

Research Article

State Heterogeneity in Public Health Expenditure Effects on Mortality in India: The Role of Institutional Quality

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Abstract

Debates around the effectiveness of public health expenditure remain unresolved, particularly in low- and middle-income countries where fiscal space is limited and health inequalities are stark. This study investigates how state-level public spending influences mortality in India, while explicitly accounting for governance quality and subnational heterogeneity. Using microdata from the National Family Health Survey 5 combined with state-level fiscal and institutional indicators, the analysis applies a multilevel probit model with random intercepts and slopes to capture both baseline mortality differences and variation in the returns to health spending across states. The results show that public expenditure significantly lowers mortality probabilities, but its impact is highly uneven. States with stronger governance, especially higher government effectiveness and adherence to rule of law, achieve greater health gains from similar spending levels, while weaker states lag behind. Mortality disparities are also evident across socio-economic groups, age cohorts, gender, and rural–urban locations, with evidence that public spending helps narrow gender gaps in survival outcomes. These findings underscore that expanding health budgets alone is insufficient. Effective mortality reduction in India requires parallel investments in governance, institutional capacity, and accountability, alongside reorienting spending to address emerging challenges such as non-communicable diseases and neglected urban health systems. The paper contributes to the literature on fiscal federalism and health by demonstrating that while financial resources matter, their effectiveness is fundamentally shaped by the quality of institutions at the state level.

Keywords

Mortality, Public Health Expenditure, Governance, Multilevel Modelling, India

1. Introduction

Spending on health, especially through public sector investment, remains fundamental to a country's economic growth by providing social protection and facilitating access to quality healthcare, particularly for low-income groups [1]. Led by international commitments under the Millennium Development Goals (MDGs) and now the Sustainable Development Goals (SDGs), there has been a sustained global push for substantially increased health system financing to

improve human capital and realize broader development objectives [2, 3]. In line with these efforts, many national and subnational governments have attempted to strategically align budget allocations to activities linked to SDG outcomes, though the causal impact of public healthcare expenditure on health outcomes remains a pivotal yet contested policy question.

India adopted the National Health Policy, 2017, to reinforce

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and clarify the government's role in shaping health systems. Under the Reproductive, Maternal, Newborn, Child, and Adolescent Health Plus framework, a spectrum of integrated initiatives has been rolled out across India to ensure continuity of care and targeted interventions at all life stages [4]. Recent evidence, however, demonstrates marked acceleration in maternal and child health achievements. The Maternal Mortality Ratio (MMR) dropped substantially, falling from 130 per 100,000 live births in 2014-16 to 93 in 2019-21 [5]. The Infant Mortality Rate (IMR) declined from 39 per 1,000 live births in 2014 to 27 in 2021, while Neonatal Mortality Rate (NMR) dropped from 26 to 19 per 1,000 live births in the same period. The Under-Five Mortality Rate fell from 45 to 31 per 1,000 live births. India's reduction in these indicators has outpaced global averages over the past three decades [6]. Despite these gains, pronounced disparities persist across Indian states in IMR, MMR, and related outcomes. Southern states (Kerala, Karnataka, Andhra Pradesh, Tamil Nadu) tend to lead in both public spending levels and health achievements; in contrast, many northern and central states continue to lag, reflecting deep-rooted socio-economic and policy heterogeneities [6].

At the policy level, public health expenditure as a share of Gross Domestic Product has increased to 1.9% in 2024-25; short of the 2.5% target of the National Health Policy, 2017, but a marked improvement from previous years [7]. Government health expenditure now accounts for 48% of the total health spending, up from 29% in 2015, with the remaining expenditure largely out-of-pocket. Notably, state governments shoulder 58% of public health expenditure, reinforcing their critical role in frontline healthcare delivery [8]. This complex landscape underlines the importance of sustained, well-governed public investment and the critical need for tailored interventions to bridge emerging disparities and accelerate progress towards the SDG targets.

Studies established that mortality declines observed globally and within India over recent decades can be attributed to multifaceted improvements encompassing advancements in public health infrastructure, medical technologies, nutritional status, and behavioral modifications, particularly increased utilization of healthcare services [9-13]. Complementary investments in fundamental public goods such as access to potable water, sanitation, housing, and education further contribute to mortality reductions, reflecting the integral role of broader socioeconomic determinants and their association with rising public health expenditures [13-15]. Empirical evidence consistently identifies public health spending as a critical determinant of health outcomes, alongside income, both at cross-country and subnational levels [12, 16-18].

Despite a growing consensus regarding the positive effect of public health expenditure on mortality and related indicators, the literature presents nuanced and, at times, conflicting findings regarding its magnitude and significance. Numerous studies document robust associations between public spending and reductions in infant and maternal mortality [16, 17,

19], whereas others report indeterminate or statistically insignificant effects after adjusting for confounders and unobserved heterogeneity [20-23]. This heterogeneity primarily stems from contextual differences in country income levels, institutional arrangements, data quality, and econometric strategies employed [12, 16, 24].

Governance quality emerges prominently in the extant literature as a salient moderator of the efficacy of public health expenditure. Robust institutional frameworks characterized by transparency, accountability, and low corruption enhance the translation of financial resources into effective health interventions [25-29]. Notably, Makuta and O'Hare [24] demonstrate that similar increments in public health spending yield approximately double the improvement in under-five mortality reduction and life expectancy in countries with high governance standards vis-à-vis those with deficient governance. The propensity for resource leakage and inefficient allocation in poor governance contexts considerably attenuates spending effectiveness, thereby limiting health gains and delaying policy objectives.

The prevalent reliance on aggregate cross-country data in the literature, while valuable, often masks substantial intra-country and individual-level heterogeneity [25, 30-33]. In response, a robust cadre of recent studies deploys subnational panel data and micro-level analyses, which permit more granular insight into the complex interactions between public health spending, governance, and health outcomes [19, 34, 35]. While some subnational time-series analyses in India reflect equivocal relationships between public spending and mortality, these often fail to explicitly incorporate governance variables or adequately address endogeneity, thereby potentially biasing inference [15, 34, 35].

Moreover, the aggregation inherent in macro-level data conceals critical disparities in healthcare access and outcomes across socioeconomic strata. Bidani and Ravallion [36] employ poverty-disaggregated analyses to reveal that deprived populations bear disproportionately worse health outcomes yet benefit more from public health expenditures relative to wealthier cohorts. This stratified impact is further substantiated by Gupta et al. [13], who, through analysis of Demographic and Health Survey data spanning over seventy countries, affirm the differential effectiveness of public spending across socioeconomic groups. These findings underscore the salience of analyzing individual- and household-level data to capture the nuanced distributional consequences of health investments.

