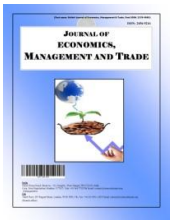

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# Economic Fluctuations and Child Health: How Well Children's Health Needs are Met in Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Author SA conceived the idea, wrote the introduction and conducted the data analysis. Author JP wrote the methodology, managed the literature sources and discussions of findings. Both authors proof read the final manuscript.*

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## ABSTRACT

One of the major functions of every government is to monitor, manage and adequately supervise the way its healthcare system works, particularly in maintaining good maternal health and reducing child mortality. Unfortunately, recent evidence shows that many countries have been falling short of their responsibility of maintaining healthy population and ensuring low mortality rate. This study was therefore conducted to investigate the effect of economic fluctuations on child mortality rates in Nigeria. Estimation techniques like descriptive statistics, ARDL Bound test and Fully-modified ordinary least square regression imbedded with distributed lag of GDP per capita were used in the study. It was found that GDP per capita significantly and negatively influence neonatal, under-5 and infant mortalities. The study found that one percent increase in GDP per capita leads to 12% decrease in neonatal, 26% decrease in infant and 23% decrease in under-5 mortality rates. In order to ascertain that the results were stable and devoid of biasness, a robustness test was conducted where public healthcare expenditure was used to replace GDP per capita. The estimates remained stable and consistent with when GDP per capita was used. The study therefore concludes that improvement in economic activities (manifested by increase GDP per

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capita and healthcare expenditure) is linked to decrease in child mortality rates, and recommends that government put in place policies that can ensure improvement in economic activities and subsequently decrease child mortality rates.

*Keywords: Economic fluctuations; GDP per capita, child health; child mortality rates.*

## 1. INTRODUCTION

One of the major functions of every government is to monitor, manage and adequately supervise the way its healthcare system works, particularly in maintaining good maternal health and reducing child mortality. In recognition of the herculean need to improve the health of this category of people, the World Health Organization's fourth Millennium Development Goal (MDG 4) is to reduce under-5 mortality by two-thirds between 1990 and 2015 [1]. Policy makers are therefore expected to increase the budgetary allocations towards good child and maternal healthcare, create awareness for good health practices and using up-to-date medical methods for improving general healthcare system. Unfortunately, recent evidence show that only 10 countries of 67 with high child mortality performed well towards achieving the MDG 4 target [2]. In view of the general failure of many countries in meeting up with the targets of MDGs, World leaders, under the umbrella of United Nations, drafted a policy framework towards complete eradication of preventable child mortality between 2016 and 2030. This forms one of the seventeen targets of Sustainable Development Goals, structured towards eradication of poverty, underdevelopment, infant and maternal mortality, and overall global economic growth and development [3,4].

Globally, socioeconomic status (at individual and country level) is among the most important health determinants throughout the life course. It determines the ability and capability of people to access health facilities, when individual's socioeconomic factor is low, general health outcomes becomes significantly affected. Particularly, young children are more vulnerable to the effects of adverse socioeconomic status and poverty. Poverty and low socioeconomic status are associated with higher risk of death in infancy and childhood, chronic childhood illness, and many acute illnesses [5]. Poor socioeconomic status is also closely linked with birth weight and child mental health problems [6]. The level of socioeconomic status of country, represented by its level and stability of productivity and output has a bearing on not only the standard of all and sundry in the country; it has direct consequences on the health outcomes of people, particularly the vulnerable group. The current study therefore aimed at examining the effect of economic fluctuations on the children health outcomes in Nigeria.

