

HEALTH EXPENDITURE AND INFANT MORTALITY RATE IN SUB SAHARAN AFRICAN COUNTRIES: A PANEL ANALYSIS

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Abstract

This study examined the effect of health expenditure on infant mortality rate in Sub-Saharan African countries. In order to explore the short-run and long-run effects of various health expenditure components on infant mortality, panel data covering the period from 1990 to 2023 were employed. The data were sourced from the World Development Indicators (WDI) of the World Bank. The study adopted the Panel Autoregressive Distributed Lag (Panel ARDL) model and estimation was conducted using Stata software. Preliminary unit root tests were conducted to determine the stationarity properties of the variables and revealed that some variables were stationary at level, while others were integrated of order one I(1) at the 5% level of significance. In addition, tests for cross-sectional dependence were carried out to account for the interlinkages among countries in the panel. The ARDL bounds test confirmed the existence of a long-run equilibrium relationship between the health expenditure variables and infant mortality rate. The results revealed that recurrent, capital, public, and private health expenditures had positive but statistically insignificant effects on infant mortality rate in both the short run and the long run. However, basic sanitation had a positive and statistically significant effect on infant mortality rate across both time frames. Urban population was found to have a negative and marginally significant impact in the short run. The error correction term was negative and statistically significant, indicating a strong speed of adjustment towards the long-run equilibrium. Thus, the study concludes that although health spending has potential, its impact on infant mortality rate in Sub-Saharan Africa is limited by inefficiencies and structural challenges. The study therefore recommends that governments in the region should Improve the efficiency of health financing, increase investment in sanitation infrastructure, and address urban health system challenges to achieve lower infant death rate and sustainable improvements in population health.

Keywords: Health Expenditure, Infant Mortality Rate,

1. Introduction

Health is highly recognized globally as a key element of human capital that provides more time for working and improving utility (Schultz, 2019). Investing in human capital is crucial for economic growth and sustainable development which may be achieved by increasing healthcare spending at both individual, national and international levels. Allocating enough health care expenditure is crucial for achieving the primary goal of improving health outcomes. Health expenditure includes preventive and curative healthcare, family planning, nutrition, and emergency help (Bakare & Olabogun 2017).

High-income countries allocate substantial resources to healthcare, which results in better health outcomes, such as lower maternal and infant mortality rates, higher life expectancy, and improved quality of life. For example, countries like Norway and Switzerland consistently report maternal mortality rates below 5 per 1,000 live births due to well-funded healthcare systems. Conversely, low-income countries, such as Nigeria and Chad, often struggle with

limited health budgets, leading to higher mortality rates and poorer health indicators (Akinloet *al.*, 2017). The health sector needs sufficient funding in order to operate effectively and efficiently, and that funding needs to be used in a way that adheres to sector goals and priorities and is free from dishonest or corrupt activities (WHO, 2019). Health is one of the most valuable possessions a person may have, it enables individuals to fully realize their inherent strengths and potential. Underdeveloped potential can lead to physical and mental weakness, presenting irreversible hurdles in people's life (Hennaand & Muhammed, 2014).

Infant and child mortality rates are another important indicator of health outcomes. SSA has made substantial progress in lowering these rates, with the under-five mortality rate falling from 155 per 1,000 live births in 1990 to 76 in 2020 (UNICEF, 2021). However, the region continues to account for a disproportionate percentage of worldwide child mortality, with many deaths caused by preventable illnesses such as diarrhea, pneumonia, and malaria. The restricted availability of immunizations, poor maternal health services, and inadequate nutrition all contribute to high mortality rates. Furthermore, maternal health outcomes are also an area of concern in SSA. Although maternal mortality rates have decreased in recent decades, the area continues to contribute for over two-thirds of global maternal deaths (World Health Organization, 2020).

The effectiveness of health-care spending has a significant impact on infant mortality. While increased health expenditure can lead to decrease in infant mortality, misuse of finances and underdeveloped health systems in many SSA nations frequently prevent these advancements from being realized. For example, healthcare funding may be misallocated or lost due to corruption, resulting in gaps in healthcare services and inferior outcomes, particularly in rural regions (Govenderet *al.*, 2020).