Within the Indian context, a constellation of studies investigates the public spending-health outcome nexus, with attention to both aggregate and micro-level dimensions [17, 34-38]. Microdata analyses, notably by Farhani et al. [19], illuminate a significant and positive association between public spending and reductions in mortality probability, particularly salient among impoverished households. Conversely, studies relying on aggregate datasets or broader samples often report null or muted effects, reflective of rural-urban hetero-

geneity, lagged expenditure effects, and unobserved confounders [34, 35]. The comprehensive body of research unequivocally indicates that mortality reductions and health improvements result from intertwined factors, among which public health expenditure stands out as an indispensable driver. However, its effectiveness is critically contingent upon governance quality and socioeconomic determinants that shape resource allocation and service delivery efficacy. This interplay necessitates employing sophisticated econometric frameworks that accommodate multilevel governance indicators, capture heterogeneity across states, and incorporate individual-level stratification to rigorously estimate the true impact of health spending.

Building on this foundation, the present study investigates the distributional incidence of public health spending on mortality probability across Indian states, incorporating key contextual variables operating at the individual, household, and state levels. Utilizing the latest nationally representative individual-level data from the fifth round of the National Family Health Survey [39], this paper employs a two-level random intercept model that accounts for potential endogeneity and unobserved heterogeneity, thus addressing limitations prevalent in prior analyses.

This study makes a distinct contribution to the growing literature on public spending and health outcomes by placing governance at the center of the analysis. Earlier work has largely focused on cross-country comparisons of expenditure and health indicators, often treating public spending as uniformly effective across regions. By contrast, this paper situates the analysis within India's federal system, where states differ widely in fiscal capacity, institutional strength, and governance quality. The study seeks to answer four key questions: Does public health expenditure significantly affect mortality outcomes? Do these effects differ across states with varying institutional capacity? To what extent does governance shape the relationship between spending and health? And are there systematic differences in the benefits of spending across age groups, gender, socio-economic strata, and rural–urban populations?

The paper advances the literature in three important ways. First, it draws on rich microdata from the National Family Health Survey (NFHS-5) to capture subnational variation in health outcomes, an aspect often hidden in country-level studies. Second, it explicitly incorporates indicators of governance quality, demonstrating how dimensions such as government effectiveness and rule of law influence the ability of states to translate fiscal resources into mortality reductions. In doing so, it moves beyond the expenditure–outcome debate to show that institutional quality critically mediates the effectiveness of spending. Third, it applies a multilevel probit model with random intercepts and slopes to reveal heterogeneity both in baseline mortality risks and in the responsiveness of mortality to additional spending—an issue seldom examined in the Indian context.

The structure of the paper is as follows: Section 2 details

the current landscape of public health spending and associated health outcomes across Indian states. Section 3 delineates the data sources, variable construction, and empirical strategy employed. Section 4 presents the main findings alongside an interpretive discussion of results. Finally, Section 5 concludes by synthesizing the implications for policy and future research directions.

2. Data and Methodology

2.1. Microdata

This study relies on unit-level data from the fifth round of the National Family Health Survey (NFHS-5), conducted by the International Institute for Population Sciences (IIPS), India, during 2019–2021. The survey, covering all 28 states and 8 Union Territories, provides comprehensive information on various aspects of health and well-being. The dataset contains details on reproductive health, women's decision-making and autonomy, domestic violence, nutrition outcomes for women and children, anaemia prevalence, pre-school education, disability, sanitation access, death registration, menstrual hygiene practices, and other family welfare indicators.

Although data collection faced disruptions due to the COVID-19 pandemic, NFHS-5 successfully surveyed 636,699 households with a 98% response rate, including 724,115 women and 101,839 men. For the purposes of this analysis, a subsample of 27,82,892 individuals from 606,270 households in 29 subnational units (28 states and the National Capital Territory of Delhi) is used after excluding missing observations. Union Territories are omitted because of unavailability of consistent data on public expenditure and governance quality.

The primary dependent variable is mortality, measured as whether a household member was reported alive or deceased during the survey reference period. The household questionnaire captures information about all household members, including those who died within two years prior to the survey. Explanatory variables are drawn from three levels: individual, household, and state. For deceased household members, only age and sex are available, which are also used for the surviving population. A complete list of variables used in this study is provided in Table 1.

2.2. State-Level Data

State-level health expenditure, comprising both revenue and capital outlays on medical and public health, is sourced from the *RBI Database on State Finances* [40]. This measure captures public spending by both Union and State governments at the state level. Expenditure on family welfare is excluded, since the analysis focuses exclusively on health-related spending.

While financial allocations are important, institutional

quality also plays a critical role in shaping health outcomes. Assessing governance, however, is complex because of its subjective and multidimensional nature, especially in a heterogeneous country such as India, with wide variations in socio-cultural, economic, and political contexts. To capture this dimension, the study incorporates five governance indicators compiled by the Public Affairs Center of India (PAI, 2019-20, the first such assessment at the subnational level):

- 1) *Voice and Accountability*: Citizen participation in governance not just as recipients but as active agents of change.
- 2) *Government Effectiveness*: Adequacy and quality of public services, civil service capacity, and the effectiveness of policy formulation and implementation.
- 3) *Regulatory Quality*: Government's ability to design and enforce policies and regulations that foster private sector development and manage common resources efficiently.
- 4) *Rule of Law*: The extent of adherence to societal rules, including contract enforcement, policing standards, and maintenance of law and order.
- 5) *Control of Corruption*: The extent to which misuse of public office for private gain whether petty, large-scale, or through elite capture is curbed.

In addition, since out-of-pocket (OOP) payments remain the predominant source of health financing in India, it is important to account for them. Although NFHS does not collect OOP data, state-level estimates of annual per capita hospitalization expenditure are drawn from the *Household Social Consumption on Health Survey* of the National Sample Survey Office [41], which is the latest available round. Finally, to account for economic development, the study includes the average per capita Net State Domestic Product for 2014–15 to

2018–19, obtained from the Ministry of Statistics and Programme Implementation [40, 42], Government of India. The complete set of variables considered in this study is summarized in Table 1.

2.3. Estimation Strategy

To implement the analysis, a binary outcome variable was constructed indicating whether an individual was reported alive or deceased at the time of the survey. Consistent with the theoretical framework, the study considers factors at three levels - individual, household, and state - arranged in a hierarchical structure (individuals nested within households, which in turn are nested within states). In such a framework, observations within the same cluster are not entirely independent. Ignoring this dependency and applying a standard regression model would yield biased results, since the assumption of independent observations is violated due to spatial autocorrelation within higher-level clusters [43]. A multilevel modeling approach is therefore necessary to account for such group-level dependencies.

The analysis employs a multilevel probit model, specified as a two-level random intercept framework. This structure allows explanatory variables at both the individual/household level and the state level to be included successively, thereby capturing how state-level public health spending influences the probability of mortality at the individual level. By modeling random intercepts, the approach accounts for unobserved heterogeneity across clusters while simultaneously estimating the effects of explanatory variables at different levels.

Table 1. Definition and definition of the variables considered in the present study.

