Journal of Economic Studies (JES)
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Anambra State, Nigeria.

Web: www.nauecojournals.com *ISSN 1119-2259*

ASSESSMENT OF THE EFFICIENCY OF HEALTHCARE FINANCING ON INFANT MORTALITY RATE IN SUB-SAHARAN AFRICA

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ABSTRACT

This study assessed the efficiency of healthcare financing in reducing infant mortality in Sub-Saharan Africa (SSA) using data from 2000 to 2023 for 45 countries. The study used pooled mean group regression and fixed-effects estimation. Health care financing was measured using three proxies; out-of-pocket health expenditure, government health expenditure and external health expenditure. Furthermore, the study built a mediation model that explored the mediating role of institutional quality and healthcare financing on infant mortality rate in SSA. The pooled mean group (PMG) regression model revealed that out-of-pocket health expenditure, government health expenditure and external health expenditure exert positive and insignificant effects on the infant mortality rate. Similarly, institutional quality exhibited a negative and significant effect on infant mortality in SSA, suggesting that efficient and effective institutional quality can trigger a significant reduction in infant mortality rates across the region. Finally, the result of the mediating equation shows that government health expenditure and external health expenditure has a strong negative relationship with infant mortality. The study recommends strong actions against corruption and embezzlement in order to ensure efficient spending of resources, as increased healthcare funding has the propensity to produce minimal result if corruption is not eradicated.

Keywords: *Infant Mortality, Out-of-Pocket Health Expenditure, Government Health Expenditure, External Health Expenditure*

JEL Classification Codes: *I10, H51, I11*

1.0 Introduction

Sub-Saharan Africa (SSA) is the region in the continent of Africa that lies south of the Sahara Desert, comprising 48 countries and characterised by rapid population growth, particularly among its youth, significant poverty rate, climate change, and low health outcomes. The region accounts for over 50% of global under-five deaths, with 1 in 15 children dying before age five; a rate 14 times higher

than in high-income regions despite contributing less than 1% of the world's health financing capacity (United Nations Children's Fund [UNICEF], 2025). It also has the world's highest infant mortality rate, with approximately 35 neonatal deaths per 1,000 live births and an overall infant mortality rate around 42–51 per 1,000 as of 2022-2025 (UNICEF, 2025). Between 2022 and 2023, SSA recorded 57% (2.8 (2.5–3.3) million) of total under-five deaths and approximately 68 deaths per 1,000 live births for children who are under five. Similarly, the risk of death in the first month of life in sub-Saharan Africa is 11 times higher than that in the lowest-mortality region such as Australia or New Zealand (World Health Organisation [WHO], 2024).

Despite rising healthcare spending in SSA and the various financing mix adopted by various countries in the region, health outcomes have remained low due to significant inefficiencies in healthcare systems, a high burden of disease, weak institutions, high corruption, heavy reliance on volatile external aid, huge out-of-pocket (OOP) costs, and persistent financial and infrastructural barriers to quality care. The proportion of Sub-Saharan Africans benefiting positively remains small, leading to low life expectancy and high infant mortality (WHO, 2023). The region has the world's highest infant mortality rate (IMR), facing a disproportionate burden of newborn and child deaths of 45 deaths per 1,000 live births compared to North America, Europe & Central Asia and East Asia & Pacific with infant mortality rates of 5, 7 and 17 deaths per 1,000 live births respectively (World Bank, 2023).

In 2022, for example, the infant mortality rate in SSA was 14.1%, lagging behind the world average infant mortality rate of 0.03%. This alarmingly high rate is primarily due to conditions such as malaria, pneumonia, diarrheal diseases, and malnutrition. These diseases are responsible for a significant number of deaths among children, reflecting broader health challenges in the region, including poor sanitation, limited access to clean water, and inadequate healthcare services (WHO, 2024; UNICEF, 2024). This abysmal trend in health outcomes in SSA has also remained a persistent concern, as it is seen as a factor that prevented the achievement of the Millennium Development Goals (MDGs) 4 and 5 that aimed at reducing child mortality (under-five mortality rate & infant mortality rate) and improving maternal health (Maternal mortality ratio) (United Nations [UN], 2015). If unabated, the desire to end preventable deaths of children under the age of five by 2030 in line with the Sustainable Development Goal (SDG) 3 may become a mirage (Lacroix & Long, 2024).

A plethora of programmes and policies have been implemented in the past at both regional and country levels to improve health outcomes in SSA. Such efforts include, but are not limited to, Primary Health Care (PHC) and Health for

All by the Year 2000 (HFA/2000) strategies, National Health policies, the Millennium Development Goals of 2000, the Sustainable Development Goals of 2015 that aspire to ensure health and wellbeing for all by 2030 and the Abuja Declaration of 2001, which called for countries to allocate at least 15% of their budgets to healthcare financing. These policies have all been implemented to improve health outcomes in SSA but to no avail (WHO, 1978; United Nations, 2000, 2015; African Union, 2001). WHO (2023) reports that only these countries – Rwanda, Botswana, Cabo Verde, Namibia, Madagascar and South Africa had met the 15% target, although 27 nations have increased the share of their national budgets devoted to health. This places a significant financial strain on households, often pushing them into poverty (Nzeribe et al., 2022).

Empirical attempts have been made by previous researches/studies in the past to proffer solutions to this dilemma. Riman and Akpan (2012) found that high levels of infant mortality and morbidity rates were associated with a high incidence of out-of-pocket payment. Also, Akinlo and Sulola (2019) observed that health care expenditures have not been translated into improvements in under-five mortality in SSA. This fundamental mismatch between health needs and financial resources lies at the core of the region's health systems challenges and forms a critical nexus between healthcare financing and infant mortality. Thus, health financing constitutes a simple but integral function of health because it enables the realisation of universal healthcare through effective health service coverage and financial protection.

