Interactive Impact of Health Expenditure and Institutional Quality on Life Expectancy in Sub-Saharan Africa.

Nyitama Zirra Stephen[1], Prof. Mohammed Inuwa Dauda[2], Dr. Idowu Daniel Onisanwa[3]

[1]Postgraduate Student, Department of Economics and Development Studies, Federal University Kashere, Gombe State.

[2,3]Department of Economics and Development Studies, Federal University Kashere, Gombe State.

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ABSTRACT

This study examines the interactive impact of health expenditure and institutional quality on life expectancy in 45 Sub-Saharan African countries from 2000 to 2024, using panel data. Health expenditure, institutional quality and life expectancy were sourced from World Bank, (2026). System Generalized Method of Moment (GMM) test was employed to analysed the data. The result revealed that both private and government health expenditure significantly and positively improve life expectancy in Sub-Saharan Africa. Among the institutional quality indicators, regulatory quality exerts a positive and significant impact on life expectancy, while government effectiveness and control of corruption show negative effects, although only control of corruption is statistically significant. The interaction results reveal that government effectiveness enhances the positive impact of government health expenditure on life expectancy. However, weak corruption control and poor regulatory quality reduce the effectiveness of health expenditure, particularly public health expenditure, in improving health outcomes. The year effects further indicate that life expectancy generally declined between 2001 and 2022, with the largest decline occurring in 2021 due to the COVID-19 pandemic, while improvements were observed in 2023 and 2024, suggesting post-pandemic recovery in the region. It is recommended that governments in Sub-Saharan Africa should increase both public and private health expenditure, particularly public health financing, to improve life expectancy. Policymakers should also strengthen regulatory quality through improved healthcare regulations, monitoring systems, enforcement mechanisms, and service standards to ensure efficient and accountable healthcare delivery. In addition, governments should implement institutional reforms aimed at enhancing governance effectiveness, reducing bureaucratic inefficiencies, and strengthening public sector management to maximize the impact of health expenditure on health outcomes. Furthermore, strong anti-corruption measures, transparency in health budgeting, and effective monitoring of public health funds should be prioritized to minimize leakages and inefficiencies that weaken the effectiveness of government health spending.

Keywords: Health Expenditure; Institutional Quality; Life Expectancy; System GMM; Sub-Saharan Africa.

INTRODUCTION

Life expectancy is widely regarded as a comprehensive indicator of population health and general well-being, yet Sub-Saharan Africa (SSA) continues to lag behind global standards despite notable improvements over time. Globally, life expectancy increased from approximately 67.4 years in 2000 to about 71.8 years in 2021, reflecting significant advancements in healthcare delivery, disease prevention, and living conditions (World Bank, 2024). While SSA has experienced gradual gains in longevity, progress remains constrained by structural challenges, particularly inadequate health financing and weak institutional systems. Theoretical insights emphasize that health is a fundamental component of human capital that enhances labour productivity and supports long-term economic growth (Grossman, 1972; Romer, 1996), while empirical evidence shows that increased health expenditure contributes positively to life expectancy (Somi et al., 2009; Novignon et al., 2012).

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However, public investment in health across SSA remains relatively low, averaging about 6.7% of total government expenditure over the study period, which is significantly below global and regional benchmarks (World Bank, 2024). At the same time, private health expenditure constitutes a substantial share of total health spending, averaging approximately 47.5%, reflecting a heavy reliance on household out-of-pocket payments. Although global trends indicate a shift toward increased public health spending from 9.5% of government expenditure in 2000 to 11.2% in 2021 and a decline in private spending from 44.2% to 36.1% (World Bank, 2024), such improvements have been less pronounced in SSA. This imbalance in health financing may limit equitable access to healthcare services and slow progress in improving life expectancy.

Importantly, the effectiveness of health expenditure in enhancing life expectancy is strongly influenced by institutional quality. Governance indicators such as government effectiveness, control of corruption, and regulatory quality determine the efficiency of public service delivery and the extent to which health resources translate into improved outcomes (Awe & Abdulrahman, 2024). In SSA, institutional performance remains relatively weak and highly volatile, with frequent fluctuations in governance indicators reflecting policy inconsistencies and limited enforcement capacity. These institutional deficiencies often undermine the impact of health spending on population health (Hadipour et al., 2023).

Although existing studies have examined the individual effects of health expenditure and institutional quality on different health outcomes (see Anwar et al., 2023; Bein & Coker-Farrell, 2020; Awoyemi et al., 2023; Bukari et al., 2024; Ebeh et al., 2024; Awe & Abdulrahman, 2024), limited empirical attention has been given to their interactive impact on life expectancy. Given that financial resources alone may not guarantee improved health outcomes without strong institutions, this study investigates the interactive impact of health expenditure and institutional quality on life expectancy in Sub-Saharan Africa from 2000 to 2024.

LITERATURE REVIEW

Conceptual Clarification

This section provides a conceptual clarification of the key variables underpinning the study, namely health expenditure, institutional quality, and life expectancy.

Concept of Health Expenditure

Health is commonly described as a state of complete physical, mental, and social well-being, and not simply the absence of illness or disability (World Health Organization, 1948). From an economic standpoint, Grossman (1972) defines health as a form of human capital that yields a continuous stream of health benefits over time. In this context, health expenditure is viewed as an investment through which individuals and governments commit resources to improve health outcomes, increase productivity, and promote longer life expectancy.

Health expenditure is broadly divided into public and private spending. Public health expenditure includes government spending on healthcare services through recurrent and capital budgets, external aid, and social health insurance schemes (World Bank, 2024). Private health expenditure, on the other hand, consists of household and private sector spending such as out-of-pocket payments, private insurance, donations, and direct healthcare expenses by firms (World Bank, 2024).

Concept of life expectancy

Life expectancy is an important indicator of health outcomes and represents the average number of years a new born is expected to live based on existing mortality patterns (United Nations, 2021). It is commonly used to assess population health because it captures the quality of healthcare systems, living conditions, and the level of socio-economic development within a country. According to Grossman's (1972) health capital theory, health is considered a stock that depreciates over time but can be improved through investments such as healthcare spending, better nutrition, and enhanced living standards. Similarly, George Hadley (1982) emphasizes that life expectancy is useful for measuring the efficiency and effectiveness of healthcare expenditure, since increased

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spending on health is expected to improve survival rates and longevity. As a result, life expectancy is widely applied in empirical research as a broad indicator of population health and welfare.

Concept of Institutional Quality

Institutional quality refers to the degree of effectiveness, transparency, and accountability within governance systems that influence economic and social performance (Gebrue, 2024; Yousaf & Riaz, 2024). It includes formal institutions such as laws, regulations, and government agencies, as well as informal norms and practices that shape societal behaviour. Strong institutional quality is characterized by effective legal systems, efficient regulatory frameworks, protection of property rights, and transparent governance structures. Institutional quality plays a vital role in determining how resources are allocated, policies are implemented, and economies perform generally. In the healthcare sector, weak institutions can reduce the efficiency of service delivery and weaken the effectiveness of health expenditure, especially in developing countries (Rizvi, 2019). In contrast, strong institutions encourage accountability, transparency, and prudent management of public resources, thereby improving the effectiveness of healthcare investments (Abubakar, 2020).

