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IMPACT OF BASIC SERVICES ON UNDER FIVE MORTALITY IN NIGERIA

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ABSTRACT

This paper investigates the impact of basic services on under-five mortality in Nigeria using annual time series data from 2000 to 2022 sourced from World Bank (2024). ARDL Bound test for cointegration was used to establish a long run relationship among the variables. The results indicate that, in the long run, access to drinking water has a negative influence on under-five mortality, while improved sanitation exerts a significant and negative impact on under-five mortality. Conversely, access to electricity and economic growth were found to have no significant long-run effect on under-five mortality. In the short run, however, both access to drinking water and improved sanitation show a positive and significant impact on under-five mortality. The error correction term is -0.386, suggesting that approximately 38% of deviations from the long-run equilibrium are corrected each period. The paper therefore recommended that Governments at all levels should invest in water infrastructure, strengthen resource policies, promote sanitation, and hygiene education.

Keywords: *Access to Drinking Water, Under-five-mortality, Improve Sanitation, Nigeria*
JEL Classification Code: *I10, I18*

1.0 Introduction

Basic services such as clean water, sanitation, healthcare, education, and housing are universally recognized as fundamental for ensuring human dignity, wellbeing, and a high quality of life (Aziz et al., 2021). More importantly, these services constitute core social determinants of child health, directly influencing the survival and development of children under five (Angelakis et al., 2021). Among them, access to safe drinking water is particularly crucial, as it significantly affects child morbidity and mortality by reducing the incidence of waterborne diseases (Sheel et al., 2024). Yet, global access to these services remains uneven. As of 2020, around 2 billion people lacked access to safely managed drinking water, while 4.2 billion were without safe sanitation services (Amaefule et al., 2023). Moreover, more than 2.4 billion people lacked improved sanitation and 946 million still practiced open defecation (Christodoulou et al., 2020). These deficiencies are major contributors to diarrhea and malnutrition key drivers of under-five mortality. The World Health Organization (WHO) estimates that up to 1.4 million global deaths annually, many of them among young children, could be prevented through improved access to Water, Sanitation, and Hygiene (WASH) services (World Bank, 2023).

In Africa, especially Sub-Saharan Africa (SSA), limited access to these essential services continues to exacerbate child health vulnerabilities. Over 600 million people in SSA lack access to safe drinking water (UNICEF, 2023), and only 55% have access to improved sanitation (World Bank, 2021). Nearly 600 million people are without reliable electricity, weakening

health systems and limiting access to maternal and child healthcare services (International Energy Agency [IEA], 2023). These deficiencies not only compromise healthcare delivery but also contribute to preventable diseases among children. In 2016, unsafe WASH was responsible for 68.6 deaths per 100,000 people in SSA, many of them under five years of age (World Bank, 2023). Despite these risks, African countries still underinvest in health infrastructure. For instance, Nigeria's health sector allocation stood at just 5.75% in 2023 far below the African Union's 15% and WHO's 18% benchmarks (Tambe, 2022; Wasiu, 2020).

Despite its status as one of Africa's largest economies, substantial disparities in access to basic services persist and are closely tied to child mortality outcomes. About 30% of Nigerians lack access to clean drinking water, particularly in rural communities (National Bureau of Statistics [NBS], 2022), and only 37% have access to improved sanitation facilities (World Bank, 2022). These gaps contribute significantly to the high incidence of diarrhea, cholera, and typhoid illnesses that are among the leading causes of under-five deaths. Each year, over 70,000 Nigerian children under five dies from diarrhea caused by unsafe water and poor sanitation (World Bank, 2023). Electricity access remains unreliable for approximately 45% of the population (International Energy Agency, 2023), disrupting healthcare delivery, especially for essential child health services like immunization and neonatal care. The health impact of these deficiencies is compounded by the gendered burden of water collection, which often falls on women and older girls, affecting both maternal care and the caregiving of young children (Swe et al., 2021).

While numerous empirical studies exist, there's a notable gap in research on Nigeria regarding the impact of basic services on under-five mortality. Existing studies often focus on individual services, overlooking their collective effect. This paper addresses this gap by adopting a comprehensive approach to examine the simultaneous impact of improved basic services on under-five mortality in Nigeria

Thus, main objective of the study is to investigate the impact of basic services on under-five mortality in Nigeria. Accordingly, the paper is structured as follows: following this introduction, section two provides literature review, section three dwells on methodology, section four contain results and discussion and finally section five dwells on conclusion and recommendation.

