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ORIGINAL ARTICLE

Determinants of Infant Mortality in Southeast Nigeria: Results from the Healthy Beginning Initiative, 2013-2014

Samantha A. Slinkard, BA;[1] **Jennifer R. Pharr,** PhD;[1]✉ **Tamara Bruno,** MPH;[1] **Dina Patel,** MSN;[1] **Amaka Ogidi,** MEd;[2] **Michael Obiefune,** MBBS;[3] **Echezona E. Ezeanolue,** MD, MPH[1]

[1]University of Nevada, Las Vegas, School of Community Health Sciences. 4505 S. Maryland Pkwy, Las Vegas, NV 89154, USA; [2]Research Resource Centre, University of Nigeria, Enugu, College of Medicine. University Road, 410001, Nsukka, Enugu State, NIGERIA; [3]Institute of Human Virology, University of Maryland School of Medicine. 655 W. Balitimore St, Balitimore, MD 21201, USA

✉Corresponding author email: jennifer.pharr@unlv.edu

ABSTRACT

Background: Neonatal mortality due to preventable factors occurs at high rates throughout sub-Saharan Africa. Community-based interventions increase opportunities for prenatal screening and access to antenatal care services (ANC) services. The Healthy Beginning Initiative (HBI) provided congregation-based prenatal screening and health counseling for 3,047 women in Enugu State. The purpose of this study was to identify determinants for infant mortality among this cohort.

Methods: This was a prospective cohort study of post-delivery outcomes at 40 churches in Enugu State, Nigeria between 2013 and 2014. Risk factors for infant mortality were assessed using chi square, odds ratios, and multiple logistic regression.

Results: There were 2,436 live births from the 2,379 women who delivered (55 sets of twins and one set of triplets), and 99 cases of neonatal/early postneonatal mortality. The neonatal mortality rate was 40.6 per 1,000 live births. Risk factors associated with neonatal mortality were lack of access to ANC services [OR= 8.81], maternal mortality [OR= 15.28], caesarian section [OR= 2.47], syphilis infection [OR= 6.46], HIV-positive status [OR= 3.87], and preterm birth [OR= 14.14].

Conclusions and Global Health Implications: These results signify that culturally-acceptable community-based interventions targeted to increase access to ANC services, post-delivery services for preterm births, and HIV and syphilis screening for expectant mothers are needed to reduce infant mortality in resource-limited settings.

Key words: Infant Mortality • Neonatal Mortality • HIV, Antenatal Care • Nigeria • Healthy Beginning Initiative

1. Introduction

Neonatal mortality due to preventable factors occurs at high rates throughout sub-Saharan Africa. It is estimated that in 2015, 2.8 million infants died during the neonatal period (the first twenty-eight days of life) worldwide.[1] While many developing

countries successfully attained significant reduction in their maternal and child mortality rates per the Millennium Development Goals 4 and 5, Nigeria faces many challenges in reducing its infant mortality rate.[1] Nigeria's population of over 167 million represents roughly 2.3 percent of the global population, yet the country contributed nearly ten percent of the 2.8 million neonatal deaths which occurred in 2015.[2, 3] Nigeria's national infant mortality rate (death during the first year of life) in 2013 was 74.3 per 1,000 live births.[4] The most recent National Demographic and Health Survey (NDHS) data from Nigeria estimates that the average neonatal mortality rate (NMR) was 37 deaths per 1,000 live births between 2009 and 2013.[2, 5] The NMR has remained consistent between 1990 and 2013 based on retrospective analysis of the NDHS results.[2] Several individual and community-level determinants have been identified as being associated with neonatal mortality in developing countries including Nigeria. These factors include socioeconomic status, infant birth weight, birth spacing, maternal health status, and access to and usage of antenatal care.[2,6,7]

This study assessed neonatal/early postneonatal mortality during the *Healthy Beginning Initiative* (HBI), a cluster randomized trial conducted between January 2013 and August 2014 in Enugu state, Nigeria. The main objectives of the HBI trial were to test the effectiveness of the congregation-based program on increasing confirmed HIV testing and ART uptake among pregnant women and their male partners.[8] The HBI Baby Shower trial successfully increased prenatal screening for the women and their male partners, but there were also cases of neonatal/early postneonatal and maternal mortality during the study period. The purpose of our study was to determine the maternal factors associated with neonatal/early postneonatal mortality for this population based study of women and their infants.

