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Research Paper

Public Funding for Infectious Disease Control in Nigeria: The Case of Sokoto State

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Abstract

This study examined the role of public funding in improving infectious disease control in Nigeria and developed a collaborative framework for sustainable funding. A mixed-methods research design was adopted, combining documentary analysis of secondary (aggregate national) data from the WHO Global Health Observatory with qualitative insights from stakeholder discussions within the Sokoto State context. Universal Health Coverage Service Index for Infectious Diseases (UHCID) served as the dependent variable, while public funding indicators – including public financing for infectious disease control (PFIDC), domestic funding measures (DFIDC1 and DFIDC2), and external funding for infectious disease control (EFIDC) – were analyzed using descriptive statistics and Ordinary Least Squares regression models. The findings indicate that actual domestic monetary expenditure on infectious disease control (DFIDC2) has a positive and statistically significant association with infectious disease service coverage ($\beta = 0.000046$; $p = 0.049$), whereas proportional expenditure indicators did not demonstrate statistically significant effects. The results suggest that absolute funding levels provide a more meaningful measure of government commitment than expenditure shares alone because the latter overstate commitment when the underlying monetary investment remains inadequate. Stakeholder evidence further highlights the importance of efficient resource allocation, surveillance systems, laboratory capacity, vaccination programs, digital technologies, and inter-agency coordination in strengthening disease control outcomes. Based on these findings, the study proposes a collaborative governance framework involving government, development partners, healthcare providers, researchers, finance experts, and communities to improve financing sustainability and reduce fiscal pressure on government. The study concludes that enhanced domestic investment,

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coupled with efficient expenditure management and strategic partnerships, offers a more effective pathway toward strengthening infectious disease control and advancing universal health coverage in Nigeria, particularly Sokoto State.

Keywords: Infectious Disease Control, Nigeria, Public Funding, Sokoto State.

INTRODUCTION

Background to the Study

Infectious disease control continues to be major public health concern in Nigeria, because the resources allocated for the control and prevention of infectious diseases remains critically inadequate. This can be largely attributed to the fact that Nigeria struggles to balance its resource allocation between several equally demanding sectors. Optimizing public funding allocations towards infectious disease control in Nigeria is essential for ensuring that the limited resources allocated for this purpose are utilized effectively and efficiently. Hence, this study is of great importance, as the effective allocation of resources can help mitigate the spread of infectious diseases and ultimately improve health outcomes for Nigerians.

Exploring the challenges associated with government resource allocation for infectious disease control in Nigeria – especially Sokoto State, and proffering strategies to address these challenges defines the scope of this study. The study adopts a systems thinking approach to provide a comprehensive understanding of the public funding system, as well as disease control mechanisms, and the interrelationships between them. This approach showcases the multiple factors responsible for the spread and transmission of infectious diseases as, environmental, social, economic, and political factors. Thus, it helps to enumerate more effective and sustainable strategies regarding public funding for infectious disease control in Nigeria.

Problem Statement and Justification

While Infectious diseases are a crucial public health dilemma because the prevention and control of such diseases require substantial financial resources, public funds are a scarce source of funding for infectious disease control programs and necessary for effectiveness in infectious diseases control. To guarantee optimal utilization of allocated public resources, this problem must be addressed. This study assesses the impact of public funding on the effectiveness of infectious disease control by way of: analyzing relevant funding indices; evaluating the effectiveness of different disease control strategies, such as vaccination programs, screening and treatment; and identifying strategies for optimizing the allocation of resources to achieve better health outcomes.

Objectives and Hypothesis

Consequently, the study explored options for establishing a framework for collaboration between public health agencies, public finance experts, policymakers and healthcare providers that ensures the reduction of the burden of infectious diseases on government, society and citizens. In this regard, the hypothesis tested (public funding has no significant impact on the effectiveness of infectious disease control programs in Nigeria) emanated from the study's main objective. That is to, assess the impact of public funding on infectious diseases control, and identify alternative approaches that reduce pressure on public resources. Other sub-objectives are:

1. To analyze data on the incidence and prevalence of infectious diseases in relation to the availability of public funds for disease control programs.
2. To identify strategies for optimizing the use of allocated resources in order to achieve better health outcomes in infectious disease control programs.
3. To establish a framework for collaboration between public health agencies, public finance experts, policymakers and healthcare providers that ensures the reduction of the burden of infectious diseases on public resources.

Research Methodology

The study adopted a mixed-methods research design, combining both quantitative and qualitative approaches in order to provide a comprehensive understanding of public funding for infectious disease control in Nigeria, and Sokoto State. While the quantitative analysis was conducted at the national level, focus group discussions gathered via a Sokoto State based academic symposium provided informed the qualitative discussions and policy implications. The appropriateness of this mixed-method approach is in view of the multidimensional nature of health funding and the need to integrate statistical evidence with contextual perspectives from stakeholders. To effectively address the objectives of the study, three major methodological steps were undertaken. First, a systematic review of relevant literature to identify existing theoretical and empirical perspectives on public health expenditure components and indicators. This process informed the literature review and provided the conceptual and theoretical basis for the study. Second, relevant secondary data were obtained from WHO global health expenditure database (also known as The Global Health Observatory) from 2013 to 2022. In this regard, the study's small sample size – due to constrained data availability, and the non-availability of Sokoto-specific indices for potential variables identification were the study's main limitations.

These data provided quantitative evidence on health expenditure patterns and infectious disease funding. Third, qualitative insights were generated through focus group discussions (FGDs) organized during a faculty-based symposium. The discussions provided contextual understanding of the mechanisms, challenges, and operational realities associated with public funding for infectious disease control in Nigeria's Sokoto State, particularly in relation to public funding sustainability. The adoption of these approaches became necessitated by the challenges associated with accessing detailed case-study data, largely due to bureaucratic limitations, and restricted institutional access. Consequently, the combination of documentary analysis and stakeholder discussions enabled the study to obtain a broader and more reliable perspective on the subject matter.

The population of the study comprised stakeholders involved in infectious disease control and public health funding in Sokoto State, Nigeria. This included top state government bureaucrats, public health administrators/experts, healthcare professionals, donor-supported health program coordinators, and other (academic and professional) stakeholders with expertise in public financial management. Given the exploratory nature of the qualitative component of the study, purposive sampling was adopted in selecting participants for the focus group discussions. Participants were selected based on their knowledge, professional experience, and involvement in public health funding of infectious disease control initiatives. This ensured that the information gathered reflected informed perspectives relevant to the objectives of the study.

