

Macroeconomic Conditions and Maternal Mortality in Nigeria: Asymmetric Evidence from a Nonlinear ARDL Technique

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ABSTRACT

Maternal mortality continues to be one of the most enduring public health problems in Nigeria, despite decades of economic reforms and health sector responses. Macroeconomic conditions are well known to be important determinants of health outcomes, yet little empirical evidence exists on how economic fluctuations influence maternal mortality, especially in developing countries. The study examines the asymmetric influence of key macroeconomic variables: economic growth, inflation, and unemployment on maternal mortality in Nigeria between 1986 and 2023. Drawing on the preston curve and the economic opportunity theory, the study employs the nonlinear autoregressive distributed lag (NARDL) technique to estimate short-run and long-run dynamics while differentiating between positive and negative macroeconomic shocks. The results indicate substantial nonlinearities: adverse macroeconomic shocks are associated with higher maternal mortality, particularly through rising inflation and unemployment, while gains in macroeconomic conditions yield comparatively weaker effects. Health system factors, such as prenatal care coverage and the quality of institutions, buffer these effects to a degree but still prove inadequate under unstable economic conditions. The findings suggest that Nigerian maternal survival is highly sensitive to macroeconomic volatility. The study therefore highlights the need for coordinated macroeconomic stabilization, provision of maternal health services, and institutional strengthening in order to realize sustained reduction in maternal mortality and accelerate progress towards Sustainable Development Goal 3.

Keywords: unemployment, inflation, economic growth, maternal mortality, NARDL, Nigeria

JEL Classification Codes: E24, E31, F31, F43, I15

INTRODUCTION

Health outcomes including mortality rates and disease prevalence are the major indicators of the health status of people and communities. A wide range of factors, such as the economic situation, living environment, health care quality, and public health policies, affect these outcomes (World Health Organization, WHO, 2021). Good health outcomes manifest as longer life expectancy, lower rates of illness and deaths, and decreased incidence of both communicable and non-communicable diseases. To ensure that these outcomes are realized, it is not only important to have access to healthcare but also to ensure that social determinants such as education, nutrition, and economic stability are addressed (Marmot et al., 2012; Becchio et al., 2022; Bloom et al., 2019; Kolawole, 2016). Considering the diverse aspects of health outcomes, maternal mortality stands out as an essential indicator that highlights healthcare quality as well as the wider socioeconomic scenario.

Maternal mortality rate is one of the leading indicators to measure the quality of healthcare systems, particularly, the maternal care during pregnancy and delivery (World Bank, 2022). Most of the times, the reasons behind high maternal mortality are limited healthcare access, low quality of maternal health services and shortage of health professionals. In addition, it is highly co-related with poverty, education and nutrition, which are the main factors that influence a woman's ability to access, use and follow up on proper prenatal and postnatal care (WHO, 2023). Besides that, maternal mortality is also influenced by the macroeconomic factors such as GDP growth and employment levels since countries with stronger economies can usually invest more in healthcare infrastructure and maternal health programs (Adepoju, 2022; United Nations, 2022). The increase in GDP growth leads to better investment in maternal care which results in improved access to skilled medical services and decreased rates of maternal death. On the other hand, a fall in inflation leads to more stable

healthcare costs, and lower unemployment results in higher household income and better access to health insurance, which in turn facilitates timely maternal visitation (Adewunmi & Olayemi, 2021). In this way, macroeconomic situation plays a fundamental role when it comes to analyzing maternal health outcomes.

Nigeria has witnessed a drastic fall in maternal deaths per 100,000 live births from 1,369 in 1986 to more than 500 in 2023 (World Bank, 2023; WHO, 2023). During the periods of strong growth, especially in the early 2000s, the decline was rapid. Nevertheless, the downward trend in deaths also continued during the economic recessions of 2016 and 2020 when GDP shrank and unemployment reached record levels (Adebayo, 2022; Abubakar et al., 2023). Even the sharp increase in the unemployment rate from 21.1 percent in 2010 to almost 39.3 percent in 2023 did not stop the declining trend in maternal mortality rates. This may indicate that economic growth cannot be solely relied on to improve maternal health (Sede & Ohemeng, 2015). The impact of inflation has also been felt by the population. For example, the headline inflation rate in Nigeria was close to 29 percent by the year 2023, compared to previous years. This has made it difficult for the population to acquire health care services and other essential commodities (WHO, 2023). However, the long-term trend towards lower maternal mortality appears to have been driven more by the impact of specific health interventions, international assistance, and commitments associated with the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs) than by the effects of inflation, as shown by Adeosun et al. (2022) and WHO (2023).

Nevertheless, Nigeria's maternal mortality rate still ranks among the highest globally, with a mortality rate of over 1,000 deaths per 100,000 live births, despite the new developments in the health care sector. This has been mainly blamed on the lack of adequate facilities, shortage of qualified personnel, lack of accessibility to emergency care especially for the rural dwellers. Additionally, socio-cultural factors like home delivery and usage of traditional birth attendants, coupled with financial barriers, are also contributing to the mortality rate, thus making it necessary to look at other dimensions such as the impact of macroeconomic factors (World Bank, 2023; WHO, 2023).

The GDP growth rate, inflation, and unemployment rate, among other macroeconomic variables, are also factors which influence maternal mortality rates depending on their effects on the wealth of the country, as well as the country's ability to offer medical care (Bloom et al., 2019; Central Bank of Nigeria, 2023; Sachs, 2014). While a high GDP growth rate could be used for the development of healthcare infrastructure, in Nigeria, this does not translate into improved healthcare outcomes for mothers because of high levels of income inequality and low levels of financing for the healthcare sector (Abubakar et al., 2023; Adebayo, 2022). Inflation reduces households' access to healthcare and nutrition, while it also reduces the government's capacity for financing healthcare (Olabiyi, 2022). High levels of unemployment also reduce access to healthcare, which affects maternal mortality (Adofo & Salami, 2018).

Despite the various interventions put in place, such as the National Health Policies, National Health Act, and Basic Health Care Provision Fund, life expectancy remains low compared to the global average, and maternal mortality remains among the highest globally. Previous studies on the subject have concentrated only on a limited number of macroeconomic indicators and linear relationships, yet the relationships between economic indicators and maternal health outcomes may be complex and non-linear, as noted by Abubakar et al. (2023), Olabiyi (2022), Adeosun et al. (2022), Sede & Ohemeng (2015), and Adebayo (2022). This emphasizes the need for a more comprehensive approach to the analysis of the subject matter.

