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Effect of Public Health Expenditure on the Under-Five Mortality Rate in Nigeria

Aliyu Inuwa Kamara[1] and Abubakar Orlando Ijoko[2]*

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ABSTRACT

In this study, we examined how public health spending affected Nigeria's under-five mortality rate between 1988 and 2023 using time series data obtained from the Central Bank of Nigeria statistical Bulletin and World Bank World Development Indicators (WDI). Four explanatory variables were used: female literacy rate, technology, HIV prevalence, and public health spending. an Auto-regressive Distributed Lagged (ARDL) model was employed for the analysis after conducting unit root and cointegration tests, which showed a mixed order of integration between the variables. From the short-term results, public health expenditure has a positive and significant impact on the under-five mortality rate, whereas the HIV prevalence rate and technology integration have a negative and significant impact. In contrast, the long-term ARDL results indicate that, public health expenditure has a negative and statistically significant impact on the under-five mortality rate. Furthermore, the HIV prevalence rate and technology integration had a long-term positive and statistically significant relationship with the under-five mortality rate. Based on these findings, to reduce the under-five mortality rate in Nigeria, we recommend that the government through the Ministry of Finance and the Ministry of Health should improve budgetary allocation to the health sector at levels with adequate supervision to prevent wastage and funding misappropriation. By following these measures, Nigeria will move toward achieving United Nations Sustainable Development Goal.3;"Ensure healthy lives and promote well-being for all at all ages."

Keywords: public expenditure, health, under-five mortality rate

1. INTRODUCTION

Health is a critical component of human development that significantly influences quality of life, and productivity, as well as the economic growth of a nation. In Nigeria, health outcomes have been a persistent concern, particularly the under-five mortality rate, which reflects the well-being of children under five years of age. The under-five mortality rate is a vital indicator of the effectiveness of healthcare systems, public health policies, and the socioeconomic conditions of a population. Despite several health interventions and policies, Nigeria has consistently recorded high under-five mortality rates, ranking among the highest in the world[1]. Globally, the under-five mortality rate defined as the probability of dying between birth and five years of age per 1000 live births has decreased by 60%, from an estimated rate of 93 deaths per 1000 live births, in 1990 to 38 deaths per 1000 live births in 2019, The United Nations Sustainable Development Goal (SDG) target is 25 deaths per 1000 live births by 2030. In 2019, an estimated 5.2 million children under-five died globally, approximately 14,000 child deaths each day before their fifth birthday[2].

Public health expenditure plays a crucial role in improving access to healthcare, infrastructure, and service delivery. Government investments in healthcare are expected to address disparities, enhance medical services, and reduce mortality rates, including those of children under five. However, in Nigeria, health financing is characterized by inefficiencies, insufficient allocation, and a high dependence on out-of-pocket expenditure, which limit the impact of public spending on health outcomes. These inefficiencies have contributed to persistently high under-five mortality rates; in 2020 the estimate was 113 deaths per 1000 live births[3]. Given these statistics, Nigeria must reduce early childhood mortality by 70% to meet the SDGs by 2030, urgent attention is required to reduce childhood deaths to below the global average[4]. Public health expenditure in Nigeria is far below the World Health Organization (WHO) recommendation, that is, 15% of the national budget. Furthermore, per capita health allocations in Nigerian states fell from $10.8 in 2020 to $8.5 in 2022, significantly lower than the WHO target of $86 per capita[5]. The gap in public health expenditure has resulted in an Inadequate healthcare infrastructure, insufficiently skilled healthcare professionals, limited access to essential medicines and vaccines, and poor health outcomes, particularly for children under five[6].

However, studies suggest that increased health expenditure does not always translate into better health outcomes because of issues such as corruption, inefficient resource allocation, and poor governance. Moreover, socioeconomic factors, such as

poverty, education, and access to clean water, interact with health expenditure to affect overall health outcomes.

This study investigates the impact of public health expenditure on under-five mortality rates in Nigeria from 1988 to 2023. By analyzing trends over this extended period, we aim to provide insights into how government spending on health has influenced child mortality and to identify potential policy gaps. These findings contribute to the ongoing debate about the effectiveness of public health investments in achieving sustainable health outcomes in Nigeria.

2. LITERATURE REVIEW

Empirical studies on the relationship between public health expenditure and under-five mortality have been conducted both in Nigeria and other countries to assess the impact of public health expenditure on under-five mortality rates.

