Preventable Multiple High-Risk Birth Behaviour and Infant Survival in Nigeria

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Abstract

Background

Globally, infant mortality has reduced considerably but has remained unacceptably high in sub-Saharan Africa, especially Nigeria where infant mortality rate is 67/1000 live births. To facilitate infant mortality reduction in Nigeria, an understanding of the synergistic effect of bio-demographic characteristics of mothers known as High Risk Birth Behaviours (HrBBs) is important. We therefore investigated the influence of HrBBs on infant survival in Nigeria.

Methods

This cross-sectional study design utilized data from the 2018 round of Nigerian Demographic Health Survey. The study participants were a representative sample of women of reproductive age ($n=21350$) who had given birth within the 5 years preceding the survey. HrBBs was measured through integration of information on maternal age at child's birth, parity, and preceding birth interval with respect to the most recent child. The HrBBs was categorized as none, single and multiple. Data were analysed using descriptive statistics, Log-rank test and Cox proportional hazard model ($\alpha = 0.05$).

Results

The mean age of the women was 29.7 ± 7.2 and 4.1% had experienced infant death. Infant mortality was highest among women with multiple HrBBs (5.1%). Being a male, having small size at birth, failure to receive tetanus injection, non-use of contraceptives and living in the core-north (North West and North East) predisposed children to higher risk of dying before 12 months of age. The hazard ratio of infant mortality was significantly higher among infants of mothers in multiple HrBBs category (aHR=1.67; CI: 1.33-2.09) compared to their counterparts with no HrBBs.

Conclusion

Multiple HrBBs increase the chances of dying among infants in Nigeria. Screening women for HrBBs for special health attention during pregnancy, birth and postnatal period will alleviate infant death in Nigeria.

Introduction

Infant Mortality which is the probability of a child dying between birth and the first birthday is one of the most useful indicators for assessing the general level of health and development of a society. It gives an overview of the functionality of a country's healthcare system, socioeconomic situation, and the state of maternal and child health. Globally, 85% and 29% of deaths among children occurred in the first five years of life and during infancy respectively. More than fifty percent of these deaths occurred in Sub-Sahara Africa (SSA) with Infant Mortality Rate (IMR) of 62 deaths per 1,000 in 2018 [1]. Improvement in child health, survival and life expectancy has been a concerted and continuous global effort as indicated in the Sustainable Development Goals – 3 (SDGs 3) which aims to end preventable deaths among children under-five years of age and targets reduction of under-five mortality to as low as 25 per 1000 live births by 2030 [2]. However, feasibility of the realization of this target is doubtful due to slow pace of mortality reduction in SSA as many countries in this world sub-region may likely fall short of the SDG target [1].

Nigeria with a population of over 200 million is one of the five countries that accounted for half of global burden of infant mortality occupying a second position after India [1, 3]. In Nigeria, previous studies have estimated a decline in IMR from 125 in 1990 to 67 in 2018 [3, 4]. Despite this achievement in IMR reduction over the years, the current level is higher than the IMR estimates for other countries in SSA like South Africa (28/1000), Kenya (31/1000) and Ghana (35/1000) which are already close to achieving the SDGs - target 3. Survival of infants in Nigeria is challenged by the prevailing poor health service delivery and malnutrition as a result of poverty which ravages the nation. Some preventable health/environmental related conditions (infectious diseases, chronic health conditions of the mother, obstetric and non-obstetric complications, lack of immunization, and other prevalent childhood diseases), socio-demographic characteristics (place of residence, region, religion, marital status and education level) and biological factors associated with mothers have been found in the literature as additional sources of threat to the survival chances of infants in Nigeria [1, 5] [6, 7]. It is important to note that risk of adverse pregnancy outcome like infant mortality are unevenly distributed among women population owing to the variation in their biologic features and demographic composition [8].

High-risk Birth Behaviours (HrBBs) in the context of this study was defined in terms of three preventable characteristics, namely; mother's age at delivery which can either be too young (less than 18 years) or too old (greater than 35 years), shorter or longer birth interval, and a high parity [9, 10]. These characteristics have been a major public health challenge to child survival in developing countries particularly Nigeria where little or no efforts are put in place to improve the health status of children. Studies have reported that teenage pregnant mothers have a greater risk of having pre-term birth, low birth weight, stillbirths and more importantly infant mortality [8, 11–13]. These unacceptable birth outcomes and child health have been linked to biological vulnerability, socioeconomic factors or inexperience of mothers in terms of pregnancy and child care management such as exclusive breastfeeding and nutritional support [8]. Women's age at marriage has somewhat increased in Nigeria with a resultant increase in age at childbirth owing to the impact of the socioeconomic changes, such as improvements in school enrolment, increased modern contraceptives use and economic opportunities [13]. Studies have reported that women who gave birth at ages 35 years and above have a higher risk of infant mortality [14–17]. A study by Yogev et al to determine pregnancy outcome at advanced maternal age reported that advanced maternal age of greater than 35 years is associated with higher risk of maternal, hormonal disorder, and low uteroplacental blood flow which increases the risk of congenital and chromosomal abnormalities such as downs syndrome that results in fetal complications with resultant infant death [17]. Studies showed that children born to young mothers (under age 18), had a 20 percent greater risk of dying in the first year of life, and children born to mothers ages 35–39 and 40 or older have a 20 percent and 50 percent greater risk of dying in the first year of life, respectively [9, 18, 19].