2. Methods

The protocol and outcomes for material, paternal, and infant HIV screening and linkage to care for HBI have been previously published.[8-11] In short, HBI leveraged high church attendance and a wide distribution of faith-based institutions to recruit over 3,000 women from 40 Christian churches to participate in the study, in either the intervention group (IG, n=20 churches) or the control group (CG, n=20 churches).[8] Participants in the IG were screened for HIV, malaria, Hepatitis B (Hep. B), and sickle cell trait (SCT) during a Baby Shower held at the church prior to delivery while participants in the CG were encourage to go to the nearest health facilities for testing and linkage to care (standard of care) at the Baby Shower. Additionally, at the Baby Shower, participants were encouraged to attend the Baby Reception which occurred six to eight weeks post-delivery. At the Baby Reception, participants in the CG were offered HIV, malaria, Hepatitis B (Hep. B), and sickle cell trait (SCT) screening.[8] The women in both groups completed post-delivery questionnaires at the Baby Receptions which included demographic, antenatal care, and delivery questions, and all women were followed for six to eight weeks post-delivery.

This was a prospective cohort study of data collected between January 2013 and August 2014 during HBI in Enugu State, Southeast Nigeria. A total of 3,047 records were collected, reviewed, and collated prior to analysis. These records represent self-reported pregnant women who were enrolled in the study and who delivered or experienced pregnancy loss (miscarriage or stillbirth) during the study period. To be included in analysis, the records had to have evidence of a delivery. All records that had incomplete postnatal data and records that indicated a pregnancy loss prior to delivery were excluded from analysis. The remaining maternal records were expanded to have individual records for each infant delivered during the study period.

Neonatal and early postneonatal mortality was estimated by all recorded live births for this cohort. Due to the short follow-up period (six to eight weeks post-delivery), infant mortality analysis is restricted to neonatal and early postneonatal survival. Using Statistical Package for the Social Sciences (SPSS) 23, descriptive statistics, cross tabulations, and univariate logistic regression were applied to this cohort to identify potential determinants for infant mortality.[12] Variables which produced significant chi-square and odds ratios (ORs) were entered into multiple logistic regressions. The study was approved by the Institutional Review Board of the University

of Nevada, Reno, and the Nigerian National Health Research Ethics Committee.

3. Results

There were 2,436 live births from the 2,379 women who delivered, including 55 sets of twins and one set of triplets. Of the 2,436 live births, there were ninety-nine cases of neonatal/early postneonatal mortality. For both the IG and the CG, there was a neonatal mortality rate of 40.6 per 1,000 live births. In addition to neonatal deaths, there were eight recorded maternal deaths, which occurred during delivery (n=6), pregnancy (n=1), or outside the postpartum period at six months postdelivery (n=1). The mean age at enrollment in the study for the women in our sample was 29.27 years.

Data for numerous maternal determinants for mortality were available for analysis. Table 1 includes the characteristics of the sample and chi-square analysis to determine significant differences between the women who experienced infant mortality and the women who did not. Women that experienced infant mortality were significantly more likely to have fewer children, have not received ANC, delivered prematurely, delivered a low birth weight infant, have been positive for syphilis and HIV, and have died intrapartum/postpartum.

Table 2 presents ORs for dichotomous variables. Women who did not initiate ANC and attend at least one appointment were 8.8 times more likely to experience infant mortality than those who accessed ANC (95% CI 3.39 – 22.85). Caesarian delivery was also a significant determinant for infant mortality as infants delivered via C-section were 2.5 times more likely to die than those birthed vaginally (95% CI 1.39 – 4.39). Infants born to mothers who died

Table 1: Descriptive characteristics of the study participants

Variable	Neonatal/early postneonatal mortality				Total		Chi square (p-value)
	Yes		No				
	N	%	N	%	N	%	
Marital Status							1.26 (0.74)
Married	91	91.9	2184	93.5	2275	93.4	
Single	8	8.1	140	6.0	148	6.1	
Divorced/separated	0	0.0	13	0.5	13	0.5	
Education							0.31 (0.96)
None	2	2.0	34	1.5	36	1.5	
Primary	25	25.5	573	24.6	598	24.6	
Secondary	56	57.1	1345	57.7	1401	57.7	
Tertiary	15	15.3	379	16.3	394	16.2	
Employment status							3.57 (0.17)
Unemployed	46	47.4	881	38.0	927	38.4	
Part Time	19	19.6	568	24.5	587	24.3	
Full Time	32	33.0	868	37.5	900	37.3	
Distance to health facility							2.63 (0.27)
0-5km	28	28.6	822	35.3	850	35.1	
5-10km	44	44.9	871	37.4	915	37.7	
10+km	26	26.5	633	27.2	659	17.1	
Number of ANC visits							0.48 (0.79)
Only one	1	1.1	21	0.9	22	0.9	
Less than four	9	10.0	180	8.0	189	8.1	
More than 4	80	88.9	2037	91.0	2117	90.9	

(Contd...)

