pattern of the relationship between infant mortality and short and longer birth intervals [Salawu et al., 2021; Van Soest & Saha, 2018; Rasooly, 2013]. In the same vein, studies have reported that children born to women with high parity (5 children and above) are at a higher risk of adverse maternal and neonatal outcomes, such as low birth weight, antenatal depression, cesarean section, and neonatal infant mortality [Maloney, 2021; Koullali, 2020; Ndiaye, 2018].

In addressing HRBBs in Nigeria, the safe motherhood initiative was established in 1990 as a way of actualizing the Millennium Development Goal (SDG 3) of reducing maternal mortality and improving access to maternal health care. The Safe Motherhood programme includes the Abiye programme and other efforts to improve maternal health with the goal of reducing maternal mortality and improving access to maternal health care. The programme includes family planning, antenatal and delivery care, HIV and STI counselling and testing, community engagement, and health system strengthening. The interventions include utilizing community leaders, traditional birth attendances (TBAs), promoting male engagement and support for healthy reproductive choices among others. However, in spite of various government and non-governmental interventions, there still exists HRBBs in Nigeria across subnational levels.

Previous studies have reported various factors influencing HRBBs in sub-Saharan Africa including Nigeria. Individual and household-level factors have been documented to be associated with HRBBs, including age, maternal

education, head of the household, women's decision-making autonomy, family type, access to family planning, and cultural norms, among others [Ekholuenetale et al., 2025; Bolarinwa et al., 2023; Seidu *et al.,* 2021; Ajayi & Somefun, 2020]. Meanwhile, available evidence from the literature suggests a systematic absence of studies which consider contextual determinants of HRBBs in Nigeria. Factors influencing HRBB need to be investigated beyond individual and household–level characteristics because two individuals with similar socio-economic characteristics living in different environments may exhibit different health outcomes owing to the influence of where they live. The Nigeria Multiple Indicator Cluster Survey (MICS) data apart from the Nigeria Demographic and Health Survey (NDHS) data provides another ground to investigate such neighbourhood characteristics due to the hierarchical nature of the dataset in which individuals are clustered within households and households clustered within the communities. Drawing on the socio-ecological model and social determinants of health, HRBB is hypothesized to be influenced by community-level characteristics. Thus, this study examines the individual and contextual factors associated with maternal HRBBs in Nigeria. This was to provide information on multi-layered determinants of maternal HRBBs in Nigeria.

Methods

Data source

The study used the Nigeria 2021 Multiple Indicator Cluster Survey (MICS). The survey was carried out in 2021 by the National Bureau of Statistics (NBS) as part of the Global MICS programmes. The survey gave estimates of the important health indicators at the national and regional levels. In addition, MICS provided estimates for urban and rural areas. MICS is a nationally representative sample survey of 38,806 households residing in non-institutional dwelling units in Nigeria.

Research design

The 2021 MICS survey utilized a cross-sectional research design. A multi-stage stratified cluster sampling was used to select the survey sample from the list of the enumeration areas (EAs) used for the 2006 census and updated in February 2021. The sampling frame was then stratified into 36 states and the Federal Capital Territory (FCT), Abuja. Households were systematically selected with probability proportional to size. A detail explanation of the sample design, sampling frame and data collection procedures has been previously published in the 2021 MICS report and is freely available at https://mics.unicef.org/surveys

Study population (Inclusion and Exclusion)

A weighted sample size of 24,242 women (15-49 years), ever-married, who had at least one childbirth either alive or not within the 2 years preceding the 2021 MICS were included in the analysis. Similarly, women (15-49 years) who had never married or were childless within the 2 years preceding the 2021 MICS were excluded from the analysis.

Measurement of variables

Outcome variables

The outcome variable is maternal high-risk birth behaviours (MHRBBs). It was categorized into; no risk, single, and multiple-risk birth behaviour. The MHRBB indicators were derived from three risky birth behaviours namely: mother's age at childbirth, prior birth interval, and the number of children ever born. The mother's age at childbirth was coded as '1' if age less than 18 years or greater than 34 years, and '0' if otherwise. The prior birth interval was coded as '1' if the preceding birth interval was less than 24 months or greater than 59 months, and '0'if otherwise. Children ever born were coded as '1' if the number of children ever born is greater than four (4), and '0' if otherwise. The summation of these indicators was 0, 1, 2, and 3. Thus, a woman with two or more of the conditions stated is categorised as having multiple high-risk, while a woman with one of the conditions specified, is categorised as single high-risk. Thus, a woman with none of the condition stated is categorised as having non-high-risk birth behaviour (Salawu et al., 2021, Das et al., 2022, Howlader et al., 2022, Bolarinwa et al., 2023).

Explanatory Variables

The selected explanatory variables for this study included individual, household and community-level factors. They were considered important in

this study based on their earlier established statistical significance in the literature. These variables include household and individual variables such as; age group (15-24, 25-34, 35-49), maternal education (no formal education, primary, secondary, higher), exposure to mass media (Not exposed, exposed), family type (monogamous, polygamous), religion (Christian, Islam, traditional, others), Other covariates include maternal health service-related factors, such as antenatal care visits (yes, no), place of delivery (health facility, home, others), and contraceptive use (yes, no). The contextual variables are: place of residence (rural, urban), region of residence (North Central, North East, North West, South East, South-South, and South West), wealth quintile (poorest, poorer, middle, richer, and richest), ethnicity (Hausa/Fulani, Igbo, Yoruba, Other ethnicity), community poverty level was generated from the combination of wealth quintiles and was classified as (low, medium, high), the proportion of women in the community with at least secondary school education, and the proportion of women in the community using contraceptive and were also classified as (low, medium, high) respectively.

Statistical analyses

Descriptive and inferential statistics were used using Stata version 14 software for the analysis. Data were weighted to adjust for the over/under-sampling and non-response during data collection, Descriptive statistics (bar chart and frequencies and percentages table) were done to describe the prevalence of maternal HRBBs and other selected explanatory variables. Inferential statistics involved bivariable and multivariable multi-level multinomial logistic regression analyses. At bivariable analysis, Pearson's chi-square test with 95% confidence intervals (CI) was performed to examine the association between maternal HRBBS and the selected covariates. In addition, the multicollinearity test was engaged among the explanatory variables using a variance inflation factor (VIF) < 5 as the fixed point before multivariable analysis. All explanatory variables with no significant evidence of collinearity (mean VIF= 1.76, maximum = 3.16 and minimum VIF = 1.03) were put in the multivariable analysis. A Multi-level multinomial logistic regression model was then constructed to examine the influence of individual, household and community level factors on maternal HRBBs. The adjusted relative risk ratio with its 95% Confidence Interval (CI) was reported and variables with a p-value less than 0.05 were declared to be significant predictors of maternal HRBBs. Four models were fitted in the model using the Stata command "mlogit". The Null/Empty model involved only maternal HRBBs while only individual and household-level variables were fitted on the maternal HRBBs in Model 1. In Model 2, the community-level factors were fitted on maternal HRBBs. Finally, in Model 3, a combined influence of the individual, household and community level factors was examined on maternal HRBBs. The community-level variables used are; place of residence, proportion using contraceptives, proportion of women's literacy, proportion of poor women/wealth index, and zone. Except for place of residence and zone, all other community-level variables were created by aggregating individual-level variables into cluster/community level variables.