The established relationship between infant mortality and birth interval has been consistent in the literature. Short and longer birth interval increased the risk of infant mortality, often referred to as a U-shape hypothesis [9, 20, 21]. Inability of the mother to give adequate care to the index child in terms of nutrition, optimal health and support, especially if the preceding child was born not too long ago has been found to be responsible for the direction of the association [9]. In a poverty-stricken environment like Nigeria, children born to high parity women may not have access to adequate care and this could impact negatively on their survival chances [10, 22]. The Nigerian population policy emphasizes that family size should be restricted to not more than four children [23]. Unfortunately, studies conducted in Nigeria after the enactment and implementation of this policy reported that most families still have more than the stipulated family size with a total fertility rate of 5.3 [24]. In a high family size situation, the harsh socioeconomic condition in Nigeria could limit an individual's ability to provide basic needs for the family, particularly for infants who are the most vulnerable to morbidity and mortality [7, 13]. Moreover, some women exhibit

more than one of these HrBBs at the same time which increases their risk of having children that are prone to death before the age of one year [11, 25, 26].

Studies have been conducted in Nigeria based on the independent analysis of maternal age at childbirth, short birth interval, high parity and infant survival [18]. However, very few studies examined the relationship between the combination of these factors as an entity and infant mortality. Against the backdrop of limited research on the association of HrBBs and infant mortality, the current study investigated the influence of the HrBBs (mother's age at childbirth < 18 years or > 34 years, preceding birth interval < 24 months or > 59 months, and number of children ever born > 4) on infant mortality. The specific objectives of the study are to; assess the association between HrBBs and infant mortality in Nigeria, to examine if HrBBs is a predictor of infant mortality amidst other factors. The outcome of this study will inform policy geared towards the improvement of survival chances among children in Nigeria.

Methodology

Study design, area and population

The present study utilized 2018 Nigeria Demographic and Health Survey (NDHS) dataset. This cross-sectional and nationally representative sample survey was designed to provide information on population, maternal and child health indicators' estimates, and fertility-related behaviours [3]. The study was conducted in Nigeria, African most populous country with about one in every 15 children dies before their first birthday [3, 27]. Nigeria has one of the highest Total Fertility Rates (TFR) worldwide (TFR of over 5 children per woman unabated) and less than 15% of women using modern contraceptive method. The birth intervals decline from 33.4 months in 2008 to 30.9 months in 2018 while age at first birth had changed from 23% in 2008 to 22% in 2018 among adolescent in Nigeria [3, 28]. Presently, 80% of women of reproductive age engaged in a high-risk birth behaviours [3].

The two-stage cluster sampling technique was used for the survey based on the sampling frame adopted from the 2006 Nigeria population and housing census. The primary sampling units, referred to as clusters, were the enumeration areas. In all, 42,000 households were sampled from 1400 clusters selected for the survey. A detailed report of the sample design and sampling procedures has earlier been published [3]. The study analysis focused on the birth history of 33924 women who had a recent birth within the 5 years preceding the 2018 NDHS. Women who did not respond to questions that are related to outcome and the main independent variables were excluded from the analysis. Analyses were restricted to a single-birth lastborn infant, and as such the study population consisted of 21350 children aged 0–11 months who had valid and complete information on HrBBs variables (mothers age at childbirth, preceding birth interval and the total number of children ever born), date of birth and date of death.

Study variables

The outcome variable of interest is the infant survival status (alive = 0; death = 1). The survival time (months) was derived for each child aged 0–11 months using survival status at 12th month, age at death, and date of interview. Children who did not experience death as at the time of the survey were right-censored and were coded 0; otherwise, 1 in the analysis. The main explanatory variable was High-risk Birth Behaviour (HrBBs) derived from mother age at childbirth < 18 years or > 34 years, preceding birth interval < 24 months or > 59 months, and number of children ever born > 4. An indicator variable was generated for each of the three risky behaviours: mother age at childbirth was coded as 1 if age < 18 years or > 34 years, 0 otherwise; birth interval coded as 1 if interval < 24 months or > 59 months, 0 otherwise; children ever born as 1 if parity ≥ 5 and 0 if otherwise. The sum of the indicator variables was 3, 2, 1 or 0; ≥ 2 was categorised as multiple, 1 as single and 0 as non-high-risk birth behaviours.

