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Research Article

Socioeconomic, bio-demographic and health/behavioral determinants of neonatal mortality in Nigeria: a multilevel analysis of 2013 demographic and health survey

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ABSTRACT

Background: Nigeria ranks as one of the countries in the world with considerable burden of neonatal mortality. This study aims to investigate the association of socioeconomic, bio-demographic and health/behavioural factors with neonatal mortality in the country using the most current available evidence.
Methods: The 2013 Nigeria demographic and health survey (NDHS) dataset was analyzed. Multiple logistic regression analysis was applied to identify determinants associated with neonatal mortality. The role of breastfeeding was examined by conducting analyses with and without adjustment for 'breastfeeding status'. Complex sample analysis was used to control for the complex sampling design used in NDHS.
Results: Neonatal mortality rate (NMR) stood at 33 deaths per 1000 live births. With or without adjustment for 'breastfeeding status', bio-demographic factors – maternal marital status, rural-urban residence, birth size, gender of child, birth interval and maternal body mass index (BMI) – were predictive of neonatal mortality. Maternal age and ethnicity became additional bio-demographic predictors after adjusting for 'breastfeeding status'. Maternal literacy (socioeconomic factor) and mode of delivery (health/behavioral factor) were significant predictors only when breastfeeding status was not adjusted for.
Conclusions: Bio-demographic factors formed the bulk of predictors of neonatal mortality in Nigeria. The effect of socioeconomic and health/behavioural factors disappeared when breastfeeding status was adjusted for. Intervention programs would need to prioritize the identified predictors for an accelerated reduction of neonatal mortality in Nigeria.

Keywords: Neonatal mortality, Nigeria, Socioeconomic, Bio-demographic, Health/behavioral determinants

INTRODUCTION

Nigeria ranks second in the world for the highest number of neonatal mortality.[1] On a daily basis, an estimated seven hundred neonates die, translating to over two hundred and fifty thousand annual mortalities in neonates in the country.[2] Available interventions so far have failed to yield the desirable results; hence, a recent study concluded, "there was no much improvement in neonatal survival" in Nigeria since 1990.[3 (p10)] Similarly, the report on 'Newborn Health' in Nigeria showed "there has been no measurable progress in reducing neonatal deaths over the past decade." [4 (p15)]

Compared to some developing countries such as Tanzania, Uganda, Malawi, Niger, Ethiopia, Liberia, and so on, Nigeria could not meet the targets of millennium development goal (MDG) 4 by 2015. Now that the sustainable development goals (SDGs) has commenced, the need to speed up the rate of reduction of

neonatal/child mortality is being emphasized. According to the UNICEF, Nigeria would need about two to three times increased reduction in child/neonatal mortality rates to be on track to meeting the targets of SDG for child survival - 12 deaths per 1000 live births for NMR and 25 deaths per 1000 live births for child mortality rate by 2030.[36]

For an accelerated reduction in neonatal and, hence, child mortality in Nigeria, a comprehensive understanding of the associated risk factors is imperative. Such information is not only crucial but critical to the conception of evidence-based interventions, especially, in a resource constraint setting like Nigeria. However, the literature on the determinants of neonatal mortality is limited in Nigeria.[3] Existing studies have largely been institutional-based with a major concentration on the medical causes of neonatal mortality.[5] Hospital-based studies are prone to selection bias and often limited by small sample sizes.[6]

Akinyemi, Bamgboye, Ayeni lamented the paucity of studies on determinants of neonatal mortality in Nigeria and claimed to have pioneered a nation-wide analysis on this subject.[3] However, their study appeared to have focused more on the trends of neonatal mortality using NDHS datasets from 1990 to 2013; consequently, important predictors were not investigated. Taking a more comprehensive approach, the current study assessed a range of factors associated with neonatal mortality as previously identified and reported in comparable developing countries. Accordingly, this paper presents socioeconomic, bio-demographic and health/behavioral determinants of neonatal mortality in Nigeria using evidence from the 2013 NDHS. The study provides current and further information on the determinants of neonatal mortality in Nigeria. Its findings, therefore, may pilot the provision of a focused and evidence-based intervention(s) aimed at speeding up the reduction of neonatal mortality in Nigeria.

METHODS

Data source

In this paper, information containing child, mother, socioeconomic, bio-demographic and health/behavioural characteristics from the childbirth dataset of 2013 NDHS was extracted and analyzed. NDHS is a nationally representative survey that provides current and up-to-date data on key reproductive health issues including but not limited to marriage, awareness and use of family planning methods, nutritional status of women and children, adults and childhood mortalities.[2] The 2013 edition of the survey is the latest in the series of its kind in Nigeria.[2] Men and women aged 15-49 years were selected for the survey by using a stratified three-stage cluster sampling techniques.[2] A representative sample of 40,680 households participated in the survey. Interviewer-administered structured questionnaires were the instruments for data collection. Three types of questionnaires, namely household's, woman's and man's were used.[2] Only singleton live births for the period of five years preceding the survey were included in this study. Details of the setting, data sources, sampling design and retrieval processes used in the 2013 NDHS have previously been published.[2]

Dependent variable

Neonatal mortality, defined as death within the first 28 days of an infant's life, and expressed as per 1000 live births – neonatal mortality rates (NMR) – is the main outcome variable of interest for this study.[1] Neonates who died (coded as 1= died) within the first 28 days of life were compared to those who survived (coded as 0 = survived).

Independent variables

Explanatory variables were selected based on the objectives of this study, their importance for neonatal survival as previously indicated in the literature and also taking into cognizance the Nigerian context. The variables were grouped into three broad categories – socioeconomic, bio-demographic and health/behavioral. Table 1 presents the categorization of the independent variables included in this study.