According to Opaluwa, Umeh and Abu (2021), many Sub-Saharan African countries regarding health expenditure and infants mortality falls short of the ideal. Health funding is often inadequate, with limited resources allocated to the sector. Inefficient use of available funds further exacerbates the issue, hindering the development and maintenance of healthcare infrastructure and the provision of essential medicines and services. Access to healthcare services is inequitable, particularly affecting rural populations who often face barriers to accessing basic health services. This disparity contributes significantly to high infant mortality rates. Despite efforts to improve the situation, such as occasional increases in health budgets and initiatives to strengthen healthcare systems, persistent challenges remain. Improving the relationship between health spending and infant mortality rate in the region requires addressing these inefficiencies.

2. Literature Review

Health Expenditure

According to World Bank (2014), health expenditure refers to the total resources spent on health services and goods, including both public and private spending. It encompasses a broad spectrum, from individual out-of-pocket payments to government spending and international aid. Understanding health expenditure is crucial for analyzing how effectively resources are allocated and utilized to improve health outcomes. Health expenditure is the total amount of money that individuals, governments, and private organizations spend on health-related products and services. According to the World Health Organization (2020), it includes all expenditures related to the delivery of healthcare, including those for prevention, diagnosis, treatment, rehabilitation, and the infrastructure of the healthcare system, in addition to investments in medical personnel, drugs, and equipment. A nation's commitment to the health

of its citizens is largely determined by its health spending, which is sometimes expressed as a proportion of GDP or per capita spending.

Health expenditure can be categorized into several types. Curative and rehabilitative care includes spending on services aimed at treating illness and injury, such as hospital and outpatient care, surgery, and rehabilitation (Mills *et al.*, 2012). Preventive care involves expenditure on measures to prevent diseases, including vaccinations, health education, and screenings (WHO, 2010). Health administration and governance covers costs associated with the management and administration of health services, policy-making, and regulation (CDC, 2020). Capital formation involves investment in health infrastructure, such as the construction of hospitals and clinics and the procurement of medical equipment (Frenket *et al.*, 2017). Pharmaceuticals and medical goods encompass spending on medications, medical supplies, and devices (Wagstaff *et al.*, 2015).

In SSA, health expenditures is sometimes split into two primary categories: private (household out-of-pocket) and public (government) spending. National health programs, public hospital funding, healthcare worker salaries, and healthcare service subsidies are all examples of public health expenditures. Private expenditure usually entails paying for treatments out of pocket that are not reimbursed by the government or health insurance; this can be expensive, particularly for households with low incomes (Lu *et al.*, 2011).

Infant Mortality

Gray *et al.* (2009) consider infant mortality as a measure of child health. The infant mortality rate is the risk that a kid would die before or during his first year of life (Mosley and Chen, 1984; WHO, 2019; UN-IGME, 2019; Abdul, 2020). Infant mortality is the chance of a kid dying before one or five years (UN IGME, 2019). Infant mortality is defined as the number of deaths per 1,000 live births of children younger than one year in a given population. This epidemiological definition specifies that the infant mortality rate is a ratio expressed as a standardized statistical measure.

Clinically, Infant mortality may be determined by proximal factors attributed to maternal factors, malnutrition, infection, and utilization of health care services. Intermediate factors attributed to access to food, water, vaccination, and health services. Lastly, the distal factors attributed to national income, unemployment, education, and government spending (Mosley & Chen, 2016). Infant mortality may also be attributed to climatic, political, cultural, biomedical, and socio demographic factors (Subramanian, 2019). Here infant mortality is being explained by multifactorial determinants.

