# SOCIO - ECONOMIC DETERMINANTS OF NEONATAL MORTALITY IN NIGERIA

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## ABSTRACT

*This study examines the determinants of Neonatal Mortality in Nigeria from 2000 to 2022, utilizing Auto Regressive Distributed Lag (ARDL)models to analyse the long and short-run relationships between neonatal mortality and some socioeconomic factors. The findings revealed a significant long-run relationship between neonatal mortality, healthcare expenditure, and Access to water. The long-run coefficients shows that a 1% increase in healthcare expenditure results in a 0.017% increase in neonatal mortality, but not statistically significant. While in the short run, the same increase leads to a 0.025% decrease. The error correction mechanism (ECM) reveals a coefficient of 0.946, indicating the speed of adjustment back to the long-run equilibrium at 94.6% of the disequilibrium in neonatal mortality within one year. These results underscore the critical role of healthcare investment, access to water and sanitation, in reducing neonatal mortality in Nigeria. The study highlights the need for integrated policy approaches to improve neonatal health outcomes in Nigeria by increasing health spendings and ensuring judicious use of it.*

**Keywords***:* Determinants, Neonatal Mortality, Infant Mortality, Health Expenditure, Access to water.

## 1.0 Introduction

Neonatal mortality is defined as the death of a child between zeros to 28 days (National Population Commission 2018), Neonatal mortality which is the absence of all traces of life in a live birth between the birth and the first 28 days of life. According to World Health Organization (WHO 2023), Neonatal deaths have decreased by 44% since 2000. Yet in 2022, nearly half (47%) of all deaths in children under 5 years of age occurred in the neonatal period (the first 28 days of life), which is among the most vulnerable periods of life and requires intensified quality intrapartum and neonatal care. (WHO, 2023).

Moreover, in 2018, 5.3 million children died staggering 2.5 million of those childhood deaths occurring in the first month of life (United Nations Inter-Agency Group for Childhood Mortality Estimation (UNCEF, 2019). While the 2.5 million deaths of neonatal globally represents progress relative to the number of neonatal mortalities 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 (NPC, 2018). However, by 2025 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, 2022).

However, in 2022 sub-Saharan Africa accounted for 57% (2.8 million) of total under-five deaths but only 30% of global live births. Sub-Saharan Africa had the highest neonatal mortality rate in the world at 27 deaths per 1000 live births, followed by central and southern Asia, with a neonatal mortality rate of 21 deaths per 1000 live births. Premature birth, birth complications (birth asphyxia/trauma), neonatal infections and congenital anomalies remain high, insufficient Health care expenditure, access of water are the leading causes of neonatal deaths. Children who die within the first 28 days of birth suffer from conditions and diseases associated with lack of quality care at birth or skilled care and treatment immediately after birth and in the first days of life. Women who receive midwife-led continuity of care (MLCC) provided by professional midwives, educated and regulated to internationals standards, are 16% less likely to lose their babies and 24% less likely to experience a pre-term birth. (WHO, 2023).

In the realm of neonatal mortality, numerous studies have delved into the multifaceted factors influencing this critical issue. These investigations have explored various dimensions, including maternal health, healthcare access, and environmental conditions. However, despite the extensive body of research, certain key aspects remain notably underrepresented in the current literature. Specifically, the influence of parents' income, mother's level of education, proximity to health care facility and religious beliefs on neonatal mortality has received limited attention.

Studies by Odjesa (2021) and Anokwuru (2023) have highlighted the connection between socio-economic factors and neonatal health outcomes, few have thoroughly examined the direct impact of parents' income on neonatal mortality rates. Similarly, although maternal education has been broadly associated with improved child health outcomes, the intricate relationship between a mother's level of education and neonatal mortality has not been extensively explored.

Furthermore, religious beliefs, as a socio-cultural determinant, can significantly shape healthcare-seeking behaviours and decision-making processes within families. Yet, scanty research exists on how religious beliefs and practices might contribute to or mitigate neonatal mortality risks. Understanding these intricate dynamics is crucial for crafting targeted interventions that resonate with diverse communities.