Statistical analysis

The association between neonatal mortality and explanatory variables was assessed using a contingency table and multilevel logistic regression analyses. Three types of analyses were conducted – univariate, bivariate and multivariable – and the outcomes expressed as NMR, Crude Odds Ratio (COR) and Adjusted Odds Ratio (AOR), respectively. Following the proposal by Hosmer-Lemeshow, only variables having p values of 0.25 or less in the univariate/bivariate analyses were eligible to be used in the multivariable model building.[7] Three sets of modelling (I, II, III) were conducted following the recommended hierarchical approach.[8]

Model I started with all socioeconomic (distal) variables having a p value of 0.25 or less. These were entered simultaneously in the initial model and variables were retained for subsequent modeling if they were significant at 10% level. Model II was fitted for variables retained from Model I together with bio-demographic (proximate) variables having a p-value ≤0.25, thus, exploring the effects of bio-demographic factors in the presence of socioeconomic variables. Again, variables that were significant at 10% level were retained for the next model. Finally, all health/behavioral (intermediate) variables having a p value of ≤0.25 were entered to build Model III; thus, assessing the effects of health/behavioral variables by controlling both socioeconomic and bio-demographic factors. At each level of the modelling, backward elimination method was applied in obtaining a parsimonious model. Predictors with $p < 0.05$ in the final model (Model III) were retained and reported together with their AOR and 95% confidence intervals (CI).

To examine the effect of 'breastfeeding status' on the association between neonatal mortality and other explanatory variables, the final model (Model III) was fitted twice – without (Model IIIA) and with (Model IIIB) adjustment for 'breastfeeding status'. The need for

this approach followed the observation that 'breastfeeding status' had a higher COR than other variables - reflecting a remarkably strong association with neonatal mortality. This strong association could potentially mask important predictor(s) or render them statistically insignificant. Furthermore, there is evidence that breastfeeding ('any breastfeeding') is commonly practiced in Nigeria while the rate of exclusive breastfeeding is low.[2,35] Also the latest report from UNICEF suggests that breastfeeding plays a significant role in neontatal survival.[36] Given these facts, it was deemed imperative to understand the relative contribution of 'breastfeeding status' to neonatal mortality and to the association of neonatal mortality with other factors in Nigeria. Analyses were weighted and adjusted for the multistage stratified cluster sampling used in the 2013 NDHS. All data management and analyses were carried out by using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp. Released 2013. Armonk, NY: IBM Corp USA).

Table 1A: Categorization of variables used in the analyses.
Socioeconomic variables.

Variables	Definition and Categorization
Maternal education level	The highest educational level of mothers categorized into four: no education, primary, secondary, higher education.
Maternal literacy level	This variable defines the level of maternal literacy, recoded as: cannot read at all, can read parts of/whole sentences.
Maternal occupation	Maternal occupation was recoded into: not working, working
Paternal education level	Paternal (husband/partner) education level categorized as: no education, primary, secondary, higher education.
Paternal occupation	Paternal occupation was recoded as: not working, working.
Wealth index	Recoded as: poor, middle, rich
Decision-making on health care need	The person who usually decides on own or women's health care needs recoded into: respondent alone, respondent and husband/partner, husband/partner alone.
Toilet facility	Recoded according to the UNICEF/WHO classification [9] as: unimproved, improved.
Source of drinking water	Recoded according to the UNICEF/WHO classification [9] as: unimproved, improved sources
Electricity access	Access to electricity was recoded as: no, yes.
Cooking fuel	Cooking fuel was recoded in line with the 'energy ladder' concept as: solid fuel, non-solid fuel[10]

Table 1B: Categorization of variables used in the analyses.
Bio-demographic variables.

Maternal age at first birtl	Recoded into: < 20 years, ≥ 20 years.
Maternal marital status	Recoded as: never in union, divorced/separated/no longer living together, married/living with a partner.
Residence	Type of residence was classified as: rural, urban.
Region of residence	Categorized according to the geopolitical zones in Nigeria: North-Central, North-East, North-West, South-East, South-South, South-West.
Ethnicity	Recoded into four (the three major ethnic groups and 'others' – all the other ethnic groups put together): Hausa, Igbo, Yoruba, 'Others'.
Religion	Recoded into the three main religions in Nigeria: Christianity, Islam, Traditionalist.
Birth order	Birth order was recoded as 1, 2-3, and ≥ 4
Size of child at birth	Recoded into: small, average, Large.
Gender of child	Sex of child: male, female.
Gender of household head	The gender of the head of household coded as: male, and female.
Preceding birth interval	Preceding birth interval was recoded as: < 24 months, ≥ 24 months.
Maternal Body Mass Index (BMI)	Recoded using the WHO International classification[11] as: underweight (<18.5 kg/m^2), normal 18.5 - 24.9 kg/m^2), overweight (25 - 29.9 kg/m^2), Obese (≥30 kg/m^2).
Maternal age (years)	Categorized into: < 20 years, 20 – 35 years, ≥36 years.

Table 1C: Categorization of variables used in the analyses.
Health/behavioral variables.

Iron intake	Iron intake during pregnancy was recoded as: yes, no.
Breastfeeding status	Breastfeeding status was categorized as: never breastfed, ever breastfed.
Breastfeeding initiation	The time breastfeeding was started was recoded as: Immediately/within the first hour of birth, beyond the first hour of birth.
Antenatal attendance	Antenatal attendance was categorized into: no, yes.
Delivery assistance	Recoded as: skilled (doctors, nurses and midwives), combined (health professionals and traditional birth attendants (TBA), no assistance.
Place of delivery	Recoded into: home, government and private facility.
Mode of delivery	Classified as: caesarean delivery, non-caesarean delivery.
Malaria Prophylaxis with IPT_p	Intermittent preventive treatment of malaria in pregnancy (IPT_p) describes whether or not mothers received malaria prophylactics (sulfadoxine/ pyremethamine) during pregnancy. The variable was recoded as: no, yes.
Tetanus injection during pregnancy	Recoded as: no, yes.