In order to fill these gaps, this paper aims to investigate the effect of macroeconomic conditions on maternal mortality rates in Nigeria from 1986 to 2023, with other determinants such as physician-population ratios, institutional factors, and environmental conditions included. The nonlinear autoregressive distributed lag (NARDL) approach is employed, which allows for both short and long-term asymmetry effects.

LITERATURE REVIEW

Theoretical Framework

The adoption of the theory of economic opportunity and the Preston curve theory is very necessary in

developing a theoretical framework that guides this study on the impact of economic growth on health outcomes in Nigeria, as these two theories offer a comprehensive view of individual and macroeconomic aspects of health outcomes. In fact, the theory of economic opportunity places a huge stress on the role that economic conditions play in health outcomes, and there is a huge emphasis on the role of individual income and wealth in promoting a healthier lifestyle. This is particularly relevant in Nigeria, where disparities in economic opportunities lead to significant variations in health outcomes. As the country undergoes economic development, the theory asserts that growth should be equated with equal opportunities of accessing economic resources by all groups at different socio-economic levels. Without equal opportunities, health inequalities can be expected to persist or increase, which would therefore be a limit to overall economic benefits (Meara et al., 2001). In contrast, the Preston curve theory explains the general case of why national income is related to maternal mortality since growing income allows a larger increase in access to healthcare services, improved nutrition, and better living standards. However, it can be noted that the flattening of the curve at higher levels of income indicates that there are indeed diminishing returns on income in relation to health status (Preston, 1975). This is important in understanding Nigeria's case since it indicates that while there can be huge gains in terms of health with macroeconomic indicators, there needs to be focus on healthcare infrastructure development and technology.

Empirical Literature

Patrick and Bryant (2025) investigated the relationship between employment status and maternal health decisions in Nigeria, considering how employed and unemployed women differ in their decision-making regarding prenatal care, childbirth, and postnatal care. Using a mixed-methods approach, combining both qualitative and quantitative data collection methods, this research highlighted how employed women generally have better access to healthcare services and are more likely to make informed health decisions compared to their unemployed counterparts. The qualitative component involved in-depth interviews with 40 women, 20 of whom were employed and 20 unemployed. The participants were selected using purposive sampling to ensure that women from diverse socioeconomic backgrounds, educational levels, and employment statuses were included. The study also revealed that the effects of employment status on maternal health decisions are mediated by socioeconomic factors, including income level, education, and geographical location.

Ezeokoye et al. (2024) examined socio-economic factors affecting maternal health in Nigeria. Mothers and children are at the highest risk of disease and death. Deaths of infants and children under 5 years are peculiar and closely related to maternal health, and the risk of death of children increases if their mothers die in childbirth. The study employed secondary data obtained from World Bank, CBN, and Nigeria Demographic and Health Survey from 1990 to 2022. Using the error correction mechanism (ECM), the data were subjected to regression analysis, where the relationship between dependent variable (maternal mortality) and independent variables (poverty rate, literacy rate, and level of government expenditure on health) were estimated. The results showed that poverty, literacy and government provision of healthcare facilities were major socio-economic factors affecting maternal health in Nigeria.

Movsisyan et al. (2024) conducted an extensive scoping review that mapped the literature on inflation and health. Of 8923 screened records, 69 empirical studies were included. These studies investigated an array of health-related risk factors (eg, diet, substance use, stress, violence) and outcomes (eg, life expectancy, mortality, suicidal behaviour, mental health) related to inflation across different contexts and time periods. These findings suggested that the overall impact of inflation on health is predominantly negative, with some socioeconomic groups being especially vulnerable.

Adegoke et al. (2022) examined the combined effect of health expenditure and other key macro-economic factors on health indices such as maternal and newborn and child mortality in Nigeria. The study used ARDL model and the study period spans from 1995 to 2020. the study found a significant negative relationship between health outcomes and macro-economic determinants namely, household consumption, total health expenditure, and gross fixed capital while a significant positive relationship was revealed between health outcomes and unemployment.

Asiedu et al. (2022) examined the link between income per capita, adult life expectancy and mortality rates for children using data from 128 developing countries. The dynamic panel model was used as the method of analysis and it was found that all else equal external factors have increased positive and significant impact on health outcomes. It was also revealed that sub-Saharan African countries have higher mortality rate and low life expectancy rate than non-sub-Saharan Africa countries and income per capita have different effect for sub-Saharan Africa countries.

The effect of economic growth on mortality in China was analyzed by Niu et al. (2021), using the panel threshold regression model. The empirical study from 2000 to 2017 shows that China's economic growth has a significant threshold effect on mortality. After the threshold is exceeded, public health will be improved dramatically. The threshold effect is heterogeneous at the regional level. The eastern region has no threshold, and both central and western regions have a single significant threshold. However, the threshold value and threshold effect in the central and western regions are also different. The heterogeneity is caused by the different levels of regional economic development.

Ochiaka and Akuma (2021) studied the effect of health care expenditure on health outcomes in Nigeria using data from 1980 to 2020. The study used descriptive statistics and correlational analyses. The health care expenditure was measured using two proxies: namely, total health care expenditure per capita, public health care expenditure to gross domestic product (GDP). Health outcomes are measured by infant mortality, maternal and adult mortality and life expectancy. The results show that increase in healthcare expenditure as measured by total healthcare expenditure per capita and public health care expenditure to GDP share positive correlation with life expectancy and negative correlation with infant, adult and maternal mortality rates respectively.

Ajak and Ogeto (2020) estimated the effect of economic growth on health in Sub-Saharan Africa, using data from 1991 to 2015. This was done by employing Pooled OLS and a two-way fixed effect method where the health outcomes were measured by infant mortality rate, fertility rate, and life expectancy (total years), along with other explanatory variables. The results showed a strongly significant negative relationship between economic growth and health outcomes. It further revealed that economic growth led to a decline in infant mortality and fertility rate due to improved health services.

Yamben and Asaah (2020) empirically analyzed the relationship between unemployment and health in Sub-Saharan Africa (SSA). The study used the modified Generalized Methods of Moment (GMM) for the period 2006 to 2017. The results revealed that, the co-integration analysis support a robust long run relationship between our variables. Consequently, unemployment rate increased total mortality rates in middle income countries. However, in low income countries unemployment rate reduced total mortality rate.

