Does More Funding Mean Better Health? A State-Level Analysis of Public Health Expenditure in India

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Abstract. In an effort to enhance government health expenditures and improve state-level health facilities, the Central Government of India adopted the Millennium Development Goals (MDGs) in 2000, launched the National Health Mission (NHM) in 2013, and most recently implemented the National Health Policy (NHP) in 2017. This study looks at how public health spending affects important health outcomes, such as the infant mortality rate, neonatal mortality rate, fertility rate, and malaria cases. It takes into account per capita income and spending on water supply and sanitation. The research examines 16 major states from 2000 to 2021. Additionally, it compares the effects of public health spending in both high-performing and under-performing states. The study used secondary data from the Sample Registration System (SRS), Economic Political Weekly Research Foundation (EPWRF), and the annual RBI state finances report. Based on the Hausman test, the study uses panel fixed-effects and random-effects models where suitable. Empirical findings show that overall public health spending decreases malaria cases, infant mortality, and neonatal mortality rates. The study also finds no significant impact between Public health spending and health outcomes, especially in under-performing states. Indian states should boost capital health spending to improve health infrastructure and consider public-private partnerships. This is important for achieving better health outcomes. This study provides key suggestions for shaping public health policy in developing countries.

Keywords: Public Health Expenditure, Health Indicators, High Performing States, Under Performing States, Fixed Effect Model, Random Effect Model.

1. Introduction

The human development paradigm effectively challenges the assumed automatic correlation between increasing affluence and expanding human opportunities. Achieving a high standard of health is a fundamental human right and is crucial for mitigating socioeconomic disparities (Backman et al., 2008). The availability, timely access, and affordability of healthcare services form the foundation for improved health outcomes and reduced financial risks for the majority of the population (WHO, 2010). India, as an emerging nation, has recently undertaken measures to augment public healthcare expenditure (PHE). According to the national health account report 2021, government health expenditure increased from 1.13 per cent of GDP in 2014-15 to 1.84% in 2021-22, as shown in Fig. 1, although this remains below the global average, estimated at 10.4% of GDP. Within the country's Total Health Expenditure (THE), the proportion of government health spending rose from 29% to 48% between 2014–15 and 2021–22, as shown in Figure. 2. Bennett et al. (2010) explained that patients, especially those with low incomes, may suffer greatly from an increase in out-of-pocket medical expenses, which could result in a lack of use of healthcare services and ultimately in poor health. Given that India has historically experienced some of the highest out-of-pocket healthcare costs globally, Fig. 2 shows that the recent decline in out-of-pocket expense (OOPE) from 64.2% of total health expenditure in 2013 to 39.4% in 2021 is a positive sign. The steady drop in overall health spending supports the significant efforts made by the government to reach financial stability and Universal Health Coverage for its citizens. Universal Health Coverage means organized healthcare systems that allow people to access basic healthcare without financial obstacles (Abiiro and Allegri, 2015). Consequently, the CAG report indicates that healthcare access in India has improved due to the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB PM-JAY) program. Over 35 crore Ayushman cards have been distributed, and the scheme now covers senior citizens over 70 years of age, irrespective of their income, providing a measure of free health coverage to

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nearly 60 million individuals, according to the Ministry of Health and Family Welfare. In FY24, full immunization coverage nationwide reached 93.5%, facilitated by the Universal Immunization Programme (UIP), which offers 11 vaccines at no cost and protects against 12 vaccine-preventable diseases. The Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP) scheme has made significant progress toward the goal of providing economical medicines with record sales in 2021 and more than 8300 Kendras across the country. India has partially achieved the MDGs' targets. India stands at 132 out of 191 countries in the 2021 Human Development Report. Rao and Choudhary (2012) and Behra and Dash (2020) consider the low Public Health Expenditure (PHE) level to be one of the reasons for India's poorer healthcare metrics. Bhalotra (2007) claimed that India's low PHE level has created an underdeveloped health system. Very few studies have been conducted on the PHE and the health status nexus in either dimension. The government needed to be more active in the healthcare system. The literature examining the relationship between public healthcare expenditure and health outcomes presents mixed findings. Certain studies report positive effects (Wolfe, 1986; Farahani et.al., 2009 , Subramanian and Canning, 2009; Boachie and Ramu, 2015; Barenberg et al., 2017; Mohanty & Behera, 2020), whereas others indicate negative or statistically insignificant effects (LeGrand, 1987; Grigoli and Kapsoli, 2013; Filmer and Pritchett, 1997; Kumar et al., 2013; Byaro and Musonda, 2016; Onabote et al., 2023).Research on this critical issue is limited to Indian states.

However, due to constraints such as insufficient financial resources, low prioritization of spending, limited absorption capacities, and inefficient expenditure, Indian states continue to face persistent disparities in health-related developmental outcomes (Durairaj and Evans, 2010; Behera and Dash, 2019; Mohanty and Bhanumurthy, 2021). The question remains: Does investment in public healthcare improve health outcomes in India? Does it have a positive or negative effect on health outcomes? What factors are important for improving health outcomes in India? How does public health spending affect different states? Research is needed to assess its impact on health outcomes. A preliminary evaluation indicates that while substantial research has occurred in low-income regions like African countries such as Nigeria, Uganda, and Ghana, along with some developed nations, there are few studies on this topic in India, which is a rapidly developing economy.

This study looks at the impact of public health spending on health indicators across 16 major states from 2000 to 2021, taking income level and basic health infrastructure into account. Public health spending has been studied primarily in relation to its impact on the Infant Mortality Rate (IMR) metric alone. This study attempts to fill a gap in the literature by analyzing health outcomes such as neonatal mortality rate (NNM), Infant Mortality Rate, Total Fertility Rate, and the incidence of diseases such as malaria, which encapsulate mortality, fertility, and morbidity.