This research seeks to bridge these gaps by investigating the nuanced connections between parents' income, mother's education, religious beliefs, and neonatal mortality. By addressing these neglected facets, this study aims to provide a comprehensive understanding of the factors that contribute to neonatal mortality and pave the way for more tailored strategies to reduce neonatal mortality rates.

The objective of the study is to investigate the impact of health care expenditure, access to water and sanitation on neonatal mortality in Nigeria.

## 2.0 Literature Review

This Demand for health model was developed by Michael Grossman (1972) as an explanation of the demand for health and health care. He constructed a model of the demand for health in terms of better health and solved the complex problems concerning the optimization of the health life cycle, the gross investment for each period, and the consumption of health care, which are seen as derived demands for health. His model concentrated more on health and investment in health, enabling a thorough understanding on the role of several variables such as age, education, and income in health production through the demand for health capital. In Grossman’s model, health is treated as an endogenous variable that people could improve through consumption and production. In addition, health is also considered to be a capital stock because it depends on time or the age of an individual and it is said to depreciate as people age. In the concept of health, the production function is health inputs such as health care, diet, environment, income, time, and other variables together with health capital stock over time in order to produce good health.

According to WHO 2020, Neonatal mortality refers to deaths of children, from zero to 28 days. It is measured by the infant mortality rate (IMR), which is the number of deaths of children from zero to 28 days per 1,000 live births. The leading causes of neonatal mortality are birth asphyxia, pneumonia, term birth complications, neonatal infection, and malaria. Many factors contribute to neonatal mortality, such as the mother's level of education, environmental conditions, political and medical infrastructure. Improved sanitation, access to clean drinking water, immunization against infectious diseases and other public health measures can help to reduce high rates of neonatal mortality.

Moreover, Maureen, 2006 opined that Neonatal mortality rate was an indicator used to monitor progress towards the Fourth Goal of the Millennium Development Goals of the United Nations for the year 2022. It is now a target in the Sustainable Development Goals for Goal Number 3 ("Ensure healthy lives and promote wellbeing for all at all ages", WHO, 2016). The rate for a given region is the number of children dying in less than one month, divided by the number of live births during the year, Multiplied by 1,000.

In the words of Ojikutu, (2018). Neonatal mortality refers to death of neonate in the first 28 days of life. Early neonatal mortality refers to death before seven days and late neonatal mortality is death on days 7 -28. The specific neonatal mortality rate by birth weight refers to the number of neonatal deaths of a determined weight per 1000 live births of the same birth weight. Perinatal mortality is the sum of early neonatal and late fetal mortality. Prematurity refers to a gestational age of less than 37 weeks or 258 completed days. Added to the problems of definition is the lack of unanimity in diagnosis of the cause of death. Child health is seen as a key indication of socioeconomic progress (Rahman et al, 2022).

Chukwuemeka et al., (2020) examined the drivers of under-five mortality rate and health human capital in sub-Saharan African (SSA) countries between the periods of 1995 to 2020 using the dynamic panel vector autoregressive (PVAR) technique, anchored on the theoretical framework of Grossman health production function. The result revealed that per capita income was positively related to under-five mortality rate while electricity consumption was negatively but significantly related to under-five mortality rate.

Similarly, Carlos, et al., (2020) examined Insights on neonatal mortality. The study evaluates the NMR in the city of São Paulo - Brazil, in the period between 2012 and 2017, considering as a determinant for neonatal mortality rate if the delivery has occurred on private or on public health service sphere. A dataset having 8,110 neonatal deaths was analysed and three graphics were created. The first one is used to assess information regarding the distribution of births by health service sphere and mother's age. The second brings information on births and neonatal mortality rates combined and compared by year and by health service sphere. Finally, in the last one births and rates are also combined and compared by year, health service sphere, but now are desegregated by mother's age group.