Bul and Moracha (2020) estimated the impact of economic growth on health outcomes in Sub-Saharan Africa, drawing data from 1991 to 2015. The health outcome indicators discussed include infant mortality rates and fertility rates, life expectancy among the other explanatory variables, through techniques of pooled OLS and two-way fixed effects estimation. These results supported a negative and statistically significant association of the levels of economic growth to health outcomes; this suggests that economic growth reduces infant mortality and fertility.

The work of Tejada et al. (2019) investigated the influence of economic crises on child health for 127 countries from 1995 to 2014. The study estimated a multivariate regression model with fixed effects for countries in order to assess how changes in economic indicators influence child mortality rates, with a special emphasis on whether such an effect is buffered by public health expenditure. The negative impact of economic indicators on child mortality was even more pronounced in the case of low-income and middle-income countries.

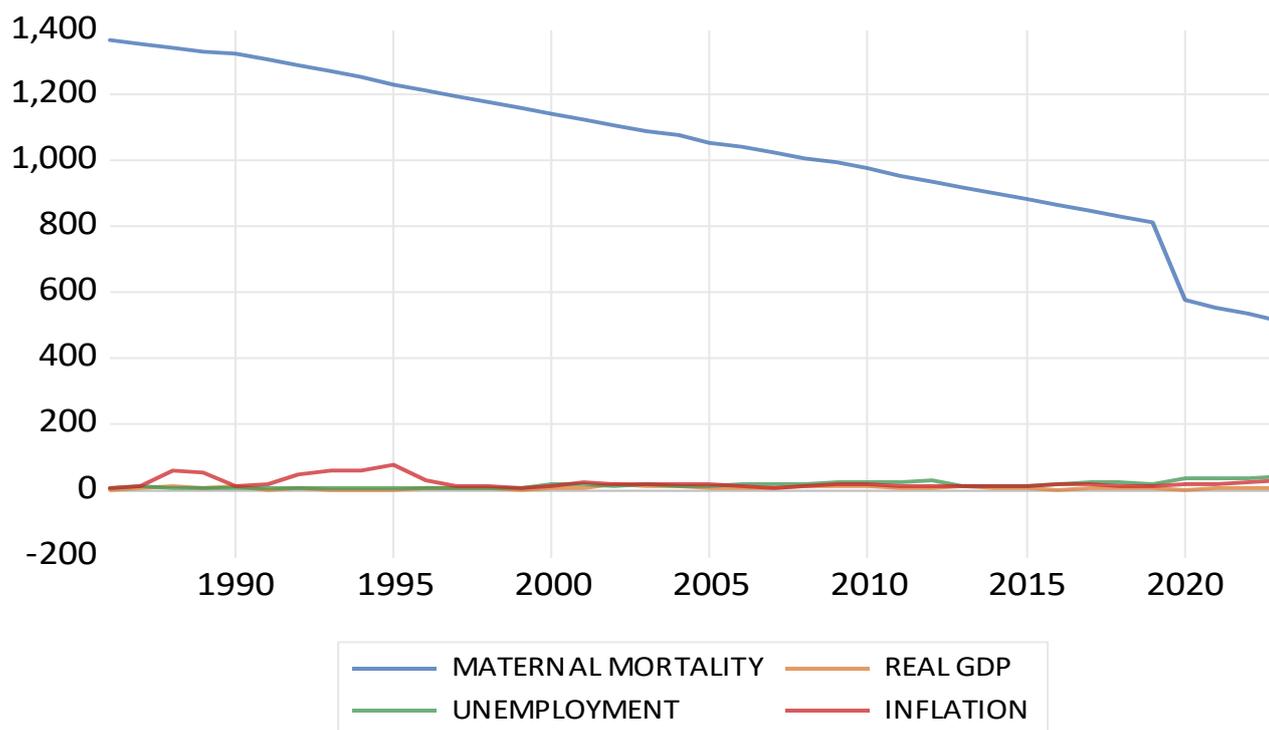
Adofu and Salami (2018) investigated the effect of unemployment rates on mortality rates in Nigeria, using time series data. The methods of data analysis were Johansen Cointegration Test and Fully-Modified Least Square Regression (embedded with distributed lag of unemployment). The second lag of unemployment rates positively and significantly influenced the mortality rates. A one percent increase in unemployment rate led to an increase of 0.16% in total mortality rate, 0.17 % increase in mortality rate of adult males, and 0.15%

increase in the mortality rate of females. Furthermore, GDP per capita has an influence on mortality rates that is highly significant and negative.

Williams et al. (2016) used multivariate regression analysis to test the effect of changes in unemployment, inflation and GDP per capita on 5 mortality indicators across 21 countries in Latin America, 1981–2010. For every 1% increase in unemployment significantly decreased population health outcomes; the largest deteriorations were for 1-5 years of age and male adult mortality rates, with increase of 1.14 and 0.53 rose per 1000 deaths, respectively. A 1% rise in the rate of inflation was associated with significant deteriorations ($p < 0.05$) in 4 population health outcomes, with the most significant deterioration in male adult mortality rate (0.0033 rise per 1000 deaths). Lag analysis demonstrated that 5 years following rises in unemployment and inflation, significant deteriorations ($p < 0.05$) in 3 and 5 mortality metrics respectively occurred. A 1% increase in the GDP per capita corresponded to no significant deteriorations in population health outcomes neither in the short term nor in the long run.

Salatini and Bidari (2014) explored the theoretical relationship between the inflation rate and women's health (life expectancy, mortality rates) in the selected middle-income countries using panel data. The estimation results using fixed effects model and GMM of those selected countries for the period of 1997-2011 showed that inflation had significant negative impacts on the life expectancy of women and significant positive impacts on the mortality rate of women in the selected middle-income group of countries.

Figure 1.1 Trend in the effects of Real GDP, Unemployment, and Inflation on Maternal Mortality in Nigeria



Source: World Bank (2023); CBN (2023)

From 1986 to 2023, the relationship between real GDP, unemployment, inflation, and maternal mortality in Nigeria exhibits an important paradox. Maternal mortality slowly, but steadily, decreased: from about 1,369 deaths per 100,000 live births in 1986 to just over 500 in 2023, in spite of an economy undergoing cycles of growth, recession, high inflation, and unemployment. As real GDP did grow sharply, particularly in the early 2000s, it appeared that the rate of reduction in maternal mortality seemed to ramp up, indicating that economic expansion created some fiscal space for health investment. But the decline in death was not inoperative, even in times of recession — when GDP shrank in 2016 and 2020 and unemployment exploded to record levels. It illustrates that the drop in maternal mortality cannot be simply explained by the macroeconomic condition. Inflation – which routinely surged above 15 per cent or more, and even jumped to nearly 73 per cent in 1995 –

didn't end the decline either, though high prices would have limited household access to health care (World Bank, 2023; CBN, 2023).