2.0 Literature Review

Basic services are essential for a decent standard of living, human dignity, and quality of life. They encompass a range of fundamental necessities, including access to healthcare facilities and services, clean water, sanitation facilities, reliable and affordable electricity, safe and secure housing, educational facilities, affordable transportation options, nutritious food and food assistance programs, communication services, and social protection services. These services are crucial for ensuring the well-being and quality of life of individuals and communities. Access to drinking water implies using drinking water from an improved source that is accessible on premises, available when needed and free from fecal and priority chemical contamination. Improved water sources include piped water, boreholes or tube wells, protected dug wells, protected springs, and package or delivered water.

According to the World Bank (2024) and World Health Organization (2024), improved sanitation refers to facilities that hygienically separate human excreta from human contact. Examples include flush/pour flush toilets connected to piped sewer systems, septic tanks, or pit latrines, ventilated improved pit (VIP) latrines, pit latrines with slabs, and composting toilets. These facilities play a crucial role in preventing disease spread and promoting public

health by ensuring proper waste management and reducing human exposure to harmful pathogens.

According to the World Bank (2024) and UNICEF (2024), access to electricity is crucial for human development and well-being. It refers to the availability of reliable, affordable, and adequate electricity on demand, enabling basic activities like lighting, refrigeration, and running household appliances. Electricity can improve people's standard of living, boost economic activity, and create jobs, ultimately contributing to a broader goal of ensuring access to affordable, reliable, sustainable, and modern energy for all.

Under-five mortality, as defined by the World Health Organization (2024), refers to the death of a child before reaching five years of age. The under-five mortality rate (U5MR) measures the number of deaths per 1,000 live births in a given year, representing the probability of a newborn dying before age five if subjected to the age-specific mortality rates of that year. This metric is a critical indicator of child health and well-being.

This review examines the relationship between basic services (access to clean water, improved sanitation, and electricity) and under-five mortality rates in developing countries, highlighting the impact of the essential services on child health and survival.

Recent studies in Nigeria highlight the critical role of basic services in reducing under-five morbidity and mortality. Key findings include:

A study by Okoroiwu et al. (2024) found high fatality rates among infants (<1 year) with leading causes of death including perinatal conditions, infections, sepsis, malnutrition, and congenital diseases. Ihual et al. (2024) assessed the public health implications of cholera and WASH-related diseases. The findings reveal that lack of access to safe drinking water, climate change, and poor hygiene practices contribute to cholera spread.

Merid et al. (2023) examined the impact of improved water and sanitation on diarrhea among under-five children. The study found improved drinking water and sanitation significantly reduced diarrhea risk, with the combined effect of both interventions more effective than either alone. These studies emphasize the importance of access to basic services like clean water, sanitation, and hygiene in reducing under-five morbidity and mortality in Nigeria and other low- and middle-income countries.

Studies by Qurat-ul-Ann et al. (2023) and Mohammed and Akuoko (2022) highlight the impact of basic services on child health. Qurat-ul-Ann et al. found that water and sanitation poverty significantly increased diarrhea cases among under-five children in Pakistan, with rural households experiencing higher rates. In contrast, Mohammed and Akuoko discovered that increased electricity access reduced infant deaths in low-mortality areas of Ghana, but had no effect in high-mortality regions. These findings emphasize the importance of tailored health and infrastructure policies that consider regional contexts and socio-economic factors to effectively reduce infant and child mortality.

Joseph and Oladokun (2022) found that improved sanitation and access to safe drinking water significantly reduced under-five, infant, and neonatal mortality rates in West Africa. Increased health expenditure and higher per capita income also improved child health, while food deficiency worsened mortality. Kalbessa et al. (2018) highlighted the need for a comprehensive approach to assess the combined impact of improved water, sanitation, and electricity on health outcomes, particularly in diverse contexts like Nigeria.

3.0 Methodology

This study is anchored on Grossman's (1972) health capital model, which conceptualizes health as a durable capital good requiring continuous investment to maintain and improve. According to the model, individuals invest in health through actions such as accessing healthcare, clean water, sanitation, and nutrition to offset health depreciation from aging and illness (Jones et al., 2022). These investments not only improve health outcomes such as reducing under-five mortality but also enhance productivity and economic performance, making health both a consumption and investment good (Kulkarni, 2016).

