ORIGINAL ARTICLE | NEONATAL MORTALITY

Determinants of Neonatal Mortality in Kenya: Evidence from the Kenya Demographic and Health Survey 2014

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ABSTRACT

Background: Globally, there has been a marked decline in neonatal mortality and overall child mortality indicators from 1990 to date. In Kenya, neonatal deaths remain unacceptably high, contributing to 40% of under-five mortality rates (U5MR) making it an important health priority. The objective of this study was to identify the determinants of neonatal mortality in Kenya. An understanding of the determinants of neonatal mortality will provide evidence for better interventions to reduce these deaths.

Methods: Neonatal deaths from singleton live-born infants were extracted from women's dataset collected for the 5-year period preceding the study published in the Kenya Demographic and Health Survey (KDHS), 2014. Data were obtained from 18,951 births. There were 356 neonatal deaths recorded. Data were weighted using an individual weighting factor to adjust for the study design and reduce sample variability. Data were analyzed using SPSS version 20.0. Logistic regression was conducted to adjust for confounding factors.

Results: Neonatal mortality rate was established at 19/1000 (95% CI:16.8-20.7). Mothers with no education had higher odds of experiencing deaths of neonates with adjusted Odds Ratio (aOR)=2.201, 95% CI: 1.43-4.15,p=0.049) compared to mothers with higher education. Low Birth Weight (LBW) neonates were 3.2 times likely to die in the first 28 days (aOR=3.206, 95% CI: 1.85-12.08, p=0.006) compared to neonates with >3.5 kilograms at birth. Mothers who did not attend ANC during pregnancy and those who attended between 1-3 ANC visits had higher odds of losing their infants (aOR=3.348, 95% CI:1.616-8.53, p=0.041, and aOR=2.316, 95% CI: 1.10-4.88, p=0.027) respectively, compared to mothers who attended >4 ANC visits.

Conclusion and Global Health Implications: Improving maternal health and nutrition during pregnancy should be enhanced to ensure adequate weight gain and reduce instances of low birth weight. Community referrals and follow-up for expectant women to take up the requisite 4 ANC visits should be encouraged. Girls' education should be emphasized to reduce the proportion of illiterate mothers.

Keywords: • Neonatal Mortality • Determinants • Low Birth Weight • Antenatal Care

1. Introduction

Neonatal mortality is defined as the death of a newborn within the first 28 days of life.[1] This period is the most vulnerable time for the child's survival. Neonatal mortality remains a significant public health problem worldwide and accounts for 60% of newborn deaths in middle- and lower-income countries (LMICs).[2] In 2017, 2.5 million children died in the first month of life globally.[2] Of these deaths, approximately one million infants died within the first week of life. Whereas there has been a recorded decline in neonatal deaths globally, the reduction of neonatal mortality is much slower compared to the other child mortality indicators among children between 1-11 months and those between 12-59 months.[2] The neonatal mortality rates fell by 51% from 37 deaths per 1000 live births in 1990 to 18 deaths per 1000 live births in 2017.[2] Disparities in neonatal deaths exist across the regions with 99% of neonatal deaths recorded in LMICs with Sub–Saharan Africa (SSA) and Southeast Asia (SEA) being the most affected. For countries to stay on track towards achieving Sustainable Development Goal (SDG) 2 on child mortality, the reduction of neonatal deaths must be prioritized.

In Kenya, the neonatal mortality rate (NMR) is 22 deaths per 1000 live births with the urban areas having a higher rate of 26 per 1000 live births compared to 21 deaths per 1000 live births in the rural areas.[3] Although Kenya has made positive progress in the overall childhood indicators over time, the country continues to lag in the neonatal mortality indicators which have only marginally reduced from 33 per 1000 live births in 2003[4] to 31 per 1000 live births in 2008/9[5] and 22 deaths per 1000 live births in 2014.[3] Whereas the Kenya government had established a health framework[6] that was aimed at reducing both neonatal and under 5 mortality rates, the reduction in childhood mortality, especially for children in the neonatal period have remained insignificant. As a result, Kenya may not realize its SDG targets on child mortality.