RESULTS

Within five years preceding the 2013 survey, a total of 30,384 singleton live births occurred. NMR was found to be 33 per 1000 live births. In total, 34.80% of study participants resided in urban areas as opposed to 65.20% in the rural areas. Table 2 presents the background characteristics of the study population alongside NMR by socioeconomic, bio-demographic and health/behavioral factors. NMR varies across regions with the North-West zone having the highest rate of 37 per 1000 live births while the North-Central zone had the lowest rate of 27 per 1000 live births. This difference, however, did not attain statistical significance (p = 0.206). NMR was significantly higher among rural dwellers (36/1000 live births, p = 0.003) compared to urban dwellers (28/1000 live births). Also, the Hausa ethnic group had a significantly higher NMR (38/1000 live births, p = 0.057) than 'other' ethnic groups (29/1000 live births). Compared to rich households (30/1000 live births), poor households had significantly higher NMR (37/1000 live births, p = 0.021). Households without electricity access equally had higher NMR (36/1000 live births, p = 0.028) than those with electricity access (30/1000 live births).

Table 2A: Characteristics of variables and neonatal mortality rates (NMR).
Socioeconomic variables.

Variables	N=30384(%)[a]	NMR[b]	P-value (x^2)
Maternal education level			
No education	49.40	35.00	0.023*
Primary	19.10	38.00	
Secondary	25.80	28.00	
Higher	5.70	24.00	
Maternal literacy level			
Cannot read at all	59.80	36.00	0.003*
Can read parts or whole sentences	40.20	28.00	
Maternal occupation			
Not working	29.60	36.00	0.116
Working	70.40	32.00	
Paternal education level			
No education	39.90	35.00	0.203
Primary	18.90	33.00	
Secondary	29.00	30.00	
Higher	12.30	27.00	
Paternal occupation			
Not Working	0.80	15.00	0.095
Working	99.20	33.00	
Wealth index			

Poor	46.90	37.00	
Middle	18.80	29.00	0.021*
Rich	34.40	30.00	
Decision-making on health care need			
Respondent alone	4.80	27.00	0.155
Respondent and husband/partner	30.50	30.00	
Husband/partner alone	64.70	34.00	
Cooking fuel			
Solid fuels	81.60	33.00	0.278
Non-solid fuels	18.40	30.00	
Toilet facility			
Unimproved	49.50	34.00	0.220
Improved	50.50	31.00	
Drinking water source			
Improved sources	55.90	32.00	0.697
Unimproved sources	44.10	33.00	
Electricity access			
No	52.00	36.00	0.028*
Yes	48.00	30.00	

*Statistically significant at 5% level in Pearson Chi-Square test (x^2). [a]Weighted for the sampling probability; [b]Deaths per 1000 live births.

Table 2B: Characteristics of variables and neonatal mortality rates (NMR). Bio-demographic variables.

Variables	N=30384 (%)[a]	NMR[b]	P-value (x^2)
Maternal age at first childbirth			
Below 20 years	59.90	33.00	0.936
20 years or more	40.10	33.00	
Maternal marital status			
Never in union	1.60	41.00	0.002*
Divorced/separated/no more living together	1.60	64.00	
Married/living with a partner	96.80	32.00	
Residence			
Urban	34.80	28.00	0.003*
Rural	65.20	36.00	
Ethnicity			
Hausa	35.40	38.00	0.057**
Igbo	11.20	34.00	
Yoruba	10.90	31.00	
Other[a]	42.60	29.00	
Religion			
Christianity	36.60	32.00	0.710
Islam	62.40	34.00	
Traditionalist	0.90	28.00	
Birth order			
1	19.90	45.00	0.001*
2-3	32.60	28.00	
≥4	47.50	31.00	
Size of child at birth			
Large	44.10	25.00	<0.001*
Average	41.20	29.00	
Small	14.70	54.00	
Gender of child			
Male	50.40	37.00	<0.001*
Female	49.60	28.00	
Gender of household head			

Male	90.40	33.00	0.825
Female	9.60	34.00	
Preceding birth interval (Months)			
<24	23.30	49.00	<0.001*
≥24	76.70	24.00	
Maternal BMI			
Underweight	08.30	29.00	0.107
Normal	66.30	32.00	
Overweight	17.50	32.00	
Obese	7.90	44.00	
Region of residence			
North-Central	13.50	27.00	0.206
North-East	17.80	33.00	
North-West	37.20	37.00	
South-East	8.80	35.00	
South-South	9.20	28.00	
South-West	13.50	30.00	
Maternal age (years)			
<20	5.10	51.00	0.002
20- 35	76.40	31.00	
36 and greater	18.50	35.00	

*Statistically significant at 5% level in pearson chi-square test (x^2); [a]Weighted for the sampling probability; [b]Deaths per 1000 live births; ** Border-line significance.

Table 2C: Characteristics of variables and neonatal mortality rates (NMR). Health/behavioral variables.

Variables	N= 30384 (%)[a]	NMR[b]	P-value (x^2)
Iron intake			
No	36.20	26.00	0.451
Yes	63.80	24.00	
Breastfeeding status			
Never breastfed	3.40	564.00	
Ever breastfed	96.60	28.00	<0.001*
Breastfeeding Initiation			
Immediately/within first hour	35.40	22.00	
Beyond first hour	64.50	24.00	0.377
Tetanus injection during pregnancy			
No	40.60	25.00	
Yes	59.40	24.00	0.617
Place of delivery			
Home	64.30	32.00	
Government facility	22.60	31.00	0.978
Private facility	13.10	31.00	
Mode of delivery			
Non-Caesarean	98.10	32.00	<0.001*
Caesarean	1.90	76.00	
Delivery assistance			
Skilled	40.00	32.00	
TBA/Combined	46.20	31.00	0.959
No assistance	13.70	31.00	
Antenatal attendance			
No	35.20	28.00	
Yes	64.80	24.00	0.096
Malaria prophylaxis with IPTs			
No	73.20	26.00	
Yes	26.80	21.00	0.105

*Statistically significant at 5% level in Pearson Chi-Square test (x^2); [a]Weighted for the sampling probability; [b]Deaths per 1000 live births.