Empirical literature

Anwar et al. (2023) examined the influence of government health expenditures on health outcomes across 38 member countries of the Organisation for Economic Co-operation and Development (OECD), using panel data spanning the period from 1996 to 2020. The System Generalized Method of Moments (GMM) estimation technique was employed to analyse the data. The findings indicated that government health expenditures significantly reduced infant mortality rates and positively influenced life expectancy. Additionally, it was also found that gross domestic product (GDP), number of doctors per capita, and air pollution were all significantly associated with health outcomes. Specifically, higher GDP and a greater number of doctors were linked to lower infant mortality and higher life expectancy, whereas air pollution was associated with increased infant mortality and reduced life expectancy.

Bein and Coker-Farrell (2020) employed both fixed effects and random effects estimation techniques to analyse the effect of public and private healthcare expenditure on health status across eight (8) selected African countries, using panel data from 2000 to 2014. The findings revealed that overall healthcare spending had a statistically significant positive impact on health outcomes. Notably, public healthcare expenditure exhibited a stronger effect than private healthcare spending in reducing mortality rates and combating communicable diseases such as tuberculosis and human immunodeficiency virus (HIV). In contrast, private healthcare spending was found to be more impactful in reducing maternal mortality.

Awoyemi et al. (2023) examine the relationship between government health expenditure and health outcomes in Nigeria using time-series data covering the period from 1995 to 2018. The study employs the Autoregressive Distributed Lag (ARDL) model estimation technique to analyse the data. The results indicate the presence of a long-run equilibrium relationship between government health expenditure and health outcomes in Nigeria. Specifically, the findings reveal that increased government spending on health is associated with a reduction in mortality rates, suggesting a negative relationship between health expenditure and mortality. In addition, life expectancy at birth responds positively to increases in health expenditure.

Aziz et al. (2021) utilized both the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimation techniques to examine the relationship between health expenditure and maternal mortality across South Asian countries, using panel data spanning from 2000 to 2017. The findings revealed that health expenditure has a positive impact on maternal mortality. Additionally, the study found that population growth exerted a statistically significant long-term positive impact on maternal mortality. In contrast, economic growth, improved sanitation, and access to clean fuel technologies were found to have significant long-term negative effects on maternal mortality.

Zhou et al. (2023) investigated the effect of health expenditures on health outcomes across 15 member countries of the Economic Community of West African States (ECOWAS), utilizing panel data covering the period from 2001 to 2020. The study adopted the Fully Modified Ordinary Least Squares (FMOLS) technique for data

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

analysis. The findings revealed that personal income had a statistically significant negative effect on infant mortality. Moreso, public health expenditure exhibited a statistically significant positive effect on infant mortality. In contrast, external health expenditure, private health expenditure, and gross domestic product (GDP) were all found to have a statistically significant negative effect on infant mortality.

Using the fifth, sixth, and seventh waves of the Afro barometer survey from 2011 to 2018, Bukari et al. (2024) examine how corruption may lead to healthcare deprivation in 29 Sub-Saharan African countries. The study utilized the use of an instrumental variable framework (Logit Regression) to analyse the data. The result revealed that the experience of corruption in the form of bribe payments, as well as the frequency of bribe payments within the healthcare sector, increases the likelihood of healthcare deprivation. Moreover, corruption experienced in other sectors, such as education, the police, public utilities, and identification authorities, has spill-over effects affecting healthcare deprivation. Further analysis reveals that the experience of corruption in multiple sectors simultaneously worsens healthcare deprivation. This implies that mitigating corruption in the healthcare sector alone may not be sufficient to end the adverse effects of corruption on effective healthcare access in Sub-Saharan African countries.

Hadipour et al. (2023) examine how institutional quality influences health system outcomes across 158 countries, both low- and high-income, from 2001 to 2020, using time series data. The study employed Fixed Effects and Generalized Method of Moments (GMM) models for data analysis. The findings indicated that better institutional quality was associated with lower infant mortality rates and higher life expectancy. Additionally, factors such as gross domestic product, average years of schooling, total health expenditure, and urbanization rate were linked to reduced infant mortality rates and increased life expectancy. In contrast, higher carbon dioxide emissions were associated with increased infant mortality rates and reduced life expectancy.

Utilizing panel data from 37 Sub-Saharan African countries spanning the period from 2007 to 2021, Awe and Abdulrahman (2024) investigated the influence of institutional frameworks, encompassing both economic and political institutions, on the quality of life in the region. The study employed the two-step System Generalized Method of Moments (GMM) estimation technique. The findings demonstrated a positive and statistically significant effect of institutional systems on quality-of-life indicators in Sub-Saharan Africa.

Ebeh et al. (2024) employed the Auto-Regressive Distributed Lag (ARDL) model to examine the relationship between institutional quality and health outcomes in Nigeria, using time series data from 1988 to 2022. The findings confirmed the existence of a long-run equilibrium relationship between institutional quality and health outcomes in the country. Moreso, in the short run, the results indicated that government effectiveness and political stability exerted a negative and statistically significant effect on the maternal mortality rate. Conversely, control of corruption demonstrated a statistically significant positive effect on life expectancy.

Data and Methodology

This section of the study presents the type and sources of data utilized for the research, as well as the model specification and the techniques employed for data analysis.

Source/ Method of Data Collection

This study employed panel data to examine the interactive impact of health expenditure and institutional quality on life expectancy in Sub-Saharan Africa from 2000 to 2024. The variables used include government health expenditure, private health expenditure, life expectancy and institutional quality. Institutional quality was proxied using three of the six components of the Worldwide Governance Indicators, namely government effectiveness, control of corruption, and regulatory quality. All data were obtained from the World Bank (2026) database covering the period from 2000 to 2024.

Model specification

To examine the interactive impact of health expenditure and institutional quality on life expectancy in Sub-Saharan Africa, this study adopts the Human Capital Model developed by Michael Grossman (1972) as its

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

theoretical foundation. The model emphasizes the dual significance of health in enhancing quality of life and promoting economic productivity. In this framework, health is viewed both as a consumption good that provides utility and as an investment good that improves human capital and productivity (Grossman, 1972). The Grossman's human capital model can be specified as follows:

$$H = F(X) \quad (3.1)$$

Where:

H = Measure of the individual health (i.e., health outcome)

X = Vector of factors that explain the health of the individual.

The Grossman Model was originally developed to examine health outcomes at the microeconomic level. However, since this study focuses on macroeconomic health outcomes, the model is extended to the macro level while retaining its theoretical foundation. Consequently, this study modifies Grossman's model to incorporate institutional factors as an additional explanatory factor.

$$h = f(Y, I) \quad (3.2)$$

where:

h = Population health (Health outcome)

Y = Vector of economic factors.

