Neonatal Mortality and Maternal/Child Health Care in Nigeria: An Impact Analysis

EWERE, F; EKE, DO

Department of Statistics, University of Benin, Benin City, Nigeria
*Corresponding Author Email: friday.ewere@uniben.edu

ABSTRACT: Reducing the rate of mortality in neonates to as low as 12 per 1,000 live births is one of the clearly spelt out aims of the third tenet of the Sustainable Development Goals (SDG) because of its importance to the dynamics of population. While there have been various studies focused majorly on the causes, rates and determinants of neonatal mortality in Nigeria, studies on the impact of maternal/child care characteristics on neonatal mortality and the potential implication of failing to attain the SDG target for neonatal mortality have seemingly been neglected. In this study, we undertake an analysis of the impact of maternal / child care characteristics on neonatal mortality using the logistic regression model. Results from the study showed that antenatal care (P-value = 0.000, odds ratio = 0.546 for women who visited the hospital during pregnancy on more than 5 occasions), postnatal care (P-value = 0.004, odds ratio = 0.402 for women who received early neonatal care from skilled medical personnel), place of delivery (P-value = 0.000, odds ratio = 0.592 for babies that were delivered in a government hospital) and skill of birth attendant (P-value = 0.000, odds ratio = 0.706 for babies who were delivered by trained doctors/nurses/midwives) had significant impact on neonatal mortality at the 95% confidence level implying that improved maternal health care: before, during and immediately after delivery as well as the quality of care to mother and child are both important and necessary to the reduction of neonatal mortality in Nigeria. To achieve the sustainable development target for neonatal mortality, it is therefore recommended that stakeholders in the public health sector improve the quality of existing health care facilities and access to quality services.

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Neonatal mortality which is the absence of all traces of life in a live birth between birth and the first 28 days of life (World Health Organization (WHO), 2011) is one of the glaring targets of the Sustainable Development Goals (SDG) because of its importance to the dynamics of any population and the role that it plays as a barometer for the measurement of social economic and demographic development (Hall, 2005). Although there have been significant progress globally in the fight against childhood mortality, neonatal mortality still maintained significantly high rates with neonatal mortality contributing nearly 50% of all mortality in children under the age of five globally and about two thirds of infant mortality (Akinyemi et al., 2015). In 2018, 5.3 million children died before their fifth birthday with a staggering 2.5 million of those childhood death (47%) occurring in the first month of life (United Nations Inter-agency Group for Childhood Mortality Estimation (UN-IGME), 2019). Whist the 2.5 million deaths of neonates globally represents progress relative to the number of neonatal mortality in 1990 which was about 5 million babies, efforts to further reduce its occurrence and accelerate progress in preventing child deaths should be considered urgent and intensified as an alarming 7000 neonates still die daily of preventable causes/illness as recently as 2018. (National Population Commission (NPC), 2018). On current trends, over 24 million babies will die in the first month of their lives between 2019 and 2030 which is approximately 2.2 million preventable annual neonatal deaths (UN-IGME, 2019). Most of these neonatal deaths occur in low and middle income countries with the highest number of occurrence recorded in south-central Asian countries and the highest rates generally in sub-Saharan Africa. (UNICEF, 2018). In Nigeria, it is unbelievably sad to know that the number of neonates that still die of preventable/treatable causes and diseases as at the year 2020 is as high as 38 per 1,000 live births (UN-IGME, 2019). The feeling that we have repeated failed the next generation and the new born is made even truer by the fact that there have not been any substantial changes in neonatal mortality in the last decade (40 deaths per 1,000 live births in 2008 versus 39 deaths per 1,000 live births in 2018) (National Population Commission (NPC), 2018; National Bureau of Statistics (NBS), 2018). This alarmingly high frequency with which new born babies die do not only

*Corresponding Author Email: friday.ewere@uniben.edu
put the country at risk of failing to achieve the sustainable development target of childhood mortality, it can also spell serious consequences for the future of our beloved nation (Ewere and Eke, 2020; Eke and Ewere 2020). It is therefore both important and imperative that researchers monitor the progress of this target in Nigeria.