Considering the mediating role of institutional quality, this study infers that the quality of a country's institutions is a crucial mediator, determining how effectively health spending translates into better health outcomes. In other words, high institutional quality can enhance the positive effects of health expenditure, making it efficient and effective. Based on the aforementioned, the study assesses the efficiency of healthcare financing on infant mortality in SSA. Specifically, the study also investigates how institutional quality moderates the effect of healthcare financing on infant mortality in SSA.

2.0 Literature Review

This section covers the conceptual literature, conceptual framework, the basic theories and other related theoretical discussions.

2.1. Conceptual Issues

2.1.1. Infant Mortality Rate

According to Lamberski (2022), health outcomes refer to both physical and psychological well-being and take into account the length of life as well as the quality of life. Infant mortality rate describes the likelihood of a child dying before reaching the age of five. It measures child health and survival expressed as the number of deaths per 1,000 live births (UNICEF, 2024; WHO, 2023 & United

Nations Population Division [UNPD], 2007). The neonatal and infant mortality rates are important subcomponents within under-5 mortality. Infant mortality rate is a sensitive indicator of both the level of child health and the development and well-being of a population.

2.1.2. Health-care Financing

Oyefabi et al. (2014) defined healthcare financing as the mobilisation of funds for healthcare services. It is not limited to the raising of resources to meet health care needs but also to ensure the accessibility, affordability and guaranteed protection against financial risk in a manner that no household is left worse off because of a necessity for healthcare (Riman & Akpan, 2012). Health care can be financed through government expenditure, compulsory health insurance, out-of-pocket payments by households and external aid (Organisation for Economic Co-operation and Development [OECD], Eurostat, & WHO, 2017).

2.2. Review of Basic Theories

2.2.1. Grossman's Health Capital Theory

The theory of the demand for health capital was propounded by Michael Grossman in 1972. The theory assumes that individuals value health but have limited incomes with which to finance health and other activities. It also assumes that individuals exert a relatively high degree of control over their health because they can influence their health-affecting consumption patterns, health care utilisation and the environment (Grossman, 1972).

As a core assumption, the theory believes that individuals are born with an initial baseline or stock of health that naturally declines over time, but can be actively maintained and improved through investments. Thus, this theory presents the individual as a person whose demand for health inputs is a derived demand, not necessarily for consumption, but to produce health outcomes. Health is treated as an endogenous variable; as such, any investment in health will enhance an individual's stock of health and reflect in improved health outcomes such as healthy time, life expectancy, and reduced child mortality. To achieve this, the individual acquires health inputs such as health care financing (public or private), education, environment and income to engage in a production process that results in a typical health outcome (Grossman, 1972).

While the theory distinguished between human capital and health capital, its basic criticism was the generalisation of the human capital model of demand for health care as preventive, ignoring illness/health challenges entirely as if declines in health are associated with ageing or health depreciation. In other words, Grossman's model ignored illness completely and instead conceptualises health status as a capital stock that depreciates or ages. Despite the criticisms, the model represents the

relationship between individual health behaviours, health investments, and health outcomes (Laporte, 2015). In essence, this theory explains much of the relationship between health financing and health outcomes.

2.2.2. Buchanan's Theory of Health Care Expenditure (1965)

Buchanan (1965) developed a theoretical framework that emphasises the role of government investment in healthcare as a means of promoting increased public expenditure on health. The central proposition of the theory is that the effectiveness and efficiency of healthcare provision should be assessed not only in terms of the delivery of healthcare services but also through efforts to reduce congestion, address the unequal distribution of healthcare personnel, improve the quality of healthcare infrastructure, and expand access to free or affordable healthcare services. In other words, political decisions regarding public healthcare spending should be made independently of healthcare demand, rather than in response to inefficiencies in the healthcare system (Buchanan, 1965).

According to the theory, when public sector services are provided for free or heavily subsidised at the point of delivery, citizens may be incentivised to increase their demand for healthcare. The theory highlights the inconsistency in citizens' choices when healthcare is funded through taxation. The theory suggests that governments seeking to maximise voter support strategically choose to implement tax increases when voters are less aware of them. They may also allocate tax revenues more closely to high-priority public expenditure programs when voters are aware of deficiencies in government services. This approach is based on the assumption that citizens are generally hesitant to support taxation, leading to predicted shortages in subsidised health care, as forecasted by Buchanan (Buchanan, 1965).

The model was criticised as ambiguous since the extent to which public finance will increase or decrease the level of health expenditure is unknown. Despite the criticism, the theory is still relevant to the study as it encourages government investment in healthcare through increased public spending on health.

2.2.3. Rational Choice Theory

Rational Choice Theory is an approach to understanding human behaviour based on the assumption that individuals make deliberate and purposeful decisions aimed at maximising their preferences and expected benefits, while taking into account their beliefs, available alternatives, constraints, and the anticipated actions of others. Although its intellectual foundations can be traced to Adam Smith (1776), the theory was further developed and applied within the social sciences through the contributions of scholars such as Cesare Beccaria, Ronald Clarke, Derek Cornish, and James Coleman. The theory posits that human

actions are generally intentional and guided by individual preferences, perceived values, and considerations of utility. Thus, individuals tend to evaluate available options and select those they perceive as most likely to advance their desired outcomes, subject to the constraints they face (Smith, 1776; Beccaria, 1764/1986; Clarke & Cornish, 1985; Coleman, 1990, 2008; Scott, 2000).

Rational choice theory in healthcare assumes that patients and providers make decisions to maximise benefits (like better health) and minimise costs (financial, time, effort), weighing options like different providers or treatments based on perceived quality, accessibility, cost, and personal goals, even under uncertainty, although rationality may include economic, social, and survival/health factors. The choice of healthcare behaviour by patients is a complex process, aimed at maximising not only their health benefits but also economic benefits, social benefits, and other factors, though these factors often impose mutual constraints on each other (Li et al. 2010; Prabhakar et al. 2023). Since patients are unable to know all the information related to medical treatment, they can only maximise their satisfaction within the bounds of limited rationality in their medical behaviour.