Descriptive statistics were employed to summarize the data and identify expenditure trends, while regression analysis was used to examine the relationship between public funding for infectious disease control and infectious disease service coverage outcomes. Specifically, the study modeled the effect of government expenditure on the UHC infectious disease service coverage sub-index. The PFIDC, DFIDC1, and DFIDC2 served as the proxies for public funding for infectious disease control in Nigeria (which are the commitment input to health funding, and the independent variables in this case), while UHC Service Coverage sub-index on infectious diseases (UHCID) captures health system performance in infectious disease services (the outcome or output, serves as the dependent variable). In addition, EFIDC is the control variable representing the 'external sources of funding for infectious diseases control in Nigeria. Together each IV in conjunction with the DV and CV form a separate strong analytical framework because the independent variables overlap but are disease-specific, just as the UHCID measures coverage and not necessarily disease control effectiveness, the endogeneity risk resulting from this imply that: stronger systems attract more funding. Thus, donor funding and governance quality influence the relationship, and time lags between expenditure and outcomes deplete short-run gains.

Notwithstanding, the proxies for the variables are theoretically sound and empirically useful for this study which is a macro-level health systems study. Specifically, there is strong policy logic for this in theory because: higher public health spending should improve infectious disease coverage. More so, infectious disease funding is strongly linked to service coverage and subsequently to outcomes, and the proxies' capture both funding (input) and coverage outcome (output). Empirically, these proxies provide a country-wide perspective which is comparable to other climes. Also, the WHO-standardized indicators ensure consistency and non-bias in data, while empirical studies reviewed also show health expenditure positively affects infectious disease-related UHC performance.

The independent variables conceptually measure the proportion of: total current health expenditure allocated to infectious diseases control (PFIDC); domestic general government expenditure on health allocated to domestic general government expenditure on infectious diseases (DFIDC1); and domestic general government expenditure on infectious diseases (DFIDC2) in millions of naira. They reflect the Nigerian government's fiscal commitment and prioritization of infectious disease control within national budgeting. The dependent variable – UHCID measures the extent to which populations can access essential infectious disease services such as immunization, tuberculosis treatment, HIV services, malaria interventions, and epidemic preparedness under Universal Health Coverage. UHCID reflects performance and effectiveness of infectious disease control systems.

For the control variable – external health expenditure allocated to infectious diseases control (EFIDC) – reflects the proportion of infectious disease funding provided by external sources, including development partners, donor agencies, and international organizations. It captures the extent to which infectious disease control programs depend on foreign financial assistance and serves to control for the influence of donor-supported funding on service coverage outcomes, independent of domestic government funding. Accordingly, the functional relationships of the study variables is expressed as follows, indicating that infectious disease service coverage is determined separately by each of public, domestic, or external funding for infectious disease control:

i. $UHCID_t = f(PFIDC_t, EFIDC_t)$;

ii. $UHCID_t = f(DFIDC1_t, EFIDC_t)$; and

iii. $UHCID_t = f(DFIDC2_t, EFIDC_t)$.

The corresponding econometric models are expressed as:

i. $UHCID_t = \beta_0 + \beta_1 PFIDC_t + \beta_2 EFIDC_t + \mu_t$;

ii. $UHCID_t = \beta_0 + \beta_1 DFIDC1_t + \beta_2 EFIDC_t + \mu_t$; and

iii. $UHCID_t = \beta_0 + \beta_1 DFIDC2_t + \beta_3 EFIDC_t + \mu_t$, where:

$UHCID_t$ = DV – UHC infectious disease service coverage sub-index at time $_t$;

$PFIDC_t$, = IV – public funding for infectious disease control (percentage measure) at time $_t$;

$DFIDC1_t$ = IV – domestic government funding for infectious disease control (percentage measure) at time $_t$;

$DFIDC2_t$ = IV – domestic government funding for infectious disease control (measure in millions of naira) at time $_t$;

$EFIDC1_t$ = CV – external funding for infectious disease control (measure in millions of naira) at time $_t$;

β_0 = intercept term (constant term);

β_1 to β_4 = slope coefficients measuring the marginal effect of each explanatory variable on UHCID; and

μ_t = stochastic error term capturing the influence of omitted factors.

Noting that based on the Cost-Effectiveness Analysis framework and the theoretical expectation that greater investment in infectious disease programs should improve service delivery, the expected coefficient (A Priori) signs are all positive because: greater public funding (PFIDC) should improve infectious disease service coverage; Higher domestic government commitment (DFIDC1) is expected to strengthen program implementation and coverage; increased domestic monetary expenditure (DFIDC2) should enhance health system capacity and service availability; and external funding from donors and development partners (EFIDC) is expected to complement domestic resources and expand access to infectious disease interventions.

The models represent the extent to which variations in infectious disease expenditure (the independent variables) influence infectious disease service coverage outcomes (UHCID). The study findings provide the basis for developing a framework for enhanced collaboration between public health agencies and other stakeholders aimed at reducing the burden of infectious disease funding on government, and improving infectious disease control outcomes in Nigeria, and particularly Sokoto State. Data analysis was conducted using STATA software (version 19) which is better suited for time-series regression and the diagnostic tests in health economics and public finance studies. Descriptive statistics, pre-estimation diagnostics, ordinary least squares (OLS) regression, and post-estimation tests were performed to examine the relationship between the variables.

LITERATURE REVIEW

Conceptual Framework

This study adopts but distinguishes between Public Funding for Infectious Disease Control and the Universal Health Coverage infectious disease service coverage sub-index as the study variables.

Public funding for infectious disease control refers to the financial resources allocated and expended on infectious disease-related programs and interventions. It stands as the financial or percentage input indicator, reflecting government and health-sector expenditure directed toward communicable disease prevention, treatment, and control. Such expenditures include funding for immunization programs, malaria control, tuberculosis treatment, HIV/AIDS interventions, and other infectious disease-related services.

In this study, while public funding indices reflect the financial inputs invested in the health system (independent variables), the dependent variable captures the effectiveness and reach of those investments in terms of healthcare delivery and service coverage, and external funding serves as the control variable. This analytical approach makes it possible to assess whether increases in public funding is associated with improvements in health service outcomes. Furthermore, it facilitates comparison between financial investments and health system performance signifying that high levels of expenditure accompanied by low infectious disease coverage indicate inefficiencies in resource utilization, whereas relatively low expenditure with high service coverage suggest efficiency gains or the significant contribution of donor-supported interventions.

Consequently, the Systems Thinking Approach (STA), Health Belief Model (HBM), and Cost-Effectiveness Analysis (CEA) framework are adopted for this study. Combined, they provide complementary perspectives for understanding how funding can improve infectious disease control and support evidence-based resource allocation. The Systems Thinking Approach views the health sector as an interconnected system in which government funding, donor support, healthcare infrastructure, surveillance systems, laboratories, healthcare workers, and communities interact to influence infectious disease outcomes. It therefore suggests that improvements in disease control depend not only on increased funding but also on effective coordination and integration among these components. The Health Belief Model explains how individuals' perceptions of disease risk, benefits of preventive actions, and barriers to care influence behaviors such as vaccination uptake, screening, and treatment seeking. Consequently, public funding that supports awareness campaigns and improves service accessibility can enhance utilization of infectious disease interventions. Finally, the Cost-Effectiveness Analysis framework guides policymakers in allocating limited resources to interventions that generate the greatest health gains relative to cost. In the context of this study, it supports evaluating whether public and external funding are translated into improved infectious disease service coverage efficiently, thereby strengthening decisions on sustainable financing and priority setting for Nigeria's infectious disease control programs, especially in Sokoto state.