Concerning Nigeria, Edeme et al. empirically investigated the effect of public health expenditure on health outcomes, as measured by life expectancy at birth and infant mortality rates[7]. This study employed the error correction mechanism (ECM) and Granger causality methods to estimate the models. The results showed that an increase in public health expenditure improved life expectancy and reduced infant mortality rates. Additionally, the urban population and the HIV prevalence rate were found to affect health outcomes significantly, whereas per capita income had no significant effect. These findings suggest that public health expenditure remains a critical component in improving health outcomes in Nigeria.

Later, Zubair studied the impact of governmental health expenditure on health status indicators (life expectancy rate, under-five mortality rate and infant mortality rate) empirically using data from 1985 to 2015[8]. The Engel Granger cointegration method was employed, and three models were developed, with each health outcome as a dependent variable. The study found that private health expenditure, gross domestic product (GDP) per capita, physicians per 1000 population, and population density significantly explained the variations in under-five and infant mortality in Nigeria and were statistically significant across the models. These findings imply that health expenditure contributes to improving health outcomes in Nigeria.

Moreover, with the aim of linking public health expenditure directly or indirectly to infant and under-five mortality in Nigeria, Yaqub et al. employed the ordinary least squares and two-stage least squares (2SLS) methods to study the impact of governmental health expenditure on infant and under-five mortality[9]. They found that public health spending has an inverse relationship with infant and under-five mortality when corruption is involved. Similarly, David used the autoregressive distributed lagged model (ARDL) bounds testing approach and Granger casualty test to examine the connection between governmental health expenditure and infant and under-five mortality empirically[10]. The results showed that public health spending, and immunization have a negative impact in both the short and long-term.

Aderopo and Emmanuel also examined the impact of public health expenditure on the infant mortality rate in Nigeria between 1991 and 2018 using time-series data[11]. The fully modified ordinary least square (FMOLS) method was used to examine these relationships. Further, various robustness checks were conducted to ensure the reliability of the results for policymakers. The findings revealed that all variables employed had a positive impact on infant and maternal mortality, except for diphtheria, pertussis, and tetanus immunization and female literacy rate.

In a recent study, Azuh et al. examined the relationship between public health expenditure and under-five mortality in Nigeria, and employed ARDL to assess the long-term effect of the variables[12]. Data were sourced from the World Bank World Development Indicators (WDIs) for 1985–2017. The results showed that, although public health expenditure was statistically significant, it was positively related to under-five mortality. This implies that a unit increase in public health expenditure leads to a 1.56% increase in the under-five mortality rate. However, in the Nigerian context, this result can be better explained by factors such as the poor coordination of health funds and maternal education. Therefore, Azuh et al. recommended the implementation of proper health fund coordination to ensure that the budget allocated to the health sector is utilized effectively.

Ojo et al. also used the ARDL technique to examine the impact of health expenditure on life expectancy in Nigeria from 1981 to 2018[13]. They found that health expenditure had an insignificant impact on life expectancy in Nigeria. Similarly, Iyakwariet al. employed the ARDL bound test to cointegration methods to investigate the effect of health expenditure on life expectancy in Nigeria empirically using time-series data from 1990 to 2021[14]. The results revealed a negative relationship between health capital expenditure, recurrent health expenditure, and life expectancy in the long-term, whereas out-of-pocket health expenditure had a positive relationship with life expectancy.

Using the under-five mortality per 1000 births and life expectancy as proxies for health outcomes, Orji et al. examined the impact of public health expenditure on health outcomes in Nigeria from 1985 to 2019[15]. The augmented Dickey-Fuller (ADF) technique was used to test the unit root of the variables. Their findings revealed that governmental health expenditure had a significant impact on the under-five mortality rate and life expectancy, as did immunization against measles for the form. In line with earlier findings, the recommendation was that the Federal Government of Nigeria increase its annual allocation to the health sector to improve population health.

Regarding cross country evidence, Kato et al. studied the effect of public health spending on under-five mortality rates in Uganda[16]. A time=series regression analysis was conducted using data obtained from World Bank Indicators covering 1980 to 2012. The findings revealed that recurrent and capital health expenditure were strongly related to the mortality rate of those under-five. Further, they found that increased public health expenditure, along with its effective allocation, would help reduce the mortality rate of people under-five in Uganda. In addition female enrollment in secondary school was significant, suggesting that increased access to education for girls reduces under-five mortality. Overall, they concluded that merely increasing public spending is not sufficient to improve child health outcomes in Uganda, but must be complemented by other factors such as female education.