Table 3A: Factors associated with neonatal mortality: unadjusted and adjusted odds ratios. Socioeconomic variables.

Variables	Unadjusted			Adjusted					
				Model IIIA			Model IIIB		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Maternal education level	-	-	0.025*						
No education	1.438	0.986 - 2.097	0.059						
Primary education	1.567	1.037 - 2.369	0.033*						
Secondary education	1.135	0.768 - 1.678	0.526						
Higher (ref)	1.000	-	-						
Maternal literacy level	-	-	0.003*	-	-	0.007*			
Cannot read at all	1.299	1.093 - 1.543	0.003*	1.399	1.098 - 1.783	0.007*			
Can read parts/whole sentences (ref)	1.000	-	-	1.000	-	-			
Maternal occupation	-	-	0.166						
Not working	1.222	0.953 - 1.320	0.166						
Working (ref)	1.000	-	-						
Paternal education level	-	-	0.185						
No education	1.313	0.979 - 1.761	0.069						
Primary	1.227	0.887 - 1.695	0.216						
Secondary	1.121	0.810 - 1.551	0.419						
Higher (ref)	1.000	-	-						
Paternal Occupation	-	-	0.104						
Not Working	0.457	0.177 - 1.175	0.104						
Working (ref)	1.000	-	-						
Wealth index	-	-	0.029*						
Poor	1.244	1.032 - 1.499	0.022*						
Middle	0.991	0.791 - 1.241	0.955						
Rich (ref)	1.000	-	-						
Decision-making on health care need	-	-	0.165						
Respondent alone	0.791	0.539 - 1.159	0.229						
Respondent and husband/partner	0.859	0.713 - 1.034	0.107						
Husband/partner alone (ref)	1.000	-	-						
Toilet facility	-	-	0.220						
Unimproved	1.107	0.941 - 1.302	0.220						
Improved (ref)	1.000	-	-						
Electricity access	-	-	0.028*						
No	1.212	1.021 - 1.439	0.028*						
Yes (ref)	1.000	-	-						
Cooking Fuel	-	-	0.279						
Solid fuels	1.128	0.907 - 1.403	0.279						
Non-solid fuels (ref)	1.000	-	-						
Drinking water source	-	-	0.697						
Improved sources (ref)	1.000	-	-						
Unimproved sources	1.034	0.872 -1.227	0.697						

*Statistically significant at 5% level. Model IIIA: Without adjustment for breastfeeding status. Model IIIB: With adjustment for breastfeeding status

Breastfeeding status and mode of delivery were the two health/behavioral factors found to be statistically significant in the bivariate analysis. Neonates that were delivered by caesarean section had about 2.5 times increased risk of dying than those delivered without a caesarean section (cor = 2.482, 95% ci: 1.769, 3.482, p<0.001).

Table 3B: Factors associated with neonatal mortality: unadjusted and adjusted odds ratios. Bio-demographic variables.

Variables	Unadjusted			Adjusted					
				Model IIIA			Model IIIB		
	OR	95%CI	P-value	OR	95%CI	P-value	OR	95%CI	P-value
Maternal age at first childbirth	-	-	0.936						
Below 20 years	0.993	0.845 - 1.168	0.936						
20 years or more (ref)	1.000	-	-						
Maternal marital status	-	-	0.006*	-	-	0.003*	-	-	0.044*
Never in union	1.264	0.803 - 1.989	0.311	2.785	1.028 - 7.545	0.044*	3.873	1.182 - 12.684	0.025*
Divorced/separated/ no longer living together	2.050	1.292 - 3.253	0.002*	2.143	1.239 - 3.709	0.006*	1.579	0.738 - 3.376	0.239
Married/living with partner (ref)	1.000	-	-	1.000	-	-	1.000	-	-
Residence	-	-	0.003*	-	-	0.023*	-	-	0.033*
Rural	0.764	1.096 - 1.564	0.003*	1.309	1.040 - 1.701	0.023*	1.405	1.027 - 1.921	0.033*
Urban (ref)	1.000	-	-	1.000	-	-	1.000	-	-
Region	-	-	0.193						
North-Central	0.896	0.607 - 1.322	0.580						
North-East	1.110	0.779 - 1.581	0.564						
North-West	1.231	0.879 - 1.723	0.227						
South-East	1.171	0.786 - 1.743	0.437						
South-South	0.949	0.637 - 1.411	0.794						
South-West (ref)	1.000	-	-						
Ethnicity	-	-	0.051*				-	-	<0.001*
Hausa	1.312	1.083 - 1.589	0.006*				1.838	1.211 - 2.789	0.004*
Igbo	1.159	0.894 - 1.504	0.265				1.443	0.816 - 2.552	0.207
Yoruba	1.068	0.765 - 1.491	0.701				1.046	0.691 - 1.582	0.831
Other (ref)	1.000	-	-				1.000	-	-
Religion	-	-	0.714						
Christianity	1.149	0.572 - 2.307	0.696						
Islam	1.210	0.623 - 2.351	0.573						
Traditionalist (ref)	1.000	-	-						
Birth Order	-	-	<0.001*						
1	1.469	1.227 - 1.759	<0.001*						
2-3	0.911	0.761 - 1.090	0.309						
≥4 (Ref)	1.000	-	-						
Size of child at birth	-	-	<0.001*	-	-	<0.001*	-	-	<0.001*
Small	2.217	1.789 - 2.746	<0.001*	2.436	1.898 - 3.128	<0.001*	2.355	1.810 - 3.065	<0.001*
Average	1.157	0.967 - 1.385	0.110	1.225	0.985 - 1.523	0.068	1.121	0.878 - 1.432	0.358
Large (ref)	1.000	-	-	1.000	-	-	1.000	-	-
Gender of child	-	-	<0.001*	-	-	0.001*	-	-	0.005*
Male	1.337	1.151 - 1.554	<0.001*	1.389	1.141 - 1.690	0.001*	1.357	1.098 - 1.676	0.005*
Female (ref)	1.000	-	-	1.000	-	-	1.000	-	-
Gender of household head	-	-	0.825						
Male	0.972	0.756 - 1.250	0.825						
Female (ref)	1.000	-							
Preceding birth interval (months)	-	-	<0.001*	-	-	<0.001*	-	-	<0.001*
<24	2.092	1.769 - 2.474	<0.001*	1.943	1.630 - 2.316	<0.001*	1.686	1.352 - 2.103	<0.001*
≥24 (ref)	1.000	-	-	1.000	-	-	1.000	-	-
Maternal BMI	-	-	0.208	-	-	0.006*	-	-	0.029*
Obese	1.390	0.987 - 1.957	0.059	1.709	1.064 - 2.747	0.027*	1.356	0.753 - 2.440	0.310
Overweight	0.977	0.780 - 1.222	0.836	1.024	0.787 - 1.333	0.858	0.863	0.653 - 1.141	0.301
Underweight	0.881	0.671 - 1.158	0.365	0.595	0.406 - 0.872	0.008*	0.537	0.338 - 0.852	0.008*
Normal weight (ref)	1.000		-	1.000		-	1.000		-
Maternal age (years)	-	-	0.001*				-	-	0.011*
<20	1.671	1.281 - 2.179	<0.001*				2.673	1.258 - 5.680	0.011*
20- 35 (ref)	1.000	-	-				1.000	-	-
36 and greater	1.141	0.918 - 1.417	0.234				1.231	0.938 - 1.616	0.134