Common causes of neonatal mortality include pre-term birth complications, intrapartum growth restrictions, infections such as tetanus, low birth weight, congenital malformations and neonatal sepsis among other factors.[7,8,9] In addition, there exists a relationship between maternal health and neonatal survival. Poor maternal nutritional and health status has been linked to poor neonatal outcomes and this is influenced by determinants such as socio-economic, demographic and biological factors. Other maternal-related factors such as age and level of education have also shown significance in neonatal birth outcomes. For instance, cultural practices that restrict access to health facilities after birth have a negative influence on neonatal outcomes.[10] Ultimately, factors related to maternal health like essential antenatal care (ANC), access to emergency obstetric care, access to skilled attendance at birth, adequate maternal nutrition, postpartum care, neonatal care and early initiation of breastfeeding if adequately implemented can ensure neonatal survival. It is for this reason that the study seeks to establish the determinants of neonatal death with a focus on the nationally representative data from the KDHS 2014.

In this study, secondary data was obtained from the Kenya Demographic and Health Survey KDHS 2014 database with authorization from the DHS program, then analyzed to establish the determinants of neonatal mortality in Kenya.[3] The study conceptual framework was adopted from Mosley and Chen's framework for child survival and contextualized to the variables of interest in this study.[11,12,13,14] Risk factors associated with neonatal deaths include household socioeconomic status, place of residence, education levels, number of ANC visits, birth weights, place of delivery and birth order of the neonate.[15] The objective of the study was to determine factors associated with neonatal mortality using KDHS 2014 data.

2. Methods

2.1. Study Design

The Kenya Demographic and Health Survey (KDHS) is a nationally representative household survey that provides data for monitoring population indicators including population, health and nutrition. This data was collected by the Kenya National Bureau of Statistics in collaboration with the Ministry of Health, National AIDS Control Council (NACC),
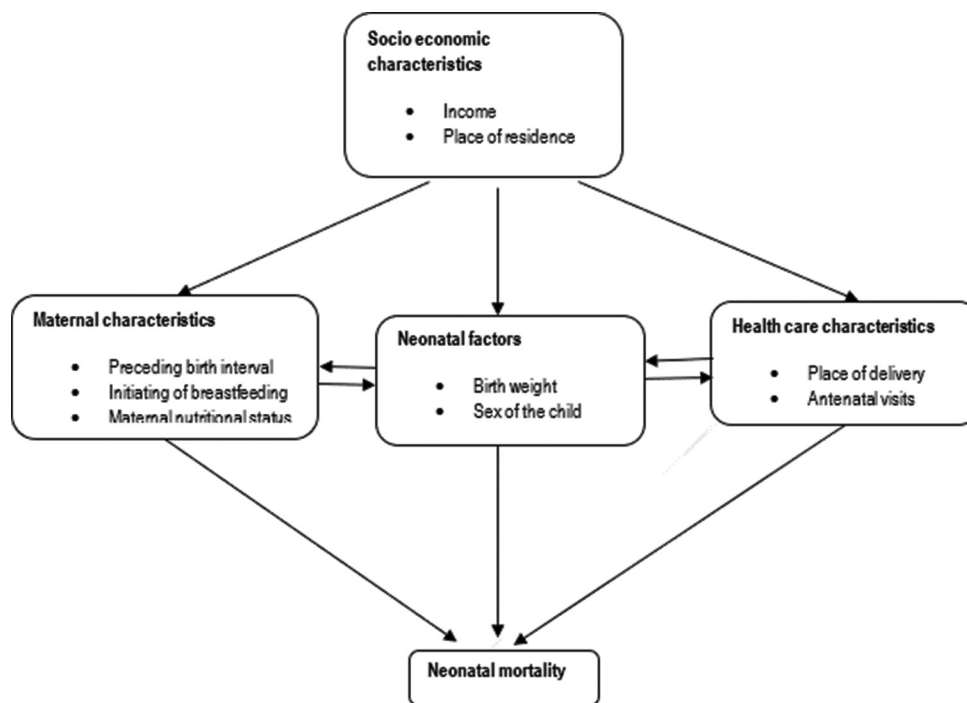
Figure 1: Conceptual framework for neonatal mortality
Source: Authors own work