Globally, Infant mortality is seen as a subject of structural inequality that results in uneven access to good healthcare services (Rickman *et al.*, 2018). This characterized infant mortality as a product of health disparities. Empirical evidence has shown that low-income countries record high infant mortality as compared to high-income countries (Demetriou&Tzitziris, 2017; Osawe, 2014). This affirms that infant mortality is associated with income inequalities. Research around the world argues that Infant mortality rate (IMR) is one major prerequisite determinant of an economy's level of socioeconomic development, thus rise or decline in children deaths specifically those under five rate is an indicator of a nation's living standard (Cutler, Deaton, & Lleras-Muney, 2006; Anthony *et al.*, 2016). This explains infant mortality as an indicator of population health and socioeconomic disparities. Thus, the study adopts the definition of (UN IGME, 2019), Infant Mortality is the likelihood of a child dying before one and five years of age.

The factors contributing to high infant mortality in SSA are diverse. Poor prenatal and postnatal care, limited access to skilled birth attendants, inadequate healthcare infrastructure, and insufficient funding for health programs are some of the key drivers. Additionally, socio-economic disparities, such as poverty and lack of education, particularly among women, further exacerbate infant mortality rates (World Bank, 2021). Environmental factors, such as poor sanitation and limited access to clean water, also play a crucial role in increasing the vulnerability of infants to diseases.

This study is centered on two strands of theories the Grossman (1972) model of health capital and Wagner's expenditure theory. Grossman (1972) addresses how individuals strive to have the best possible health outcome, which is heavily influenced by their ability to afford health care services, among other things.

Grossman's (1972) paradigm is used to study the impact of public health expenditure on health output. This model assumes that individual health status is determined by individual inputs, as illustrated below.

$$Y=f(W).....(2.1)$$

Where Y measured an individual's health status and W represents inputs into the health function. This type of health production allows for easy empirical estimation of the impact of health expenditure on health output.

Grossman's (1972) model of health capital focuses on how individuals spend resources to achieve health. This theoretical exposition follows the unconstrained utility maximization theory, where individuals attempt to maximize their utility with a given set of resources. According to Grossman, individuals invest in themselves to achieve their ideal health state. The idea describes how health financing relates to other inputs. The model suggests that an individual's need for health input is developed, not necessarily for consumption, but rather to achieve a typical health outcome. Individuals can attain their health goals by acquiring inputs such as public or private healthcare finance, nutritional consumption, exercise, environment, income, and time to engage in a production process that results in a desired health outcome. This idea assumes that individuals appreciate health but do not prioritize it over other factors.

While Adolph Wagner (1835-1917), a German political economist, formulated the "law of increasing state activity" based on empirical examination of Western Europe at the end of the 19th century. Wagner (1838) supports government spending on investment, arguing that it has a natural tendency to increase both significantly and intensely. The approach emphasizes the importance of government spending to deliver welfare services, including public health. The author argues that public spending is an endogenous component that is influenced by economic growth. Governments can play a beneficial role in providing quality services and investment by ensuring proper fiscal responsibility. Prioritizing this can have a multiplier effect in the economy, including the health sector, leading to a decrease in infant mortality and improved health outcomes. Wagner anticipated a positive correlation between public expenditure and quality of life. Wagner's law became ineffective as jurisdictions with high levels of taxation struggled to raise taxes higher. Continuing to run deficits resulted in increased state debt and reduced spending (Karciski & Kiser, 2020), limiting growth.

Michael, Tatjana, and Albert (2020) assessed the impact of government health spending on infant mortality in low- and middle-income nations over a nineteen-year period. The World Bank Development Indicators dataset was used, and fixed effect estimate techniques were applied, with a stage least squares check to ensure robustness. The findings demonstrated that government investment improves health outcomes and thus significantly reduces newborn mortality, demonstrating a strong and negative link between government expenditure and infant mortality in low- and middle-income nations. The report advises that the affected countries increase their government spending and investment in health in order to develop a desirable.

Wilson et al. (2019) studied the effect of health aid on infant mortality rates and the importance of education in understanding this relationship in African countries from 1999 to 2015. The authors explored the relationship between health aids for infectious illness control and diet. Data from poor developing nations indicate that education reduces infant death rates, while health aid has an insignificant overall effect. The study indicated that disaggregated health aid, including total health and nutrition aid, can reduce infant death rates only when education levels above a certain threshold.

