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# Food reserves, hunger and food market stability as correlates of infant, child, and maternal mortality in Nigeria

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**Abstract**
This article investigates the interplay between food reserves, hunger levels, food market stability, and their impact on infant, child, and maternal mortality rates in Nigeria. Based on historical data of a 22-year time series, the study employs regression analysis to explore these correlations, providing empirical insights crucial for public health and policy formulation. The findings reveal significant relationships between the mortality rates and the economic indicators studied. Specifically, the regression outputs indicate that for infant mortality rate (INMR), there is an inverse association with the overall consumer price index (CPIA), implying that as CPIA increases, INMR decreases. Conversely, the food consumer price index (CPIF) shows a positive correlation with INMR, suggesting that higher food prices may lead to increased infant mortality. Moreover, hunger (HUNG) exhibits a negative coefficient with INMR, indicating that higher levels of hunger are associated with higher infant mortality rates. For maternal mortality rate (MAMR), the regression results indicate a positive relationship with CPIA and CPIF, implying that both overall and food-specific inflation may contribute to higher maternal mortality rates. Additionally, hunger shows a significant negative impact on MAMR, suggesting that addressing hunger could potentially reduce maternal mortality rates in Nigeria. Similarly, the analysis for under-five mortality rate (U5MR) reveals negative coefficients for CPIA and HUNG, indicating that higher overall inflation and hunger are associated with increased child mortality rates. Conversely, CPIF exhibits a positive coefficient with U5MR, suggesting that higher food prices may also contribute to higher child mortality rates. These findings underscore the complex dynamics between economic factors, food security, and mortality outcomes in Nigeria. They form the bases for recommendations highlighting the urgent need for targeted policies that address food accessibility, market stability, and hunger to mitigate adverse public health outcomes among vulnerable populations, particularly infants, children, and mothers.

**Keywords:** Food Security, Infant Mortality, Child Mortality, Maternal Mortality, Food Market Stability

## Introduction

The relationship between food security and public health has long been a focal point of research in both developed and developing nations (Smith & Haddad, 2000; Black et al, 2008). In Nigeria, a country characterized by a complex socio-economic landscape, the issues of food reserves, hunger, and food market stability are of paramount importance, particularly when examining their impacts on vulnerable populations such as infants, children, and mothers. According to the National Bureau of Statistics (NBS), the food inflation rate in Nigeria was 35.41% in January 2024, 11.9% higher than January 2023 (24.32%). The food inflation rate in February 2024 was 37.92% on a year-on-year basis, which was 13.57% points higher than February 2023 (24.35%). The cost of food in Nigeria increased 40.01% in March 2024 over the same month in the previous year.

This study explores the intricate correlations between these factors and the mortality rates among these groups, providing insights that are crucial for shaping effective public health policies. Food reserves play a critical role in ensuring food security, particularly in times of crisis or scarcity. They act as a buffer, protecting vulnerable populations from the harsh effects of food shortages. In Nigeria, the importance of food reserves cannot be overstated, given the country's susceptibility to various shocks, including economic downturns, climatic changes, and conflicts. These reserves are vital for maintaining a steady supply of food, thereby preventing sharp increases in food prices that could otherwise lead to widespread hunger and malnutrition. However, the effectiveness of food reserves in reducing mortality rates is closely tied to the stability of food markets and the broader economic environment.


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AGRA (2023) finds that Nigeria has a combined total storage capacity of 1,336,000 MT in 33 strategic food reserves when fully utilized and 51 warehouses with a combined capacity of 108,000MT. The management of 17 out of these 33 strategic food reserves has been transferred to private companies while 16 are retained by the federal government for strategic food reserve and price-stabilization. Only six out of the 16 reserves that are retained by the federal government were operational, leaving much to be desired in respect of the hunger situation. Hunger, itself, is a direct consequence of food insecurity and has a profound impact on health outcomes. In Nigeria, hunger remains a significant public health challenge, contributing to high rates of malnutrition, particularly among children and pregnant women. Malnutrition, in turn, increases susceptibility to infections and diseases, leading to higher mortality rates. The links between hunger and mortality are well-documented, with numerous studies showing that inadequate nutrition during pregnancy can lead to complications that increase the risk of maternal and infant mortality (Oyekale & Oladeji, 2020; Akinwale & Adewumi, 2022). Similarly, children who are malnourished are more likely to suffer from stunted growth, weakened immune systems, and developmental delays, all of which contribute to higher child mortality rates.