Another study carried out by Zamboni et al., (2021) on the effect of collaborative quality improvement on stillbirths, neonatal mortality and neonatal care practices in hospitals of Telangana and Andhra Pradesh, India. They aimed to evaluate programme effects on implementation of maternal and neonatal care practices, and impact on stillbirths, 7- and 28-day neonatal mortality rate in labour wards and neonatal care units. Using a quasi-experimental plausibility design with a nested process evaluation, they evaluated effects on stillbirths, mortality and secondary outcomes relating to adherence to 20 evidence-based intrapartum and neonatal care practices, comparing survey data from 29 hospitals receiving the intervention to 31 hospitals expected to receive the intervention later, using a difference-in-difference analysis. The result shows that only 7 of the 29 intervention hospitals were engaged in the intervention for its entire duration. There was no evidence of an effect of the intervention on stillbirths [DiD − 1.3 percentage points, 95% CI − 2.6–0.1], on neonatal mortality at age 7 days [DiD − 1.6, 95% CI − 9–6.2] or 28 days [DiD − 3.0, 95% CI − 12.9—6.9] or on adherence to target evidence-based intrapartum and neonatal care practices.

Patel et al., (2021) examined the changes in neonatal and infant mortality rates in Nigeria over the period 1990 to 2018 using Nigerian Demographic and Health Survey (NDHS) data, and they assess their socio-demographic determinants using data from the most recent survey conducted in 2018. Based on their study infant mortality rate was 87 per 1000 live births in 1990, and this increased to 100 per 1000 live births in 2003 – an increase of around 15% over 13 years. Also, the study shows that neonatal and infant mortality rates started to decline steadily thereafter and continued to do so until 2013. After 2013, neonatal morality rose slightly by the year 2018. Information for 27,465 infants under 1 year of age from the NDHS-2018 was analysed using bivariate and multivariate analysis and the Cox proportional hazard technique. In 2018, infant deaths decreased as wealth increased, and the incidence of infant deaths was greater among those of Islam religion than among those of other religions. A negative association was found between infant deaths and the size of a child at birth. Infant mortality was higher in rural than in urban areas, and was higher among male than female children. Both neonatal and infant death rates varied by region and were found to be highest in the North West region and lowest in the South region.

Das et al. (2021) examined the role of place of delivery in preventing neonatal and infant mortality rate in India. They examine the role of place of delivery with respect to neonatal and infant mortality in India using four rounds of the Indian National Family Health Survey conducted in 2015–2016. The place of birth has been categorized as "at home" or "public and private institution." The role of place of delivery on neonatal and infant mortality was examined by using multivariate hazard regression models adjusted for clustering and relevant maternal, socio-economic, pregnancy and new-born characteristics. There were 141,028 deliveries recorded in public institutions and 54,338 in private institutions. The estimated neonatal mortality rate in public and private institutions during this period was 27 and 26 per 1000 live births respectively. The study shows that when the mother delivers child at home, the chances of neonatal mortality risks are higher than the mortality among children born at the health facility centers. Regression analysis also indicates that a professionally qualified provider′ s antenatal treatment and assistance greatly decreases the risks of neonatal mortality. The results of the study illustrate the importance of the provision of institutional facilities and proper pregnancy in the prevention of neonatal and infant deaths.

## 3.0 Methodology

The study will utilize the annual time series data to determine the relationship between the dependent variable; neonatal mortality and independent variables; health care expenditure and access to water. The data span the period 2000 - 2022. The data will be obtained from the World Bank Databank. The study employs Autoregressive Distributed Lag (ARDL) Pesaran & Shin (1999) Modelling Process. To examine the long-run relationship between health care expenditure and neonatal mortality. The model by (Narayan, 2005 which provides efficient and unbiased estimation even if the sample size employed is small will be employed. This study will estimate the following models to determine the long-run relationship:

$$\Delta lnY_t = \alpha_i + \sum_{i=1}^{n} \delta_i \, \Delta lnX_{t-1} + \sum_{j=1}^{m} \beta_j \, lnX_{t-1} + \varepsilon_{it} \dots \dots \dots \dots (3.4)$$

