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Impact of Macroeconomic Indicators on Mortality Rate in Nigeria (1990-2023)

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Abstract

This research is motivated to understand how economic factors influence public health outcomes in a developing economy. This paper examines the impact of key macroeconomic variables on mortality rates in Nigeria from 1990 to 2023. An Autoregressive Distributed Lag (ARDL) approach was employed to assess both short-term and long-term relationships among the variables. The mortality rate is the dependent variable represented by the crude death rate while the independent variables are the interest rate, unemployment rate, exchange rate, and gross domestic product (GDP) growth rate. Data were obtained from reliable sources such as the World Development Indicators and National Bureau of Statistics. The results indicate that inflation rates have a positive and insignificant impact while interest rates have a positive and significant impact on the mortality rate. In contrast, unemployment, exchange rate and GDP growth rate had a negative and insignificant impact on mortality rate. The findings suggest that government interventions in stabilizing economic growth, reducing unemployment, and managing inflation can substantially improve the mortality rate in Nigeria. Recommendations are directed to the Ministry of Finance and the Central Bank of Nigeria to develop policies that stabilize inflation rates and promote job creation, as well as to the Ministry of Health to prioritize public health resources for vulnerable populations most affected by economic volatility.

Keywords: *Mortality Rate, Crude Death Rate, Inflation Rate, Interest Rate, Unemployment Rate*

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Background to the Study

The interplay between macroeconomic variables and health outcomes has long been a subject of academic interest, with mortality rates serving as a key indicator of public health. Globally, factors such as unemployment, inflation, exchange rate fluctuations, and economic growth have been shown to significantly impact mortality rates, particularly in developing economies (Rahman *et al.*, 2018; Adeosun *et al.*, 2022). In high-income nations, macroeconomic policies tend to provide a buffer against these impacts. However, in low and middle-income countries, economic volatility often correlates with increased mortality rates due to limited healthcare access and inadequate social safety nets (Kidane & Woldemichael, 2020). This has heightened concern over how economic conditions, especially in nations like Nigeria, affect the well-being and life expectancy of the population. Nigeria, with its volatile macroeconomic landscape characterized by recurrent inflationary pressures, fluctuating exchange rates, and inconsistent economic growth, has experienced mixed results in efforts to reduce mortality rates. The country's crude death rate, which serves as a proxy for mortality in this paper, reflects the health burden imposed by economic challenges. According to World Bank data, Nigeria's crude death rate was 18.6 deaths per 1,000 people in 1990, a figure that has shown only slight improvements over the years with 12.43 deaths per 1,000 people in 2023 due to economic shocks and policy inadequacies (World Bank, 2023). Nigeria ranks 129th out of 174 countries in terms of crude death rate. Unemployment, which rose to 33% in 2020, combined with interest rate volatility and exchange rate instability, has further strained household incomes and access to healthcare services (Raji, 2020; Adesete *et al.*, 2022).

Despite several policy interventions aimed at economic stabilization and poverty reduction, such as the Economic Recovery and Growth Plan (ERGP) of 2017 and various health-related initiatives like National Health Insurance Scheme (NHIS) of 2005, Primary Health Care (PHC) Under One Roof Initiative in 2011, Maternal and Child Health Policies (e.g., Safe Motherhood Initiative, 2005), National Malaria Elimination Program (NMEP, 2014), Immunization Policies (e.g., National Routine Immunization Schedule, 2017), Tuberculosis Control Programs (Updated 2020), HIV/AIDS Control and Prevention Policy (updated in 2021). Nigeria continues to experience high mortality rates. These policies have not effectively addressed the structural issues that tie macroeconomic instability to health outcomes (Adofu & Abdulganiyu, 2018; Pillah & Pillah. 2023; Admin, 2023; Ope, 2020; Sokunbi *et al.,* 2022; Ahigh, 2023). The persistence of poor mortality statistics points to the need for a deeper investigation into how macroeconomic variables, specifically the interest rate, unemployment rate, exchange rate, and GDP growth rate, influence mortality trends over time (Sede & Ogiemudia, 2021). This paper aims to explore the extent to which these macroeconomic variables have impacted the mortality rate in Nigeria from 1990 to 2023, shedding light on the policy gaps and providing evidence-based recommendations to guide future interventions. The paper is structured into five sections which is the introduction, literature review, methodology, presentation and interpretation of results, conclusion and recommendation.

The following hypotheses will be tested to achieve the objective of the paper:

$\mathbf{H_{01}}$: Inflation rate has no significant impact on mortality rate in Nigeria.

$\mathbf{H_{02}}$: Interest rate has no significant impact on mortality rate in Nigeria.

$\mathbf{H_{03}}$: Unemployment rate has no significant impact on mortality rate in Nigeria.
$\mathbf{H_{04}}$: Exchange rate has no significant impact on the mortality rate in Nigeria.
$\mathbf{H_{05}}$: Gross domestic product growth rate has no significant impact on mortality rate in Nigeria.

Literature Review

Conceptual Review

Mortality refers to the incidence of death within a population over a specified period. It is a fundamental demographic indicator that reflects the overall health and well-being of a society. The crude death rate (CDR), used as an indicator of mortality, is the total number of deaths per 1,000 individuals in a given population during a particular year. It is a key metric that helps in understanding population dynamics and health outcomes (World Bank, 2020). In developing countries like Nigeria, high crude death rates often signal underlying issues such as poor healthcare access, malnutrition, and adverse macroeconomic conditions (Adeosun *et al.*, 2022). While the interest rate represents the cost of borrowing or the reward for saving, typically expressed as a percentage of the principal. In macroeconomic terms, it influences investment decisions, consumption, and overall economic activity. High interest rates can dampen economic growth by increasing the cost of capital, while low rates can stimulate growth but may also lead to inflationary pressures (Raji, 2020). Interest rates can indirectly affect mortality rates by influencing economic factors such as poverty and access to healthcare. When borrowing costs rise, households may cut back on essential expenditures, including healthcare, thereby exacerbating health risks (Ohioze *et al.,* 2022).