Theoretical Framework

In theory, several public expenditures could be seen as expenditure towards disease control. Such expenditures (categorized traditionally as capital or recurrent expenditures) are directed at: infrastructure development, equipment and technology, and information systems; and the costs incurred in respect of personnel emoluments, vaccines and medicines, program operations, surveillance and monitoring, public awareness and research. Some research on disease control expenditure follow the capital versus recurrent distinction described herein after, but adds detail on actual costs and where gaps remain, especially for surveillance and vaccination in low- and middle-income locations (such as states and municipalities).

Capital expenditures are directed towards: the construction or renovation of healthcare facilities, laboratories, and other infrastructure necessary for disease diagnosis, treatment, and prevention; purchase of medical equipment, diagnostic tools, machines and technological equipments that support disease diagnosis and treatment; and development and implementation of health information systems, surveillance systems, and data management tools to track disease outbreaks and monitor program effectiveness. Recurrent expenditures, however, cater for: salaries, benefits, and training for healthcare workers, epidemiologists, and other staff involved in disease control programs; procurement and distribution of vaccines, medications, and other essential supplies for disease prevention and treatment; funding for program management, coordination, and implementation, including logistics, transportation, and communication; expenses related to disease surveillance, outbreak investigation, and monitoring of disease trends and program effectiveness; funding for public health campaigns, community outreach, and education programs to promote disease prevention and control; and investments in diagnostic tools for research, treatments, and vaccines for infectious diseases.

For infectious diseases control, these expenditures can also be categorized based on the different disease control programs, such as: prevention programs where expenditures are focused on preventing disease outbreaks, such as vaccination programs and public education campaigns; treatment programs involving expenditures focused on providing treatment and care for individuals infected with diseases, such as medication procurement and healthcare personnel costs; and surveillance and response programs for monitoring disease trends, detecting outbreaks, and responding to public health emergencies. The very nature of categorizing the expenditures by programs indicates that tracking them (the expenditures) can provide opportunities for governments and policymakers to improve how resources are being allocated, used, as well as identify areas funding improvement are required in disease control programs.

Thus, categorization of public expenditures towards disease control, including capital and recurrent expenditures can be understood through two theories - the Health Belief Model (HBM) and the Systems Thinking Approach (STA). HBM explains and predicts health behavior based on an individual's beliefs, attitudes, and perceptions regarding a health problem and the benefits and barriers of taking action (Jones et al., 2015). In infectious disease control, HBM examines individuals' attitudes and beliefs towards vaccination, screening, and treatment programs, and how these factors influence their participation in these programs. STA identifies multiple factors contributing to the spread and transmission of infectious diseases, including environmental, social, economic, and political factors (Buckee et al., 2021; Xia, et al., 2017; and Seventer & Hochberg, 2016). Combining these theoretical frameworks provides an understanding of the complex dynamics of infectious disease control in Sokoto state, Nigeria.

In the context of public expenditures, STA helps identify the complex dynamics of resource allocation and utilization in disease control programs. For instance, when funding: Infrastructure Development such as, construction or renovation of healthcare facilities and laboratories (capital expenditure) can be seen as addressing environmental and social factors that contribute to disease transmission; Program Operations, the activities directed at program management, coordination, and implementation (recurrent expenditure) are understood to be addressing the complex interactions between different components of the healthcare system; and Surveillance and Monitoring, the expenses related to disease surveillance and outbreak investigation (recurrent expenditure) can be seen as critical for understanding the dynamics of disease transmission and identifying areas for improvement.

The HBM framework explains and predicts health behavior based on an individual's beliefs, attitudes, and perceptions regarding a health problem and the benefits and barriers of taking action (Jones et al., 2015). In the context of public expenditures, HBM can help understand how different expenditures influence individual behavior and participation in disease control programs. For example: in public awareness and education, funding for public health campaigns and community outreach (recurrent expenditure) can be seen as addressing individual beliefs and attitudes towards disease prevention and control; for vaccination programs, procurement and distribution of vaccines (recurrent expenditure) are seen as activities that reduce the perceived barriers to vaccination, thereby increasing participation in vaccination programs; in the case of treatment programs, expenditures focused on providing treatment and care for individuals infected with diseases (recurrent expenditure) are targeted at addressing individual perceptions of the benefits and barriers to seeking treatment.

Similarly, CEA embeds choices about which interventions to fund, where, for whom, and with what uncertainty and equity implications. Core elements of the CEA framework, include the: interventions compared, outcome metric, and cost-effective ratio. The interventions compared are the: case management, prophylaxis, vector control, vaccination, digital adherence tools, and One Health approaches across HIV, TB, malaria, COVID-19 and food-borne zoonoses (O'Donovan et al., 2025; and Tomeny, 2024; and Gunda & Chimbari, 2017). For outcome metric, DALY (also the years of life lost plus years lived with disability) is the dominant measure in global infectious disease CEA, particularly in LMICs (O'Donovan et al., 2025; Gunda & Chimbari, 2017; Neumann et al., 2016; and Oostvogels et al., 2014). Also, the cost-effectiveness ratio, which is the incremental cost-effectiveness ratio (ICER) is equal to extra cost divided by extra DALY averted. This is often judged against context-specific thresholds (O'Donovan et al., 2025; Chriselda et al., 2024; and Oostvogels et al., 2014). Table 1 below explains the key operational dimensions in infectious disease CEAs.

Table 1: Examples of Outcomes and Decisions

Dimension	Examples from studies	Sources
Diseases	Malaria, TB, HIV, COVID-19, NTS, LF	O'Donovan et al., 2025; and Tomeny, 2024; and Gunda and Chimbari, 2017
Decisions	Which intervention; which mix; which population/region	Tomeny, 2024; and Dasgupta, et al., 2021
Outcomes beyond DALY	Deaths averted, OOP costs, catastrophic expenditure, equity	Sanni et al., 2024; and Dasgupta, et al., 2021

Source: *Authors' Compilation (2026) based on Literature Reviewed for the study.*

There are central issues regarding equity, uncertainty, and resource allocation. For equity and financial protection, extended CEA incorporate deaths averted plus out-of-pocket and catastrophic expenditure by income groups. In Nigeria, this showing pro-poor gains from targeted malaria subsidies and distributional impacts of TB digital adherence technologies (Foster et al., 2024; and Dasgupta, et al., 2021). Regarding uncertainty, advanced methods like probabilistic modelling and new frameworks (such as Wasserstein-based) are used to propagate and then eliminate uncertainty in ICERs (Chriselda et al., 2024). Notwithstanding, allocation efficiency and geospatial optimization models being adopted to allocate budgets across interventions and regions in order to maximize cases or deaths averted such as in Nigeria's malaria program (Maity et al., 2023) and COVID-19 vaccination choices (Ruiz et al., 2023).