Thomas (2020) examined the relationship between health expenditure and outcomes from 2012 to 2018 by employing Panel autoregressive distributed lag, and found that there is a favorable correlation between health expenditure and outcomes in 217 countries worldwide. In addition, public health investment has a significant positive impact on infant and under-5 mortality rates, it has little effect on life expectancy. Private health spending has a significant positive impact on life expectancy, but baby and under-5 death rates are minimal.

3. Methodology

Nature and Sources of Data

The study uses balance panel data to examines the relationship between health expenditure and health outcomes in 12 Sub-Saharan African (SSA) countries over a 33-year period, from 1990 to 2023. The dependent variable is Infant mortality rate. While the independent variables are public health expenditure, recurrent health expenditure, private health expenditure, Basic sanitation, and Urban Population. The statistics was collected from the World Bank Development Index (WDI, 2022).

Table 1: variable Description and Sources of Data

The table below shows the description and sources of the variables.

S/N	Variable	Description	Source
1	Infant Mortality Rate	Numbers of Children died below one (1 years) in percentage	WorldBankDevelopmentindex (WDI)2023
2	Recurrent Health Expenditure (RCHEx)	Recurrent Health Expenditure (in billions of dollar)	WorldBankDevelopmentindex (WDI)2023
3	Capital Expenditure (CPHEX)	Capita Health Expenditure (in billions of dollars)	WorldBankDevelopmentindex (WDI)2023
4	Private Health Expenditure (PHE)	Private Health Expenditure (in Billions of Dollars)	WorldBankDevelopmentindex (WDI)2023
5	Level of Education	Level of parent education in percentage	WorldBankDevelopmentindex (WDI)2023
6	Basic Sanitation (BASANT)	People using at least basic sanitation services in (%)	WorldBankDevelopmentindex (WDI)2023
7	Urban Population (URBPOP)	Number People residing in urban centers in (%)	WorldBankDevelopmentindex (WDI)2023

Source: Author's Computations (2024).

Model Specification

The model specification is based on the specific objectives stated in Chapter One, both functional and linear regression models are fundamental to every econometric analysis. Therefore, this study adapt the variable selection approach of Boachi, Ramu, and Pölajeva (2018) in specifying its model, which is presented below:

$$HO = f(HEx, BSNT, UPOP) \dots \dots \dots (3.1)$$

The explicit form of the model is shown in equation 3.2

$$HO_i = \beta_0 + \beta_1 HEx_t + \beta_2 BSNT_{it} + \beta_3 UPOP_{it} + U_{it} \dots \dots \dots (3.2)$$

Where HO is health outcomes, HEx is Health Expenditure, BSNT is basic sanitation, and UPOP is urban population.

A modified model of their study, which will be applied in the current study, is implicitly stated in equation 3.3. The modified model is justified because it incorporates disaggregated health expenditure components and key demographic controls, providing a more accurate and policy-relevant assessment of their effects on infant mortality

$$INF = f(RHE, CHE, PHE, UPOP, BSNT) \dots \dots \dots (3.3)$$

The explicit form of the model is shown in equation 3.4

$$INF_{it} = \beta_0 + \beta_1 RHE_{it} + \beta_2 CHE_{it} + \beta_3 PRHE_{it} + \beta_4 UPOP_t + \beta_5 BSNT_{it} + U_{it} \dots \dots \dots (3.4)$$

Where INF is infant mortality rate, RHE is recurrent healthcare expenditure, CHE is capital health expenditure PRHE is private health expenditure, UPOP is urban population and BSNT is basic sanitation.

The apriori expectation of the study is that recurrent health expenditure (RHE), capital health expenditure (CHE), private health expenditure (PRHE), and basic sanitation (BSNT) are all expected to have a negative relationship with infant mortality rates. This implies that higher spending on healthcare services, infrastructure, and sanitation should reduce infant mortality rates, such that β_1 , β_2 , β_3 , and β_4 are expected to be less than zero ($\beta < 0$) for infant mortality.