According to Lancet (2018), three quarters of neonatal deaths usually occurs in the first week of life with the first day of birth representing the highest risk of neonatal death. Most of these newborns death are caused by preterm birth, severe infections, asphyxia, maternal complications in labour and birth injuries resulting from poorly managed labour and lack of emergency obstetrics service and can be prevented by reaching high coverage of quality antenatal care, skilled care at birth, postnatal care for mother and baby, and care of small and sick newborns. (Hall, 2005; Titaley et al., 2012). Given the possible impact that neonatal mortality could potentially have on population dynamics, life expectancy and under-five mortality rates as well as on the mothers of the deceased babies, there is need for studies that focuses on the link between maternal/child health care during and after pregnancy and neonatal mortality. However, studies on neonatal mortality have seemingly suffered neglect in favour of under-five mortality. Most indigenous researchers in the field of child survival studies who have carried out researches in neonatal mortality have often tended to focus on health facility-based regional mortality rates and trends using data obtained from tertiary health facilities subject to selection bias (Bangboye and Familusi, (1990); Njokanma, (1995); Adimora and Odetunde, (2007); Odu, (2008); Omoigborale et al., (2010); Adedini, (2014)). Others who have used national representative survey have tended to focus on the determinant and trends of neonatal mortality (Akinyemi et al., (2015); Usman et al., (2019)). Therefore, the objective of this paper is to report the study on the impact of maternal / child care characteristics on neonatal mortality using the logistic regression model.

MATERIAL AND METHOD
Study Area: This paper is focused on Nigeria. Nigeria which is the most populous country in Africa is divided into 36 states and a Federal Capital Territory (FCT), grouped into six geopolitical zones; North Central, North-East, North-West, South-East, South-South, and South-West.

Data Source: The study utilized data obtained from the Nigeria Demographic and Health Survey (NDHS) for 2018 for its analysis. The survey used a two stage cluster design for the selection of its respondent and collected primary information about households including sexual and reproductive health histories from women between the ages of 15 and 49 for the five years preceding 2018. For the purpose of this study, the child recode data which contains all follow-up information on all children born to the interviewed women within five years preceding the survey is used.

Variables
Outcome variables: The outcome variable for this study is neonatal mortality. The dataset was cleaned and the age at death variable imputed in days, weeks and months was recoded and used to obtain all deaths within the neonatal period (first month of life) for all children born to the interviewed women.

The Explanatory variables: The explanatory (independent) variables included in this study based on the objective of the study are:

Mode of delivery = MoD; Care at Birth = CaB; Post Natal Care = PnC; Number of Antenatal Visit = NaV;
Size of child at birth = ScB; Caesarean Section Decision Timing = CsDT and Place of Delivery = PoD. Data cleaning, manipulation and analysis were performed using SPSS software version 22.

Statistical Analysis: In the 2018 NDHS survey, 41,821 women participated and 33,924 children were born to the women within five years preceding the survey. Of the 33,924 children born to the interviewed mothers, 1,278 children died within the first 28 days of life (neonatal period). All analysis in this study was based on the survivorship of the 33,924 children within the first month of their lives. The analysis of the study based on the selected maternal/ child health care characteristics, was conducted in three stages. First, the univariate analysis was conducted to obtain information on the background characteristics of the women in Nigeria relative to the appropriate explanatory variables and the summary of the frequency distribution displayed in Tables 1-7. Next, the bivariate relationship between maternal/child health care characteristics and neonatal mortality was obtained using the chi-square test of association to determine the significant bivariate correlation between the risk factors of the selected maternal/child health care characteristics and the outcome variable (neonatal mortality). Subsequently an analysis of the estimates of neonatal mortality rate by the selected mother’s health/childcare related characteristics in Nigeria were obtained. The third stage of the study’s statistical analysis was conducted to determine the extent to which all the variables had an impact on neonatal mortality in Nigeria dependent on each other’s presence using the binary logistic regression model.
The logistic regression test performed using the SPSS software at 5% significance level reports the odds ratio, confidence interval and statistical significance (P-value) which broadened insights on the impact of mother and child health care during and immediately after delivery on neonatal mortality in Nigeria.