Variable	Definition	Measurement	Source
Dependent Variable			
Dead	The response is recorded as dead or alive at the time of the survey	Binary: 0 – Alive; 1 – Dead within 2 years prior to the survey	NFHS 5
State Variables			
Natural log of Average per Capita Public Expenditure on Health in the last five years	Per Capita Public Spending on Medical and Public Health as given in state budget documents for year 2014-15 to 2018-19	Continuous: ln(In rupees)	RBI database
Natural log of average per capita income in the last five years	Per capita income at the states for year 2014-15 to 2018-19	Continuous: ln(In rupees)	MoSPI
Natural log of average out-of-pocket health expenditure on hospitalization	Per capita out-of-pocket health expenditure in hospitalization in last 1 years prior to survey	Continuous: ln(in rupees)	NSSO / MoSPI
Voice and Accountability	The extent of participation in the governance process	Continuous: Index value	PAI

Variable	Definition	Measurement	Source
Government effectiveness	Adequacy and quality of public services	Continuous: Index value	PAI
Rule of law	Having confidence in and abiding by the rules of society	Continuous: Index value	PAI
Regulatory quality	The ability of the Government to formulate and implement sound policies and regulations	Continuous: Index value	PAI
Control of corruption	Prevention of exercising of public power and authority for private gain	Continuous: Index value	PAI
<i>Household Variables</i>			
Rural	Location of stay of the respondent	Binary: 0 – Urban; 1 – Rural	NFHS 5
Wealth Quantile	Socio-economic condition of the households' measured in terms of wealth quantiles	Ordinal: 1 – poorest; 2 – poor; 3 – middle; 4 – rich; 5 – richest	NFHS 5
Exposure to smoke	Exposure to smoke in the households	Binary: 0 – No; 1 – Yes	NFHS 5
Access flush toilet	Access to flush toilets for the household members	Categorical: 0 – No; 1 – Flush toilet; 2 – other types of latrines	NFHS 5
Hindu	Religion of the households	Binary: 0 – Non-Hindu; 1 – Hindu	NFHS 5
Caste	Social category of the households	Categorical: 1 – General; 2 - Scheduled Caste; 3 – Scheduled Tribe; 4 – Other Backward Classes	NFHS 5
<i>Individual Variables</i>			
Age Group	Age-group of the individual	Categorical: 1 – 0-1 year; 2 - 1-5 years; 3 – 5-18 Years; 4 – 18-45 years; 5: 45-80 years; 6 – 80+ years	NFHS 5
Female	Gender of the individual	Binary: 0 – Male; 1 – Female	NFHS 5

Note: * Variables are taken in natural logarithm form in estimation model

This strategy not only controls for factors at the individual, household, and state levels but also enables the examination of whether mortality patterns differ significantly across states, even after accounting for these covariates. Importantly, the model can capture variation in the effect of specific predictors across states, which is central to the present inquiry. Although disaggregated data on health spending below the state level (districts, households, or individuals) are not available, analyzing expenditure at the state level remains highly relevant for policy, given that states are the principal agents of health

financing and service delivery in India.

Thus, the outcome variable of interest was a binary response (dead or alive) ' Y_{ij} ' of individual 'i' in the state 'j'. It takes a value 1 if the response was dead and 0 otherwise. Assuming ' Y_{ij} ' to follow a Bernoulli distribution with probabilities π_{ij} : $y_{ij} \sim \text{Bernoulli}(1, \pi_{ij})$. Given that the probability that the individual 'i' is dead to be $\pi_{ij} = p(y_{ij} = 1|x, z)$, then the two-level mixed effect probit model can be defined as:

$$\Theta^{-1}(\pi_{ij}) = \alpha_0 + \alpha_1 S_j + \alpha_2 G_j + \sum_k (\beta_k x_{ijk}) + \sum_l (\lambda_l z_{jl}) + \sum (\delta_{kl} x_{ijk} z_{jl}) + C_j \mu_j + \epsilon_{0jk}$$

Where $\Theta^{-1}(\pi_{ij})$ is the inverse cumulative distribution function of the standard normal with 'i' and 'j' referring to the individual and states (cluster), respectively. α_0 is the intercept term referring to the probability of death of the reference group, α_1 and α_2 are the marginal effect of public spending on health and governance levels at the state level, respectively. The set x and z are the individual/household and state-level control factors, whereas C_j is the cluster level corresponding

to random effect ' μ_j ', β and λ are the vectors representing coefficients of 'k' individual/ household and 'l' state-level control factors. δ_{kl} represent the indirect or heterogeneous effects of the interaction terms, and finally, ϵ_{0jk} is the error term which is distributed as a standard normal with mean 0 and variance 1 and are independent of ' μ_j '. The described Model is estimated through a maximum likelihood estimator (MLE) with standard errors clustered at the state level al-

lowing adjustment for the conditional heteroskedasticity and correlation among the observations within the state [44], and the Model is estimated using *meprobit* command in the State 17.¹ It should be noted that clustering at the state level also takes care of any lower-level clustering, such as at the household level [35].

2.4. Addressing Endogeneity Concerns

A key methodological challenge in this study is the potential endogeneity of public health expenditure. Public spending may not be exogenous, since state-level health outcomes or other unobserved factors can influence budgetary allocations to health, leading to biased estimates. This suggests a possible

bi-directional relationship between health outcomes and health spending. To address this, the study adopts an instrumental variable (IV) approach, recognizing that the reliability of IV estimates depends critically on the strength and validity of the chosen instruments. Prior research indicates that health spending is strongly conditioned by the fiscal capacity or fiscal space of governments [19, 45]. States with greater fiscal space typically allocate more resources to health. Accordingly, Own Tax Revenue (OTR) is used as a proxy instrument, as it expands fiscal space without directly influencing individual mortality risk, making it a plausible instrument. In the Indian context, [45] also employed OTR as an instrument when examining the effect of health spending on infant mortality.

Table 2. Summary Statistics.

Variables	Mean	Std. Dev.	Min	Max
Death	0.028	0.165	0.000	1.000
Average per capita public expenditure on health in the last five years (INR)	1235	1112	490	6686
Average per capita income in the last five years (INR)	128799	66749	40715	423716
Average out-of-pocket health expenditure on hospitalization (INR)	19124	6209	4754	30869
Natural log of average per capita public expenditure on health in the last five years	6.919	0.558	6.194	8.808
Natural log of average per capita income in the last five years	11.538	0.523	10.525	12.892
Natural log of average out-of-pocket health expenditure on hospitalization	9.790	0.403	8.467	10.338
Governance Parameters				
Voice and Accountability	-0.216	0.996	-1.789	2.073
Government effectiveness	-0.135	0.922	-1.897	2.045
Rule of law	-0.208	0.941	-2.799	1.368
Regulatory quality	0.112	1.005	-1.657	2.013
Control of corruption	0.069	0.596	-1.602	1.370
Rural	0.762	0.426	0.000	1.000
Wealth quantiles				
Poorest	0.228	0.419	0.000	1.000
Poorer	0.215	0.411	0.000	1.000
Middle	0.204	0.403	0.000	1.000
Richer	0.189	0.392	0.000	1.000
Richest	0.164	0.370	0.000	1.000
Exposure to smoke in the households	0.283	0.450	0.000	1.000
Access to toilet				
No access	0.187	0.390	0.000	1.000
Flush toilet	0.663	0.473	0.000	1.000
Other types of toilets	0.150	0.357	0.000	1.000
Hindu	0.773	0.419	0.000	1.000

Variables	Mean	Std. Dev.	Min	Max
Caste				
General	0.227	0.419	0.000	1.000
SC	0.202	0.402	0.000	1.000
ST	0.188	0.390	0.000	1.000
OBC	0.383	0.486	0.000	1.000
Age group				
0-1 year	0.019	0.136	0.000	1.000
1-5 year	0.067	0.250	0.000	1.000
5-18 year	0.236	0.425	0.000	1.000
18-45 year	0.398	0.489	0.000	1.000
45-80 year	0.263	0.440	0.000	1.000
80+ years	0.017	0.131	0.000	1.000
Female	0.502	0.500	0.000	1.000

Note: Total sample size is 27,82,892.