There are also methodological and threshold considerations, such as: standardization and comparability, DALY construction, and Thresholds. While standardization and comparability involve large reviews showing wide heterogeneity in methods and reporting, motivating use of CHEERS and WHO-CHOICE guidance to improve comparability (O'Donovan et al., 2025; Chriselda et al., 2024; Neumann et al., 2016; and Oostvogels et al., 2014;), DALY construction disability weights for TB vary and are often poorly reported, affecting DALY estimates and decisions (Tomeny, 2024). However, thresholds (such as the GDP-based thresholds and the fixed dollar cut-offs per DALY) are still being used for many infectious disease CEAs. Though country-specific, the Opportunity Cost Thresholds (such as the South African 53% of GDP per capita per DALY) is now being increasingly proposed (Gunda & Chimbari, 2017; and Oostvogels et al., 2014).

Empirical Framework

Evidence demonstrates this challenge across multiple dimensions. Cohen (2000) established that infectious diseases are associated with over 13 million deaths annually despite prevention efforts. Regarding funding mechanisms, Tan et al. (2003) identified the Global Fund as an important step forward but noted "the pitiful lack of funds committed by world governments" as the most significant barrier. On allocation patterns, Stuckler et al. (2008) found that in 2006–07, WHO allocated 87% of its budget to infectious diseases, yet this distribution was heavily skewed by donor-driven extra-budgetary funds rather than member-state decisions. In addition, Rannan-Eliya (2021) documented that plateauing international funding for malaria has constrained progress toward elimination, while Astuti et al. (2025) confirmed that while global partnerships facilitated financial assistance, challenges persist in coordination and policy alignment. These findings across 25 years of research consistently highlight insufficient funding and governance misalignment as core obstacles. Thus, infectious diseases remain a persistent public health concern, with emerging diseases like COVID-19, Ebola, and Zika, and re-emerging diseases like measles, tuberculosis, and malaria.

Public funding is critical for disease control programs, provided through government budgets, taxes, and grants from international organizations like the World Health Organization (WHO) and the Global Fund to Fight AIDS, Tuberculosis, and Malaria. To effectively address public funding issues in infectious disease control, it is essential to consider the following key contexts. Strengthening health systems is crucial, including investing in infrastructure development, such as laboratories and emergency operations centers, to enhance disease detection and response capabilities (Zhang et al., 2023; Kan, 2022). In addition, workforce development is vital, including training healthcare workers, epidemiologists, and laboratory personnel to improve disease surveillance, detection, and response (Saif-Ur-Rahman et al., 2025; Lee et al., 2023; Yeh et al., 2021). In addition, international cooperation and funding are also critical, including collaborating with global health initiatives and leveraging grant opportunities from organizations like the WHO and the Centers for Disease Control and Prevention (Zhang et al., 2023).

Disease-specific interventions, such as vaccine development and distribution, and targeted interventions, like insecticide-treated bed nets and indoor residual spraying, are also essential (Babatuyi et al., 2024). Furthermore, surveillance intensification or preparedness for emergency and response plans are vital for quickly detecting and responding to outbreaks (Saif-Ur-Rahman et al., 2025; Lee et al., 2023). Research and development are also crucial, including investing in research to develop new diagnostic tools, treatments, and vaccines for infectious diseases, and leveraging innovative technologies, such as digital and genomic health tools, to enhance disease surveillance, detection, and response (Ugwu et al., 2025; Lee et al., 2023; Kan, 2022; Yeh et al., 2021). Other key sources that support these contexts include the World Health Organization (WHO), the Global Fund to Fight AIDS, Tuberculosis, and Malaria, and the Centers for Disease Control and Prevention (CDC).

Studies have shown that public funding is positively associated with better health outcomes, such as reduced incidence and prevalence of infectious diseases (The Global Fund, 2025; Rodrigues, 2020; & Korenromp et al., 2013). Table 2 below brings the theoretical and empirical framework into agreement, revealing that: though capital expenditure builds infrastructure, equipment, and systems, just as recurrent expenditure sustains personnel and logistical supplies; real-world budgets often understate capital needs and struggle to apportion shared costs in a situation of over reliance on recurrent personnel expenditure while under-investing in long-term infrastructure and information systems. A situation very much likely due to the counterpart funding conditions usually dictated by donor partners who provide much of the funding for infectious disease control programs.

Consequently, the two most significant spending challenges when comparing spending levels are that: first, capital costs are a small portion of total expenditure on infectious disease control (Lane et al., 2025; Huang et al., 2021; Erondu et al., 2019; Hossain et al, 2018) with many countries failing to meet up on explicit budgets on key surveillance categories, especially laboratory infrastructure, and overheads – suggesting hidden or unfunded capital needs (Erondu et al., 2019; Hossain et al, 2018). Second, shared resources (such as buildings, vehicles, and staff time across multiple programs) make it difficult to specifically attribute expenditures to particular disease control programs (Lane et al., 2025; Gobin et al., 2024; Erondu et al., 2019; Hossain et al, 2018).

Table 2: Typical Cost Categories and Components for Disease Control Programs

Cost Area	Examples in Studies	Sources
Personnel	Salaries, trained surveillance staff (largest cost share are between 50 to 60%) with 58% in Costa Rica and 51% in Nepal	Lane et al., 2025; Huang et al., 2021; Erondu et al., 2019; Hossain et al, 2018
Laboratory and Diagnostics	Lab supplies, tests reagents, equipment (cost share is less than 28%)	Lane et al., 2025; Huang et al., 2021; Erondu et al., 2019; Hossain et al, 2018
Transport and Logistics	Vehicles, fuel, maintenance, mission expenses, specimen transport	Lane et al., 2025; Huang et al., 2021; Erondu et al., 2019
Program Management and Coordination	Planning, meetings, supervision, coordination units (major share in Ebola response)	Huang et al., 2021; Hossain et al, 2018
Information and	Data collection systems, reporting,	Lane et al., 2025; Gobin et al.,

Surveillance systems	surveillance functions	2024; Erondu et al., 2019; Hossain et al, 2018
Vaccines and Medicines	Procurement and delivery for influenza, HPV, STI control, etc.	Chukwudi, 2025; Carrico et al., 2021; Jakovljevic et al., 2019

Source: *Authors' Compilation (2026) based on Literature Reviewed for the study.*

Table 2 above identifies the principal expenditure channels through which public health funding translates into infectious disease control outcomes. Increased government allocation to health enhances the availability of personnel, laboratories, surveillance systems, logistics, program coordination, and medicines. These investments improve access to and coverage of essential infectious disease services, which are captured by the WHO UHC Service Coverage Sub-index on Infectious Diseases. Therefore, the relationship between the independent variables (IVs) and the dependent variable (DV) UHCID is active, and the six expenditure categories reflect an intermediate theoretical mechanism (transmission channels linking the IVs and DV) through which public funding influences infectious disease outcomes. Therefore, the study models specified for this study are a good fit for this framework, and the causal pathway is:

Various Health Expenditures – The IVs (PFIDC, DFIDC1, DFIDC2), and the CV (EFIDC)

↓

Funding of disease-control cost categories (see 6 categories on table 2)

↓

Improved service readiness and system capacity

↓

Expanded coverage of infectious disease interventions

↓

Higher UHC Service Coverage Sub-index on Infectious Diseases

DATA PRESENTATION AND ANALYSES

Data Presentation

Table 3 presents the annual data used for the study covering the period 2013–2022. The dataset consists of five (5) variables. The one is the UHC Service Coverage Sub-index on Infectious Diseases (UHCID), which serves as the dependent variable and measures the extent of coverage of essential infectious disease services. Three serve as the independent variables chosen to proxy the level of public funding commitment for infectious disease control in Nigeria (PFIDC, DFIDC1, and DFIDC2). While one is the control variable representing the 'external sources of funding on infectious diseases in Nigeria' - EFIDC. Though the UHCID data is available from 2000 to 2023, all other data are only available from 2013 to 2022. Thus, the choice of the 10-year time series to provide a basis for examining whether changes in public health expenditure are associated with improvements in infectious disease service coverage in Nigeria.

Table 3: Study Data on Public Funding and Infectious Diseases Components

Years	UHCID (DV)[1]	PFIDC (IV)[2]	DFIDC1 (IV)[2]	DFIDC2 (IV)[2]	EFIDC (CV)[2]
2013	24	66	54	214,071	72
2014	30	66	52	210,963	74
2015	35	68	60	334,976	85
2016	37	68	61	298,342	82
2017	38	71	78	478,788	87
2018	41	61	56	359,828	42
2019	45	63	51	351,993	81
2020	45	64	55	425,930	86
2021	41	59	36	342,765	83
2022	39	56	40	495,655	79

Source: *Authors' Tabulation (2026) based on Data gathered from World Health Organization (WHO) databases: the Global Health Observatory[1], and the Global Health Expenditure[2].*

Data Analyses

The quantitative data is analyzed and guided by the main objective of the study of examining the effect of public funding on infectious disease service coverage in Nigeria. The analysis begins with descriptive statistics to summarize the characteristics and trends of the study variables, followed by inferential analysis using regression techniques to evaluate the nature and magnitude of the relationship between government health expenditure and infectious disease service coverage. The results are interpreted in line with the study's theoretical expectations that increased public investment in health strengthens healthcare infrastructure, workforce capacity, disease surveillance, and access to essential infectious disease interventions, thereby improving coverage outcomes. The findings provide empirical evidence on the extent to which public funding contributes to infectious disease control and offer insights for policy decisions aimed at strengthening health system performance and funding sustainability in Nigeria.

Descriptive Statistics

The descriptive statistics on table 4 summarize the key characteristics of the data before proceeding to inferential analysis and the main features of the dataset are explained below it.

Table 4: Descriptive Statistics on Public Funding and Infectious Diseases Components

Variable	Role	Obs.	Mean	Median	Std. Dev.	Min.	Max.	Range
UHCID	DV	10	37.5	38.5	6.54	24	45	21
PFIDC	IV	10	64.2	65	4.57	56	71	15
DFIDC1	IV	10	54.3	54.5	11.54	36	78	42
DFIDC2	IV	10	351,331.10	347,379.00	96,841.53	210,963	495,655	284,692
EFIDC	CV	10	77.1	81.5	13.27	42	87	45

Source: *Authors' Computation (2026) using STATA Version 19 based on Data gathered from World Health Organization (WHO) databases: the Global Health Observatory, and the Global Health Expenditure.*

The descriptive statistics reveal several important insights into the relationship between public funding and infectious disease control in Nigeria during the study period 2013 to 2022. The UHC Infectious Disease Service Coverage Index (UHCID) recorded a mean value of 37.50, with observations ranging from 24 to 45 (range = 21), indicating that infectious disease service coverage generally improved over the period but exhibited moderate variation across years. The relatively modest standard deviation (6.54) suggests that coverage performance became more stable over time. Regarding public funding, Public Funding for Infectious Disease Control (PFIDC) recorded an average value of 64.20, fluctuating between 56 and 71 (range = 15). This narrow dataset range indicates that aggregate funding for infectious disease control remained relatively stable during the study period. However, the persistence of only moderate variation implies that improvements in funding were incremental rather than transformational. The two domestic funding indicators exhibit contrasting patterns. DFIDC1 recorded a mean of 54.30 with a relatively large range of 42 (36–78), reflecting considerable year-to-year fluctuations in domestic government funding.

Such variability suggests that although government commitment to infectious disease control existed, the level of domestic support was not consistently maintained, potentially affecting the continuity and sustainability of disease control interventions. Similarly, DFIDC2, measured in naira terms, exhibited the greatest dispersion among all variables, with an average value of 351,331.10 and a range of 284,692 (210,963–495,655). This substantial variation reflects sizeable changes in the absolute amount of domestic resources devoted to infectious disease control over time. This is because, while increases in nominal expenditure imply stronger fiscal commitment, they could also reflect inflationary effects, changing budget priorities, or varying economic conditions rather than proportional improvements in service delivery. The External Funding for Infectious Disease Control (EFIDC) variable recorded an average of 77.10, ranging from 42 to 87 (range = 45), indicating notable fluctuations in donor and external partner support. The comparatively high variability suggests that external funding remained an important but unstable source of funding for infectious disease programs. This underscores the potential vulnerability of disease control initiatives to changes in international funding priorities.

Emerging from the foregoing discussion, there are three main Public Funding issues emerging from the descriptive statistics. They are that: there is great dependence on multiple funding sources; the improvements in service coverage are not solely related to funding levels; and that resource allocation and funding efficiency remain critical challenges. Hence, whereas PFIDC remained relatively stable, the substantial fluctuations observed in both domestic (DFIDC1 and DFIDC2) and external funding (EFIDC) suggest that infectious disease control funding relies on multiple funding streams rather than a consistently expanding domestic government commitment. This reinforces concerns about the long-term sustainability of programs if external support declines. In addition, the average UHCID of 37.50 reflects continued improvements in infectious disease service coverage despite considerable fluctuations in domestic and external funding.

This suggests that gains in service coverage are also attributable to improved program efficiency, strengthened health systems, technological innovations, donor-supported interventions, policy reforms, or better resource management, rather than funding increases alone. Also, the large disparities observed in DFIDC2 and EFIDC, coupled with the relatively stable progression in UHCID, imply that the effectiveness of infectious disease control depends not only on the amount of money spent but also on how efficiently resources are allocated and utilized. Funds targeted toward surveillance systems, laboratory infrastructure, healthcare workforce development, vaccination programs, and program coordination are likely to generate greater improvements in service coverage than indiscriminate increases in expenditure.