Other covariates that were considered important according to literature and were included in the analyses include: household/environmental characteristics (regions, residence, ethnicity, religion, wealth quintile, type of cooking fuel, source of drinking water and type of toilet facility), child/mother characteristics (child's sex, birth size, mother's education, employment, marital status, desired for child), and health service-related characteristics (contraceptive use, decision-making involvement, number of ANC visits, tetanus injection received, breastfeeding initiation, health facility perception, place of delivery, prenatal attendant, type of delivery, and birth attendant) [26].

Statistical methods of analysis

Descriptive statistics and survival analysis were used for the analysis. Data were weighted before use due to the complex sampling design used during data collection. Weighting the data will extrapolate the analysis output to other areas not covered during the survey in order to enhance generalizability of the study's findings. At univariate level, descriptive statistics were used to describe high-risk birth behaviours by background characteristics. The log-rank test was used to examine the relationship between survival status and the selected characteristics. Cox proportional hazard regression was used to identify determinants of infant mortality.

Cox proportional hazards (CPH) model: The CPH modelled the hazard function as the dependent variable to determine which combination of explanatory variables significantly affects the hazard. We thus expressed the CPH model with the predictors as

$$h(t_i) = h_0(t) \ell^{b_1 x_{1i} + b_2 x_{2i} + \dots + b_p x_{pi}} = h_0(t) \ell^{\sum_{j=1}^p b_j x_{ji}}$$

$\xrightarrow{\text{implying}} \ln \frac{h(t_i)}{h_0(t)} = b_1 x_{1i} + b_2 x_{2i} + \dots + b_p x_{pi} = \sum_{j=1}^p b_j x_{ji}$ Where b_j - vector of the coefficients of the explanatory variables,

$h_0(t)$ - baseline hazard function and

$\frac{h(t)}{h_0(t)}$ - hazard ratio (HR).

The crude Cox PH model was used to explain the relationship between infant mortality and high-risk birth behaviours. Amidst other independent variables, four adjusted Cox PH models 1–4 were fitted. Models 1–3 encompassed variables to define household, child/maternal, and health service-related characteristics, respectively; while model 4 included all the significant factors ($p < 0.20$) based on the log-rank test. The hazard ratios (OR) including their CIs are reported. In each of the models, Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) values are also reported for model comparison; the model with the least value was adjudged as being more adequate[8]. All analyses were carried out at 5% level of significance.

The coefficients b_j indicates the changes in the expected time to infant death due to a unit change in the j th predictor. The exponentials of the coefficients suggest the tendency of exposure to infant death; thus, $HR > 1$ indicates higher exposure, $HR < 1$ lower exposure and $HR = 1$ equality. The hazard ratios (HR) and their respective 95% confidence intervals were reported. Importantly, we weighed the data to adjust for differences in population sizes of each region in Nigeria. All analyses were carried out at 5% level of significance, using STATA 14 SE.

Results

Background characteristics of infants

Infant survival status by household, demographic and health service utilization characteristics are described in Table 1. Most infants (60.3%), lived in a rural area, 35.0% were from the North-west region and 46.6% were of Hausa/Fulani ethnicity. About half of the children (43.8%) were from poor wealth quintiles' household; the majority (59.1%) resided in households with an improved source of drinking water and 89.8% had no improved cooking fuel. Half of the infants were male (51.2%) and 51.9% had reported average birth size. Nearly half and one-thirds of the infants had mothers who were uneducated (44.5%) and currently unemployed (31.7%), respectively. Almost all the infants had mothers who were ever married (97.6%). Majority of the infants received tetanus injection (69.9%), 15.0% delayed initiation of breastfeeding, 96.9% were delivered normally and 57.7% had mothers who visited ANC for at least 4 times. Most mothers (63.7%) received prenatal assistance from skilled personnel but 41.6% had their delivery attended to by unskilled personnel.

Table 1
Weighted percentage distribution of infant survival status by socio-demographic and health services utilisation characteristics