Source: Authors' estimates.

In addition to OTR, two further instruments are included: state-level Sustainable Development Goal (SDG) performance and the Ease of Doing Business (EoD) index. Both are expected to influence government spending priorities but are unlikely to directly affect individual mortality outcomes, thereby strengthening the instrument set. From an estimation standpoint, the study applies a two-step IV procedure, since the meprobit command does not permit instrumental variables to be incorporated directly into the multilevel probit framework. In the first stage, state-level public health expenditure is predicted using OTR, SDG scores, EoD index, and other covariates included in the mortality equation. In the second stage, the predicted values of health spending replace the observed expenditure variable in the mortality model, ensuring consistent estimation of the marginal effect of health spending. It is important to emphasize that valid instruments must both (i) significantly explain the variation in the endogenous regressor and (ii) remain uncorrelated with the error term in the structural equation. Failure to satisfy these conditions risks producing biased and unreliable estimates [24].

3. Results and Discussion

Table 2 reports the descriptive statistics of the variables used in the analysis. The overall probability of mortality in the sample is around 3%. Average per capita public health expenditure over the five-year period (2014-15 to 2018-19) is estimated at Indian Rupee (INR) 1,235, though with striking interstate disparities: ranging from as low as INR 490 in Uttar

Pradesh to as high as INR 6,686 in Arunachal Pradesh. Private out-of-pocket expenditure on hospitalization per capita is considerably higher at INR 19,124, with Arunachal Pradesh recording the lowest (INR 4,754) and Punjab the highest (INR 30,869).

State-level income differences are also substantial. The average per capita income in 2018-19 was INR 128,799, varying between INR 40,715 in Bihar and INR 423,716 in Goa. Consistent with expectations, wealthier states tend to spend more on health from the public purse. On governance indicators, the average scores for Voice and Accountability (-0.216), Government Effectiveness (-0.135), and Rule of Law (-0.208) fall below the mean benchmark, while Regulatory Quality (0.112) and Control of Corruption (0.069) are slightly above average.

Turning to household-level characteristics, about 76% of the sample population resides in rural areas, and 77% identify as Hindus. Social group distribution shows that Other Backward Castes account for 38% of individuals. Roughly 28% of households are exposed to smoke, while 66% report access to flush toilets and 15% to other forms of sanitation facilities. At the individual level, the majority fall within the 18-45 years age group (40%), followed by 45-80 years (26%) and 5-18 years (24%). The sample is nearly gender-balanced, with 50% males and 50% females.

Table 3 presents the results from the two-level mixed-effects probit model of mortality probability, with state-level per capita public health expenditure (2014-15 to 2018-19 average) as the primary explanatory variable. Model 1 provides baseline estimates without addressing endogeneity, while Models 2-6 incorporate corrections for endogeneity in

public spending. The exogeneity test confirms that public health spending is indeed endogenous, implying that ignoring this issue would yield biased results. The weak instrument test further validates that the instruments used (Own Tax Revenue (OTR), SDG score, and the Ease of Doing Business index) are both relevant and strong. Specifically, Model 2 presents a

bivariate specification, Model 3 incorporates governance indicators, Model 4 controls for additional state-level covariates, Model 5 adds household-level characteristics, and Model 6 presents the full model with all levels of controls. For interpretation, the discussion emphasizes results from the full specification i.e., Model 6.

Table 3. Public Spending on Health and Probability of Death.

Probability of dead	Model 1		Model 2		Model 3	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Average per Capita Public Expenditure on Health in last five years*	-0.095***	0.027	-0.398***	0.083	-0.398***	0.082
Voice and accountability	-0.016	0.013			-0.004	0.045
Government effectiveness	-0.006	0.013			-0.031	0.062
Rule of law	-0.006	0.008			0.026	0.048
Regulatory quality	0.012	0.009			-0.012	0.030
Control of corruption	-0.008	0.015			-0.084	0.063
Average per capita income in last five years	0.024	0.030				
Average out-of-pocket health expenditure on hospitalization	-0.046	0.021				
Rural	-0.023***	0.007				
Wealth quantiles (base: poorest)						
Poorer	-0.016***	0.007				
Middle	-0.044***	0.008				
Richer	-0.072***	0.011				
Richest	-0.144***	0.012				
Exposure to smoke in the households	0.017***	0.005				
Access to toilet (base: No access)						
Flush toilet	-0.021***	0.008				
Other types of toilets	-0.023***	0.007				
Hindu	0.022***	0.009				
Caste (base: General)						
SC	0.041***	0.008				
ST	0.016**	0.010				
OBC	0.010**	0.007				
Age group (base: 0-1 year)						
1-5 year	-1.033***	0.034				
5-18 year	-1.351***	0.037				
18-45 year	-1.264***	0.032				
45-80 year	-0.507***	0.025				
80+ years	0.724***	0.030				
Female	-0.171***	0.011				

Probability of dead	Model 1		Model 2		Model 3	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Constant	-0.995***	0.030	-1.804***	0.039	-1.812***	0.039
var(_cons)	0.002	0.001	0.042	0.024	0.039	0.022
ICC	0.002	0.001	0.040	0.022	0.037	0.020
Log pseudolikelihood	-294405		-354423		-354421	

Probability of dead	Model 4		Model 5		Model 6	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Average per Capita Public Expenditure on Health in last five years*	-0.422***	0.069	-0.991***	0.110	-0.114**	0.054
Voice and accountability	0.018	0.015	0.069**	0.035	-0.014	0.014
Government effectiveness	-0.017	0.024	-0.036	0.052	-0.005	0.016
Rule of law	0.003	0.017	-0.005	0.045	-0.010	0.011
Regulatory quality	-0.015	0.016	-0.050	0.039	0.013	0.010
Control of corruption	-0.016	0.021	-0.035	0.050	-0.013	0.017
Average per capita income in last five years	0.302***	0.060	0.748***	0.105	0.036	0.048
Average out-of-pocket health expenditure on hospitalization	-0.290***	0.077	-0.749***	0.131	-0.063	0.046
Rural			0.054***	0.007	-0.020***	0.007
Wealth quantiles (base: poorest)						
Poorer			-0.020***	0.007	-0.015**	0.007
Middle			-0.035***	0.010	-0.044***	0.008
Richer			-0.042***	0.011	-0.070***	0.011
Richest			-0.052***	0.014	-0.141***	0.012
Exposure to smoke in the households			0.019***	0.005	0.018***	0.005
Access to toilet (base: No access)					0.000	
Flush toilet			0.046***	0.009	-0.017**	0.008
Other types of toilets			0.059***	0.010	-0.017**	0.007
Hindu			0.047***	0.011	0.020**	0.009
Caste (base: General)					0.000	
SC			-0.040***	0.009	0.040***	0.008
ST			0.071***	0.013	0.029**	0.013
OBC			-0.030***	0.010	0.009	0.007
Age group (base: 0-1 year)					0.000	
1-5 year					-1.033***	0.034
5-18 year					-1.350***	0.037
18-45 year					-1.263***	0.031
45-80 year					-0.506***	0.025