The Intra-Class Correlation (ICC) and the Proportional Change in Variance (PVC) were calculated to measure the random effects within or between clusters. The ICC was calculated as $ICC = \frac{VA}{(VA + 3.29)}\ x\ 100$ where VA signifies the estimated variance. The PCV was also calculated as $PCV = \frac{VA - VB}{VA}\ x\ 100$ Where VA is the variance in maternal high-risk behaviours in the empty model and VB is the variance in successive models. The goodness of fit of the regression models was determined using Akaike information criteria (AIC). A lower value of AIC indicates a better fit [Boco, 2010].

Ethical Consideration

Before the 2021 MICS data collection, the National Statistical Office, the National Bureau of Statistics, and UNICEF in Nigeria obtained informed consent from every participant before their participation. The details of the ethical consideration have been published in the published report. Also, before the datasets were released, all participants' personally identifiable information was removed. Therefore, in using the datasets, permission to use and download the

datasets was sought and granted. The data are available freely online: https://mics.unicef.org/surveys

Results

Background characteristics of the respondents

Table 1 shows that the mean age of respondents was 30.7 (±8.2) years. Almost half of the respondents (49.3%) were in the age group of 25-34 years. Nearly 38.7% of respondents have no formal level of education while 45.9% have secondary education and above. The vast majority of respondents were married or cohabiting (95.7%) while (91.4%) were not exposed to media. At least two out of every five respondents were Hausa. In addition, the majority of the respondents (70.5%) were from monogamous family types while 93.3% of the households were headed by males. As regards religion affiliations, the result shows that three out of every five respondents (60%) were of Islamic religion while 39% were Christians. Most of the respondents (63%) lived in a rural area. Three out of every five respondents (62.8%) were from the Northern geopolitical zone with 32.5% in North West. Besides, out of 37.2% of respondents from the Southern part of the country, about 17% were from the South West. Finally, 24.2% of the respondents were from the poorest. This was followed by 22% from the poorer quintile.

Table 1: Background characteristics of the respondents

Variable	Sample size (n = 36,573)	Percent (100%)
Age group		
15-24	4681	12.8
25-34	17092	46.7
35-49	14799	40.5
Mean (±SD) = 32.1 (±6.9)		
Education		
No formal education	17,380	47.5
Primary	6016	16.5
Secondary	10353	28.3
Higher	2817	7.7
Media exposure		
Not exposed	34322	93.9
Exposed	2250	6.1
Ethnicity		
Hausa	18678	51.1
Igbo	3370	9.2
Yoruba	3715	10.1
Others	10810	29.6
Family type		
Monogamy	23564	64.6
Polygamy	12898	35.4
Gender		
Male	35378	96.7

Female	1195	3.3
Religion		
Christianity	11572	31.6
Islam	24750	67.7
Others	250	0.7
Place of residence		
Urban	11789	32.2
Rural	24784	67.8
Geopolitical zone		
North Central	4383	12.0
North East	6377	17.4
North West	15133	41.4
South East	2475	6.8
South South	3317	9.1
South West	4888	13.4
Wealth index		
Poorest	10193	27.9
Second	8910	24.4
Middle	7202	19.7
Fourth	5496	15.0
Richest	4771	13.0
Community contraceptive use		
low	15735	43.0
Medium	8516	23.3
High	12321	33.7
Community poverty level		
low	14336	39.2
Medium	11350	31.0
High	10886	29.8
Community literacy level		
low	11726	32.1
Medium	11238	30.7
High	13609	37.2

Figure 1 presents the health-related characteristics of the respondents which involve the utilisation of health care services and practices related to delivery and use of contraceptives. The results revealed that 76.8% of the respondents used antenatal care services, more than half of births (56.4%) occurred at home while 42.1% of births took place in health facilities, and 19% of respondents reported using some form of contraception.

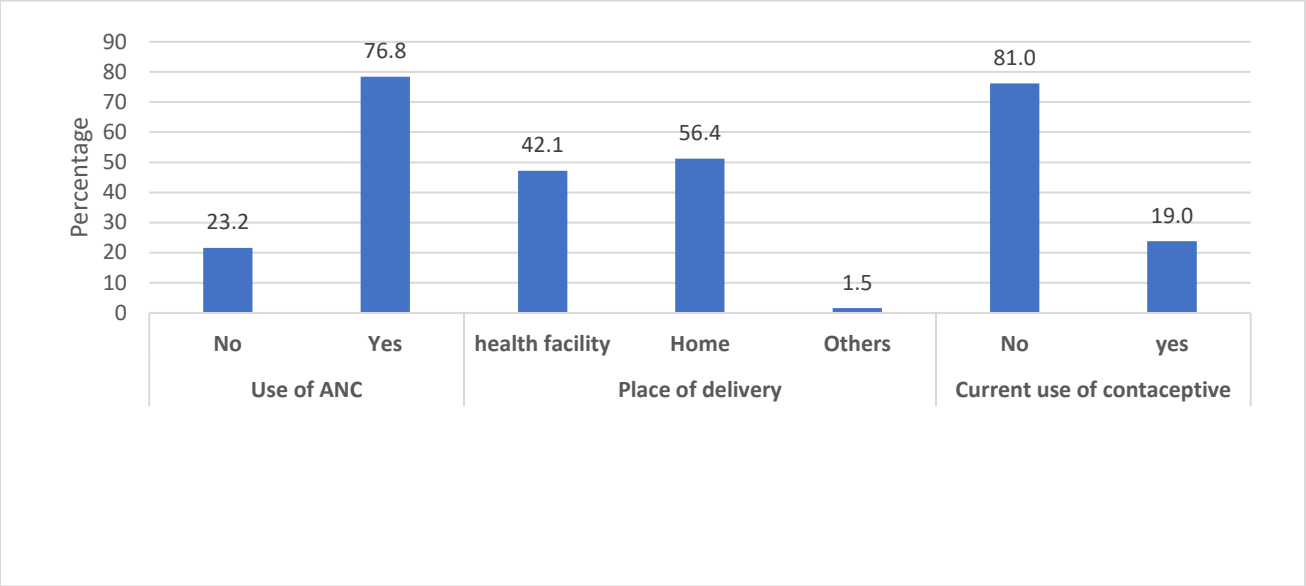

Figure 1: Percentage distributions of health-related characteristics of respondents

Prevalence of maternal high-risk birth behaviour

Table 2 shows different categories of maternal high-risk birth behaviour experienced in the last 2 years before the survey. The results show that at least three out of every five (63.3%) of the respondents have experienced any avoidable risk while about 18.3% of respondents have experienced unavoidable risk of first-order births between the ages of 18 and 34. On the type of unavoidable risk, the result shows that 0.6% of the respondents have had a birth less than 18 years and 15.8% of the respondents after 34 years. In addition, only 7.2% of the respondents indicated having a birth with intervals shorter than 24 months, and 11.4% had more than 3 birth orders. Furthermore, information on multiple risk categories shows that less than 1% (0.1%) of the respondents had an experience of birth below 18 years alongside a birth interval of less than 24 months. Also, about 4% of the respondents had a multiple-risk birth at more than 34 years with short birth intervals (<24 months). Likewise, respondents over 34 years old with a birth order greater than 3 made up 13.8%. A combination of short birth intervals and a birth order greater than 3 was found among 4.5% of the respondents. Similarly, a combined risk of being over 34 years, having short birth intervals, and having a birth order greater than 3 was identified among 5.8% of the respondents. In all, 36.7% of births by the respondents were identified as having no risk, 35% of births as single risk, and 28.3% of births as multiple risk.