Where: X = (HEX & ACW),

## 3.1 Model Specification

This section presents the different models that will be used to achieve the objectives of this study. For this research work, the functional model follows the Grossman model (1972) as also used by Eriamiatoe, (2022) as follows:

$NM_t = F$ (HEX, ACW) ……………………………………… (3.5)

Where $NM^t$ = neonatal mortality, HEX is health care expenditure and access to water).

i = (1,2,… ,3)

j = (1,2,…,3)

t=time

The long-run and short-run causal relationship among the variables is determined using the following equations.

$$\Delta NM_t = \beta_{0t} + \beta_{1j} NM_{t-j} + \beta_2 HEX_{t-j} + \beta_2 \, ACW_{t-j} + \sum_{t=0}^{m} \delta_k \Delta NM_{t-j} + \sum_{l=0}^{n} \xi_p \, \Delta HEX_{t-j} + \sum_{w=0}^{o} \vartheta_{\varpi} \, \Delta ACW_{t-j} + \varphi ECT_{t-1} \dots \dots \dots (3.8)$$

Where the variables are as defined earlier in this section. In each case, for long-run causality to occur the coefficient of error correction term must be significantly negative.

## 4.0 Results and Discussion

Table 1. Descriptive Statistics

| STATISTICS | NM | HEX | ACW |
|---|---|---|---|
| **Mean** | 38.930 | 72.814 | 18.815 |
| **Median** | 37.800 | 69.762 | 18.329 |
| **Maximum** | 46.400 | 207.391 | 28.985 |
| **Minimum** | 34.800 | 17.652 | 13.725 |
| **Std. Dev** | 3.284 | 38.535 | 3.979 |
| **Skewness** | 0.894 | 1.589 | 1.258 |
| **Kurtosis** | 2.815 | 7.744 | 4.448 |
| **Jarque-Bera** | 3.099 | 31.245 | 8.080 |

Source: 2024 Authors' computation using EViews 10

Table 1 above presents a summary and analysis of the descriptive statistics for various determinants of neonatal mortality. The variables considered include neonatal mortality rate, healthcare expenditure and access to water. Each variable is analyzed in terms of its central tendency, dispersion, and shape of distribution.

The mean neonatal mortality rate is 38.930, with a relatively small standard deviation of 3.283, indicating limited variation among observations. The distribution is moderately skewed to the right (Skewness = 0.894), suggesting a few higher values. The kurtosis value (2.814) is close to 3, indicating a distribution similar to a normal distribution. Healthcare expenditure has a mean of 158.836 and a relatively high standard deviation of 35.254, showing greater variability. The distribution is significantly left-skewed (Skewness = -1.482), indicating a concentration of higher values with fewer low outliers. The kurtosis is 4.406, indicating a leptokurtic distribution with more extreme values.

The mean access to water is 18.814, with a standard deviation of 3.979. The distribution is right-skewed (Skewness = 1.258), indicating a few higher values. The kurtosis value (4.447) indicates a leptokurtic distribution with more extreme values. Adolescent fertility has a mean of 119.785 and a standard deviation of 12.139. The skewness is negative (-0.550), suggesting a concentration of higher values with fewer low outliers. The kurtosis value (1.697) indicates a platykurtic distribution with fewer extreme values.

The descriptive statistics provide valuable insights into the characteristics of the determinants of neonatal mortality. Most variables show moderate skewness and kurtosis values, indicating varying degrees of asymmetry and peakedness in their distributions. Healthcare expenditure and access to water exhibit significant skewness and kurtosis, suggesting the presence of extreme values.