Probability of dead	Model 4		Model 5		Model 6	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
80+ years					0.724***	0.030
Female					-0.171***	0.011
Constant	-1.903***	0.016	-1.974***	0.042	-1.004***	0.031
var(_cons)	0.006	0.002	0.031	0.010	0.003	0.001
ICC	0.006	0.002	0.030	0.010	0.003	0.001
Log pseudolikelihood	-354393		-354028		-294405	

Note: Coeff. and CSE stand for meprobit coefficients and standard error clustered at state level. Model 1 allows the Endogeneity while Model 2 to Model 6 control for endogeneity issues. Wald test for exogeneity is rejected at 1% level. Weak instrument tests rejected at 1% level. Hausman test between Model 1 and Model 6 provide support for Model 6 at 1% level. ***, **, and * represent significant at 1%, 5%, and 10% respectively

Source: Author's Estimations

Table 4. Indirect Effects of Governance through Public Spending on Probability of Death.

Probability of dead	Voice and Accountability		Government effectiveness		Rule of law	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Average Per Capita Public Expenditure on Health in last five years	-0.101*	0.060	-0.102*	0.055	-0.125**	0.054
Voice and Accountability	-0.007	0.015	-0.025*	0.014	-0.013	0.014
Government effectiveness	-0.011	0.016	0.012	0.017	-0.005	0.013
Rule of law	-0.009	0.012	-0.008	0.011	0.009	0.013
Regulatory quality	0.015	0.012	0.014	0.010	0.008	0.010
Control of corruption	-0.016	0.017	-0.015	0.018	-0.009	0.016
Public spending × Voice and Accountability	-0.027	0.025				
Public spending × Government effectiveness			-0.032**	0.015		
Public spending × Rule of law					-0.034**	0.015
Public spending × Regulatory quality						
Public spending × Control of corruption						
var(_cons)	0.003	0.001	0.002	0.001	0.002	0.001
ICC	0.003	0.001	0.002	0.001	0.002	0.001
Log pseudolikelihood	-294404		-294402		-294403	

Probability of dead	Regulatory quality		Control of corruption		All	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Average Per Capita Public Expenditure on Health in last five years	-0.106**	0.053	-0.114**	0.054	-0.098*	0.060
Voice and Accountability	-0.021	0.015	-0.014	0.014	-0.016	0.016

Probability of dead	Regulatory quality		Control of corruption		All	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Government effectiveness	-0.001	0.014	-0.005	0.015	0.005	0.019
Rule of law	-0.005	0.011	-0.009	0.010	0.007	0.014
Regulatory quality	0.010	0.010	0.013	0.010	0.013	0.013
Control of corruption	-0.013	0.017	-0.012	0.025	-0.006	0.023
Public spending × Voice and Accountability					-0.023	0.019
Public spending × Government effectiveness					-0.031	0.027
Public spending × Rule of law					-0.023*	0.014
Public spending × Regulatory quality	0.022	0.017			-0.005	0.029
Public spending × Control of corruption			-0.002	0.042	-0.021	0.033
var(_cons)	0.002	0.001	0.003	0.001	0.002	0.001
ICC	0.002	0.001	0.003	0.001	0.002	0.001
Log pseudolikelihood	-294404		-294405		-294400	

Note: Coeff. and CSE stand for meprobit coefficients and standard error clustered at state level. Estimates are obtained addressing for endogeneity issues.

Source: Author's Estimations

The findings provide robust evidence of a negative and statistically significant association between public health spending and mortality probability. In other words, higher public spending is consistently associated with lower mortality at the individual level across Indian states. Moreover, the magnitude of this effect is stronger when public spending is treated as endogenous, suggesting that baseline estimates may underestimate the true impact. With respect to governance, the study does not find strong evidence of a direct effect of governance quality on mortality, although the associations are negative. However, two dimensions namely Government Effectiveness and Rule of Law emerge as important mediators. States with stronger institutions in these domains are more successful in translating higher public health expenditure into reduced mortality. For Voice and Accountability and Control of Corruption, the coefficients are negative but not statistically significant. Taken together, these results underscore that while public spending is a critical determinant of mortality reduction, the quality of governance conditions its effectiveness. States with more capable and effective governments achieve greater health gains from the same level of spending. These findings align with earlier evidence in the literature [25], reaffirming the dual role of resources and institutions in shaping health outcomes.

In contrast to much of the cross-country evidence, this study does not find a statistically significant effect of per capita income on mortality probability. These results are consistent with Farhani et al. [46], who also reported no impact of per capita state domestic product on mortality once

individual- and household-level covariates were taken into account. Unlike Farhani et al. [46], however, the present analysis additionally fails to establish a significant relationship between private out-of-pocket hospitalization expenditure and mortality, though the association remains negative.

Instead, the findings highlight the importance of household socio-economic position, as reflected in wealth quantiles. Mortality probability declines steadily with improvements in household wealth, suggesting that economic status at the micro level is more relevant for health outcomes than aggregate state income or private health spending. Interestingly, mortality is found to be lower in rural areas compared to urban areas: an opposite result to that of Farhani et al. [46]. A plausible explanation is the expanded reach of rural health interventions in recent years, including the strengthening of the National Rural Health Mission and related schemes. By contrast, urban health systems have received relatively less policy attention. Municipalities, despite their critical role in addressing public health challenges such as sanitation, pollution, road traffic injuries, and pandemic vulnerabilities, remain institutionally weak, possibly contributing to higher mortality in urban populations.

Basic sanitation access also emerges as a key determinant. Households with flush or other toilet facilities show significantly lower mortality probabilities, underscoring the well-established link between the absence of sanitation, poor hygiene, diarrheal infections, and higher health risks [47]. Similarly, exposure to household smoke is positively associated with mortality. Programs such as the Pradhan Mantri

Ujjwala Yojana, which promote clean cooking fuel, represent important policy responses, though behavioral shifts toward sustained use of clean energy remain critical.

The analysis also reveals notable socio-religious and caste differentials. Mortality probability is higher among Hindus compared to non-Hindus, and among Scheduled Castes and Scheduled Tribes relative to other social groups. Age patterns

conform to expectations, with the highest mortality observed among infants (0-1 years) and the elderly (80+ years). With respect to gender, males face higher mortality risks than females. However, the gender gap narrows as public health spending increases, suggesting that higher investment in public health infrastructure can mitigate gender disparities in survival (Figure 1).

