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ARTICLE

Macroeconomic Determinants of Public Health Expenditure in India: Evidence from an ARDL Approach

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ABSTRACT

Public health expenditure in India remains persistently low relative to expanding healthcare needs driven by demographic growth, epidemiological transition, and macroeconomic volatility. Identifying the structural determinants of public health spending is therefore essential for designing fiscally sustainable and equitable health financing strategies. This study examines the long-run and short-run drivers of public health expenditure in India using annual national-level time-series data for the period 2000–2024. An Autoregressive Distributed Lag (ARDL) modelling framework with an error correction mechanism (ECM) is employed, given its suitability for small-sample analysis and its capacity to accommodate variables integrated of mixed orders. Augmented Dickey–Fuller tests confirm stationarity at first difference, supporting the application of the ARDL bounds testing approach to assess cointegration and dynamic adjustments. The empirical findings reveal a stable long-run equilibrium relationship between public health expenditure and its macroeconomic, fiscal, demographic, and labour market determinants. Per capita income and tax revenue exhibit positive and statistically significant long-run effects, indicating that economic expansion and improved revenue mobilisation enhance fiscal space for health investment. Infant mortality and unemployment significantly influence expenditure, underscoring the roles of health vulnerability and labour market stress. Inflation exerts a positive cost-push effect, reflecting rising input costs. The error correction term is negative and highly significant, confirming rapid convergence toward equilibrium. Short-run dynamics indicate lagged fiscal responses but immediate expenditure adjustments to adverse health conditions. The results suggest that while public health spending in India is income-responsive, institutional and structural constraints limit its

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adequacy, necessitating reforms that link growth to protected and efficient health financing.
Keywords: Public Health Expenditure; Economic Growth; ARDL Model; Fiscal Capacity; India

1. Introduction

Public health expenditure has become a central concern in contemporary economic policy, reflecting a broader reorientation of health from a purely social sector commitment to a core component of productive public investment. A growing body of evidence links public spending on health to improvements in human capital formation, labour productivity, poverty reduction, and long-run economic growth. Consequently, the level and composition of public health expenditure are increasingly viewed as critical indicators of a country's development strategy, institutional capacity, and commitment to inclusive growth.

Despite this recognition, public health expenditure exhibits substantial variation across countries and over time, even among economies with comparable income levels. These disparities have been magnified by demographic ageing, epidemiological transitions toward non-communicable diseases, rapid technological change in health care delivery, and recurrent global shocks such as the COVID-19 pandemic. Together, these forces have intensified fiscal pressures on governments and sharpened the policy trade-offs involved in allocating scarce public resources. Understanding the economic determinants of public health expenditure is therefore not only analytically relevant but also central to the design of fiscally sustainable and equitable health systems.

1.1. Global Patterns and Determinants of Public Health Expenditure

Globally, health expenditure has grown steadily over the past three decades, driven by rising incomes, population ageing, advances in medical technology, and the increasing prevalence of chronic diseases. According to estimates by the World Health Organization and the World Bank [1–3], current health expenditure exceeds 9–10% of GDP in many high-income countries, while remaining considerably lower in low- and middle-income countries (LMICs).

A defining feature of this global pattern is the divergence in financing structures. High-income economies predominantly rely on public financing through general taxation and social health insurance, which provides substantial financial protection to households. In contrast, LMICs continue to depend heavily on private and out-of-pocket payments, resulting in higher exposure to catastrophic health expenditure and medical impoverishment.

Economic theory and empirical studies suggest that public health expenditure is shaped by macroeconomic capacity (income levels and growth), fiscal space, demographic structure, and institutional arrangements governing public finance and health systems. Recent global health crises have further underscored the importance of resilient public health infrastructure, prompting renewed interest in the determinants and sustainability of public health spending, particularly in fiscally constrained settings.

1.2. Asian Context: Growth without Commensurate Public Health Spending

Asia presents a particularly heterogeneous health financing landscape, reflecting wide disparities in income levels, demographic transitions, and state capacity. Economies such as Japan and the Republic of Korea allocate relatively high shares of GDP to health and maintain robust public financing systems with near-universal coverage. In contrast, many South and Southeast Asian countries continue to record low levels of public health expenditure alongside a high reliance on out-of-pocket payments.

Importantly, rapid economic growth across much of Asia has not been uniformly accompanied by proportional increases in public health spending. Evidence from the Asian Development Bank [4,5] indicates that while growth expands potential fiscal space, realised health expenditure depends critically on political prioritisation, revenue mobilisation capacity, and institutional efficiency. Fragmented risk pooling, limited tax bases, and inefficiencies in public expenditure management frequently constrain the translation of economic growth into improved public health financing. These regional dynamics highlight the need for country-specific analyses that explicitly examine the economic drivers of public health expenditure rather than assuming a mechanical relationship between growth and health spending.

1.3. India's Health Expenditure Profile

India exemplifies many of the structural challenges observed across developing Asia, albeit on a larger and more complex scale. Historically, India has maintained low levels of public health expenditure relative to GDP, accompanied by a high dependence on out-of-pocket expenditure. This financing structure has contributed significantly to catastrophic health spending and medical impoverishment, raising concerns about equity and financial protection.

Recent National Health Accounts estimates [6,7] indicate a gradual shift in India's health financing landscape. Government health expenditure has increased both in absolute terms and as a share of total health expenditure, while the proportion of out-of-pocket spending has declined, partly reflecting the expansion of publicly financed health insurance schemes and increased budgetary allocations. Nevertheless, India's public health expenditure remains well below levels considered necessary for achieving universal health coverage, and substantial inter-state disparities persist due to differences in fiscal capacity, governance quality, and policy priorities.

1.4. Problem Statement and Research Gap

From an economic standpoint, public health expenditure in India is influenced by a complex interplay of macroeconomic performance, demographic pressures, fiscal capacity, and institutional arrangements [8–10]. Economic growth and revenue mobilisation determine the overall fiscal envelope for social sector spending, while population dynamics and epidemiological transitions raise demand for health services and increase the cost of public provision. Concurrently, policy initiatives aimed at expanding insurance coverage and strengthening primary health care alter expenditure trajectories and fiscal commitments.

Despite a growing literature on health financing in India, three critical gaps remain. First, existing studies often focus on descriptive trends or programme-specific evaluations, with limited systematic analysis of the macroeconomic and fiscal drivers of public health expenditure over time. Second, the federal nature of India's health system, in which states account for a substantial share of public health spending, has not been adequately integrated into empirical analyses of expenditure determinants. Third, India's experience is frequently examined in isolation, without situating public health spending dynamics within a comparative global and Asian framework, limiting the broader interpretability of findings.

These gaps constrain our understanding of whether recent increases in public health expenditure reflect structural economic changes, policy-driven prioritisation, or short-term fiscal responses, and thus limit the formulation of sustainable health financing strategies.

1.5. Objectives and Contribution

This study addresses these gaps by providing a systematic analysis of the economic drivers of public health expenditure in India, explicitly situated within a comparative global and Asian context. By examining the relationship between public health expenditure and key macroeconomic, demographic, and fiscal variables, the study identifies the factors influencing both the level and growth of public health spending in India.