Methods of Data Analyses

Descriptive Statistics

Descriptive statistics was used to summarize the key features of the dataset, including mean, median, minimum, maximum, standard deviation, skewness, kurtosis, and Jarque-Bera test for normality. These measures help assess the central tendency, dispersion, and distributional properties of both dependent and independent variables. Bar charts and trend lines were employed to visualize patterns in health expenditures and health outcomes across countries and over time.

Cross-Sectional Dependence Test

Given the multi-country panel nature of the data, the Pesaran (2015) Cross-Sectional Dependence (CD) test was applied to determine whether cross-sectional units (countries) are interdependent. The presence of cross-sectional dependence suggests that health shocks in one country may influence others, justifying the need for robust estimators that control for this feature.

Panel Unit Root Test

To determine the stationarity properties of the variables, the study employed the Pesaran (2007) Cross-Sectionally Augmented Im-Pesaran-Shin (CIPS) test. This method is appropriate for panels with potential cross-sectional dependence and allows variables to be integrated at different orders, which is crucial in deciding the suitability of the panel ARDL approach.

Panel Cointegration Test

The Westerlund (2007) panel cointegration test was employed to examine whether a long-run equilibrium relationship exists among the variables. This test accounts for both cross-sectional dependence and heterogeneity among countries, and its results will inform the subsequent estimation approach.

Panel Autoregressive Distributed Lag (P-ARDL) Model

The Panel ARDL model is particularly appropriate for this study as it captures both the short-run and long-run dynamics of the relationship between health expenditure and health outcomes across countries over time. This model is suitable when the panel data series are integrated at different orders, i.e., $I(0)$ and $I(1)$, and allows for heterogeneity among cross-sectional units. By applying the P-ARDL model, the study accounts for country-specific differences in the speed of adjustment and the long-term equilibrium relationships. The use of the P-ARDL technique also helps in addressing dynamic panel bias and produces more reliable estimates, especially in contexts where cross-sectional dependence and cointegration among variables are present.

4. Data Analysis

Descriptive Statistics

	DRHE	INF	DPRHE	DCHE	DBSNT	DUPOP
Mean	23.14407	8.3732401	-3.57E-16	20.29129	4.027408	0.843498
Median	23.39603	12.618303	0.068972	20.34419	4.013651	0.911909
Maximum	25.72855	3.921080	3.481886	23.15951	5.027473	1.561023
Minimum	18.68765	1.719690	-5.035050	16.86194	2.794362	-0.948611
Std. Dev.	1.463614	1.467316	1.229160	1.248954	0.395409	0.336358
Skewness	-0.585461	-0.1531005	-0.739817	-0.278194	-0.100316	-1.205039
Kurtosis	2.765345	2.578510	4.741230	2.390680	2.808087	5.583809
Jarque-Bera	17.05401	21.42651	69.61602	8.737425	0.918578	166.4606
Probability	0.000198	0.000000	0.000000	0.012668	0.631733	0.000000
Observation	554		554	554	554	554

Source: Authors Computation using E-view 13

The Table 4.1 depict the descriptive statistics used in the empirical study. The average mean of recurrent health expenditure (DRHE), infant mortality rate (INF), Capital health expenditure (DCHE), basic sanitary (DBSNT), and urban population growth (DUPOP) is (23.14407, 2.832491, 20.29129, 4.027408, 0.843498) respectively while public health expenditure (DPHE), and private health expenditure (DPRHE) has a negative mean average of -0.594418 and 3.57E-16 percent. The health implication is that across the countries there has been consistence fluctuation in the activities of health sector. Meanwhile the skewness measures the asymmetry of the distribution of the series. Inline with the kurtosis, normal distribution is value at 3. platykurtic (variables are spread far from the mean) when the kurtosis is less than 3 and its platykurtic, and leptokurtic (variables are concentrated around the mean) when it is greater than 3. The kurtosis indicate that some variables are leptokurtic which mean the have long tail (they are greater than 3) such variables are private health expenditure (DPRHE) and urban population growth (DUPOP), while some variables are platykurtic which mean the have short tail (the are less than 3) such variables are recurrent health expenditure (RHE), infant mortality rate (INF), capital health expenditure (DCHE), and basic sanitary (DBSNT). Having confirmed that none of the kurtosis and skewness values for the aforementioned variables satisfies the conditions of normality, we affirm that the series is not normally distributed.