Taken together, the descriptive statistics indicate that while infectious disease service coverage in Nigeria improved during the 2013–2022 period, the funding landscape remains characterized by variability in domestic allocations and external support. The descriptive statistics suggest that achieving sustainable improvements in infectious disease control requires not only adequate funding but also predictable domestic funding, efficient resource allocation, strong governance, and strategic coordination between government and development partners. These descriptive patterns provide the empirical basis for the subsequent regression analysis examining the extent to which public funding influences infectious disease service coverage outcomes.

Regression Analyses

Tables 5 to 7 present the results of the Ordinary Least Squares (OLS) regression estimates that examined the effect of the three public funding indicators (PFIDC, DFIDC1, and DFIDC2), controlling for EFIDC, on the UHC Service Coverage Sub-index on Infectious Diseases (UHCID). The results show that a one-unit increase in PFIDC and DFIDC1 is associated with decreases of approximately 0.614 and 0.075 units, respectively, in UHCID, whereas a one-unit increase in DFIDC2 is associated with an increase of approximately 0.000046 units in UHCID. Nevertheless, the lack of statistical significance for PFIDC and DFIDC1, coupled with their low adjusted R^2 values, indicates that percentage-based public funding measures do not adequately explain variations in infectious disease service coverage over the study period. Conversely, the positive coefficient on DFIDC2 provides evidence that higher actual domestic expenditure on infectious disease control is associated with improved infectious disease service coverage, highlighting the importance of the scale of financial investment rather than its proportional share within broader health expenditure.

Table 5: OLS Regression Model (i)

Variable	Coefficient	t-stat	p-value
Constant	68.666	2.157	0.068
PFIDC	-0.614	-1.2	0.271
EFIDC	0.107	0.608	0.562
Model statistics: $R^2 = 0.177$ Adjusted $R^2 = -0.059$ F-statistic = 0.751 Prob(F) = 0.507			

Source: *Authors' Computation (2026) using STATA Version 19 based on data obtained from the World Health Organization (WHO) Global Health Observatory Database (2000–2023).*

The results in table 5 above reveal that in the first model (i), PFIDC has a negative but statistically insignificant association with UHCID ($p = 0.271$), while EFIDC is also insignificant. However, the results in table 6 below reveal that in the second model (ii), neither DFIDC1 nor EFIDC significantly explains UHCID, and the model has very weak explanatory power (Adjusted $R^2 = -0.253$).

Table 6: OLS Regression Model (ii)

Variable	**Coefficient**	**t-stat**	**p-value**
Constant	37.646	2.132	0.070
DFIDC1	-0.075	-0.352	0.735
EFIDC	0.051	0.275	0.791
Model statistics: • $R^2 = 0.026$ • Adjusted $R^2 = -0.253$ • F-statistic = 0.092 • Prob(F) = 0.913			

Source: *Authors' Computation (2026) using STATA Version 19 based on data obtained from the World Health Organization (WHO) Global Health Observatory Database (2000–2023).*

Table 7: OLS Regression Model (iii)

Variable	**Coefficient**	**t-stat**	**p-value**
Constant	23.640	2.037	0.081
DFIDC2	0.000046	2.384	0.049
EFIDC	-0.031	-0.217	0.835
Model statistics: • $R^2 = 0.453$ • Adjusted $R^2 = 0.296$ • F-statistic = 2.896 • Prob(F) = 0.121			

Source: *Authors' Computation (2026) using STATA Version 19 based on data obtained from the World Health Organization (WHO) Global Health Observatory Database (2000–2023).*

The results in table 7 above reveal that in the third model (iii), DFIDC2 is positively associated with UHCID and statistically significant at the 5% level ($p = 0.049$). This model provides to be the highest explanatory power ($R^2 = 0.453$; Adjusted $R^2 = 0.296$), although the overall F-test is not significant at the 5% level due to the small purposive sample size in view of the data available for analyses. Thus, the third model (iii) offers the strongest empirical support for the proposition. Suggesting that actual domestic expenditure on infectious disease control (measured in monetary terms) is more closely associated with infectious disease service coverage than percentage-based funding indicators. When comparing models with different numbers of predictors, the Adjusted R^2 for the third model (iii) is generally preferred because it penalizes unnecessary variables and provides a more reliable measure of explanatory power.

Test of Hypotheses

The null hypothesis (H_0) that public funding has no significant impact on the effectiveness of infectious disease control programs in Nigeria, was rejected based on the third model (iii) of the regression analyses, whereby the coefficient of DFIDC2 (Domestic Funding for Infectious Disease Control) is 0.000046 with a t-statistic of 2.384 and a p-value of 0.049. Thus, public funding, as measured by DFIDC2, has a statistically significant positive impact on the effectiveness of infectious disease control programs in Nigeria. The positive coefficient indicates that increases in domestic funding for infectious disease control are associated with improvements in the UHC Service Coverage Sub-index on Infectious Diseases (UHCID), holding external funding constant. However, PFIDC and DFIDC1 from models i and ii were statistically insignificant during the same period as DFIDC2. Thus, the significance of public funding depends on how funding is measured. Actual domestic monetary expenditure (DFIDC2) exhibits a statistically significant positive association with infectious disease service coverage, whereas proportional expenditure measures (PFIDC and DFIDC1) do not. In addition, the overall model F-test is not statistically significant being that Prob(F) = 0.121 and > 0.05, suggesting that the explanatory variables are not jointly significant at the 5% level despite the individual significance of DFIDC2. Thus, the model explains approximately 45.3% of the variation in UHCID ($R^2 = 0.453$), with an Adjusted R^2 of 0.296, indicating moderate explanatory power.

Discussion of Findings

The Impact of Public Funding on the Effectiveness of Infectious Disease Control Programs

The regression results provide mixed evidence depending on how public funding is measured. Specifically, the model employing DFIDC2 (domestic funding for infectious disease control measured in monetary terms) produced a positive and statistically significant coefficient ($\beta = 0.000046$; $t = 2.384$; $p = 0.049$), indicating that increases in actual domestic financial allocations to infectious disease control are associated with improvements in the UHC Service Coverage Sub-index on Infectious Diseases (UHCID). This finding led to the rejection of the null hypothesis and suggests that targeted domestic investment contributes positively to infectious disease service coverage. In contrast, alternative funding indicators expressed as expenditure shares (PFIDC and DFIDC1) did not exhibit statistically significant relationships with UHCID in the models i and ii, implying that proportional budget allocations alone did not adequately capture the effectiveness of government funding commitment. This distinction is important because percentage-based measures can remain stable even when actual monetary resources available for disease control change substantially. The findings are broadly consistent with the theoretical expectation that public funding strengthens disease surveillance, laboratory systems, vaccination programs, medicine procurement, and workforce capacity, thereby improving access to essential infectious disease services. They also align with broader evidence that well-funded public health interventions can substantially improve infectious disease outcomes and outbreak preparedness. The finding therefore suggests that public expenditure alone is insufficient to explain improvements in infectious disease service coverage. Figure 1 provides a detailed and vivid representation of the factors more likely to contribute to the success of disease control programs.