Basic services like clean drinking water, improved sanitation, and electricity are seen as critical health investments that reduce disease risk and strengthen living conditions. These services serve as inputs in the health production function:

$$H_t = f\left(I_t, X_t\right) \tag{1}$$

H_t is a function of health investments I_t and other influencing factors X_t. Investments in basic services are modelled as crucial inputs that directly enhance health capital.

3.1 Model Specification

Following the specification of Obaka and Noman (2019), we specify a model for the impact of access to basic services on under-five mortality as:

$$USMTI_t = \beta_0 + \beta_1 AWT_t + \beta_2 ASN_t + \beta_3 AEC_t + \beta_4 GDP_t + \varepsilon_t \tag{2}$$

Where $USMTI_n$ is the under-five mortality rate at time t, AWT_t represents access to drinking water at time t, ASN_t is the access to improve sanitation at time t, AEC_t is access to electricity at time t, and GDP is the gross domestic product at time t.

A priori β_1, β_2, β_3 and $\beta_4 < 0$

The expected negative sign for β_1, β_2, β_3, and β_4 indicates that improved access to clean drinking water, improved sanitation, and electricity are associated with a decrease in under-five mortality rates. This relationship is plausible, as access to safe drinking water reduces the risk of waterborne diseases, a major cause of child deaths. By reducing exposure to contaminated water, improved access to clean drinking water can lead to better child health outcomes and lower mortality rates. In addition, enhanced sanitation reduces the incidence of gastrointestinal infections and other preventable diseases. Also, access to electricity can improve health outcomes by supporting better healthcare infrastructure and improving living conditions. Finally, higher GDP per capita generally correlates with better health outcomes. Increased economic resources typically lead to better healthcare services and improved living standards, contributing to lower under-five mortality rates

3.2 Type and Sources of Data

Annual time series data, spanning 2000 to 2022 were sourced from World Bank (2024) database. Variables for the study include under -five mortality, access to drinking water, improved sanitation, access to electricity, and Gross Domestic product. All data are sourced from World bank (2024). Under-five- mortality is measured as the number of children that died before their fifth birthday in every 1000 children. Access to drinking water is percentage of population with access to basic drinking water; Percentage of population with access to improved sanitation is a measure of access to improved sanitation. In this study, access to

electricity is calculated as percentage of population with access to electricity. While GDP per capita at constant US$ is a measure of GDP a proxy for economic growth.

This study used the ARDL model to examine the impact of basic services namely; access to drinking water, sanitation, and electricity on health outcomes, specifically under-five mortality. The ARDL model is advantageous because it can handle variables that are not necessarily of the same order of integration and provides a comprehensive framework for understanding both the immediate and cumulative effects of health service access on health outcomes. The Autoregressive Distributed Lag (ARDL) model is a versatile econometric technique used to analyze the dynamic relationships between variables, particularly in the context of cointegration. It is especially useful when dealing with time series data that may be integrated of different orders, specifically I(0) and I(1). The ARDL approach allows for the modeling of variables with mixed integration orders and provides insights into both short-term dynamics and long-term equilibrium relationships (Pesaran et al., 2001).

The ARDL model addresses endogeneity concerns common in studies involving health outcomes and policy variables like access to water, sanitation, and electricity. By incorporating lagged dependent and independent variables, it helps control for omitted variable bias and improves estimate reliability (Ang, 2007). Additionally, ARDL allows for the derivation of an Error Correction Mechanism (ECM), which shows how quickly variables return to equilibrium after a shock crucial for understanding the responsiveness of health outcomes to changes in basic services (Banerjee et al., 1998).

The ARDL model for (2) is specified in (3).

$$\begin{aligned}\Delta U5MTI_t &= \alpha_0 + \alpha_1 \ln U5MLT_{t-1} + \alpha_2 \ln AWT_{t-1} \\ &+ \alpha_3 \ln ASN_{t-1} + \alpha_4 \ln AEC_{t-1} + \alpha_5 \ln GDP_{t-1} + \sum_{t=0}^{p} \beta_1 \Delta U5MLT_{t-1j} \\ &+ \sum_{t=0}^{p} \beta_2 U5MLT_{t-1} + \sum_{j=0}^{p} \beta_3 \Delta \ln AWT_{t-1} + \sum_{k=0}^{q2} \beta_4 \Delta \ln ASN_{t-1} \\ &+ \sum_{l=0}^{p} \beta_5 \Delta \ln AEC_{t-1} + \sum_{m=0}^{p} \beta_6 \Delta \ln GDP_{t-1} + \mu_t\end{aligned} \tag{3}$$

Where: 'α_1, α_2, α_3, α_4, and α_5 are the long run parameters, while the short run parameters are represented as β_1, β_2, …, β_6. The Δ's are the first difference operator. μ_t is the error term.