The result from the summary statistics showed that Jarque-Bera estimates probability values are not normally distributed due to their probability value which is less than the probability of 0.05 DRHE, LFE, INF, MMT, DPRHE, DCHE, DUPOP except DBSNT and their respective values is 0.000198, 0.000000, 0.000000, 0.000000, 0.012668, 0.000000, 0.631733. From the Central Limit Theorem (CLT), non-normality does not affect mean values since ARDL parameters are mean values, the non-normality of the variables does not affect the parameters in the model to be estimated.

Cross- Sectional Dependence Test

Panel Unit Root Tests

Table 4.3: Panel Unit Root Test

CADF Test			
	Levels	First Diff	Remark
Entire sample			
Infant Mortality (INF)	-1.142	-8.012***	I(1)
Capital health expenditure (CHE)	-2.835	-7.269***	1(1)
Recurrent health expenditure (RHE)	0.003	-6.122***	1(1)
Basic sanitary (BSNT)	-1.266	-7.178***	1(1)
Urban population (UPOP)	-2.248	-6.319***	1(0)
Private Health expenditure (PRHE)	-5.511***	-5.511***	1(0)
Critical Values 10% 5% 1%	-2.210	-2.330	-2.550

Source: Author's Computation using Stata.

Note: variables are all in linear log transformation

Table 4.3 shows the results of the Pesaran (2007) CADF test for stationarity. The test checks whether the variables are stable over time or if they have trends that make them non-stationary. The results indicate that urban population (UPOP) and private health expenditure (PRHE) are already stable at their original form (level), while Infant Mortality rate INF, capital health expenditure (CHE), recurrent health expenditure (RHE), and basic sanitary (BSNT), only become stable after taking their first difference. This means that some variables are stationary at level and others at first difference, showing a mixed order of integration. Because of this mixed order, we cannot use cointegration tests that require all variables to behave the same way. Instead, the study uses the Westerlund (2007) cointegration test, which is suitable when variables are a mix of level and first-difference stationarity and when there is also cross-country interdependence.

Panel Cointegration Test

Table 4.4: Cointegration Test Result

Statistic	Value	Z-value	P-value
Gt	-3.226	-1.200	0.047
Ga	-5.321	6.712	0.970
Pt	-5.982	5.129	0.910
Pa	-2.824	6.188	1.000

Source: Author's computation using Stata 17 Version

The results of the panel unit root test show that some variables have a unit root, meaning they are not stationary in their original form. This makes it necessary to check if there is a long-run relationship among the variables. To achieve this, the study applies the Westerlund (2007) panel cointegration test. In this test, if the probability value of at least one of the statistics is significant, it suggests the presence of a long-run relationship. From the results of the panel cointegration presented above, one of the statistics is statistically significant, leading to the

rejection of the null hypothesis of no cointegration. This indicates that there is a long-run equilibrium relationship among the variables in the panel.

Panel Autoregressive Distributed Lag (ARDL) Test

Table 4.5 (Dynamic) Common Correlated Effects Estimator – Mean Group (CS-ARDL)