*Statistically significant at 5% level. Model IIIA: Without adjustment for breastfeeding status. Model IIIB: With adjustment for breastfeeding status.

Table 3C: Factors associated with neonatal mortality: unadjusted and adjusted odds ratios. Health/behavioral variables.

Variables	Unadjusted			Adjusted					
				Model IIIA			Model IIIB		
	OR	95 %CI	P -value	OR	95%CI	P-value	OR	95%CI	P-value
Iron intake	-	-	0.451						
No	1.083	0.880 - 1.331	0.451						
Yes (ref)	1.000	-	-						
Breast feeding status	-	-	<0.001*				-	-	<0.001*
Never breastfed	44.50	35.61 - 55.57	<0.001*				45.111	33.988 - 59.874	<0.001*
Ever breastfed (ref)	1.000	-	-				1.000	-	-
Breastfeeding initiation	-	-	0.377						
Within first hour	0.911	0.740 - 1.121	0.377						
Beyond first hour (ref)	1.000	-	-						
Tetanus injection during pregnancy	-	-	0.617						
No	1.053	0.860 - 1.291	0.617						
Yes (ref)	1.000	-	-						
Place of delivery	-	-	0.979						
Home	1.024	0.803 - 1.306	0.851						
Government health facility	1.011	0.770 - 1.326	0.938						
Private health facility (ref)	1.000	-	-						
Mode of delivery	-	-	<0.001*	-	-	<0.001*			
Caesarean section	2.482	1.769 - 3.482	<0.001*	2.882	1.660 - 5.003	<0.001*			
Non-caesarean section (ref)	1.000	-	-	1.000	-	-			
Delivery assistance	-	-	0.965						
Skilled	1.023	0.795 - 1.317	0.857						
TBA/combined	0.999	0.785 - 1.270	0.991						
No assistance (ref)	1.000	-	-						
Antenatal attendance	-	-	0.096						
No	1.188	0.970 - 1.455	0.096						
Yes (ref)	1.000	-	-						
Malaria prophylaxis in pregnancy	-	-	0.106						
No	1.258	0.952 - 1.661	0.106						
Yes (ref)	1.000	-	-						

*Statistically significant at 5% level. Model IIIa: without adjustment for breastfeeding status. Model IIIb: with adjustment for breastfeeding status.

Table 3 presents the effects of factors on neonatal mortality by COR and AOR with their 95% CIs as well as p-values. Without controlling for any other variables/confounders (bivariate analysis), maternal education level, literacy level, wealth index, and electricity access were the four socioeconomic factors found to be significantly associated with neonatal mortality. Compared to mothers with higher educational attainment, the likelihood of neonatal mortality was about 57% higher in neonates whose mothers had only primary education (COR = 1.567, 95% CI: 1.037, 2.369, P = 0.033). Among the bio-demographic factors, maternal marital status, rural-urban residence, ethnicity, birth order, size of child at birth, gender of child, preceding birth interval, and maternal age were found to be significantly and independently associated with neonatal mortality (Table 3). The odds of neonatal mortality were over two times higher in neonates of mothers who were divorced, separated or no longer living together with partners compared to those whose mothers were married or living with partners (COR = 2.050, 95%CI: 1.292, 3.253, p = 0.002). Furthermore, the odds of neonatal mortality were about 24% lower among neonates of urban dwellers compared to the neonates of rural dwellers (COR = 0.764, 95%CI: 0.639, 0.912, p = 0.003). Breastfeeding status and mode of delivery were the two health/behavioral factors found to be statistically significant in the bivariate analysis. Neonates that were delivered by Caesarean section had about 2.5 times increased risk of dying than those delivered without a caesarean section (COR = 2.482, 95% CI: 1.769, 3.482, p< 0.001).

Multivariable analysis

Regardless of adjustment of 'breastfeeding status', six bio-demographic factors – maternal marital status, rural-urban residence, birth size, gender of child, preceding birth interval and maternal BMI – were significantly predictive of neonatal mortality (Table 3: Model IIIA and Model IIIB). Living in rural residence, being born with a small body size, having a preceding birth interval of less than two years, and being of a male gender were all associated with higher risks of neonatal mortality. Similarly, being born to divorced/separated mothers as well being born to single mothers (who had no previous marital history) increased significantly the odds of dying during the neonatal period. Contrary to expectation, maternal underweight was found to be protective against neonatal mortality.