Table 1: (*Continued*)

Variable	Neonatal/early postneonatal mortality				Total		Chi square (p-value)
	Yes		No				
	N	%	N	%	N	%	
Received ANC							28.88 (<0.01)
No	6	6.1	17	0.7	23	0.9	
Yes	93	93.9	2320	99.3	2413	99.1	
Gestation							45.57 (<0.01)
Full term	81	93.1	2290	99.5	2371	99.2	
Preterm	6	6.9	12	0.5	18	0.8	
Weight classification							45.00 (<0.01)
Normal	28	87.5	1369	90.2	1397	90.0	
Low	3	9.4	68	4.4	71	4.6	
High	1	3.1	82	5.4	83	5.4	
Maternal outcome							24.23 (<0.01)
Mother alive	88	96.7	2241	99.8	2329	99.7	
Mother dead	3	3.3	5	0.2	8	0.3	
Malaria							0.83 (0.36)
Yes	70	98.6	1771	99.4	1841	99.4	
No	1	1.4	10	0.6	11	0.6	
Syphilis							7.18 (<0.01)
Yes	2	2.8	8	0.4	10	0.5	
No	69	97.2	1782	99.6	1851	99.5	
HIV							13.45 (<0.01)
Yes	8	10.7	59	3.0	67	3.3	
No	67	89.3	1914	97.0	1981	96.7	
Sickle cell							0.49 (0.48)
Yes	18	25.4	389	21.8	407	22.0	
No	53	74.6	1392	78.2	1445	78.0	
Hepatitis B							2.19 (0.15)
Yes	6	8.5	83	4.6	89	4.8	
No	71	91.5	1708	95.4	1862	95.2	
	Mean		Mean		Mean		P value
Maternal age at enrollment	29.27		29.02		29.03		0.68
Number of live children	2.08		3.04		3.01		<0.01

intrapartum/postpartum were 15.28 times more likely to die than those born to mothers who survived (95% CI 3.59 – 64.95). Additionally, infants born preterm were 14.1 times more likely to die than those carried full-term (95% CI 5.18 – 38.61).

Maternal infection status during pregnancy was an important measure throughout the HBI study period. Our analysis found that syphilis infection and positive HIV serostatus were significant risk factors for infant mortality (Table 2). Infants born to mothers who had syphilis were 6.5 times more likely to die than those born to mothers without syphilis (95% CI 1.35 – 30.97). Infants born to HIV+ mothers were 3.9 times more likely to die than those born to HIV- mothers (95% CI 1.78 – 8.43).

Table 2: Determinants of neonatal/early postneonatal mortality among the HBI cohort – univariate analysis to calculate odds ratios (OR)

Variable	Odds Ratio	OR confidence interval
Education level (none vs primary – tertiary)	1.40	0.33 – 5.90
Employment status (unemployed vs employed)	1.47	0.98 – 2.21
Distance to health facility	0.97	0.61 – 1.53
Mother received ANC (no vs yes)	8.81	3.39 – 22.85
Maternal outcome (died vs lived)	15.28	3.59 – 64.95
Mode of delivery (C-section vs vaginal)	2.47	1.39 – 4.39
Gestation (preterm vs full-term)	14.14	5.18 – 38.61
Maternal malaria infection	0.40	0.05 – 3.13
Maternal syphilis infection	6.46	1.35 – 30.97
Maternal hepatitis B infection	1.90	0.80 – 4.51
Maternal HIV+serostatus	3.87	1.78 – 8.43

Bold indicates significant variables (p<0.05).

Multiple logistic regression analysis was conducted to predict infant mortality using variables that were significant in univariate regression (Table 3). Of the seven variables entered into regression models, five remained statistically significant predictors for infant mortality. Mothers who died intrapartum ($p<0.05$), delivered preterm ($p<0.05$), were positive for syphilis ($p=0.02$) and HIV ($p=0.04$), and had fewer children ($p<0.05$) were more likely to experience infant mortality.

Table 3: Results of multiple logistic regression analysis predicting infant mortality for significant univariate variables

Variable	B	p-value
Mother received ANC (no vs yes)	1.50	0.09
Maternal outcome (died vs lived)	4.29	<0.01
Mode of delivery (c-section vs vaginal)	0.63	0.10
Gestation (preterm vs full-term)	2.93	<0.01
Maternal syphilis infection	2.16	0.02
Maternal HIV+serostatus	1.06	0.04
Number of living children	0.48	<0.01

Bold indicates significant variables (p<0.05).