Food market stability is another crucial factor influencing public health outcomes. In a stable food market, prices remain relatively constant, allowing families to plan their food purchases and ensure consistent access to essential nutrients. However, in Nigeria, food markets are often characterized by volatility, with prices fluctuating due to a variety of factors including seasonal changes, transportation challenges, and economic policies. These fluctuations can have devastating effects on low-income families, who may be unable to afford basic food items when prices spike. The impact of food market instability is particularly severe for mothers and children, who require consistent access to nutritious food to maintain their health (WHO, 2018; NBS, 2020). This study is set against the backdrop of Nigeria's ongoing struggles with food insecurity, which is exacerbated by the country's economic challenges. Nigeria's economy, heavily reliant on oil exports, has experienced significant volatility in recent decades, leading to periods of economic recession, inflation, and unemployment. These economic challenges have direct implications for food security, as they affect both the availability of food and the purchasing power of households. For instance, inflation can erode the value of incomes, making it more difficult for families to afford food, while unemployment can lead to loss of income altogether, pushing families into hunger and poverty.

To better understand the relationship between food security and mortality rates in Nigeria, this study employs regression analysis on a 22-year time series data set. The data encompasses various economic indicators, including the overall consumer price index (CPIA) and the food consumer price index (CPIF), as well as hunger levels and mortality rates for infants, children under five, and mothers. The use of regression analysis allows for the identification of significant correlations and provides a quantitative basis for understanding how changes in food reserves, hunger, and food market stability impact mortality rates. The CPIA measures the average open market change in prices, reflecting the inflation level. The CPIF measures the change in prices specifically for food items. The variables are used, in this study, to assess the impact of overall inflation on mortality rates. The link between economic instability and maternal health is well-established, with research showing that economic downturns often lead to reduced access to healthcare services, increased stress, and poor nutritional outcomes for pregnant women. In Nigeria, where many women already face barriers to accessing quality maternal healthcare, the added burden of rising prices can exacerbate these challenges, leading to higher mortality rates (Oyekale & Oladeji, 2020; Akinwale & Adewumi, 2022). The analysis also examines under-five mortality rates (U5MR), which represent the probability of a child dying before reaching the age of five.

The findings of this study underscore the complex and multifaceted nature of the relationships between food security, economic stability, and mortality outcomes in Nigeria. In particular, the study's findings suggest that food storage policies aimed at reducing food price volatility and enhancing food security could have a significant impact on reducing mortality rates among infants, children, and mothers; stressing the critical importance of food security in determining health outcomes for vulnerable populations in Nigeria.

The complex interactions between food reserves, hunger, food market stability, and mortality rates underscore the need for a comprehensive approach to public health that takes into account the broader economic context. By addressing the root causes of food insecurity and market instability, policymakers can make significant strides toward reducing mortality rates and improving the overall public health status of Nigeria's population. Among the most well-known attempts to explain food security and related issues are the Malthusian and neo-Malthusian theories, which link food security and sustainable development. According to Scanlon (2003), food security requires three components: adequate and reliable supply, access to the supply and ability to utilise the supply to gain nutrition. Any short-circuitry along the line will precipitate negative consequences. Studies examining the relationships between food reserves, hunger levels, food market stability, and mortality rates in Nigeria have employed various methodological approaches, including regression analysis (Akinwale et al. (2022a, 2022b, 2022c) and descriptive statistics (Oyekale & Oladeji, 2020).


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**Food security and mortality rates**

"Food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Idisi, 2021:9). Food security is an explanatory variable for public health outcomes, across the demographics of infants, children, and mothers. Studies by Smith and Haddad (2000) and Black et al (2008) are among others who have continued to associate food insecurity with increased mortality rates among the populations of concern here. The NBS (2020) indicates that approximately 40% of the population in Nigeria are contending with moderate to severe food insecurity. The WHO (2018) and FAO (2017) have converged to the conclusion that food insecurity is associated with increased mortality rates. In Nigeria, food insecurity is a significant challenge, with a study by Oyekale et al. (2020) finding that food insecurity was significantly associated with increased infant mortality rates in Nigeria.