Most studies reviewed, confirm that macroeconomic conditions significantly influence health outcomes, including mortality rates, across both developed and developing countries. For studies that used cross-country and regional panel data, there is consistent agreement that economic growth reduces mortality (Ajak and Ogeto 2020; Bul and Moracha, 2020), while unemployment and inflation worsen health outcomes, particularly in low and middle-income countries (Salatini and Bidari, 2014; Movisisyan et al, 2024). Nigeria-specific studies also reveal that poverty, unemployment, and inadequate health expenditure are major factors that adversely affect maternal and general health outcomes (Patrick and Bryant, 2025; Ezeokoye et al, 2024; Adegoke et al, 2022).

Although existing studies have established that macroeconomic conditions influence general health outcomes and mortality rates, there still exists some limitations in the literature in several aspects.

First, most of the studies did not explicitly study maternal mortality as a standalone outcome variable, particularly within country-specific time-series frameworks for Nigeria, rather, they mostly treated health outcomes generally (Movisisyan et al, 2024; Adegoke et al, 2022) while others considered other health indicators such as infant mortality, life expectancy, or total mortality (Ajak & Ogeto, 2020; Bul & Moracha, 2020; Williams et al., 2016). Secondly, most macroeconomic-health studies rely on cross-country panel data (Asiedu et al., 2022; Yamben & Asaah, 2020; Tejada et al., 2019), which downplays country-specific dynamics and policy environments. Even Nigerian focused studies (Adegoke et al., 2022; Ezeokoye et al., 2024) apply linear models and do not explore nonlinear macroeconomic transmission channels. This study which applies a time-series analysis on Nigeria, intends to fill this gap.

Despite a number of Nigerian studies investigating maternal or overall health outcomes based on macroeconomic and socioeconomic indicators, the majority of these have been conducted in linearised settings using traditional models (OLS, ARDL, VAR, or VECM) that assume a symmetric effect of economic changes (e.g., Kelani et al., 2019; Lawal et al., 2021; Onwube et al., 2021). One implication of such approaches is that improvements and deteriorations in the macroeconomic environment will similarly have equal but opposite effects on health outcomes. But this logic might hide the disproportionate harm from adverse economic shocks on fragile health systems. We add to the literature by using a Nonlinear Autoregressive Distributed Lag (NARDL) model to explicitly represent and capture the asymmetric and nonlinear response of maternal mortality in the face of positive and negative macroeconomic shocks and to provide more policy-relevant evidence for Nigeria.

Despite the relevance of the role of inflation volatility in determining maternal mortality outcomes in developing countries, it remains underexplored in most studies while emphasizing poverty, literacy, and health expenditure (Ezeokoye et al., 2024; Ochiaka & Akuma, 2021). Finally, most existing studies did not adequately examine both the short-run and long run dynamics of macroeconomic variables on maternal mortality in Nigeria over the study period, rather, they mostly considered the short-run effects by using short-run models like ECM and OLS (Ezeokoye et al, 2024) while this gap is filled by applying the NARDL which measures both short-run and long-run asymmetric effects of key macroeconomic conditions on maternal mortality in Nigeria over the period 1986–2023 .

METHODOLOGY

Model Specification

The empirical model specification for this study is guided by both the theoretical framework and empirical literature reviewed, ensuring that the functional relationship between economic growth and selected health outcomes in Nigeria is effectively captured. The economic opportunity theory and Preston curve theory informed the selection of variables and their relationships within the models. Thus, based on the model of Ezeokoye et al. (2024) which this present study adapted, the model is specified as:

$$\text{MMR} = f(\text{POV}, \text{LIT}, \text{GEH}) \quad (1)$$

Where, MMR is maternal mortality; POV is poverty rate; LIT= literacy rate, and GEH = level of government expenditure on health.

The model of Ezeokoye et al. (2024) is adapted for the current study to include more variables with the view to develop a comprehensive model on macroeconomic variables and health outcomes in Nigeria. This model therefore defines maternal mortality (MMR) as a function of economic growth (GDPG) and inflation (INFR) and unemployment (UNER) and social factors such as institutional quality (INSQ) and prenatal care (PNC) which demonstrate how economic and institutional elements affect health outcomes.

Prenatal care coverage and the quality of the institutions were considered as control variables since macroeconomic conditions directly and indirectly affect maternal outcomes through health system performance. Prenatal care reflects service utilization and access to skilled maternal services and institutional quality measures governance effectiveness, accountability, and resource allocation efficiency. These variables serve to isolate the independent effect of macroeconomic shocks on maternal mortality.

The general form of the health outcomes Equation is expressed as follows:

$$MMR = f(GDPG, INFR, UNER, PNC, INSQ) \tag{2}$$

Where, MMR = Maternal mortality rate; GDPG = Gross domestic product growth rate; INFR = Inflation rate; UNER = Unemployment rate; PNC = Prenatal care; INSQ = Institutional quality.

Mathematically, the Equation is specified as:

$$MMR = GDPG + INFR + UNER + PNC + INSQ \tag{3}$$

The econometric equation is specified as:

$$MMR = \beta_0 + \beta_1GDPG + \beta_2INFR + \beta_3UNER + \beta_4PNC+ \beta_5INSQ + \varepsilon \tag{4}$$

From the above, β_0 is the intercepts, while $\beta_1 - \beta_5$ are the coefficients. ε is the stochastic error terms and the t denotes time measured in years.