Rana et. al. studied the association between health expenditure and health outcomes[17]. Heterogeneity and cross-sectional dependence were controlled for in the panel data, which comprised of 161 countries for the period 1995–2014. Infants under-five years of age, maternal mortality, and life expectancy at birth were selected as measures of health outcomes. Cross-sectional augmented Im, Pesaran, and Shin (IPS) unit root, panel ARDL and the Toda Yamamoto approach to the Granger causality test were used to investigate the relationships across four income groups. The results revealed that the link between health expenditure and health outcomes is stronger in low-income countries than in high-income countries. Furthermore, increasing health expenditure was found to reduce child mortality but was not significantly associated with maternal mortality at all income levels. Variations in child mortality were better explained by increased health expenditure than by maternal mortality. They concluded that the influence of health expenditure on health outcomes varies significantly across income levels except for maternal health.

However in contrast, Rahman et al. used fixed and random effects models to examine the relationship between private, public and total health care and three selected health outcomes (life expectancy, under five mortality and crude death rates) in the South Asian Association for Regional Cooperation and Association of Southeast Asian Nations (SAARC ASEAN) regions[18]. Both increased public and private health expenditure improved life expectancy and significantly decreased the mortality rates of the under-five in the region. Moreover, in Iran, Shahraki investigated the causality between public health expenditure and life expectancy in the short and long term from 2000 to 2017 in Iran using the Johansen cointegration approach, findings showed a bidirectional causal relationship between these factors in short and long-term[19].

Using the ARDL estimation technique, Renuka et al. investigated the relationship between public, private, and out-of-pocket health expenditures and the under-five mortality rate in Malaysia[20]. New critical test values were recalculated for a bound testing technique of cointegration using the response surface methodology expanded by Turner, which is based on a small time-series sample of 22 years, from 1997 to 2018. These findings suggest that an increase in out-of-pocket health expenditure increases the under-five mortality rate, indicative of a worsening health situation. In contrast, the effects of public and private health expenditure were found to be statistically insignificant. Thus, these results do not support out-of-pocket payments as an effective way of financing healthcare to improve child health, implying that the cost of out-of-pocket payments is a barrier to seeking medical care. Consequently, reducing out-of-pocket payments is necessary because they contribute to worsening child health outcomes. Therefore, a reliable and effective health financing system, along with the targeted health-related safety net, is essential to protect families.

Ayipe and Tanko examined the relationship between public health expenditure and under-five mortality in low-income sub-Saharan African countries (SSA) using data from the WDIs spanning the year 2000 to 2019[21]. The Breusch Pagan Lagrange test was conducted to investigate the evidence for panel effects across countries. The results specifically indicate that, for every 1% increase in domestic general government health expenditure, there is a reduction of approximately 5.3 under-five deaths per 1000 live births. This indicates a strong relationship between state health spending from domestic funds and under-five mortality rates in low-income SSA countries suggesting that increased public health expenditure in SSA countries is required.

Hosokawa et al. examined the relationship between healthcare spending and healthy life expectancy at birth using descriptive statistics and correlation analyses across all secondary medical areas in Japan. The results revealed significant regional disparities and that the number of medical personnel supporting clinics for home healthcare delivery facilities, home visit treatments, and expenditure per capita (dentistry) have a positive relationship with both life expectancy and healthy life expectancy. This finding is consistent with that of Li et al. who revealed that an increase in the healthy diet score based on food expenditure by 1% will result in a 0.07% increase in life expectancy among men alone, women alone, and men and women combined in the US[22].

2.1. Theoretical Framework. The Grossman production function forms the theoretical foundation of this study. Fayissa and Gutema extended the Grossman, model by incorporating social, economic, and environmental factors as inputs to the health production process[23]. Grossman posited that many health related behaviors, such as seeking medical care, are valued primarily for their contributions to health[24]. Within this framework, the demand for health is modeled using a health production function, in which health is "produced" from various inputs to yield an individual's health status. At the micro-level, the theoretical formulation is represented by:

$$H = F(\mathrm{x}) \tag{1}$$

Here. H denotes health output, and x is a vector of inputs that includes economic variables (e.g., income per capital), social variables (e.g., education), environmental variables (e.g., urbanization), demographic indicators (e.g., population below or above certain age group), health service indicators (e.g., population-doctor ratio, population-hospital ratio etc.), and other factors influencing health status.