National Council for Population and Development (NCPD) and Kenya Medical Research Institute (KEMRI). ICF Macro provided technical assistance for the survey through the DHS program. The sample design for the KDHS 2014 was drawn from the master sampling of the fifth National Sample Survey and evaluation program (NASSEP V).[3] KDHS is designed as a stratified 2 stage cluster design with the first sampling stage involving a random selection of 1,612 clusters from the NASSEP V spread across the country (995 in the rural areas and 617 in the urban areas). In the second stage, 25 households are randomly selected from each of the already selected enumeration areas (EAs). Data was collected using a structured household and women's questionnaire administered by an enumerator. The women's questionnaire collected information including the women's birth history, childhood mortality, fertility preferences, antenatal and post-natal care, place of delivery, childhood diseases and childhood vaccinations. Conceptual frameworks for analyzing child survival for developing countries have been used by other authors including the Mosley and Chen framework which has been widely used.[11,12,13,14] In this study, the conceptual framework based on the Mosley and Chen framework was developed to guide the potential explanatory variables (determinants) to neonatal mortality as shown in Figure 1.

2.2. Study Variables

The outcome variable for this study is neonatal deaths as reported by the mothers. It was defined as the death of a neonate between birth and 28 days of life. The variable took a binary form such that neonatal death was a success and coded as= 1 and neonatal survival in the 28 days was a failure and coded as=0. The variable was examined against the explanatory variables categorized into 4 categories i.e., socioeconomic and demographic characteristics, maternal characteristics, child

characteristics and health facility characteristics. The explanatory variables included in this study are in Table 1.

2.3. Statistical Analysis

Statistical analysis was done using SPSS V 20.0.[16] Descriptive statistics was used to explain the characteristics of the mothers and neonates captured in the study. Frequency distribution tables were used to present the descriptive statistics. Neonatal mortality was computed using the formula defined by Rutstein and Rojas[17] in the guide to analyzing demographic health surveys and the results presented in Table 2. Univariate and multivariate analyses were conducted to establish associations between the potential explanatory variables and the study outcome. Logistic regression models were fitted using SPSS regression functions.

Table 1: Variable names and definitions

Variable	Definition
Demographic characteristics	
Household income	0=Poorest 1 =poor, 2=Middle, 3=Richer, 4=Richest.
Place of residence	0=Urban, 1=Rural
Maternal characteristics	
Mothers' education	0=No education, 1=Primary, 2=Secondary, 3=Tertiary education or higher
Age at first birth	Age of the mother at the first birth 0=<19 years, 1=20-29 years, 2=30-39 years, 4= > 40 years.
	0=1st child, 2=2nd and 3rd child, 3=>4th child
Birth spacing	0=<2 years, 1=>2 years
Birth order	0=First child, 1=2 and 3rd child, 3>4th child
Initiation of breastfeeding	0=Immediately, 1=1hr-24 hours, 2=>24 hours
Child characteristics	
Sex of the child	0=Male, 1=Female
Birth weight	0=LBW, 1=Normal BW, 2=>Normal
Health service characteristics	
Place of delivery	0 Home, 1=Public and private hospital,
Number of ANC visits	0= None, 1=<1-3 ANC visits, 2=> 4 ANC visits

Table 2: Sociodemographic and Economic, Maternal, child and health service characteristics

Sociodemographic and economic	No of women	Percentage (%)
Household income		
Poor	8,418	44.4
Middle	3,385	17.9
Rich	7,149	37.7
Place of residence		
Rural	12,168	64.2
Urban	6,783	35.8
Maternal characteristics		
Mother's education		
No education	2,244	11.8
Primary	10,652	56.2
Secondary	4,485	23.7
Higher	1,571	8.4
Age at first birth		
<19 years	10,573	55.8
20-29 years	8,122	42.9
30-39 years	247	1.4
>40 years	9	0.
Birth spacing		
<2 years	3,003	21.6
>2 years	10,917	78.4
Initiation of breastfeeding		
Immediately after birth	4,207	68.2
>1 hour -24 hours	1,955	31.8
Child characteristics		
Sex of the child		
Male	9,601	50.8
Female	9,350	49.2
Birth weight		
Not weighed	3,021	33.6
<2.5 kg	372	5
2.5-3.5 kg	3,124	34.7
>3.5 kgs	2,447	26.7
Health service characteristics		
Place of delivery		
Home deliveries	7,159	38.3
Facility deliveries	11,524	61.7
Number of ANC visits		
No ANC visits	563	4
1-3 visits	5,419	38.2
>4 Visits	8,161	57.8