The unemployment rate measures the percentage of the labor force that is without work but is available and seeking employment. High unemployment often results in reduced household income, leading to lower living standards and diminished access to healthcare and essential services. Studies show a strong link between unemployment and adverse health outcomes, including higher mortality rates (Adofu & Abdulganiyu, 2018). In Nigeria, persistent unemployment, particularly among the youth, has contributed to economic instability, which in turn affects mortality rates as families struggle to meet basic health needs (Raji, 2020).

The exchange rate is the price of one country's currency in terms of another. It plays a pivotal role in international trade, affecting the cost of imports and exports. In countries like Nigeria, where a significant proportion of goods are imported, fluctuations in exchange rates can have a profound impact on the economy, especially on inflation and public health. A depreciating currency can increase the cost of imported goods, including medical supplies, which can deteriorate healthcare services and outcomes (Ohioze *et al.,* 2022). Exchange rate instability has been shown to correlate with higher mortality rates due to its effect on the affordability of essential goods and healthcare (Raji, 2020). The Gross Domestic Product (GDP) growth rate is a key indicator of the economic health of a country. It reflects the rate at which a nation's economy is growing or shrinking, measured as the annual percentage increase in the value of all goods and services produced. A robust GDP growth rate often indicates economic prosperity, higher employment levels, and improved living standards, all of which contribute to better health outcomes (Dadgar & Norström, 2016). However, slow or negative growth can

lead to economic strain, exacerbating poverty and limiting access to healthcare, thus increasing mortality rates (Adeosun *et al.,* 2022). In Nigeria, inconsistent GDP growth, coupled with poor economic management, has been linked to poor health outcomes, including higher crude death rates (Edeme & Olisakwe, 2019).

Empirical Review

Okoli *et al.* (2022) examines the geographic and socioeconomic inequalities in child survival in Nigeria. Using a cross-sectional study design and logistic regression analysis on Demographic and Health Survey (DHS) data, they found that child mortality rates were significantly higher in rural areas and among poorer households. The study concluded that macroeconomic disparities contribute to mortality differences in the country. While Bao *et al.* (2022) explored the relationship between real estate prices, inflation, and health outcomes in developed economies. Utilizing a panel data approach with fixed effects, the study found that rising real estate prices and inflation negatively affected public health outcomes, including mortality rates. The authors highlighted the importance of stabilizing economic variables to improve health metrics. In another research carried out by Adesete *et al.* (2022) investigated the impact of public health spending and macroeconomic uncertainty on health outcomes in Nigeria. The study employed an error correction model (ECM) using annual data from 1990 to 2020. It revealed that public health spending positively impacts health outcomes, but macroeconomic uncertainty, including inflation and unemployment, exacerbates mortality rates. Ohioze *et al.* (2022) investigated the effects of macroeconomic variable uncertainty on health outcomes in Nigeria. The study utilized a generalized method of moments (GMM) approach to analyze data from 1986 to 2020. It found that uncertainties in interest rates and exchange rates had significant adverse effects on mortality rates due to their impact on healthcare costs and availability.

Adeosun *et al.* (2022) explored the impact of key macroeconomic factors such as economic growth (measured by GDP per capita), inflation, and population size on the mortality rate in Nigeria using secondary data from 1991 to 2019 and the autoregressive distributed lag (ARDL) was used for analysis. The analysis revealed that in the short run, GDP per capita and inflation were found to have a positive relationship with the mortality rate, suggesting that increased economic growth and inflation did not contribute to reducing mortality. Importantly, the study found no evidence of long-term relationships between the examined macroeconomic variables and the mortality rate. They recommended that Nigerian policymakers adopt strategies aimed at mitigating the short-term negative impacts of inflation and economic growth on the population's health.

Onogiese *et al.* (2022) examined how population growth and related demographic factors affect GDP per capita across 66 countries that account for 85% of the global population. The study employed fixed effects estimators and panel causality tests from 2001 to 2019. The analysis revealed that aggregate population and fertility rate have a negative and significant impact on GDP per capita, indicating that higher population growth tends to reduce economic growth in terms of income per person. Furthermore, the panel causality tests demonstrated a bidirectional relationship between GDP per capita and the demographic and

capital variables, implying that changes in GDP per capita can also influence these factors over time. They recommended the implementation of policy measures to control the rising fertility rate as a way to improve GDP per capita. In another study, Sede and Ogiemudia (2021) focused on the effects of financial liberalization on health outcomes in Nigeria, particularly infant mortality. By applying vector autoregression (VAR) to analyze time series data from 1990 to 2018, the study found that financial liberalization had mixed effects on health outcomes, with indirect adverse impacts on mortality through economic instability and inequality. Raji (2020) also analyzed the effects of macroeconomic conditions on infant and under-five mortality rates in Nigeria. The study used an autoregressive distributed lag (ARDL) model to investigate the period from 1980 to 2017. The findings showed that high unemployment and inflation rates were associated with higher child mortality, while improvements in GDP growth reduced mortality.

Kidane and Woldemichael (2020) assessed the relationship between inflation and child mortality in developing countries. Using a panel data approach covering multiple countries, including Nigeria, they found that food inflation significantly increased child mortality rates. The study concluded that inflationary pressures worsen health outcomes by reducing household purchasing power and access to nutritious food. Edeme and Olisakwe (2019) examined the influence of public health expenditure and economic growth on health outcomes in Nigeria. Using the ARDL approach on data from 1990 to 2016, the study found that higher public health expenditure improved life expectancy and reduced mortality rates, while economic growth had a lesser, but still significant, effect. While Adofu and Abdulganiyu (2018) explored the relationship between unemployment and mortality rates in Nigeria. The study employed an ordinary least squares (OLS) regression analysis on data from 1990 to 2015. It found that higher unemployment rates led to increased mortality rates due to reduced access to healthcare services and lower living standards.