The Error Correction Model which captures the short-run dynamics and the speed of adjustment of the model is specified as (4):

$$\begin{aligned}\Delta \ln U5MTL_t &= \gamma_0 + \sum_{i=0}^{p} \delta_{1,i} \Delta \ln U5MTL_{t-i} + \sum_{l=0}^{p} \delta_{2,j} \Delta \ln AWT_{t-j} \\ &+ \sum_{k=0}^{p} \delta_{3,k} \Delta \ln ASN_{t-k} + \sum_{l=0}^{p} \delta_{4,l} \Delta \ln AEC_{t-l} + \sum_{m=0}^{p} \delta_{5,m} \Delta \ln GDP_{t-m} + \lambda \mu_{t-1} + \varepsilon_t\end{aligned} \tag{4}$$

Δ denotes the first difference of the variables (i.e., $\Delta U5MLT_t = U5MLT_t - U5MLT_{t-1}$), μ_{t-1} is the lagged error correction term (the residual from the long-run equation), λ is the speed of adjustment coefficient, which shows how quickly the model returns to equilibrium after a deviation in the short run. It should be negative if the system is converging to equilibrium.

ε_t is the white noise error term.

4.0 Results and Discussion

4.1 Descriptive Statistics

The result of the descriptive statistics of under -five mortality, access to drinking water, improved sanitation, access to electricity, and Gross Domestic product is presented in Table 1.

Table 1: Descriptive Statistics

	U5MTL	AWT	ASN	AEC	GDP
Mean	130.71	61.76	36.10	51.96	2239.23
Median	125.40	61.67	35.55	52.50	2401.18
Maximum	173.70	79.64	46.57	60.50	2679.55
Minimum	100.90	44.44	27.99	43.20	1462.54
Std.Dev	20.61	10.94	5.88	5.09	371.24
Skewness	0.60	0.02	0.23	-0.12	-0.77
Kurtosis	2.37	1.78	1.82	1.99	2.36
Jarque-Bera	1.77	1.42	1.54	1.03	2.67

Source: Authors' computation

The descriptive statistics show that Nigeria's average under-five mortality rate (U5MTL) from 2000 to 2022 was 130.7 deaths per 1,000 live births, with a peak of 173.7 in 2000 and a low of 100.9 in 2022. Nigeria remains a major contributor to global under-five deaths. Average access to improved water (AWT) was 61.76%, sanitation (ASN) 36.10%, and electricity (AEC) 51.96%. All showed positive skewness except AEC, which was slightly negative. GDP averaged ₦2239.23 billion, also negatively skewed. The data highlight disparities in basic service access and persistent health challenges.

4.2 Unit Root Test Result

The unit root test results from Augmented Dickey–Fuller (ADF) and Phillip Peron (PP) across two-equation test options are presented in Table 2. The results revealed a mixed order of integration, as such the probable existence of a long-run relationship is investigated.

Table 2: Unit Root Test Results

Variable	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)		Order of Integration
	Level	First Diff	Level	First Diff	
U5MTL	-0.5986	-3.0766**	-3.6958**	-10.0333***	I(1)
AWT	8.5557	-11.3994***	3.4049	-28.4888***	I(1)
lnASN	-18.4233***		2.0214	-23.8893***	I(0)
lnAEC	-0.3625	-5.2936***	-1.4733	-5.2937***	I(1)
lnGDP	-3.0467**		-4.0825**		I(0)

*Note: *, **. *** represent levels Significant at 10%, 5% and 1%*
Source: Authors' Computation

The unit root test results confirm that access to sanitation (ASN) and GDP per capita, while under-five mortality (U5MTL), access to water (AWT), and electricity (AEC), become stationary only after first differencing, indicating they are I(1). This mixed integration order

satisfies the conditions for using the ARDL model, which can handle both I(0) and I(1) variables.