When no adjustment was made for 'breastfeeding status' (Table 3: Model IIIA), maternal illiteracy (socioeconomic factor), maternal obesity (bio-demographic factor) and Caesarian mode of delivery (health/behavioral factor) were significantly associated with higher risks of neonatal mortality. Compared to neonates whose mothers were literate, odds of mortality were 39.9% higher among those whose mothers were illiterate (AOR = 1.399, 95% CI: 1.098, 1.783, p = 0.007). Neonates whose mothers were obese had about 71% increased odds of mortality (AOR = 1.709, 95% CI: 1.064, 2.747, p = 0.027) compared to those whose mothers had normal weight. Also, risks of mortality were 2.9 times higher in neonates whose mothers had undergone a caesarean section (AOR = 2.882, 95% CI: 1.660, 5.003) compared to those whose mothers did not.

After making an adjustment for 'breastfeeding status' (Table 3: Model IIIB), no socioeconomic or health/behavioral (except breastfeeding status) variable was predictive of neonatal mortality. However, ethnicity and maternal age (bio-demographic factors) attained significant status after adjustment for 'breastfeeding status'. Compared to 'otherc' ethnic groups, the odds of neonatal mortality were 84% higher in neonates born to Hausa mothers (AOR = 1.838, 95% CI: 1.211, 2.789, p = 0.004). Also, the odds of mortality were 2.673 times higher in neonates born to mothers under 20 years of age (AOR = 2.673, 95% CI: 1.258, 5.680, p = 0.011).

DISCUSSION

In this study, we identified socioeconomic, bio-demographic and health/behavioral determinants of neonatal mortality in Nigeria using the most current evidence – 2013 NDHS. Based on our multiple logistic regression analysis, without adjustment for 'breastfeeding status' (Table 3 A: Model IIIA), maternal literacy was the only socioeconomic factor found to be significantly associated with neonatal mortality. After making an adjustment for 'breastfeeding status' (Table 3 A: Model IIIB), no socioeconomic factor was predictive of neonatal mortality. Six bio-demographic factors, namely, maternal marital status, rural-urban residence, birth size, gender of child, preceding birth interval, and maternal BMI were significantly associated with neonatal mortality when no adjustment was made for 'breastfeeding status' (Table 3 B: Model IIIA). All these bio-demographic factors retained their predictive ability, with maternal age and ethnicity as two additional significant factors, even after making an adjustment for 'breastfeeding status' in Model IIIB (Table 3 B). Only one health/behavioral factor, mode of delivery, was found to be significantly associated with neonatal mortality in Nigeria when 'breastfeeding status' was not controlled (Table 3 C: Model IIIA). After making an adjustment for 'breastfeeding status' (Table 3 C: Model IIIB), mode of delivery lost its significance, leaving 'breastfeeding status' as the only health/behavioral predictor.

In their analysis of 2008 NDHS, Ezeh, Agho, Dibley, Hall, Page found NMR for singleton live-born infants to be 36.7 per 1000 live births.[2] In our analysis of 2013 NDHS, NMR for singleton live-born infants was found to be 33 per 1000 live births – a reduction of about 10% between 2008 and 2013. Birth interval, birth order, residence, maternal age, size of baby at birth, and mode of delivery were the identified predictors of neonatal mortality in the 2008 NDHS.[5] All of these factors, except birth order and maternal age, retained their predictive ability in the analysis of 2013 NDHS (Model IIIA only). Additional predictors were, however, found in our study as earlier reported (Model IIIA and Model IIIB).

Similarly, in the analysis of the trends of neonatal mortality in Nigeria from 1990 to 2013, Akinyemi, Bamgboye, Ayeni reported that residence, marital status, antenatal attendance, mode of delivery, gender of child, size of child at birth, birth interval, and maternal age were significantly associated with neonatal mortality based on the 2013 NDHS dataset.[3] Their findings agree with the results of our Model IIIA except for maternal age and antenatal attendance, which did not attain statistical significance in our study. These observed differences may be attributed to the number and range of variables investigated. Our study adjusted for several important variables that were missing in Akinyemi, Bamgboye, Ayeni.[3] For instance, while maternal BMI and literacy level were predictive of neonatal mortality in our study, they were not investigated in the work of Akinyemi, Bamgboye, Ayeni.[3]

Contrary to the results of a study in rural India, where socioeconomic factors explained a large portion of neonatal mortality, bio-demographic factors formed the bulk of predictors in our study.[13] And with adjustment for 'breastfeeding status', maternal literacy (the only significant socioeconomic factor) lost its significance. Also, granted that maternal BMI was predictive of neonatal mortality (with and without adjustment for 'breastfeeding status'), maternal obesity only assumed statistical significance when no adjustment was made for

'breastfeeding status'. An impressive body of evidence supports that maternal obesity is a significant risk factor for adverse neonatal outcomes, including mortality.[14] Our findings (Model IIIB) equally suggest that breastfeeding practice had eliminated the risk of neonatal death associated with maternal illiteracy and obesity.

Furthermore, our study found maternal underweight to be significantly associated with a reduced incidence of mortality in neonates. This protective role does not agree with the popular opinion in literature.[15,16] However, a mixed effect of maternal underweight on perinatal mortality has been reported.[17] Also, maternal underweight was found in a study to be protective against neonatal mortality in multiparous women, although, the result of the said study did not attain a statistical significance.[14]

Maternal education was not directly predictive of neonatal mortality as found in our study. However, maternal literacy – a function of education – was significantly associated with neonatal mortality if 'breastfeeding status' was not adjusted for (Table 3 A: Model IIIA). Studies have established a crucial association between maternal literacy/education and child survival.[18-20] Literate/educated mothers are more likely to have higher socioeconomic status, make better health choices as well as utilize appropriate medical/health care services.[21]