Data Analysis Techniques

The study applies NARDL to capture both short-run and long-run relationships between macroeconomic indicators and health outcomes. Non-linear auto regressive distributed lag model which was developed by Shin et al. (2014) has several advantages over other approach. The method is an improvement of the linear ARDL which can be used to model cointegrating relationships in small or finite samples. It uses positive and negative partial sum decomposition which detects the asymmetric effects in the long and short term. The model does not require that all the variables be integrated of order one or I(1). However, none of the variables must be integrated of order two i.e I(2) or above, if so, the none linear auto regressive distributed lag approach will not be applicable. The Augmented Dickey–Fuller (ADF) test is used to check for stationarity, while the bounds testing approach determines cointegration among variables. Diagnostic tests, including normality, serial correlation, heteroscedasticity, and stability (CUSUM and CUSUMSQ) are conducted to ensure model robustness. This approach allows for detecting asymmetric effects of GDP growth, inflation, and unemployment on life expectancy and maternal mortality in Nigeria. The NARDL is expressed as;

$$\begin{aligned} \ln MMR_t = & \ln \beta_0 + \beta_1 \ln MMR_{t-1} + \beta_2 - \ln NEG(GDPG)_{t-1} + \beta_3 - \ln NEG(UNER)_{t-1} + \beta_4 - \ln NEG(INFR)_{t-1} \\ & + \beta_5 + \ln POS(GDPG)_{t-1} + \beta_6 + \ln POS(UNER)_{t-1} + \beta_7 + \ln POS(INFR)_{t-1} \\ & + \sum_{i=1}^p \alpha_1 \Delta \ln MMR_{t-1} + \sum_{i=1}^p \alpha_2 - \Delta \ln NEG(GDPG)_{t-1} + \sum_{i=1}^p \alpha_3 \\ & - \Delta \ln NEG(UNER)_{t-1} + \sum_{i=1}^p \alpha_4 - \Delta \ln NEG(INFR)_{t-1} + \sum_{i=1}^p \alpha_5 + \Delta \ln POS(GDPG)_{t-1} \\ & + \sum_{i=1}^p \alpha_6 + \Delta \ln POS(UNER)_{t-1} + \sum_{i=1}^p \alpha_7 + \Delta \ln POS(INFR)_{t-1} + \mu_t \end{aligned} \tag{3.29}$$

Where, Δ is the first difference operator; $\beta_1, \beta_2, \beta_3 \dots \beta_7$ represent short-run dynamics of the model; $\alpha_1, \alpha_2, \alpha_3 \dots \alpha_7$ represent the long-run elasticities.

Sources of Data

Table 3.1: Nature and Sources of Data

S/N	Variables	Nature of the Variables	Sources of Data
1	Maternal mortality rate (MMR)	It is calculated as the number of maternal deaths per 100,000 live births during a given time period.	World Bank (2023), National Bureau of Statistics various years
2	Gross domestic product growth rate (GDPG)	It is calculated as the percentage change in real GDP (i.e., GDP adjusted for inflation) between two periods—usually year-on-year.	World Bank, National Bureau of Statistics (2024)
3	Inflation rate (INFR)	The variable is calculated as the percentage change in the Consumer Price Index (CPI) over a specified period.	National Bureau of Statistics (2024)
4	Unemployment rate (UNER)	The unemployment rate is calculated by dividing the number of people who are actively seeking employment but are without work by the total labor force (which includes both the employed and the unemployed) and then multiplying the result by 100 to express it as a percentage.	National Bureau of Statistics (2024)
5	Prenatal care	This measures the percentage of pregnant women who receive at least one prenatal care visit during their pregnancy.	World Development Indicators (2024)
6	Institutional quality (INSQ)	Institutional quality is calculated using composite indices that measure different aspects of institutions, such as governance, regulatory quality, corruption, and the rule of law. It is measured in index	World Bank, Transparency International (2024)

Source: Authors' Compilation, 2025

RESULT PRESENTATION, INTERPRETATION AND DISCUSSION OF FINDINGS

Result Presentation and Interpretation

Correlation Matrix

The correlation matrix measures how closely related two variables in the model are which can be used to check if multicollinearity exists or not. Multicollinearity in a model means there exists perfect or exact linear relationship in a model. If this exists, it violates the rule of OLS and our estimates become unreliable.

Table 4.1: Correlation Matrix Result

	MMR	GDPG	INFR	UNER	PNC	INSQ
MMR	1.000000					
GDPG	0.069422	1.000000				
INFR	0.298814	-0.324521	1.000000			

UNER	-0.686484	0.044670	-0.293019	1.000000		
PNC	0.044286	-0.332835	0.100038	0.070614	1.000000	
INSQ	-0.562368	-0.129089	-0.074581	0.695431	0.027986	1.000000

Source: Authors' Computation using Eviews 13.0

The results shows that maternal mortality negatively correlates with unemployment (UNER) at -0.69 and institutional quality (INSQ) at -0.56, which suggests that high unemployment is correlated with high maternal mortality. Likewise, institutional quality (INSQ) negatively correlates with MMR at -0.56, suggesting that better institutions are correlated with fewer maternal deaths. Moderate positive correlation between inflation (INFR) and MMR is 0.29, indicating inflation pressure could exacerbate the maternal outcome. Between MMR and GDP growth (GDPG), the correlation is weakly positive at 0.069, and PNC is highly negatively correlated with MMR (-0.04) here, which indicates a room for mediation through other structural factors. From the findings, the coefficient values for all the variables are below the threshold of 0.80. This clearly suggests that there is no multicollinearity in the model. Thus, the null hypothesis can be accepted and it is concluded that the model is free from multicollinearity.

Augmented Dickey Fuller Stationarity Test

This subsection deals with the test of unit root. Since time series data usually exhibit unit root, ADF unit root test was employed to test for stationarity. This test is necessary so as not to have misleading results. The result is thus presented on Table 4.2.

Table 4.2: ADF Unit Root Test

Variables	ADF @Level	Critical Value @5%	ADF@ Diff.	Ist	Critical Value @5%	Order of Integration
MMR	-1.7991	-2.9434	-5.4998		-2.9458	I(1)
GDPG	-4.0941	-2.9434	-10.8439		-2.9458	I(0)
UNER	-1.0130	-2.9434	-6.4049		-2.9458	I(1)
INFR	-3.8681	-2.9458	-5.4097		-2.9458	I(0)
INSQ	-0.4176	-2.9434	-6.7094		-2.9458	I(1)
PNC	-2.9766	-2.9434	-5.9129		-2.9458	I(0)

Source: Authors' Computation using Eviews 13.0

ADF unit root test statistics revealed the stationarity characteristics of the variables. At MMR, UNER and INSQ are stationary after first differencing, since their ADF statistics are greater than the respective critical values, which is evidence that they are integrated of order one, I(1). Alternatively, GDPG, PNC and INFR are stationary at level since their ADF statistics are greater than the respective critical values, which is evidence that they are integrated of order zero, I(0). It is then concluded that the variables are stationary and our estimates can produce consistent and unbiased results.