**Economic indicators and mortality rates**

Every segment of a country's population is involved in a struggle for economic survival. It is therefore to be expected that economic variables, including inflation and consumer price indices, have palpable consequences for food security and mortality rates. Inflation, which compromises the purchasing power of households and makes access to nutritious food difficult, can be causative to increased mortality rates as confirmed by WHO (2018) while stable and predictable food markets can increase food affordability and result in declining mortality rates (FAO, 2017).

Saddled with a burgeoning population and economic adversities simultaneously, Nigeria finds it difficult to ensure food security, maintain tolerable living standards, and reduce mortality rates among vulnerable populations (Smith & Haddad, 2000). Yet, food security remains an insuperable determinant of public health outcomes, particularly among infants, children, and mothers (Black et al, 2008).

**Food Reserves and Mortality Rates**

Food reserves can play a critical role in ensuring food availability during times of crisis (AGRA, 2023). Cognisant of this fact, Nigeria embarked on the construction of her first set of high capacity metallic Silo Complexes for her National Strategic Food Reserve system in 1987. Progress since then has been questionable. A study by Akinwale et al. (2022a, 2022b, 2022c) found that food reserves were significantly associated with reduced infant, child and maternal mortality rates in Nigeria.

**Hunger and mortality rates**

Hunger is a significant challenge in Nigeria, with approximately 20% of the population experiencing hunger (NBS, 2020). Results from studies by Oyekale and Oladeji (2020a, 2020b) also confirm that hunger is associated with increased mortality rates, particularly among infants and children.

**Food market stability and mortality rates**

Food market stability is critical in ensuring food access and reducing mortality rates (Olomola, 2015, Mkawani et al, 2016). A study by Oyekale et al. (2020) found that food market stability was significantly associated with reduced infant mortality rates in Nigeria. Several other authors have shared the same findings in their separate studies (Adesanya, 2022; Adekunle, 2020). Another study by Akinwale et al. (2022) found that food market stability was significantly associated with reduced child mortality rates in Nigeria. Conclusions to that effect have also been reached by Salami (2021).

Despite the significant body of research examining the relationships between food security, hunger, and mortality rates in Nigeria, gaps remain. Few studies have examined the specific relationships between food reserves, hunger levels, and food market stability and mortality rates.

The foregoing highlights the complex dynamics between food security, hunger, and mortality rates in Nigeria. The findings emphasize the need for policymakers to prioritize food security and economic stability to reduce mortality rates among vulnerable populations.

Nigeria, with its large population and diverse economy, faces significant challenges in ensuring food security and reducing mortality rates among vulnerable populations. Food insecurity, hunger, and food market instability are critical issues that affect the health and well-being of infants, children, and mothers. This literature review examines the relationships between food reserves, hunger levels, food market stability, and infant, child, and maternal mortality rates in Nigeria.

**Problem statement**

Nigeria, the most populous country in Africa, faces significant public health challenges, particularly concerning high rates of infant, child, and maternal mortality. Record show that is even behind other African countries in these areas. The 2020 estimate of WHO (2018) shows the maternal mortality ratio in the African Region at 531 deaths per 100 000 live births. Nigeria, with 1047, is classified among those with extremely high maternal mortality rates along with South Sudan's 1223 deaths and Chad's 1063 deaths. These mortality rates are critical indicators of the overall health and socio-economic development of a nation. Despite ongoing efforts to improve


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health outcomes, Nigeria continues to struggle with alarming mortality rates that contribute to the country's poor ranking in global health indices. This situation is exacerbated by economic instability, widespread poverty, and food insecurity, which are pervasive issues in the country.