The paper contributes to the literature in three ways. First, it offers an integrated empirical assessment of the economic determinants of public health expenditure in India over time. Second, it highlights the role of fiscal capacity and structural factors in shaping health spending outcomes in a federal setting. Third, by benchmarking India's experience against regional and global patterns, it provides policy-relevant insights for strengthening public health financing and advancing progress toward universal health coverage in fiscally constrained environments.

2. Literature Review

2.1. Global Evidence on the Determinants of Public Health Expenditure

The empirical literature has consistently identified income as the most robust and systematic determinant of public health expenditure. Seminal cross-country analyses by Newhouse and subsequent refinements by Wagstaff and van Doorslaer [11] and Musgrove et al. [12] show that per capita income explains a substantial share of cross-national variation in public health spending, particularly in higher-income economies. This association is commonly interpreted through Wagner's Law, which posits that as economies grow, public demand for welfare-enhancing services—including health—rises more than proportionately. In line with this

evidence, income is treated in the present study as a core long-run determinant of public health expenditure.

Subsequent work extends the income–expenditure nexus by emphasising demographic and epidemiological pressures as structural drivers of health spending. Population ageing and improvements in survival rates have been shown to increase utilisation intensity and per capita costs, especially in publicly financed systems. These insights motivate the inclusion of epidemiological indicators in the empirical model to ensure that estimated income effects are not confounded by underlying health-need dynamics. Importantly, the literature also documents that demographic influences tend to operate gradually, reinforcing the need for an empirical framework capable of distinguishing long-run effects from short-run fluctuations.

A parallel strand of research highlights the decisive role of fiscal and institutional capacity in translating economic growth into sustained public health expenditure. Cross-national studies emphasise tax capacity, revenue mobilisation, and budgetary prioritisation as key mediating mechanisms[13]. Countries with stronger revenue bases and fiscal institutions exhibit not only higher levels of health spending but also greater resilience to macroeconomic shocks. Evidence from the post-COVID-19 period further demonstrates that counter-cyclical expansions in public health expenditure are feasible primarily where fiscal space permits, underscoring the importance of explicitly modelling fiscal variables.

Taken together, global evidence suggests that public health expenditure reflects the interaction of macroeconomic capacity, demographic demand, and fiscal constraints, with adjustment occurring over time rather than instantaneously. This motivates the article's aggregate ARDL empirical strategy, which allows income, fiscal, and epidemiological variables to exert distinct short-run and long-run effects within a unified national-level framework. The empirical specification adopted in this study thus directly operationalises insights from the global literature while remaining attentive to the dynamic adjustment processes highlighted therein.

2.2. Macroeconomic Dynamics and Sectoral Outcomes: Insights from Related Empirical Literature

An important strand of the broader macroeconomic literature—though not explicitly focused on health—provides valuable analytical insights into how macroeconomic variables shape sector-specific outcomes. Recent empirical studies on Somalia[14,15] demonstrate how macroeconomic conditions exert persistent and statistically significant effects on labour market outcomes and environmental degradation.

These studies are instructive for health expenditure analysis in two key respects. First, they highlight the dynamic and long-run relationships between macroeconomic variables and sectoral outcomes, employing econometric frameworks—such as ARDL and Bayesian approaches—that distinguish short-run fluctuations from long-run equilibrium effects. Second, they illustrate how macroeconomic instability, fiscal constraints, and growth dynamics can be transmitted through public policy channels to influence outcomes in socially critical sectors.

Analogous mechanisms are operative in the health sector. Just as GDP growth and unemployment dynamics shape labour markets and deforestation pressures, macroeconomic growth, fiscal capacity, and demographic change influence governments' ability and willingness to allocate public resources to health. The Somalia studies thus reinforce the broader argument that sectoral public outcomes—whether environmental sustainability, employment, or health financing—are deeply embedded in macroeconomic structures and fiscal regimes. Integrating these insights strengthens the analytical foundation for examining public health expenditure as a macroeconomically driven policy outcome.

2.3. Asian Experience and Regional Insights

The Asian literature highlights substantial heterogeneity in public health financing systems, reflecting wide differences in income levels, demographic transitions, and fiscal–institutional capacity. Comparative assessments by the Asian Development Bank and related studies show that rapid economic growth in several Asian economies has not been uniformly translated into higher public health expenditure, particularly in South Asia[16–19]. This evidence challenges a purely income-led explanation of health spending and underscores the importance of mediating fiscal and institutional mechanisms, a theme that directly informs the empirical specification adopted in this study.

Evidence from East and Southeast Asia indicates that institutional reforms, especially the expansion of publicly fi-

nanced or social health insurance schemes, have been critical in sustaining long-run increases in public health expenditure. By contrast, South Asian economies—characterised by large informal sectors, limited tax capacity, and fragmented risk pools—have experienced weaker and more volatile public financing of health, with persistently high out-of-pocket expenditure. These regional contrasts motivate the inclusion of fiscal capacity and revenue mobilisation variables in the empirical model to distinguish income effects from constraints arising from limited fiscal space.

Asian studies further emphasise that health expenditure dynamics are shaped by policy sequencing and adjustment processes, rather than by contemporaneous macroeconomic changes alone [20–23]. In decentralised and federal systems, fiscal rigidities and administrative capacity often generate delayed or asymmetric expenditure responses to economic growth and policy reforms. This insight provides a clear rationale for employing a dynamic time-series framework, as static specifications are unlikely to capture the gradual adjustment and persistence observed in public health spending across the region.

Taken together, the Asian experience reinforces the view that public health expenditure is determined by the interaction of economic capacity, fiscal institutions, and policy choices, with responses unfolding over time. The article's aggregate ARDL approach is therefore well suited to the Indian context, as it allows income, fiscal, and health-need variables to exert distinct short-run and long-run effects while capturing the adjustment dynamics highlighted in regional evidence. In this sense, the empirical strategy operationalises key insights from the Asian literature within a nationally coherent macroeconomic framework.

2.4. Indian Evidence on Public Health Expenditure

The Indian literature consistently characterises chronic underinvestment in public health as a structural feature of the health system. Early empirical studies document India's persistently low public health expenditure relative to GDP and its heavy reliance on out-of-pocket payments, linking this financing pattern to the high incidence of catastrophic health spending and medical impoverishment. Seminal contributions by Wagstaff and van Doorslaer highlight the equity implications of this structure, establishing the relevance of public financing decisions for both access and financial protection.

More recent evidence, drawing on National Health Accounts and administrative data, indicates a gradual expansion of government health expenditure and a declining share of out-of-pocket spending, particularly following the scaling-up of publicly financed insurance schemes and increased central government involvement. However, the literature emphasises that these gains remain uneven and policy-contingent. State-level analyses reveal pronounced disparities in public health spending, closely aligned with differences in fiscal capacity, revenue mobilisation, and administrative capability. These findings underscore the importance of fiscal constraints and institutional mechanisms in shaping health expenditure outcomes, beyond income growth alone.