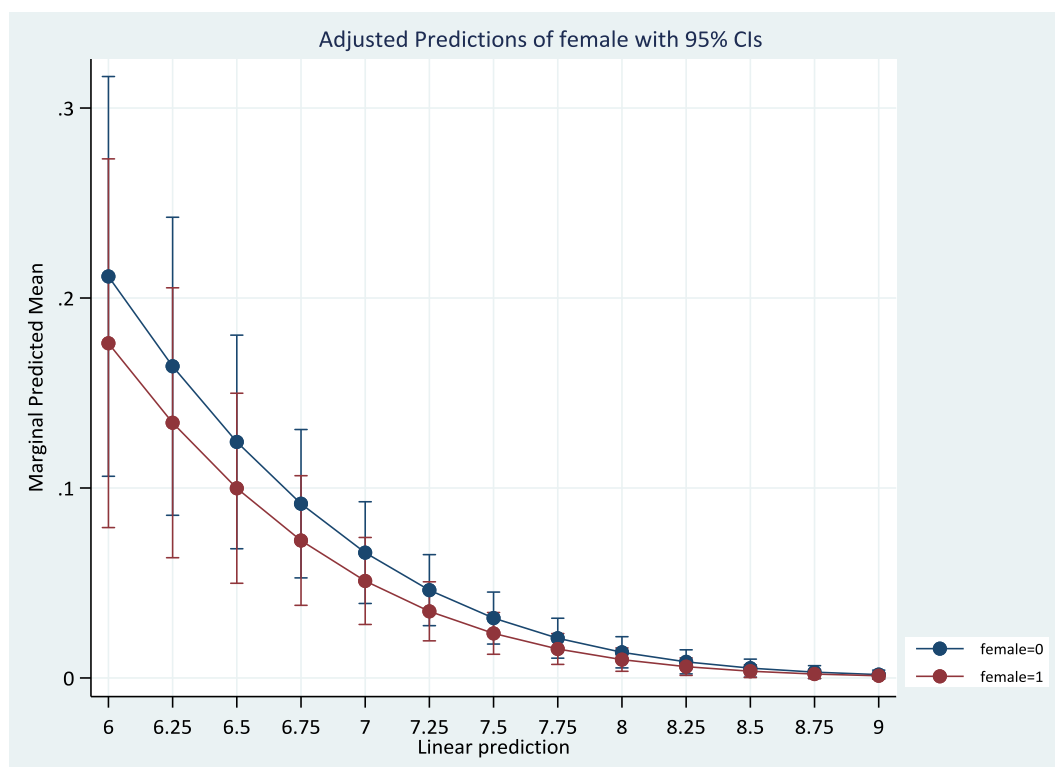


Figure 1. Public Spending and Predicted Mortality Probabilities across Gender.

Table 5 presents the results from the interaction analysis between per capita public health spending and key socio-demographic factors—place of residence (rural/urban), household wealth (quantiles), age groups, and gender. This framework allows us to examine whether the mortality-reducing effect of public spending is uniform or varies across different subpopulations. The results indicate clear heterogeneity across age groups and gender. Public health expenditure has the strongest effect in reducing mortality among young children (1–5 years), with smaller but still significant benefits for school-age and working-age adults. By contrast, spending shows little additional effect at very old ages (80+), where mortality risks remain high due to age-related conditions less responsive to public interventions. Gender interactions suggest that women benefit slightly more from public spending, contributing to a narrowing of the mortality gap between men and women.

By contrast, the interaction terms with wealth status and location of residence are not statistically significant, implying that the marginal effect of public spending is broadly similar across rural and urban areas as well as across wealth quintiles. Nonetheless, both factors retain strong and significant direct effects: mortality is lower among wealthier households and in rural areas relative to their counterparts. This suggests that while the distributional incidence of public spending may not differ systematically across these groups, underlying socio-economic and spatial disparities continue to shape health outcomes. Taken together, these findings suggest that the benefits of public health spending are not evenly distributed across the population. They are particularly pronounced for children and to some extent for women, while socio-economic and spatial inequalities persist largely through baseline differences rather than through the way public spending operates.

Table 5. Heterogeneous Effects of Public Spending on Probability of Death across Households and Individual Factors.

Probability of dead	Rural		Wealth Quantile		Age Group		Female		All	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
Average per Capita Public Expenditure on Health in last five years	-0.113**	0.056	-0.126**	0.053	-0.164**	0.075	-0.099**	0.053	-0.175***	0.066
Voice and Accountability	-0.014	0.014	-0.014	0.014	-0.014	0.014	-0.014	0.014	-0.014	0.014
Government effectiveness	-0.005	0.015	-0.005	0.016	-0.004	0.015	-0.005	0.016	-0.004	0.015
Rule of law	-0.010	0.011	-0.010	0.011	-0.008	0.010	-0.009	0.011	-0.008	0.011
Regulatory quality	0.013	0.010	0.013	0.010	0.012	0.010	0.013	0.010	0.012	0.010
Control of corruption	-0.013	0.017	-0.013	0.017	-0.013	0.017	-0.013	0.017	-0.013	0.017
Average per capita income in last five years	0.036	0.048	0.038	0.048	0.036	0.048	0.036	0.048	0.038	0.047
Average out-of-pocket health expenditure on hospitalization	-0.064	0.046	-0.065	0.045	-0.056	0.045	-0.063	0.046	-0.057	0.045
Rural	-0.020***	0.007	-0.019***	0.007	-0.019***	0.007	-0.020***	0.007	-0.019***	0.007
Wealth quantiles (base: poorest)										
Poorer	-0.015**	0.007	-0.016**	0.007	-0.015**	0.008	-0.015**	0.007	-0.016**	0.007
Middle	-0.044***	0.008	-0.045***	0.008	-0.043***	0.008	-0.044***	0.008	-0.044***	0.008
Richer	-0.070***	0.011	-0.071***	0.010	-0.070***	0.011	-0.070***	0.011	-0.070***	0.010
Richest	-0.141***	0.013	-0.142***	0.012	-0.141***	0.012	-0.141***	0.012	-0.142***	0.012
Age group (base: 0-1 year)										
1-5 year	-1.033***	0.034	-1.033***	0.034	-1.022***	0.015	-1.032***	0.034	-1.022***	0.015
5-18 year	-1.350***	0.037	-1.351***	0.037	-1.343***	0.026	-1.350***	0.037	-1.343***	0.026
18-45 year	-1.263***	0.031	-1.263***	0.031	-1.258***	0.021	-1.263***	0.031	-1.258***	0.022
45-80 year	-0.506***	0.025	-0.506***	0.025	-0.502***	0.021	-0.506***	0.025	-0.503***	0.021
80+ years	0.724***	0.030	0.724***	0.030	0.724***	0.031	0.724***	0.030	0.724***	0.031
Female	-0.171***	0.011	-0.171***	0.011	-0.171***	0.011	-0.172***	0.009	-0.171***	0.009
Public spending × Rural	-0.002	0.021							0.013	0.017
Public spending × Wealth quantiles (base: poorest)										
Poorer			0.006	0.011					0.007	0.011
Middle			0.001	0.016					0.006	0.015
Richer			0.030	0.020					0.037**	0.019
Richest			0.013	0.029					0.028	0.025
Public spending × Age group (base: 0-1 year)										
1-5 year					0.194***	0.027			0.194***	0.026
5-18 year					0.102*	0.060			0.101*	0.060

Probability of dead	Rural		Wealth Quantile		Age Group		Female		All	
	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE	Coeff.	CSE
18-45 year					0.110**	0.052			0.108**	0.053
45-80 year					0.028	0.058			0.026	0.059
80+ years					-0.087	0.079			-0.088	0.080
Public spending × Female							-0.036*	0.022	-0.032	0.021
Constant										
var(_cons)	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001
ICC	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001
Log pseudolikelihood	-294405		-294401		-294238		-294393		-294221	

Note: Coeff. and CSE stand for meprobit coefficients and standard error clustered at state level. Estimates are obtained addressing for endogeneity issues.