One of the critical factors influencing health outcomes in Nigeria is food security, encompassing food reserves, market stability, and hunger levels (Black et al., 2008). AGRA (2023) affirms government recognising that food security is a complex and multifaceted issue directly affecting the health and survival of vulnerable populations, particularly infants, children under five, and pregnant women, and, with the Federal Ministry of Agriculture and Rural Development (FMARD), published a 2023 report - "Strategic Food Reserve in Nigeria: An Assessment of Optimal Stock Levels and Storage Capacity. The report found that with a provision of 2,646,000 MT in a year or a provision of 1,323,000 MT twice a year in the buffer stock, the country can cope with its price stabilisation, vulnerable groups and emergency reliefs. Yet, there remains the lack of stable food markets, coupled with inadequate food reserves and high hunger levels, leading to malnutrition and other health complications, increasing mortality risks among these groups. A different effort to address this situation is the National Strategic Food Reserve Agency (NSFRA) which has been involved in managing food reserves. However, the specific ways in which these factors interact with and contribute to mortality rates remain underexplored in the Nigerian context. The relationship between food reserves, market stability, hunger, and mortality rates is intricate and influenced by various economic and social factors. For instance, fluctuations in food prices, often driven by market instability, can severely impact household food security. When food prices rise, particularly for staple foods, low-income families may struggle to afford adequate nutrition, leading to higher rates of malnutrition among children and pregnant women. The food inflation rate in Nigeria was 35.41% in January 2024, 11.9% higher than January 2023 (24.32%). The food inflation rate in February 2024 was 37.92% on a year-on-year basis, which was 13.57% points higher than February 2023 (24.35%). The cost of food in Nigeria increased 40.01% in March 2024 over the same month in the previous year (NBS, 2024).

Malnutrition is a well-documented risk factor for increased infant and child mortality, as it weakens the immune system, making children more susceptible to infections and diseases such as pneumonia, diarrhea, and malaria, which are leading causes of death in Nigeria. Similarly, for pregnant women, malnutrition can result in complications during pregnancy and childbirth, contributing to high maternal mortality rates. Adequate nutrition is essential for maternal health, as it supports the mother's immune system, reduces the risk of pregnancy-related complications, and promotes healthy fetal development. Inadequate food reserves and market instability, therefore, pose a significant threat to maternal health, particularly in a country like Nigeria, where access to quality healthcare is already limited for many women, especially those in rural areas. Economic indicators such as the overall consumer price index (CPIA) and the food consumer price index (CPIF) are critical measures of economic stability and inflation in a country. These indices provide insights into the general price level of goods and services and specifically food prices, which directly impact household purchasing power and food security. In Nigeria, where a large proportion of the population lives below the poverty line, even small increases in food prices can have devastating effects on food access and nutrition. The relationship between CPIA, CPIF, and mortality rates is complex. On the one hand, a rising CPIA, indicating general inflation, can reduce household disposable income, limiting access to essential goods and services, including food, healthcare, and education. This reduction in disposable income can increase mortality rates, particularly among vulnerable populations. On the other hand, some studies suggest that moderate inflation can stimulate economic growth, potentially improving public health outcomes through increased investment in healthcare infrastructure and services. However, the CPIF, which measures food-specific inflation, is of particular concern in the Nigerian context. Given the high levels of poverty and food insecurity, rising food prices can significantly reduce food consumption, leading to malnutrition and increased mortality rates. This is especially true for children under five, who are highly vulnerable to the effects of malnutrition, and for pregnant women, whose nutritional needs are heightened during pregnancy.

Hunger, as an indicator of food insecurity, is another critical factor influencing mortality rates. High levels of hunger reflect a lack of access to sufficient, safe, and nutritious food, which is essential for maintaining health and well-being. In Nigeria, hunger is a pervasive issue, with millions of people experiencing food insecurity daily. The impact of hunger on mortality rates is profound, particularly for infants, children under five, and pregnant women, who are most vulnerable to the adverse effects of malnutrition and food insecurity. Despite the recognized importance of these factors, there is limited empirical research that systematically explores the interplay between food reserves, hunger levels, food market stability, and mortality rates in Nigeria. Most existing studies focus on individual aspects of food security or economic stability without considering their combined effects on health outcomes. This gap in the literature hinders the development of comprehensive policies and interventions aimed at reducing mortality rates and improving public health in Nigeria. The present study addresses this critical gap by investigating the relationships between food reserves, hunger levels, food market stability, and infant, child,


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and maternal mortality rates in Nigeria. Understanding the relationship between economic indicators such as CPIA and CPIF, and mortality rates is essential for developing effective policies to improve public health outcomes.
Given the foregoing, the study objectives are as below.
1. to analyze the correlation between the overall consumer price index (CPIA) and infant mortality rates (INMR) in Nigeria.
2. to examine the impact of food-specific inflation (CPIF)
on under-five mortality rates (U5MR) in Nigeria.
3. to evaluate the relationship between hunger levels (HUNG) and maternal mortality rates (MAMR) in Nigeria.
4. to assess the combined effect of food reserves, market stability, and economic indicators (CPIA, CPIF, HUNG) on mortality rates among infants, children, and mothers in Nigeria.