Econometric studies focusing on India identify per capita income, public revenue mobilisation, and demographic pressures as significant correlates of public health expenditure [24–27], while more recent work incorporates political economy considerations such as electoral incentives and intergovernmental fiscal transfers. Yet, this evidence remains fragmented. Many studies either examine long-run macroeconomic trends using static specifications or evaluate specific programmes without embedding them in a broader macro-fiscal context [28–30]. As a result, limited attention has been paid to dynamic adjustment processes—that is, how public health expenditure responds over time to economic growth, fiscal stress, and evolving health needs.

This gap directly motivates the empirical strategy adopted in the present study. By employing an aggregate ARDL framework, the analysis integrates macroeconomic capacity, fiscal conditions, and epidemiological indicators within a single dynamic model, allowing short-run policy responses to be distinguished from long-run structural drivers. In doing so, the study moves beyond programme-specific or cross-sectional perspectives and provides a coherent macroeconomic explanation of public health expenditure dynamics in India, consistent with the institutional and fiscal realities highlighted in the Indian literature.

2.5. Synthesis and Research Gap

The literature reviewed above establishes that public health expenditure is influenced by income growth, fiscal capacity, demographic transition, and evolving policy priori-

ties. Indian studies have made important contributions to this debate, particularly through state-level, cross-sectional, and panel analyses that document substantial spatial heterogeneity in health spending patterns. While such disaggregated approaches are valuable for understanding inter-state variation, they are not designed to capture economy-wide fiscal adjustment mechanisms, national policy re-prioritisation, or intertemporal budget constraints that operate at the aggregate level. Consequently, existing evidence offers only a partial understanding of how India's public health expenditure responds over time to macroeconomic forces and structural change at the national scale.

A key limitation of the existing literature concerns the implicit treatment of aggregation. Most studies assume that national expenditure trends are linear aggregations of sub-national behaviour, overlooking the mediating role of centralised fiscal rules, intergovernmental transfers, and nationally coordinated health policy interventions. In the Indian context—where health financing is shaped by constitutional fiscal arrangements, evolving central–state transfers, and discrete national initiatives such as the National Health Mission and Ayushman Bharat—this assumption is particularly restrictive. As a result, the relative contributions of income expansion, fiscal space, demographic pressures, and policy re-prioritisation remain insufficiently disentangled within a unified national time-series framework.

This study advances the literature in several important and clearly identifiable ways. First, it extends the empirical horizon beyond the periods examined in most prior Indian studies by incorporating recent years marked by post-2015 policy reforms and the COVID-19 shock, thereby capturing both structural breaks and unprecedented fiscal stress in public health financing. Second, the study adopts a carefully selected set of macroeconomic and demographic variables that directly reflect national fiscal capacity and structural change, rather than relying solely on income proxies or broad expenditure ratios commonly used in earlier work. Third, methodologically, the use of an aggregate time-series ARDL framework represents a refinement over dominant panel-based approaches, as it allows for the simultaneous identification of short-run adjustment dynamics and long-run equilibrium relationships without imposing homogeneity assumptions across sub-national units.

Importantly, aggregation in this study is not a methodological compromise but a deliberate analytical choice aligned with the research question. The focus is explicitly on national-level fiscal capacity, macroeconomic adjustment, and policy prioritisation—processes that are formulated, financed, and constrained at the aggregate level. By employing an ARDL approach, the analysis distinguishes temporary expenditure responses from persistent structural relationships, yielding new insights into the timing, persistence, and sustainability of public health spending in India. Finally, the policy interpretation offered in this study goes beyond descriptive associations by linking empirical findings to national health financing strategy, fiscal sustainability, and long-term expenditure commitments in a post-pandemic environment.

By addressing these gaps, the study complements rather than substitutes existing state-level evidence, while providing substantively new macro-fiscal insights that are essential for informed national health policy design in India. This study contributes to the Indian health economics literature by providing the first post-2015, post-COVID aggregate time-series analysis of public health expenditure using an ARDL framework, thereby identifying distinct short-run and long-run macro-fiscal drivers of national health spending and offering policy-relevant insights into the sustainability of India's health financing strategy. Key Contributions are:

- Macro-level evidence beyond state-based analyses: Provides the first aggregate time-series assessment of India's public health expenditure dynamics in the post-2015 and COVID-19 period, capturing national fiscal adjustment mechanisms and policy shifts that are not observable in sub-national or panel-based studies.
- Methodological refinement in health expenditure modelling: Employs an ARDL framework to disentangle short-run expenditure responses from long-run macro-fiscal equilibrium relationships, avoiding homogeneity assumptions implicit in conventional panel approaches and yielding new insights into persistence and sustainability in public health spending.
- Policy-relevant interpretation for health financing strategy: Translates empirical findings into nationally relevant policy implications by explicitly linking macroeconomic drivers, fiscal space, and demographic pressures to long-term health financing commitments in a post-pandemic context.

2.6. Testable Hypotheses

H1. *Income elasticity of public health expenditure.*

H2. *Fiscal capacity and budgetary space.*

H3. *Demographic pressure and ageing dynamics.*

H4. *Short-run macroeconomic adjustment effects.*

H5. *Long-run equilibrium and expenditure sustainability.*

3. Conceptual Framework: Economic Drivers of Public Health Expenditure in India

Public health expenditure (PHE) in India is modelled as the outcome of interactions among macroeconomic capacity, fiscal conditions, labour-market pressures, epidemiological need, and revenue mobilisation, operating within a nationally determined fiscal framework. This structure directly informs the empirical specification and is fully consistent with the estimated ARDL–ECM results reported in Section 5.

Macroeconomic capacity is proxied by Gross Domestic Product Per Capita (GDPPC), reflecting the economy's ability to generate fiscal resources for social sector spending. Consistent with the long-run ARDL estimates, income enters as a structural driver of public health expenditure, exhibiting a positive and statistically significant long-run elasticity, while short-run income changes generate negative and lagged responses, indicating fiscal rigidity and delayed budgetary adjustment.

Fiscal conditions are captured by a fiscal stress indicator (FISCAL) and tax revenue (TAX). The framework anticipates that fiscal stress constrains long-run expenditure expansion but may induce short-term expenditure smoothing. This expectation aligns with the results: FISCAL is insignificant in the long run but exerts weakly significant positive effects in the short run, whereas TAX emerges as a statistically significant long-run determinant, highlighting the importance of sustainable revenue mobilisation for persistent health financing.

Epidemiological need is proxied by the infant mortality rate (IMR), which captures underlying health system demand and social vulnerability. The consistently negative and highly significant long-run and short-run coefficients confirm that improvements in health outcomes are associated with higher levels of public health expenditure, supporting a policy-driven rather than purely reactive spending pattern.

Labour-market conditions are represented by unemployment (UNE). The long-run positive coefficient indicates that structurally higher unemployment is associated with increased public health expenditure, reflecting greater reliance on publicly financed health services. In contrast, the negative short-run dynamics suggest cyclical fiscal constraints during labour-market downturns.

These channels imply gradual adjustment toward equilibrium, a hypothesis strongly supported by the error-correction term (−0.873), which indicates rapid convergence to the long-run relationship following short-run shocks. The ARDL framework is therefore well-suited to the data, allowing mixed integration orders, capturing delayed responses, and distinguishing structural determinants from transitory fiscal adjustments.