Hone *et al.* (2019) aimed to assess the association between economic recession and adult mortality in Brazil during the period of 2014-2016, using longitudinal analysis of 5,565 Brazilian municipalities from 2012 to 2017. With fixed-effect panel regression models They found that between 2012 and 2017, the crude municipal adult mortality rate in Brazil increased by 8%, from 143.1 deaths per 100,000 in 2012 to 154.5 deaths per 100,000 in 2017 and that a 1-percentage-point increase in the unemployment rate was associated with a 0.50 increase per 100,000 populations in all-cause mortality, primarily due to cancer and cardiovascular diseases. They recommended that adequate healthcare and social safety net programs can buffer the detrimental effects of unemployment on public health, especially in economically disadvantaged and vulnerable populations.

Rahman *et al.* (2018) assessed the impact of health expenditure on improving the overall health status in this region, which lags behind the OECD and global standards. They employed a panel data analysis, utilizing data from 15 countries in the SAARC-ASEAN region over a 20-year period (1995–2014). They used fixed and random effects models to estimate the effects of total health expenditure, public health expenditure, and private health expenditure on life expectancy, crude death rate, and infant mortality. The study also included

control variables like GDP per capita and sanitation improvements to isolate the effects of health spending on outcomes. The study revealed that all types of health expenditure—total, public, and private—contributed significantly to reducing infant mortality rates, with private health expenditure having a more substantial impact than public health expenditure. They recommended increasing healthcare expenditure in the SAARC-ASEAN region to enhance population health outcomes.

Adewuyi *et al.* (2017) analyzed the risk factors for infant mortality in rural and urban Nigeria. Using multivariate logistic regression on household survey data, the study identified that higher unemployment and lower income levels were significant predictors of higher infant mortality in both rural and urban settings. The study by Gordon and Sommers (2016) explored the relationship between macroeconomic conditions—particularly recessions, poverty, and unemployment—and mortality in the United States. Their primary aim was to assess how economic downturns, poverty rates, and lower median incomes affect mortality in both the short and long term by using a fixed-effects model to evaluate state-level data in the United States between 1993 and 2012. Their model incorporated unemployment rates, poverty rates, and median income as the key independent variables, while mortality rates served as the dependent variable. They also controlled for various socio-economic and demographic factors, including age and race, to isolate the specific impact of economic conditions on mortality. They found that higher unemployment rates have a modest negative impact on mortality, indicating that mortality tends to slightly decrease when unemployment rises compared to the impact of poverty. They suggested that safety-net programs, such as unemployment insurance and healthcare access for low-income individuals, should be strengthened, especially during and following recessions.

Dadgar and Norström (2016) sought to examine both the short-term and long-term effects of Gross Domestic Product (GDP) growth on traffic death rates in 18 OECD countries from 1960 to 201. They employed error correction modelling (ECM) to estimate the short-term and long-term effects of GDP on traffic deaths. The ECM allowed them to capture both the immediate changes in traffic deaths following GDP growth (short-term) and the more gradual effects over time (long-term). Period-specific analyses were also conducted to explore structural changes over time. The results revealed that GDP increases lead to a short-term rise in traffic deaths and recommended that countries continue investing in road safety measures and public health improvements to mitigate the short-term rise in traffic deaths that accompanies economic expansion.

Onwumere *et al.* (2016) aimed to explore the relationship between inflation and public health outcomes in Nigeria. Using a structural vector autoregression (SVAR) model, the study revealed that inflationary pressures increased mortality rates by raising healthcare costs and reducing affordability of essential medicines and services. Bakare and Sanmi (2015) examined the impact of exchange rate fluctuations on public health outcomes in Nigeria. Applying the ARDL model, they found that exchange rate depreciation led to an increase in the prices of imported medical equipment and drugs, which adversely affected healthcare delivery and contributed to higher mortality rates.

Theoretical Framework

This paper adopts the Grossman Health Production Theory, which was propounded by Michael Grossman in 1972, emphasizing that health can be viewed as a durable good or capital that depreciates over time (Grossman, 1972). Grossman suggests that individuals invest in their health—through medical care, healthy behaviors, and lifestyle choices—to increase their stock of health capital, which in turn influences their productivity and longevity (Grossman, 1972). The Grossman Health Production Theory treats health as both a consumption good and an investment good. As a consumption good, health directly provides utility to individuals because they feel better when they are healthy. As an investment good, healthy increases the number of healthy days available for work, thus improving individuals' earning potential and overall economic productivity (Grossman, 1972). People "produce" health by making choices about medical care, nutrition, exercise, and other factors, while also facing the risk of illness and aging, which deplete health capital over time (Grossman, 1972). In the context of this paper, on the impact of macroeconomic variables on mortality rate in Nigeria, Grossman's theory can be used to explain how economic factors like inflation rate, unemployment rate, interest rate, exchange rate, and GDP growth rate indirectly affect health outcomes and mortality. For instance: The unemployment rate can affect individuals' ability to invest in health due to loss of income, leading to lower health capital and higher mortality rates (Adofu & Abdulganiyu, 2018). Inflation rate impacts the prices of medical facilities, the interest rate impacts the cost of borrowing, which may influence healthcare investments; for example, households may avoid taking loans for medical care when interest rates are high (Adesete *et al.,* 2022). Exchange rate fluctuations can affect the cost of importing essential medical supplies, which can then impact the quality of healthcare services (Ohioze *et al.*, 2022). The GDP growth rate represents overall economic performance, and a growing economy generally increases health capital by providing resources for improved healthcare infrastructure and better living conditions (Edeme & Olisakwe, 2019). Thus, Grossman's Health Production Theory provides a robust framework to understand how macroeconomic conditions shape health investments, ultimately influencing mortality rates. This theory helps establish a conceptual link between the independent macroeconomic variables (interest rate, unemployment, exchange rate, GDP growth) and the dependent variable (mortality rate) in the paper.