Our study further shows that newborns with small birth size were at a greater risk of mortality compared to those with large birth size. Also, preceding birth interval of less than two years was a significant risk factor for neonatal mortality. All of these findings are consistent with previous studies.[3,22] After making an adjustment for 'breastfeeding status', maternal age less than 20 years became a significant risk factor for neonatal mortality. Teenage mothers are known to be vulnerable to physical, and physiological immaturity.[23] These together with possible low socioeconomic status and educational attainment may predispose their neonates to adverse health conditions with consequences for mortality.[24]

Similarly, ethnicity assumed statistical significance following adjustment for breastfeeding status. While Hausa ethnicity was a significant risk factor, Igbo ethnicity was protective against neonatal mortality. Differences in sociocultural practices among the ethnic nationalities in Nigeria is a logical explanation for this finding. For instance, breastfeeding practice may be playing a role in the finding given that the effect was observed only when adjustment was made for 'breastfeeding status'. There is evidence that the rate of breastfeeding is low in the North-East and North-West zones of Nigeria, where Hausas are the majority compared to the South-East zone where Igbos are majorly found. [25] In addition, early or child marriage is especially common in northern Nigeria (where Hausas are majorly found) compared to the South-East zone.[26] Evidence in a recent study indicates that early marriage (age ≤ 19 years) has a strong association with preterm delivery and low birth weight, both of which are known risk factors for neonatal mortality.[27] Disparity in socioeconomic status and educational level is another possible explanation for the finding. For instance, in the North-East and North-West zones of the country (where Hausas are majorly found), about 70% of women and 50% of men are uneducated, while in the South-South zone, only 15% and 8% of women and men, respectively, are uneducated.[2]

Although maternal marital status was highly predictive of neonatal mortality; the results differ marginally with adjustment for breastfeeding status. When 'breastfeeding status'was not adjusted for, both divorce/separation as well as extramarital childbearing (without marital history) were risk factors for neonatal mortality. Following adjustment for 'breastfeeding status', extra-marital childbearing remained the only risk factor for mortality. This result (with no adjustment for 'breastfeeding status') agrees with a previous study in Nigeria.[3] However, a study in Ethiopia had a different finding.[28] The emotional and financial support that marital relationship affords, especially, in a developing country like Nigeria is a logical explanation for this result.

When no adjustment was made for 'breastfeeding status', caesarean delivery attained statistical significance as a risk factor for neonatal mortality. This result is consistent with the findings of Ezeh, Agho, Dibley, Hall, Page but contradicts that of a study in Egypt.[5,29] Caesarean section is a vital obstetric intervention and should ordinarily be a safer mode of delivery.[29] However, in Nigeria, it is not a popular choice. As revealed in Table 2 for this study, only 1.9% of mothers had caesarean delivery – signifying a low uptake of the intervention. Most instances of caesarean deliveries in the country were performed under emergency situation in women with life-threatening complications.[5] Emergency caesarean sections are associated with increased odds for neonatal mortality, and this possibly explains the Nigerian context.[30]

Ezeh, Agho, Dibley, Hall, Page suggested that the low uptake of caesarean section in Nigeria as equally observed in the analysis of 2008 NDHS was explained by unfounded fear and apprehension borne out of misconception for caesarean delivery.[5] Granted that this position is highly likely, it is equally true that caesarean section is considerably expensive in Nigeria and more unlikely to be within the reach of an average family.[31] Hence, the high cost of this obstetric intervention may be one of the major barriers to its uptake in Nigeria.

Our study found 'breastfeeding status' to be a highly significant predictor of neonatal mortality. A convincing body of literature supports the protective role of breastfeeding (particularly, early initiation and exclusive breastfeeding) against neonatal mortality.[32,33] Although breastfeeding initiation was not significant statistically in our study, the WHO's recommendation is for neonates to be initiated into breastfeeding within the first hour of

delivery, exclusively breastfed for the first six months of life and continued to be breastfed albeit with the introduction of appropriate complementary feeding for about two years.[34,35] As found in our study, breastfeeding modulated the effects of some of the variables on neonatal mortality. For instance, the risk of neonatal mortality associated with maternal illiteracy, maternal obesity, caesarean delivery, divorce/separation from spouse/partner (Model IIIA) all disappeared after making an adjustment for 'breastfeeding status' (Model IIIB).

This study leverage on some significant strengths. First, the dataset used is the latest and it is nationally representative. Thus, findings reflect the most current situations in Nigeria and are generalizable. Second, sampling weight was adjusted using the complex sample analysis approach. Hence, estimates and their 95% CIs are reasonably accurate and reliable. Third, the collection of data within a period of five years preceding the survey as done in NDHS reduces the incidence of recall bias. Fourth, possible influence of breastfeeding status was investigated by fitting models with and without adjustment for the variable. Lastly, missing data is relatively small and could not have significantly influenced the findings in this study. Some limitations, however, need to be taken into consideration when interpreting the results in this study. First, the risk of underestimation of NMR cannot be ruled out since only surviving women participated in the NDHS. Second, the study design in NDHS is cross-sectional, thus, it is limited in estimating the causal relationship between the outcome and the explanatory variables. Third, gestational age, a possible risk factor, was not investigated.

CONCLUSION

Socioeconomic, bio-demographic and health/behavioral determinants of neonatal mortality in Nigeria were examined. NMR was found to be 33 per 1000 live births indicating about 10% reduction from the rate in the 2008 NDHS. Intervention programs with a major focus on the risk factors identified in this study will further contribute to speeding up the reduction of neonatal mortality in Nigeria. Such programs would need to focus on neonates in general but give priority to the vulnerable groups – neonates of Hausas, neonates of obese mothers, neonates of teenage mothers, neonates of divorced/separated and single mothers as well as neonates in rural residence. Improved practice of breastfeeding, education of girl children and family planning need to be further prioritized and promoted. It is desirable that future studies will aim at exploring the causal relationship between neonatal mortality and socioeconomic, bio-demographic and health/behavioral factors.