**Materials and Methods**

The study followed a quantitative research design, as it utilises secondary data. Specifically, the study adopted regression analysis, which, being an *ipso facto* research design, relies on historical data, to investigate the quantitative relationships among food reserves, hunger levels, food market stability, and infant, child, and maternal mortality rates in Nigeria. The data base for the analysis is a 22-year time series, spanning from 2001 to 2022, which was selected to ascertain sufficient temporal coverage for robust statistical analysis.

Sources of data

The data used in this study were obtained from multiple reputable and reliable databanks. Mortality data, including infant mortality rate (INMR), under-five mortality rate (U5MR), and maternal mortality rate (MAMR), were sourced from the World Health Organization (WHO) as published by *STATISTA* and Nigeria's National Bureau of Statistics (NBS). Data on economic indicators such as the overall consumer price index (CPIA) and the food consumer price index (CPIF) were obtained from *STATISTA* sourcing from the Central Bank of Nigeria (CBN) and the Food and Agriculture Organization (FAO). Hunger levels (HUNG) were derived from the Global Hunger Index (GHI) reports published by the International Food Policy Research Institute (IFPRI). Additionally, information on food reserves was obtained from the Nigerian Federal Ministry of Agriculture and Rural Development (FMARD).

Identification of variables

The primary dependent variables in this study are the infant mortality rate (INMR), under-five mortality rate (U5MR), and maternal mortality rate (MAMR). These variables represent the public health outcomes that the study seeks to explain. The independent variables include the overall consumer price index (CPIA), food consumer price index (CPIF), and hunger levels (HUNG). CPIA reflects the overall inflation rate, while CPIF specifically measures inflation in food prices. HUNG is a composite index representing the level of hunger within the population.

Analysis of data

Data were analysed in compliance with a procedure of multiple linear regression. The specified models were computed to evaluate the relationship between the dependent and independent variables. The regression models were specified as follows:

1. $INMR = \beta_0 + \beta_1 CPIA\ \beta_2 CPIF + \beta_3 HUNG + e$…….(1)
2. $MAMR = \beta_0 + \beta_1 CPIA\ \beta_2 CPIF + \beta_3 HUNG + e$……..(2)
3. $U5MR = \beta_0 + \beta_1 CPIA\ \beta_2 CPIF + \beta_3 HUNG + e$……...(3)

Where:
- $\beta_0$ is the intercept,
- $\beta_1$, $\beta_2$, $\beta_3$ are the coefficients for the respective independent variables,
- e is the error term.

Model estimation and diagnostic tests

The above models were estimated using the ordinary least squares (OLS) method, which provides the most efficient and the best linear unbiased estimators (BLUE) of the coefficients the usual OLS assumptions still applied, namely - the error terms are normally distributed with constant variance (homoscedasticity). Diagnostic tests conducted were the Durbin-Watson, the Breusch-Pagan, and the Jarque-Bera, respectively for autocorrelation, heteroscedasticity, and normality, to ensure the validity of the regression models.
To address potential multicollinearity among the independent variables, the Variance Inflation Factor (VIF) was calculated for each variable. Variables with VIF values greater than 10 were scrutinized and considered for exclusion or transformation to reduce multicollinearity.
Software


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The data analysis was performed using statistical software MINITAB 18.0. This software was chosen for its robust regression analysis capabilities and its extensive suite of diagnostic tools, which were essential for ensuring the validity and reliability of the study's findings.

Ethical Considerations

The study was free from ethical issues, having been based on secondary data from publicly available sources. Analytical procedure complied fully with best practices for the use of secondary data in research. Also, all data sources were duly acknowledged.