Methodology

The research design employed in this research is ex-post facto, utilizing secondary annual time series data spanning from 1990 to 2023. The data on crude death rate, serving as the indicator for mortality, were sourced from the World Bank Online Data Bank, 2024. Key macroeconomic variables including the inflation rate, interest rate, exchange rate, and gross domestic product (GDP) growth rate were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin, December 2024. Unemployment rate data and mortality rate (crude death rate) were gathered from the World Bank Online Data Bank, 2024. All data were selected for their relevance to the analysis of the impact of macroeconomic variables on mortality rates in Nigeria.

Model Specification

This investigation employed the Autoregressive Distributed Lag (ARDL) technique, grounded in the theoretical framework outlined in the research. The model was adapted from the work of Ohioze *et al*. (2022), who examined macroeconomic variable uncertainties and their impact on health outcomes in Nigeria. Their functional relationship model is expressed as:

$$Hoct = f(X\_unc)\ t + ut \qquad (1)$$

In this equation, $Hoct$ represents the dependent variable, and $XuncX_\{unc\}$Xunc denotes a vector of uncertainties associated with the macroeconomic variables. For this paper, the vector of uncertainties has been replaced with the relevant explanatory variables.

$$Hoct = \beta 0 + \beta_1 EXR\_UNCt + \beta_2 INFR\_UNCt + \beta_3 LnPCI\_UNCt + u_t \qquad (2)$$

For this paper, $Hoct$ represents health outcomes, Exr_unc denotes exchange rate uncertainty, $Infr\_unc$ is inflation rate uncertainty, and $LnPCI\_UNCt$ stands for the natural logarithm of per capita income uncertainty, with "t" representing the time period from 1980 to 2019. The coefficient is represented by β.

Equation (2) is modified to align with the objectives of this research and to establish the functional relationship between macroeconomic variables and mortality rate in Nigeria. Consequently, the functional form of the model for this study, which includes macroeconomic variables and mortality rate indicator, is expressed in the following implicit model:

$$MTR = f(IRN, ITN, URN, ERN, GDPR) \qquad (3)$$

Where;

MRN is the mortality rate, IRN is Inflation Rate, ITN is Interest Rate, URN is Unemployment Rate, ERN is Exchange Rate, GDPR is Real Gross Domestic rate.

This research further specifies equation (3) in a stochastic (linear regression) form to gives:

$$MTR_t = \alpha_0 + \alpha_1 IRN_t + \alpha_2 ITN_t + \alpha_3 URN_t + \alpha_4 ERN_t + \alpha_5 GDPR_t + \mu_t \qquad (4)$$

Where;

The α_0 is Intercept, α_1, α_2, α_3, α_4, and α_5 are Slope and μ_t is the Error Terms. The Autoregressive Distributed Lagged (ARDL) model that was used in this paper is specified as follows:

$$MTR = \alpha_0 + \sum_{i=1}^{i} \alpha_{1i} \Delta MTR_{t-i} + \sum_{i=1}^{j} \alpha_{2i} \Delta IRN_{t-i} + \sum_{i=1}^{k} \alpha_{3i} \Delta ITN_{t-i} + \sum_{j=1}^{l} \alpha_{4i} \Delta URN_{t-i} + \sum_{i=1}^{m} \alpha_{5i} \Delta ERN_{t-i} + \sum_{i=0}^{n} \alpha_{6i} \Delta GDPR_{t-i} \qquad (5)$$
$$+ \alpha_{7i} \Delta MTR_{t-i} + \alpha_{8i} \Delta IRN_{t-i} + \alpha_{9i} \Delta ITN_{t-i} + \alpha_{10i} \Delta URN_{t-i} + \alpha_{11i} \Delta ERN_{t-i} + \alpha_{12} \Delta GDPR_{t-i} + \mu_t$$

Equation (5) was employed to assess both the short-run and long-run relationships, as well as the impact of macroeconomic variables on mortality rate in Nigeria. The Error Correction Model (ECM) utilized in this investigation is formulated as follows:

$$\Delta MTR = \alpha_0 + \sum_{g=1}^{i} \alpha_{1i} \Delta MTR_{t-i} + \sum_{k=1}^{j} \alpha_{2i} \Delta IRN_{t-i} + \sum_{i=1}^{n} \alpha_{3i} \Delta ITN_{t-i} + \sum_{j=1}^{l} \alpha_{4i} \Delta URN_{t-i} + \sum_{k=1}^{m} \alpha_{5i} \Delta ERN_{t-i} + \sum_{l=0}^{n} \alpha_{6} \Delta GDPR_{t-i} + ECM_{t-i} + \mu_i \quad (6)$$

Equation (6) was employed to assess both the short-run and long-run relationships, as well as the impact of macroeconomic variables on mortality rate in Nigeria.

Variable Description, Measurements and Apriori Expectation

Table 2: Description of the Variables Used for the Model

Variable	Description/Measure	Type	Source	Apriori Expectation
MRN	Mortality Rate (Crude Death Rate per 1,000 people)	Dependent	World Bank (Online Databank), 2023	Not Applicable
IRN	Inflation Rate	Independent	Central Bank of Nigeria (CBN)	$\alpha_1 > 0$
ITN	Interest Rate (Lending interest rate %)	Independent	Central Bank of Nigeria (CBN)	$\alpha_2 > 0$
URN	Unemployment Rate (% of total labor force)	Independent	National Bureau of Statistics (NBS)	$\alpha_3 > 0$
ERN	Exchange Rate (Naira per US Dollar)	Independent	CBN Statistical Bulletin, 2023	$\alpha_4 > 0$
GDPR	Gross Domestic Product Growth Rate (%)	Independent	World Bank (Online Databank), 2023	$\alpha_5 < 0$