Source: Author's Estimations

4. Random Intercept and Slope Effects: Evidence from Indian States

We now extend the analysis by examining the random intercepts and slopes in relation to mortality probabilities. This approach allows us to capture not only the baseline variation in mortality across states but also how the impact of public

health spending differs regionally. By permitting both the intercepts and the coefficients of public spending to vary randomly across states, the results reveal substantial interstate heterogeneity in the spending–mortality relationship. The evidence for this heterogeneity is strong: the estimated standard deviations of both the intercept and slope residuals are more than four times larger than their corresponding standard errors, confirming statistically significant variation across Indian states (Table 6).

Table 6. Intercept and Slope Residuals.

Random effects	Estimate	Standard Error	95% LL	95% UL
States: Independent				
sd(public spending)	0.213	0.056	0.127	0.357
sd(_cons)	0.172	0.035	0.116	0.257

Table 6 provides the variance components of the random effects model. The estimated standard deviation of the random slope for public health spending is 0.213, with a 95% confidence interval ranging from 0.127 to 0.357. Since the lower bound is well above zero, this confirms substantial variation across states in how additional public spending affects mortality. Some states derive much larger mortality reductions from each additional unit of spending, while others

show weaker or even negligible effects. Similarly, the standard deviation of the random intercept is 0.172, with a confidence interval of 0.116–0.257. This indicates that baseline mortality risks, before accounting for spending, also vary significantly across states. Taken together, these variance estimates validate that both starting points (intercepts) and responsiveness to spending (slopes) are far from uniform across Indian subnational units.

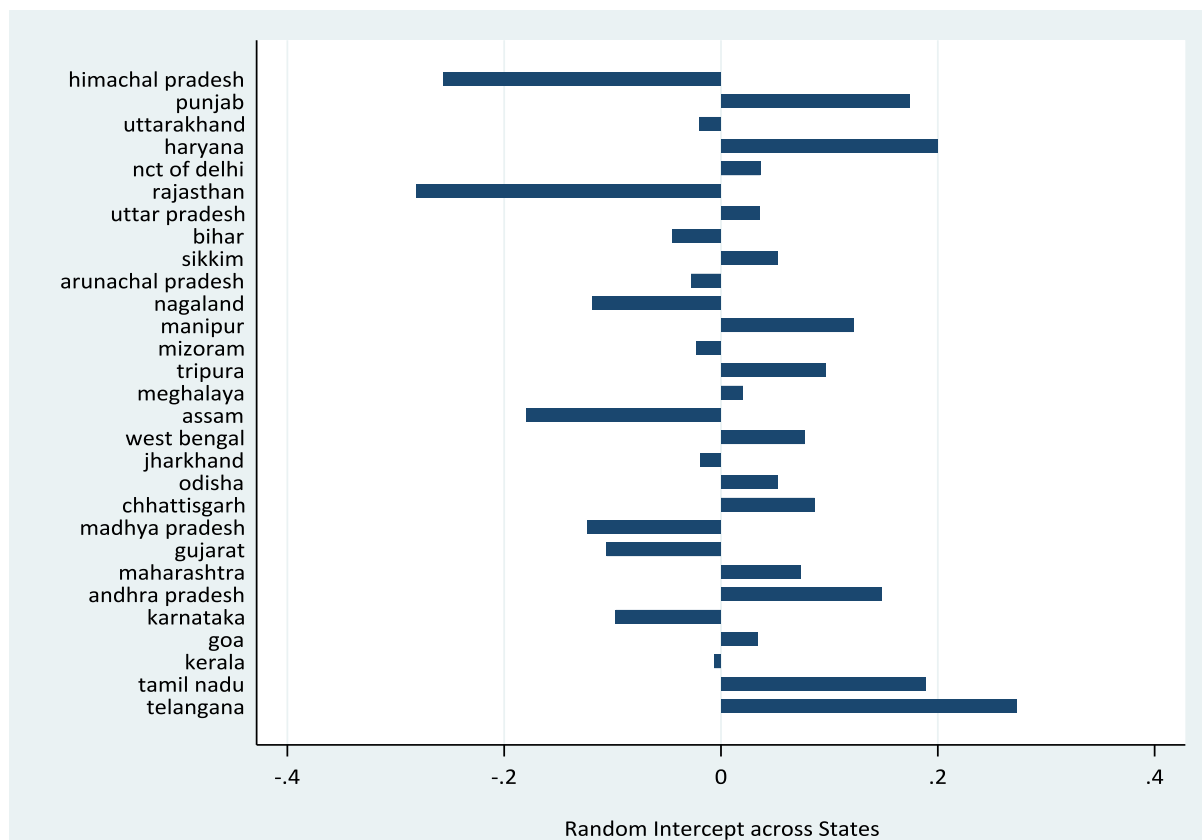


Figure 2. Random Intercept Effects.