**Results**

The estimated regression models are shown in Appendix 3. The analyses conducted are quite revealing.

Infant Mortality Rate (INMR).

Among the independent variables, CPIA and CPIF have significant effects on INMR. Specifically, CPIA has a negative coefficient (-1.178) with a highly significant p-value (0.000), suggesting that as the overall consumer price index increases, infant mortality decreases. This surprising result is due to growing reliance on absolute breast-feeding which is not traded in the open markets (UNICEF, 2023).

On the other hand, CPIF shows a positive coefficient (0.902) with a similarly significant p-value (0.000). This implies that higher food prices are associated with increased infant mortality, possibly because rising food costs reduce access to adequate nutrition for infants, thus elevating mortality rates, as in Akinwale & Adewumi (2022). Hunger (HUNG), although negatively associated with INMR (-0.597), is not statistically significant (p-value = 0.137). This result indicates that, while hunger levels might negatively impact infant mortality, the effect is not strong enough to be conclusive within this model. The relatively low variance inflation factor (VIF) for HUNG (2.42) also suggests that multicollinearity is not a concern, and the lack of significance is likely due to other underlying factors not captured in the model.

Maternal Mortality Rate (MAMR)

The regression analysis for MAMR came up with a low explanatory power, which indicates that the selected economic indicators are poor predictors of maternal mortality in this context.

None of the independent variables (CPIA, CPIF, HUNG) show statistically significant effects on MAMR, with p-values of 0.188, 0.229, and 0.125, respectively. The coefficients for CPIA and CPIF are positive and negative, respectively, which suggests that overall consumer prices might slightly increase maternal mortality, while food-specific inflation might reduce it. However, these relationships are not statistically robust, as indicated by their p-values.

The coefficient for hunger (HUNG) is negative (-5.33), suggesting that higher hunger levels might reduce maternal mortality, but this counterintuitive result, coupled with its non-significance, indicates that hunger alone does not capture the complex dynamics affecting maternal health. The relatively low R-squared value suggests that other unexamined factors, such as healthcare access, education, or cultural practices, may play more significant roles in determining maternal mortality.

Under-Five Mortality Rate (U5MR)

The U5MR regression model is moderately strong, explaining 89.69% of the variance in the dependent variable, with an adjusted R-squared of 87.87%. This indicates that the selected economic indicators are relatively good predictors of under-five mortality.

CPIA has a significant negative coefficient (-1.596, p-value = 0.000), indicating that higher overall inflation is associated with lower under-five mortality. Similar to the INMR model, this may suggest that general economic improvement, reflected in rising consumer prices, contributes to better child health outcomes.

CPIF, however, has a positive and significant coefficient (1.270, p-value = 0.000), which aligns with the INMR results, showing that higher food prices are linked to higher under-five mortality. This finding reinforces the idea that food price stability is crucial for child health.

Hunger (HUNG) again shows a negative coefficient (-1.274), but it is not statistically significant (p-value = 0.179), indicating that while hunger might affect under-five mortality, its impact is not clearly defined within this model.

**Conclusion**

The analyses make it evident that economic factors exert more influence on the earlier years of life than in adulthood, implying that general economic improvement – moderately priced and available food, would benefit very young people in their formative years.

The study reaches the conclusion that economic factors seriously reflect on infant and child mortality rates in Nigeria more significantly than on maternal mortality.


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**Recommendations**

Given the foregoing conclusions, it is recommended that:

1. To improve public health outcomes in Nigeria, especially in respect of infant, child, and maternal mortality:
2. A stabilisation policy on food prices should be more consciously pursued by public authorities. The food reserves and national strategic reserves system indeed had this in mind. Yet it remains factual that food prices have been fluctuating wildly. Measures such as food subsidies, price controls, and improved agricultural productivity must be introduced to ensure that basic foodstuffs remain affordable for vulnerable populations.
3. Pro-Poor Policies are essential to ensure that the poorest households are not suffocated by economic growth and price increases. These underprivileged and economically excluded families need better protection from the adverse effects of inflation. Economic advancement should translate into better health outcomes for all, particularly infants and children.
4. Food security and access should be improved through investments in agriculture, social safety nets, and nutrition programmes.
5. Expansion of quality and access to health care are critical determinant of maternal mortality and need enhancement. Upscaled investment in maternal healthcare services, including availability of skilled birth attendants, particularly in rural and underserved areas are a necessity.
6. Policy making and implementation should address these recommendations towards reducing mortality rates among infants, children, and mothers in Nigeria, thereby improving overall public health and contributing to the country's socio-economic development.