Lag Length Selection

This section presents the appropriate lag length for this study before estimating the long and short run coefficients of the model.

Table 4.3: Lag Order Selection Criteria

Model Selection Criteria Table					
Dependent Variable: MMR					
Sample: 1986 2023					
Included observations: 37					
Model	LogL	AIC*	BIC	HQ	Specification
1	-173.804124	10.043466	10.565926	10.227658	ARDL(1,1,1,1,1,1)

Source: Authors' Computation using Eviews 13.0

Before estimating the non-linear ARDL model, it is vital to find out the appropriate lag length to be employed in the regression model. The optimum lag length can be selected using the available lag length criteria based on Akaike information criterion as shown in Table 4.3. Based on the results obtained, it is established that the combination of (1,1,1,1,1,1) is selected as the appropriate lag length. This implies that it is appropriate to include one lag of the endogenous variables in the regression model.

Non-linear ARDL Bounds Test for Cointegration

The following step after identifying the order of integration of the variable is to use a bound F-test in order to determine the long-run relationship between the variables. The result of the test is presented in Table 4.4

Table 4.4: Non-linear ARDL Bounds Test

Null hypothesis: No levels relationship						
Number of cointegrating variables: 5						
Trend type: Rest. constant (Case 2)						
Sample size: 37						
Test Statistic			Value			
F-statistic			6.852605			
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
35	2.331	3.417	2.804	4.013	3.900	5.419
40	2.306	3.353	2.734	3.920	3.657	5.256
Asymptotic	2.080	3.000	2.390	3.380	3.060	4.150
* I(0) and I(1) are respectively the stationary and non-stationary bounds.						

Source: Authors' Computation using Eviews 13.0

Summary results from the NARDL bounds test are presented in Table 4.4. However, the results showed that there was cointegration between the variables since the value of the F statistic, which was 6.8526, was higher than the upper and lower bounds at 5 percent critical level. This rejects the null hypothesis which states that there was no long-run relationship among the variables.

Non-Linear Autoregressive Distributed Lag (NARDL) Model

The NARDL is necessary in this study because there is long run relationship among the variables. Thus, the result is presented in Tables 4.5.

Table 4.5: Long Run Estimates

Dependent Variable: D(MMR)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MMR(-1)*	-0.270774	0.249691	-1.084437	0.2925
GDPG_POS(-1)	0.886754	0.151148	2.868130	0.0081
GDPG_NEG(-1)	-0.627466	0.185138	-0.510956	0.6156
INFR_POS(-1)	-0.502570	0.905873	-1.658698	0.1145
INFR_NEG(-1)	0.338590	0.539021	0.628158	0.5378
UNER_POS(-1)	-0.406354	0.478906	-2.180943	0.0427
UNER_NEG(-1)	0.300159	0.857044	0.700123	0.4928
PNC(-1)	0.826975	0.965682	1.438165	0.1675
INSQ(-1)	0.019291	0.287931	1.526580	0.1442
C	-114.1859	407.3035	-0.280346	0.7824

Source: Authors' Computation using Eviews 13.0

From the result, a one percent increase in past maternal mortality rate causes a reduction of about 0.27 percent in current maternal mortality, indicating a slight correcting pattern over time. A one percent increase in positive GDP growth caused an increase of about 0.89 percent in maternal mortality, indicating a significant impact. Nevertheless, a one percent increase in negative GDP resulted in a decrease of about 0.62 percent in maternal mortality, indicating that economic recessions negatively affected maternal mortality. Increase in the positive unemployment by one percent reduced maternal mortality by roughly 0.41 percent, and it is statistically significant. Conversely, a one percent reduction in negative unemployment increased maternal mortality by about 0.30 percent, although this finding is not statistically significant either. Positive inflation has a negligible impact, as a one percent increase led to about a 0.50 percent decline in maternal mortality. However, a one percent increase in negative inflation resulted in approximately a 0.34 percent rise in maternal mortality, implying that deflationary periods caused high maternal mortality. A one percent increase in prenatal care also led to an estimated 0.37 percent increase in maternal mortality, though this effect is statistically insignificant. More so, a one percent increase in institutional quality decreased the health of mothers and increased maternal mortality significantly by 0.83 percent.

Table 4.6: Short Run Estimates

Dependent Variable: D(MMR)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.270774	0.058707	-4.612316	0.0001
D(GDPG_POS)	0.188072	0.589038	3.548836	0.0014
D(GDPG_NEG)	-0.788507	1.510930	-0.521869	0.6060
D(INFR_POS)	-0.664038	0.499504	-3.331383	0.0025
D(INFR_NEG)	0.859743	0.472074	1.821204	0.0797
D(UNER_POS)	-0.270901	1.043197	-7.928413	0.0000
D(UNER_NEG)	0.901719	1.469775	0.613508	0.5447
D(PNC)	0.648035	1.340300	2.975704	0.0085

D(INSQ)	-0.178477	1.409927	-0.126586	0.9002
R-squared	0.693917	Mean dependent var		-23.44444
Adjusted R-squared	0.603226	S.D. dependent var		36.74114
S.E. of regression	23.14324	Akaike info criterion		9.333601
Sum squared resid	14461.46	Schwarz criterion		9.729481
Log likelihood	-159.0048	Hannan-Quinn criter.		9.471773
F-statistic	7.651426	Durbin-Watson stat		1.917549
Prob(F-statistic)	0.000026			
* p-values are incompatible with t-Bounds distribution.				

Source: Authors' Computation using Eviews 13.0

From the results of the short-run estimates for Equation two, the ECM term (COINTEQ), has a coefficient of -0.2708, that is, all deviations from long-run equilibrium were corrected at 0.27% annually. The positive GDP growth, with a coefficient of 0.1881, implied that an increase in positive GDP growth by 1% resulted in an increase of 0.19% in maternal mortality. Similarly, negative GDP growth has a coefficient of -0.7885, and it showed that 1% increase in negative GDP growth caused maternal mortality to decrease by 0.79%. The positive unemployment, has a coefficient of -0.2709, meaning that an increase of 1% in positive unemployment reduced maternal mortality by 0.27%. However, negative unemployment D(UNER_NEG), has a coefficient of 0.9017, and it suggested that when negative unemployment rate was increased by one percent, maternal mortality increased by 0.90%. Similarly, positive inflation is -0.6640, which means a one percent increase in positive inflation resulted in a 0.66% decrease in maternal mortality rate in Nigeria. The lagged negative inflation D(INFR_NEG(-1)), is 0.8597 and it implied that negative inflation worsened maternal mortality by 0.86%. The lagged value of prenatal care, D(PNC(-1)) is 0.6480, and it showed that an increase in the lagged value of prenatal care access by one percent increased maternal mortality by 0.65%. Institutional quality has a coefficient value of -0.1785, meaning that a one percent increase in institutional quality resulted in a 0.18% decrease in maternal mortality rate. The R² is 0.6939, implying that 69% variations in MMR are explained by GDPG, UNER, INFR, INSQ and PNC, while only about 31% of the variables not explicitly captured in the model are explained by the error term. These percentages are quite high and they suggested that our models are good fit. There is also joint significant impact between the dependent and independent variables of the study since the F-calculated of 50.7455 is greater than F-tabulated (2.53).