The weights used for the adjustment of the KDHS data are recommended in the guide to analyzing DHS statistics.[17] Odds Ratios (OR) and 95% confidence intervals (CI) were calculated to assess the adjusted risk factors that affected the study outcomes and those with p=0.05 were retained in the final model.

Approval to utilize data for this study was obtained from the DHS program, Rockville Maryland, USA. Approval was also obtained from Egerton University, Njoro, Kenya.

3. Results

3.1. Neonatal Mortality Characteristics

Table 2 presents a description and distribution of neonatal deaths across the explanatory variables. The study results show that 64.1% of the births occurred in rural areas whereas 35.9% occurred in urban areas. In addition, 11.9% of women had no education, 56.4% of women had primary education, 19.2% of women had secondary level education and 12.4% of the women had tertiary education. Regarding mothers' age, 46.8% were below 19 years, 50% were between 20-29 years and 2.6% were above 30 years as presented in Table 2.

Table 3 presents the total live births and Neonatal Mortality Rate (NMR) by socio-demographic and economic characteristics, maternal, child and health facility characteristics. We found that NMR was higher in rural areas than in urban areas (NMR:19.6 vs 17.4). Neonates born to poor mothers had a higher NMR compared to mothers from middle-class households (NMR: 20.6 vs 19.2). Neonates with low birth weight had a higher NMR compared to those with normal birth weight (NMR:45.7 vs 9.0). Mothers with a shorter interpregnancy interval < 2 years, had a higher NMR compared though those with interpregnancy intervals >2 years (NMR: 23.6 vs 15.9). Mothers who delivered at home experienced higher NMR compared to those who delivered at health facilities (NMR:19.3 vs 17.9). Mothers who did not attend any ANC at the time of their pregnancy had a higher NMR compared to those who attended between 1-3 visits and those who

Table 3: Neonatal mortality rates with 95% Confidence intervals

Variables	Neonatal deaths	Total births	NMR 95% C.I
Place of residence			
Urban	118	6,783	17.4(14.3-20.5)
Rural	238	12,168	19.6 (17.1-22.0)
Wealth			
Poor	168	8,418	20.6(16.9-23.0)
Middle			
Rich	65	3,385	19.2(14.5-23.9)
Mothers' education	124	7,149	17.3(14.3-20.4)
No education	45	2,244	20.1(14.2-25.9)
Primary	217	10,652	20.4(17.7-23.1)
Secondary	57	4,485	12.9 (9.4-16.0)
higher	37	1,571	23.6(16.0-31.1)
Mother's age			
< 19 years	24	983	24.4(14.6-34.2)
20-29 years	180	10,487	17.2(14.7-19.4)
30-39 years	115	6,212	18.5(15.1-21.9)
>40 years	38	1,271	29.9 (20.4-39.4)
Birth spacing			
<2 years	71	3,003	23.6 (18.1-29.1)
>2 years	174	10,917	15.9 (13.6-18.3)
Sex			
Male	185	9,601	19.3 (16.5-22.0)
Female	171	9,350	18.3 (15.5-21.0)
Birth weight			
Underweight	17	372	45.7(24.0-67.4)
Normal weight	28	3,124	9.0 (5.6-12.3)
Above N W	26	2,447	10.6 (6,5-14.7)
Not weighed at birth	79	3,021	26.2 (20.4-31.9)
Place of delivery			
Facility	206	11,524	17.9 (15.4-20.3)
Home	138	7,159	19.3 (16.1-22.5)
No. of ANC visits			
No ANC visits	24	563	42.6(25.6-59.7)
1-3 ANC visits	80	5,419	14.8 (11.5-18.0)
>4 ANC visits	87	8,161	10.7 (8.4-12.9)

N.W=Normal Weight

attended the requisite minimum of 4 ANC visits (NMR: 42.6 vs 14.8 vs 10.7).