Characteristics	n (%)	Death (%)	p-value#	Characteristics	n (%)	Death (%)	p-value#
Household				Health service			
Region			< 0.001*	Contraceptive use			< 0.001*
Northcentral	3791(13.8)	3.8		Using	3520(17.2)	1.9	
Northeast	4430(17.7)	4.5		Not using	17830(82.8)	4.6	
Northwest	6198(35.0)	4.7		Decision involvement⁺			0.064
Southeast	2301(9.7)	3.4		None	8032(39.3)	4.3	
Southsouth	2137(9.2)	3.3		Low	10050(50.1)	3.9	
Southwest	2493(14.6)	3.4		High	1913(10.6)	3.6	
Residence			0.191	ANC visit⁺			< 0.001*
Urban	7543(39.7)	4.0		None	5279(24.9)	5.0	
Rural	13807(60.3)	4.1		1–3	3710(17.4)	4.2	
Religion			< 0.001*	≥ 4	12039(57.7)	3.6	
Christianity	8721(38.0)	3.4		Tetanus injection⁺			< 0.001*
Islam	12456(61.5)	4.5		Received	14768(69.9)	3.6	
Others	173(0.5)	3.0		Not received	6478(30.1)	5.4	
Ethnicity			0.009*	Breastfeeding initiation⁺			0.001*
Hausa/Fulani	9079(46.6)	4.7		Not delayed	17795(85.1)	2.6	
Igbo	2761(12.5)	3.5		Delayed	2969(15.0)	3.6	
Yoruba	2285(12.5)	3.3		Health fac. perception			0.337
Other	7225(28.4)	3.7		Not-problem	9559(46.6)	3.9	
Wealth status			< 0.001*	Problem	11791(53.4)	4.3	
Poorest	4947(21.6)	4.4		Place delivery			0.042*
Poorer	4816(22.2)	4.9		Hospital	9097(42.7)	3.9	
Middle	4477(20.2)	4.0		Home	12253(57.4)	4.3	
*significance at 5%; #based on log-rank test;							

Characteristics	n (%)	Death (%)	p-value#	Characteristics	n (%)	Death (%)	p-value#
Richer	3939(18.7)	3.8	0.018*	Prenatal attendant			< 0.001*
Richest	3171(17.2)	3.2		None	5279(24.5)	5.0	
Drinking water source				Unskilled	448(2.5)	6.5	
Improved	12273(59.1)	3.8	0.596	Semi-skilled	2252(9.4)	4.0	
Not improved	9077(41.0)	4.5		Skilled	13371(63.7)	3.7	
Type of toilet facility				Type of delivery⁺			0.005*
Improved	10424(51.2)	4.0	0.205	Normal	20650(96.9)	4.0	
Not improved	10926(48.8)	4.2		Caesarean	610(3.1)	6.1	
Cooking fuel⁺				Delivery attendant			0.038*
Improved	1742(10.2)	4.0	0.003*	None	2223(10.8)	3.6	
Not improved	19310(89.8)	4.1		Unskilled	8995(41.6)	4.4	
Child/maternal				Semi-skilled	1346(6.1)	4.8	
Sex			< 0.001*	Skilled	8786(41.6)	3.8	
Male	10919(51.2)	4.5					
Female	10431(48.8)	3.7					
Birth size⁺			< 0.001*				
Small	2818(13.5)	5.5					
Average	10923(51.9)	3.8					
Large	7284(34.5)	3.7	< 0.001*				
Highest education							
No education	9356(44.5)	4.7					
Primary	3342(15.1)	4.5	0.122				
Secondary/tertiary	8652(40.4)	3.3					
Employment							
Working	14488(68.3)	4.1	0.441				
Not working	6862(31.7)	4.2					
Marital status							

*significance at 5%; #based on log-rank test;

Characteristics	n (%)	Death (%)	p-value#	Characteristics	n (%)	Death (%)	p-value#
Not married/ in-union	600(2.4)	5.0					
Married or in-union	20750(97.6)	4.1					
Desire for last child			0.165				
Then	18670(87.9)	4.2					
Later	1936(8.8)	3.3					
No more	744(3.3)	4.6					
<i>Total</i>	<i>21350</i>	<i>4.1</i>		<i>Total</i>	<i>21350</i>	<i>4.1</i>	
*significance at 5%; #based on log-rank test;							

In Fig. 1, the higher the number of HrBBs engaged by infants' mothers the higher the percentage of infant mortality. Specifically, 5.1% of infant deaths occurred among mothers who engaged in multiple HrBBs compared with 4.4% infant death among mothers with single risk and 3.3% death among none high-risk birth behaviours.

Figure 2 shows the cumulative hazard ratio by the high-risk birth behaviour and some selected variables

Association between high-risk birth behaviour and infants background characteristics

Region of residence, religion, ethnicity, wealth status, source of drinking water, sex, birth size, maternal education, contraceptive use, ANC visit, tetanus injection, place and type of delivery, prenatal and delivery assistant, and breastfeeding initiation were significantly associated with infant mortality ($p < 0.05$). Specifically, the prevalence of infant death was common among mothers who did not use contraceptive (4.6%) relative to contraceptive users (1.9%). Children who were male (4.5%), of small size at birth (5.5%), born via caesarean (6.1%), and did not receive tetanus injection (5.4%) were more prone to infant death compared to their respective counterparts. Similarly, the prevalence of death was higher among infants whose mothers were uneducated (4.7%) and had zero visit to ANC (5.0%). Also, children from the North west (4.7%) and of Hausa/Fulani tribe (4.7%) were more vulnerable to die during infancy. (Table 1).