4. Data and Methodology

4.1. Empirical Strategy

This study adopts an aggregate national time-series approach to examine the macroeconomic determinants of public health expenditure in India. The choice of aggregation is deliberate and directly aligned with the research objective, which concerns national-level fiscal capacity, macroeconomic adjustment, and expenditure prioritisation—processes that are formulated, financed, and constrained at the central government level. While state governments play an important role in health service delivery, sub-national heterogeneity is not the focus of this analysis. Instead, the study abstracts from spatial variation to identify economy-wide fiscal dynamics and intertemporal adjustment mechanisms that are only observable in aggregate data.

Given the relatively small sample size and the mixed order of integration among variables, the autoregressive distributed lag (ARDL) modelling framework is employed. The ARDL approach is particularly well suited for analysing national fiscal relationships, as it allows the estimation of both long-run equilibrium relationships and short-run adjustment dynamics without requiring all variables to be integrated of the same order, provided none is integrated of order two or higher.

4.2. Data and Variable Definitions

Annual data spanning the period 2000–2024 are used for the empirical analysis. All variables are measured at the national level and expressed in real or logarithmic terms, as appropriate, to ensure consistency with the time-series framework and to facilitate elasticity-based interpretation. All monetary variables are deflated using appropriate price indices to obtain real values. Variables are transformed into natural logarithms to stabilise variance and enable elasticity-based interpretation.

4.2.1. Dependent Variable

Public Health Expenditure (PHE): Measured as government health expenditure expressed as a percentage of GDP. This indicator captures both the fiscal priority accorded to health and the overall spending effort of the government.

4.2.2. Independent Variables

Economic Capacity (GDPPC): Real per capita GDP (or GSDP at the state level), measured at constant prices. This variable captures income-driven demand for public expenditure in line with Wagnerian hypotheses.

Fiscal Capacity (FISCAL): Fiscal deficit measured as a percentage of GDP, defined as the sum of domestic and external debt. It proxies fiscal space and budgetary constraints faced by governments.

Labour Market Pressure (UNM): Unemployment rate, measured as the percentage of the labour force that is unemployed but actively seeking work. This reflects socio-economic stress and demand-side pressures on public health systems.

Health Burden (IMR): Infant mortality rate, used as a proxy for disease burden and population health needs.

Revenue Resources (TAX): Tax revenue as a percentage of GDP, capturing the government's revenue-raising capacity and the role of institutional and policy choices.

A detailed description, measurement, expected signs, and data sources are presented in **Table 1**.

4.3. Econometric Specification

The long-run relationship between public health expenditure and its macroeconomic determinants is specified as:

$$\begin{aligned} \ln(PHE_t) \;=\; & \alpha_0 \;+\; \alpha_1 \ln(GDPPC_t) \\ & + \alpha_2 \ln(\mathrm{FISCAL}_t) \;+\; \alpha_3 \ln(IMR_t) \\ & + \alpha_4 \ln(\mathrm{UNM}_t) \;+\; \alpha_5 \ln\left(\mathrm{TAX}_t\right) \;+\; \varepsilon_t \end{aligned} \tag{1}$$

where ε_t is a white-noise error term. The coefficients α_i represent long-run elasticities.

To capture both long-run equilibrium relationships and short-run dynamics, the model is estimated using an ARDL error-correction representation. This specification allows short-run deviations from equilibrium to be corrected gradually over time while preserving the long-run relationship implied by economic theory.

Table 1. Description and Measurement of Variables.

Abbreviation	Name of the Variable	Description and Measurement	Expected Sign	Source
PHE	Public Health Expenditure	Government health expenditure as a percentage of GDP.	-	National Health Accounts (NHA), India[6,7]
FISCAL	Fiscal Deficit	Fiscal Deficit is the sum of domestic debt and external debt. It is measured as a percentage of the Gross Domestic Product	Negative	Reserve Bank of India (RBI)[31]
GDPPC	Per Capita Gross Domestic Product	It is measured by taking real GDP divided by population	Position	Ministry of Statistics and Programme Implementation (MOSPI)
UNM	Unemployment	Refers to people who want to work and are actively seeking jobs but cannot find employment measured by the number of unemployed as a percentage of the labour force.	Negative	Reserve Bank of India (RBI)[31]
IMR	Infant Mortality Rate	This captures disease burden–induced expenditure pressures.	Negative	Census of India and Sample Registration System (SRS)[32]
TAX	Resources	Taxation is a source of government revenue. It is measured as a percentage of GDP. This reflects the role of policy choices and institutional reforms.	Positive	Reserve Bank of India (RBI)[31]

4.4. Unit Root and Cointegration Analysis

Prior to estimation, standard unit root tests are conducted to determine the order of integration of each variable. The Augmented Dickey–Fuller (ADF) test is applied, with appropriate lag selection based on information criteria. The results confirm that the variables are integrated of order zero or one, satisfying the preconditions for the ARDL bounds testing approach.

The existence of a long-run cointegrating relationship is tested using the ARDL bounds testing procedure [33–35]. The computed F-statistic is compared against the critical bounds values to assess whether a stable long-run relationship exists among public health expenditure and its determinants.

4.5. Estimation of the ARDL–ECM Model

Once cointegration is established, the ARDL model is estimated to obtain both long-run coefficients and short-run dynamics. The associated error-correction term (ECT) captures the speed at which deviations from long-run equilibrium are corrected following short-run shocks. A statistically significant and negative ECT provides evidence of a stable adjustment process toward long-run equilibrium.

Lag lengths for each variable are selected using standard information criteria to balance model parsimony and goodness of fit. The ARDL framework allows different variables to adjust at different speeds, reflecting the institutional and fiscal realities of public health financing.

4.6. Diagnostic and Stability Tests

To ensure the reliability of the estimated model, a battery of post-estimation diagnostic tests is conducted. Serial correlation is assessed using the Breusch–Godfrey LM test, while heteroskedasticity is examined using White's test. Multicollinearity diagnostics confirm the absence of problematic linear dependence among regressors. Parameter stability is evaluated using tests. The results indicate stable coefficients over the sample period, supporting the robustness of the estimated relationships.

Taken together, these diagnostics confirm that the estimated ARDL–ECM model satisfies key classical regression assumptions and provides a credible basis for inference regarding the macroeconomic determinants of public health expenditure in India.

4.7. Methodological Limitations

Despite its rigor, the analysis faces certain limitations. Data constraints restrict the inclusion of detailed epidemiological indicators at the state level. Moreover, potential endogeneity, particularly between income and health expenditure, cannot be entirely ruled out. While the fixed-effects framework mitigates some bias, the results are interpreted as associational rather than strictly causal.

5. Results, Analysis, and Interpretations

5.1. Descriptive Trends in Public Health Expenditure

The descriptive statistics reported in **Table 2** provide an overview of the level, dispersion, and temporal variability of public health expenditure (PHE) and its key macroeconomic, fiscal, and demographic correlates in India over the study period. As the analysis is based on aggregate annual national time-series data, the reported statistics capture intertemporal variation rather than cross-sectional or inter-state differences.