Table 4: Logistic regression analysis of the determinants of neonatal mortality, KDHS 2014.

Variables	cOR	C.I	p-value	aOR	C.I	P value
Residence						
Rural (ref)						
Urban	1.005		0.971			
Wealth status						
Richest (ref)						
Poorest	0.741		0.191			
Poor	0.670		0.088			
Middle	0.927		0.763			
Rich	0.748		0.235			
Mothers' characteristics						
Mothers' education						
Higher (ref)						
No education	1.437	1.206-2.937	0.031*	2.202	1.43-4.15	0.049*
Primary	0.332		0.001*	0.809		0.256
Secondary	0.218		0.000*	0.039		0.128
Mother's age						
<19 years	0.841		0.807			
20-29 years	1.608		0.501			
30-39 years	0.803		0.753			
Birth spacing						
>2 years(ref)						
<2 years	1.001		0.997			
Birth Order						
> 4th child						
First child	1.451	1.011-2.083	0.043*	0.972		0.954
2nd or 3rd child	0.998	0.712-1.399	0.990	1.064		0.885
Child Characteristics						
Sex of the child						
Female (ref)						
Male	0.968		0.823			
Birth weight						
>NBW (ref)						
Not weighed	2.497	1.425-4.375	0.001*	2.662	1.004-7.058	0.049*
LBW	3.582	1.467-8.748	0.005*	3.206	1.849-12.08	0.006*
NBW	1.725		0.113	2.228	0.082-6.037	0.115
Health facility characteristics						
Place. of delivery						
Home (ref)						
Facility	0.761	0.761-1.028	0.075			
ANC visits						
>4ANCvisits (ref)						
No ANC visits	4.054	1.728-9.511	0.001*	3.384	1.616-8.53	0.041*
1-3ANC visits	1.704	1.102-2.634	0.017*	2.316	1.101-4.875	0.027*

cOR= Crude Odds ratio, aOR= p=Level of significance

3.2. *Factors Associated with Neonatal Mortality*

Logistic regression analysis was conducted in 2 stages as presented in Table 4. In the first step of the logistic regression model, each of the explanatory variables was entered individually into the regression model. The analysis showed that infants whose mothers had no education were 1.4 times more likely to die in the first 28 days compared to mothers with higher education levels Crude Odds Ratio (cOR)=1.44, 95% CI: 1.21-2.94, p=0.003. First-borns were 1.4 times more likely to die in the first month of life (cOR=1.43, 95% CI: 1.01- 2.08, p=0.043) compared to 4th order infants. Low birth weight infants (<2.5 kgs) were 3.5 times more likely to die (cOR=3.58, 95% CI:1.47- 8.75, p=0.005) compared to infants with a birth weight >3.5 kgs. Mothers who did not attend ANC clinic were 4 times more likely to experience deaths of their neonates (cOR=4.05, 95% CI:1.72-9.51, p=0.001) compared to mothers attending more than 4 visits. Infants of mothers who attended between 1-3 ANC visits were 1.7 times more likely to die (cOR=1.70, 95% CI: 1.10- 2.63, p=0.017) in the first month of life.

In the second stage logistic regression model, only the variables that were significant at the first analysis were entered in the final model. After adjusting for confounding factors, the mother's education, birth weight and the number of ANC visits were established to be significant determinants of neonatal mortality. Mothers with no education were 2.2 times more likely to lose their infants in the neonatal period compared to those with higher education levels Adjusted Odds Ratio (aOR=2.20, 95% CI: 1.43-4.15, p=0.049). Low birth weight infants were 3.2 times more likely to die in the neonatal period (aOR=3.21, 95% CI: 1.85-12.08, p=0.006) compared to those with >3.5 kgs at birth. Mothers who attended >4 ANC had a lower risk of experiencing neonatal mortality. Those who only attended between 1-3 ANC visits were three times more likely to lose their infants (aOR=3.35, 95% CI:1.62-8.53, p=0,041 in the first 28 days, compared to those with >4 ANC visits. Similarly, mothers who did not attend any ANC visits were twice as likely to experience neonatal deaths (aOR=2.32, 95% CI: 1.10-4.88, p=0.027) compared to mothers who attended >4 ANC visits.