Table 2. Result for Unit Root Test: ADF and PP

| | ADF | | PP | |
|---|---|---|---|---|
| **Variables** | **Atlevel I(0)** | **At 1st Diff I (1)** | **At Level I (0)** | **At 1st Diff I (1)** |
| **ACW** | -2.129 | 0.857 | -1.173 | **5.828**** |
| **HEX** | -2.596 | -5.071*** | -2.596 | **-5.071***** |
| **NM** | -1.255 | -3.212** | -5.058*** | **-1.079** |

Source; Authors computation using Eviews10

The unit root test results reveal that the majority of the variables exhibit non-stationarity at the level. The Augmented Dickey-Fuller (ADF) test indicates that health care expenditure, and neonatal mortality are non-stationary at the level, but become stationary after first differencing (p-value < 0.05). This suggests that these variables have a unit root and require appropriate transformation to address this issue. The Phillips-Perron (PP) test, which is more robust to heteroskedasticity, yields similar results for access to water, indicating that they are non-stationary at the level but become stationary after first differencing (p-value < 0.05).

Table 3: ARDL Bound Test for the Long Run Relationship

| **Critical value bounds of the F-statistics: $F_{NM}$ (HEX, ACW)** | | | | | | |
|---|---|---|---|---|---|---|
| **F-stat** | 1% critical value | | 5% critical value | | 10% critical value | |
| 5.582** | 1(0) | 1(1) | 1(0) | 1(1) | 1(0) | 1(1) |
| | 5.155 | 6.265 | 3.2538 | 4.428 | 2.915 | 3.695 |

Note: ** represent significance level at 5%. The critical values are based on the underlying data for N = 30 due to the small sample size of the study.

From the result on table 4 above, there is long-run relation between the variable (Neonatal mortality, health care expenditure, access to water). As the value of the F – Statistic is greater than the upper bound and the lower bound at 1%, 5% and 10% level of significance. The long-run relationship between neonatal mortality, healthcare expenditure, access to water reveals that investing in healthcare infrastructure and services can lead to improved health outcomes, reduced neonatal mortality rates, and ultimately, derive economic growth.

Table 4; Long Run Coefficients for Model I: NM = HEX, ACW

| Variables | Coefficient | Std-Error | T-Stat | Probability |
|---|---|---|---|---|
| HEX | 0.171 | 0.031 | 5.484 | 0.002 |
| ACW | -0.421 | 0.060 | -6.972 | 0.000 |

Source: Authors Computation Using Eviews10

The result on table 4 above shows that 1% increase in health care expenditure will lead to 0.171% increase in Neonatal mortality in the long run. This outcome is in line with previous studies (such as Usman, 2024; Adeosun 2020) who found that increase Health care expenditure increases neonatal mortality, but got a long run relation between neonatal mortality and Health care expenditure and also health care expenditure possesses a positive correlation with neonatal mortality due to the institutional corruption bedeviling the system.

For Access to water, the coefficient shows that 1% increase in ACW will leads to 0.421% decrease in neonatal mortality in the long run. These findings underscore the significance of water supply in reducing neonatal mortality in Nigeria, and the result is statistically significant at 5% level of significant.

Table 5: Short Run Coefficients for Model I: NM = HEX, ACW

| Variables | Coefficient | Std-Error | T-Stat | Probability |
|---|---|---|---|---|
| **D(LACW)** | -0.025 | 0.007 | -3.433 | 0.040 |
| - | - | - | | - - |
| **CointEq(-1)** | -0.132 | 0.025 | -5.207 | 0.000 |
| **R-Squared** | 0.946 | | | |
| **Adjusted R-Squared** | 0.936 | | | |
| **Durdin-Watson Stat** | 2.998 | | | |

Source: Author's computation using EViews 10

The results of the analysis revealed a statistically significant negative relationship between access to water and neonatal mortality in the short run. Specifically, the coefficient of -0,025 indicates that a 1% increase in access to water is associated with 0.025% decrease in Neonatal mortality. This relationship is significant at the 5% significance level.