I = Vector of Institutional quality factors.

Health expenditure (Y) is measured by the government health expenditure and private health expenditure, institutional qualities (I) is proxied by three (3) out of six (6) Worldwide governance indicators, namely; government effectiveness, control of corruption, and regulatory quality, while (h) is life expectancy

This study, therefore, adapt Hadipour et al. (2023) model, in order to investigates the interactive impact of health expenditure and institutional qualities on life expectancy in Sub-Saharan Africa. The functional relationship of equation (3.2) can be given as:

$$LEX = f(GHEX, PHEX, GEF, COC, REQ) \quad (3.3)$$

Where LEX is life expectancy; GHEX is government health expenditure; PHEX is private health expenditure; GEF is government effectiveness; COC is control of corruption and REQ is regulatory quality

While the econometric model of equation (3.3) is given as:

$$LEX_{it} = \alpha_0 + \alpha_1 LEX_{it-1} + \alpha_2 GHEX_{it} + \alpha_3 PHEX_{it} + \alpha_4 GEF_{it} + \alpha_5 COC_{it} + \alpha_6 REQ_{it} + \alpha_7 (GHEX_{it} * GEF_{it}) + \alpha_8 (GHEX_{it} * COC_{it}) + \alpha_9 (GHEX_{it} * REQ_{it}) + \alpha_{10} (PHEX_{it} * GEF_{it}) + \alpha_{11} (PHEX_{it} * COC_{it}) + \alpha_{12} (PHEX_{it} * REQ_{it}) + \alpha_{13} \varphi_{it} + \mu_i + \varepsilon_{it} \quad (3.4)$$

Where:

LEX = Life expectancy proxy for health outcome

LEX_{it-1} = The lagged life expectancy

GHEX = Government health expenditure

PHEX = Private health expenditure

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

GEF = Government effectiveness

COC = Control of corruption

REQ = Regulatory quality

$GHEX_{it} * GEF_{it}$ = Interaction between government expenditure and government effectiveness.

$GHEX_{it} * COC_{it}$ = Interaction between government expenditure and control of corruption.

$GHEX_{it} * REQ_{it}$ = Interaction between government expenditure and regulatory quality.

$PHEX_{it} * GEF_{it}$ = Interaction between private health expenditure and government effectiveness.

$PHEX_{it} * COC_{it}$ = Interaction between private health expenditure and control of corruption.

$PHEX_{it} * REQ_{it}$ = Interaction between private health expenditure and regulatory quality.

α_0 = Intercept or constant

α_1 - α_{13} = Coefficient of the independent variables

φ_{it} = Vectors of dummy variable from 2000 to 2024

i and t = Country and time period, respectively

μ_i and ε_{it} = Country-specific effects and the error term, respectively

Expected outcomes

The a priori expectation of this study is that higher levels of health expenditure, measured through government and private health spending, are associated with an increase in life expectancy. Furthermore, improvements in institutional quality are anticipated to exert a positive impact on life expectancy in Sub-Saharan African countries, as stronger governance, better regulatory frameworks, and reduced corruption enhance the efficiency and effectiveness of public service delivery, including healthcare provision.

Measurement of the variables

Life Expectancy: Life expectancy at birth indicates the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life (World Bank, 2026).

Government Health Expenditure: Public expenditure on health from domestic sources as a share of total public expenditure. It indicates the priority of the government to spend on health from its own domestic public resources (World Bank, 2026).

Private Health Expenditure: Share of current health expenditures funded from domestic private sources. Domestic private sources include funds from households, corporations, and non-profit organizations. Such expenditures can be either prepaid to voluntary health insurance or paid directly to healthcare providers (World Bank, 2026).

Government effectiveness: Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the Worldwide Governance Indicator (World Bank, 2026)

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

Control of corruption: Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the Worldwide Governance Indicator (World Bank, 2026)

Regulatory quality: Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the Worldwide Governance Indicator (World Bank, 2026)

Method of data analysis

A descriptive statistical analysis has been conducted. This step is important in research involving large datasets, as it facilitates data organization, enables a better understanding of the underlying distribution, and provides a concise summary of key characteristics. The descriptive analysis presents critical statistical measures such as the mean, median, minimum and maximum values, standard deviation, and Jarque-Bera statistics, among others. These indicators offer insights into the central tendency, dispersion, and normality of the data, thereby laying the groundwork for further empirical analysis. To examine the stationarity properties of the variables, this study applies the second-generation Cross-sectional Augmented Im, Pesaran, and Shin (CIPS) unit root test developed by Pesaran (2007), which takes into account cross-sectional dependence caused by common shocks and unobserved heterogeneity across units. After determining the stochastic characteristics of the variables and carrying out any necessary data transformations, the empirical analysis is estimated using the one-step Generalized Method of Moments (GMM) approach. To ensure the reliability and robustness of the GMM estimates, several post-estimation diagnostic tests are conducted. These include the Arellano-Bond test, which checks for serial correlation in the differenced residuals, and the Hansen (or Sargan) test, which assesses the validity of the instruments and confirms the absence of over-identifying restrictions.

RESULT AND DISCUSSION

Descriptive statistics test

Descriptive statistics was carried out to know the variability of the variable used in the study and their distribution pattern. The results are shown in Table 4.1.

Table 4.1: Descriptive statistics test result

Variables	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
LEX	1,125	59.40	6.77	14.67	77.24	-0.44	5.59
PHEX	1,125	47.59	18.43	7.49	89.48	0.01	2. 16
GHEX	1,125	6.79	3.39	0.73	32.40	1.14	6.46
GEF	1,125	27.04	20.16	0.11	84.62	0.84	2.79
COC	1,125	32.40	22.39	-1.17	91.90	0.57	2.31
REQ	1,125	29.39	18.72	0.47	89.69	0.70	2.91

Source: Authors' Computation Using STATA 17 (2026)

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

Based on descriptive statistics in Table 4.1, the of mean life expectancy (LEX) is 59.40 years. Meaning, on average, people in Sub-Saharan Africa are expected to live about 59.40 years**.** The standard deviation of 6.77 suggests a moderate variation in life expectancy in Sub-Saharan African nations. This demonstrates that life expectancy varies among Sub-Saharan African nations, with some having higher life expectancies than others. Between 2000 and 2024, life expectancy ranges from a minimum of 14.67 years which was recorded in Central African Republic in the year 2009 and it might be attributed to political instability, armed conflict, weak health systems, and the prevalence of infectious diseases which significantly reduced survival rates during that period; to a maximum of 77.24 years which is recorded in Seychelles in the year 2020 which might be attributed to better healthcare infrastructure, higher income levels, effective public health policies, and improved access to medical services and sanitation**.** A skewness coefficient of -0.44 for life expectancy indicates a negatively skewed distribution, characterized by a longer left tail. This suggests that some Sub-Saharan African countries record moderate to relatively high levels of life expectancy, while others exhibit very low life expectancy. Furthermore, the kurtosis value of 5.59, which exceeds the benchmark value of 3 ($k > 3$), signifies positive excess kurtosis, commonly referred to as a leptokurtic distribution. This reflects a distribution with a pronounced peak and heavier tails, implying the presence of extreme values.