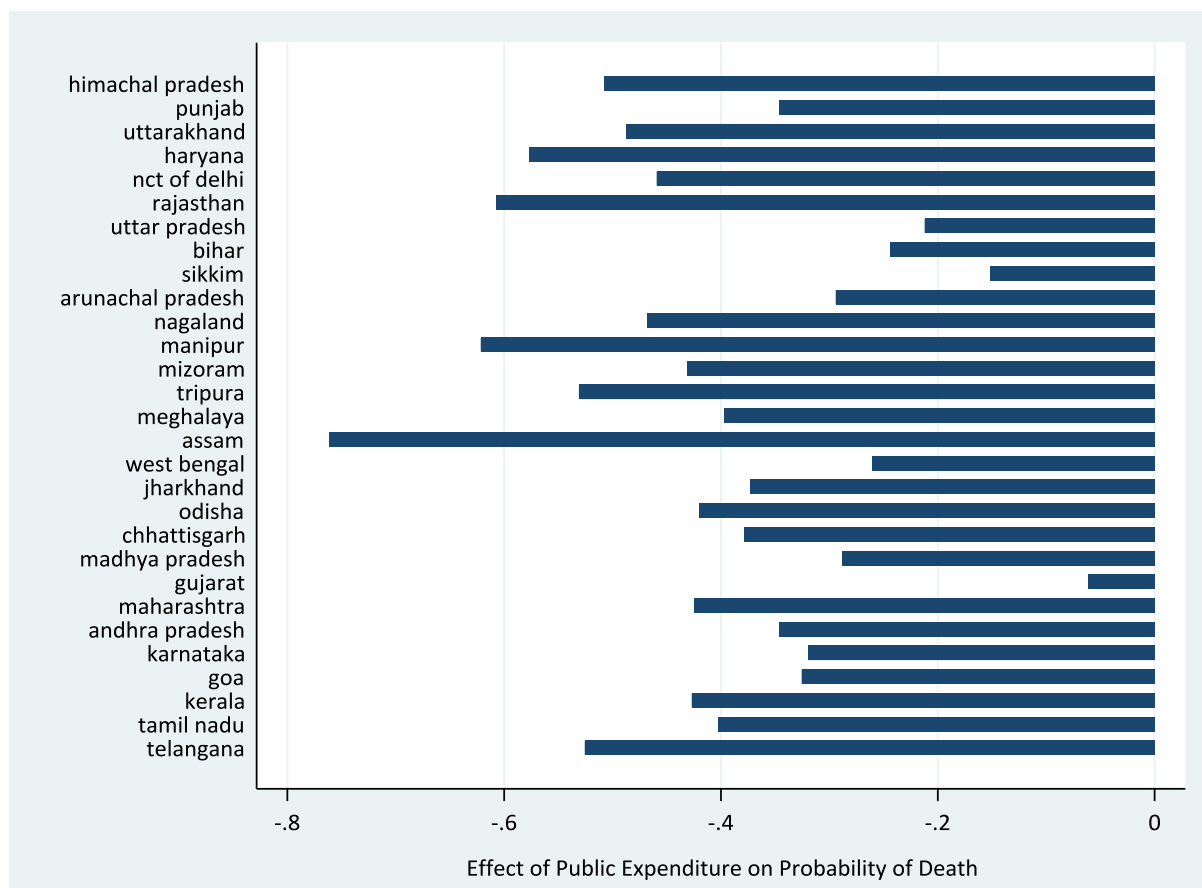


Figure 3. Random Slope Effects of Public Spending.

Figure 2 illustrates these random intercept effects graphically. States such as Punjab, Uttarakhand, and Kerala have higher intercepts, indicating elevated baseline mortality probabilities, while Himachal Pradesh, Rajasthan, and West Bengal have lower intercepts, implying relatively better initial health outcomes. These results are consistent with earlier research [25, 48], which highlights that even after controlling for individual and household characteristics, substantial cross-regional disparities in health outcomes persist due to demographic profiles, historical public health investments, and institutional quality.

Figure 3 depicts the random slope effects of public health expenditure. In almost all states, the slope is negative, confirming that increased public spending reduces mortality probabilities. However, the magnitude varies widely. For instance, Assam, West Bengal, and Rajasthan show steep negative slopes, implying that additional spending translates into significant mortality reductions. In contrast, states such as Kerala, Goa, and Telangana display flatter slopes, suggesting smaller marginal gains. This heterogeneity resonates with the findings of Farahani et al. [46], who show that the effect of health spending is conditional on governance, and Barenberg et al. [45], who argue that states with stronger fiscal capacity and administrative effectiveness realize more benefits from public expenditure.

The broader implication of these results is that public spending works, but not equally everywhere. States differ not only in their baseline mortality (intercepts) but also in their efficiency in converting spending into health gains (slopes). As Makuta & O'Hare [24] observed in Sub-Saharan Africa, "money matters, but institutions matter more." In the Indian case, this means that central transfers alone cannot close mortality gaps; state-level governance capacity and health system efficiency must also be strengthened to ensure that higher spending translates into real survival gains.

5. Conclusion

This study examined the effect of public health spending on mortality in India, using a multilevel probit framework with individual, household, and state-level covariates. By addressing potential endogeneity and explicitly modeling random intercepts and slopes, the analysis demonstrates that higher public spending reduces mortality probabilities. However, the benefits are uneven: baseline mortality risks and the responsiveness to spending vary significantly across states, reflecting both structural disparities and differences in institutional capacity.

The results highlight several important findings. Aggregate income and private out-of-pocket spending do not exert a significant effect on mortality, but household socio-economic status, sanitation access, and exposure to household smoke are strong predictors. Mortality risks are higher among Scheduled Castes/Scheduled Tribes and Hindus relative to other groups, and among infants (0-1 years) and the elderly (80+ years).

Men face higher mortality probabilities than women, though this gender gap narrows with greater public health spending. Interestingly, mortality is found to be lower in rural areas compared to urban areas, suggesting that recent expansions of rural health programs have been effective, while urban health systems remain underdeveloped.

At the state level, the interaction analysis shows that the effect of spending is broadly similar across rural-urban locations and wealth groups but varies significantly across age groups and gender. Random intercepts reveal wide disparities in baseline mortality across states, while random slopes confirm that the marginal effect of public spending differs sharply across regions. These findings are consistent with earlier evidence that institutional quality mediates the effectiveness of health spending. In particular, government effectiveness and rule of law appear to be critical channels through which spending translates into survival gains.

The contributions of this paper are threefold. First, it uses large-scale microdata (NFHS-5) to analyze health spending effects within India's federal system, uncovering heterogeneity that national-level analyses obscure. Second, it integrates governance quality directly into the analysis, showing that institutional dimensions condition the impact of fiscal allocations. Third, it employs random effects to identify variation in both baseline mortality and the responsiveness of spending; an aspect rarely examined in the Indian context.

The study also has limitations. Reliance on cross-sectional data constrains causal inference and prevents examination of dynamic feedback between health and spending. Data limitations preclude district-level analysis, masking possible intra-state variation. The mortality measure is broad and not disaggregated by cause, limiting insights into differential effects on communicable versus non-communicable diseases. Finally, while instrumental variables were used, the complexity of budgetary decisions means some residual endogeneity may remain.

Despite these caveats, the findings yield clear policy implications. India's public health spending is far below international benchmarks and the goals of the National Health Policy (2017), making higher allocations urgent. Yet increasing spending alone is not enough; improvements in governance, transparency, and implementation capacity are essential to ensure effective use of resources. Policy priorities must also shift to address the growing burden of non-communicable diseases, while urban health systems, often neglected, require urgent strengthening. For the Union government and the Finance Commission, the evidence highlights a dual challenge: bridging fiscal gaps through enhanced transfers while also incentivizing governance reforms that improve states' ability to translate resources into health outcomes.

Abbreviations

IIPS International Institute for Population Sciences

IMR	Infant Mortality Rate
INR	Indian Rupee
MDGs	Millennium Development Goals
MMR	Maternal Mortality Ratio
NFHS	National Family Health Survey
OOP	Out-of-pocket
OTR	Own Tax Revenue
PAI	Public Affairs Center
SDGs	Sustainable Development Goals

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Author Contributions

Bhabesh Hazarika: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing

Ankit Singh: Data curation, Investigation, Validation, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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ⁱ meprobit fits mixed-effects models for binary or binomial responses. The conditional distribution of the response given the random effects is assumed to be Bernoulli, with success probability determined by the standard normal cumulative distribution function.