In the present study, 16 states are included:, Rajasthan, Assam, Tamil Nadu, Bihar, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Andhra Pradesh, Uttar Pradesh and West Bengal. They selected these states for three reasons. First, geographically, they approximately represent the entire nation. For instance, Kerala, Tamil Nadu, Andhra Pradesh, and Karnataka are located in the South, and Maharashtra and Gujarat are in the West. It is bordered by Madhya Pradesh, Uttar Pradesh, Rajasthan, Himachal Pradesh, Punjab, and Haryana in the north. On the east are Bihar, Odisha, West Bengal, and Assam. Second, based on the GDP contribution according to the Ministry of Statistics, 2022-23, these are states together forming 85.91% of India's GDP, that is effectively two-thirds of India's GDP. Thirdly, health outcomes, according to the Sample Registration Report (SRS) 2021, show that Bihar had the highest Total Fertility Rate (TFR) at 3, while Tamil Nadu and West Bengal had the lowest TFR at 1.4. In 2021, Madhya Pradesh had the highest Infant Mortality Rate (IMR) at 41 per 1,000 live births, compared to Kerala's lowest rate at 6. Lastly, regarding per capita income, Tamil Nadu, Karnataka, Gujarat, and Haryana rank among the top 10 states. Meanwhile, Assam, Uttar Pradesh, and Bihar are at the bottom, based on the Ministry of Statistics report for 2023-24.

States are categorized into the following two types of groups in the study: High Performing States (HPS) and Under Performing States (UPS). Use Bihar, Odisha, UP, Rajasthan, Madhya Pradesh and Assam in place of these states for UPS. The HPS includes Kerala, Tamil Nadu, Gujarat, West Bengal, Karnataka and Maharashtra. The latter

distinction rests upon the following three bases.First, on the GDP contribution. The HPS states contribute 50 per cent of the country's GDP, while the UPS states account for 25.56 per cent. Second, in terms of health performance, HPS states have an average infant mortality rate (IMR) of 16.83, compared to 35.33 in the UPS states in 2021, as reported by the SRS report 2021.This means the UPS rate is more than double the HPS rate. Similarly, in terms of Total Fertility Rate (TFR), HPS states average 1.58, while UPS states have a TFR of 2.43, which is over 50% higher than that of HPS. Third, in per capita income, HPS states average Rs 207,170, whereas UPS states earn less than half that, at Rs 87,798 in 2019-20, according to National Statistical Office data. These statistics clearly show the difference in public health spending effects between high and under performing states.

The paper moves in two stages. First, it looks at the effect of public health spending on select health outcomes using panel models across 16 major Indian states from 2000 to 2021. Next, it compares the impact of public health spending between high and under performing states.

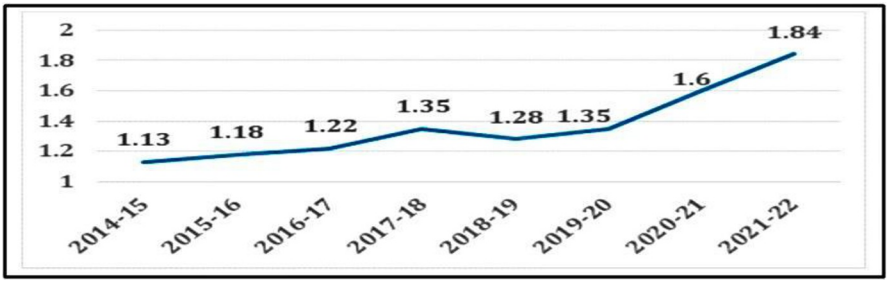

Figure 1: Government health spending (GHE) as a proportion of GDP (gross domestic product). Source: National Health Account Report

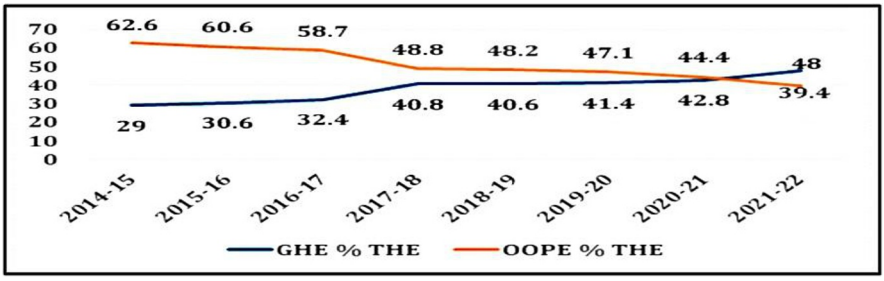

Figure 2: Out-of-pocket expenses (OOPE) and government health expenditures (GHE) as a percentage of total health expenditures (THE). Source: National Health Account Report

1.1 Trends of health indicators pre and post covid-19

Figure 3 shows the trends in health indicators. The Sample Registration Report 2021 mentioned that the country's Infant Mortality Rate (IMR) has declined from 34 in 2016 to 27 in 2021. The scores dropped an average of 7 points over the last 5 years, or 1.4 points per year. The rural IMR has declined by 8 points (from 38 in 2016 to 30 in 2021). Urban IMR dropped by 5 points, from 23 in 2016 to 18 in 2021. The Total Fertility Rate (TFR) per woman for 2020 and 2021 was 2.0. On average, a rural woman, with a TFR of 2.2, will have around one more child than an urban

woman, whose TFR is 1.6. At the national level, the TFR went down by 0.3 points from 2016 to 2021, falling by 0.3 points in rural areas and 0.2 points in urban areas. The national Crude Birth Rate (CBR) of 2021 is 19.3, 0.2 lower than that of 2020. The national CBR experienced a decline of 1.1 points between 2016 and 2021, with a reduction of 1.2 points and 0.1 points in the rural and urban areas, respectively. In contrast, the country's Crude Death Rate (CDR) rose from 6.0 in 2020 to 7.5 in 2021, with a 1.5-point difference in just one year. The rising death rate is mostly because of COVID-19. The pandemic has significantly impacted the healthcare sector worldwide. India was one of the hardest-hit countries during this crisis. According to the World Health Organization, over 530,000 people in India have died from COVID-19, as the country faced three major waves of the virus, making it the third most affected country in the world after the USA and Brazil.