The result shows that private health expenditures (PHEX) in Table 4.1 have a mean of 47.59% of the current health expenditure and a standard deviation of 18.43 indicates a moderate distribution of private health expenditure around the mean. Countries and times when private health spending was relatively low are reflected in the observed minimum value of 7.49% of current health expenditure which is recorded in Lesotho in the year 2019 and this is because a larger share of healthcare financing was likely provided by public funding and international donor support, thereby reducing reliance on private out-of-pocket expenditure**.** On the other hand, nations with extraordinarily high private health expenditure are indicated by the maximum value of 89.48% of current health expenditure which is recorded in Equatorial Guinea in the year 2002 might be associated with limited public health financing and a heavy reliance on out-of-pocket payments by households for healthcare services**.**

Furthermore, a slightly positive but nearly symmetric distribution is shown by the skewness coefficient of 0.01, suggesting that private health expenditure is distributed fairly among Sub-Saharan African nations with no discernible concentration at either extreme. Additionally, a platykurtic distribution is indicated by the kurtosis value of 2.16, which is below the normality threshold of 3 ($k < 3$). In comparison to a normal distribution, this suggests that the distribution is comparatively flat, with lighter tails and fewer extreme values. In other words, over the study period, domestic private health spending is steady and predictable with little impact from outliers.

The mean and standard deviation of government health expenditure (GHEX) in Table 4.1 are found to be 6.79% of general government health expenditure and 3.39, respectively. The standard deviation's magnitude shows that government expenditure on health care varies considerably around its mean, indicating significant variations in the distribution of public funds by Sub-Saharan African countries to the health sectors across time and among nations. Periods of unusually low or falling government health expenditure are shown by the minimum value of 0.73% of general government health expenditure which is recorded in Cameroon in the year 2017 might be as the result of fiscal constraints, competing budgetary priorities, and macroeconomic pressures that limited government allocation to the health sector**.** On the other hand, periods of comparatively substantial government commitment to health financing are shown by the maximum value of 32.40% of general government health expenditure which is recorded in Sao Tome and Principe in the year 2000 might be as the result of strong policy commitment to public health investment and increased budgetary allocation to healthcare services**.**

The distribution of government health spending is skewed to the right, as indicated by the skewness coefficient of 1.14, which is positive. This suggests the existence of a long right tail, indicating that certain Sub-Saharan African nations or periods record significantly higher government health spending, while the majority of observations cluster around lower expenditure levels. As a result, government spending on health care is not evenly allocated within the Sub-Saharan Africa region. A leptokurtic distribution is indicated by the kurtosis value of 6.46, which is higher than the benchmark value of 3 ($k > 3$). The existence of thick tails and extreme values indicates that outliers have an impact on the expenditure series.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

Beyond health expenditure, the institutional environment within which public services are delivered is further reflected in the region's governance effectiveness indicators. The mean governance effectiveness (GEF) score of 27.04 on a scale ranging from 0 to 100, points out generally weak governance performance across Sub-Saharan African countries. The relatively high standard deviation of 20.16 indicates substantial disparities in governance quality among countries. The minimum value of 0.11 reflects extremely ineffective governance in some cases, while the maximum value of 84.62 suggests notable improvements in governance effectiveness in others. The distribution is positively skewed (0.84), indicating that most countries cluster at lower governance scores, with only a few attaining relatively higher levels. The kurtosis value of 2.79, being below 3, indicates a platykurtic distribution with lighter tails.

Closely related to governance effectiveness, the descriptive results for control of corruption (COC) in Table 4.1 further highlight institutional weaknesses across the region. The mean value of 32.40 on a 0 to 100 scale (where higher values indicate stronger control) suggests moderate to high levels of perceived corruption overall. The standard deviation of 22.39 reflects considerable variation in corruption control across countries. The minimum value of -1.17 points to very weak institutional control of corruption, likely linked to fragile institutions and limited enforcement capacity, whereas the maximum value of 91.90 indicates substantial improvements in some countries, potentially driven by increased transparency, accountability, and anti-corruption reforms. The skewness coefficient of 0.57 shows a mildly right-skewed distribution, with a greater concentration of observations at lower control-of-corruption scores. The kurtosis value of 2.31, well below 3, indicates a platykurtic distribution characterized by lighter tails and fewer extreme observations.

Finally, the pattern observed in other governance indicators is reinforced by the results for regulatory quality. The mean value of 29.39 suggests generally suboptimal regulatory environments across Sub-Saharan Africa, while the standard deviation of 18.72 points to wide variation in the quality and effectiveness of regulatory frameworks across countries. The minimum value of 0.47 reflects extremely weak regulatory capacity in some cases, whereas the maximum value of 89.69 indicates relatively strong regulatory systems in others, although such performance is not widespread. This wide range underscores the absence of a consistently sustained regulatory framework across the Sub-Saharan African region. The skewness value of 0.70 indicates a positively skewed distribution, with most observations concentrated at lower levels of regulatory quality, while the kurtosis value of 2.91, which is close to 3, suggests a mesokurtic distribution that approximates the normal distribution.

Unit root test

Second-generation Cross-sectional Augmented Im, Pesaran and Shin (CIPS) unit root test was conducted in order to ascertain the stationarity condition of the variables used in the study. The result is presented in Table 4.2

Table 4.2 Cross-Sectional Augmented Im, Pesaran and Shin (CIPS) Unit Root Test Results

Variable	**At Levels**		**At First Difference**		**Order of Integration**
	CIPS	**5% Critical Level**	**CIPS***	**5% Critical Level**	
LEX	-1.928	-2.11	-4.153**	-2.11	I(1)
PHEX	-2.286**	-2.11	-5.063	-2.11	I(0)
GHEX	-2.084	-2.11	-5.276**	-2.11	I(1)
GEF	-2.327**	-2.11	-5.184	-2.11	I(0)
COC	-1.829	-2.11	-5.232**	-2.11	I(1)
REQ	-2.115**	-2.11	-5.577	-2.11	I(0)

Source: Authors' Computation Using STATA 17 (2026)

Note: ** indicate level of stationarity at 5%

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

Based on the Cross-Sectional Augmented Im, Pesaran and Shin (CIPS) panel unit root test results in Table 4.2, the variables exhibit mixed orders of integration after accounting for cross-sectional dependence. Private health expenditure (PHEX), government effectiveness (GEF), and regulatory quality (REQ) are stationary at levels, indicating they are integrated of order zero [I(0)]. In contrast, life expectancy (LEX), government health expenditure (GHEX), and control of corruption (COC) become stationary after first differencing, implying they are integrated of order one [I(1)] and follow stochastic trends.