Table 2: Prevalence of maternal high-risk birth behaviours types

	Frequency	Percent
Unavoidable risk		
First-order births between the ages of 18 and age 34 years	6685	18.3
Single high-risk category		
Mother's age <18 only	223	0.6
Mother's age >34 years only	5780	15.8
Birth interval <24 months only	2636	7.2
Birth order >3 only	4185	11.4
Multiple high-risk category		

Age <18 years and birth interval <24 months	21	0.1
Age >34 years and birth interval <24 months	1474	4.0
Age >34 years and birth order >3	5057	13.8
Birth interval <24 months and birth order >3	1657	4.5
Age >34 years and birth interval <24 months and birth order >3	2132	5.8
Risk Category		
No risk	13407	36.7
Single risk	12825	35.0
Multiple risk	10341	28.3
Any avoidable risk	23165	63.3

Bivariate analysis

Table 3 shows the association between selected characteristics of respondents and maternal high-risk birth behaviour. The results depict that except for the sex of the household head, all the explanatory variables; age, education, media exposure, ethnicity, family type, religion, place of residence, geopolitical zone, wealth quintile, contraceptive use, community contraceptive use, community poverty level, community literacy level, use of ANC, and place of delivery were statistically significantly associated with maternal HRBBs ($p<0.001$).

Table 3: Relationship between selected characteristics of respondents and Maternal High-Risk Birth Behaviour in Nigeria

	High Risk Behaviour						
	No risk		Single risk		Multiple risk		Statistics
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	
Age group							
15-24	3102	66.4	1342	28.7	225	4.8	$\chi^2 = 11600$ $p<0.0001$*
25-34	8931	52.3	6004	35.2	2133	12.5	
35-49	1375	9.3	5440	36.8	7983	53.9	
Education							
None	5234	30.2	6150	35.4	5982	34.4	$\chi^2 = 1391.09$ $p<0.0001$*
Primary	1971	32.8	2146	35.7	1894	31.5	
Secondary	4979	48.2	3386	32.8	1973	19.1	
Higher	1217	43.3	1104	39.3	492	17.5	
Media exposure							
Not exposed	12344	36.0	11937	34.8	10003	29.2	$\chi^2 = 241.22$ $p<0.0001$*
Exposed	1064	47.3	849	37.7	338	15.0	

Geopolitical zone							
North	8789	34.0	9039	35.0	8034	31.1	$\chi^2 = 439.65$ p<0.0001*
South	4618	43.3	3747	35.1	2307	21.6	
Family type							
Monogamy	9638	40.9	8138	34.6	5762	24.5	$\chi^2 = 712.24$ p<0.0001*
Polygamy	3718	28.9	4602	35.7	4565	35.4	
Ethnicity							
Hausa	5887	31.6	6533	35.0	6235	33.4	$\chi^2 = 778.27$ p<0.0001*
Igbo	1389	41.2	1338	39.8	638	19.0	
Yoruba	1716	46.2	1277	3434	721	19.4	
Other ethnicity	4414	40.9	3638	33.7	2747	25.4	
Religion							
Christianity	4980	43.1	4071	35.2	2511	21.7	$\chi^2 = 472.81$ p<0.0001*
Islam	8345	33.8	8623	34.9	7754	31.4	
Others	83	33.0	93	37.0	75	30.0	
Place of residence							
Urban	4756	40.4	4099	34.8	2915	24.8	$\chi^2 = 150.29$ p=0.0002*
Rural	8651	34.9	8687	35.1	7425	30.0	
Wealth status							
Poorest	3230	31.7	3606	35.4	3354	32.9	$\chi^2 = 537.58$ p<0.001*
Second	3143	35.3	3141	35.3	2618	29.4	
Middle	2553	35.5	2474	34.4	2163	30.1	
Fourth	2370	43.2	1804	32.9	1310	23.9	
Richest	2112	44.3	1761	36.9	895	18.8	
Community contraceptive use							
low	5453	34.7	5550	35.3	4710	30.0	$\chi^2 = 98.37$ P=0.0011*
Medium	3116	36.6	2905	34.1	2485	29.2	
High	4838	39.3	4331	35.2	3145	25.5	
Community poverty level							
low	5885	41.1	4990	34.9	3433	24.0	$\chi^2 = 305.35$ p<0.001*
Medium	3795	33.5	3927	34.6	3622	31.9	
High	3726	34.2	3869	35.6	3286	30.2	
Community education level							

Low	3700	31.6	4233	36.1	3789	32.3	$\chi^2 = 684.91$ p<0.0001*
Medium	3763	33.5	3843	34.3	3614	32.2	
High	5945	43.7	4710	34.7	2937	21.6	
Use of antenatal care							
No	9935	35.8	9714	35	8127	29.3	$\chi^2 = 43.94$ p=0.0079*
Yes	2563	39.3	2296	35.2	1671	25.6	
Current use of contraceptive							
No	9935	35.8	9714	35.0	8127	29.3	$\chi^2 = 43.94$ p=0.0079
Yes	2563	39.3	2296	35.2	1671	25.6	
Place of delivery							
Health facility	6390	41.6	5367	34.9	3619	23.5	$\chi^2 = 410.47$ p<0.0001*
Home	6799	33.0	7237	35.1	6574	31.9	
Other	218	39.8	183	33.3	147	26.9	

Multivariable Analysis

Fixed effects

Table 4 shows the result of the multi-level multinomial logistic regression models. The fixed effects measure the association between the relative risk of MHRBBs and the selected individual and community-level factors at a 95% confidence interval. The Null model was fitted without any variable to test for association of between-cluster and within-cluster variability. Likewise, Model 1 was fitted with individual and household level factors on the relative risk of MHRBBs. The results showed that the relative risk of exposure to single-risk birth behaviour and multiple risk birth behaviour were 19% (RRR=0.81, p<0.005, 95%CI [0.66-0.99]) and 36% (RRR=0.64, p<0.005, 95%CI [0.46-0.87]) lower among respondents who had exposure to media compared to those who do not have exposure to media. Similarly, the relative risk of exposure to single risk birth behaviour and multiple risk birth behaviour reduces with a higher level of education. Likewise, respondents from polygamous families have a higher relative risk of exposure to single risk (RRR=1.42, p<0.001, CI [1.28-1.56]) and multiple risks (RRR=1.76, p<0.001, CI [1.53-2.03]) than monogamously family.

Model 2 was fitted with the community-level factors on the relative risk of maternal HRBBs. The result revealed that place of residence, wealth index proportion using contraceptives and geo-political zone were statistically significantly associated with maternal HRBBs. For instance, the relative risk of exposure to multiple-risks reduces as the wealth quintile increases with 23% lesser chances for the poorest group to 48% lesser chances for the richest group, with all levels significant at p<0.001. In addition, chances of single and multiple-risk are highest among respondents from Southeast, with 52% and 86% additional chances respectively, single risk (RRR=1.52, p<0.001, CI [1.32-1.75]) and multiple risk (RRR=1.90, p<0.005, CI [1.61-2.24]), while there is statistical significance across the different regions on high-risk fertility behaviour the Southwest group shows no significance.