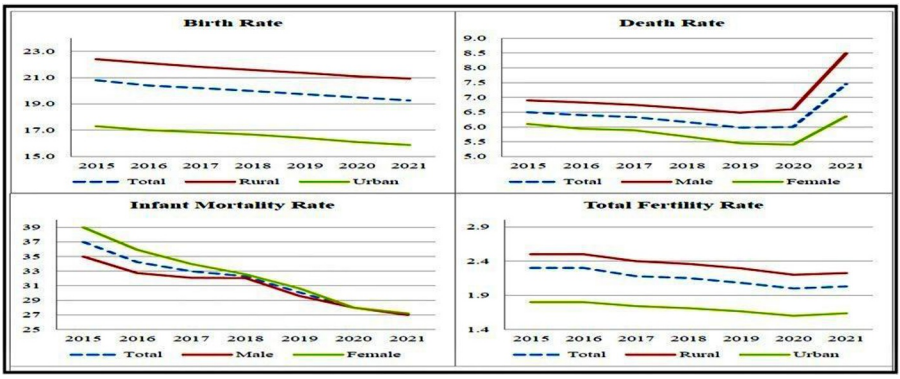

Figure 3: Trends of birth rate, Death Rate, Infant Mortality Rate and Total Fertility Rate in India. Source: Sample Registration System (SRS), Census of India.

Following the introduction, the remainder of the study is organized as follows: Section 2 provides a selected review of the issue and summary statistics. The data and methodology of the study are detailed in Section 3. Section 4 focuses on empirical analysis and discussion of the results. The conclusion and policy implications are provided in Section 5.

2. Literature review

2.1. Studies outside India

Governments use public health spending as a policy tool to improve the health of their populations. As a result, healthcare delivery systems and how they are used have been closely studied over the last thirty years (Berger and Messer, 2002; Kofi Boachie et al., 2018). Boachie and Ramu (2015) argue that public health spending, among other factors, has helped lower or stabilize Ghana's infant mortality rate. Becchetti et al., (2017) analyzed the impact of health spending on health outcomes for a large group of Europeans aged 50 and older, using both individual and regional data. Their results show that health spending, both as a percentage of GDP and per person, negatively and significantly influences the prevalence of chronic diseases. (Kato et al., (2018) applied the Simple Ordinary Least Squares (OLS) approach in Uganda and concluded that persistent health costs, capital expenditures for health, women's literacy ratio, and urban population proportions significantly correlate with under-five mortality rates. Shafuda and De (2020) established a considerable negative relationship between government healthcare expenditure and fertility rate, neonatal mortality rate, and under-five mortality rate over time in Namibia. Umaru et al., (2022)

employed the Vector Autoregressive model (VAR) to demonstrate that government expenditure on health has a negative impact on infant mortality in Nigeria. Sultana et al., (2024) studied Bangladesh from 1990 to 2019 and found that the government health budget played a significant role in lowering maternal and child mortality rates and in increasing life expectancy. Factors contributing to this include government funds directed to improve hospital bed availability and hiring enough doctors for underserved areas.

On the other hand, many studies suggest that the effect of government health spending on health outcomes is not significant. Musgrove (1996) conducted two studies on the connection between health spending and child mortality and found no significant relationship. The studies concluded that public health investment simply replaces out-of-pocket (OOP) health spending, thus having no effect on child mortality. Filmer and Pritchett (1997) reported that health spending has a minor effect on newborn and child health, contradicting Hanmer et al., (2003), who argued that health interventions can significantly impact infant and child health. Grigoli and Kapsoli (2013) found that public health spending had no meaningful effect on health outcomes when it was inefficient in emerging and developing nations. Byaro and Musonda (2016) noted that changes in government health spending from 1995 to 2013 did not affect health outcomes in Tanzania, especially infant and under-five mortality rates. Dhrifi (2019) found that health spending only improved child mortality in upper-middle and high-income countries, with no significant impact in low and lower-middle-income countries. Onabote et al., (2023) used the Autoregressive Distributed Lag (ARDL) model and discovered no connection between government spending and human growth in Nigeria from 1986 to 2021, blaming this on high levels of corruption.