Choosing between Difference Generalized Method of Moments (GMM) and System Generalized Method of Moments (GMM)

The choice of the System GMM estimator is based on the rule of thumb proposed by Bond (2002) for dynamic panel models. Bond recommends comparing pooled OLS, fixed effects (FE), and difference GMM estimates of the lagged dependent variable. While pooled OLS provides an upward-biased estimate and FE produces a downward-biased estimate due to Nickell bias, the difference GMM estimate should lie between them. Since the difference GMM estimate in this study was close to or below the FE estimate, indicating weak instruments, the System GMM estimator was adopted because it provides more efficient and reliable estimates by combining equations in levels and first differences.

Following this procedure, the pooled OLS, fixed effects, and difference GMM estimates are first reported and compared in Tables 4.3 using life expectancy as response variable.

Table 4.3: Pooled OLS, Fixed Effect, and Difference GMM Results (LEX as response variable)

VARIABLES	**Coefficient**	**VARIABLES**	**Coefficient**	**VARIABLES**	**Coefficient**
Pool OLS Estimate		**Fixed Effect Estimate**		**Difference GMM**	
L.LEX	0.8917***	L.LEX	0.4822**	L.LEX	0.2186
	(0.6472)		(0.1481)		(0.3233)
PHEX	-0.0025	PHEX	-0.0061	PHEX	-0.0384*
	(0.0032)		(0.0098)		(0.0239)
GHEX	-0.0086	GHEX	0.0381	GHEX	-0.3133*
	(0.0239)		(0.0478)		(0.1725)
GEF	0.0149*	GEF	0.0039	GEF	0.0295
	(0.0102)		(0.0115)		(0.0513)
COC	0.0053	COC	-0.0080	COC	-0.0030
	(0.0055)		(0.0151)		(0.0248)
REQ	-0.0095	REQ	0.0150	REQ	-0.0301
	(0.0097)		(0.0249)		(0.1157)

Source: Authors' Computation Using STATA 17 (2026)

Robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

The pooled OLS results in Table 4.3 show a lagged life expectancy (LEX) coefficient of 0.8917, while the fixed effects (FE) estimate is lower at 0.4822. The difference GMM estimate is even smaller at 0.2186. Following Bond (2002), a difference GMM coefficient below the FE estimate indicates weak instruments and downward bias, thereby justifying the use of the System GMM estimator. Consequently, the study adopts the one-step System GMM approach, which is more robust in finite samples, less prone to instrument proliferation, and more reliable given the relatively large time dimension (T = 25).

Interactive impact of health expenditure and institutional quality on life expectancy in Sub-Saharan Africa

This study incorporates multiple interaction terms within a single model to more fully capture the complexities of how life expectancy is influenced by the combined impact of institutional framework strength and health expenditure, providing insights into whether increases in institutional quality increase the efficiency of health expenditure in increasing life expectancy. The results obtained from investigating the combined impact of **health expenditure and institutional quality on life expectancy are shown in Table 4.4**

Table 4.4: Generalized Method of Moments (GMM) test result of the interactive impact of health expenditure and institutional quality on life expectancy in Sub-Saharan Africa

Group variable: numeric Co~D Number of obs = 1080

Time variable: Year Number of groups = 45

Number of instruments = 24 Obs per group: min = 24

Wald chi2(38) = 1.80e+06 avg = 24.00

Prob > chi2 = 0.000 max = 24

VARIABLES	Coefficient	Standard Errors	Prob
L. LEX	0.0821379	0 .0133208	0.000
PHEX	0.0652832***	0.0050617	0.000
GHEX	0.2653733***	0.0432455	0.000
GEF	-0.0485794	0.0441457	0.271
COC	-0.0748148***	0.0108602	0.000
REQ	0.2499703***	0.1957056	0.000
GHEX*GEF	0.0068798	0.0028436	0.016
GHEX*COC	-0.001651	0.0008338	0.048
GHEX*REQ	-0.0179555	0.0033784	0.000
PHEX*GEF	0.0004815	0.0005216	0.356
PHEX*COC	0.0015982	0.0001452	0.000
PHEX*REQ	-0.0032063	0.0006706	0.000

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

yr2001	-0.5026456	0.1527596	0.001
yr2002	-0.8550917	0.1498028	0.000
yr2003	-0.9569748	0.1466028	0.000
yr2004	-1.130804	0.1453851	0.000
yr2005	-1.202042	0.1446519	0.000
yr2006	-1.312484	0.1431022	0.000
yr2007	-1.414118	0.1427696	0.000
yr2008	-1.271036	0.14164	0.000
yr2009	-1.236303	0.1391145	0.000
yr2010	-1.177672	0.1403931	0.000
yr2011	-1.085687	0.138028	0.000
yr2012	-1.02345	0.1371341	0.000
yr2013	-0.9896287	0.1373805	0.000
yr2014	-0.9692004	0.137477	0.000
yr2015	-0.7922644	0.1373855	0.000
yr2016	-0.7282178	0.1354633	0.000
yr2017	-0.6116089	0.1351836	0.000
yr2018	-0.5570188	0.1362383	0.000
yr2019	-0.6603257	0.1348063	0.000
yr2020	-0.7682213	0.1350939	0.000
yr2021	-1.690879	0.1340844	0.000
yr2022	-0.4389884	0.1335164	0.001
yr2023	0.7922644	0.1345536	0.000
yr2024	0.7831541	0.1373855	0.000
Constant	64.62146	0.9924918	0.000

Source: Authors' Computation Using STATA 17, (2026)

*** p<0.01, ** p<0.05, * p<0.1

The dynamic panel model in Table 4.4 was estimated using the one-step System Generalized Method of Moments (System GMM) estimator for a panel of 45 Sub-Saharan African countries over 24 years, yielding a

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

total of 1,080 observations. The balanced panel structure is evidenced by the minimum, average, and maximum observations per group all equalling 24. The model employed 24 instruments, which is lower than the number of cross-sectional units (45 countries), thereby satisfying the recommended threshold for avoiding instrument proliferation in System GMM estimation. This suggests that the instrument set is parsimonious and unlikely to overfit the endogenous variables. Additionally, it should be noted that the coefficients for private health expenditure (PHEX) and government health expenditure (GHEX) are not directly comparable because the variables are measured in different units. Private health expenditure (PHEX) is measured as a percentage of current health expenditure while government health expenditure (GHEX) is measured as a percentage of total government health expenditure

Based on the results in Table 4.4, health expenditure measured by private health expenditure (PHEX) and government health expenditure (GHEX) exhibits coefficients of 0.0652 and 0.2653, respectively. These results indicate that health expenditure has a statistically significant and positive impact on life expectancy (LEX), in Sub-Saharan Africa. Specifically, a one-percentage-point increase in private health expenditure is associated with increases of 0.0652 years in life expectancy. Additionally, one-percentage-point increase in government health expenditure (reallocation of government budget priorities) is associated with increase of 0.2653 years in life expectancy. This finding implies that increased investment in the health sector enhances access to healthcare services, improves the quality and coverage of medical infrastructure, and strengthens preventive and curative care, thereby translating into longer life expectancy and improved overall population health in the region. The findings of this study are consistent with those of Anwar et al. (2023), Bein and Coker-Farrell (2020), and Awoyeni et al. (2023), all of whom similarly reported that health expenditure plays a significant role in enhancing health outcomes and improving overall health status.