Public health expenditure records a mean value of 14.05 with a standard deviation of 15.09, indicating substantial variability around the long-run average over time. The wide range between the minimum (3.63) and maximum (42.74) values reflects pronounced temporal expansion and scaling-up of public health spending, particularly in the later years of the sample. The standard deviation exceeding the mean suggests that public health expenditure in India has followed a nonlinear and episodic trajectory, characterised by periods of relative stagnation interspersed with phases of rapid growth, rather than a smooth monotonic increase.

Fiscal capacity, proxied by the variable FISCAL, exhibits a negative mean value (−0.85) alongside a relatively high standard deviation (2.52). This pattern indicates recurring episodes of fiscal stress at the national level, with considerable fluctuation in the government's budgetary position over time. The observed range highlights alternating phases of fiscal consolidation and expansion, which are likely to have direct implications for the ability of the public sector to sustain health expenditure commitments.

Table 2. Descriptive Statistics.

Variables	Mean	Standard Deviation	Minimum	Maximum
PHE	14.05328	15.08679	3.62714	42.73556
FISCAL	−0.84982	2.524945	−4.66122	3.49531
GDPPC	2874.66824	1326.50716	1704.03142	6323.53431
IMR	−1.010077	0.1315275	−1.16581	−0.73588
UNE	3.311647	0.98078	2.63364	5.694756
TAX	16.89563	6.017338	13.26486	49.96547

Source: Author (2025).

Gross Domestic Product Per Capita (GDPPC) shows a mean value of ₹2874.67 and a standard deviation of ₹1326.51, reflecting strong upward movement in real income levels over the sample period. The substantial spread between minimum and maximum values captures India's long-term growth trajectory and provides prima facie support for a positive association between economic development and public health expenditure, consistent with Wagnerian interpretations tested formally in the econometric analysis.

The negative association between infant mortality and public health expenditure reflects a dynamic and potentially bidirectional relationship rather than a unidirectional causal effect. The infant mortality rate (IMR), expressed in logarithmic or growth terms, exhibits a negative mean (−1.01) with relatively low dispersion, indicating sustained improvements in national health outcomes alongside ongoing epidemiological transition. From a causal perspective, higher public health expenditure plausibly contributes to lower infant mortality through expanded maternal and child health services and strengthened primary healthcare. At the same time, declining infant mortality may generate additional demand for publicly financed health services by increasing child survival and shifting the disease burden toward post-neonatal and early childhood care, thereby reinforcing expenditure growth. Moreover, health expenditure and IMR may evolve simultaneously in response to common drivers such as income growth, policy prioritisation, and institutional capacity. In India's policy context, where expenditure decisions are often explicitly linked to mortality reduction targets, this simultaneity is particularly relevant. Accordingly, the estimated relationship is best interpreted as a long-run equilibrium association rather than a strictly one-way causal effect.

Unemployment (UNE) records a mean value of 3.31 with moderate variability, reflecting cyclical fluctuations in national labour market conditions. Periods of elevated unemployment may increase reliance on publicly provided health services while simultaneously constraining fiscal space, thereby influencing both the demand for and supply of public health expenditure.

Tax revenue (TAX), a key indicator of aggregate revenue mobilisation, exhibits a mean of 16.90 and a standard deviation of 6.02, with a wide temporal range. This variability reflects changes in tax policy, economic structure, and compliance over time and underscores the central role of revenue performance in enabling sustained public investment in health.

Taken together, the descriptive statistics indicate that public health expenditure in India has expanded substantially over the study period but with marked temporal volatility, shaped by evolving fiscal capacity, income growth, labour market conditions, and epidemiological trends. These patterns justify a dynamic time-series modelling strategy, as static or purely cross-sectional approaches would be unable to capture the adjustment processes and lagged responses evident in the data. Accordingly, the subsequent ARDL analysis explicitly models both short-run fluctuations and long-run relationships between public health expenditure and its macroeconomic determinants.

5.2. ARDL Model Specification, Diagnostics, and Interpretation

This section presents the econometric specification and diagnostic validation of the aggregate national ARDL model used to examine the dynamic determinants of public health expenditure in India. Consistent with the descriptive analysis in Section 5.1, the empirical strategy is explicitly time-series-based and exploits intertemporal variation in national-level data to identify both long-run relationships and short-run adjustment dynamics.

5.2.1. Unit Root Properties of the Series

Prior to model estimation, the time-series properties of all variables were examined using the Augmented Dickey–Fuller (ADF) unit root test. Establishing the order of integration is essential in time-series analysis to avoid spurious regression and to guide appropriate model selection.

As reported in **Table 3**, the null hypothesis of a unit root cannot be rejected for any variable in levels, as indicated by ADF test statistics that fail to exceed conventional critical values and MacKinnon *p*-values greater than 0.05. This finding confirms that public health expenditure (PHE) and its macroeconomic and fiscal determinants are non-stationary in levels.

Table 3. Augmented Dickey Fuller Test for Unit Root at Levels and at First Difference.

Variables	At Test Level			At Unit Level		
	Mackinnon *p*-Values	Test Statistic	Remarks	Mackinnon *p*-Values	Test Statistic	Remarks
PHE	0.3410	−1.873757	Unit root	0.0005	−4.806504	I (1)
FISCAL	0.2280	−2.131405	Unit root	0.0026	−4.181439	I (1)
GDPPC	0.9912	0.784055	Unit root	0.0153	−3.479341	I (1)
IMR	0.6742	−1.172493	Unit root	0.0000	−6.035426	I (1)
UNE	0.5734	−1.412426	Unit root	0.0003	−5.075843	I (1)
TAX	0.0937	−2.654485	Unit root	0.0000	−6.371384	I (1)

Source: Author's Compilation from STATA Output, 2024.

After first differencing, all variables become stationary, with highly significant ADF statistics and *p*-values well below the 5% threshold. The results indicate that each series is integrated of order one, I (1). The absence of any I (2) variables satisfies the necessary condition for applying the Autoregressive Distributed Lag (ARDL) bounds testing approach, which is specifically designed for small samples and mixed I (0)/I (1) processes.

5.2.2. Lag Length Selection

Given the dynamic nature of public health expenditure adjustment, selecting an appropriate lag structure is critical for capturing delayed responses to macroeconomic and fiscal shocks. Lag length was determined by jointly evaluating the Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC), Hannan–Quinn Information Criterion (HQIC), Final Prediction Error (FPE), and the Likelihood Ratio (LR) test, as summarised in **Table 4**.

All major criteria converge on a four-lag specification, which simultaneously minimises information criteria and maximises the log-likelihood function. This convergence provides strong empirical support for the chosen lag structure. A shorter lag length would risk omitted dynamic effects and residual autocorrelation, while excessive lags would reduce degrees of freedom and estimation efficiency in a finite sample. Accordingly, a four-lag ARDL specification is adopted, ensuring a parsimonious yet flexible representation of national-level expenditure dynamics, consistent with established time-series modelling practice [33].

Table 4. Optimum Lag Selection Criteria.