Model 3 (full model) shows the combined effect of individual/household and community levels factors influencing MHRBBs. The fixed effect results show that age, level of education, place of delivery, sex of household head, family type, wealth index, ethnicity, geopolitical zone and contraceptive use, were statistically significantly associated with MHRBBs. As regards to age of respondents, the result shows that respondents aged 35 -49 years are about 14 times experiencing single risk (RRR=13.79, p<0.001, CI [11.22-16.94]) compared to the lesser age group. Also, chances of experiencing single and multiple risks reduce as the educational level increase, indicating the impact of education on fertility behaviour Another finding reveals that user of contraceptives have higher chances of experiencing single risk (RRR=1.26, p<0.001, 95% CI [1.11-1.42]) and multiple risk (RRR=1.56, p<0.001, CI [1.30-1.88]). Family types also reveals a significant

influence on maternal high-risk birth, as respondents from polygamous homes are 44% more likely to experience single-risk (RRR=1.44, p<0.001, CI [1.31-1.59]) and multiple-risks (RRR=1.78, p<0.001, CI [1.54-2.05]) compared to those from monogamous families. After considering factors across the levels, wealth index and geopolitical zones still show significance with maternal high-risk birth at a 5% level of significance.

Random effect/ Model comparison

The result of the random effect indicated the variances attributable to the different nested levels in the model. The ICC value in the empty/null model shows that 26.1% and 30% of the variation in maternal single high-risk and multiple high-risk behaviour respectively across the clusters was attributed to community-level variables. The variability however was reduced to 27.2**%** and 38.2% for single high-risk and multiple high-risk behaviours respectively after the inclusion of individual and community-level variables in model 3. The empty model which contains no explanatory variable indicated that between-communities variation, expressed as VPC, associated with multiple risk (30.0%) was larger than between-community variation associated with single risk (9.6%), and this gap was consistent across individual and community levels. The result further indicated that individual-level variation associated with the single risk and multiple-risks was estimated at 27.7% and 40.1% respectively (Model 1), and when adjusted for other factors was estimated at 27.2% and 38.2% respectively (Model 3). These results indicated that community-level factors account for a significant proportion of the variation in the risk of multidimensional deprivations and severe multidimensional deprivations

Table 4: Multilevel multinomial logistic regression of predictors of maternal high-risk birth behaviour

	Empty Model RRR (CI)		Model 1 RRR (CI)		Model 2 RRR (CI)		Model 3 RRR (CI)	
High risk birth	**SR**	**MR**	**SR**	**MR**	**SR**	**MR**	**SR**	**MR**
Age group								
15- 34 years			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
35 – 49 years			13.9 (11.3-17.1)**	280.7 (223.3-352.9)**			13.79 (11.22-16.94)**	279.8 (222.4-351.9)**
Level of education								
None			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Primary			0.99 (0.87-1.13)	1.15 (0.95-1.39)			0.96 (0.84-1.1)	1.11 (0.91-1.35)
Secondary			0.62 (0.55-0.7)**	0.51 (0.42-0.62)**			0.59 (0.51-0.68)**	0.5 (0.4-0.63)**
Higher			0.42 (0.34-0.52)**	0.17 (0.12-0.24)**			0.41 (0.33-0.52)**	0.21 (0.15-0.3)**
Exposure to media								
Not exposed			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Exposed			0.81 (0.66-0.99)*	0.64 (0.46-0.87)*			0.82 (0.67-1)	0.71 (0.52-0.98)*
Ethnicity								
Hausa			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Igbo			1.35 (1.09-1.66)*	1.39 (1-1.93)*			1.59 (1.12-2.26)*	1.88 (1.09-3.25)*
Yoruba			0.75 (0.61-0.91)*	0.35 (0.26-0.49)**			1.11 (0.84-1.45)	0.71 (0.46-1.09)
Others			0.9 (0.8-1.03)	0.92 (0.76-1.12)			1 (0.87-1.16)	1.05 (0.84-1.32)
Contraceptive use								
No			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Yes			1.21 (1.08-1.36)*	1.41 (1.19-1.68)**			1.26 (1.11-1.42)**	1.56 (1.3-1.88)**
Place of delivery								
Health facility			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Home			1.17 (1.05-1.3)*	1.47 (1.25-1.73)*			1.13 (1.01-1.26)**	1.36 (1.15-1.6)*
Other			1.41 (0.98-2.03)	1.31 (0.75-2.27)			1.38 (0.96-2)	1.12 (0.64-1.97)
Antenatal use								
No			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Yes			1.05 (0.93-1.17)	1.12 (0.94-1.32)			1.05 (0.93-1.17)	1.12 (0.95-1.33)
Sex of household head								
Male			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Female			0.7 (0.56-0.88)*	0.63 (0.44-0.9)*			0.69 (0.55-0.87)*	0.58 (0.4-0.83)*
Family type								

Monogamy			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Polygamy			1.42 (1.28-1.56)**	1.76 (1.53-2.03)**			1.44 (1.3-1.59)**	1.78 (1.54-2.05)**
Religion								
Christianity			1.0 (RC)	1.0 (RC)			1.0 (RC)	1.0 (RC)
Islam			1.03 (0.9-1.18)	1.23 (0.98-1.53)			1.01 (0.86-1.17)	1.29 (1.01-1.66)*
Others			1.19 (0.71-2)	1.14 (0.53-2.43)			1.16 (0.69-1.93)	1.1 (0.52-2.35)
Place of residence								
Urban					1.0 (RC)	1.0 (RC)	1.0 (RC)	1.0 (RC)
Rural					0.88 (0.8-0.97)*	0.86 (0.77-0.97)*	0.92 (0.8-1.05)	0.95 (0.76-1.19)
Community contraceptive use								
Low					1.0 (RC)	1.0 (RC)	1.0 (RC)	1.0 (RC)
Medium					1 (0.91-1.09)	1.08 (0.97-1.2)	1.02 (0.9-1.15)	0.87 (0.72-1.06)
High					1 (0.91-1.1)	1.06 (0.95-1.19)	0.91 (0.79-1.05)	0.77 (0.62-0.97)*
Community secondary education								
Low					1.0 (RC)	1.0 (RC)	1.0 (RC)	1.0 (RC)
Medium					0.93 (0.84-1.03)	1.12 (0.99-1.26)	1.26 (1.08-1.47)*	1.52 (1.2-1.93)*
High					0.76 (0.67-0.86)**	0.81 (0.69-0.94)*	1.23 (1-1.52)	1.46 (1.05-2.03)*
Wealth index								
Poorest					1.0 (RC)	1.0 (RC)	1.0 (RC)	1.0 (RC)
Second					0.84 (0.77-0.92)**	0.77 (0.7-0.84)**	0.85 (0.75-0.95)*	0.83 (0.7-0.99)*
Middle					0.87 (0.79-0.97)*	0.75 (0.67-0.84)**	0.93 (0.8-1.07)	0.85 (0.69-1.06)
Fourth					0.79 (0.71-0.9)**	0.63 (0.55-0.72)**	0.8 (0.67-0.95)*	0.72 (0.55-0.94)*
Richest					0.8 (0.7-0.92)*	0.52 (0.45-0.62)**	0.81 (0.65-1.01)	0.47 (0.33-0.66)**
Zone								
North central					1.0 (RC)	1.0 (RC)	1.0 (RC)	1.0 (RC)
North east					1.32 (1.18-1.47)**	1.48 (1.29-1.69)*	1.62 (1.38-1.9)**	2.15 (1.65-2.79)**
North west					1.47 (1.31-1.64)**	1.86 (1.62-2.13)*	1.61 (1.34-1.93)**	2.14 (1.6-2.86)**
South east					1.52 (1.32-1.75)**	1.9 (1.61-2.24)*	1.26 (0.88-1.81)	1.46 (0.83-2.57)
South south					1.24 (1.09-1.42)*	1.68 (1.43-1.96)*	1.49 (1.21-1.83)**	2.25 (1.62-3.11)**
South west					1.07 (0.94-1.22)	1.02 (0.86-1.2)	0.93 (0.73-1.19)	0.9 (0.61-1.34)
Random effect								
Variance (SE)	1.16 (0.02)	1.41 (0.03)	1.26 (0.03)	2.20 (0.09)	1.10 (0.02)	1.28 (0.03)	1.23 (0.03)	2.03 (0.09)
VPC (%)	26.1	30.0	27.7	40.1	25.1	28.0	27.2	38.2