Also, Table 4.4 shows that institutional quality, proxied by government effectiveness (GEF), control of corruption (COC), and regulatory quality (REQ) which are measured on a percentile rank scale from 0 to 100, has coefficients of -0.0485, -0.0748, and 0.2499, respectively. These results indicate that government effectiveness and control of corruption exert negative impacts on life expectancy in Sub-Saharan Africa, although only the impact of control of corruption is statistically significant at the 5% level, while government effectiveness is not statistically significant. The outcome of this study contradicts the findings of Bukari et al. (2024) and Hadipour et al. (2023), who reported that improvements in institutional frameworks exert a significant positive effect on health outcomes and overall health status. Conversely, regulatory quality has a statistically significant positive impact on health outcomes. Specifically, a one-unit increase in government effectiveness and control of corruption is associated with reductions of approximately 0.0485 and 0.0748 years in life expectancy, whereas a one-unit improvement in regulatory quality leads to an increase of about 0.2499 years in life expectancy. This implies that while weak implementation capacity and ineffective governance structures may hinder the efficient delivery of health-related services and reduce their impact on population health, strong and well-designed regulatory frameworks enhance policy enforcement, improve service standards, and promote accountability, thereby fostering better health outcomes and increased life expectancy in Sub-Saharan Africa.

Given the independent roles of health expenditure and institutional quality, the analysis further explores their joint effects on health outcomes. The interaction between health expenditure and institutional quality, proxied by government effectiveness (GEF), as presented in Table 4.4, yields coefficients of 0.00687 for government health expenditure (GHEX) and 0.00048 for private health expenditure (PHEX). While the coefficient associated with government health expenditure is statistically significant at the 5% level, that of private health expenditure is not. Indicating that government health expenditure, when complemented by effective governance structures, exerts a positive impact on life expectancy (LEX), in Sub-Saharan Africa. Specifically, one-percentage-point increase in government health expenditure (reallocation of government budget priorities) when interacted with improved government effectiveness, is associated with increases of 0.00687 years in life expectancy. This suggests that effective government institutions enhance the productivity of public health expenditure.

Building on this, the analysis further examines the role of institutional quality through the lens of control of corruption (COC). The results reveal that the interaction coefficients between health expenditure and control of corruption are -0.00165 for government health expenditure (GHEX) and 0.00160 for private health expenditure (PHEX). This indicates that government health expenditure, when interacted with the control of corruption

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

index, has a statistically significant negative impact on life expectancy in Sub-Saharan Africa. On the order hand, private health expenditure, when interacted with the control of corruption index, exerts statistically significant positive impact on life expectancy. This implies that a unit increase in private health spending, when combined with corruption control, leads to a 0.00160 increase in life expectancy. Conversely, one-percentage-point increase in government health expenditure (reallocation of government budget priorities) when interacted with control of corruption reduces life expectancy by 0.00165 years. The positive interaction between private health expenditure and control of corruption suggests that improved governance enhances the efficiency of private healthcare spending, leading to better health outcomes and higher life expectancy. Conversely, the negative interaction between government health expenditure and control of corruption implies that increased public health spending may not automatically improve life expectancy due to inefficiencies, weak public financial management, or poor allocation of resources within the public health sector. This indicates that improving institutional quality alone is insufficient unless accompanied by greater efficiency, transparency, and accountability in government health spending.

In a similar vein, regulatory quality further conditions the effectiveness of health expenditure. Table 4.4 shows that the interaction between health expenditure and regulatory quality (REQ) yields a coefficient of -0.01795 and -0.00320 for government and private health expenditure respectively. This suggests that increased health spending, when combined with poor or ineffective regulatory frameworks, adversely impacts life expectancy in Sub-Saharan Africa. The implication of these results is that weak regulatory quality reduces the effectiveness of both government and private health expenditure in improving life expectancy in Sub-Saharan Africa. The negative interaction coefficients imply that increased health spending under poor regulatory frameworks may lead to inefficiencies, misallocation of resources, weak service delivery, and poor monitoring of healthcare systems, thereby limiting the health benefits of such expenditures. Economically, this suggests that higher health spending alone is insufficient to improve health outcomes unless supported by strong regulatory institutions that ensure accountability, efficiency, quality healthcare delivery, and effective implementation of health policies.

Finally, the year dummy coefficients capture the time-specific effects on life expectancy in Sub-Saharan Africa relative to the omitted base year. The negative and statistically significant coefficients from 2001 to 2022 imply that life expectancy during these years was generally lower compared to the reference year, after controlling for health expenditure, institutional quality, and other explanatory variables in the model. The declining coefficients between 2001 and 2007 suggest worsening health conditions or adverse macroeconomic and institutional factors during the early years of the period. Although the magnitude of the negative effects gradually reduced after 2008, the coefficients remained significantly negative, indicating persistent structural health challenges across the region. Notably, the coefficient for 2021 (-1.690879) shows the largest negative effect on life expectancy, which may reflect the severe health and socioeconomic disruptions associated with the COVID-19 pandemic. However, the positive and statistically significant coefficients for 2023 and 2024 indicate an improvement in life expectancy relative to the base year, suggesting a post-pandemic recovery in health outcomes, healthcare delivery, and living conditions in Sub-Saharan Africa.

Generalized Method of Moments (GMM) diagnostic test

The results of the GMM diagnostic tests, which evaluate the validity and reliability of the estimate model, are shown in Table 4.4. The table presents important post-estimation statistics to assess the instruments' applicability and the overall robustness of the GMM estimations.

Table 4.5: Autocorrelation and instrument validity test result

Arellano-Bond test for AR (2) in first differences	z = 0.51 Pr > z = 0.169
Hansen test of overid. Restrictions	chi2(46) = 6.31 Prob > chi2 = 0.182

Source: Authors' Computation Using STATA 17, (2026)

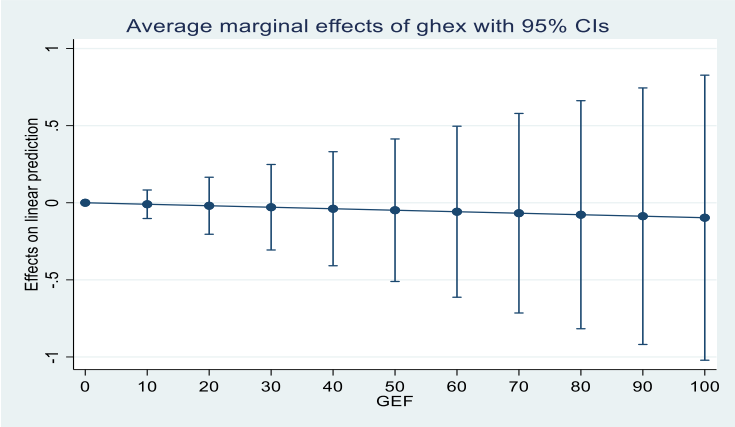
The test for autocorrelation is checked using the Arellano-Bond test for AR (2) in first differences, with the null hypothesis that the error term is not serially correlation. The probability value of 0.169 for Arellano-Bond test

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

for AR (2) shows no second order series correlation (that is the value of AR (2)>0.05). This implies that the original error term is serially uncorrelated and the moment conditions are correctly specified. The Hansen test for overall validity of the instrument is used and it has the p-value of 0.182 which gives support to the choice of instruments since the p-value is not below 0.50 but between 0.05 and 0.80 thus, the instruments are valid.