2.2. India studies

This section discusses various studies conducted in India. Kaur and Misra (2003) examined data from 15 states between 1985 and 2001 and found a weak link between public spending and health, indicating that health spending is insufficient. Access to infrastructure seems to play a crucial role in lowering infant mortality. In addressing health disparities related to gender and urban-rural divides, education is seen as more important than state funding. Farahani et al., (2010) used data for all 26 Indian states from 1998 to 1999 and found that a 10% increase in health spending in India led to a 2% decrease in the average number of deaths, with significant effects on women, the elderly, and senior adults. Gopalakrishnan and Rao (2012) discovered a positive relationship between public expenditure and human development. Kumar et al., (2013) examined time-series cross-sectional data for 1985-2009. They used varying regression models and concluded that increased government health expenditure does not produce improved health outcomes in India. There is an urgent need to address the disparities in public health spending across states. The Empowered Action Group (EAG) states should receive more funding for public health due to their poorer health outcomes compared to other states. Makla et al., (2013) used a mixed regression model and found no significant link between public health spending and child mortality in the 1-4 age group, suggesting that investment in health alone is not enough to affect child mortality in India from 1997 to 2009. Mulagund (2015) discovered that public health spending in India obstructs the reduction of maternal mortality rates (MMR), infant mortality rates (IMR), total fertility rates (TFR), and life expectancy growth. Research shows that more government spending on health and education leads to better human development. Kulkarni (2016) noted that increased government spending is linked to higher IMR or lower health outcomes, emphasizing the need for improvements in service delivery quality and funding mechanisms for public health spending efficiency in BRICS nations. Das (2017) used data from the National Family Health Survey to show the advantages of increased government spending on maternal and child healthcare in India. Barenberg et al., (2017) noted that a 1% increase in government-level net domestic product reduces infant mortality in India by about nine deaths per 1,000 live births. Mohapatra (2019) found that the revenue part of public spending significantly affects health outcomes, while the capital part does not. Mohanty and Behera (2023) used a fixed-effects panel model to investigate 28 Indian states, discovering that per capita health care spending positively and significantly affects life expectancy and immunization while negatively impacting infant mortality, child mortality, and malaria cases. The descriptive statistics and pair wise correlation for Indian states is

shown in table 1. The study also segregated it for underperforming and high performing states which is summarized in table 2 and table 3 respectively.

Summary Statistics

Table 1: Summary statistics, and pair-wise correlations of variables of Indian states. *Source*: Author's calculation

				CORRELATION		
VARIABLE	**OBS**	**MEAN**	**SD**	**PCPHE**	**PCGSDP**	**PCWSSE**
BR	352	21.03	4.914	-0.524	-0.672	-0.237
DR	352	7.19	1.02	-0.279	-0.449	-0.265
IMR	352	42.7	18.9	-0.578	-0.729	-0.3335
TFR	352	2.38	0.746	-0.5341	-0.663	-0.291
NNM	352	28.1	11.9	-0.551	-0.706	-0.292
CMR	336	12.94	6.36	-0.5787	-0.740	-0.349
MALRIA	336	1.20	2.28	-0.227	-0.234	-0.135
PCPHE	352	721.52	470.84			
PCGSDP	352	79160.7	44389.1			
PCWSSE	352	428.87	459.65			

Table 2: Summary statistics, and pair-wise correlations of variables of Underperforming states. *Source*: Author's calculation

				CORRELATION		
VARIABLE	**OBS**	**MEAN**	**SD**	**PCPHE**	**PCGSDP**	**PCWSSE**
BR	132	25.77	3.64	-0.678	-0.745	-0.601
DR	132	7.76	1.23	-0.503	-0.465	-0.560
IMR	132	56.81	15.86	-0.653	-0.591	-0.669
TFR	132	3.06	0.70	-0.693	-0.784	-0.609
NNM	132	36.60	9.90	-0.665	-0.495	-0.621
CMR	126	17.55	5.10	-0.645	-0.579	-0.661
MALRIA	126	2.15	3.37	-0.113	0.045	-0.170
PCPHE	132	564.41	358.70			
PCGSDP	132	45756.9	20412.5			
PCWSSE	132	405.200	422.56			

Table 3: Summary statistics, and pair-wise correlations of variables of High Performing states. *Source*: Author's calculation

				CORRELATION		
VARIABLE	**OBS**	**MEAN**	**SD**	**PCPHE**	**PCGSDP**	**PCWSSE**
BR	132	17.8	2.88	-0.54	-0.406	-0.133
DR	132	6.76	0.68	-0.009	-0.146	-0.100
IMR	132	30.1	14.6	-0.681	-0.590	-0.342

TFR	132	1.94	0.35	-0.534	-0.427	-0.214
NNM	132	20.3	9.83	-0.690	-0.587	-0.330
CMR	126	9.77	6.24	-0.627	-0.658	-0.351
MALRIA	126	0.706	0.81	-0.550	-0.529	-0.326
PCPHE	132	725.37	372.33			
PCGSDP	132	100299	44337.7			
PCWSSE	132	299.38	213.47			

3. Research design and methodology.

The study used annual panel data from 16 major Indian states, based on secondary data from 2000 to 2021. This period was selected due to important policy changes in India, including the Millennium Development Goals (MDGs) in 2000, the National Rural Health Mission in 2005, the National Health Mission in 2013, the Sustainable Development Goals (SDGs) in 2015, the National Health Policy (NHP) in 2017, and the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB PM-JAY) program in 2018. This timeframe allows for an evaluation of the effects of increased funding in the healthcare sector. The primary independent variable is per capita real public health expenditure (PCPHE). The focus is on public healthcare expenditure, which includes medical and public health costs, along with family welfare programs. Data on public health expenditure came from the annual State Finance Reports of the Reserve Bank of India (RBI).

Per capita real water supply and sanitation (PCWSSE) is the control variable. Better water and sanitation can reduce the risk of death for children under five by approximately 5 to 20% and reduce diarrhea rates in children by 7 to 17% (Gunther and Fink, 2010). Public spending on water supply and sanitation is regarded as essential basic infrastructure for public health, economic development, and people's well-being (Joardar, 1998). Data on public spending in these areas can be found in annual India's State Finance Reports. Another control variable is the per capita Gross State Domestic Product (GSDP). Income can affect health outcomes through various indirect ways, such as better housing, sanitation, and nutrition (Filmer and Pritchett, 1999). The data on GSDP at factor cost were taken from the "Handbook of Statistics on the Indian Economy," released annually by the Reserve Bank of India. Per capita were calculated by the estimated population of the states for each year to obtain per capita values. Population data was obtained from the "Population Projections for India and States" report published by the Office of the Registrar General and Census Commissioner, Government of India. Real per capita government health expenditure, real per capita GSDP, and real water supply and sanitation were estimated by adjusting nominal spending state-by-state with the relevant GSDP deflators. Nominal data were deflated to real (constant) at constant prices (2011-12 = 100).