The error correction mechanism (ECM) reveals a coefficient of 0.946, indicating the speed of adjustment back to the long-run equilibrium. This implies that approximately 94.6% of the disequilibrium in neonatal mortality is corrected within one year. In other words, when neonatal mortality deviates from its long-run equilibrium, the model adjusts rapidly, with nearly 95% of the adjustment occurring within a single period. The model's goodness of fit measures, R-squared (0.946) and Adjusted R-squared (0.936), indicate an excellent fit, explaining around 94% of the variation in neonatal mortality. The Durbin-Watson statistic (2.998) confirms no significant autocorrelation, supporting the reliability of the results.

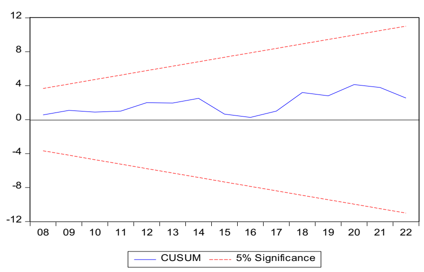
Table 6: Diagnostic Test

| Test Statistics | Chi-square/LM Test | Probability Value |
|---|---|---|
| **Model I** | | |
| **Serial Correlation** | 2.532 | **0.106** |
| **Functional Form** | 0.918 | **0.355** |
| **Normality** | 4.558 | **0.102** |

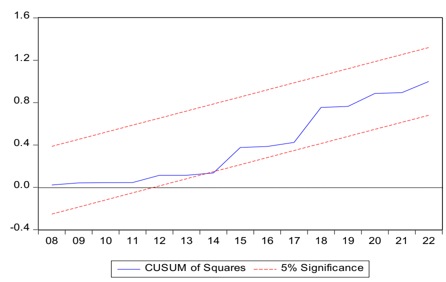
| | | |
|---|---|---|
| **Heteroskedasticity** | 0.537 | **0.771** |

A number of post-estimation diagnostic tests are equally conducted. Test include Jarque–Bera normality test, Breusch–Pagan serial correlation LM test, ARCH LM test for heteroscedasticity, Ramsey RESET test for functional specification and CUSUM and CUSUM Squares for model stability. Jarque–Bera normality test assumes that the models are normally distributed. Serial correlation LM test assumes that there is no problem of serial correlation. ARCK LM test assumes homoscedasticity. Ramsey RESET test assumes that the models are rightly specified, while the CUSUM and CUSUM Square tests assume that the models are stable as presented in table 10 below. If the tests are not statistically significant, we can accept that the estimated models have a good fit and are therefore suitable for policy formation and implementation.

Table 7: Cusum and Cusum of Squares.




CUSUM




CUSUM Squares

## 5.0 Summary, Conclusion and Recommendation

From the Model estimation, Healthcare expenditure, Access to water and sanitation have long-run relationship with neonatal mortality. A 1% increase in healthcare expenditure leads to a 0.171% increase in neonatal mortality, however the result is not statistically significant, which could be attributed to other factors like corruption that were not part of this study. while a 1% increase in access to water and sanitation will lead to a 0.421% decrease in neonatal mortality. This shows that increasing healthcare expenditure, access to water and sanitation is crucial to reducing neonatal mortality. Governments and donor organizations should prioritize investments in healthcare infrastructure and access to water. The study also reveals that access to water is essential for reducing neonatal mortality. Policies aimed at improving economic conditions, such as poverty reduction programs, can have a positive impact on neonatal health.

This study provides robust evidence that healthcare expenditure, GDP per capita, access to sanitation facilities, control of corruption, and urbanization are critical determinants of neonatal mortality. The findings suggest that investing in healthcare, improving economic conditions, increasing access to sanitation facilities, reducing adolescent fertility and promoting urbanization can significantly reduce neonatal mortality.

The governments and healthcare organizations need to prioritize investments in healthcare infrastructure, sanitation facilities, and economic development programs. By addressing these factors, countries can make significant strides in reducing neonatal mortality and improving overall public health. Overall, this research contributes to the existing body of knowledge on the determinants of neonatal mortality, providing valuable insights for policymakers, healthcare professionals, and researchers working to improve maternal and child health outcomes globally.

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