Rational choice theory establishes a dynamic analytical framework between the healthcare needs of individuals and their healthcare-seeking behaviour based on perceived quality, accessibility, cost, and personal goals. Therefore, analysing individuals' medical choices from the perspective of rational choice theory is of great theoretical and practical significance as it illustrates the value individuals place on their health and the economic rationality (financial risk) behind their choice of health investments.

2.3 Review of Other Related Issues

a. Trends in healthcare financing in Sub-Saharan Africa

The health financing landscape of SSA has been characterised by a mix of funding mechanisms aimed at enhancing health outcomes within the region.

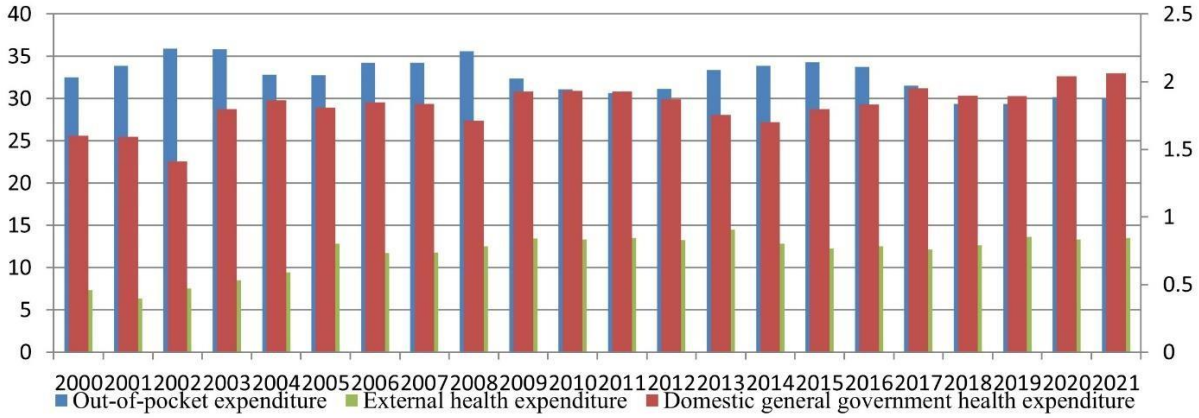


Fig 2.1: Healthcare financing mix in Sub-Saharan Africa
Source: Researchers' compilation using statistics from (WDI 2024)

These mechanisms range from government health expenditure to out-of-pocket expenditure, external health expenditure and, more recently, health insurance schemes. Healthcare financing in SSA has largely been constituted by high levels of out-of-pocket expenditure, although domestic government health financing has been increasing recently. Figure 2.1 shows that out-of-pocket health expenditure constituted the major chunk of healthcare financing in SSA from 2000 to 2017 (WHO, 2016, 2018). Similarly, domestic general government health expenditure (% of GDP) fluctuated below out-of-pocket health expenditure, although it gradually increased from 2018 to date but such increase is still not significant. The figure also shows that external health expenditure flows has not been significant (WHO, 2018; World Bank, 2025). Considering the desirable role of external health aid and the continuous emigration currently experienced in SSA, there is a need to maximise this opportunity by attracting significant external health funding necessary to promote health outcomes in the region (WHO, 2016, 2024).

b. Trends in current health expenditure (% of GDP) in Sub-Saharan Africa and the rest of the world

Figure 2.2 compares current health expenditure (% of GDP) between SSA, OECD, Europe & Asia and the rest of the world. Specifically, it shows that government health expenditure in SSA has been lagging behind other regions, with wide variation.

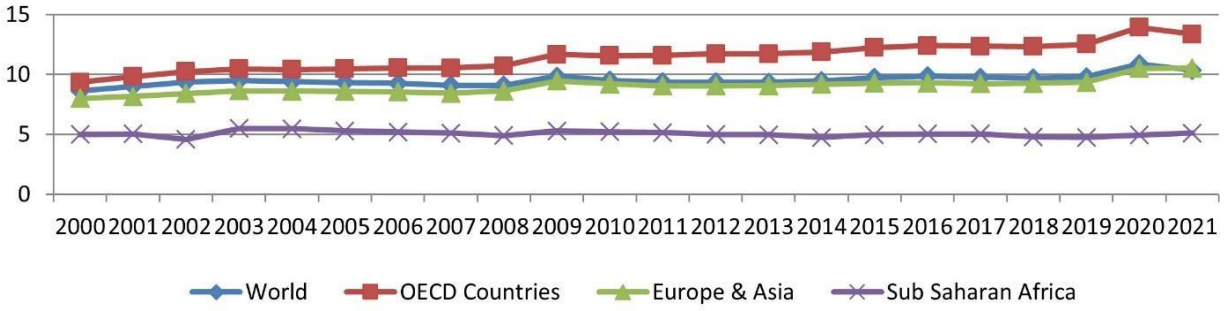


Fig 2.2: Healthcare expenditure (% of GDP) in SSA, OECD countries, Europe & Asia and the rest of the world

Source: Researchers' compilation using statistics from (WDI 2024)

The share of healthcare government spending in SSA increased over the past decade and more. In 2009, SSA spent 6.1 percent of its total GDP on health, a far cry from the OECD's 9.5 percent of its GDP (Elovainio & Evans, 2011). According to Barroy et al. (2018), sluggish growth in government health spending in SSA region has been a persistent concern, as it is perceived to be a significant obstacle to achieving the universal healthcare goal enshrined in the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).

c. Infant mortality (U5MR) in Sub-Saharan Africa and the rest of the world

Child mortality remained a major public health issue in sub-Saharan Africa (SSA) prior to the year 2000. Children in sub-Saharan Africa under the age of five were more than 14 times more likely to die than children in developed regions. As a result, a reduction by two-thirds of under-five (child) mortality (U5MR) between 1990 and 2015 thus became the fourth goal of the eight United Nations MDGs (United Nations, 2013, 2015). The leading causes of death in children under 5 years include, but are not limited to, preterm birth complications, pneumonia, birth asphyxia, diarrhoea and malaria (Liu et al., 2016). Despite the concerted effort to drastically reduce under-5 mortality in the region, the rate of this reduction was insufficient to reach the MDG target by the year 2015 (UN, 2015).