## 2. LITERATURE REVIEW

Currently, not many studies have been conducted on the relationship between economic fluctuations and child health outcomes. The few relevant ones to the current study are reviewed below. Using World Bank's Development Indicators and Global Development Finance (2013 edition), Maruthappu, Bonnie, Williams, Atun and Zeltner [7] investigated the effect of economic downturns on child mortality both globally and among subgroups of 204 countries. controlling for country-specific differences in political, healthcare, cultural, structural, educational and economic factors and adopting multivariate regression (with robust estimates), the study found that reductions in government healthcare spending are associated with significant increases in child mortality, with the largest increases occurring in low-income countries. In a similar study, Maruthappu, Watson, Watkins, Zeltner, Raine and Atu [8] examined the relationship between reductions in government health spending and child mortality rates of 176 high- and low-income countries. Controlling for differences in infrastructure and demographics and using multivariate regression, the study found that decrease in government health spending was associated with a significant increase in child mortality measures, with the health effect of the downturns being worse in low-income countries, than in high income countries. The authors concluded that reduction in healthcare spending could lead to deteriorating health outcomes and suggested that reduced spending could be achieved through increased efficiency of care delivery. Also, in an investigation of effect of short-term fluctuations in aggregate income on infant mortality of a data set of 1.7 million births in 59 developing countries, Baird, Friedman and Schady [9] found a negative association between per capita GDP

and infant mortality. The study found that Female infant mortality is more sensitive than male infant mortality to negative economic shocks, suggesting that policies that protect the health status of female infants may be especially important during economic downturns. Conley and Springer [10] equally found that state spending, which varied according to the institutional structure of the welfare state, negatively affected infant mortality. Studies like Paxson and Schady [11], and Asali [12] equally found negative relationship between macroeconomic variables and infant mortality rates.

Contrary to the overwhelming evidence of negative effect of economic downturns on infant health, there are other studies that show that economic fluctuations have pro-cyclical effect with infant health outcomes. Studying the response of child health and survival to fluctuations in world Arabica coffee prices, Miller and Urdinola [13] found procyclical pattern of mortality and privacy of time value in the production of child and survival. They found that, for a county with median coffee cultivation, a 25 percent birth year price increase is associated with a 0.4 to 2.0 percent decrease in cohort size. The study equally found primacy time value in the production of child health and survival. It was found that coffee price reductions are associated with substantial decline in both probability that adults work and in hours of work of employed adults. The study concluded that reductions in the relative price of health are more important in explaining observed declines in mortality across time and space. Dehejia and Lliras-Muney [14] also found that unemployment at conception has a positive effect on health outcomes (less probability of low birth weight). However, mixed effects of macroeconomic fluctuations on child health outcomes in middle-income countries were found in a study conducted by Schady and Smitz, [15]. The study found that, in five countries, the average year-on-year decline in infant mortality was larger when growth was positive than when it was negative. In twelve countries, it was found that infant mortality was larger in recessions than during economic expansions. The study concluded that aggregate economic shocks have income and substitution effects on child health; the total effect depends on whether income or substitution effect dominates. Given the dearth of literature on the economic fluctuations and infant health outcomes in developing countries, particularly Nigeria, this study investigates the nature of association between economic fluctuations and child mortality in Nigeria.

## 3. RESEARCH METHODOLOGY

### 3.1 Nature and Sources of Data

This study uses time series data covering the period of 1970 to 2018 for all the variables, except for public health expenditure that is from 1982 to 2018. Data for child mortality rates (neonatal, under 5 and infant mortality rates) were sourced from UNICEF website, GDP per capita, percentage of population of people under 15 years, percentage of population over 64 years, total population size are sourced from World Bank Development Indicators, while public health expenditure was sourced from Central Bank of Nigeria Statistical Bulletins.

### 3.2 Model Specification

Neonatal, postnatal and under-5 mortalities were used as dependent variables, with each serving as separate dependent variables in three regressions. GDP per capita, representing economic fluctuations, is the main independent variable, while, log transformed GDP per capita, log transformed total population size, percentage of population under 15 years and percentage of population over 64 years were used as control variables. To evaluate stable effect of economic fluctuations on mortality rates, 1 to 4-year time-lag of GDP per capita was introduced into the main models, and also to public health expenditure model used to confirm robustness of the main models. This, according to Brenner [16], helps to know the true effect of independent variable on the dependent variable. The choice of variables for this study is based on Maruthappu, Bonnie, Williams, Atun, and Zeltner [7]. The basic specification of the models is:

Childmort = f (HE, LGDPC, Pop15, Pop64, Ltopup) …… ……1

The structural form of the model is:

$$\text{Childmort} = \beta_1 \text{GDPC} + \beta_2 \text{LGDPC} + \beta_3 \text{Popu15} + \beta_4 \text{Popu64} + \beta_5 \text{LTopup} + \mu \ldots\ldots\ldots 2$$

Where Childmort = child mortality indicators (Neonatal mortality, under-5 mortality and infant mortality), GHE = government health expenditure, LGDPC = log transformed GDP per

capital, Popu15= percentage of population under 15 years, Popu64= percentage of population above 64 years, Ltopup= log transformed total population size of the country. In the first model, neonatal mortality was used as the dependent variable, infant mortality in the second and under-5 mortality in the third model.