Following the diagnostic tests, marginal effects analysis was also conducted to examine the extent to which changes in the explanatory variables influence the dependent variable. The results of the marginal effects estimation are presented thus:

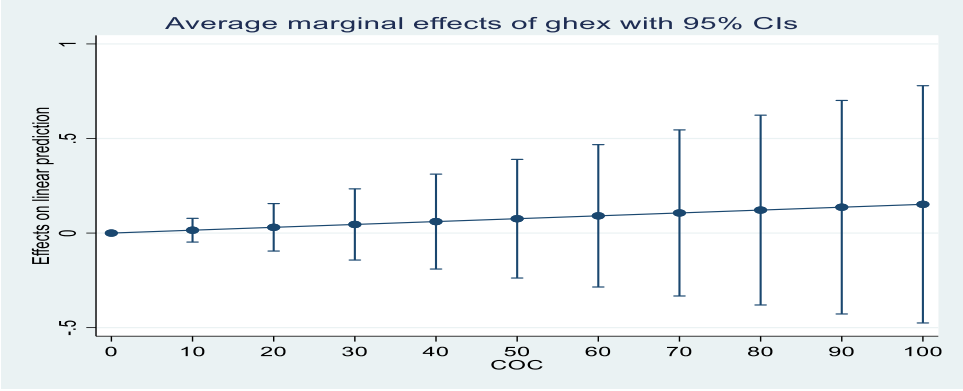
Fig. 4.1 Marginal effect of government health expenditure on life expectancy as government effectiveness varies



Source: Author's Compilation Using Data from World Bank

The marginal effect plot in Figure 4.1 shows that the impact of government health expenditure (GHEX) on life expectancy (LEX) becomes increasingly negative as government effectiveness (GEF) rises. This suggests that higher government effectiveness weakens the positive contribution of public health expenditure to life expectancy in Sub-Saharan Africa. However, the wide confidence intervals crossing zero indicate that the marginal effects are not statistically significant across most levels of government effectiveness.

Fig. 4.2 Marginal effect of government health expenditure on life expectancy as control of corruption varies varies

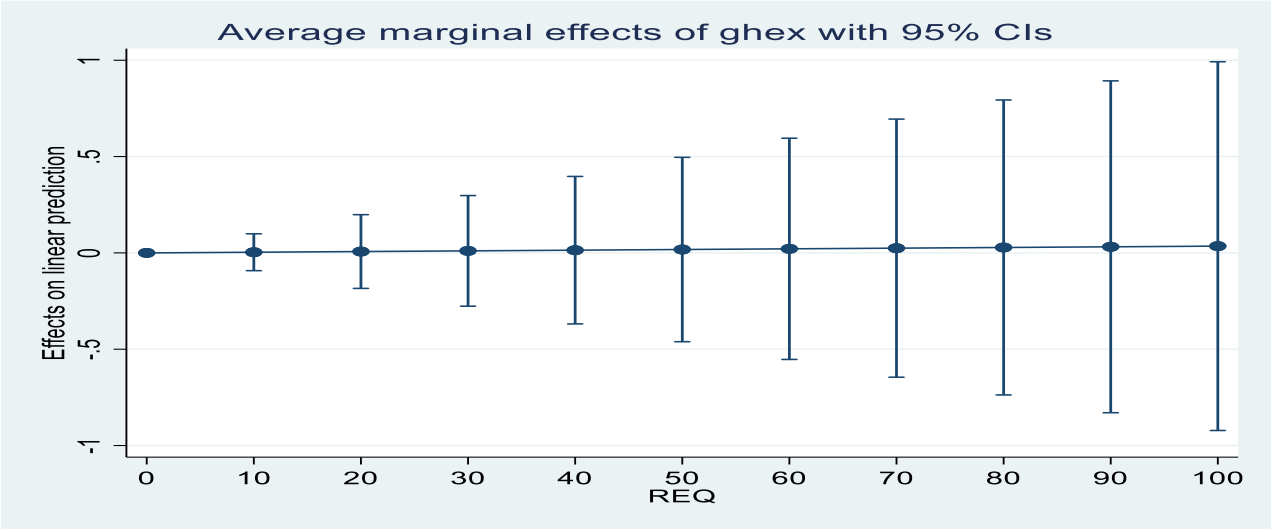


Source: Author's Compilation Using Data from World Bank

The marginal effect plot in Figure 4.2 shows that the impact of government health expenditure (GHEX) on life expectancy (LEX) becomes more positive as control of corruption (COC) improves. The upward-sloping line indicates that better corruption control enhances the effectiveness of public health spending in improving life expectancy in Sub-Saharan Africa. This suggests that stronger anti-corruption measures promote more efficient allocation and utilization of government health resources, leading to better health outcomes. However, the wide confidence intervals at higher levels of control of corruption indicate some uncertainty in the estimates, and the marginal effects may not be statistically significant across all levels of corruption control.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

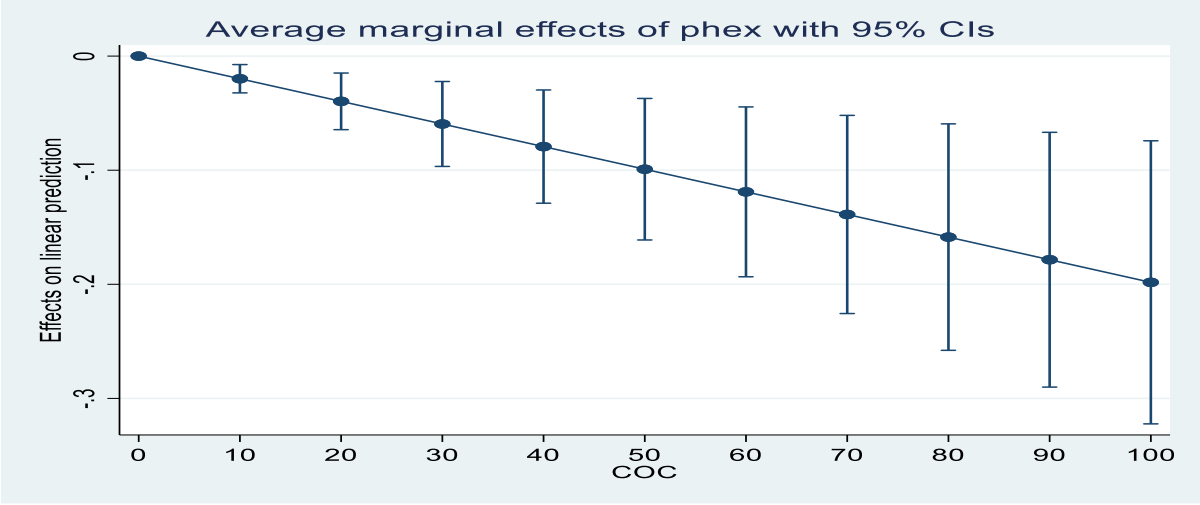
Fig. 4.3 Marginal effect of government health expenditure on life expectancy as regulatory quality varies