Influence of high-risk birth behaviours on infant survival status

The crude and adjusted models of time to infant death are set out in Table 2. The tendency of infant deaths increased as the number of HrBBs increases. Specifically, the hazards of infant mortality were significantly higher among mothers who engaged in single (HR = 1.23; CI: 1.05–1.44) and multiple (HR = 1.56; CI: 1.32–1.83) compared to those who engaged in none HrBBs as observed in the crude/simple model. The hazard of infant mortality remained significantly higher among infants whose mothers practiced multiple HrBBs while controlling for household, child/maternal and health service-related characteristics. Of note, the hazard of multiple HrBBs among mothers increased to 1.67 (aHR = 1.67; CI: 1.33–2.09) while all significant variables at bivariate level were adjusted for. Besides, being a male, having small size at birth, non-use of contraceptive, failure to receive tetanus, and being assisted by unskilled personnel at childbirth were other significant predictors that increase the tendency of children aged 0–11 months death. The likelihood of infant death was significantly more pronounced in the North West 67

(aHR = 1.45; CI: 1.03–2.02) and North East 67 (aHR = 1.41; CI: 1.03–1.93) compared with North Central. However, children who resided in rural areas (aHR = 0.79; CI: 0.62–0.99) were less likely to die at infant compared to their urban counterparts. Although the influence of breastfeeding initiation was insignificant statistically, child whose mother delayed in breastfeeding initiation was more likely to experience infant death.

Table 2
Factors associated with infant mortality

Characteristics	Unadjusted HR (95%CI)	aHR (95%CI)			
		Model1	Model2	Model3	Model4
High risk behaviour					
Non-risk	1	1	1	1	1
Single	1.23(1.05,1.44) ^a	1.16(0.99,1.36)	1.14(0.96,1.34)	1.22(0.99,1.51)	1.19(0.96,1.48)
Multiple	1.56(1.32,1.83) _a	1.46(1.23,1.72) _a	1.43(1.20,1.71) _a	1.76(1.42,2.17) _a	1.67(1.33,2.09) _a
Region					
Northcentral		1			1
Northeast		1.19(0.94,1.51)			1.41(1.03,1.93) _c
Northwest		1.22(0.95,1.58)			1.45(1.03,2.02) _c
Southeast		0.89(0.53,1.52)			0.54(0.23,1.24)
Southsouth		0.86(0.63,1.17)			0.84(0.53,1.35)
Southwest		0.92(0.62,1.36)			0.68(0.37,1.26)
Residence					
Urban		1			1
Rural		0.88(0.74,1.04)			0.79(0.62,0.99) _c
Religion					
Christianity		1			1
Islam		0.98(0.78,1.23)			0.83(0.60,1.15)
Others		0.80(0.33,1.95)			0.57(0.14,2.35)
Ethnicity					
Hausa/Fulani		1			1
Igbo		0.94(0.56,1.59)			1.13(0.51,2.51)
Yoruba		0.79(0.51,1.21)			0.92(0.48,1.75)
Other		0.94(0.75,1.19)			0.91(0.67,1.23)
Wealth status					

^a p < 0.05, ^b p < 0.01, ^c p < 0.001

Characteristics	Unadjusted HR (95%CI)	aHR (95%CI)			
		Model1	Model2	Model3	Model4
Poorest		1			1
Poorer		1.17(0.96,1.41)			1.13(0.90,1.42)
Middle		0.98(0.78,1.23)			0.97(0.73,1.29)
Richer		0.84(0.64,1.12)			0.91(0.64,1.30)
Richest		0.77(0.54,1.09)			0.67(0.42,1.09)
Drinking water source					
Improved		1			1
Not improved		1.10(0.96,1.27)			1.13(0.94,1.36)
Toilet facility					
Improved		1			
Not improved		0.92(0.78,1.09)			
Cooking fuel					
Improved		1			
Not improved		0.79(0.57,1.11)			
Sex					
Male			1.24(1.08,1.42) b		1.25(1.05,1.49) a
Female			1		1
Birth size					
Small			1.55(1.29,1.85) a		1.39(1.09,1.77) b
Average			1		1
Large			1.03(0.89,1.20)		1.04(0.85,1.26)
Highest education					
No education			1		1
Primary			0.95(0.78,1.14)		1.24(0.95,1.61)
Secondary/tertiary			0.67(0.57,0.79) a		0.83(0.60,1.13)
Employment					