### 3.3 Unit Root Test

Since times series data is used in this study, unit root test was performed to ascertain the level of integration of the variables and determine the appropriate type of cointegrating method to be used. Augmented Dickey Fuller unit root test, developed by Dickey and Fuller [17,18] was carried out. The augmented version of unit root test includes extra lagged terms of the dependent variable in order to eliminate autocorrelation. It can be specified as below:

$$\Delta y_t = \alpha_0 + \alpha_{1t} + \sum_{i=1}^{p} ß_i \Delta y_{t-i} + \varepsilon_t \quad 3$$

In equation (3), y is the variable whose unit root is to be tested, Δ is the first difference operator, $\alpha_0$ is intercept, $\alpha_1$ is a trend term, ρ is a lag order of the autoregressive process, and $\varepsilon_t$ is the error term.

### 3.4 ARDL Bound Test

After conducting the unit root test, and all the variables are integrated of different, 2 shows that all the variables are not integrated of the same order, instead a combination of I (1) and I (0) series. Therefore, Autoregressive Distributive Lag (ARDL) Bound Test [19] is considered as the most appropriate estimation technique in this study because it has superior small sample properties as compared to the Johansen Co-integration test, and gives better result when variables under consideration are cointegrated of different order. The ARDL representation of equation 6, 7, 8 and 9 are stated as follows

$$\text{In } Childmort_t = \alpha_0 + \sum_{i=1}^{p} \theta_I InChildmort_{t-i} + \beta_1 lnGDPC_t + \beta_2 Popu15_t + \beta_3 Popu64_t + \beta_4 lnTotpup_t + \sum_{i=0}^{q-1} \beta^*_1 \Delta lnGDPC_{t-i} + \sum_{i=0}^{q-1} \beta^*_2 Popu15_{t-i} + \sum_{i=0}^{q-1} \beta^*_3 Popu64_{t-i} + \sum_{i=0}^{q-1} \beta^*_4 \Delta lnTotpup_{t-i} + u_t \ldots\ldots\ldots\ldots\ldots\ldots \quad .4$$

The above model represents the variables in question and their respective maximum levels. The null hypothesis indicates that, there is no long-run relationship between the dependant and independent variables. The decision rule is to reject null hypothesis when F-statistic of the bound test is greater than the critical value of upper bound at a chosen level of significance (5% level of statistical significance). On the other hand, the null hypothesis is accepted when the F-statistics is less than that of the Critical Value of the Lower Bound. When the F-statistics falls between the upper and the lower bound, it then means that the test is considered inconclusive.

### 3.5 Fully Modified Ordinary Least Squares

After the Cointegration relationship has been established among the variables in the models, Fully Modified Ordinary Least Squares (FMOLS), developed by Phillips and Hansen [20], was used to estimate the relationship that exists in the models. It provides consistent and efficient estimates in the presence of cointegration, explicates serial correlation effects and checks for endogeneity among regressors.

## 4. PRESENTATION OF RESULTS AND DISCUSSION

### 4.1 Unit Root Results

The stationarity test shown below is extracted from the unit root results conducted by the researcher.

As shown in the table, child mortality outcomes (neonatal, under-5 and infant mortalities) are integrated of order zero, while GDP per capita, Popu15, Popu64 and Topup are integrated of order one. Given the existence of combinations of order one and order zero stationarity levels, ARDL Bound test was used to test for existence of long run among the variables in the three models.

### 4.2 Cointegration Results

Using ARDL bound test, the existence of long-run relationship or otherwise was tested in the three models above. The results are in Table 2.