The single variable logistic regression model is given by:

$$P(Y = 1|X) = f(x) = \frac{\exp(\beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_nX_n + \mu)}{1 + \exp(\beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_nX_n + \mu)}$$  \hspace{1cm} (3)

Where $n$ is the number of independent variables. The logit transformation for the multiple logistic regression is given by:

$$\lambda = \beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_nX_n + \mu$$  \hspace{1cm} (4)

Thus, the regression model is given by

$$f(x) = \frac{e^\lambda}{1 + e^\lambda}$$  \hspace{1cm} (5)

The odds ratio of neonatal mortality which is the relative risk of the occurrence of neonatal mortality is a measure of the probability of success $P(y = 1)$ to the probability of failure $1 - P(y = 0)$ and is given by

$$\frac{p}{1 - p}$$  \hspace{1cm} (6)

The logit of the logistic regression model to test the significant effect of maternal/child care characteristics on the outcome variable (neonatal mortality) for this study is given as

$$\lambda = \beta_0 + \beta_1MoD + \beta_2CaB + \beta_3PnC + \beta_4NalV + \beta_5ScB + \beta_6CsDT + \beta_7PoD + \mu$$  \hspace{1cm} (7)

and the logistic regression model is given as

$$Y_{neo} = \frac{\exp(\beta_0 + \beta_1MoD + \beta_2CaB + \beta_3PnC + \beta_4NalV + \beta_5ScB + \beta_6CsDT + \beta_7PoD + \mu)}{1 + \exp(\beta_0 + \beta_1MoD + \beta_2CaB + \beta_3PnC + \beta_4NalV + \beta_5ScB + \beta_6CsDT + \beta_7PoD + \mu)}$$  \hspace{1cm} (8)

where $y$ is the outcome variable and it is referred to as the logistic transformation of probability of neonatal mortality occurring. $\beta_0$ is the intercept representing the probability of occurrence of the neonatal mortality in the absence of all the underlying factors. $\beta_1, \ldots, \beta_7$ are the odds ratios of neonatal mortality occurring. The "$\mu$" is the error term.

RESULTS AND DISCUSSION

Table 1 shows the frequency distribution of the 'mode of delivery' determinant of neonatal mortality. A total of 33,778 children born to the interviewed women representing 99.6% of the children born to the interviewed women within the five years preceding the NDHS 2018 were reported. This differs from the 33,924 of the children born to the interviewed women. This difference could be as a result of missing values or non-response from the interviewed mothers. From Table 1, 97.0% of the women delivered their babies normally while 2.6% of the interviewed mothers gave birth to their babies via a Caesarean Section. Table 2 displays the frequency distribution of the number of antenatal visits by the interviewed mothers prior to the delivery of their babies for the five years preceding the 2018 NDHS. Table 2 reveals that more than half of the women interviewed did not visit the hospital for antenatal care before the delivery of their babies. This could be as a result of the fact that most of the women interviewed were from rural communities who did not have ready access to hospitals, clinics and government owned health centres. Only 21.4% of the interviewed mothers visited the hospital on five or more occasions. The frequency distribution of the sizes at birth of children born to the interviewed women for the five years preceding the 2018 survey is shown in Table 3. Over half of the children given birth to were average sized babies with only about 14% of the babies recorded to be small sized babies. The size of the baby could also potentially determine the weight at birth.
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Table 4 is a display of the frequency distribution of the timing on the decision for giving birth via a CS. A total of 879 children were reported to have been given birth to via CS. This represents 2.6% of the total number of children given birth to in the five years preceding the NDHS for 2018.

Table 1. Frequency distribution of live births by the mode of delivery

| Mode of Delivery | Frequency | Percentage |
|------------------|-----------|------------|
| Normal Delivery  | 32,899    | 97.0       |
| Caesarean Section| 879       | 2.6        |
| Total            | 33,778    | 100.0      |

Table 2: Frequency distribution of the number of antenatal visit

| Number of Antenatal Visit | Frequency | Percentage |
|---------------------------|-----------|------------|
| None                      | 17,224    | 52.5       |
| Below 5                   | 19,317    | 56.1       |
| 5 and above               | 2,277     | 6.4        |
| Total                     | 33,818    | 100.0      |