^a p < 0.05, ^b p < 0.01, ^c p < 0.001

Characteristics	Unadjusted HR (95%CI)	aHR (95%CI)			
		Model1	Model2	Model3	Model4
Not working			1		1
Working			1.09(0.94,1.26)		1.09(0.90,1.32)
Marital status					
Not married/ in-union			1		
Married or in-union			0.67(0.44,1.01)		
Desire for last child					
Then			1		1
Later			0.85(0.65,1.12)		0.69(0.44,1.08)
No more			0.99(0.69,1.41)		1.20(0.75,1.91)
Contraceptive use					
Using				1	1
Not using				1.97(1.42,2.72) ^a	1.80(1.29,2.52) ^a
Decision involvement					
Not				1	1
Low				0.92(0.77,1.11)	1.00(0.82,1.21)
High				0.96(0.69,1.34)	1.15(0.81,1.62)
ANC visit					
None				0.99(0.71,1.39)	1.01(0.72,1.43)
1–3				1.22(0.96,1.56)	1.09(0.85,1.39)
≥ 4				1	1
Tetanus injection					
Received				1	1
Not received				1.54(1.16,2.05) ^b	1.38(1.03,1.85) ^c
Breastfeeding initiation					
Not delayed				1	1

^a p < 0.05, ^b p < 0.01, ^c p < 0.001

Characteristics	Unadjusted HR (95%CI)	aHR (95%CI)			
		Model1	Model2	Model3	Model4
Delayed				1.29(1.03,1.62) ^c	1.24(0.99,1.56)
Health facility perception					
Not-problem				1	
Problem				1.14(0.95,1.36)	
Place delivery					
Hospital				0.96(0.66,1.41)	1.12(0.75,1.67)
Home				1	1
Prenatal attendant					
None				1	1
Unskilled				1.20(0.66,2.16)	1.36(0.73,2.52)
Semi-skilled				1.08(0.79,1.46)	1.01(0.74,1.38)
Skilled				1	1
Type of delivery					
Normal				1	1
Caesarean				0.92(0.47,1.82)	1.04(0.52,2.07)
Delivery attendant					
None				1	1
Unskilled				1.26(0.96,1.66)	1.39(1.05,1.83) ^c
Semi-skilled				1.30(0.80,2.11)	1.45(0.87,2.43)
Skilled				1.08(0.68,1.72)	1.34(0.82,2.19)
-LL	8785.9	8671.6	8422.9	5076.4	4958.0
AIC	17575.9	17383.2	16867.8	10186.7	9996.0
BIC	17591.8	17542.3	16955.3	10320.2	10309.6
N	21350	21052	21025	19002	18753
^a p < 0.05, ^b p < 0.01, ^c p < 0.001					

Discussion

The global efforts with various intervention to reduce Infant Mortality Rate (IMR) has yielded progress in most parts of the world except in sub-Sahara Africa where infant mortality is still unacceptably high and account for more than fifty percent of global infant death. Sadly, Nigeria is one of the five countries of the world that account for this poor statistic. Infant survival has been unduly affected by several preventable factors such as health/environmental related conditions, socio-demographic and biological characteristics of the mothers. Most importantly, the bio-demographic characteristics of mothers which is referred to as High-risk Birth Behaviours (HrBBs) has a strong impact on infant survival. This study therefore examined the influence of the combination of these three risk factors on infant survival in Nigeria.

Our findings showed that the higher the number of HrBBs engaged by infants' mothers, the higher the likelihood of the infant mortality. A similar study conducted in Nigeria substantiates this finding [10]. A multi-national study also found that the more birth risks a child faces, the higher the risk of dying [9]. Yogev et al in a study to determine pregnancy outcome at advanced maternal age found out that advanced maternal age of greater than 35 years is associated with higher risk of maternal, hormonal disorder, and low uteroplacental blood flow which increases the risk of congenital and chromosomal abnormalities that results in fetal complications with resultant infant death. Studies showed that children born to young mothers (under age 18), had a 20 percent greater risk of dying in the first year of life, and children born to mothers ages 35–39 and 40 or older have a 20 percent and 50 percent greater risk of dying in the first year of life, respectively [9, 17]. The effect of a short birth interval of less than 24 months has been shown to affect infant survival, this harmful effects of a non-optimal preceding birth interval are concentrated in early infancy [20]. High parity also influences the chances of child survival as most mothers with many children tend to belong to lower socioeconomic status, have low education status and live in less favourable lifestyle [22]. The findings from previous studies on the association between each of the three factors used for the creation of HrBBs and infant survival was consistent with that of the combined HrBBs demonstrated in the current study [9, 26].

Furthermore, other predictors of infant death found in our study are being a male child, small birth size, living in the North west and North East regions, rural place of resident, failure to receive tetanus injection and presence of unskilled birth delivery assistant. This is consistent with research findings from similar studies [26, 29, 30]. Our study also found that non-use of contraceptive commodities among the mothers increased the risk of infant mortality as compared with mothers that used contraceptives. Non-use of contraceptives expose women to the risk of unplanned births and undesirable children which may account for high parity and subject the infants to neglect and improper care especially in the midst of ravaging poverty [31]. Low contraceptive usage does not allow the mother to fully recover from previous births and thus may not be fully prepared for subsequent births in terms of reproductive and socioeconomic reasons. This may also have an influence on maternal health with resultant birth of infants with health challenges coupled with inadequate care [32]. These factors contribute to high infant mortality.