Figure 1: Improving the Effectiveness of Infectious Disease Control through Enhanced Public Funding and Stakeholder Coordination

Source: *Authors' Conceptualization from Study Findings (2026).*

Nevertheless, the regression diagnostics indicate that although the explanatory power of the model is moderate ($R^2 = 0.453$), the overall F-statistic is not statistically significant (*Prob(F) = 0.121), suggesting that factors beyond domestic public funding also influence infectious disease service coverage. These likely include governance quality, donor funding, implementation efficiency, institutional capacity, and coordination among stakeholders. From a policy perspective, the results imply that increasing financial allocations alone is insufficient. The effectiveness of public funding depends on how resources are deployed across critical interventions such as immunization, surveillance, diagnostics, and emergency preparedness. This interpretation is supported by evidence from Nigeria and other settings showing that successful infectious disease control requires both adequate funding and effective public health policies and governance mechanisms. Hence, the study demonstrates that actual domestic expenditure directed toward infectious disease control is more informative than expenditure ratios when evaluating program effectiveness. The results support the argument that Nigeria should not only increase funding but also strengthen expenditure efficiency and leverage partnerships with donors, private organizations, and development agencies to reduce fiscal pressure on government while sustaining effective infectious disease control programs. Long-term and sustainable funding arrangements are increasingly recognized as essential for achieving durable public health gains.

Analysis of Infectious Disease Burden in Relation to Public Funding Availability

The analysis revealed that variations in public funding did not correspond proportionately with variations in infectious disease service coverage. Although infectious disease service coverage continued to improve progressively, the results suggest that the improvements are not solely attributable to domestic public funding. Rather, they reflect the combined effects of donor support, vaccination initiatives, surveillance programs, health-system strengthening interventions, and international disease-control partnerships. This finding indicates that infectious disease incidence and prevalence are influenced by broader system-level investments and program effectiveness rather than expenditure levels alone (see figure 2).

Thus, the findings support the Systems Thinking Approach (STA), which argues that infectious disease outcomes emerge from interactions among multiple system components rather than from a single input. Although domestic government expenditure remained relatively low and statistically insignificant, infectious disease service coverage improved over time. This suggests that health outcomes have been supported by complementary factors including donor funding, international partnerships, improved surveillance systems, vaccination campaigns, laboratory strengthening, and other workforce development initiatives. The result aligns with the empirical literature showing that effective disease control requires integrated investments across multiple sectors and institutions.

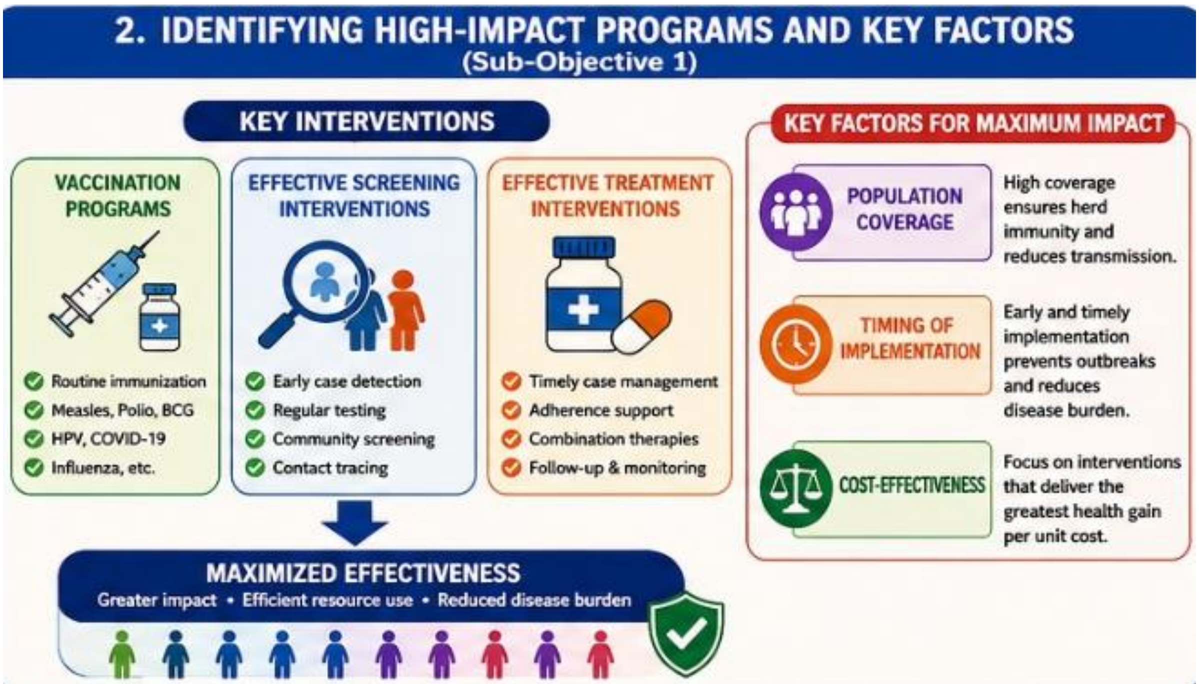

Figure 2: Identifying High-Impact Infectious Disease Interventions and Critical Success Factors

Source: *Authors' Conceptualization from Study Findings (2026).*

Strategies for Optimizing Resource Utilization in Infectious Disease Control Programs

The identified optimization strategies strongly support the Cost-Effectiveness Analysis framework. The literature emphasizes that limited resources should be directed toward interventions capable of producing the greatest health gains per unit of expenditure. The findings suggest that improvements in infectious disease outcomes are more likely to result from efficient resource allocation than from expenditure increases alone. Investments in surveillance systems, laboratory capacity, vaccination programs, workforce development, and information systems represent high-value interventions that strengthen overall health-system performance. The findings further support recent studies advocating allocation efficiency, geospatial targeting, uncertainty analysis, and evidence-based budgeting as mechanisms for maximizing public health benefits.

Figure 3: Data-Driven Resource Allocation and Cost-Effectiveness Framework for Infectious Disease Control

Source: *Authors' Conceptualization from Study Findings (2026).*

Figure 3 above provides evidence from the stakeholder focus group discussions obtained via an academic symposium. The Stakeholders emphasized that efficient allocation and utilization of resources are as important as increasing expenditure levels. The discussions identified several strategies for improving the effectiveness of available resources:

1. Improved appropriation of allocated funds, accountability, and financial transparency.
2. Increased investment in laboratory and diagnostic infrastructure.
3. Strengthening disease surveillance and health information systems.
4. Capacity development for healthcare workers and epidemiological personnel.
5. Greater emphasis on preventive interventions, including vaccination and public awareness campaigns.
6. Enhanced integration of donor-funded and government-funded programs.
7. Adoption of digital technologies for surveillance, monitoring, and reporting.
8. Prioritization of expenditure toward interventions demonstrating high cost-effectiveness.