Source: Author Compilation, 2024

The presupposition for this paper is that the coefficients of the independent variables (α_1, α_2, α_3, α_4 and α_5) may signify either positive or negative correlations with mortality rate (MRN). Specifically, it is expected that rising α_1 inflation may increase the cost of medical supplies and healthcare services, making them less accessible. and α_2 (Interest Rate) and α_3 (Unemployment Rate) will have positive relationships with MRN, implying that higher interest rates and unemployment rates could lead to increased mortality due to reduced affordability of healthcare and loss of income. Similarly, α_4 (Exchange Rate) is anticipated to positively affect MRN, as fluctuations in exchange rates may increase the cost of imported medical supplies, thereby worsening health outcomes. Conversely, α_5 (Gross Domestic Product Growth Rate) is expected to have a negative relationship with MRN, as higher economic growth is associated with better living conditions and increased health capital, leading to a reduction in mortality rates. Thus, changes in these macroeconomic variables will influence the crude death rate in Nigeria over the study period.

Method of Analysis

This paper utilized the Autoregressive Distributed Lag (ARDL) technique, introduced by Pesaran and Pesaran in the late 1990s. The ARDL technique is particularly useful for analyzing the dynamic relationships between variables, as it allows for the examination of both short-run and long-run effects within a single framework.

Presentation and Interpretation of Results

Descriptive Analysis

Table 3: Descriptive Analysis

	MTR	IRN	ITN	URN	ERN	GDPR
Mean	15.89812	18.08576	18.23970	4.082242	146.6518	4.600909
Median	15.56100	12.88000	17.95000	3.878000	129.3600	4.050000
Maximum	18.87000	72.84000	29.80000	5.633000	425.9800	14.60000
Minimum	12.98900	5.390000	12.14000	3.507000	8.040000	-1.920000
Std. Dev.	2.178198	16.10830	3.654074	0.539717	116.5638	3.898779
Skewness	0.124712	2.199110	0.980023	1.536287	0.837470	0.502970
Kurtosis	1.473658	6.826989	4.887923	4.302040	2.932355	2.825816
Jarque-Bera	3.288907	46.73650	10.18330	15.31203	3.863745	1.433102
Probability	0.193118	0.000000	0.006148	0.000473	0.144877	0.488434
Sum	524.6380	596.8300	601.9100	134.7140	4839.510	151.8300
Sum Sq. Dev.	151.8255	8303.273	427.2723	9.321426	434787.6	486.4153
Observations	33	33	33	33	33	33

Source: Researcher's Computation Using EViews-12 (2024)

Table 3 presents the descriptive statistics for the variables used in the study. The average mortality rate (MTR) in Nigeria over the period is 15.89812, with a maximum of 18.87 and a minimum of 12.9890. The standard deviation of 2.17819 suggests moderate variability in the mortality rate. For the inflation rate (IRN), the mean value is 18.08576, with a significantly higher maximum value of 72.84 and a minimum of 5.39, indicating high inflation volatility during the period. The interest rate (ITN) averages at 18.23970, with a maximum of 29.80 and a minimum of 12.14. Unemployment rate (URN) shows an average of 4.082242, with a relatively stable range between 3.51 and 5.63. The exchange rate (ERN) displays a mean value of 146.6518, reflecting the impact of exchange rate fluctuations over time, with a wide range from a minimum of 8.04 to a maximum of 425.98. The real GDP growth rate (GDPR) has a mean of 4.600909, with a maximum of 14.60 and a minimum of -1.92, highlighting both periods of growth and contraction in the economy.

Mortality rate (MTR) has a kurtosis of 1.473658, which is less than 3, indicating a platykurtic distribution (flatter than a normal distribution) while Inflation rate (IRN), Interest rate (ITN) and Unemployment rate (URN) has a kurtosis of 6.826989, 4.887923 and 4.302040 respectively, which is greater than 3, showing a leptokurtic distribution (more peaked and with fatter tails than normal) and the Exchange rate (ERN) and GDP growth rate (GDPR) has a kurtosis of 2.932355 and 2.825816 respectively, which is close to 3, indicating a mesokurtic distribution (similar to normal). The Jarque-Bera test for normality suggests that the inflation rate (IRN) and interest rate (ITN) deviate from normal distribution, with p-values less than

0.05. In contrast, mortality rate (MTR), unemployment rate (URN), exchange rate (ERN), and real GDP growth rate (GDPR) appear to be normally distributed, as their p-values exceed 0.05.

Correlation Matrix Results

Table 4: Correlation Matrix Results

Correlation

Probability	**MTR**	**IRN**	**ITN**	**URN**	**ERN**	**GDPR**
MTR	1.000000					

IRN	0.467689	1.000000				
	0.0061	-----				
ITN	0.616485	0.306883	1.000000			
	0.0001	0.0824	-----			
URN	-0.437234	0.064158	-0.386605	1.000000		
	0.0109	0.7228	0.0263	-----		
ERN	-0.891453	-0.323941	-0.602967	0.618566	1.000000	
	0.0000	0.0659	0.0002	0.0001	-----	
GDPR	0.057403	-0.307020	0.276720	-0.612669	-0.197207	1.000000
	0.7510	0.0822	0.1190	0.0002	0.2713	-----

Source: Author's Computation, using E-Views 12, (2024)

Table 4 shows the correlation matrix of the variables used in this paper and the correlation matrix results indicate that the mortality rate (MTR) has varying degrees of association with the independent macroeconomic variables. Starting with the inflation rate (IRN), the correlation coefficient is 0.4677, showing a moderate positive relationship between inflation and mortality rate. This suggests that as the inflation rate increases, mortality rates also rise, and the relationship is statistically significant with a p-value of 0.0061, confirming the importance of inflation in affecting health outcomes. Next, the interest rate (ITN) demonstrates a strong positive correlation with the mortality rate, as reflected by a coefficient of 0.6165 and a p-value of 0.0001. This significant result suggests that higher interest rates are associated with higher mortality rates, implying that economic conditions linked to borrowing costs can directly or indirectly influence health outcomes in Nigeria. On the other hand, the unemployment rate (URN) shows a negative correlation with the mortality rate, with a coefficient of -0.4372 and a p-value of 0.0109. This moderate negative relationship suggests that increases in unemployment tend to lower mortality rates, although this could be due to complex economic or social factors affecting labor force dynamics and healthcare access.