Aside the sampling errors that can limit the extent to which the findings from this study can be generalized to the entire population, the cross-sectional nature of the data used for this study inhibits the causal relationship between HrBBs and infant mortality. To attribute infant death to high risk birth behavior, further studies that will use cohort or quasi-experimental design approach are thus recommended. The use of a large nationally representative data remains a strength of this study.

Conclusions

HrBBs is an important predictor of infant mortality and multiple HrBBs increases the chances of dying among infants in Nigeria. Screening women for HrBBs for special health attention during pregnancy, birth and postnatal

period will alleviate infant death in Nigeria. In addition, living in the core-north region, residing in the rural area, being a male child, smaller size at birth, and attended to by unskilled personnel during child delivery predisposed infants to higher risk of dying in Nigeria. These factors should also be considered while designing strategies aim at reducing infant mortality in Nigeria. The findings also require the Nigerian government to institute an aggressive approach in ending infant mortality by endorsing policy which will end HrBBs by stating the minimum age at marriage, enforce the recommended birth interval and family size and promote the use of family planning methods.

Abbreviations

HrBBs: High risk Birth Behaviours

IMR: Infant mortality rate

NDHS: Nigerian Demographic Health Survey

TFR: Total Fertility Rate

ANC: Antenatal care

SDG: Sustainable Development goal

CPH: Cox proportional hazards

Declarations

Ethics approval and consent to participate

Ethical approval for the parent study was obtained from the National Health Research Ethics Committee (NHREC) and the ICF Institutional Review Board. The details of the ethical approval have been reported earlier [3]. The present study analysis utilised a secondary dataset, freely available for use in the public domain, which requires no ethics approvals. Meanwhile, the Demographic and Health Surveys Program, ICF Macro USA granted authorisation to access the raw data set used for the present analysis.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and/or analysed during the current study are available in the [The DHS Program] repository, [<http://dhsprogram.com/pubs/pdf/FR359/FR359.pdf>]

Competing interests

The authors declare that they have no competing interest.

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Authors' contributions

MMS conceptualized the research idea, RFA and ASA carried out the analysis, RFA and AFF interpreted the results, MMS, RFA, BMG and ATS participated in writing the discussion. All authors participated in drafting and revision of the manuscript. All authors read and approved the final manuscript. All authors assert ownership of and responsibility for the manuscript. MMS and RFA are the guarantors of the paper.

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References

1. **Levels & Trends in Child Mortality: Report 2019, Estimates developed by the United Nations Inter-agency Group for Child Mortality Estimation', United Nations Children's Fund, New York** [<https://www.unicef.org/reports/levels-and-trends-child-mortality-report-2019>]
2. **United Nations sustainable development summit: Sustainable development goals. SDG3.2** [<http://www.who.int/topics/sustainable-development-goals/targets/en/>]
3. National Population Commission - NPC, ICF Macro: **Nigeria Demographic and Health Survey 2018 - Final Report**. In. Abuja, Nigeria: NPC and ICF; 2019.
4. National Population Commission (NPC), ICF Macro: **Nigeria Demographic and Health Survey 1990 - Final Report** In.; 1991.
5. **Children: Reducing Mortality. Fact sheet 178. Geneva** [<http://www.who.int/mediacentre/factsheets/fs178/en/>]
6. **Maternal and perinatal health** [http://www.who.int/reproductivehealth/publications/maternal_perinatal_health/en/]
7. Kinney MV, Kerber KJ, Black RE, Cohen B, Nkrumah F, Coovadia H, Nampala PM, Lawn JE, Science in Action: Saving the lives of Africa's Mothers N, Children working g *et al*: **Sub-Saharan Africa's mothers, newborns, and children: where and why do they die?** *PLoS Med* 2010, **7**(6):e1000294-e1000294.
8. Gurmu E, Tariku D: **Correlates of High Risk Fertility Behaviour in Ethiopia: A Multilevel Analysis of the 2011 Ethiopian Demographic and Health Survey Data**. *Journal of Health, Medicine and Nursing* 2017, **39**.
9. **The Effects of Fertility Behavior 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/pubs/pdf/AS37/AS37.pdf>]
10. Rahman M, Hosen A, Khan MA: **Association between Maternal High-Risk Fertility Behavior and Childhood Morbidity in Bangladesh: A Nationally Representative Cross-Sectional Survey**. *The American Society of Tropical Medicine and Hygiene* 2019, **101**(4):929–936.
11. Finlay J, Norton M: **Adolescent Fertility and Child Health: The Interaction of Maternal Age, Parity and Birth Intervals in Determining Child Health Outcomes**. *International Journal of Child Health and Nutrition* 2017, **6**(1):16-33.
12. Gibbs C, Wendt A, Peters S, Hogue C: **The impact of early age at first childbirth on maternal and infant health**. *Paediatric Perinatal Epidemiology* 2012, **26**:259–284.
13. Oyefara JLJRoh, sciences s: **Maternal Age at First Birth and Childhood Mortality in Yoruba Society: The Case of Osun State, Nigeria**. 2013, **3**:246-256.