3. METHODOLOGY

In this study, we investigated the impact of public health expenditure on the under-five mortality rate in Nigeria between 1988 and 2023 using time series data obtained from the Central Bank of Nigeria (CBN) statistical Bulletin and World Bank WDIs.

3.1. Model Specification. The model used in this study is adapted from the work of Mubarak[23], and is shown in functional and econometric form: in Eqs. (2) and (3), respectively.

$$\mathrm{UMR} = \mathrm{f}(\mathrm{PHE},\ \mathrm{HIVPR},\ \mathrm{TECH},\ \mathrm{FLR}) \tag{2}$$

$$\mathrm{UMR} = \beta_0 + \beta_1\mathrm{PHE} + \beta_2\mathrm{HIVPR} + \beta\mathrm{TECH} + \beta_4\mathrm{FLR} + \mu \tag{3}$$

In the model *UMR* represents the mortality rate of those under-five, *PHE* denotes public health expenditure, and *HIVPR* refers to the *HIV* prevalence rate, *TECH* captures the level of technology, and *FLR* stands for the female literacy rate. The symbol β

represents the coefficients of the independent variables, and μ is the error term.

3.2. Estimation Technique. We used the ARDL model, which is applicable in testing for cointegration when the variables are either purely I(0) or I(1) or have a mixture of stationarity. If variables are found to be nonstationary, the cointegration test, which is a pretest for spurious regression is first carried out. In addition, a pretest for stationarity is necessary in the application of the ARDL model because it does not allow for the inclusion of variables having I(2) and above.

The long-term model is given by Eq. (4).

$$\begin{aligned}\Delta UMRt = {} & \delta_o + \delta_1 UMR_{t-1} + \delta_2 PHE_{t-1} + \delta_3 HIVPR_{t-1} \\ & + \delta_4 TECH_{t-1} + \delta_5 FLR_{t-1} + \sum_{i=0}^{p} \rho_1 \Delta UMR_{t-1} \\ & + \sum_{i=0}^{p} \rho_1 \Delta PHE_{t-1} + \sum_{i=0}^{p} \rho_1 \Delta TECH_{t-1} \\ & + \sum_{i=0}^{p} \rho_1 \Delta FLR_{t-1} + \mu_t \end{aligned} \quad (4)$$

In contrast, the short-term model is given by Eq. (5).

$$\begin{aligned}\Delta UMRt = {} & \varphi_o + \varphi_1 UMR_{t-1} \pm \varphi_2 PHE_{t-1} \\ & \pm \varphi_3 HIVPR_{t-1} \pm \varphi_4 TECH_{t-1} \pm \varphi_5 FLR_{t-1} \\ & + \sum_{i=0}^{p} \Psi_1 \Delta UMR_{t-1} \pm \sum_{i=0}^{p} \Upsilon_1 \Delta \mathrm{PHE}_{t-1} \\ & \pm \sum_{i=0}^{p} \Upsilon_1 \Delta \mathrm{HIVPR}_{t-1} \pm \sum_{i=0}^{p} \Upsilon_1 \Delta \mathrm{TECH}_{t-1} \\ & \pm \sum_{i=0}^{p} \Upsilon_1 \Delta FLR_{t-1} + ECM_{t-1} + \mu_t \end{aligned} \quad (5)$$

The coefficient of ECM_{t-1}, is negative, statistically significant, and has a value less than one in absolute terms.

3.3. Data Sources. The data collection technique for the research is time series in nature, and in the secondary form sourced mainly from the WDIs from World Bank[5] and CBN statistical bulletin[26]. Specifically, data regarding public health expenditure were collected from the CBN Statistical Bulletin, whereas data on mortality rate, HIV prevalence, technology and female literacy were collected from the WDIs.

3.4. Variable Measurement. Five variables are included in this study. The dependent variable was the under-five mortality rate, measured as the number of deaths among children under-five per 1000 live births. The explanatory variables were public health expenditure (PHE), measured as domestic general government health expenditure; HIV prevalence rate (HIVPR), measured as the number of HIV infections per 100,000 individuals; technology (TECH), measured as the number of individuals using the internet; and female literacy rate (FLR), measured as the female primary school enrollment rate.