The exchange rate (ERN) exhibits a strong negative correlation with mortality rate, as indicated by a coefficient of -0.8915 and a p-value of 0.0000. This implies that a rising exchange rate, which likely affects the cost of imported goods including healthcare supplies, is associated with lower mortality rates, possibly due to increased affordability of health-related imports when the currency appreciates. Finally, the correlation between real gross domestic product growth rate (GDPR) and mortality rate is very weak, with a coefficient of 0.0574 and an insignificant p-value of 0.7510. This suggests that GDP growth has no substantial direct effect on mortality rate within the period studied.

Stationary Tests (Unit Root Tests)
This section shows the unit root of the variables using the Augmented Dickey-Fuller (ADF) Test to check the stationary at a 5 per cent level of significance.

Table 5: Unit Root Test Result

Variable	Augmented Dickey-Fuller (ADF) Test		
	ADF	@ 5%	Status
MTR	-2.583015	-1.951687	1(0)
IRN	-4.645122	-2.957110	1(1)
ITN	-3.718300	-2.957110	1(0)
URN	-3.283683	-2.960411	1(1)
ERN	-3.972567	-2.957110	1(1)
GDPR	-3.318763	-2.954021	1(0)

Source: Author's Computation Using EViews-12 (2024)

Table 5 displays the results of the Augmented Dickey-Fuller (ADF) unit root test conducted on the variables used in this study: mortality rate (MTR), inflation rate (IRN), interest rate (ITN), unemployment rate (URN), exchange rate (ERN), and real gross domestic product growth rate (GDPR). The ADF test results reveal that MTR, ITN, and GDPR are stationary at level, indicating that these variables are integrated of order zero, denoted as 1(0), at the 5% level of significance. This means that they do not require differencing to achieve stationarity.

In contrast, IRN, URN, and ERN are not stationary at level but become stationary after first differencing, signifying that they are integrated of order one, denoted as 1(1). These results suggest that the variables exhibit a mix of integration orders, with some being stationary at level and others after first differencing. Given this mix of integration orders, the autoregressive distributed lag (ARDL) bounds test will be appropriate for examining the long-run relationship among the variables. The ARDL model, as outlined by Pesaran *et al*. (2001), can handle such a combination of stationary variables at different levels, allowing for the analysis of both short-run and long-run dynamics.

Co-integration of ARDL-Bounds Test
This section shows the ARDL co-integration bounds test of the variables used in this paper.

Table 6: ARDL-Bound Testing

Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	4.987061	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.08	3
5%	2.39	3.38
2.5%	2.7	3.73
1%	3.06	4.15

Source: Researcher's Computation Using EViews-9 (2023)

Table 6 presents the ARDL bounds test for co-integration conducted across all six models in line with the research objectives. The test results reveal that the calculated F-statistic of 4.987061 surpasses the critical values from the Pesaran Table at the 5% significance level, with the lower bound at 2.39 for 1(0) and the upper bound at 3.38 for 1(1). This indicates that the variables—mortality rate (MTR), inflation rate (IRN), interest rate (ITN), unemployment rate (URN), exchange rate (ERN), and real gross domestic product growth rate (GDPR)—are co-integrated at the 5% significance level, confirming a long-run relationship among the macroeconomic variables and mortality rate in Nigeria.

ARDL Regression Result

The Autoregressive Distributed Lag (ARDL)-ECM and long-run estimates presented here provide significant insights into how macroeconomic variables affect mortality rate in Nigeria over short and long term.

Table 7: Method- ARDL-ECM and Long Run Estimates
Dependent Variable: RGDP

Error Correction Estimates

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(MTR(-1))	-0.452059	0.170003	-2.659126	0.0288
D(IRN)	0.006313	0.001111	5.679504	0.0005
D(IRN(-1))	-0.003861	0.001238	-3.118133	0.0143
D(IRN(-2))	-0.004820	0.001190	-4.051759	0.0037
D(ITN)	-0.004777	0.004098	-1.165763	0.2773
D(ITN(-1))	-0.055516	0.007276	-7.629522	0.0001
D(ITN(-2))	-0.022036	0.005591	-3.941258	0.0043
D(URN)	-0.467279	0.072140	-6.477418	0.0002
D(URN(-1))	0.255310	0.111474	2.290307	0.0512
D(ERN)	0.002023	0.000655	3.089899	0.0149
D(ERN(-1))	0.001223	0.000812	1.507098	0.1702
D(ERN(-2))	-0.004038	0.000662	-6.100402	0.0003
D(GDPR)	-0.003759	0.004908	-0.765944	0.4657
D(GDPR(-1))	0.050398	0.007676	6.565319	0.0002
D(GDPR(-2))	0.012006	0.004452	2.697054	0.0272
CointEq(-1)*	-0.168557	0.021565	-7.816105	0.0001
R-squared	0.999726			
Adjusted R-squared	0.999008			
F-statistic	1391.741			
Prob(F-statistic)	0.0000			
Durbin-Watson stat	2.402030			
Long-Run Estimates				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
IRN	0.060995	0.037528	1.625312	0.1427
ITN	0.365072	0.106074	3.441676	0.0088
URN	-1.066561	1.525984	-0.698933	0.5044
ERN	-0.005723	0.008208	-0.697250	0.5054
GDPR	-0.270904	0.175494	-1.543668	0.1612
C	12.71798	4.920036	2.584936	0.0324

Source: Researcher's Computation Using EViews-12 (2024)

Table 7 presents the ARDL long-run results, which reveal several important relationships between the variables under consideration. The coefficient for the error correction term (CointEq(-1)) is -0.16855, with a standard error of 0.021565 and a t-statistic of -7.816105. The probability value of 0.0001 indicates that the coefficient is highly significant, implying that any short-term disequilibrium is corrected by approximately 16.86% each period toward long-run equilibrium. This reflects a strong adjustment speed toward restoring equilibrium in the long run.