14. Balasch J, Gratacós E: **Delayed childbearing: effects on fertility and the outcome of pregnancy.** *Current Opinion Obstetric Gynecology* 2012, **24**(3):187–193.
15. Fall C, Sachdev H, Osmond C, Restrepo-Mendez M, Victora C, Martorell R, al e: **Association between maternal age at childbirth and child and adult outcomes in the offspring: a prospective study in five low-income and middle-income countries (COHORTS collaboration).** *Lancet Glob Health* 2015, **3**(7):e366–377.
16. Hsieh TT, Liou JD, Hsu JJ, Lo LM, Chen SF, Hung TH: **Advanced maternal age and adverse perinatal outcomes in an Asian population.** *European journal of obstetrics, gynecology, and reproductive biology* 2010, **148**(1):21-26.
17. Mousiolis A, Baroutis G, Sindos M, Costalos C, Antsaklis A: **Maternal age as a predictive factor of pre-term birth. An epidemiological study from 1999 to 2008 in Greece.** *Journal of obstetrics and gynaecology : the journal of the Institute of Obstetrics and Gynaecology* 2013, **33**(1):28-31.
18. Kandala N, Ji C, Stallard N, Stranges S, Cappuccios F, : **Spatial analysis of risk factors for childhood morbidity in Nigeria.** *American Journal of Tropical Medicine and Hygiene* 2007, **77**:770–779.
19. Bayrampour H, Heaman M, Duncan AK, Tough S: **Advanced maternal age and risk perception: A qualitative study.** *BMC Pregnancy and Childbirth* 2012, **12**(100).
20. DaVanzo J, Hale L, Razzaque A, Rahman M: **The effects of pregnancy spacing on infant and child mortality in Matlab, Bangladesh: how they vary by the type of pregnancy outcome that began the interval.** *Population Studies* 2008, **62**:131–154.
21. **The Effect of Birth Intervals on Causes of Under-five Mortality in Afghanistan.** DHS Working Papers. Calverton, MD: ICF International
22. Sonneveldt E, DeCormier W, Stover J: **Linking high parity and maternal and child mortality: what is the impact of lower health services coverage among higher order births? .** *BMC Public Health* 2013, **13**(S7).
23. [www.healthpolicyproject.com]
24. [<https://www.macrotrends.net/countries/NGA/nigeria/fertility-rate>]
25. Santhya KG: **Early marriage and sexual and reproductive health vulnerabilities of young women: a synthesis of recent evidence from developing countries.** *Current opinion in obstetrics & gynecology* 2011, **23**(5):334-339.
26. Adebowale A: **Intra-demographic birth risk assessment scheme and infant mortality in Nigeria.** *Glob Health Action* 2017, **10**, 1366135.
27. **WORLD POPULATION DATA SHEET** [https://www.prb.org/wp-content/uploads/2018/08/2018_WPDS.pdf]
28. National Population Commission (NPC), ICF Macro: **Nigeria Demographic and Health Survey 2008 Final Report** In. Abuja, Nigeria; 2009.
29. Rutstein SO: **Further Evidence of the Effects of Preceding Birth Intervals on Neonatal, Infant, and Under-Five-Years Mortality and Nutritional Status in Developing Countries: Evidence from the Demographic and Health Surveys.** Demographic and Health Surveys, 2000 to 2005 DHS Analytical Studies of 52 DHS surveys. Demographic and Health Research Division, Macro International Inc. 11785 Beltsville Drive, Calverton, MD 20705, USA. 2008.
30. Amir-ud-Din R, Naz L, Rubi A, Usman M, Ghimire U: **Impact of High-Risk Fertility Behavior on Under-five Mortality in Asia and Africa: Evidence from Demographic and Health Surveys.** *Research Square*.
31. Saha UR, van Soest A: **Contraceptive use, birth spacing, and child survival in Matlab, Bangladesh.** *Studies in family planning* 2013, **44**(1):45-66.

32. Contraception Needed to Avoid High-Fertility-Risk Births, and Maternal and Child Deaths That Would Be Averted. Evidence from the Demographic and Health Surveys, 2006 to 2012. DHS Analytical Studies No. 50. Rockville, Maryland, USA: ICF International [<https://dhsprogram.com/publications/publication-as50-analytical-studies.cfm>]

Figures

Figure 1

Distribution of death by high-risk birth behaviour

Figure 2

Hazard function of time to infant death