Framework for Collaboration among Stakeholders

The study found that sustainable infectious disease control requires stronger collaboration among public health institutions, finance authorities, policymakers, healthcare providers, donor organizations, researchers, and communities. This finding is consistent with the Systems Thinking Approach, which recognizes that health outcomes emerge from interactions among multiple actors operating within complex systems. Effective infectious disease control therefore requires coordinated planning, funding, implementation, monitoring, and evaluation. The proposed collaborative framework addresses several weaknesses identified in both the empirical literature and stakeholder consultations, including fragmented governance, weak coordination, donor dependency, and inefficient resource allocation. Accordingly, the study proposes a collaborative funding and governance framework (see figure 4) in which public funding serves as the foundation, while donor resources, technical expertise, surveillance systems, healthcare providers, policymakers, and community stakeholders collectively contribute to improved service readiness, expanded infectious disease coverage, and ultimately reduced disease burden in Nigeria and particularly Sokoto State.

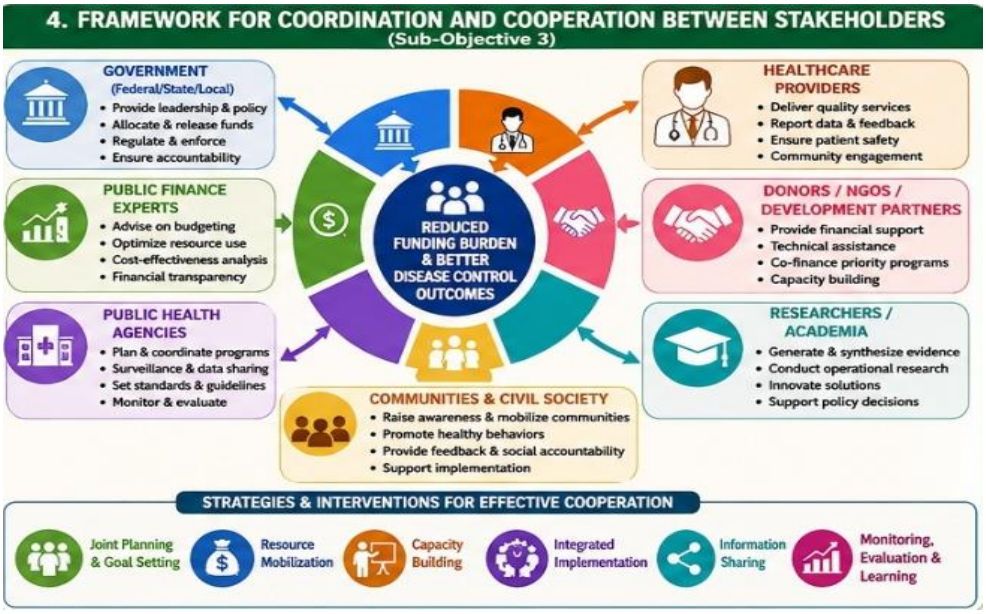

Figure 4: Collaborative Governance Framework for Sustainable Infectious Disease Funding and Control in Nigeria

Source: *Authors' Conceptualization and Proposed Collaborative Framework based on Study Findings (2026).*

Findings from the documentary review and stakeholder discussions demonstrated strong support for a collaborative framework involving public health agencies, public finance experts, policymakers, healthcare providers, donor organizations, researchers, and community stakeholders. Participants identified fragmented budgeting systems, weak inter-agency coordination, duplication of activities, and excessive dependence on donor funding as major constraints to sustainable infectious disease control funding. The findings, therefore, support the establishment of a coordinated governance framework capable of improving resource mobilization, allocation efficiency, accountability, and program sustainability.

Conclusion

Public Funding plays an important but not exclusive role in improving the effectiveness of infectious disease control programs in Nigeria. While actual domestic expenditure on infectious disease control (DFIDC2) exhibited a statistically significant positive relationship with the UHC Service Coverage Sub-index on Infectious Diseases (UHCID), other expenditure-based indicators did not, suggesting that the magnitude and targeted application of funding matter more than budgetary proportions alone. The findings further reveal that improvements in infectious disease outcomes are influenced by a combination of domestic funding, donor support, governance quality, health system capacity, surveillance infrastructure, vaccination programs, and stakeholder coordination. The results of the study analysis demonstrate that increasing expenditure without ensuring efficient allocation, transparency, and accountability is unlikely to produce optimal health outcomes.

Cost-effective investments in laboratories, surveillance systems, workforce development, preventive interventions, and digital health technologies are essential for maximizing the impact of available resources. Furthermore, the study highlights the importance of integrated planning and collaboration among government agencies, healthcare providers, development partners, researchers, and communities to reduce fragmentation and enhance program sustainability. Thus, sustainable infectious disease control in Nigeria requires a balanced funding strategy that combines increased domestic investment with efficient resource management and multi-stakeholder collaboration. Such an approach can reduce excessive pressure on government finances while strengthening service delivery, expanding coverage, and improving long-term public health outcomes, particularly in Sokoto State and comparable settings.

Recommendations

1. The federal and Sokoto state governments of Nigeria should adopt a strategic, performance-based financing framework that prioritizes actual monetary investments in infectious disease control over percentage budget allocations alone. Public funds should be directed toward high-impact areas such as disease surveillance, laboratory infrastructure, vaccination programs, workforce development, and emergency preparedness, while strengthening accountability and coordination with development partners and the private sector to maximize health outcomes and reduce fiscal pressure on government.

2. The federal and Sokoto state governments of Nigeria, public health agencies, and donor organizations should prioritize high-impact interventions – particularly mass vaccination, early disease screening, and prompt treatment programs – and ensure that these interventions achieve broad population coverage, timely implementation, and demonstrable cost-effectiveness. Resource allocation should be guided by epidemiological evidence so that investments target interventions with the greatest potential to reduce infectious disease burden.

3. Policymakers and budget authorities of the federal and Sokoto state governments should institutionalize evidence-based and cost-effectiveness-driven budgeting by routinely using disease burden data, program performance indicators, and economic evaluations to guide resource allocation. Investments should prioritize preventive services, surveillance systems, laboratory capacity, digital health technologies, and workforce development while embedding transparent monitoring and periodic expenditure reviews to ensure equitable and efficient utilization of scarce public resources.

4. The federal and Sokoto state governments should establish a formal multi-stakeholder governance platform that integrates ministries of health and finance, public health agencies, healthcare providers, development partners, researchers, civil society organizations, and local communities into a unified planning and accountability framework. This collaborative mechanism should coordinate financing, implementation, monitoring, and information sharing, reduce duplication of efforts, mobilize additional resources, and strengthen the long-term sustainability of infectious disease control programs in Nigeria.

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