For the inflation rate (IRN), the coefficient is 0.060995 with a standard error of 0.037528 and a t-statistic of 1.625312. The probability value of 0.1427 shows that the impact of inflation on mortality rate is insignificant at the 5% level, suggesting that changes in inflation do not have a meaningful long-term influence on the mortality rate in Nigeria. The interest rate (ITN) presents a positive and significant coefficient of 0.365072, with a standard error of 0.106074 and a t-statistic of 3.441676. The probability value of 0.0088 confirms its significance, indicating that an increase in the interest rate significantly contributes to higher mortality rates in Nigeria over the long run. Unemployment rate (URN), with a coefficient of -1.066561, standard error of 1.525984, and a t-statistic of -0.698933, shows an insignificant negative impact on mortality rate, as indicated by the probability value of 0.5044. This suggests that variations in unemployment do not significantly affect the mortality rate in the long term.

Similarly, the exchange rate (ERN) shows an insignificant negative coefficient of -0.005723, with a standard error of 0.008208 and a t-statistic of -0.697250. The probability value of 0.5054 suggests that changes in exchange rate do not significantly influence mortality rate in Nigeria over the long term. Lastly, the real gross domestic product growth rate (GDPR) has a coefficient of -0.270904, a standard error of 0.175494, and a t-statistic of -1.543668. With a probability value of 0.1612, this indicates an insignificant negative effect on mortality rate, implying that economic growth does not significantly influence mortality in Nigeria over the long term.

The hypothesis tests further clarify these findings. The hypothesis stating that H_{01}: Inflation rate has no significant impact on mortality rate in Nigeria is accepted, given the probability value of 0.1427, which is greater than the 5% significance level. However, the hypothesis H_{02}: Interest rate has no significant impact on mortality rate is rejected, given the probability value of 0.0088, which is below the 5% level, signifying that interest rates have a significant long-term impact on mortality in Nigeria. In contrast, H_{03}: Unemployment rate has no significant impact on mortality rate is accepted, as the probability value of 0.5044 exceeds the 5% threshold. Likewise, H_{04}: Exchange rate has no significant impact on mortality rate is accepted due to its probability value of 0.5054, which is greater than 0.05. Finally, H_{05}: Economic growth rate has no significant impact on mortality rate is accepted, with a probability value of 0.1612, suggesting that economic growth does not significantly influence mortality rate in the long run.

Post-Estimation Checks (ARDL Diagnostic Test)

The ARDL diagnostic checks presented in Table 8 are essential for confirming the robustness and reliability of the regression model used to examine the impact of macroeconomic variables on mortality rate in Nigeria. These post-estimation tests evaluate key assumptions of the ARDL regression analysis, ensuring that the conclusions drawn from the model are statistically valid and dependable.

Table 8: Results of ARDL Diagnostic Checks

Tests		Outcomes	
		Coefficient	Probability
Breusch-Godfrey-Serial-Correlation Test	F-stat.	3.162782	0.1154
Heteroscedasticity-Breusch-Pagan-Godfrey Test	F-stat.	0.586177	0.8444
Normality Test	Jarque-Bera	3.264031	0.195535

Source: Author's Computation Using EViews-12 (2024)

Table 8 presents the results of the diagnostic tests carried out to validate the ARDL model. The Breusch-Godfrey Serial Correlation LM Test checks for the presence of serial correlation in the residuals. Serial correlation can compromise the efficiency of estimators and lead to biased standard errors. In this case, the test yields an F-statistic of 3.162782 and a probability value of 0.1154, indicating that the null hypothesis of no serial correlation cannot be rejected. This implies that the residuals are independent over time, a desirable property in time series models. Next, the Heteroscedasticity Breusch-Pagan-Godfrey Test is applied to check for heteroscedasticity, where the variance of the error terms is unequal across levels of the independent variables. The F-statistic of 0.586177 and a probability value of 0.8444 suggests that there is no significant evidence of heteroscedasticity in the model. Thus, the error terms have constant variance, ensuring reliable standard errors and hypothesis tests. Finally, the Jarque-Bera Normality Test is used to assess whether the residuals are normally distributed. The test statistic is 3.264031, with a probability value of 0.195535, indicating that the residuals follow a normal distribution. With a high p-value, the null hypothesis of normality cannot be rejected, fulfilling another key assumption of the classical linear regression model.

Discussion of Findings

The paper focuses on the impact of macroeconomic variables on the mortality rate in Nigeria. Based on the research objectives, the results indicate that the inflation rate (IRN) has a positive but insignificant impact on mortality in Nigeria, implying that an increase in inflation rate does not significantly affect mortality. This finding aligns with the study of Adeosun *et al.,* (2022). who investigate the impact of critical macroeconomic drivers like economic growth (gross domestic product (GDP)/capita), inflation and population size on the mortality rate of Nigeria and found a weak relationship between inflation and mortality rates. On the other hand, the interest rate (ITN) shows a positive and significant impact on mortality, suggesting that an increase in interest rates is associated with a significant rise in mortality. This outcome is consistent with findings by Sede and Ogiemudia (2021), who examined the effect of financial liberalization on health outcomes, taking on the case of infant mortality in Nigeria, concluding that higher interest rates adversely affect public health. Unemployment rate

(URN) presents a negative but insignificant relationship with mortality, indicating that higher unemployment does not significantly reduce mortality in Nigeria. This result is in line with the work of Gordon and Sommers (2016), who investigated recessions, poverty, and mortality in the United States: 1993–2012. and found to have substantial effect of unemployment on mortality rates.