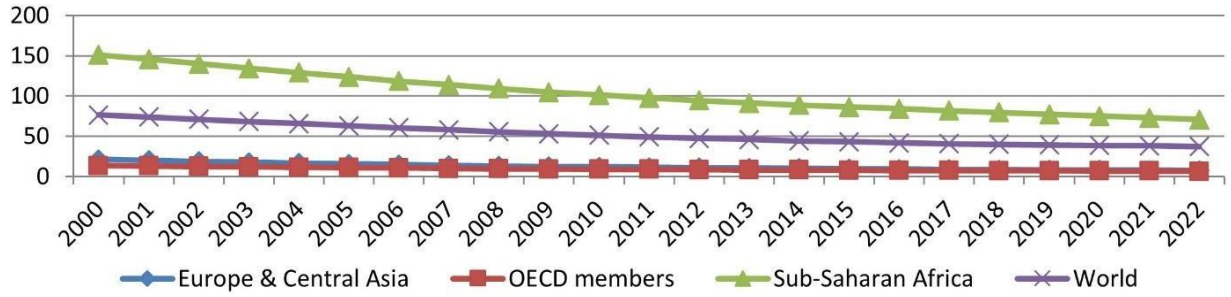


Fig 2.3: Infant mortality (U5MR) in Sub-Saharan Africa and the rest of the world
Source: Researchers' compilation using data from WDI (2024)

But since 2000, child mortality has dramatically decreased in the region. Figure 2.3 shows that from year 2000 and beyond, under-five (child) mortality (U5MR) in SSA region has maintained a consistent decreasing trend. Despite this positive outcome, under-five (child) mortality (U5MR) in SSA is high compared to Europe and Central Asia and Organisation for Economic Cooperation and Development (OECD) countries (UNICEF, 2024).

2.4 Empirical Literature Review

Riman and Akpan (2012) carried out research on healthcare financing and health outcomes in Nigeria. The study utilised the multivariate analytical tool to describe the relationship that exists between health care financing, health facility utilisation, and health outcomes in Nigeria. The research focused on women who are of childbearing age and who had given birth to at least one child within the past five years. The study adopted the stratified sampling technique comprising two rural Local Government Areas and one Urban Local Government Area in Cross River State, Nigeria. The study demonstrated that the high levels of infant mortality and morbidity rates were associated with the high incidence of out-of-pocket payments and the wide disparity and inequality in income distribution. The study further observed a disproportionate disparity in

the spatial distribution of health facilities, with concentration of health facilities in urban areas rather than rural areas, which of course contributed to the poor service demand.

Onisanwa et al. (2018) carried out a study on healthcare financing and health status analysis in Nigeria. Building on the framework of Grossman's Model of Health Production Function and utilising time series data spanning a period of 35 years, the study assessed the interrelation between healthcare financing and health outcomes in Nigeria. The study employed the Autoregressive Distributed Lag (ARDL) technique proposed by Pesaran, Shin and Smith (2001) to establish the cointegrating relationship among the variables. The result confirmed government spending on health as a key factor influencing health status in Nigeria. Specifically, public health spending had an inverse and significant impact on the rate of infant mortality in Nigeria.

Akinlo and Sulola (2019) examined the impact of public health expenditure on under-five and infant mortality rates in 10 selected SSA countries for the period 2000–2008, using fixed effects and generalised method of moments (GMM). The results showed that government health expenditure had a positive effect on under-five and infant mortality. However, the results show that GDP per capita, health aid, HIV prevalence and immunisation had significant negative effects on under-five and infant mortality. The results clearly suggest that health care expenditures have not translated into improvement in under-five mortality in SSA. The results possibly reflect the high level of corruption and fungibility of public health expenditure in sub-Saharan African countries.

Hamzat et al. (2019) investigated the impact of health expenditure on child mortality rate in Nigeria within the period of 1980-2015. The ARDL model was used to examine the long-run relationship that exists among the variables. The long-run and ECM results obtained revealed that public and private health expenditure and per capita income had negative impacts on the infant mortality rate and were also statistically significant.

Karanja (2020) examined the impact of public, private and donor health financing on childhood mortality in Kenya. The study approach was based on the theoretical model of Grossman (1972) that applies a vector of inputs in the production of health outcomes. The study used time series data from 1980-2014 and applied an ARDL analysis method. The short-run result showed that health financing, per capita GDP, doctors' population, measles immunisation, and women's literacy level did not influence infant mortality. On the other hand, public health financing, per capita GDP and doctors' population improved infant mortality in the long run. Analysis of the under-five mortality model revealed that, in the short-run health financing, per capita GDP, doctors' population, measles immunisation, and

women's literacy level did not influence under-five mortality rates, while child immunisation against measles, women's literacy level and per capita GDP improved under-five mortality in the long run.

Chireshe and Ocran (2020) studied the effect of health care expenditure on health outcomes in SSA, using data from 1995 to 2018 for 45 countries. The study used fixed effects and GMM estimation approaches for the analysis. The results showed that an increase in health care expenditure, as measured by total health care expenditure per capita (THCEPC) and public health care expenditure to GDP (PHCEGDP), led to a decline in under-5 mortality rates. The results also revealed that THCEPC resulted in an increase in life expectancy.

Kiross, et al. (2020) determined the impact of health care expenditure on infant mortality in 46 SSA countries, employing the panel data from 2000 to 2015. The random effects model was selected over the fixed effects model based on the Hausman test to assess the effect of health care expenditure on infant and neonatal mortality. Both public and external health care spending showed a significant negative relationship with infant and neonatal mortality. Conversely, private health expenditure was not significantly associated with either infant or neonatal mortality.