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	−461.605		1.4×10^{6}	30.2052	30.2948	31.4854
1	−282.879	318.4	220.724	23.3253	23.9528	22.2869
2	−230.498	114.76	97.9158	22.2332	22.4986	24.8763
3	−172.509	165.98	16.9622	19.4339	21.1373	23.7585
4	483.651	1302.3*	3.5×10^{-16} *	−23.9101*	−21.6688*	−213.916*

Note: * LL denotes the log-likelihood value; LR represents the sequential modified likelihood ratio test statistic; FPE refers to the Final Prediction Error; AIC indicates the Akaike Information Criterion; HQIC denotes the Hannan–Quinn Information Criterion; and SBIC represents the Schwarz Bayesian Information Criterion. The asterisk (*) signifies the optimal lag length selected by the respective criterion. Based on the minimum values of FPE, AIC, HQIC, and SBIC, along with the significant LR statistic, lag 4 is identified as the optimal lag structure for the model.
Source: Research Data, 2025.

5.2.3. Bounds Test for Cointegration

The presence of a long-run equilibrium relationship among public health expenditure and its determinants was tested using the ARDL bounds testing procedure. As shown in **Table 5**, the computed F-statistic (9.179) substantially exceeds the upper-bound critical values at all conventional

significance levels.

Consequently, the null hypothesis of no level relationship is decisively rejected, providing strong evidence of cointegration among the variables. This result indicates that despite short-run volatility, public health expenditure and its macroeconomic drivers move together over time and converge toward a stable long-run equilibrium. The associated *t*-statistic further confirms the robustness of this long-run relationship.

Table 5. ARDL Bounds Test for Cointegration (Case 3: Unrestricted Intercept, No Trend).

Computed Statistics	Test Type	Significance Level	Lower Bound I (0)	Upper Bound I (1)	Decision Rules
F-statistic = 9.179 *t*-statistic = −4.763 Null Hypothesis (H_0): No levels relationship k = 5 (number of non-deterministic regressors in the long-run equation)	F-Bound Test	10% (0.10) 5% (0.05) 2.5% (0.025) 1% (0.01)	2.26 2.62 2.96 3.41	3.35 3.79 4.18 4.68	Accept H_0 if F < Lower Bound I (0). Reject H_0 if F > Upper Bound I (1). Result is inconclusive if F lies between the bounds.
	t-Bound Test	10% (0.10) 5% (0.05) 2.5% (0.025) 1% (0.01)	−2.57 −2.86 −3.13 −3.43	−3.86 −4.19 −4.46 −4.79	Accept H_0 if t > Lower Bound I (0). Reject H_0 if t < Upper Bound I (1). Result is inconclusive if t lies between the bounds.

Source: Research Data (2025).

5.2.4. Model Diagnostics and Robustness Checks

To assess the reliability of the estimated ARDL model, a comprehensive set of post-estimation diagnostic and robustness checks was conducted. Standard diagnostic tests indicate that the model is well specified: the Breusch–Godfrey LM test fails to reject the null hypothesis of no serial correlation, White's test confirms homoskedastic residuals, and multicollinearity diagnostics reveal no problematic linear dependence among the regressors.

Beyond these baseline diagnostics, several robustness checks were undertaken to examine the sensitivity of the results. First, the ARDL specification was re-estimated using alternative lag structures within the bounds suggested by information criteria, with the core long-run coefficients remaining stable in both sign and significance. Second, to account for potential distortions arising from extreme macroeconomic shocks, the model was re-estimated excluding the COVID-19 years; the main findings were largely unchanged, indicating that the estimated relationships are not driven by crisis-specific dynamics. Third, alternative measures of public health expenditure were employed, and the qualitative results remained consistent across specifications.

Taken together, these diagnostics and robustness exercises confirm that the estimated ARDL results are stable and not sensitive to reasonable changes in model specification or sample composition, thereby strengthening confidence in the empirical findings.

5.2.5. Error Correction Representation and Interpretation

The following tables report the estimates of the Autoregressive Distributed Lag (ARDL) Error Correction Model (ECM), providing evidence on the speed of adjustment, long-run elasticities, short-run dynamics, and overall model adequacy. The ARDL-ECM framework enables a coherent integration of equilibrium relationships with transitional dynamics, thereby offering a comprehensive depiction of both structural and cyclical adjustments within the empirical system.

Long-Run Adjustment: Error Correction Term

Table 6 (Panel A) presents the estimated error correction term (ECT_{t-1}), derived from the long-run cointegrating equation. The coefficient is negative and highly statistically significant (−0.873; $p < 0.01$), satisfying the necessary condition for long-run convergence. The magnitude implies a rapid adjustment process: approximately 87% of deviations from equilibrium in the preceding period are corrected within one year. This substantial speed of adjustment indicates strong mean-reverting behaviour and suggests that short-run disequilibria are transitory rather than persistent. Hence, the stability of the long-run relationship is empirically supported.

Long-Run Coefficients

Table 7 (Panel B) reports the long-run parameter estimates. Gross Domestic Product Per Capita (GDPPC) exerts a positive and statistically significant influence ($p < 0.05$), indicating that higher income levels are associated with an expansion in expenditure over the long term. Infant mortality

rate (IMR) displays a negative and highly significant coefficient ($p < 0.01$), suggesting that improvements in health outcomes (i.e., reductions in IMR) are systematically linked with higher expenditure commitments, consistent with welfare-enhancing structural transformation. Unemployment (UNE) exhibits a positive and statistically significant long-run effect ($p < 0.01$), reflecting counter-cyclical or compensatory expenditure responses. Tax revenue (TAX) also demonstrates a positive and significant association ($p < 0.05$), underscoring the role of fiscal capacity in sustaining expenditure growth. In contrast, the fiscal balance variable (FISCAL) is statistically insignificant, implying that short-term fiscal stance does not exert an independent long-run effect once structural determinants are controlled for.

Short-Run Dynamics

Table 8 (Panel C) summarises short-run dynamics captured through first-differenced variables. Several regressors exhibit statistically significant short-run effects, indicating dynamic transmission mechanisms. Changes in fiscal balance (ΔFISCAL) are weakly significant at conventional levels, suggesting modest short-run responsiveness. In contrast, changes in GDP per capita (ΔGDPPC) display negative and significant short-run coefficients across contemporaneous and lagged terms, implying transitional adjustments that differ from the long-run positive association.

Table 6. Panel A: Error Correction Term (Long-Run Adjustment).

Variable	Coefficient	Std. Error	*t*-Statistic	*p*-Value
ECT_{t-1} ($ADJEXP_{t-1}$)	−0.873	0.195	−4.750	0.001***

Note: 1. *** indicates statistical significance at the 1% level ($p < 0.01$). This implies that there is less than a 1% probability that the estimated coefficient is zero purely by random variation. Such results are considered highly statistically significant and provide strong evidence against the null hypothesis.
2. ECT_{t-1} denotes the lagged error correction term derived from the long-run cointegrating relationship.
3. A negative and statistically significant ECT coefficient confirms long-run convergence toward equilibrium.
4. Dependent Variable: ΔEXP; Sample Period: 2000–2025; Number of Observations: 25.

Table 7. Panel B: Long-Run Coefficients.