Table 4.3: ARDL Bound Test Result

F-Statistic	1% Critical Value	5% Critical Value	10% Critical Value
6.9563	I(0): 3.74 I(1): 5.06	I(0): 2.86 I(1): 4.01	I(0): 2.45 I(1): 3.52

Source: Authors' Computation

The results in Table 3 confirm a cointegrating relationship among the variables, with under-five mortality as the dependent variable. The F-statistic of 6.96 exceeds the 5% critical bounds, indicating a long-run relationship. This suggests a long-term relationship among access to drinking water, sanitation, electricity, and GDP as well as under-five mortality.

4.4 Impact of Basic Services on Under-five Mortality in Nigeria

The long run and short run coefficients are presented in Table 4.4.

Table 4.4: Long Run and Short Run Coefficients

Variable	
LNAWT	-0.0817**
	(0.0176)
LNASN	-0.0844***
	(0.0013)
LNAEC	-0.0061
	(0.8139)
LNGDP	0.1117
	(0.2453)
Const.	4.2451***
	(0.0001)
Short Run coefficient	
Δ(LNAWT)	0.0427
	(0.9032)
Δ (LNAWT (-1))	-0.5470**
	(0.0034)
Δ(LNASN)	0.5485***
	(0.0000)
Δ (LNASN (-1))	0.6866**
	(0.0035)
Δ (LAEC)	0.4321
	(0.2312)
Δ(LNGDP)	-0.0199
	(0.1419)
ECT_{t-1}	-0.3861***
	(0.0000)

Note: ***, **, * represents significance levels at 1%, 5% and 10% respectively. The figures in parenthesis are the probability values of the estimate.

Source: Authors' computation

Table 4.4 shows that access to drinking water (AWT) has a significant negative impact on under-five mortality (U5MTL) in Nigeria. A 1% increase in AWT reduces U5MTL by 8.17% in the long run, aligning with apriori expectations. This relationship highlights how clean water improves child health by supporting hygiene, preventing infectious diseases, and enhancing nutrition. These benefits contribute to lower child mortality from illnesses like pneumonia and diarrhea. The finding underscores the vital role of water access in promoting child survival and public health and is consistent with previous studies by Aremu et al. (2021), Omotayo et al. (2021), and Merid et al. (2023).

The findings further reveal that access to improved sanitation (ASN) has a significant negative relationship with under-five mortality (U5MTL) in Nigeria. A 1% increase in ASN leads to an 8.44% reduction in U5MTL in the long run, significant at the 1% level. This aligns with apriori expectations, as improved sanitation reduces exposure to fecal contamination, thereby lowering the incidence of diseases like diarrhea, cholera, and typhoid—major causes of child mortality. By reducing open defecation and maintaining cleaner environments, sanitation facilities help prevent fatal infections in children. These findings align with studies by Cameron et al. (2021), Sorumlu (2021), and Addelhady et al. (2022).

The results show that access to electricity (AEC) and economic growth (GDP) both have no statistically significant impact on under-five mortality (U5MTL) in Nigeria in the long run.

While electricity can improve health outcomes, its effect is limited without reliable supply and health-focused integration. Similarly, GDP growth alone does not significantly influence child mortality, highlighting the need for targeted interventions beyond economic expansion and basic infrastructure

The short-run ARDL results show that the error correction term (ECT) is -0.3861, negative, statistically significant, and less than one, indicating a 38.6% speed of adjustment to restore long-run equilibrium when distorted. Access to drinking water (AWT), lagged one period, has a negative and significant effect on under-five mortality (U5MTL), confirming its short- and long-run impact. However, access to improved sanitation (ASN) shows a positive and significant short-run impact on U5MTL, contrary to expectations and long-run findings. GDP's short-run coefficient is negative but not significant, mirroring the long-run result, implying GDP has no meaningful effect on U5MTL in Nigeria.

4.5 Diagnostic Test Result

The validity and consistency of the estimated coefficients are examined based on Chi-square and langrage Multiplier (LM) test as well as stability tests. The result of the diagnostic test for model 1 is presented in Table 5.

Table 5: Diagnostic Test Result

Test Statistics	Chi-Square/LM Test	Probability Value
Serial Correlation	16.6337	0.4002
Functional Form	1.6315	0.2373
Normality	3.3190	0.1902
Heteroskedasticity	6.6685	0.6716

Source: Authors' computation

Note: Serial correlation is determined using Langrage multiplier test of residual, functional form based on Ransey-Reset test, Normality based on Jaque-Bera and Heteroscedasticity based squared Breusch-Pagan test.