Musa (2022) analysed the impact of health expenditures on health status in Nigeria using annual time series data from 1986 to 2020. The study employed co-integration and ECM for the analysis. The findings showed that health capital expenditure and health recurrent expenditure dampened infant mortality in Nigeria during the period under study. Furthermore, GDP per capita and level of education had a negative and insignificant relationship with infant mortality rate.

Anokwuru and Chidinma (2023) analysed the effect of public health expenditure on infant mortality rate in Nigeria from 2002 to 2021, using the ARDL Bounds testing procedure. The long-run result showed that total government expenditure on health (TGEH), as well as migration of doctors and nurses trained in Nigeria but working in other countries (MDNTN), had a negative and insignificant relationship with the infant mortality rate. Contrarily, TGHE as well as MDNTN had a positive and significant relationship with the infant mortality rate in Nigeria in the short run. The implication of the result is that despite the government's expenditures on the health sector in Nigeria from 2002 to 2021, the expenditures have been low and could not reduce the infant mortality rate to a near-zero level in Nigeria.

Kalu et al. (2023) examined the impact of public health expenditure on the under-five mortality rate in Nigeria from 1986 to 2022 using the Grossman health capital theoretical framework. The analytical techniques used were the Granger causality test and the vector

error correction model (VECM) involving the forecast error variance decomposition (FEVD) and the impulse response functions (IRFs). The coefficient of government health expenditure was negative yet significantly related to the under-five mortality rate. On the other hand, foreign direct investment was negative and insignificant to the under-five mortality rate. The result further showed a unidirectional causality between government health expenditure and the under-five mortality rate and no causality between foreign direct investment and under-five mortality. From the result, the shock of public health expenditure is exogenously weak throughout the ten period horizons, implying that public health expenditure had no significant positive impact on the under-five mortality rate.

Babawulle (2024) employed the ARDL Bound test in examining the long-run effect of public health expenditure on under-five mortality in Nigeria. Data were sourced from the World Development Indicators for the period 1990 - 2022. The long-run result showed that general expenditure on health had a negative and significant impact on infant mortality rate. This suggests that greater financial resources and improved living standards translate to improved healthcare infrastructure, access to medical services, and better health outcomes for individuals and society.

Idris and Abdullahi (2024) examined the impact of healthcare investment on infant mortality in Nigeria. The study used secondary data covering the period from 1995 to 2023. The study utilised the ARDL technique and found the existence of a long-run relationship between healthcare expenditure and infant mortality in Nigeria for the period of study. The study further confirmed that public investment in child support programmes and improving nutrition exhibited a long-run positive impact on infant mortality in Nigeria. On the other hand, public investment in children's immunisation and education exhibited a long-run negative impact on child mortality in Nigeria. The estimated cointegration error correction term (ECT) was negative and statistically significant, indicating that the model readjusted to the long-run equilibrium in the current year with approximately 31%.

Ogwuche et al. (2025) examined the impact of health expenditures on infant mortality rates in Nigeria between the period of 1992 and 2023. The study employed descriptive analysis and the ARDL technique. The long-run result indicated that capital health expenditure (CHE) had a negative but statistically insignificant impact on infant mortality. This suggested that CHE had a weak impact in reducing infant mortality rates in Nigeria. Similarly, recurrent health expenditure (RHE) showed a negative and statistically significant impact, indicating that increased RHE significantly contributed to reducing infant mortality in Nigeria. The coefficient value for donor health expenditure

(DHE) showed a positive and statistically significant impact, suggesting that DHE had an increasing impact on infant mortality. In contrast, the coefficient of out-of-pocket health expenditure showed a negative but statistically insignificant impact on infant mortality.

2.5. Gap in the Literature

The study did not consider the mediating role of institutional quality in enhancing the positive effects of health expenditure on infant mortality. It was a state-level and gender-selective study which focused on women who are of child bearing age and who had given birth to at least one child within the past five years. This means it has limited inference to offer as it has a limited sample size. Similarly, the study failed to specify the model of analysis as it is a primary survey. Finally, the study failed to consider country-specific descriptive statistics and model estimates

3.0 Methodology

3.1 Theoretical Framework

The theoretical framework of the study is Grossman's Health Capital Theory, which was propounded by Grossman (1972). The theory assumes that an individual inherits an initial stock of health capital that depreciates with time but can be increased through investments in health. It is based on constrained utility maximisation, in which an individual seeks to maximise his utility with a given set of resources.

3.2 Model Specification

The study estimated baseline models using the pooled mean group (PMG) estimator and Fixed effects/Random effects.

The model specification follows the empirical model of Chireshe and Ocran (2020)

$$H_{it} = \alpha + \ln HE_{it} + \ln ED_{it} + \ln GDP_{it} + HFS_{it} + \ln INFRA_{it} + e_{it} \quad (3.1)$$

where H represents health outcomes as measured by under-5 mortality and life expectancy; HE represents health care expenditure as measured by total health care expenditure per capita, public health care expenditure to GDP, and private health care expenditure to total health expenditure; ED represents the country's level of education; GDP is the level of income measured by real GDP per capita; HFS measures the country's health financing structure, while INFRA is a proxy for access to basic infrastructure like water, sanitation, electricity, and roads.

The present study adapts and modifies the empirical model of Chireshe and Ocran (2020). The model specified infant mortality rate as a function of out-of-pocket health expenditure, government health expenditure and external health financing. It is specified as follows;

$$IMR_{nit} = \alpha_i + \beta_1 OPHE_{nit} + \beta_2 GHE_{nit} + \beta_3 EHE_{nit} + \beta_4 GDPPC_{nit} + \beta_5 INSQ_{nit} + \mu_{nit} \quad (3.2)$$

Infant mortality rate is the dependent variable as observed in the literature in country *i* at time *t, (for i= 1,2,----------, N; t = 1,2,… , T).*

α_i is a fixed effect reflecting time differences between countries; β_j is the elasticity of infant mortality rate concerning a given fundamental, (for j = 1, 2,…, 6).

Table 3.1 provides the summary of the theoretical expectations.