Post Estimation Tests

Test for Serial Correlation

Table 4.7: Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 1 lag			
F-statistic	0.152606	Prob. F(1,17)	0.7009
Obs*R-squared	0.320291	Prob. Chi-Square(1)	0.5714

Source: Authors' Computation using Eviews 13.0

The result presented here shows that there is no serial correlation due to the fact that the probability value of F-statistic which is 0.7009 is greater than 5% critical level of significance, and as such, the null hypothesis is accepted.

Test of Heteroscedasticity

Table 4.8: Heteroscedasticity Test

Heteroscedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoscedasticity			
F-statistic	0.124959	Prob. F(17,18)	0.4211
Obs*R-squared	31.34229	Prob. Chi-Square(17)	0.1181
Scaled explained SS	4.184947	Prob. Chi-Square(17)	0.6063

Source: Authors' Computation using Eviews 13.0

The result of the diagnostic test for heteroscedasticity is shown in Table 4.8. The test indicates that the variance of the error is homoscedastic at the 5% level of significance. This is revealed by the probability value of the F-statistic, which is greater than 0.05. The null hypothesis that the error variance is homoscedastic cannot be rejected.

Normality Test

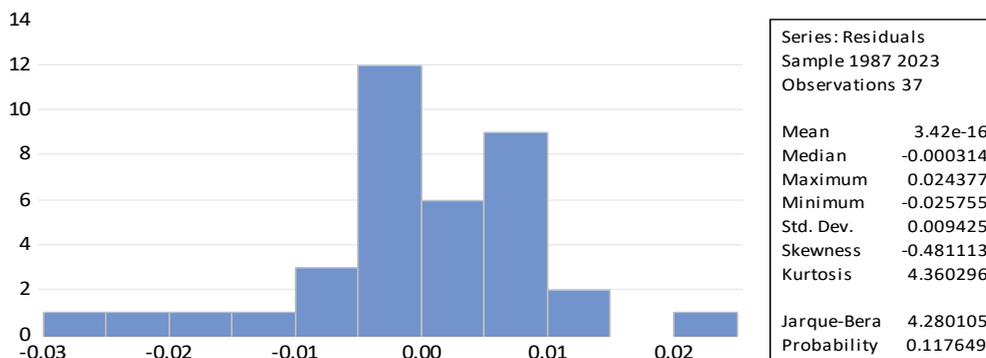


Figure 4.1: Histogram Normality Test

Source: Authors' Computation using Eviews 13.0

The histogram depicts residuals investigation from the model. The average residuals are near zero, which implies that the predictions from the model are on average accurate and unbiased. At the 5% significance level, the Jarque-Bera test with a probability value of 0.1176 indicated that the residuals are normally distributed.

Tests for Stability

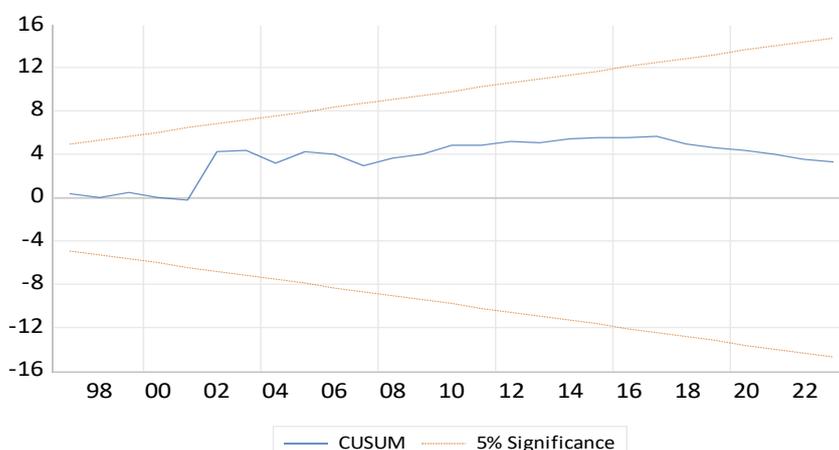


Figure 4.2: Cumulative Sum Result

Source: Authors' Computation using Eviews 13.0

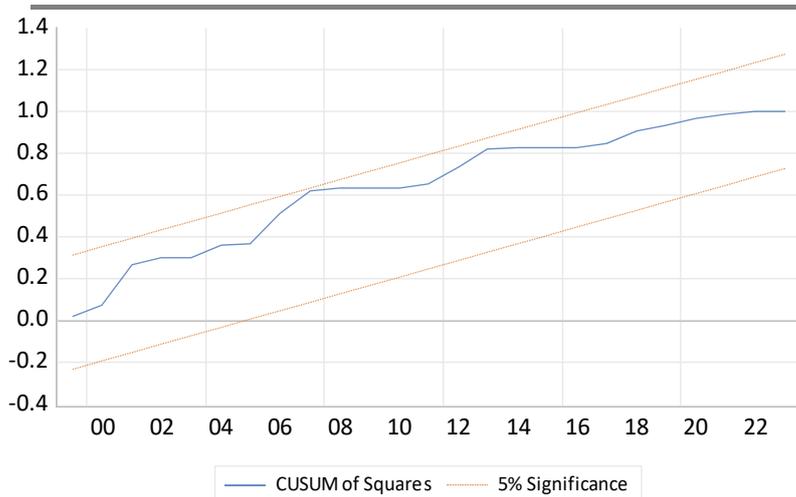


Figure 4.3: Cumulative Sum of Squares Result

Source: Authors' Computation using Eviews 13.0

The CUSUM and CUSUMSQ tests as presented in Figures 4.2 and 4.3 respectively implied that the base lines lied within the critical bounds, and it suggested that the variance of the residuals is stable over time, indicating no significant changes in the model's error structure.