Explained variation	Ref	Ref	-6.2	-33.6	3.9	6.6	-4.4	-27.2

** p<0.05, **significance at p<0.001, SR – Single-risk, MR – Multiple-risks*, CI: confidence interval, RC: Reference category, RR: Relative risk

Discussion

This study examined contextual determinants of maternal high-risk fertility behaviour in Nigeria with a view to providing information on regional-specific and multi-layered determinants of high-risk fertility behaviour in the country. The largest age group represented in this study was between the ages of 30-34 representing one-fourth, and 25-29 years, representing one-fifth of the total respondents. With traces of younger age (15-19 years) and older (45-49 years) age brackets only three percent were formerly married which include those divorced, separated, or widowed. This study's findings are consistent with the previous study (Kusheta *et al.*, 2023) conducted in Ethiopia where the majority of respondents fell in the same age group as the current study but lower in percentage compared with the study conducted in Bangladesh; as more than two-thirds of the respondents were of the age group of 20 and 34 years (Khan & Harris, 2023). Furthermore, responses on media exposure reveal vast majority (91%) of the respondents are not exposed to media while 9% indicated exposure.

Findings on level of education indicated that only one-tenth of the respondents have a higher level of education as respondents with no level of education, primary level and secondary level represent one-third of the total participant each. These findings corroborate a previous study (Woldeamanuel *et al.*, 2023) conducted in Ethiopia as the half of respondents were uneducated. Hausa ethnic group emerged as most household heads and only a few of the households were headed by the female gender. More than half of the respondents live in rural settings as more than two-thirds of the population residents in the northern part of the country and slightly more than one-quarter fell in the quintile of the poorest.

The majority of the participants reported using antenatal care services, however, more than half of births reported occurred at home. The proportion of respondents who reported using antenatal services is inconsistent with the previous study (Woldeamanuel *et al.*, 2023) findings in Ethiopia on the study of Burden of maternal high-risk fertility behaviour on under-five children's health status where two-thirds of respondents reported using antenatal services. Meanwhile, the proportion of births that occurred at home in this study is higher than that of findings in rural Haramaya District, Eastern Ethiopia where one-fourth of births occurred at home (Kifle *et al*., 2017). This may be due to an increase in the campaign and awareness of maternal utilization of antenatal services by the government and non-governmental organizations in the study area of the current study. This study indicated only one-fifth of the respondents were on contraceptive use or family planning, this is consistent with the study (Woldeamanuel *et al*., 2023) conducted in Ethiopia on women's education, contraception use, and high-risk fertility behaviour where two-thirds of the respondents do not use any contraceptive despite awareness. .

Of the prevalence of HRFB among respondents, unavoidable risk indicates less than one-fourth of first-order births occurred between the ages of 18 and 34 which is considered an unavoidable risk category. However, the single high-risk categories revealed less than 1% of respondents fall in the category of having a birth below 18 years, this is contrary to a similar study conducted in Bangladesh where more than one-quarter experience HFRB giving birth under 18 years (Khan & Harris, 2023) but almost consistent with the findings among same population in Ethiopia where the single HRFB of a mother giving birth at under 18 is zero (Kusheta *et al.*, 2023), although only five percent indicated having a birth after 34 years and fall in the category of birth intervals shorter than 24 months respectively, and less than one-quarter had more than 3 birth order. This is inconsistent with previous findings in Ethiopia where the most common single maternal HRFB was birth order >3 which was more than two-thirds and birth order >3 (81.6%) (Kusheta *et al.*, 2023). Information on multiple risk categories shows that only one per cent of the women had an experience of birth below 18 years alongside a birth interval of fewer than 24 months. Also, five out of a hundred of the respondents had a multiple-risk birth at more than 34 years with short birth intervals. This is contrary to a similar study in India where the most common form of multiple high-risk fertility behaviour was pregnancy aged above 34 years although with almost half of the respondents having birth order above two (Dimbuene *et al.*, 2023) followed by a birth interval less than 24 months and birth order

above 2 (Khan & Harris, 2023). Summarily, almost half of births were identified as having no risk, while one-third of the respondents had a single risk, and multiple risk factors were observed in one-fourth of the respondents. The findings in this study are contrary to previous studies in Bangladesh and Ethiopia where HRFB is prevalent at 38% (Khan & Harris, 2023) and 42% (Kusheta *et al.*, 2023) respectively reporting single HRFB. Also in other studies from Congo, the prevalence of multiple HRFB was reported at two-thirds of women of reproductive age (Dimbuene et al., 2023) and 8% in Bangladeshi (Khan & Harris, 2023). This inconsistency may be because these countries are different with regards to socio-economic development and cultures as pooling data could mask country-specific context. It is also possible that the educational level of husbands/partners has the better socio-economic situation in individual countries and in a culture that values high fertility under the assumption that children are God's blessings, these men tend to have more children than their uneducated neighbours.

Examining the regional pattern of maternal high-risk fertility, the result shows a significant association between region and high-risk birth as indicated in the north-central of Nigeria, about one-third of respondents, had no risk birth, almost half had a single risk birth, and one-fourth had multiple risks. Also, in the North East one-third of the respondents had no risk of birth, almost half of the respondents with a single risk, and slightly above one-fifth had multiple risks in North West, the distribution tends towards a higher risk of birth, with only a few having no risk birth, and half of respondents with a single risk birth, one forth with multiple risks. Likewise, the South East zone revealed one-third having no risk at birth, two-thirds with a single-risk birth, and more than one-fourth with multiple risks at birth, reflecting the North West's pattern but with a slightly higher proportion of no birth risk behaviour South-South, exhibit a similar pattern with almost one-third exhibit no birth risk behaviour, although, half of the population has a single-risk birth, only one-fourth has multiple risks at birth, showcasing the highest proportion of single birth risk behaviour among all zones with a similar trend in the South-West.

The pattern of HRFB across regions in Nigeria reveals a similar trend according to this current study with no or little difference in no risk, single risk and multiple risk variation, however revealed a significant decline in the number of HRFB experiences in previous findings of Babalola & Fatusi (2009) in Nigeria as Nigeria was reported a leading contributor to the maternal death figure in sub-Saharan Africa. Nigeria's maternal mortality ratio of 1,100 is higher than the regional average. With an estimated 59,000 maternal deaths, Nigeria which has approximately two per cent of the world's population contributes almost 10% of the world's maternal deaths (Babalola & Fatusi, 2009).