Table 3.1: Summary of A priori Expectations

Variables (IVs)	Expected Relationship	Justification
Out-of-pocket health expenditure (OPHE)	+ve/-ve	An increase in OPHE will lead to an increase/decrease in infant mortality rate
Government health expenditure (GHE)	Negative (< 0)	An increase in GHE will lead to a decrease in infant mortality rate
External health expenditure (EHE)	Negative (< 0)	An increase in EHE will lead to a decrease in infant mortality rate
Gross domestic product per capita (GDP_{PC})	Negative (< 0)	An increase in GDP_{PC} will lead to a decrease in infant mortality rate
Institutional quality (INSQ)	Negative (< 0)	An increase in INSQ will lead to a decrease in infant mortality rate

Source: Researchers' Compilation, 2025

3.2.1. Mediating Equation

The study specifies a mediation model that will investigate the mediating role of institutional quality and healthcare financing (government health expenditure and external health expenditure) in infant mortality. The index for institutional quality through a principal component analysis (PCA) will capture government effectiveness, political stability and absence of violence, voice and accountability, rule of law, control of corruption and regulatory quality.

$$IMR_{nit} = \alpha_i + \beta_1 OPHE_{nit} + \beta_2 GHE_{nit} + \beta_3 INSQ * GHE_{nit} + \beta_4 EHE_{nit} + \beta_5 INSQ * EHE_{nit} + \beta_6 GDPPC_{nit} + \beta_7 INSQ_{nit} + \mu_{nit} \quad (3.3)$$

3.3 Estimation Techniques

Pooled Mean Group (PMG) estimation, proposed by M. Hashem Pesaran et al. (1999) is a method of dynamic panel estimation, permitting short-run coefficients, variances, and adjustment rates to vary across groups, with homogeneous long-run relationships. It can be used to efficiently deal with panel data with short-run heterogeneity and long-run equilibrium behaviour. Fixed Effects Model (FEM) and Random Effects Model (REM) are two types of static panel data models used to deal with unobservable heterogeneity in panel data, with FEM allowing for correlation between individual-specific effects and regressors, while REM assumes no such correlation between individual-specific effects and regressors.

3.4. Data Sources

The study employed annual panel data which has both space (cross-section observation) and time (time series observation) dimensions, for 45 selected SSA countries covering the period 2000 to 2023. The data are drawn from the World Development Indicators and governance indicators.

4.0 Result Presentation and Discussion of Findings

4.1. Result Presentation

4.1.1. Descriptive Statistics Analysis

The descriptive statistics are summarised and presented in Table 4.1

Table 4.1: Summary of Descriptive Statistics Result

	IMR	OPHE	GHE	EHE	GDPPC	INSQ
Mean	90.44936	40.64350	30.86524	21.34279	2017.605	-0.037495
Median	86.20000	41.11112	27.99243	16.62513	909.5002	0.003932
Maximum	228.4000	86.49805	83.55032	74.81972	19481.65	1.841779
Minimum	13.40000	3.577817	4.057905	0.000000	255.1003	-2.420839
Std. Dev.	41.10729	20.57882	16.65943	17.33519	2886.498	0.986259
Skewness	0.289506	-0.01977	0.787770	0.880492	2.993716	-0.306836
Kurtosis	2.869399	1.953917	3.135131	2.992027	12.82697	2.378296
Jarque-Bera	11.50882	35.79788	81.68576	101.3034	4325.679	24.92823
Probability	0.003169	0.000000	0.000000	0.000000	0.000000	0.000004
Sum	70912.30	31864.50	24198.34	16732.75	1581802.	-29.39637
Sum Sq. Dev.	1323121.	331590.8	217311.1	235298.5	6.52E+09	761.6294
Observations	784	784	784	784	784	784

Source: Researchers' computation (2025)

The mean infant (U5) mortality rate (IMR) is 90.44 deaths per 1,000 live births, while the maternal mortality rate (MMR) is 503.05 deaths per 100,000 live births. The significantly high average values pose a great challenge for the region in its pursuit of attaining improved health outcomes. The skewness values for all the variables except out-of-pocket health expenditure (OPHE) and institutional quality (INSQ) are positive, indicating that the tail on the right side of the distribution is longer or fatter than the left side (there are more extreme high values). On the contrary, the skewness value for OPHE and INSQ is negative, suggesting that the data are left-skewed (longer or fatter left tail). Kurtosis values for infant mortality rate (IMR), out-of-pocket health expenditure (OPHE), external health expenditure (EHE) and institutional quality (INSQ) were less than 3, depicting a platykurtic distribution with lighter tails and a flatter peak. The Jarque-Bera test statistics for all the variables were significant, indicating the normality of the distribution.

4.1.2 Test of Cross-Sectional Dependence

To test for cross-sectional dependence in the model residuals, we use the Pesaran CD test,

which is based on a scaled average of the pairwise correlation coefficients between the residuals of each unit. The result is presented in Table 4.2

Table 4.2: Results of Cross-Sectional Dependence CD Test

Variable	Lag Length (L)					
	L = 0	**P-value**	**L = 1**	**P-value**	**L = 2**	**P-value**
IMR	131.505	0.000	131.505	0.000	128.49	0.000
OPHE	25.559	0.000	25.559	0.000	25.559	0.000
GHE	3.561	0.000	3.561	0.000	3.561	0.000
EHE	21.203	0.000	21.203	0.000	21.203	0.000
GDPPC	54.247	0.000	54.22	0.000	54.628	0.000
InsQ	46.105	0.000	36.701	0.000	36.621	0.000

Source: Researchers' Compilation (2025)

Table 4.2 presents the results of a cross-sectional dependence (CD) test for the variables; IMR, OPHE, GHE, EHE, GDPPC, and InsQ. The interpretation relies on the p-value associated with the CD-test statistic. P-values close to zero (<0.05) lead to the rejection of the null hypothesis of cross-sectional independence. For all variables in the table: IMR, OPHE, GHE, EHE, GDPPC, InsQ; the p-value for each of these variables is 0.000. Since all p-values are effectively zero, the null hypothesis of cross-section independence is strongly rejected, indicating the data are correlated across panel groups. Therefore, the data for IMR, OPHE, GHE, EHE, GDPPC, and InsQ are all cross-sectionally correlated.