Researchers have identified several health outcome variables that influence public health expenditure (PHE) significantly. Anand and Ravallion (1993) noted three main measures of health spending: life expectancy at birth, infant mortality rate, and mortality rate for children under five. Pritchett and Summers (1996), Filmer and Pritchett (1997), Anyanwu and Erhijakpor (2007), and Kumar et al., (2013) have recognized infant and under-five mortality rates as strong indicators of health conditions. Barenberg et al. (2017) focused on the infant mortality rate, while Mohanty and Behra (2023) considered infant mortality rate, child mortality rate, life expectancy, malaria cases, and immunization. Mohapatra (2016) looked at six health indicators: Infant Mortality Rate (IMR), Child or Under-Five Mortality Rate (CMR), Neonatal Mortality Rate (NNR), Total Fertility Rate (TFR), the percentage of children aged three years born to ever-married women classified as underweight (UWT), reflecting children's nutritional status, and the number of people per thousand suffering from Tuberculosis (TB).

To summarize, this study examined four health outcomes: Infant Mortality Rate (IMR), Neonatal Mortality Rate (NNM), Total Fertility Rate (TFR), and per thousand malaria cases (MAL). These outcomes were chosen because

they reflect three important parameters: mortality, fertility, and morbidity indicators of health status. Data for IMR, NNM, and TFR were sourced from the annual Sample Registration System (SRS) Bulletins by the Office of the Registrar General & Census Commissioner, Government of India. Data for malaria cases came from the EPW Research Foundation (EPWRF) India Time Series. The Infant Mortality Rate is the number of deaths of infants under one year of age per 1,000 live births in a given year. The Total Fertility Rate (TFR) shows the average number of children a woman is expected to have during her lifetime, based on current age-specific fertility rates, as long as she lives through her childbearing years. The Neonatal Mortality Rate (NNM) is the number of deaths of infants under 28 days of age per 1,000 live births. Per thousand malaria cases refers to the number of malaria cases per thousand reported in a year.

The model is specified as follows: The model is specified as follows:

$$Y_{it} = \alpha_1 + \alpha_2 X_{it} + \alpha_3 Z_{it} + v_i + e_{it}$$

In this model, "i" denotes states, and "t" represents time. The dependent variable, Y_{it}, encompasses various health outcomes, including the Infant Mortality Rate (IMR), Neonatal (NNM), Total Fertility Rate (TFR), and malaria cases per thousand (MAL). The explanatory variable, X_{it}, is defined as per capita real public health expenditure (PCPHE), while the control variable, Z_{it}, includes per capita real water supply and sanitation (PCWSSE) and per capita real Gross State Domestic Product (PCGSDP). The parameter $_1$ represents the intercept and constant term. The v_i represents the effects of the omitted variables that do not change over time and can affect the state's health outcome. The e_{it} error term is termed the idiosyncratic or time-varying error.

In terms of methodology, both fixed and random effect models were used. The state-specific effects vi are considered as fixed rather than random. Unobserved determinants such as literacy rates, other health infrastructures, and public policies can influence health outcomes in this analysis. In addition, the selection of Indian states used in this study was purposefully and methodically chosen instead of randomly, making it appropriate to employ the fixed effects model. Since v_i is believed to refer to one or more x_{it}, the motive for employing a fixed effect is to eliminate it. When α_1 is determined to be uncorrelated with or independent of the explanatory variables throughout all periods, equations (1–4) are converted into a random-effects model (RE). Therefore, the Hausman test can be used to confirm this. Based on various regression parameters, the Hausman test results recommend both fixed and random effect models. This statistical method facilitates the management of unobservable, time-invariant characteristics specific to each state. These characteristics are exceptionally difficult to measure, and neglecting them could result in omitted variable bias within regression models.

The estimated panel regression equations are as follows:

$$\ln IMR_{it} = \alpha_1 + \beta_1 \ln PCPHE_{it} + \beta_2 \ln PCWSSE_{it} + \beta_3 \ln PCGSDP_{it} + v_i + e_{it} \quad (1)$$

$$\ln NNM_{it} = \alpha_1 + \beta_1 \ln PCPHE_{it} + \beta_2 \ln PCWSSE_{it} + \beta_3 \ln PCGSDP_{it} + v_i + e_{it} \quad (2)$$

$$\ln TFR_{it} = \alpha_1 + \beta_1 \ln PCPHE_{it} + \beta_2 \ln PCWSSE_{it} + \beta_3 \ln PCGSDP_{it} + v_i + e_{it} \quad (3)$$

$$\ln MAL_{it} = \alpha_1 + \beta_1 \ln PCPHE_{it} + \beta_2 \ln PCWSSE_{it} + \beta_3 \ln PCGSDP_{it} + v_i + e_{it} \quad (4)$$

We transformed the variables into a logarithmic form for the following reasons. Firstly, regression analysis can be significantly influenced by outliers in one or both variables; thus, the log–log specification reduces skewness and standardizes the data. Given the variables employed in the selected panel regressions, we prefer the logarithmic form. Secondly, this approach facilitates the measurement of elasticity and simplifies the interpretation of coefficient values, which denote percentage changes in one variable relative to others. In these equations, lnIMR denotes the

logarithm of the infant mortality rate; lnNNM, the logarithm of the neo natal mortality rate; lnTFR, the logarithm of the total fertility rate; and lnMAL, the logarithm of per thousand malaria cases, where explanatory variable lnPCPHE, the logarithm of the per capita real public health expenditure; lnPCWSSE, the logarithm of the per capita real water supply and sanitation expenditure and lnPCGSDP, the logarithm of the per capita gross state domestic product.