This study indicated a significant association between ANC utilization and HRFB as high-risk fertility behaviour is higher among the participants who did not utilize ANC services. Conversely, it was revealed in this current study almost half of the participants who are not using contraceptives fell in the category of single-risk fertility behaviour and also more than one-third of the contraceptive users have a single-risk fertility behaviour. This study indicated that there is a significant association between contraceptive use and high-risk behaviour. However, this current study revealed a significant association between place of delivery and high-risk birth as one-third of respondents who delivered in the health facility had no risk.

This study revealed the association between maternal health service-related factors and maternal high-risk fertility behaviour. These factors include antenatal care (ANC) utilization, contraceptive use, and the place of delivery, each indicating a significant role in shaping maternal health outcomes. The result of this study revealed no significant association between ANC use and high-risk behaviour in this current study. ANC is universally considered essential in identifying and managing potential risks during pregnancy. However, this finding revealed potential shortcomings in the effectiveness or accessibility of ANC services, particularly among marginalized populations. This is consistent with existing literature highlighting the need to address barriers to ANC access and quality to maximize its potential in reducing maternal risks (Kifle et al., 2017).

Also, this study highlights the impact of contraceptive use on reducing high-risk pregnancies. Contraceptive users revealed lower rates of high-risk behaviours compared to non-users, emphasizing the role of family planning in maternal health. These findings align with previous research demonstrating the effectiveness of contraceptive use in preventing unintended pregnancies and spacing births, thereby reducing maternal and neonatal morbidity and mortality (Erim et al., 2012). Regarding the place of delivery, the study showed a significant association between delivery location and the risk of high-risk birth. Delivering in a health facility is associated with lower maternal and neonatal mortality rates due to the availability of skilled birth attendants and emergency obstetric care. However, disparities in the quality and accessibility of facility-based care contribute to high-risk behaviours among certain populations, emphasizing the need for comprehensive healthcare system improvements (Kifle et al., 2017). In this case, effective interventions must not only focus on increasing access to maternal health services but also on enhancing their quality, cultural sensitivity, and comprehensiveness. By addressing these factors, policymakers and healthcare providers can work towards reducing maternal morbidity and mortality rates and promoting maternal well-being (Olonade et al., 2019).

As regards age, younger respondents (≤20 years) show a lower association towards high-risk behaviour, with half of the respondents having no risk, although as age increases, particularly among age 35 and older, high-risk behaviours significantly rise, with almost two-thirds having multiple risk behaviour which revealed an association between age and high-risk behaviour This is consistent with the previous study in Bangladesh where it was indicated that as age increases HRFB also increases (Howlader *et al.,* 2022). Also in another, study it was demonstrated that the age of mothers increases women's high-risk fertility behaviour and subsequently increases the occurrence of perinatal mortality in general and is further compounded with increasing numbers of high-risk fertility behaviours (Khan & Harris, 2023).

Similarly, for the level of education there is a statistically significant relationship was found with high-risk behaviour, as those with no education or only primary education have higher percentages of single and multiple-risk behaviours compared to those with secondary and higher education. This pattern suggests that level of education might play a protective role against engaging in high-risk behaviour. This finding corroborates the previous study where it was reported that compared to women who have never had any formal education, those with a higher level of education had a lower likelihood of high-risk fertility behaviour (Howlader et al., 2022) and this result was also supported by the previously conducted studies (Woldeamanuel et al., 2023).

The reason for this could be having no formal education impacts work status and leads to lower income and independence all of which affect purchasing power, taking proper care of the mother during pregnancy, and visiting ANC. Women who received formal education have better knowledge and awareness about self-health consciousness, proper diet thus leading to low odds of HRFB (Kusheta et al., 2023).

Marital status also influences risk behaviour in this study, as married or cohabiting respondents indicated one-third for no risk, almost the majority with single risk and one-fourth for multiple HFRB, whereas two-thirds among never-married respondents reported single risks. This relationship is statistically significant, highlighting the impact of marital status on risk behaviour. However, this report is inconsistent with the findings of Samuel et al. (2023). As the overall proportion of maternal HRFB among currently married women was 60.3%, with 35.0% falling into a single high-risk category and 25.3% falling into multiple high-risk categories. This finding was higher than the Ethiopian DHS data and study conducted in the other Afar region, but lower than the prevalence in India. The differences might be attributed to the socioeconomic status of the mother in the study areas (Kusheta et al., 2023).

Media exposure is another critical factor reported in this study as respondents not exposed to media are more likely to engage in high-risk behaviours (single risk – 49.1% and multiple risk – 23.7%) compared to their exposed respondents with statistical association between media exposure and high-risk behaviour. Religious

affiliation similarly impacts risk behaviour with Islam and Christianity followers showing similar patterns, whereas traditional and other religious affiliations have distinct distributions, albeit based on much smaller sample sizes. This result is consistent with the previous study conducted in Bangladeshi where Muslim has higher odds of having HFRB (Howlader et al., 2022). In this case, it was the traditional and other affiliated religions. These may be attributed to cultural and socioeconomic differences of this study population as traditional women are less likely to use contraceptive or family planning this may explain why traditional women in this current study has higher risk of HRFB than other religion (Howlader et al., 2022). It was also demonstrated in another study that women who were Muslims, aged above 35 years, having had normal childbirth, had low literacy levels, having had unwanted pregnancies, not using birth control methods were at increased risk of having HRFB (Khan & Harris, 2023).

Likewise, place of residence has an impact on risk behaviour with urban residents (30.6%) showing a slightly higher tendency towards no risk behaviours compared to rural residents (29.4%), showing a statistically significantly difference. This is similar to the study of Hassan et al (2023) conducted in Ethiopia where it was indicated that women in the rural area of Rangpur are found more than double to have HFRB than the women living in the urban area of Sylhet. This is probably because women in remote locations may stay behind in terms of utilizing reproductive health services, such as ANC, poor family planning adopted rates related to religious beliefs and community attitudes, as well as having poor literacy levels. However, this inequity in utilizing reproductive health facilities among different regions in Nigeria should be minimized to reduce the odds of HRFB Howlader et al., 2022). Finally, wealth status correlates with risk behaviour, indicating that as wealth increases, the percentage of respondents engaging in no-risk behaviour slightly rises, and those in the highest wealth quintile show a lower percentage of multiple birth risks. This trend is statistically significant, suggesting an association between socioeconomic status and high-risk fertility behaviours.

On the influence of individual-level factors on maternal HRFB, the multilevel multinomial analysis indicated that age, media exposure, ethnicity, contraceptive use, family type and sex of household head showed an association with maternal high-risk behaviour. At the individual level, one-fifth and more than three times less likely to experience single and multiple-risks respectively and also, the higher the level of maternal education, the lesser the chances of single and multiple risks and respondents from polygamous families have higher chances of experiencing single and multiple risks. This is particularly so in the previous study where which reported early childbearing is associated with more children being born, which is associated with poorer maternal, newborn, and child health outcomes (Woldeamanuel et al., 2023). Also in similar findings, it was reported that HRFB was found 19% less common in younger women and 6.42 times more likely in women over 35 years (Howlader et al., 2022).

As regards the community-level factor findings reveal the influence of community-level factors on maternal high-risk fertility behaviour, with place of residence, wealth index proportion using contraceptives and geopolitical zone. For instance, the likelihood of experiencing multiple-risks reduces as the wealth index increases with more than two times fewer chances for the poorest group to almost five times fewer chances for the richest group. However, chances of single and multiple-risks are highest among respondents from Southeast, with five times and more than eight times additional chances respectively as there is statistical significance across the different regions on high-risk fertility behaviour, the Southwest group shows no significance. The findings in this study is Consistent with previous studies where women who belong to households with a lower wealth index have higher chances of experiencing HRFB compared to women from rich households. This finding indicates that women who come from socioeconomically disadvantaged backgrounds may encounter challenges in obtaining necessary health information, possess lower levels of awareness regarding family planning, and experience limited autonomy over the timing and number of children they have. These challenges can eventually impair their ability to live a healthy

life, including the appropriate intervals between births, the number of children, and the age of the first pregnancy (Kifle et al., 2017).