The result revealed the model is free of serial correlation, and heteroscedasticity. The residuals are normally distributed, and the model did not suffer from functional misspecification as evidenced by the not statistically significant probability value.

The stability of the estimated model is evaluated using Cumulative Sum of Recursive residuals (CUSUM), and The Cumulative Sum of Squares of recursive residuals (CUSUM SQ). The result evidently revealed that the estimated model is stable over the period under study (Figures 1 and 2).

Figure 1: CUSUM

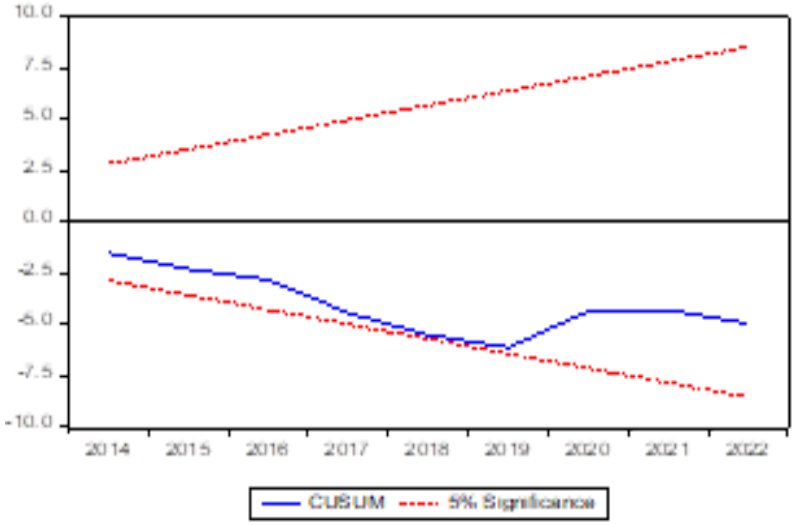
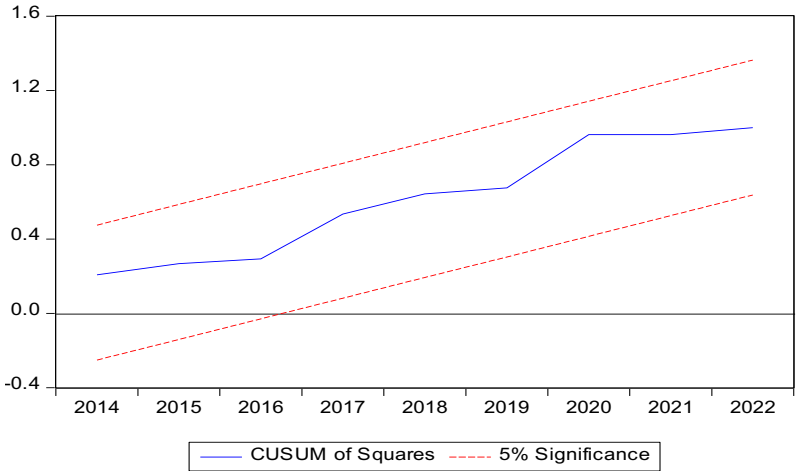


Figure 2: CUSUMSQ



5.0 Conclusions and Recommendations

In conclusion, the basic services such as access to drinking water (AWT) and improved sanitation (ASN) demonstrated noticeable impacts in the long run, indicating their crucial roles in reducing under-five mortality (U5MTL) in Nigeria for the period under study. However, access to electricity (AEC) and economic growth Proxied by Gross Domestic Product (GDP) were not significant, suggesting that these access to electricity (AEC) as basic service and economic growth Proxied by Gross Domestic Product (GDP) do not have a substantial long-term influence on under-five mortality (U5MTL) in Nigeria.

On the Basis of the findings, this study recommends that Governments must invest in clean water infrastructure and promote improved sanitation, especially in vulnerable areas. These efforts, combined with hygiene education, directly combat waterborne diseases, a major cause of child deaths. Furthermore, pro-poor economic policies that channel growth benefits into primary healthcare and preventive services, will create a robust support system for child survival, addressing both immediate health needs and underlying socioeconomic determinants.

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