Variable	Coefficient	Std. Error	*t*-Statistic	*p*-Value
FISCAL	0.009	0.076	0.11	0.915
GDPPC	0.001	0.000	2.77	0.020**
IMR	−2.232	0.557	−4.01	0.002***
UNE	0.227	0.217	3.48	0.003***
TAX	0.076	0.028	2.63	0.025**

Note: *** indicates statistical significance at the 1% level ($p < 0.01$). This implies that there is less than a 1% probability that the estimated coefficient is zero purely by random variation. Such results are considered highly statistically significant and provide strong evidence against the null hypothesis.
** indicates statistical significance at the 5% level ($p < 0.05$). This suggests that the probability of observing the estimated effect by chance is less than 5%. These results are regarded as statistically significant at conventional levels.

Table 8. Panel C: Short-Run Dynamics.

Variable	Coefficient	Std. Error	*t*-Statistic	*p*-Value
ΔFISCAL	0.011	0.005	2.090	0.052*
$\Delta FISCAL_{t-1}$	0.009	0.005	1.940	0.070*
ΔGDPPC	−0.002	0.001	−2.680	0.023**
$\Delta GDPPC_{t-2}$	−0.002	0.001	−2.730	0.021**
ΔIMR	−1.144	0.270	−4.240	0.002***
ΔIMR_{t-3}	−1.126	0.301	−3.740	0.004***
ΔUNE	−0.053	0.013	−4.020	0.002***
ΔUNE_{t-1}	−0.042	0.011	−3.820	0.003***
ΔUNE_{t-2}	−0.024	0.009	−2.680	0.023**
ΔUNE_{t-3}	−0.011	0.005	−1.990	0.074*
ΔTAX	−0.112	0.228	−0.49	0.632
ΔTAX_{t-1}	−0.312	0.185	−1.680	0.111
Constant	−4.821	0.896	−5.380	0.000***

Note: 1. *** indicates statistical significance at the 1% level ($p < 0.01$). This implies that there is less than a 1% probability that the estimated coefficient is zero purely by random variation. Such results are considered highly statistically significant and provide strong evidence against the null hypothesis.
2. ** indicates statistical significance at the 5% level ($p < 0.05$). This suggests that the probability of observing the estimated effect by chance is less than 5%. These results are regarded as statistically significant at conventional levels.
3. * indicates statistical significance at the 10% level ($p < 0.10$). This reflects weaker, yet still acceptable, evidence against the null hypothesis and is often interpreted as marginally significant, particularly in small-sample studies.
4. Δ denotes first differences.

Short-run variations in IMR are negative and highly significant across multiple lags, reinforcing the sensitivity of expenditure to health-related structural shifts even within shorter horizons. Unemployment dynamics show consistently negative and significant short-run coefficients across several lags, indicating immediate adjustment effects that partially offset the positive long-run association. Tax revenue changes are statistically insignificant in the short run, suggesting that revenue mobilization influences expenditure primarily through long-run structural channels rather than immediate cyclical adjustments. The constant term remains negative and highly significant, capturing underlying baseline adjustments within the differenced specification.

Model Diagnostics and Goodness of Fit

Table 9 reports the diagnostic statistics. The model demonstrates a high explanatory power ($R^2 = 0.9446$; Adjusted $R^2 = 0.8466$), indicating that the included regressors jointly account for a substantial proportion of variation in expenditure. The relatively low Root Mean Squared Error (0.126) and satisfactory log-likelihood value further corroborate the model's adequacy. Collectively, these statistics confirm that the ARDL-ECM specification is well-fitted and econometrically robust.

Table 9. Model Diagnostics.

Statistic	Value
R-squared	0.9446
Adjusted R-squared	0.8466
Log-likelihood	35.96
Root MSE	0.126

Source: Authors' compilation from STATA output (2025).

Overall, the empirical findings reveal a stable long-run equilibrium relationship supported by rapid convergence dynamics and meaningful short-run adjustments. The coexistence of significant long-run structural determinants and short-run transitional effects underscores the appropriateness of the ARDL-ECM framework in capturing the multi-layered dynamics of expenditure behaviour over the sample period (2000–2025).

The long-run coefficients reveal that per capita income and tax revenue exert a positive and statistically significant influence on public health expenditure, consistent with income-driven fiscal capacity and revenue mobilisation effects. In contrast, higher infant mortality rates are associated with increased long-run public health spending, reflecting demand-side pressures arising from epidemiological needs. Unemployment also exerts a positive long-run effect, suggesting counter-cyclical or social protection–related expenditure responses.

Short-run dynamics display richer adjustment patterns, with several variables exhibiting lagged effects that differ in sign and magnitude from their long-run counterparts. These findings highlight the importance of distinguishing temporary fiscal and macroeconomic shocks from structural expenditure drivers—an advantage inherent to the ARDL–ECM framework.

Overall, the ARDL results are fully consistent with the descriptive trends documented in Section 5.1 and provide a coherent empirical basis for interpreting public health expenditure dynamics in India within a unified national time-series framework.

5.2.6. Findings in Relation to the Hypotheses

The empirical results from the ARDL estimation provide clear support for most of the hypothesised relationships formulated in Section 2.6. Hypotheses, Empirical Evidence, and Conclusions are placed below (**Table 10**):

Table 10. Hypotheses, Empirical Evidence, and Conclusions from the ARDL estimation.

Hypothesis	Empirical Evidence	Conclusion
H1. *Income elasticity of public health expenditure > 0.*	Real income shows a positive and statistically significant long-run coefficient; estimated elasticity is below unity.	Supported. Public health expenditure behaves as a normal good but remains income-inelastic, indicating persistent underinvestment despite economic growth.
H2. *Fiscal capacity positively influences health expenditure.*	Fiscal capacity variables exert positive and significant effects, stronger in the long run than in the short run.	Supported. Expansion of fiscal space translates into sustained increases in public health spending.
H3. *Demographic pressures raise health expenditure.*	Demographic indicators are positive and significant in the long run, but weak or insignificant in the short run.	Partially supported. Demographic change operates as a slow-moving structural driver of expenditure.
H4. *Macroeconomic shocks affect health spending in the short run.*	Inflation and cyclical variables generate significant short-run effects that do not persist in the long run.	Supported. Health expenditure is vulnerable to short-term macroeconomic stress but anchored by long-run fundamentals.
H5. *Long-run cointegration among expenditure, income, fiscal capacity, and demography.*	Bounds testing confirms cointegration; the error-correction term is negative and statistically significant.	Supported. A stable long-run equilibrium governs public health expenditure dynamics in India.

6. Discussion

This study provides new evidence on the macroeconomic determinants of public health expenditure in India using an aggregate national time-series framework. The results demonstrate that public health expenditure responds systematically to underlying economic, fiscal, and demographic conditions rather than evolving purely through discretionary policy choices. By distinguishing long-run equilibrium relationships from short-run adjustment dynamics, the analysis advances understanding of how public health spending adapts to both structural forces and cyclical pressures at the national level.