Table 3: Frequency distribution of size of child at birth

| Size of child at birth | Frequency | Percentage |
|------------------------|-----------|------------|
| Large                  | 11,725    | 35.2       |
| Average                | 17,351    | 51.7       |
| Small                  | 4,372     | 13.5       |
| Total                  | 33,558    | 100.0      |

The decision of timing is an important determinant of neonatal mortality and is closely related to antenatal visits. Mothers who frequently made the antenatal care trip to the hospital were more likely to know if they could give birth normally or would require a CS. From the total of 879 babies delivered via CS, 499 babies representing 56.77% were given birth to after their mothers had entered into labour only to discover that they could not give birth normally. The frequency distribution of the place of delivery as a maternal health care determinant of neonatal mortality is displayed in Table 5. From the table, 19,949 babies were given birth to at home accounting for approximately 59% of the total number of babies born to the interviewed mothers for the 2018 NDHS. Government owned health centers accounted for most of the babies given birth to in the hospital with only 12.2% given birth to in private hospitals.

Table 5: Frequency distribution of place of delivery

| Place of Delivery  | Frequency | Percentage |
|--------------------|-----------|------------|
| Home               | 19,949    | 58.8       |
| Public Government Hospital | 9,365   | 27.6       |
| Private Hospital   | 4,123     | 12.2       |
| Total              | 33,818    | 100.0      |

Table 4: Frequency distribution of caesarean section decision timing

| Caesarean Section Decision Timing | Frequency | Percentage |
|----------------------------------|-----------|------------|
| Before Labour Started            | 380       | 43.23      |
| After Labour Started             | 499       | 56.77      |
| Total                            | 879       | 100.0      |

Table 5: Frequency distribution of place of delivery

| Place of Delivery | Frequency | Percentage |
|-------------------|-----------|------------|
| Home              | 19,949    | 58.8       |
| Public Government Hospital | 9,365 | 27.6       |
| Private Hospital  | 4,123     | 12.2       |
| Total             | 33,818    | 100.0      |

Table 6: Frequency distribution of ‘care at delivery’

| Car at Birth | Frequency | Percentage |
|--------------|-----------|------------|
| Trained Doctors / Nurses / Midwives | 6,947   | 94.8       |
| Community Health Workers | 352   | 4.8        |
| Traditional Birth Attendant | 29   | 0.4        |
| Total        | 7,328     | 100.0      |

Table 7: Frequency distribution of ‘post natal care’

| Post Natal Care | Frequency | Percentage |
|-----------------|-----------|------------|
| Skilled         | 3,365     | 74.3       |
| Semi-skilled    | 355       | 7.8        |
| Unskilled       | 811       | 17.9       |
| Total           | 4,531     | 100.0      |