4.1.3 Panel unit root (Stationarity Test)

This study employed the Levin–Lin–Chu (2002) and Im–Pesaran–Shin (2003) panel unit root tests based on the balanced and unbalanced nature of the panel data for the study. The dependent variable, infant mortality rate (IMR), has a balanced panel dataset; hence, the Levin–Lin–Chu (2002) test was used to test their stationarity. On the other hand, the Im–Pesaran–Shin took care of the independent variables, which contained unbalanced panels. The results are presented in Table 4.3

Table 4.3: Results of Panel Unit Root Tests

Levin–Lin–Chu t-Statistics			Im–Pesaran–Shin W-Statistics		
Variables	**Level**	**1st Difference**	**Variables**	**Level**	**1st Difference**
			OPHE	-1.1893	-15.6287**
IMR	-11.3660**		GHE	-2.2109**	
			EHE	-6.3357**	
			GDPPC	0.9925	-13.0260**
			INSQ	-8.8865**	

*Note: ** indicate rejection of the respective null hypothesis at any conventional significance level (e.g., 1%, 5%, or 10%)*

Source: Researchers' Compilation (2025)

The Levin–Lin–Chu bias-adjusted t statistic for the dependent variable IMR is -11.3660. It is significant at level, thus, allowing us to reject the null hypothesis at any conventional significance level (e.g., 1%, 5%, or 10%). On the other hand, the Im–Pesaran–Shin W-Statistic of the independent variables GHE, EHE, INSQ; -2.2109, -6.3357, -8.8865 respectively were significant at level, while OPHE and GDPPC, with IPS statistics of -15.6287 and -13.0260 were significant at first difference. Therefore, they are stationary across the panel dataset.

4.1.4 Test of Cointegration

The study therefore tested for the existence of a long-run relationship between the variables in each of the equations. This is presented in Table 4.4

Table 4.4: Result of Panel Cointegration Test

Panel Cointegration Test	Equ 2
Modified Dickey-Fuller t	4.2280 *(0.0000)*
Dickey-Fuller t	5.0720 *(0.0000)*
Augmented Dickey-Fuller t	5.5019 *(0.0000)*

NB: Probabilities are in parenthesis

Source: Researchers' Compilation (2025)

The Kao test for cointegration presented above evaluates whether a long-run equilibrium relationship exists among the panel variables across 31 panels with an average of approximately 8.68 time periods. The test statistics reported Modified Dickey-Fuller t, Dickey-Fuller t, Augmented Dickey-Fuller t, and their unadjusted counterparts, with corresponding p-values well below the conventional 5% significance level. Equation 2 has a Modified Dickey-Fuller t statistic of 4.2280 with a p-value of 0.0000, indicating strong evidence against the null hypothesis, while the Augmented Dickey-Fuller t statistic of 5.5019 with a p-value of 0.0000 lays credence to this assertion. We reject the null hypothesis of no cointegration and accept the alternative that the variables are cointegrated across the panels.

4.2. Estimation Results

4.2.1. Model Estimates for Infant Mortality and Healthcare Financing

Table 4.5: Pooled mean group (PMG) for Infant Mortality and Healthcare Financing

Panel A: Long run coefficients: Dependent Variable – Infant Mortality Rate			
Pooled Mean Group Estimate			
Regressors	**Coef.**	**t-stat.**	**P-value**
Out of pocket health expenditure (OPHE)	0.0379	0.41	0.679
Government health expenditure (GHE)	0.0602	0.59	0.556
External health expenditure (EHE)	0.0871	0.96	0.337
Gross domestic product per capita (GDPpc)	0.0367	10.27	0.000
Institutional quality (INSQ)	-4.7781	-5.38	0.000
Panel B: Short run coefficients: Dependent Variable – Infant Mortality Rate			
Regressors	**Coef.**	**t-stat.**	**P-value**

ECT	-0.0459	-6.75	0.000
ΔOPHE	0.0435	1.08	0.280
ΔGHE	0.0425	1.36	0.173
ΔEHE	0.0215	0.68	0.498
ΔGDPpc	-0.004	-1.80	0.071
ΔINSQ	0.5737	0.95	0.342
Constant	-1.0024	-2.19	0.028
Log Likelihood	***-554.474***		

Source: Researchers' Compilation (2025)

Table 4.5 shows the PMG estimates for infant mortality and healthcare financing in SSA. In the long run, OPHE, GHE, EHE and GDPpc exert positive and insignificant effect on infant mortality, except GDPpc, which shows a significant effect. This suggests that any increase (say 1%) in OPHE, GHE, EHE and GDPpc is associated with higher infant mortality in SSA. This may not be far from the truth, as SSA has the highest infant mortality rates, at approximately 42.7 deaths per 1,000 live births, according to data from UNICEF, as against the global average infant mortality rate, which stood at approximately 25 deaths per 1,000 live births. The departure from the expected theoretical sign could be attributed to a number of issues ranging from poor infrastructure to inefficiency, which thwart effective implementation of the health budget. This may also be linked to inadequate public spending, a lack of access to quality care (especially in rural areas), and socioeconomic challenges like poverty, poor education, and inadequate nutrition that are outside the healthcare system's direct control. On the other hand, institutional quality exhibited a negative and significant effect on infant mortality in SSA. This suggests that efficient and effective institutional quality can reduce infant mortality rates in the region.