4. RESULTS AND DISCUSSION

Table 1 lists the descriptive statistics which offer a snapshot of the central tendency, variability, and distribution of the variables, providing an understanding of the dataset. The data indicate that the mean (average value) under-five mortality rate was 2.190859, with a standard deviation of 0.101181. Additionally, for public health expenditure, standard deviation is 0.109207, and its average value is estimated to be 1.207256. The HIV prevalence rate has a mean value of 1.527778 and a standard deviation of 0.377670. Similarly, technology has a standard deviation of 4.321579 and a mean of 14.74815. However, the female literacy rate has a mean value of 83.18652 and a standard deviation of 4.988682. The median values, which represent the midpoint of the distribution, indicate that half of the observations fall above or below these figures. The Kurtosis of under-five mortality, technology and female literacy rates are <3, indicating platykurticity. Whereas, those of public health expenditure and HIV prevalence rate are >3 indicating leptokurticity.

Table 1. *Descriptive statistics*

	UMR	PHE	HIVPR	TECH	FLR
Mean	2.190859	1.207256	1.527778	14.74815	83.18652
Median	2.183708	1.201628	1.55	17.01462	83.64627
Maximum	2.321305	1.429614	2.1	19.13475	92.15672
Minimum	2.021411	0.858742	0.6	8.573574	72.81351
Std. Dev.	0.101181	0.109207	0.37767	4.321579	4.988682
Skewness	−0.045045	−0.332164	−0.525426	−0.351579	−0.324534
Kurtosis	1.555252	4.695917	3.026495	1.300186	2.344129
Jarque-Bera	3.14312	4.976199	1.657488	5.075697	1.277182
Probability	0.207721	0.083068	0.436597	0.079036	0.528036
Sum	78.87093	43.46121	55	530.9333	2994.715
Sum Sq. Dev.	0.358318	0.417415	4.992222	653.6615	871.0432
Observations	36	36	36	36	36

Table 2. *Results of the unit root test*

Variables	ADF statistics	Critical value	Stationarity status
LogUMR	−9.79295	−3.54849	1(0)
LogPHE	−3.613128	−3.544284	1(0)
HIVPR	−6.595028	−3.544284	1(0)
TECH	−3.724449	−3.54849	1(1)
LogFLR	−4.294966	−3.557759	1(1)

4.1. Stationarity. The ADF test was employed to assess the present of unit root in the data. Each variable was initially tested for the presence of both a trend and an intercept. Because all five variables exhibited both, the ADF test was conducted, including both a trend and an intercept, in the regression (Table 1).

The results of the unit root test in Table 2 show that three variables (UMR, PHE, and HIVPR) were stationary, whereas two variables (TECH and FLR) were stationary at the first difference. The mixed order of stationarity of the variables enables the use of ARDL for analysis.

4.2. Cointegration Results. The results of cointegration based on the ARDL model are listed in Table 3 and are based on three maximum lag selections.

The cointegration test results in Table 3 were obtained using the ARDL bounds test. This is necessary to avoid spurious regression results. Table 3 lists the result of the long-term cointegration test between the dependent and independent variables in the model. The results reveal a long-run relationship between the dependent and independent variables. This conclusion is supported by the F-statistic obtained from the F-bound test, which is greater than both the lower and upper critical values at the 5% significance level.

4.3. Long-term Coefficients. Table 4 list the long-term ARDL coefficient results of PHE, HIVPR, TECH and FLR in Nigeria. The results show that PHE has a negative and significant impact on the under-five mortality, having a coefficient of −0.20224848 and a p-value of 0.0000 at the 1% significance level. This implies that a 1% increase in public expenditure on health will lead to a 0.202248% decrease in the under-five mortality rate in the long-term. The result is consistent with the theoretical expectation of this model. Furthermore, the HIVPR and TECH are statistically significant and have a positive impact on the under-five mortality rate, having p-values of 0.0236 and 0.0291 respectively. In the long-term, this implies that a 1% increase in HIVPR and TECH leads to 0.057894% and 0.002766%, respectively, increase in the under-five mortality rate. Furthermore, the results show that FLR has no significant relationship with the under-five mortality rate in the long-term, as indicated by its p-value of 0.4340.