As shown in Table 2, F-statistics values of the three models are greater than their upper bound values at 5% level of statistical significance. This led to rejection of the null hypothesis of no long-run relationship between child mortality rates and GDP per capital in Nigeria. This implies that there is long-run relationship between child mortality rates and GDP per capital in Nigeria in Nigeria. In order to establish the extent of the

relationship, the estimates of FMOLS are shown in Table 3.

### 4.3 Long-run Relationship from Fully Modified Ordinary Least Square

After establishing that the models are cointegrated in the long-run, the cointegrating relationships were established from fully modified Ordinary Least Square. The results are provided in Table 3.

Table 3 contains extracts from the FMOLS of models 1, 2 and 3 respectively. The coefficients of GDP per capita (at current level) in the three models are statistically significant, and negatively influenced child mortality rates. In the first model, it shows that one percent increase in GDP per capita leads to 6% decrease in neonatal mortality rates. In the second model, it shows that one percent increase in GDP per capita leads to 15% decrease in infant mortality rates. In the third model, it shows that one percent increase in GDP per capita leads to 11% decrease in under-5 mortality rates. This shows that economic conditions in those months shortly before and shortly after birth have the biggest effect on the probability that a child survives.

When the dependent variables were lagged for four times, to show the effect of previous economic conditions on the current child health, the coefficients of GDP per capita in the three models are still statistically significant, and negatively influenced child mortality rates. In the first model, it shows that one percent increase in GDP per capita leads to 12% decrease in neonatal mortality rates. In the second model, it shows that one percent increase in GDP per capita leads to 26% decrease in infant mortality rates. In the third model, it shows that one percent increase in GDP per capita leads to 23% decrease in under-5 mortality rates. This shows that economic conditions in four years before birth have the biggest effect on the probability that a child survives. It equally shows that the effect after four years is more than that of the current changes in economic conditions.

The table equally shows that percentage of population under 15 years and total population size of the country are negatively significant in influencing mortality rates within the time period, and that percentage of population above 64 years significantly influences only neonatal mortality and postnatal mortality rates. The $R^2$ of the models show that a large percentage of variation in the model is explainable by variations in the independent variables. Also, given that the probability values of the Jaque Berra test of the models that are greater than 5% level of statistical significance, we can reject the null hypothesis of non-normal distribution of the models. This means that the models are normally distributed and have results that are reliable, stable and generalizable.

**Table 1. Stationarity test of the variables**

| Variables | ADF | Critical level | P-value | Order of Integration |
|---|---|---|---|---|
| Neonatal | -3.2802 | -1.9492 | 0.0017 | I (0) |
| Under-5 | -2.5521 | -1.9485 | 0.0119 | I (0) |
| Infant | -12.1752 | -3.5131 | 0.0000 | I (0) |
| GDPC | -6.5452 | -3.5130 | 0.0000 | I (1) |
| Popu15 | -1.6501 | -1.6117 | 0.0928 | I (1) |
| Popu64 | -2.2821 | -1.9493 | 0.0234 | I (1) |
| Topup | -3.7388 | -2.9281 | 0.0066 | I (1) |

**Table 2. Long-run cointegrating relationship**

| Statistics | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| F-statistics | 11.5078 | 13.2959 | 4.4136 |
| K | 4 | 4 | 4 |
| Lower Bound of 5% Statistical Significance | 2.86 | 2.56 | 2.56 |
| Upper Bound of 5% Statistical Significance | 4.01 | 3.49 | 3.49 |

**Table 3. Fully modified ordinary least square results**

| Variables/Regions | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Intercept | 15.3053(0.5870)*** | 22.4161(0.9311)*** | 19.8026(0.7989)*** |
| LGDPC | -0.0632(0.0274)** | -0.1493(0.0434)*** | -0.1126(0.0373)*** |
| LGDPC (-4) | -0.1232(0.0225)*** | -0.2614(0.0358) | -0.2344(0.0307)*** |
| LTOPUP | -0.4184(0.0108)*** | -0.6263(0.0171)*** | -0.5636(0.0147)*** |
| POPU15 | -0.0687(0.0077)*** | -0.0424(0.0123)*** | -0.0413(0.0106)*** |
| POPU65 | 0.5862(0.1378)*** | 0.4732(0.4732)** | 0.5121(0.1875) |
| Observations | 46 | 46 | 46 |
| $R^2$ | 99% | 99% | 99% |
| Test of Normality | (0.1378)*** | (0.2185)*** | (0.1875)*** |