4. Results

4.1. Scatter Plot between Per capita real public health expenditure (PCPHE) and health indicators

In India, initial results suggest an inverse correlation between PCPHE, IMR, and NNM. Figure 3 presents the scatter plots of PCPHE against IMR and TFR for each of the selected states between 2000 and 2021, including a linear regression line. Figure 4 illustrates that states with higher PCPHE have experienced lower IMR (the line slopes downward in "A") and TFR (the line slopes downward in "B").

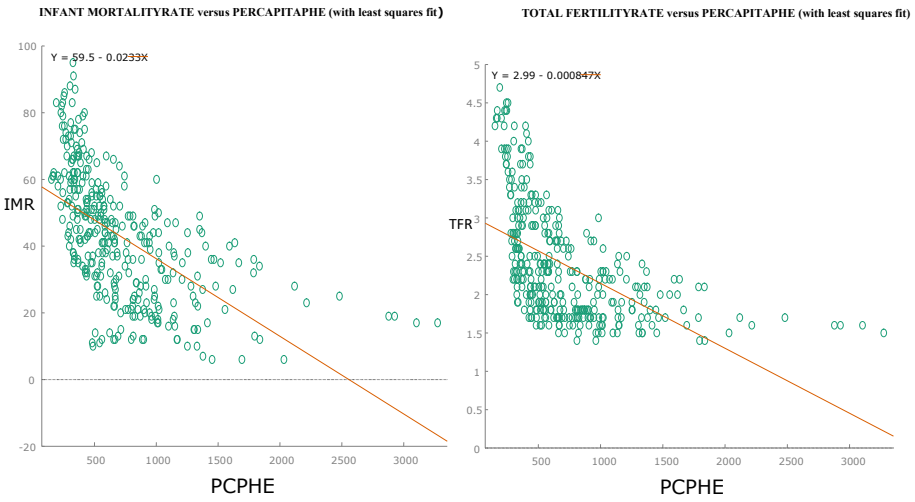

Fig. 4 Data from 2000 to 2021 are used to create scatter plots of (A) per capita publically funded health spending, Infant Mortality Rate(IMR) and (B) Total Fertility Rate(TFR) among Indian states. Source: The author's own calculation

4.2. Panel unit root tests

Before conducting regression estimation, one has to check for stationarity, and thus, stationarity properties of the selected variables were tested using panel unit roots Levin, Lin & Chu (LLC) in Tables 4 and table 5 respectively. The results of the unit root tests indicate that the variables reject the null hypothesis of no unit root, suggesting that the selected series are stationary at first difference. Hence, we can use a short-run regression model without time series effect for the study of a non-stationary dependence of one variable (the dependent variable) on one or more other variables (the independent variables).

Table 4: Augmented Dickey-Fuller (ADF) test

First Difference	Inverse chi-square	Inverse normal test	Logit test
lnPCPHE	235.248***	-12.6009***	-16.4013***
lnPCGSDP	131.887***	-7.51336***	-8.9313***
lnPCWSSE	143.237***	-8.5809***	-9.86483***
lnIMR	120.095***	-7.1321***	-8.1279***
lnTFR	200.471***	-10.1834***	-13.9136***
lnNNM	241.931***	-12.7011***	-16.8507***
lnMAL	92.4975***	-4.50789***	-5.23974***

Note: The natural logarithm is represented by ln, and *** p<0.01, ** p<0.05, and * p<0.1

Table 5: Levin Lin Chu Test

First Difference	t statistics	Z score
lnPCPHE	-13.165***	-5.72489***
lnPCGSDP	-13.215***	-4.91438***
lnPCWSSE	-14.203***	-6.81866***
lnIMR	-12.439***	-5.71817***
lnTFR	-15.752***	-7.4511***
lnNNM	-17.413***	-8.65268***
lnMAL	-13.768***	-7.77564***

Note: The natural logarithm is represented by ln, and *** p<0.01, ** p<0.05, and * p<0.1

Regression results: all states

The regression analysis results between Public Health Expenditure (PHE) and specific health outcomes, namely Infant Mortality Rate (IMR), Neonatal Mortality (NNM), Total Fertility Rate (TFR), and Malaria incidence, across 16 Indian states are presented in Table 6, with Per Capita Gross State Domestic Product (PCGSDP) and Public Water Supply and Sanitation Expenditure (PWSSE) as control variables. Separate analyses for the under- and high-performing states of India are provided in Tables 7 and 8, respectively.

The results in the case of all states (Table 6) indicate that Per Capita Public Health Expenditure (PCPHE) is significant and negative with reference to mortality indicators IMR and NNM. A percentage increase of 1% in PCPHE is associated with a 0.11% reduction in IMR and a 0.116% reduction in NNM. In contrast, PCPHE has no significant effect on the TFR. As regards morbidity, a 1% increase in PCPHE results in a reduction of malaria prevalence by 0.66%. These results are consistent with previous research indicating that PCPHE has a detrimental impact on health outcomes such as child and infant mortality (Barenberg et al., 2017; Mohanty and Behera, 2023; Thomson et al., 2018; Mulagund, 2015).