4.4. Error Correction Mechanism. Because the variables were found to be cointegrated, implying that they have long-term equilibrium relationships, short-term relationships were investigated.

The Table 5 lists the ARDL short-term coefficients obtained with an ECM. The results show that in the short-term, PHE has a positive and statistically significant impact on under-five mortality rates with a coefficient of 0.178165 and a p-value of 0.0277. This implies that a 1% increase in PHE results in a 0.179165% increase in the mortality rate of those under the age of five. This may be because, unlike the long-term period, the short-term

Table 3. *ARDL bounds testing for Cointegration*

F-bounds test		Null hypothesis: No levels of relationship		
Test Statistic	Value	Significance.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.53215	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.50%	2.88	3.87
		1%	3.29	4.37

Table 4. *Estimated ARDL long-term coefficients*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PHE	−0.202248	0.026498	7.632648	0.0000
HIVPR	0.057894	0.021279	2.720685	0.0236
TECH	0.002766	0.001067	2.591946	0.0291
FLR	0.054116	0.066083	0.818912	0.434
CointEq(-1)	2.374781	0.145051	16.37201	0.0000

Table 5. *Error correction mechanism*

Variable	Coefficient	Std. Error	t-Statistics	Prob.
D(UMR(1))	1.109142	0.156586	7.083295	0.0001
D(PHE)	0.178165	0.066354	2.536555	0.0277
D(HIVP)	−0.040584	0.016899	−2.401619	0.0431
D(TECH)	−0.006708	0.002733	−2.454632	0.0396
D(FLR)	0.001246	0.000919	1.355756	0.2122
CointEq(-1)	−0.800535	0.183688	−4.358114	0.0024

R^2 = 0.996238, adjusted R^2 = 0.9916694, F-statistic = 3.532151 probability = 0.0003, and Durbin-Watson = 2.971880

Table 6. *Breusch Pagan Godfrey test for heteroskedasticity*

F-statistic	1.855698	Prob. F(22,9)	0.1695
Observed R^2	26.21981	Prob. x^2 (22)	0.2424
Scaled explained sum of squares	2.262211	Prob. x^2 (22)	1.0000

period is insufficient for public expenditure to have a meaningful impact on the health sector. HIVP had a negative and statistically significant impact on the under-five mortality rate, having a coefficient of -0.040584 and a corresponding p-value of 0.0431. This implies that a 1% increase in HIV prevalence results in a 0.040584% decrease in the under-five mortality rate at the 5% significance level. This finding is contrary to a priori expectations and may be attributed to medical advances that prevent HIV transmission from mothers to unborn babies. Furthermore, the result of TECH in the long-term shows a negative and statistically significant relationship, having a coefficient of -0.006708 and a p value of 0.0396. This means that a 1% increase in technology usage results in a 0.006708% decrease in the under five mortality rate at the 5% level of significance. This finding is consistent with the a priori expectations of this study, indicating that improvements in technology use in the health sector reduce the under-five mortality rate in Nigeria. The result in Table 5 also show that the FLR has a positive but statistically insignificant effect on under-five mortality, having a coefficient of 0.001246 and a p value of 0.2122. The results further indicate an error correction term (ECT) value of −0.800535 with a p-value of 0.0024, which is consistent with the theoretical expectation that the ECT should be negative. This implies that the speed of adjustment from the short-term disequilibrium to the long-term equilibrium is approximately 8% annually. The model also had a good fit, as indicated by the R^2 and adjusted R^2 values of 0.996238 and 0.991669 respectively, indicating that the variations in the dependent variable are well explained by the explanatory variables in the model.

4.5. Heteroscedasticity Test on the ARDL Model. As the test result in Table 6 shows, the F-statistic, observed R^2, and the scaled explained sum of squares obtained from the Breusch Pagan Godfrey test shows that the ARDL model is free from heteroscedasticity because their probability values are greater than 0.05 (5% level of significance)

4.6. Cumulative Sum Test for ARDL Model Stability. The cumulative sum (CUSUM) test (Figure 1) shows that CUSUM falls within the critical region, indicating that the model parameters are stable over the sample period (1988 – 2023).