Table 7 displays the frequency distribution of postnatal care for the babies given birth to for the five years preceding the 2018 NDHS. Of the 33,924 babies, only 4,531 accounting for a paltry 13.4% were given postnatal care. This relatively low number of babies receiving postnatal care relative to the number of babies born to the interviewed mothers partly explains the averagely high number of neonatal mortality in Nigeria. From Table 7, a total of 3,365 babies representing 74.3% received postnatal care from skilled personnel. Table 8 is a summary of the results of cross tabulation analysis carried out between the selected maternal/child care characteristics and neonatal mortality using Pearson chi-square test of association. Table 8 shows that there exists a strong bivariate relationship between each of the selected maternal/child care characteristics and neonatal mortality with each independent variable having P-value < 0.05. The percentage of the number of babies that died within the first 28 days of life based on the “care at birth” variable were 2.1%, 2.3% and 0% for the deliveries that were carried out by trained medical personnel with only 29 babies representing 0.4% being attended to by traditional birth attendants.
doctors/nurses, auxiliary nurses and traditional birth attendants respectively. A possible explanation for the 0% neonatal mortality by traditional birth attendants could be that most of victims of inexperienced traditional birth attendants were not captured in the course of the survey. However, most women who patronize the services of traditional care attendants usually fall into the category of those who may never have visited the hospital for antenatal care and as a result may never know of any underlying health challenge that could lead to complications during child delivery. The ‘mode of delivery’ as an independent variable also showed significant bivariate relationship with neonatal mortality ($P$-value = 0.000) with an associated 3.8% and 7.3% mortality rate for babies who were delivered normally and via CS respectively. The number of antenatal visits by pregnant and expectant mother prior to the delivery of their babies is a maternal care characteristic that also showed significant bivariate relationship with neonatal mortality. It was also a factor that could possibly influence the timing of the decision to undergo caesarean section with both variables having an associated $P$-value of 0.000 and 0.029 respectively indicating a significant bivariate association. Table 9 displays the estimates of neonatal mortality rates in Nigeria for the five years preceding the 2018 survey and their confidence intervals based on the selected maternal/child care characteristics. From Table 9, neonatal mortality rates were significantly lower for babies that were given birth to normally with about 92% neonatal mortality increase for babies who were delivered via caesarean section. A possible reason for the substantial neonatal mortality increase could be due to the fact that a greater number of respondents made the decision to deliver their babies via caesarean section after they had gone into labour allowing little or no time for the delivery care attendant, doctors, nurses or midwife to carry out all the necessary CS procedures. This late CS decision timing which is closely related to the number of visits during antenatal resulted in about 34% increase in neonatal mortality relative to mothers who took the decision of a CS before entering into labour. Mothers who visited the hospital during pregnancy for antenatal on 5 or more occasions experienced 50% less neonatal mortality rates compared to mothers who did not go for any antenatal care prior to the delivery of their babies. Given the fact that most neonatal death occurs in the first week of life, with the first day being the most vulnerable, it therefore comes as no surprise that babies who were given Early Neonatal Care (ENC) by skilled attendants experienced 60% less neonatal mortality compared to babies who received post natal care from unskilled attendants. The neonatal mortality estimate for the size of the child at birth shows that babies who were small at birth experienced about 50% more neonatal mortality compared to those babies who were large in size.

Table 8: Bivariate Relationship between Maternal/Child care characteristics and neonatal mortality

| Maternal/Child care characteristics | Neonatal Mortality | $P$-value |
|------------------------------------|--------------------|-----------|
| Care at Birth                      |                    |           |
| Trained Doctors / Nurses / Midwives| Yes: 143           | No: 6803  |           |
| Auxiliary Nurses / Community Health Workers | 8 | 344 | 0.022 |
| Traditional Birth Attendant        | 0                  | 29        |           |
| Mode of Child Delivery             |                    |           |
| Normal Delivery                    | 1216               | 31683     |           |
| Caesarean Section                  | 66                 | 818       | 0.000     |
| Post Natal Care                    |                    |           |
| Skilled                            | 27                 | 3337      |           |
| Semi-skilled                       | 4                  | 351       |           |
| Unskilled                          | 16                 | 795       | 0.000     |
| Number of Antenatal Visit          |                    |           |
| None                               | 855                | 16969     |           |
| Below 5                            | 229                | 8624      |           |
| 5 and above                        | 194                | 7032      | 0.000     |
| Size of child at birth             |                    |           |
| Large                              | 376                | 10899     |           |
| Average                            | 347                | 17005     |           |
| Small                              | 296                | 4276      | 0.000     |
| Caesarean Section Decision Timing  |                    |           |
| Before Labour Started              | 22                 | 357       |           |
| After Labour Started               | 38                 | 461       | 0.029     |
| Place of Delivery                  |                    |           |
| Home                               | 723                | 19226     |           |
| Public Government Hospital         | 369                | 8995      |           |
| Private Hospital                   | 160                | 3963      | 0.036     |

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The place of delivery and care at birth showed only marginal difference in neonatal mortality rates with 41, 38 and 40 as estimates for babies who were delivered at home, public hospitals and private hospitals respectively. The neonatal mortality estimates of 21, 23 and 25 are for babies who received care at birth from trained health care personnel, auxiliary nurses/community health workers and Traditional birth attendants respectively. All the neonatal mortality estimates were calculated at 95% confidence interval.

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Conclusion: This study applied the logistic regression model to examine the impact of maternal/child care characteristics on neonatal mortality in Nigeria. Findings from this study revealed that antenatal care, place of delivery, mode of delivery and the skill of birth attendants were statistically significant determinants of neonatal mortality implying that improved maternal health care before, during and immediately after delivery is essential to the reduction of the seemingly static neonatal mortality rates in Nigeria.

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