4. Discussion

The overall aim of the study was to establish and identify the risk factors associated with neonatal mortality in Kenya using the nationally representative KDHS data. After adjusting for confounding factors, 3 factors were significantly associated with neonatal mortality and they have been discussed below.

Maternal education was significantly associated with neonatal mortality. Mothers with no formal education and those with primary level education had a higher likelihood of experiencing neonatal deaths compared to mothers with tertiary levels of education. These findings are consistent with previous literature which has demonstrated that higher levels of education are associated with better chances of neonatal survival.[18,19,20] The benefits of mothers' education have been shown to influence mothers' reproductive health choices and fertility preferences such as uptake of contraception, better health-seeking behaviors, better nutrition knowledge and practices that increase the likelihood of neonatal survival.[21]

This study also established that LBW infants have a higher likelihood of dying in the first 28 days of life. These findings are consistent with studies conducted in other parts of the world especially in Brazil and Ethiopia.[22,23,24,25] The increased likelihood of mortality in LBW infants may be linked to neonatal illness and lack of specialized care for the infants. In addition, increased risk of death is associated with low Apgar scores and congenital abnormalities that increase the risk of mortality.[26] Our study findings showed a significant relationship between the number of ANC visits and neonatal deaths. These findings are consistent with similar cross-sectional studies conducted in India, Nigeria and Uganda, which showed that women who did not take up maternal care during pregnancy had a higher odds of experiencing neonatal deaths. The benefits of early commencement of prenatal care are the detection of possible health concerns which are likely to result in complications for both the mother and the child. In addition, women who are consistent with their ANC appointments and received the requisite minimum of 4 ANC visits, were more likely to be healthy and more compliant to health recommendations as demonstrated by studies in India, Bangladesh and Ethiopia.[27,28,29,30]

4.1. Limitations

The strength and weaknesses of this study need to be considered when drawing conclusions and inferences. This study is a nationally representative survey with a 2-stage stratified sampling that presents generally representative data and findings. Limitations of this study should also be considered when drawing conclusions and interpretations of the results. KDHS collects data up to 5 years before the survey and recalls errors are a possibility especially on information related to neonatal mortality. Some variables such as birth weight had missing data and as such should be interpreted with caution. Information on the pregnancy-related complications and other underlying comorbidities that may influence pregnancy outcomes such as pre-existing health conditions before delivery was not available.

4.2. Recommendation for Further Studies

The findings from this study indicate the need to continuously educate the communities on the importance of girls' education. Whereas the Kenyan government is implementing free primary education, cultural inclinations, and practices such as female genital cutting predispose girls to early marriages, thus pushing them out of school.

The government of Kenya, through the community health strategy, should facilitate continuous sensitizations and referral mechanisms on the uptake and follow-up of prenatal care to at least meet the recommended threshold of a minimum of 4 visits.

5. Conclusion and Global Health Implications

This study intended to establish the determinants of neonatal mortality in Kenya in 2014. The findings from the analysis showed that mothers' level of education, birth weight and the number of ANC visits were significantly related to neonatal deaths. The findings of the study contribute to the body of knowledge toward the reduction of neonatal mortality and overall childhood mortality in the country and even globally.

Compliance with Ethical Standards

Key Messages

► Health service determinants such as the number of ANC visits a mother attended during pregnancy, maternal level of education and neonatal weight at birth have an influence on the neonatal outcomes.

► When mothers attend 4+ ANC visits during the prenatal period, their neonates have a higher chance of survival attributable to care received at the health facilities.

► Neonates born of uneducated mothers have an elevated risk of dying in the neonatal period 2.2 times higher than mothers who have primary, secondary and higher education levels.

► Low birth weight neonates were 3 times more likely to die compared to normal birth weight neonates.

► Multi-sectoral policy action that ensures community sensitization to increase uptake of antenatal care, promotion of basic education and improved health and nutrition is crucial in the realization of reduction in neonatal deaths.

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