Dependent Variable: Infant Mortality Rate (INF)						
	Coef.	Std.Err.	Z	P>z	95% Conf. Interval	
Short Run Est.						
DRHE	0.069	0.058	1.190	0.234	-0.044	0.731
DCHE	-0.042	0.040	-1.050	0.295	-0.121	0.827
DPRHE	-0.091	0.051	-1.780	0.075	-0.191	0.872
DUPOP	-0.029	0.039	-0.750	0.452	-0.106	0.652
DBSNT	-0.113	0.046	-2.460	0.014	-0.203	0.823
DINF	-0.341	0.152	-2.240	0.026	-0.639	0.945
Adjust. Term						
lr_DINF	-1.282	0.133	-9.640	0.000	-1.543	0.544
Long Run Est.						
lr_DRHE	0.057	0.049	1.160	0.246	-0.039	0.207
lr_DCHE	-0.039	0.032	-1.230	0.219	-0.102	0.083
lr_DPRHE	-0.084	0.041	-2.060	0.039	-0.164	0.984
lr_DUPOP	-0.025	0.037	-0.680	0.497	-0.098	0.732
lr_DBSNT	-0.092	0.035	-2.610	0.009	-0.160	0.173

Source: Author's Computation using *Stata 17 Version*

Health expenditures in Sub-Saharan African countries have shown varying effects on infant mortality, as indicated in the short-run and long-run estimations. Recurrent health expenditure, which covers routine health spending such as salaries and daily operations, has a positive and insignificant impact on infant mortality in both the short-run and long-run estimates, with coefficients of (0.091) and (0.087) respectively. This implies that a one percent increase in recurrent health expenditure is associated with a marginal increase in infant mortality, but the effect is statistically insignificant. This suggests that routine health spending in these countries may not be efficiently managed or sufficiently impactful to reduce infant mortality, possibly due to misallocation, administrative leakages, or lack of targeting toward essential maternal and child health needs.

Capital health expenditure, which represents government investment in long-term health infrastructure, also shows a negative but statistically insignificant effect on infant mortality in both the short-run and long-run. With a short-run coefficient of (−0.056) and a long-run coefficient of (−0.048), the results indicate that a one percent increase in capital health spending is expected to slightly reduce infant mortality, though the effect is not significant. This suggests that investments in health facilities and infrastructure may not yield immediate or substantial improvements in infant health indicators, possibly due to long gestation periods, poor project execution, inadequate maintenance, or underutilization of health facilities.

Private health expenditure, often funded out-of-pocket by individuals and households, has a negative and statistically significant impact on infant mortality in the long run, with a coefficient of (-0.084) , and is marginally significant in the short run, with a coefficient of (-0.091) . This implies that a one percent increase in private health spending is associated with a decline in infant mortality. The result suggests that private healthcare financing plays a complementary role in enhancing access to maternal and child health services, particularly in regions where public health systems are underfunded or inefficient. It indicates that individuals who invest in personal healthcare through consultations, antenatal services, medications, or private health facilities are more likely to experience improved infant survival rates. This finding may also reflect the growing relevance and effectiveness of private healthcare providers in bridging service delivery gaps across Sub-Saharan Africa.

Urban population also shows a negative and insignificant relationship with infant mortality. The short-run coefficient is (-0.036) , while the long-run estimate is (-0.029) , indicating that a one percent increase in urban population is associated with a slight decline in infant mortality, though not statistically significant. This may suggest that although urbanization can enhance access to healthcare services, sanitation, and improved living conditions, its potential benefits are often undermined by factors such as overcrowding, environmental pollution, and unequal access to quality healthcare, thereby limiting its overall impact on infant survival.

Basic sanitation has a negative and statistically significant impact on infant mortality in both the short-run and long-run. The short-run coefficient is (-0.113) with a p-value less than (0.05) , and the long-run coefficient is (-0.092) with a p-value less than (0.05) . This implies that a one percent increase in access to basic sanitation leads to a corresponding decrease in infant mortality by (0.113) percent in the short run and (0.092) percent in the long run. The implication is that improvements in access to clean water and sanitary facilities significantly contribute to better infant health conditions, reducing the incidence of waterborne and respiratory diseases that commonly affect children.

Finally, the error correction term (adjustment coefficient) is (-1.282) with a p-value of (0.000) , which is negative and statistically significant. This indicates a strong speed of adjustment, where deviations from the long-run equilibrium in infant health outcomes are corrected by approximately 128 percent in the following period. This means that despite the short-run inefficiencies in health expenditure, the model adjusts strongly toward its long-term path, suggesting that the system is stable and responsive to correcting imbalances over time.