*Note: Standard errors in parentheses; *** significant at the 1% level; ** significant at the 5%; *significant at the 10%;*

**Table 4. Fully modified ordinary least square results**

| Variables/Regions | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Intercept | 7.8228 (1.6363)*** | 7.5626(2.3560)*** | 6.5367(2.1210)*** |
| GHE | -0.03471(0.0336) | -0.1522(0.0483)*** | -0.1349(0.0436)*** |
| LGHE (-4) | -0.1546(0.0186)*** | -0.2357(0.0268)*** | -0.2101(0.0242)*** |
| LTOPUP | -0.1562(0.0680)** | -0.1167 (0.0979) | -0.0981(0.0882)*** |
| POPU15 | -0.0817(0.0108)*** | -0.0643(0.0155)*** | -0.0543(0.0139)*** |
| POPU65 | 1.2421(1.6363)*** | 1.6341(0.0872)*** | 1.4624(1.4624) |
| Observations | 33 | 33 | 33 |
| $R^2$ | 99% | 99% | 99% |
| Test of Normality | (0.1441)*** | (0.3115)*** | (0.4513)*** |

*Note: Standard errors in parentheses; *** significant at the 1% level; ** significant at the 5%; *significant at the 10%*

### 4.4 Robustness Check

To show that the models estimated in this study are stable and consistent, an alternative economic variable, government healthcare expenditures, was used to replace GDP per capita in the models. The results obtained are contained in Table 4.

Table 4 shows that both the current and cumulative lags of healthcare expenditure are negative strong predictors of child mortality rates. One percent increase in government healthcare expenditure dramatically leads to decrease in child mortality. This corresponds to the effect of GDP per capita on child health outcomes and confirms the substantial effect of economic fluctuations on child health outcomes. Also, given that the probability values of the Jaque Berra test of the models that are greater than 5% level of statistical significance, we can reject the null hypothesis of non-normal distribution of the models. This means that the models are normally distributed and have results that are reliable, stable and generalizable.

Similar to what is what is obtainable in Table 3, Table 4 equally shows that percentage of population under 15 years and total population size of the country are negatively significant in influencing mortality rates within the time period (except in postnatal mortality where it is insignificant), and that percentage of population above 64 years significantly influences only neonatal mortality and postnatal mortality rates.

## 5. CONCLUSION AND POLICY RECOMMENDATIONS

This study investigates the effect of economic fluctuation, proxied by nominal GDP per capital, on child mortality rates (neonatal, under-5 and infant mortalities). Using ARDL Bound test, to test the existence of long-run relationship among the variables, and Fully Modified Cointegration regressions, to ascertain the extent of the relationship, it was revealed that both the current GDP per capital and four years' cumulative lags of GDP per capita have statistical significance on child health outcomes. A one percent increase in GDP per capita leads to significant decrease in

child mortality rates. The effect more substantial when cumulative lags of GDP per capita was considered. It shows that the past economic fluctuation has significant effect on the child's chances of survival. These findings are similar that of Maruthappu, Watson, Watkins, Zeltner, Raine and Atu [9]; Paxson and Schady [12]; Chung and Muntaner [10], who have investigated the relationship between economic fluctuations and child mortality rates. The findings of this study are contrary to the procyclical relationship found by Miller and Urdinola [14]; Dehejia and Lliras-Muney [15] and Abdala, F., R. Geldstein and S. Mychaszula [21].

In order to test the sensitivity and stability of the models to alternative economic variables, government healthcare expenditures were used to replace GDP per capita in the models. It was equally found that government health expenditure equally significantly affects child mortality rates. This is in line with the findings of Maruthappu, Bonnie, Williams, Atun, and Zeltner [7]. Given that improvement in economic activities (manifested by increase GDP per capita and healthcare expenditure) is linked to decrease in child mortality rates in Nigeria, policy makers are advised to put in place policies that can ensure improvement in economic activities, which will in turn lead to decrease child mortality rates.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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