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**Appendix 1: Economic Variables and Mortality Rates**

| Year | CPI(All items)[A] | CPI (food)[A] | Hunger (%)[B] | Infant Mortality Rate[B] | Maternal Mortality Rate Per 100,000 Live Births[E] | Under-5 Mortality Rates (Deaths per 1000 live births)[F] |
|---|---|---|---|---|---|---|
| 2000 | 33.93 | 31.78 | 00 | 112.684 | 1148 | 182.5 |
| 2001 | 39.53 | 40.97 | 8.80 | 109.775 | 1127 | 177 |
| 2002 | 44.34 | 44.71 | 8.80 | 106.865 | 1112 | 171.3 |
| 2003 | 54.89 | 51.61 | 8.50 | 103.956 | 1083 | 165.6 |
| 2004 | 60.39 | 57.86 | 7.80 | 101.031 | 1088 | 160 |
| 2005 | 67.37 | 66.84 | 7.00 | 98.106 | 1073 | 154.6 |
| 2006 | 73.13 | 69.43 | 6.60 | 95.180 | 1071 | 149.7 |
| 2007 | 77.93 | 75.14 | 6.40 | 92.255 | 1081 | 145.2 |
| 2008 | 89.66 | 88.64 | 6.70 | 89.330 | 1099 | 141.3 |
| 2009 | 102.2 | 102.4 | 7.50 | 86.485 | 1101 | 138 |
| 2010 | 114.2 | 115.4 | 8.40 | 83.587 | 1123 | 135.3 |
| 2011 | 126.0 | 128.1 | 9.20 | 80.715 | 1070 | 132.9 |
| 2012 | 141.1 | 141.2 | 9.70 | 77.844 | 1087 | 130.9 |
| 2013 | 152.3 | 154.3 | 9.60 | 74.972 | 1109 | 129.1 |
| 2014 | 164.4 | 168.4 | 9.50 | 72.406 | 1135 | 127.7 |
| 2015 | 180.1 | 186.2 | 9.30 | 69.840 | 1113 | 126.2 |
| 2016 | 213.6 | 218.6 | 9.60 | 67.274 | 1129 | 124.5 |
| 2017 | 246.4 | 261.0 | 10.10 | 64.708 | 1127 | 122.4 |
| 2018 | 274.6 | 296.4 | 10.60 | 62.142 | 1135 | 119.9 |
| 2019 | 307.5 | 339.9 | 12.40 | 60.662 | 1122 | 116.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2020 | 355.9 | 406.4 | 14.20 | 59.181 | 1047 | 113.9 |
| 2021 | 411.5 | 477.0 | 15.90 | 57.701 | | 110.6 |

**Sources**:
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**Appendix 2: Regression Output Details**

Regression Analysis: INMR versus CPIA, CPIF, HUNG

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 3 | 5727.05 | 1909.02 | 213.03 | 0.000 |
| CPIA | 1 | 787.87 | 787.87 | 87.92 | 0.000 |
| CPIF | 1 | 587.15 | 587.15 | 65.52 | 0.000 |
| HUNG | 1 | 21.79 | 21.79 | 2.43 | 0.137 |
| Error | 17 | 152.34 | 8.96 | | |
| Total | 20 | 5879.39 | | | |

Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 2.99352 | 97.41% | 96.95% | 94.18% |

Coefficients

| Term | Coef | SE Coef | T-Value | P-Value | VIF |
|---|---|---|---|---|---|
| Constant | 122.27 | 2.87 | 42.60 | 0.000 | |
| CPIA | -1.178 | 0.126 | -9.38 | 0.000 | 306.96 |
| CPIF | 0.902 | 0.111 | 8.09 | 0.000 | 309.61 |
| HUNG | -0.597 | 0.383 | -1.56 | 0.137 | 2.42 |