In the short run, OPHE, GHE, EHE and GDPpc maintained a positive and insignificant effect on the infant mortality rate in SSA. These health expenditures have been insignificant and unable to reduce/decrease the infant mortality rate in the region. Similarly, institutional quality, which showed a negative and significant relationship in the long run, produced a negative and significant relationship with infant mortality in the short run. Also, GDPpc affected infant mortality negatively, although the impact was insignificant. The result suggests that a higher GDP per capita will lead to better living standards, which include improved access to healthcare, better nutrition, sanitation, and education for parents, all of which contribute to lower infant mortality rates. Finally, the error correction term is statistically significant at 5% level of significance and is correctly signed with an adjustment rate of -0.0459. This suggests therefore that about 4.59% of the disequilibrium in the model is corrected each period.

4.2.2. Moderating effect of institutional quality and healthcare financing on infant mortality in SSA

The study examined how institutional quality moderates the effect of healthcare financing on infant mortality rates in SSA. The result is presented in Table 4.6.

Table 4.6: Panel Least Squares of institutional quality and healthcare financing on infant mortality using Fixed Effects and Random Effects

	Fixed Effects			Random Effects		
Regressors	**Coef.**	**t-stat.**	**P-value**	**Coef.**	**t-stat.**	**P-value**
LNOPHE	0.256030	8.072769	0.0000	0.259096	8.699977	0.0000
LNGHE	-0.054780	-2.186116	0.0291	-0.062622	-2.557626	0.0107
LNEHE	-0.026457	-1.868263	0.0621	-0.048420	-3.510473	0.0005
LNGDPPC	-0.857555	-19.59858	0.0000	-0.610351	-19.36161	0.0000
INSQ	-0.491879	-2.869574	0.0042	-0.559189	-3.370355	0.0008
LNOPHE*INSQ	0.022870	0.846285	0.3977	0.042422	1.653478	0.0986
LNGHE*INSQ	0.097347	3.830082	0.0001	0.102107	4.131913	0.0000
LNEHE*INSQ	-0.008021	-0.793740	0.4276	-0.012114	-1.232924	0.2180

Researchers' Compilation (2025)

The Hausman test statistic of 131.46 is significant (df = 9, p-value = 0.0000), thus leading to the rejection of the null hypothesis that the random effects estimator is consistent. The fixed effects specification is the correct and more reliable choice for inference, as the random effects model contains unobserved heterogeneity across cross-sections that is correlated with the regressors

a. Variable-Level Comparisons

The coefficient comparisons between fixed and random effects highlight where the differences are most pronounced. For LNEHE and LNGDPPC, the differences are statistically significant, indicating that these variables are particularly sensitive to the correlation between regressors and unobserved effects. Similarly, the interaction term LNOPHE*INSQ (p = 0.0213) reinforces the conclusion that institutional quality modifies the impact of healthcare expenditure variables in ways that random effects fail to capture.

b. Fixed Effects Model Estimates

This result shows that government health expenditure (LNGHE) and external health expenditure (LNEHE) have a strong negative relationship with infant mortality, although external health expenditure was insignificant, suggesting that higher government health spending is associated with reductions in the infant mortality rate. On the other hand, out-of-pocket health expenditure (LNOPHE) is positive but significant ($p \approx 0.00$), suggesting that out-of-pocket health expenditure, though significant, may be inefficient in reducing infant mortality.

c. Model Fit and Diagnostics

The fixed effects model demonstrates strong explanatory power, with R^2= 0.918 and Adjusted R^2 = 0.912, meaning that over 91% of the variation in infant mortality is explained by the regressors. The F-statistic is highly significant ($p < 0.0001$), confirming the overall validity of the model.

4.3. Discussion of Findings

The findings reveal that health spending increases the infant mortality rate, but insignificantly. This result is also consistent with the empirical findings of Berger and Messer (2002); Anyanwu and Erhijakpor (2009). However, this unusual result could be attributed to a number of issues ranging from inefficiency in allocation to governance to poor infrastructure. There's also inefficiency in the implementation of the health budget as funds may be diverted or wasted on inefficient systems. Also, the lack of access to quality care (especially in rural areas), and socioeconomic challenges like poverty, poor education, and inadequate nutrition that are outside the healthcare system's direct control may also influence the effect of increased healthcare funding on infant mortality rate. Again, GDPpc exhibited a positive and significant effect on infant mortality rate. This positive link suggests that economic benefits are not translating effectively into health investments due to factors such as rapid, unplanned growth causing disparities, poor health system spending, or specific country contexts where economic gains aren't reaching vulnerable mothers/infants, leading to worsening outcomes despite overall growth. On the other hand, institutional quality exhibited a negative and significant effect on infant mortality in SSA, suggesting that efficient and effective institutional quality can trigger a significant reduction in infant mortality rates across the region.

5.0. Conclusion and Policy Recommendations

The results of the study show that healthcare financing does not have any significant influence on infant mortality rate. This suggests that as these healthcare financing mechanisms increase, infant mortality in SSA continues to rise. The result is because SSA has the highest infant mortality rates, at approximately 42.7 deaths per 1,000 live births, as against the global average infant mortality rate, which stood at approximately 25 deaths per 1,000 live births.

In light of these findings and conclusions, the following recommendations were made:

1. **Institutional, governance and transparency:** The findings revealed that institutional quality moderates the effect of healthcare financing on infant mortality. Therefore, strong actions against corruption and embezzlement will help ensure efficient spending of resources as increased healthcare

funding will produce minimal results if corruption is not eradicated.

2. **Healthcare System Reforms:** To effectively reduce infant and maternal mortality, health care financing must be combined with comprehensive reforms that address the underlying health system inefficiencies and the broader socioeconomic factors that influence health outcomes. Policies aimed at reducing household copayments should be considered as it has the potency of reducing financial barriers to accessing healthcare and increase the consumption of healthcare services in SSA where the majority of households are poor.
3. **Immunization and vaccines:** Evidence suggests that missed vaccinations contribute to rising infant mortality rates as diarrheal diseases, lower respiratory infections, and meningitis, could have been prevented with vaccines. There is a need to emphasise and improve on immunization/vaccines, as they reduce infant mortality by fighting life-threatening infections, preventing diseases like pneumonia, diarrhoea, and measles and reducing mortality from preventable illnesses.

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