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REFERENCES

1. UNICEF. Committing to Child Survival: A Promise Renewed, Progress Report. UNICEF. New York. 2014.
2. National Population Commission. Nigeria Demographic and Health Survey. Abuja: National Population Commission. 2014.
3. Akinyemi JO, Bamgboye EA, Ayeni O. Trends in neonatal mortality in Nigeria and effects of bio-demographic and maternal characteristics. BMC Pediatr. 2015;15:36.
4. Federal Ministry of Health. Saving newborn lives in Nigeria: Newborn health in the context of the Integrated Maternal, Newborn and Child Health Strategy. 2nd edition. Abuja: Federal Ministry of Health, Save the Children, Jhpiego. 2011.
5. Ezeh OK, Agho KE, Dibley MJ, Hall JJ, Page AN. Determinants of neonatal mortality in Nigeria: evidence from the 2008 demographic and health survey. BMC Public Health. 2014;14(1):521.
6. Merrill RM. Introduction to epidemiology. Jones & Bartlett Publishers. 2013.
7. Hosmer DW, Lemeshow S, Sturdivant RX. Model-building strategies and methods for logistic regression. Applied Logistic Regression, Third Edition. 2000:89-151.
8. Victora CG, Huttly SR, Fuchs SC, Olinto MTA. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. International journal of epidemiology. 1997;26(1):224-227.
9. WHO/UNICEF. Improved and unimproved water sources and sanitation facilities. 2012.
10. Reinhardt E. Fuel for life: Household energy and health. UN Chronicle. 2006;43(2):70-71.
11. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organization technical report series. 2000;894:i.
12. Upadhyay R, Dwivedi P, Rai S, Misra P, Kalaivani M, Krishnan A. Determinants of neonatal mortality in rural Haryana: a retrospective population based study. Indian pediatrics. 2012;49(4):291-4.
13. Kristensen J, Vestergaard M, Wisborg K, Kesmodel U, Secher NJ. Pre-pregnancy weight and the risk of stillbirth and neonatal death. BJOG: An International Journal of Obstetrics & Gynaecology. 2005;112(4):403-8.

14. Mittal S, Hall S. How Does Low Maternal BMI Affect Obstetric and Neonatal Outcome? Paper presented at: Bjog-An International Journal of Obstetrics and Gynaecology. 2013.
15. Sebire NJ, Jolly M, Harris J, Regan L, Robinson S. Is maternal underweight really a risk factor for adverse pregnancy outcome? A population-based study in London. British Journal of Obstetrics and Gynaecology. 2001;108(1):61-6.
16. Ezzati M. Comparative quantification of health risks: sexual and reproductive health. Vol 2: World Health Organization. 2004.
17. Basu AM, Stephenson R. Low levels of maternal education and the proximate determinants of childhood mortality: a little learning is not a dangerous thing. Social science & medicine. 2005;60(9):2011-23.
18. Zanini RR, Moraes ABd, Giugliani ERJ, Riboldi J. Contextual determinants of neonatal mortality using two analysis methods, Rio Grande do Sul, Brazil. Revista de Saúde Pública. 2011;45(1):79-89.
19. Ali S, Tahir C, Qurat-ul-ain N. Effect of maternal literacy on child health: Myth or reality. Ann. PIMS-Pak. Inst. Med. Sci. 2011;7:100-3.
20. Raghupathy S. Education and the use of maternal health care in Thailand. Social Science & Medicine. 1996;43(4):459-471.
21. Rutstein SO. 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. International Journal of Gynecology & Obstetrics. 2005;89:S7-S24.
22. Kozuki N, Lee AC, Silveira MF. The associations of parity and maternal age with small-for-gestational-age, preterm, and neonatal and infant mortality: a meta-analysis. BMC Public Health. 2013;13(3):S2.
23. Navot D, Drews M, Bergh P. Age-related decline in female fertility is not due to diminished capacity of the uterus to sustain embryo implantation. Fertility and sterility. 1994;61(1):97-101.
24. Agho KE, Dibley MJ, Odiase JI, Ogbonmwan SM. Determinants of exclusive breastfeeding in Nigeria. BMC pregnancy and childbirth. 2011;11(1):2.
25. Chukuezi C. Socio-cultural factors associated with maternal mortality in Nigeria. Research journal of social sciences. 2010;1(5):22-6.
26. Fall CH, Sachdev HS, Osmond C. 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). The Lancet Global Health. 2015.
27. Mekonnen Y, Tensou B, Telake DS, Degefie T, Bekele A. Neonatal mortality in Ethiopia: trends and determinants. BMC public health. 2013;13(1):483.
28. Seedhom AE, Kamal NN. Some determinants of neonatal mortality in a rural area, El-Minia governorate, Egypt, 2008. Egyptian Journal of Community Medicine. 2010;28(2).
29. Ugwu E, Obioha K, Okezie O, Ugwu A. A five-year survey of caesarean delivery at a Nigerian tertiary hospital. Annals of medical and health sciences research. 2013;1(1):77-84.
30. Oyewole WR, Umar A, Yayok RP, Shinaba ST, Atafo CI, Olusanya MO. An Evaluation of the Factors That Influences Caesarean Section in F.C.T Hospitals, Nigeria. Iosr, Journals. 2014.
31. Edmond KM, Zandoh C, Quigley MA, Amenga-Etego S, Owusu-Agyei S, Kirkwood BR. Delayed breastfeeding initiation increases risk of neonatal mortality. Pediatrics. 2006;117(3):e380-e386.
32. Huffman SL, Zehner ER, Victora C. Can improvements in breast-feeding practices reduce neonatal mortality in developing countries? Midwifery. 2001;17(2):80-92.
33. World Health Organization. Indicators for assessing infant and young child feeding practices part 3: country profiles. 2010.
34. Adewuyi EO, Adefemi K. Breastfeeding in Nigeria: a systematic review. Int J Community Med Public Health. 2016;3(2):385-96.
35. UNICEF, Committing to Child Survival: A Promise Renewed, Progress Report 2014. 2014. New York, USA: UNICEF, 2015.

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