Source: Author's Compilation Using Data from World Bank

The marginal effect plot in Figure 4.3 shows that the impact of government health expenditure (GHEX) on life expectancy (LEX) changes only slightly as regulatory quality (REQ) increases. The nearly flat but slightly upward-sloping line suggests that improvements in regulatory quality marginally enhance the effectiveness of government health expenditure on life expectancy in Sub-Saharan Africa. However, the very wide confidence intervals, especially at higher levels of regulatory quality, indicate high uncertainty, and since the confidence intervals cross zero at most levels, the marginal effects are not statistically significant across the distribution of regulatory quality.

Fig. 4.4 Marginal effect of private health expenditure on life expectancy as control of corruption varies

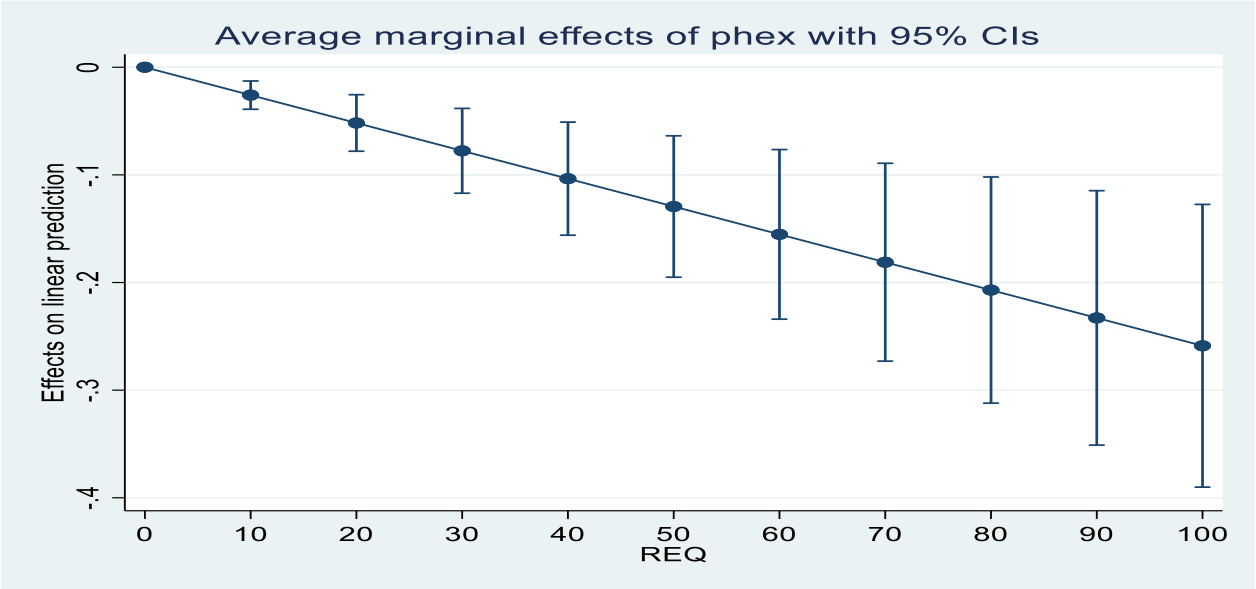


Source: Author's Compilation Using Data from World Bank

Figure 4.4 shows that the marginal effect of private health expenditure (PHEX) on life expectancy (LEX) becomes increasingly negative as control of corruption (COC) increases. This indicates a negative interaction effect between private health expenditure and COC, implying that the impact of private health spending on life expectancy is conditional on institutional quality. At low levels of corruption control, the marginal effect is close to zero, whereas at higher control of corruption levels the effect turns significantly negative. The widening 95% confidence intervals at higher control of corruption values suggest reduced precision of the estimates in that range, although the overall downward trend supports the presence of a moderating effect of corruption control on the private health expenditure-life expectancy relationship.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

Fig. 4.5 Marginal effect of private health expenditure on life expectancy as regulatory quality varies



Source: Author's Compilation Using Data from World Bank

Figure 4.5 indicates that the marginal effect of private health expenditure on life expectancy becomes increasingly negative as regulatory quality (REQ) improves. This suggests a negative interaction effect between private health expenditure and regulatory quality, implying that the effect of private health spending on life expectancy is conditional on the quality of regulation and governance institutions. At lower levels of regulatory quality, the marginal effect is close to zero, while at higher regulatory quality levels the effect becomes more strongly negative. The widening 95% confidence intervals at higher regulatory quality values indicate greater estimation uncertainty, but the consistent downward pattern supports the existence of a moderating effect of regulatory quality on the relationship between private health expenditure and life expectancy.

CONCLUSION AND RECOMMENDATIONS

The study examined the interactive impact of health expenditure and institutional quality on life expectancy in Sub-Saharan Africa from 2000 to 2024 using panel data for 45 countries. The one-step System Generalized Method of Moments (System GMM) estimator was employed for the analysis. The findings show that both private and government health expenditure significantly and positively improve life expectancy in Sub-Saharan Africa. Among the institutional quality indicators, regulatory quality exerts a positive and significant impact on life expectancy, while government effectiveness and control of corruption show negative effects, although only control of corruption is statistically significant. The interaction results reveal that government effectiveness enhances the positive impact of government health expenditure on life expectancy. However, weak corruption control and poor regulatory quality reduce the effectiveness of health expenditure, particularly public health expenditure, in improving health outcomes. The year effects further indicate that life expectancy generally declined between 2001 and 2022, with the largest decline occurring in 2021 due to the COVID-19 pandemic, while improvements were observed in 2023 and 2024, suggesting post-pandemic recovery in the region.

Based on these findings, the study recommends that:

i. Governments in Sub-Saharan Africa should increase both public and private health expenditure, particularly public health financing, since higher investment in the health sector significantly improves life expectancy and overall population health.

ii. Policymakers should strengthen regulatory quality by improving healthcare regulations, enforcement mechanisms, monitoring systems, and service standards to ensure efficient and accountable healthcare delivery.

iii. Governments should implement institutional reforms aimed at improving governance effectiveness, reducing bureaucratic inefficiencies, and strengthening public sector management in order to maximize the impact of health expenditure on health outcomes.

iv. Strong anti-corruption measures, transparency in health budgeting, and effective monitoring of public health funds should be prioritized to reduce leakages and inefficiencies that undermine the effectiveness of government health expenditure.

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