Similarly, the exchange rate (ERN) demonstrates a negative but insignificant effect on mortality, meaning that fluctuations in the exchange rate do not have a significant influence on mortality in Nigeria. This finding agrees with the study of Raji (2020) who found that exchange rate enhanced the increased level of infant and under-five mortality rates in Nigeria, indicating that it does not substantially reduce mortality in Nigeria. While GDP growth rate with negative insignificant impact on mortality rate which does not align with Dadgar and Norström, (2016) findings that increased GDP leads to an immediate increase in traffic deaths, but after the mid-1970s, this short-term effect is more than outweighed by a stronger protective long-term effect. Overall, the findings highlight the mixed impact of macroeconomic variables on mortality in Nigeria, with interest rates showing the only significant relationship, while other variables such as inflation, unemployment, exchange rate, and economic growth exhibit insignificant effects.

Conclusion and Recommendations

In conclusion, this paper examined the impact of various macroeconomic variables on mortality rate in Nigeria using ARDL results. Among the independent variables, only the interest rate (ITN) was found to have a statistically significant impact, showing a positive relationship with mortality. This indicates that higher interest rates contribute to an increase in mortality rates in the country. Other variables, such as inflation rate (IRN), unemployment rate (URN), exchange rate (ERN), and real GDP growth rate (GDPR), did not show significant effects on mortality. Based on these findings, the following recommendations are proposed:

1. Given the positive but insignificant impact of the inflation rate on mortality, it is recommended that the Central Bank of Nigeria (CBN) and the Ministry of Finance work together to maintain stable inflation levels by strengthening monetary policy tools and fiscal discipline. This would ensure that inflation remains under control, which, in turn, could help to improve health outcomes indirectly by preserving the purchasing power of households, particularly for healthcare needs.
2. Since the interest rate has a significant and positive impact on mortality, it is crucial for the Central Bank of Nigeria to implement policies that aim at reducing interest rates. Lowering interest rates can encourage borrowing and investment in sectors like healthcare, leading to better access to health services and infrastructure. The CBN should prioritize monetary policies that keep interest rates at levels that foster health-improving investments.
3. Although unemployment was found to have an insignificant relationship with mortality, reducing unemployment rates could still enhance overall well-being. The Ministry of Labor and Employment and National Directorate of Employment (NDE) should intensify job creation initiatives, especially targeting youth and rural

populations, which could indirectly lead to improved health outcomes by increasing access to healthcare services through higher household incomes.

4. The paper's results suggest that exchange rate fluctuations do not significantly affect mortality. However, maintaining a stable exchange rate can contribute to overall economic stability. The CBN and Ministry of Trade and Investment should implement strategies to stabilize the exchange rate, as this will help control the cost of imported medical supplies and healthcare services, ultimately contributing to improved health conditions.
5. Although real GDP growth did not significantly reduce mortality in this paper, sustained economic growth could enhance healthcare funding and infrastructure development. The Federal Ministry of Budget and National Planning should prioritize healthcare investment in national development plans. By allocating more resources to health and increasing spending on social services, economic growth can translate into better healthcare outcomes, potentially reducing mortality over time.

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APPENDICES

APENDIX A: DATA FOR REGRESSION

Table 1: Data for Regression

YEARS	MTR	IRN	ITN	URN	ERN	GDPR
1990	18.631	7.36	25.5	3.71	8.04	11.63
1991	18.819	13.01	20.01	3.83	9.91	-0.55
1992	18.805	44.59	29.8	3.773	17.3	2.19
1993	18.702	57.17	18.32	4.095	22.05	1.57
1994	18.87	57.03	21	4.152	21.89	0.26
1995	18.859	72.84	20.18	4.276	21.89	1.87
1996	18.757	29.27	19.74	4.12	21.89	4.05
1997	18.531	8.53	13.54	4.008	21.89	2.89
1998	18.289	10	18.29	3.948	21.89	2.50
1999	17.865	6.62	21.32	4.037	92.69	0.52
2000	17.464	6.93	17.98	3.991	102.11	5.52
2001	17.158	18.87	18.29	3.92	111.94	6.67
2002	16.919	12.88	24.85	3.606	120.97	14.60
2003	16.541	14.03	20.71	3.566	129.36	9.50
2004	16.271	15	19.18	3.507	133.5	10.44
2005	15.883	17.86	17.95	3.692	132.15	7.01
2006	15.561	8.23	17.26	3.726	128.65	6.73
2007	15.322	5.39	16.94	3.791	125.83	7.32
2008	15.161	11.58	15.14	3.791	118.57	7.20
2009	14.82	12.54	18.99	3.755	148.88	8.35
2010	14.628	13.74	17.59	3.731	150.3	9.54
2011	14.336	10.83	16.02	3.77	153.86	5.31
2012	14.193	12.22	16.79	3.768	157.5	4.21
2013	14.004	8.5	16.72	3.71	157.31	5.49
2014	13.892	8.05	16.55	3.878	158.55	6.22
2015	13.803	9.01	16.85	4.106	193.28	2.79
2016	13.638	15.7	16.87	4.52	253.49	-1.58
2017	13.435	16.5	17.56	4.885	305.79	0.82
2018	13.239	12.1	19.33	5.119	306.08	1.91
2019	12.989	11.4	15.53	5.206	306.92	2.27
2020	12.997	13.25	12.32	5.633	358.81	-1.92
2021	13.083	16.95	12.65	5.264	400.24	3.40
2022	13.173	18.85	12.14	3.83	425.98	3.10
2023	13.188	24.66	12,65	3.576	645.19	3.20

Source: World Development Indicators, 2024 and National Bureau of Statistics, 2024

Note: MRN is the mortality rate (proxied by crude death rate), IRN is Inflation Rate, ITN is Interest Rate, URN is Unemployment Rate, ERN is Exchange Rate, GDPR is Real Gross Domestic rate.