4. Discussion

This study found several risk factors for infant mortality. HBI provided prenatal testing for HIV, other infectious diseases, as well as genetic diseases for pregnant women. Despite greater rates of testing and linkage, there were still cases of neonatal/early postneonatal mortality among both the IG and the CG, with a neonatal/early postneonatal mortality rates of 40.6 per 1,000 live births. This rate is similar to neonatal and postneonatal mortality rates published for Nigeria between 2009 and 2013 as well as rates specific to Southeast Nigeria which were 37 and 45, respectively.[5] By comparison, the regional neonatal mortality rate for sub-Saharan Africa was 29 per 1,000 live births in 2015.[13]

Antenatal care (ANC) provided by skilled healthcare providers (doctors, nurses, etc.) exposes women to important health counseling for themselves and their children and provides an opportunity for early screening for health problems that could compromise the pregnancy and the long-term health of the mother and child.[14, 15] Lack of initial access to ANC was an important factor that increased mortality among the infants in this study. The new 2016 World Health Organization ANC guideline recommends a minimum of eight antenatal care visits, compared to the previous recommendation of four visits, beginning in the first twelve weeks of pregnancy.[5,16] Unfortunately, early initiation of antenatal care services is low in Nigeria. Per the 2013 NDHS, with 34% of women do not receiving ANC, and only 18% of women who receive ANC do so in the first trimester of pregnancy.[5] This low rate of initiation is due to several individual

and community-level factors, including the age of the mother, parity, and socioeconomic status. Additionally, pregnant women in rural areas are less likely to initiate ANC with 47% of rural women in Nigeria receiving no ANC.[5]

Birthweight in term and preterm infants is a predictor of mortality in neonates.[17] In this study, infant birthweight, classified as low (<2.5kg), normal (2.5kg – 4.5 kg), and high (>4.5kg), was found to be a significant determinant of neonatal mortality. A majority of the low birthweight infants (87.5%) died during the neonatal period. This result is consistent with findings in other studies conducted in resource-limited settings and developed countries.[17-19] Low birthweight infants are more susceptible to infections and other health problems (physical and mental), placing them at greater risk of mortality and chronic morbidity when compared to healthy weight neonates.[17, 18]

In addition to ANC initiation, maternal infection status was a risk factor for infant mortality. This finding reinforces the continued need for prenatal testing and early infant diagnosis (EID) for this population to protect against infant mortality related to HIV/AIDS, Hep B, syphilis, and malaria. Maternal syphilis and HIV increased the likelihood of mortality among infants born to mothers who were found to be positive for either of these infections.

Population-based studies have certain strengths which make them valuable sources of mortality data and estimations. HBI recruited from churches throughout Enugu state, providing data from a diverse study population. Population-based studies produce data that are representative of various socioeconomic statuses, health statuses, and other social determinants of health such as cultural values. The data utilized for analysis for this study is representative of the Christian population living in Enugu state, Nigeria. The NMR for this study population was slightly higher (40.6 per 1,000 live births) than the average national neonatal mortality rate (37 per 1,000 live births) measured between 2009 and 2013. This study found several risk factors that placed infants born to this population at risk of mortality within their first month of life. Through recognizing these risk factors, as well as variables influenced by cultural values, future interventions can be targeted to address this specific population's needs.

Studies conducted in resource-limited settings presents unique challenges to researchers. For this study, the greatest limitation was the unavailability of clear and complete records. More than 500 of the 3,048 available records were excluded from analysis due to incomplete post-delivery records. This limitation decreased our sample size and may have produced falsely significant results, especially for the maternal infection results. Additionally, women who experienced infant mortality may have decided not to attend the Baby Reception, so there may be an under-reporting of infant mortality. Some information on the post-delivery questionnaire was self-reported, which may have resulted in self-report bias.

5. Conclusion and Global Health Implications

These results indicate that targeted interventions to increase ANC are needed in Nigeria and other countries with low ANC initiation, as mothers who did not receive ANC had a greater risk of neonatal/early postneonatal mortality. ANC programs should provide screening for HIV and syphilis for expectant mothers so that treatment can be started prior to delivery. Post-delivery services for preterm births and post-delivery care for mothers at greatest risk for mortality are needed to reduce infant mortality in resource-limited settings including Nigeria. The congregation-based HBI program successfully increased prenatal screening for the women because it was accepted by the community. Similarly, interventions to increase ANC and post-delivery care should be culturally-acceptable and community-based. Future research should continue to identify and address gaps in ANC coverage and infectious disease screening. In addition, future research should explore other risk factors for pregnancy loss, including miscarriages.

Compliance with Ethical Standards

Conflict of Interest: *The authors declare no conflict of interest.* ***Funding:*** *The research was co-funded*

Key Messages

- Antenatal care initiation early in pregnancy can help reduce neonatal mortality.
- Programs like the Healthy Beginning Initiative that improve infectious disease screening and linkage to care among pregnant women may reduce infant mortality due to infectious disease in resource-limited settings.
- Post-partum care for mothers and neonates should be more accessible in rural and resource-limited settings to reduce neonatal mortality.
- Infectious disease screening during pregnancy should remain a priority in rural and resource-limited settings.

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