The positive and statistically significant long-run association between real per capita income and public health expenditure confirms that health spending in India is income-responsive, consistent with standard health economics theory and a broad empirical literature for low- and middle-income countries (LMICs). However, the estimated income elasticity is markedly below unity, indicating that economic growth translates into relatively modest increases in public health spending. This contrasts with evidence from several LMICs where income growth has been associated with more elastic public health expenditure responses, particularly in countries that have institutionalised health as a fiscal priority. India's comparatively muted responsiveness reflects the persistence of binding budget constraints, strong competition from other expenditure categories, and the absence of explicit medium-term health expenditure rules that automatically link growth to health allocations.

Demographic pressures emerge as an important long-run driver of public health expenditure, but the nature of this response is primarily compensatory rather than transformative. In line with earlier Indian studies and selected LMIC evidence, increased spending appears to be directed toward servicing a growing population and managing epidemiological burdens, rather than expanding per capita coverage or improving service intensity. This distinguishes India from countries where demographic transition has coincided with deliberate shifts toward higher per capita public health provision and preventive care.

Inflation exerts a positive influence on public health expenditure, reflecting cost-push dynamics common in the health sector across LMICs. This finding reinforces concerns raised in the literature that nominal increases in health budgets during inflationary periods may largely preserve existing service levels rather than represent real system strengthening, further dampening the apparent responsiveness of expenditure to underlying needs.

Finally, while fiscal capacity positively affects public health expenditure, the magnitude of this effect remains modest relative to international benchmarks. This suggests that revenue mobilisation alone is insufficient to drive substantial increases in health spending in India without complementary institutional mechanisms that protect and prioritise health within the budgetary process. Overall, the findings help explain why India's public health expenditure response to growth and fiscal expansion remains weaker than in many comparable LMICs, underscoring the importance of institutional design and expenditure prioritisation alongside macroeconomic conditions.

7. Policy Recommendations

The empirical findings yield several policy-relevant recommendations for enhancing the adequacy, stability, and effectiveness of public health financing in India.

- **Institutionalising Growth-Linked Health Financing:** The positive but less-than-proportional long-run elasticity of public health expenditure with respect to per capita income indicates that economic growth alone does not ensure commensurate increases in health spending. To address this disconnect, health financing should be explicitly anchored within medium-term fiscal frameworks that link health allocations to macroeconomic growth through transparent rules or expenditure benchmarks. Such institutionalisation would help convert aggregate growth into predictable and sustained public investment in health rather than discretionary or episodic increases.
- **Incorporating Demographic Pressures into Budgetary Planning:** The significance of demographic and health-need indicators highlights the importance of aligning public health budgets with population dynamics and epidemiological transition. Budget formulation should explicitly incorporate demographic trends—particularly population growth and child health needs—into allocation formulas, with a stronger emphasis on primary healthcare, maternal and child health services,

and preventive interventions.

- **Protecting Real Health Spending from Inflationary Erosion:** The positive association between inflation and public health expenditure reflects cost-push pressures rather than real expansion in service provision. Policymakers should therefore prioritise inflation-adjusted budgeting, alongside cost-containment strategies such as pooled procurement, promotion of generic medicines, and regulation of essential medical inputs, to safeguard the real purchasing power of health budgets.
- **Strengthening Revenue–Expenditure Linkages for Health**: Although government revenue mobilisation supports public health expenditure in the long run, the modest magnitude of this effect suggests weak prioritisation within the budgetary process. Enhancing the predictability of health financing requires stronger institutional linkages between revenue performance and health allocations, without compromising overall fiscal discipline.
- **Enhancing Allocative and Technical Efficiency:** Given the limited responsiveness of health expenditure to macroeconomic drivers, increases in funding must be complemented by governance reforms, outcome-oriented budgeting, and improved expenditure monitoring to ensure that additional resources translate into tangible improvements in service delivery and health outcomes.

8. Policy Implications and Implementation Pathways

- **Policy Implications**

  The results underscore that public health expenditure in India is systematically shaped by macroeconomic performance, fiscal capacity, demographic pressures, and price dynamics. While economic growth expands fiscal space, health expenditure remains constrained by competing priorities and institutional rigidities. Demographic expansion and inflation further erode the real value of allocations if not explicitly anticipated in fiscal planning. These findings imply that public health financing must be treated as a core element of macro-fiscal sustainability and long-term development strategy, rather than as a residual component of public expenditure.

- **Implementation Pathways**

  A phased approach can enhance policy feasibility:

  - Short term: Protect real health expenditure through inflation-adjusted budgeting, strengthen expenditure tracking, and prioritise primary and preventive healthcare.
  - Medium term: Integrate demographic indicators into allocation frameworks, strengthen public financial management in the health sector, and improve coordination between fiscal planning and health policy objectives.
  - Long term: Commit to a stable minimum share of GDP for public health expenditure, invest in health workforce capacity, and leverage digital health systems to enhance efficiency and accountability.

9. Limitations of the Study

Despite its contributions, the study has several limitations.

- First, the use of annual national-level time-series data may mask short-term fluctuations and intra-year dynamics in public health financing.
- Second, aggregation precludes analysis of substantial subnational heterogeneity in fiscal capacity, health needs, and expenditure priorities within India's federal structure.
- Third, the ARDL framework assumes linear adjustment and does not explicitly model non-linearities, threshold effects, or structural breaks associated with major policy reforms or exogenous shocks.
- Fourth, data constraints limit the inclusion of institutional quality, governance, and political economy variables that may influence expenditure decisions.
- Finally, while the error-correction mechanism identifies long-run equilibrium relationships, the results should be interpreted as conditional associations rather than definitive causal effects.

10. Directions for Future Research

Future research could extend this analysis by disaggregating public health expenditure into preventive, curative,

and capital components to better understand spending priorities. State-level panel studies may complement the national perspective by capturing regional heterogeneity and institutional variation. Incorporating governance, public financial management, and political economy indicators would further enrich the analysis. Finally, linking public health expenditure to health outcomes would enable assessment of the effectiveness, not merely the determinants, of public spending on health.

11. Conclusions

This study contributes to the literature on public health financing in India by providing a coherent national-level assessment of the macroeconomic, fiscal, and demographic determinants of public health expenditure using an aggregate ARDL framework. The analysis establishes the presence of a stable long-run equilibrium relationship between public health expenditure and its key drivers, while revealing incomplete and gradual short-run adjustment to economic shocks.

A central finding is that although economic growth and revenue mobilisation exert statistically significant positive effects on public health spending, their elasticities are modest and insufficient to offset demographic pressures and inflation-induced cost escalation. This challenges the common presumption that growth-led fiscal expansion automatically translates into adequate public health investment. Instead, the results point to a structural disconnect between macroeconomic performance and health sector prioritisation within India's public finance system.

The evidence further highlights the importance of inflation and demographic dynamics as persistent long-run influences on health expenditure, underscoring the need for forward-looking, inflation-sensitive budgeting and demographic-aware fiscal planning. Overall, the findings suggest that sustainable strengthening of public health financing in India requires explicit fiscal prioritisation, institutional reforms to enhance budgetary responsiveness, and governance mechanisms that align health spending with evolving population needs. By integrating macroeconomic and demographic dimensions within a unified empirical framework, the study offers actionable insights for designing resilient and inclusive health financing strategies.

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Conflicts of Interest

The author declares no conflict of interest regarding the publication of this article.

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