However, concerning individual and community levels factors, the fixed effect results in this current study showed that age, level of education, place of delivery, contraceptive use, ethnicity, sex of household head, family type, wealth index and geopolitical zone are significantly associated with maternal high-risk birth. In this study as regards age, respondents aged thirty-five and above are about 14 times of experiencing single risk compared to the younger age group. Also, chances of experiencing single and multiple risks are reduced as the education level increases, indicating the impact of education on fertility behaviour. Also, findings reveal that users of contraceptives have higher chances of experiencing single risk and multiple risks. Compared to women who reside in urban, women who live in rural areas were found to have an increased probability of HRFB. This finding is consistent with studies conducted in East Africa (Tamirat et al., 2021) Bangladesh (Howlader et al., 2022) and Nepal Woldeamanuel et al. (2023). This is most likely because women in rural areas may lag in terms of utilizing reproductive health care such as ANC, having low rates of family planning acceptance due to religious beliefs and community attitudes, and having low literacy levels.

However, the sex of household heads significantly influences high-risk fertility as revealed Comparing homes headed by males, respondents from female-headed homes are three times less likely to encounter a single risk and four times less likely to face multiple risks. Moreover, family type also reveals a significant influence on maternal high-risk birth, the respondents from polygamous homes are four and half times more likely to experience single risk and multiple risk compared to those from monogamous families. After considering factors across the levels, wealth index and geopolitical zones thus showed significance with maternal high-risk birth at a 5% level of significance.

Finally, the result of the random effect in this current study indicated the variances attributable to the different nested levels in the model. The empty model in this study indicated that between-communities variation, expressed as VPC, associated with multiple risks (30.0%) was larger than between-community variation associated with single risk (9.6%), as this gap was consistent across individual and community levels. The result from this study further indicated that individual-level variation associated with the single risk and multiple risks was estimated at approximately thirty per cent and forty per cent respectively at the individual level, and when adjusted for other factors was estimated at twenty-eight and thirty-eight respectively at combined. Therefore, these results indicated that community-level factors account for a significant proportion of the variation in the risk of multidimensional deprivations and severe multidimensional deprivations.

Strengths and limitations of the Study

One of the major strengths of the study was that the study was able to give insight into the combined effects of individual, household and community-level factors on high-risk fertility behaviour amongst childbearing age women in Nigeria. Also, MICS is a national data which make it easy to generalize the findings to all geopolitical zones. However, some variables like household size, occupation of the woman and preference for sex were not captured in the study due to the limitation of the secondary data used. In addition, the MICS was retrospective survey, therefore memory lapses can occur. Similarly, MICS is a cross-sectional survey hence, it is difficult to established cause-effects relationship among the variables examined.

Conclusion

In examining the association between maternal health service utilization and high-risk fertility behaviour, focusing on antenatal care (ANC) utilization, contraceptive use, and place of delivery, this study indicated a significant association is found between ANC use and high-risk behaviour, indicating the importance of use in the accessibility or effectiveness of ANC services, particularly among marginalized populations. Also, contraceptive users demonstrate lower rates of high-risk behaviours compared to non-users, emphasizing the important role of family planning in reducing maternal and neonatal morbidity and mortality. Additionally, the study highlights the

significance of delivery location, revealing that delivering in a health facility is linked to lower mortality rates due to skilled birth attendants and emergency obstetric care. However, disparities in facility-based care quality and accessibility contribute to high-risk behaviours among certain populations, calling for comprehensive improvements in healthcare systems to address these disparities and promote maternal well-being.

Age emerges as a significant determinant, with younger respondents exhibiting lower associations with HRFB, while older age groups, particularly those aged 35 and above, demonstrate an increase in high-risk behaviours. Similarly, education level, marital status, media exposure, religious affiliation, place of residence, and wealth status all indicated associations with HRFB, highlighting the multifaceted nature of maternal health outcomes. Importantly, higher education levels and urban residence seem to offer protective effects against engaging in high-risk behaviours, whereas factors such as marital status and religious affiliation may present varying degrees of influence. Addressing these sociodemographic disparities through targeted interventions aimed at enhancing access to reproductive health services, promoting education, and addressing cultural and socioeconomic barriers is crucial in reducing the prevalence of HRFB and improving maternal and neonatal health outcomes overall.

List of Abbreviations
AIC: Akaike information criterion, AOR: adjusted odds ratio, BIC: Bayesian information criterion, CI: confidence interval, ICC: intraclass correlation coefficient, MICS: Multiple indicators Cluster survey, PCV: proportional change in variance, SD: standard deviation, SE: standard error

Declarations

Consent for publication
Not applicable

Availability of data and materials
The 2021 Multiple Indicators Cluster Survey (MICS) datasets are freely available at https://mics.unicef.org/surveys

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No competing interest

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Author contributions
Joseph Ayodeji Kupoluyi (JAK) conceived the research idea, designed, analyzed, interpreted, discussed, proofread, and submitted the draft manuscript.

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References

Ahinkorah, B. O. (2021). Maternal age at first childbirth and under-five morbidity in sub-Saharan Africa: analysis of cross-sectional data of 32 countries. Archives of Public Health. 79, 1-10. https://doi.org/10.1186/s13690-021-00674-5.

Ajayi, A. I., & Somefun, O. D. (2020). Patterns and determinants of short and long birth intervals among women in selected sub-Saharan African countries. Medicine, 99-19: e20118. doi: 10.1097/MD.0000000000020118.

Amir-ud-Din, R., Naz, L., Rubi, A., Usman, M., and Umesh Ghimire, U. (2021). Impact of high-risk fertility behaviours on under-five mortality in Asia and Africa: evidence from Demographic and Health Surveys. BMC Pregnancy and Childbirth 21:344 https://doi.org/10.1186/s12884-021-03780-y

Aragaw, F. M., Chilot, D., Belay, D. G., Merid, M. W., Kibret, A. A., Alem, A. Z., and Asratie, M. H. (2023). Spatial distribution and determinants of high-risk fertility behaviour among reproductive-age women

in Ethiopia. Aragaw et al. Tropical Medicine and Health, 51, 14. https://doi.org/10.1186/s41182-023-00506-y

Babalola, S., and Fatusi, A (2019). Determinants of the use of maternal health services in Nigeria-Looking beyond individual and household factors. BMC Pregnancy and Childbirth, 9, 43. https://doi.org/10.1186/1471-2393-9-43

Boco, Adébiyi Germain. (2010). Individual and Community Level Effects on Child Mortality: An Analysis of 28 Demographic and Health Surveys in Sub-Saharan Africa. DHS Working Papers No. 73. Calverton, Maryland, USA: ICF Macro. https://dhsprogram.com/pubs/pdf/WP73.pdf

Bolarinwa, O. A., Hajjar, J. M., Alawode, O. A., & Ajayi, K. V. (2023). Multiple high-risk fertility behaviours and children under five mortality survivors among ever-married women of reproductive age in Nigeria. Arch Public Health **81**, 175. https://doi.org/10.1186/s13690-023-01192-2