Several post-estimation diagnostic tests were conducted to ensure model reliability. The Breusch–Godfrey LM test confirmed the absence of serial correlation, the Breusch–Pagan test indicated no heteroskedasticity, the Jarque–Bera statistic supported residual normality, and the CUSUM and CUSUMSQ tests verified parameter stability over the sample period. These results confirm the robustness of the NARDL estimates.

Limitations

Despite its contributions, this study has some limitations. First, data constraints limited the inclusion of variables such as inequality indices and detailed health expenditure components. Second, measurement errors may exist in historical maternal mortality estimates. Third, the country-specific design may limit generalizability to other contexts. Future research could extend the analysis using panel data across Sub-Saharan African countries or incorporate additional socioeconomic determinants

DISCUSSION OF FINDINGS

The results indicate that maternal mortality in Nigeria is influenced by a combination of macroeconomic and institutional factors. The negative coefficient of the lagged maternal mortality term suggests a mild adjustment process, implying that past maternal health outcomes have some influence on current mortality levels, although the effect is weak. This confirms that improvements in maternal health occur gradually, consistent with Ezeokoye et al. (2024) who demonstrated that maternal health problems in Nigeria continue to exist as a continuous challenge. The positive economic expansion produced unanticipated outcomes because it increased maternal death rates which demonstrated that economic development fails to enhance maternal health outcomes.

This finding is in tandem with that of Adebayo (2022) and Abubakar et al. (2023), who showed that GDP growth in Nigeria is often accompanied by inequality and weak health sector financing. On the other hand, negative economic growth led to a reduction in maternal mortality, implying that during periods of economic decline, resource redistribution and external health interventions could offset risks to maternal health. Similar patterns were observed by Tejada et al. (2019) in low- and middle-income countries. Overall, the GDP results do not fully conform to theoretical expectations.

Unemployment also exhibited asymmetric effects. Positive unemployment had a reducing effect on maternal mortality, while negative unemployment had a positive effect on maternal mortality. Although this is contrary

to the a priori expectation, it is consistent with Yamben and Asaah (2020), who showed that unemployment lowered mortality in low-income countries, perhaps due to social support networks. On a contrary, the results are not consistent with Adofu and Salami (2018) or Williams et al. (2016), who revealed that unemployment adversely affects health outcomes. Unemployment outcomes are a true reflection of the Nigerian structural framework

The effects of inflation showed mixed outcomes because positive inflation decreased maternal deaths while negative inflation caused more maternal deaths. The results of this study differ from theoretical expectations and empirical research evidence which links inflation to worse health results (Salatini & Bidari, 2014; Movsisyan et al., 2024). The findings show partial agreement with the study by Adeosun et al. (2022) which found that Nigeria experienced persisted long-term mortality reductions which continued even during inflation periods.

Prenatal care and institutional quality both showed positive effects on maternal mortality rates, yet these effects remained statistically insignificant. This suggests that maternal death rates would not decrease through improved service access and governance enhancements until improvements were made to service quality, institutional coverage and socioeconomic conditions. This finding corroborates Patrick and Bryant (2025) and Ezeokoye et al. (2024), who emphasized the mediating role of income, education, and access. The error correction results further indicate a slow adjustment toward long-run equilibrium, confirming that maternal mortality responds gradually to macroeconomic and institutional changes, consistent with Adegoke et al. (2022) and Ochiaka and Akuma (2021).

From the policy perspective, the results imply that maternal mortality reduction cannot depend on the health sector alone. Equally important are macroeconomic stabilization policies. Stabilizing the economy by controlling inflation through prudent monetary policies, reducing unemployment through job creation and social protection programmes, promoting growth in economic activity without compromising the purchasing power of households and improving the accessibility of maternal health services are the means of preventing these risks. In addition, counter-cyclical fiscal expenditures to protect maternal and child health budgets in slow economic conditions can buffer against macroeconomic shocks. Connecting macroeconomic management with health financing strategies is thus critical for the accomplishment of Sustainable Development Goals 3 and 10 in Nigeria.

CONCLUSION AND POLICY RECOMMENDATIONS

The research on maternal mortality showed that maternal health results in Nigeria develop through various economic and social and institutional factors which interact with each other. The factors which determine maternal mortality extend beyond healthcare access because they include economic growth patterns and employment conditions and inflation and the effectiveness of governance systems. The evidence shows that to decrease maternal deaths health systems need to implement complete solutions which tackle all economic barriers and all systemic obstacles which prevent women from receiving maternal healthcare. The findings demonstrated that changes in economic and social variables have a delayed but significant impact on maternal mortality, reflecting the slow response of maternal health outcomes to policy interventions. Short-term gains in employment opportunities and health service delivery will not be adequate unless accompanied by long-term investments in maternal health, education, and system transformation. Improvement in maternal health cannot be seen as separate from the larger development agenda for Nigeria. Enhancing maternal health is not just a development issue, but a means to a broader end, which also means an improved future for the country, while at the same time highlighting the importance of economic stability, health, and good governance.

The following recommendations are made in line with the findings of the study;

- i. To ensure that economic growth translates into improved maternal health outcomes, the Federal Ministry of Finance, in collaboration with the Federal Ministry of Health and the National Assembly, should mandate the automatic allocation of a fixed proportion of annual growth-related revenues to maternal and primary healthcare services, particularly at the state and local government levels.

- ii. In response to the significant influence of unemployment, the Federal Ministry of Labour and Employment, alongside the National Health Insurance Authority (NHIA) and State Ministries of Health, should expand subsidized maternal health insurance and conditional health support programs targeted at unemployed and informally employed women.
- iii. In view of the negative consequences of inflation, the Central Bank of Nigeria (CBN), in partnership with the Federal Ministry of Health and the National Agency for Food and Drug Administration and Control (NAFDAC), should ensure that the prices of critical maternal health inputs are stabilized through subsidies, bulk purchases, and health financing programs that are responsive to inflation.
- iv. To improve the efficiency of prenatal care, the Federal Ministry of Health, in collaboration with the State Primary Health Care Development Agencies and the National Primary Health Care Development Agency (NPHCDA), should implement quality-based standards for antenatal care, including the availability of skilled personnel and maternal risk screening.

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