Regression Equation

INMR = 122.27 - 1.178 CPIA + 0.902 CPIF - 0.597 HUNG

Fits and Diagnostics for Unusual Observations

| Obs | INMR | Fit | Resid | Std Resid | |
|---|---|---|---|---|---|
| 1 | 112.68 | 110.99 | 1.70 | 1.37 | X |
| 21 | 59.18 | 61.30 | -2.12 | -1.26 | X |

*X Unusual X*

Regression Analysis: MAMR versus CPIA, CPIF, HUNG

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 3 | 3079 | 1026.2 | 1.54 | 0.240 |
| CPIA | 1 | 1250 | 1250.1 | 1.88 | 0.188 |
| CPIF | 1 | 1036 | 1036.3 | 1.56 | 0.229 |
| HUNG | 1 | 1733 | 1733.4 | 2.60 | 0.125 |
| Error | 17 | 11321 | 665.9 | | |
| Total | 20 | 14399 | | | |

Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 25.8055 | 21.38% | 7.51% | 0.00% |

Coefficients


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| Term | Coef | SE Coef | T-Value | P-Value | VIF |
|---|---|---|---|---|---|
| Constant | 1117.2 | 24.7 | 45.15 | 0.000 | |
| CPIA | 1.48 | 1.08 | 1.37 | 0.188 | 306.96 |
| CPIF | -1.199 | 0.961 | -1.25 | 0.229 | 309.61 |
| HUNG | -5.33 | 3.30 | -1.61 | 0.125 | 2.42 |

Regression Equation

MAMR = 1117.2 + 1.48 CPIA - 1.199 CPIF - 5.33 HUNG

Fits and Diagnostics for Unusual Observations

| Obs | MAMR | Fit | Resid | Std Resid | | |
|---|---|---|---|---|---|---|
| 1 | 1148.0 | 1129.5 | 18.5 | 1.73 | | X |
| 2 | 1127.0 | 1079.9 | 47.1 | 2.15 | R | |
| 21 | 1047.0 | 1082.4 | -35.4 | -2.45 | R | X |

*R* *Large* *residual*

*X Unusual X*

Regression Analysis: U5MR versus CPIA, CPIF, HUNG

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 3 | 7449.33 | 2483.11 | 49.31 | 0.000 |
| CPIA | 1 | 1446.82 | 1446.82 | 28.73 | 0.000 |
| CPIF | 1 | 1163.65 | 1163.65 | 23.11 | 0.000 |
| HUNG | 1 | 99.09 | 99.09 | 1.97 | 0.179 |
| Error | 17 | 856.12 | 50.36 | | |
| Total | 20 | 8305.45 | | | |

Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 7.09646 | 89.69% | 87.87% | 65.50% |

Coefficients

| Term | Coef | SE Coef | T-Value | P-Value | VIF |
|---|---|---|---|---|---|
| Constant | 189.84 | 6.80 | 27.90 | 0.000 | |
| CPIA | -1.596 | 0.298 | -5.36 | 0.000 | 306.96 |
| CPIF | 1.270 | 0.264 | 4.81 | 0.000 | 309.61 |
| HUNG | -1.274 | 0.908 | -1.40 | 0.179 | 2.42 |

Regression Equation

U5MR = 189.84 - 1.596 CPIA + 1.270 CPIF - 1.274 HUNG

Fits and Diagnostics for Unusual Observations

| Obs | U5MR | Fit | Resid | Std Resid | | |
|---|---|---|---|---|---|---|
| 1 | 182.50 | 176.05 | 6.45 | 2.19 | R | X |
| 21 | 113.90 | 119.92 | -6.02 | -1.51 | | X |

*R* *Large* *residual*

*X Unusual X*

**Appendix 3: Estimated Models**

Presented here are the three estimated functions.

INMR = 122.27 – 1.178CPIA + 0.902CPIF – 0.597HUNG ……(1)

MAMR = 1117.2 + 1.48CPIA - 1.199CPIF – 5.33HUNG ……(2)

U5MR = 189.84 – 1.596CPIA + 1.270CPIF – 1.274HUNG ……(3)

Equations 1, 2 and 3 express Infant Mortality Rate, Maternal Mortality Rate and Child Mortality Rate respectively as functions of overall Consumer Price Index, Food Consumer Price Index and Hunger.


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