Budu, E., Ahinkorah, B.O., Okyere, J. et al. (2023). High risk fertility behaviour and health facility delivery in West Africa. BMC Pregnancy Childbirth **23**, 842. https://doi.org/10.1186/s12884-023-06107-1

Das, M., Jana, A., & Muhammad, T. (2022). Understanding the associations between maternal high-risk fertility behaviour and child nutrition levels in India: evidence from the National Family Health Survey 2015–2016. Scientific Reports, 12(1), 17742. https://doi.org/10.1038/s41598-022-20058-1

Dimbuene, T. Z., Tadesse Tessema, Z., & Wang Sonne, S. E. (2023). High-risk fertility behaviours among women of reproductive ages in the Democratic Republic of the Congo: Prevalence, correlates, and spatial distribution. PloS One, 18(3), e0283236. https://doi.org/10.1371/journal.pone.0283236

Ekholuenetale, M., Nzoputam, C.I., Barrow, A. et al. (2025). 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. Reprod Health **22**, 17 https://doi.org/10.1186/s12978-025-01956-9

Erim, D. O., Resch, S. C., & Goldie, S. J. (2012). Assessing health and economic outcomes of interventions to reduce pregnancy-related mortality in Nigeria. BMC Public Health, 12, 786. https://doi.org/10.1186/1471-2458-12-786

Finlay, J. E., Norton, M. K. (2017). Adolescent fertility and child health: the interaction of maternal age, parity and birth intervals in determining child health outcomes. Int J Child Health and Nutr. 6(1). https://doi.org/10.6000/1929-4247.2017.06.01.2.

Gurmu, E. (2017). Differentials and determinants of men's sexual behavior in Ethiopia. Ethiopian Journal of Health Development, 31(1), 36-43.

Gurmu, E., & Tariku, D. (2017). Correlates of High-Risk Fertility Behaviour in Ethiopia: A Multilevel Analysis of the 2011 Ethiopian demographic and health survey data. J Health Med Nurs. 39. https://www.iiste.org/journals/index.php.JHMN/article/viewFile/37514/38595

Howlader, M.H., Roshid, H.O., Kundu, S. *et al*. (2022). Determinants associated with high-risk fertility behaviours among reproductive aged women in Bangladesh: a cross-sectional study. *Reprod Health* **19**, 17 https://doi.org/10.1186/s12978-022-01333-w

Khan, J.R., Awan, N. A (2017). Comprehensive analysis on child mortality and its determinants in Bangladesh using frailty models. Arch Public Health **75**, 58 https://doi.org/10.1186/s13690-017-0224-6

Khan, M. N., & Harris, M. L. (2023). Association between maternal high-risk fertility behaviour and perinatal mortality in Bangladesh: evidence from the Demographic and Health Survey. https://doi.org/10.1371/journal.pone.0294464

Kifle, D., Azale, T., Gelaw, Y. A., & Melsew, Y. A. (2017). Maternal health care service seeking behaviour s and associated factors among women in rural Haramaya District, Eastern Ethiopia: a triangulated community-based cross-sectional study. Reproductive Health, 14(6). https://doi.org/10.1186/s12978-016-0270-5

Koullali, B., Van Zijl, M.D., Kazemier, B. M. et al. (2020). The association between parity and spontaneous preterm birth: a population based

study. BMC Pregnancy and Childbirth 20, 223. https://doi.org/10.1186/s12884-020-02940-w

Kusheta, S., Demelash, R., Kenea, E., Kasa, G., Ermako, W., & Daniel, D. (2023). Burden of maternal high-risk fertility behaviour on under-five children's health status in Hadiya zone, Southern Ethiopia: a facility-based cross-sectional study. BMJ Open, 13(6):e072551. https://doi.org/10.1136/bmjopen-2023-072551

Maloney S.I., Abresch C., Grimm B., Lyons K., and Tibbits M. Factors associated with giving birth at advanced maternal age in the United States. Midwifery2021. 98 (102975). https://doi.org/10.1016/j.midw.2021.102975

National Population Commission (NPC) [Nigeria] and ICF (2019). Nigeria demographic and health survey 2018 - final report. Abuja: NPC and ICF. dhsprogram.com/pubs/pdf/FR359/FR359.pdf

Ndiaye K. Portillo E. Ouedraogo D. Mobley A. and Babalola Stella (2018). High-risk advanced maternal age and high parity pregnancy: Tackling a neglected need through formative research and action. Global Health: Science and Practice 6(2):372-383. https://doi.org/10.9745/GHSP-D-17_00417

Olonade, O., Olawande, T. I., Alabi, O. J., & Imhonopi, D. (2019). Maternal mortality and maternal health care in Nigeria: Implications for socio-economic development. Open Access Macedonian Journal of Medical Sciences, 7(5), 849–855. https://doi.org/10.3889/oamjms.2019.041

Oyefara, J.L. (2013). Maternal age at first birth and childhood mortality in Yoruba society: the case of Osun state, Nigeria. Res Humanit Soc Sci. 3:246-56. http://pakacademicsearch.com/pdf-files/art/448/246-256 Vol 3, No 1 (2013).pdf

Pal, S. K., & Shekhar, C. (2021). Examining the role of high-risk fertility behaviour in chronic undernutrition among Indian married women age 15-49. Clinical Epidemiology and Global Health, 11, 100739. https://doi.org/10.1016/j.cegh.2021.100739

Rasooly M.H. (2013). The effect of birth intervals on under-five mortality in Afghanistan. https://doi.org/10.13140/RG.2.1.4258.2169

Rutstein, Shea, and Rebecca Winter (2014). The effects of fertility behaviour on child survival and child nutritional status: evidence from the demographic and health surveys, 2006 to 2012. DHS Analytical studies No 37. Rockville, Maryland, USA: ICF international. https://dhsprogram.com/publications/publication-as37-analytical-studies.cfm

Salawu, M.M., Afolabi, R.F., Gbadebo, B.M. et al. (2021). Preventable multiple high-risk birth behaviour and infant survival in Nigeria. BMC Pregnancy Childbirth **21**, 345 https://doi.org/10.1186/s12884-021-03792-8

Seidu, A. A., Ahinkorah, B. O., Anjorin, S. S., Tetteh, J. K., Hagan, J. E., Zegeye, B., Adu-Gyamfi, A. B., & Yaya, S. (2023). High-risk fertility behaviours among women in sub-Saharan Africa. Journal of Public Health (Oxford, England), 45(1), 21–31. https://doi.org/10.1093/pubmed/fdab381

Tessema, Z.T., Tamirat, K.S. (2020). 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 **48**, 93. https://doi.org/10.1186/s41182-020-00280-1

Van Soest A and Saha U.R. (2018). Relationship between infant mortality, birth spacing and fertility in Matlab, Bangladesh. Plos One. 13(4): e0195940. doi:10.1371/journal.pone.0195940

Woldeamanuel, B. T., Gessese, G. T., Demie, T. G., Handebo, S., & Biratu, T. D. (2023). Women's education, contraception use, and high-risk fertility behaviour : A cross-sectional analysis of the demographic and health survey in Ethiopia. Frontiers in Global Women's Health, 4, 1–9. https://doi.org/10.3389/fgwh.2023.1071461

World Health Organization (2019). Maternal mortality https://www.who.int/news-room/fact-sheets/detail/maternal-mortality