Discussion of Findings

This study analyzed the impact of health expenditure on infant mortality rate, and the ARDL estimates revealed that both private and capital health expenditures have significant negative effects on infant mortality, implying that increases in these forms of spending lead to reductions in infant deaths. Recurrent on the other hand, showed insignificant relationships with infant mortality, suggesting that regular administrative spending has not yet translated into improved child survival outcomes in the region. The positive contribution of private health spending reflects the critical role played by private healthcare facilities and household investments in child health. These findings are consistent with Rana and Goli (2017), who discovered that public investment on child care significantly lowers child mortality, though private spending plays a complementary role. Similarly, Barenberg, Basu, and Soylu (2017) confirmed that increased public health expenditure reduces infant mortality, while Novignon and Lawanson (2017) reported that inefficiencies in resource use explain why some countries fail to achieve proportional reductions in child deaths despite higher health budgets. Bokhari et al. (2018) also found elasticities ranging from 0.13 to 0.33 for infant mortality, suggesting that even modest

increases in health spending yield measurable improvements in infant survival rates. Therefore, the results of this study emphasize the importance of both public and private sector collaboration to achieve sustainable reductions in infant mortality in Sub-Saharan Africa.

5.1 Conclusion and Recommendation

This study examined the impact of health expenditure on infant mortality in Sub-Saharan Africa, over the period 1990–2023. Using the panel ARDL model, the results confirmed a strong long-run relationship between health expenditure and infant mortality rate, indicating that the pattern and structure of spending directly influence infant mortality rate across the region.

The findings revealed that recurrent health expenditure exerts a negative and statistically insignificant reduce infant mortality rates. This demonstrates that day-to-day operational spending, such as salaries and administrative costs, has not translated into meaningful infant mortality rate due to inefficiencies, poor budget implementation, and weak accountability systems within the healthcare sector.

Capital health expenditure showed a insignificant effect on infant mortality. This indicates that while investments in infrastructure and equipment have the potential to enhance healthcare delivery, their impact has remained limited because of poor project execution, maintenance gaps, and delays in translating capital projects into functional health outcomes.

In contrast, private health expenditure displayed a positive and statistically significant relationship with infant mortality. It was found to significantly reduce infant mortality rates. This highlights the crucial role of private investment and household spending in improving healthcare access and quality in Sub-Saharan Africa, particularly where public health systems remain underfunded or inefficient.

Basic sanitation had a consistently significant positive effect on infant mortality rate, contributing to reduction in infant mortality. This finding underscores the importance of clean water and sanitation in preventing infectious diseases and promoting community health.

The following recommendations are suggested for the study:

- i. Recurrent health expenditure should be strategically managed to enhance the quality and accessibility of essential healthcare services. Governments should channel more resources toward preventive and promotive healthcare, continuous training of medical personnel, and consistent provision of essential drugs. Ensuring that recurrent expenditure is efficiently utilized will help improve health service delivery, which in turn can lead to a decrease in infant mortality across the region.
- ii. Capital health expenditure should be directed toward building and upgrading health facilities, particularly in rural and underserved areas. Priority should be given to equipping maternal and child healthcare centers with modern equipment, skilled personnel, and emergency obstetric care units. Adequate investment in infrastructure and maternal health programs will significantly reduce infant deaths and improve women's access to safe and reliable healthcare services.

- iii. Private health expenditure should be encouraged through the establishment of effective public–private partnerships (PPPs) that promote access to affordable neonatal and pediatric care. Governments should create supportive environments that allow private providers to complement public efforts, particularly in immunization, nutrition, and early childhood disease prevention. At the same time, public health expenditure should be reformed to ensure transparency and accountability so that funds are directed toward child health initiatives with measurable impacts on survival rates.
- iv. Given the significant role of sanitation in improving health outcomes, governments should invest in clean water supply, waste management, and hygiene education programs. Enhancing sanitation infrastructure will not only reduce the incidence of communicable diseases but also lower infant mortality rates.

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