The effect of PCGSDP also negatively impacts health indicators, with a 1% increase in PCGSDP leading to a 0.66% and 0.65% reduction in IMR and NNM, respectively. However, PCPHE shows no significant relationship with malaria incidence. PCGSDP also negatively affects TFR by 0.208%, suggesting that increased state revenue may promote PHE, improved nutrition, and sanitation, ultimately enhancing health indicators. Additionally, a 1% increase in PCWSSE negatively impacts IMR, TFR, and malaria by 0.0257%, 0.072%, and 0.51%, respectively, indicating that basic infrastructure, such as water supply and sanitation expenditure, contributes to better health indicators. Conversely, some studies have revealed that PHE alone is insufficient to achieve desired health outcomes; per capita income and basic infrastructure are also necessary (Bradley, et.al., 2016; Gunther & Fink, 2010; Filmer & Pritchett, 1999; Pritchett & Summers, 1996).

Table 6: Shows the findings of panel multiple regression in the sample of India's states using a fixed and random effects model. Source: The computations of the author

Variable	lnIMR	lnNNM	lnTFR	lnMAL
lnPCPHE	−0.115*** 0.0322	−0.116*** 0.042	−0.00637 0.0163001	−0.666*** 0.206572
lnPCGSD	−0.660*** 0.0468	−0.658*** 0.0601***	−0.208*** 0.0231	−0.204 0.288278
lnPCWSSE	−0.0267246* 0.0204	0.0055 0.0262	−0.072*** 0.010	−0.501*** 0.129105
Constant	11.859*** 0.352	11.254*** 0.452	3.589*** 0.174	8.167*** 2.183
Hausman P value	0.0055	0.012	2.9487e-05	0.221
States FE	YES	YES	YES	NO
R Squared	0.959	0.933	0.854	0.875
F test	443.919***	259.236***	544.494***	124.086***
No of observations	352	352	352	336
No of States	16	16	16	16
Time period	22	22	22	21

Note: Standard errors are shown in parentheses, ***p < 0.01, **p < 0.05, and **p < 0.1. ln: Natural logarithm. The Hausman test's significant probability (p) values indicate the use of fixed effects (FE) models, whereas other regression specifications make use of random effects (RE) models. The nation FE: Yes—FE; No—RE

Regression results: Under Performing States (UPS)

According to Under Performing States results (Table 3), PCPHE also has a statistically significant negative effect on mortality indicators, with a 1% increase in PCPHE resulting in a 0.10%, 0.17% decrease in IMR and NNM, respectively. Additionally, an increase in PCPHE reduces malaria cases among Union States, with a 1% increase in PCPHE leading to a 1.13% decrease in malaria incidence. As previously mentioned, PCGSDP negatively influences mortality, and similar results are observed in UPS, although no correlation is found between PCGSDP and malaria incidence. Interestingly, PCWSSE has no impact on any health indicator in UPS, indicating that water supply and sanitation expenditure does not improve health indicators in these states.

Table 7: Shows the findings of panel multiple regression in the sample of India's high-focus states using a fixed and random effects model. Source: author's computation

Variable	lnIMR	lnNNM	lnTFR	lnMAL
lnPCPHE	−0.109*** 0.0288	−0.171*** 0.0513	−0.0207 0.0219	−1.131*** 0.374
lnPCGSD	−0.583*** 0.0546	−0.381*** 0.0972	−0.416*** 0.0413	−0.632 0.707
lnPCWSSE	−0.0290 0.0198	−0.0303 0.0353	0.0057 0.0150	−0.0647 0.2625
Constant	11.039*** 0.4429	8.844*** 0.7879	5.614*** 0.3445	13.386*** 5.7100
Hausman p value	3.01713e-32	7.28695e-42	0.9408	0.00091
States FE	YES	YES	NO	YES

R Squared	0.958	0.842	0.916	0.544
F test	936.18***	219.69***	450.83***	46.65***
No of observations	132	132	132	126
No of States	16	16	16	16
Time period	22	22	22	21

Note: Standard errors are shown in parenthesis, ***p < 0.01, **p < 0.05, and *p < 0.1. ln: Natural logarithm. The Hausman test's significant probability (p) values indicate the use of fixed effects (FE) models, whereas other regression specifications make use of random effects (RE) models. The nation FE: Yes—FE; No—RE

Regression results: High Performing States (HPS)

For high-performing states, a comparable empirical study was conducted (Table 3). The results reveal that public health spending per capita (PCPHE) has both a negative and significant effect on IMR, NNM, and malaria. More particularly, a 1% increase in PCPHE will lead to a 1%, 0.253% and 0.209% decrease in malaria, NNM and IMR, respectively.

On the other hand, PCGSDP has a negative impact on the health indicators, with the exception of malaria cases. An increase in PCGSDP will bring a reduction in IMR and NNM in High Performing States. One of the interesting discoveries of our study is that higher per capita water supply and sanitation expenditure (PCWSE) negatively influences all the health indicators. A 1% increase in PCWSSE results in decreases in IMR, NNM, TFR, and MAL by 0.14%, 0.11%, 0.10%, and 1.09%, respectively

Table 8: Shows the findings of panel multiple regression in the sample of India's High Performing States using a fixed and random effects model. Source: The computations of the author