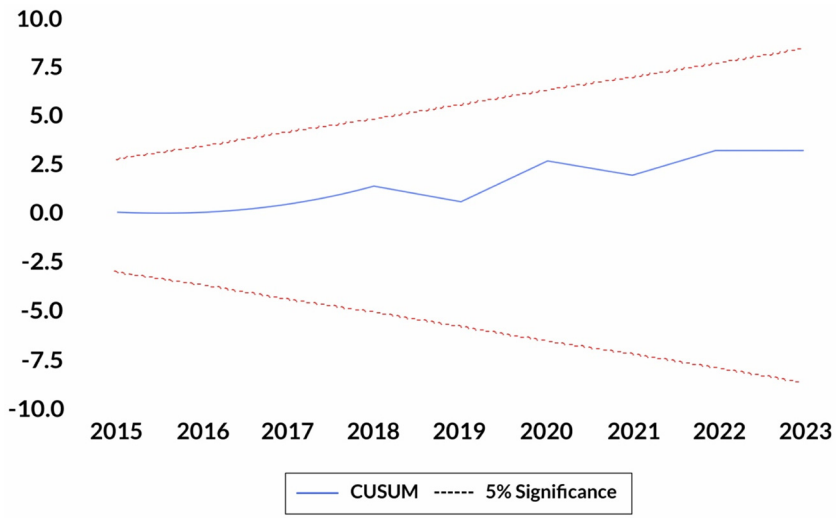

Figure 1. Cumulative sum test results

4.7. Discussion. The results of the analysis of the relationship between under-five mortality and public health expenditure revealed that in the long-term, public expenditure on health has a negative and significant impact on the under-five mortality rate at the 5% significance level. This result aligns with the findings of Azuh et al. and Kato et al. [12,16], but contrasts with the findings of Yaqub et al. [9], who reported that an increase in public health expenditure leads to an increase in under-five mortality rate.

However, the results of the analysis of the relationship between the female literacy rate and under-five mortality rate show that the female literacy rate has a positive but statistically insignificant impact on under-five mortality at the 5% significance level in both the short-term and long-term periods. This finding contradicts that of Aderopo and Emmanuel [11]. However, the results suggest that female literacy did not significantly improve the well-being of children under five years of age in Nigeria during the period under review.

5. CONCLUSIONS

In this study we examine the impact of public health expenditure on the under-five mortality rate in Nigeria from 1988 to 2023 using time-series data obtained from the CBN Statistical Bulletin and World Bank WDIs. The findings indicate that increased public health expenditure significantly reduces under-five mortality in the long-term, although the short term effect was found to be contrary. This underscores the importance of sustained public health investments in improving child health outcomes. Additionally, the study found a negative and statistically significant relationship between technology and under-five mortality in the short-term, suggesting that technologicaladvancements contribute to better child health outcomes in Nigeria. Based on these findings, the following recommendations are proposed:

(1) The demonstrated long-term effect of public health expenditure reducing under-five mortality highlight the need for the Federal Government of Nigeria to increase and sustain funding in the health sector. Priority areas should include infrastructure, health workforce development, and public health education campaigns. Transparent disbursement mechanisms must be implemented, involving effective oversight from relevant agencies such as the Economic and Financial Crimes Commission, to prevent the diversion or misuse of funds

(2) The government, through the Ministry of Communications and Digital Economy, should continue promoting the use of innovative health technologies to strengthen healthcare delivery, particularly in pediatric care. Mobile health applications should be deployed to empower parents and caregivers by offering tools to track children's health metrics, access educational content, and receive timely reminders for vaccinations and checkups.

(3) The government should intensify its investment in health research and development, especially to prevent mother-to-child transmission of HIV during pregnancy. The ministry of Education should prioritize female education, recognizing the pivotal role women play in family health decision-making. Programs aimed at educating girls not only improve their health but also enhance their capacity to advocate for their families' well-being.

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AFFILIATIONS AND AUTHOR DETAILS

Undergraduate Author

Aliyu Inuwa Kamara – *Department of Economics, Nigerian Army University Biu (NAUB), Nigeria;*
0009-0008-4291-2629
Email: aliyuinuwa30@gmail.com

Corresponding Author

Abubakar Orlando Ijoko – *Research Mentor, Department of Economics, Nigerian Army University Biu (NAUB), Nigeria;*
0000-0001-5632-2365
Email: abuijoko@gmail.com

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