Variable	**lnIMR**	**lnNNM**	**lnTFR**	**lnMAL**
lnPCPHE	−0.2097*** 0.0676	−0.2592*** 0.0628	−0.0210 0.0315	−1.001*** 0.2809
lnPCGSD	−0.3807*** 0.0977	−0.3791*** 0.0907	−0.1016** 0.0454	0.5366 0.4141
lnPCWSSE	−0.1495*** 0.0443	−0.1162*** 0.0411	−0.1018*** 0.0206	−1.0988*** 0.1863
Constant	9.7858*** 0.6886	9.5062*** 0.6399	2.4985*** 0.3206	5.1736*** 2.841
Hausman test p value	0.03469	0.04754	8.51387e-08	1.33156e-05
States FE	YES	YES	YES	YES
R Squared	0.8701	0.8861	0.7807	0.7490
F test	274.777***	319.052***	145.988***	116.385***
No of observations	132	132	132	126
No of States	16	16	16	16
Time period	22	22	22	21

Note: Standard errors are shown in parenthesis, ***p < 0.01, **p < 0.05, and *p < 0.1. ln: Natural logarithm. The Hausman test's significant probability (p) values indicate the use of fixed effects (FE) models, whereas other regression specifications make use of random effects (RE) models. The nation FE: Yes—FE; No—RE

Discussion

Empirical findings show that public health expenditure (PHE) negatively impacts health indicators, particularly infant mortality, neonatal mortality, and malaria cases. The data reveal that a 1% increase in per capita PHE (PCPHE) results in a 0.66% reduction in malaria cases. On the other hand, per capita income negatively affects all health indicators except malaria, including fertility and mortality rates. The study emphasizes that improving the standard of living is essential for better health indicators (Hlafa et.al., 2019; Ssozi and Amlani, 2015). It also concludes that, regardless of the states' development levels, basic infrastructure, particularly water supply and sanitation, helps improve health indicators. The findings show that water supply and sanitation reduce the infant mortality rate, total fertility rate, and malaria cases. Notably, a 1% increase in per capita expenditure on water supply and sanitation leads to a 0.5% reduction in malaria cases. This study is very relevant to state-level efforts to achieve universal health coverage. The results allow for a comparison of the effects of public health expenditure between Under Performing States (UPS) and High Performing States (HPS). The study shows that PCPHE has a greater effect on health indicators in HPS than in UPS. In terms of PCPHE, HPS significantly lowers neonatal mortality rates (NNM) and infant mortality rates (IMR) compared to UPS. PCGSDP affects UPS more than HPS in terms of all health indicators. This shows that improving the standard of living at UPS impacts health more than it does at HPS. The study reveals surprising results about basic infrastructure, especially water supply and sanitation, related to UPS and HPS. The results suggest that water supply and sanitation do not significantly affect UPS, but they significantly contribute to reducing all indicators in HPS. The study concludes that basic infrastructure is vital for improving health indicators in HPS compared to UPS.

This important result connects to the early adoption of the Millennium Development Goals (MDGs) and the rise in funding from the Central Government under the National Health Mission (NHM) since it started in 2005-2006. The Central Government provides 60% of the total NHM funds to General Category States (GCS) and 90% to Special Category States (SCS). The recent adoption of the Sustainable Development Goals (SDG) and the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB PM-JAY) program in 2018 has increased public health spending from 1.13% of GDP in 2013-14 to 1.84% of GDP, according to the National Account Report.

5. Conclusion

Our findings suggest a strong correlation between public health expenditure and improvements in health indicators. Thus, direct interventions and publicly funded health interventions are critical in improving these indicators. Compared to the High-Performing States (HPS) and Under-Performing States (UPS), our research demonstrates that public health expenditure has a stronger influence on HPS than UPS for health results. Moreover, per capita income plays a major role in improving health outcomes. A rise in per capita income affects health indicators more strongly than public health expenditure, which shows that an improved standard of living improves nutritional factors and has a greater effect than public health spending. Additionally, per capita income affects Under Performing States more than High-Performing States in comparison to HPS. Basic infrastructure also plays a part in enhancing health outcomes, albeit more strongly in High-Performing States than in Under-Performing States.
India has already initiated efforts to combat mortality and attain the Sustainable Development Goals (SDGs) by 2030 in various areas of health, such as malaria control and treatment, supply of safe drinking water, proper sanitation, and nutrition, through actions like the Swachh Bharat Mission, National Health Mission, and other state government initiatives. For Indian states, the findings of this study have significant policy implications regarding publicly supported health spending. Firstly, there is a need to increase state-level public capital health expenditure, which currently constitutes only about 10 per cent of total public health expenditure. An increase in capital health expenditure would aid in building better health infrastructure, potentially enabling the rapid achievement of health objectives. Secondly, the government should increase public health expenditure in underperforming states. The per capita health expenditure on average in Under Performing States is approximately Rs. 564 compared to Rs. 724 in high-performing states, which is 28 % lower than in high-performing states. So, the government provided more

funds to under performing states through the National Health Mission and the recent National Health Policy. Thirdly, public-private partnerships are crucial in the current context. The recent government Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB PM-JAY) program is also based on the PPT model, where the government finances the healthcare services, and private hospitals are empanelled to provide those services to eligible beneficiaries. As developing countries like India face budget constraints, public health expenditure is very low compared to many other developed and even developing countries. More such public-private partnerships model is an urgent need for improving the health outcomes. But only increasing the health expenditure will not help in improving health outcomes, Government must also focus on enhancing the skills of health professionals and training them to cater to local needs of the public. These measures are likely to enhance the effectiveness of the nation's public healthcare system. In light of the health requirements of Indian states, the paper recommends increasing publicly funded health spending and enhancing state-level health infrastructure. This study can be expanded to cover all 28 states to assess the impact of public health expenditure on health indicators, depending on future data availability. Future studies can explore the contribution of public health services, such as the impact of the number of doctors, nurses, paramedical staff, and community workers on health outcomes, including maternal and child health, as well as other forms of physical and mental health.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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