Public Spending on Health and Childhood Mortality in India

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Abstract

The present study attempts to investigate the association between public spending on health and childhood mortality in India; using time-series cross-sectional data from various government sources for the period 1985-2009. Infant and child (age 1 to 4 years) mortality rates were used as the indicators for childhood mortality. Ordinary least squares, generalized least squares and fixed effects regression models were used to investigate the association between public spending on health and childhood mortality. The findings suggest insignificant association between public spending on health and childhood mortality both at the country level and for the EAG states. On the contrary, per capita state income and female literacy were significantly associated with improved childhood survival. Percentage of the population living below the poverty line was significantly associated with infant and child mortality only in the EAG states. The findings call for a number of other measures along with increased public spending on health to reduce infant and child mortality in India.

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Introduction

Attainable high standard of health is a human right of every person and is also basic to reduce socio-economic inequality (Backmanet et al., 2008). Availability, timely access and affordability of health care services are the fundamentals of better health, and to reduced financial risks to the majority of the population (WHO, 2010). Studies document that poor health is concentrated among poor households in the poorer states or countries (Wagstaff, 2000; Bhalotra, 2007). For example, under-five deaths in poor countries constitute 30% of the total death, which is less than 1% in rich countries (Cutler et al., 2006). Further, of the total under-five deaths, 10 million children die due to preventable diseases which are rare in the developed world (Jones et al., 2003). Not only the poor health is concentrated among the poor, but poor in most of the countries also have restricted access to health care services. Preker et al. (2002) showed that a majority of 1.3 billion poor people around the globe have restricted access to health services due to their inability to pay for the health care services. Studies also show that the poor are more likely to utilize public health facilities than the rich (Gwatkin, 2000; Wagstaff, 2000) and that public health spending matters more to the poor than to the rich (Bidani and Ravallion, 1997; Gupta et al., 2003). Increased public spending on health improves the availability, accessibility and affordability of health care services, which reduces the chances of childhood mortality in a population.

Public spending on health varies significantly across the different countries. According to the World Health Statistics (2011) the per capita total health expenditure is US$47 in Afghanistan – having highest levels of infant mortality in the world - of which government contributes only 22%. On the other hand, Norway spends US$8019 per person on health of which government’s share is 79%. In the United States of America, the per capita health expenditure is US$7164, of which government's share is 49% while India spends only US$122 with the government's share being only 28%. Interestingly, the infant mortality rates in USA and India are seven and 50 infant deaths per 1000 live births respectively (WHO, 2011).

Findings of the studies that have investigated the association between public health expenditure and infant and child (under-5 years) mortality are mixed – some studies show indeterminacy or exceedingly small effect and others show a positive effect. Further, the effect of public health expenditure on childhood mortality in developing countries is found to depend heavily on the socio-economic situation of the country. Kim and Moody (1992) found that the contribution of health resources to the infant mortality is rather small in comparison to the role of socio-economic resources. Musgrove (1996) concluded that public health expenditure simply replaces out-of-pocket (OOP) health expenditure due to which it does not have any effect on child mortality. Similarly, Filmer and Pritchett (1999) found quite a small impact of public spending on health on child and infant mortality in a cross-country study of developing countries during the 1990s. The study by Gupta et al. (2002) also revealed that although public spending on health improves health indicators in developing and transition countries, the relationship between public spending on health and infants and children mortality rates are rather weak. After controlling for unobserved inter-state heterogeneity in India, Deolalikar (2004) found a weak relationship between public health expenditure and infant mortality.

On the other hand, Wagstaff (2002) found a negative association between public health spending and under-five mortality when he treated public health spending as an exogenous variable. The effect of public health expenditure on under-five mortality became insignificant when public health spending was treated as an endogenous variable (Wagstaff and Claeson, 2004). In another study based on data from 127 countries, Bokhari et al., (2007) found that 10% increase in per capita public health expenditure led to an average reduction of 3.3% in under-five mortality rates. A study by Bhalotra (2007) found a significant effect of public health expenditure on infant mortality. Farahani et al. (2010) found that public health expenditure reduced the probability of death among women, young, and elderly in India.

The reviews presented earlier clearly suggest that the association between public health expenditure and childhood mortality remains inconclusive. Furthermore, we could come across only three studies that have investigated the relationship between public health spending and infant and child mortality in India. But, all three studies have used data sets that are older by 10 or more years. Taking cognizance of the paucity of recent evidence on the relationship between public spending on health and childhood mortality, the present study attempts to examine this relationship using cross-sectional time-series data sets obtained from various sources at the national level and for a group of states (more commonly known as empowered action group states). The study also gains significance given the fact that the central and the state governments have invested a huge amount of money to reduce infant and child mortality through various programmes like the *Integrated Child Development Scheme (ICDS)*, *Reproductive and Child Health (RCH)* programme, *National Rural Health Mission (NRHM)*, etc. There is a need for empirical evidence at the national and state levels to examine the effectiveness of these programmes.

Study Context

Although there has been considerable decline in infant and child mortality in India over the last two decades, it is still way behind the developed countries. More than 2.3 million child deaths occurred in India in 2005 which was around 20% of the total deaths worldwide (The Million Death Study Collaborators, 2010). Two diseases pneumonia and diarrheal diseases accounted for 50% deaths among children age 1-59 months in India. The infant mortality rate and child mortality rates were 57.0 and 18.4 per 1000 live births in 2005-06 respectively. Infant mortality rate varies from as high as 73 per 1000 live births in Uttar Pradesh to as low as 15 per 1000 live births in Kerala. Similarly, child mortality rates range between 1.0 per 1000 live births in Kerala and 28.8 in Arunachal Pradesh (IIPS & ORC Macro, 2007). Furthermore, child mortality rates show substantial regional differences indicating a difference in covariates like social, behavioral and biological risk factors for child death (The Million Death Study Collaborators, 2010). The life expectancy at birth is 63.5 years in India, which varies between as low as 58 years in Madhya Pradesh to as high as 74 years in Kerala. There are stark rural-urban and male-female differences in life expectancy at birth in the major states of India (ORGI, 2008).

Data on health expenditure suggests that public spending on health has declined in India during last couple of decades. Public Health expenditure share has declined from 1.3% of GDP in 1990 to 0.7% in 2009 (MOHFW, 2005; RBI, 2011; RBI). Among major states of India, the share of public health expenditure to the net state domestic product (NSDP) in 2009 was highest in Assam (1.75%) and lowest in Maharashtra (0.48%). In 2009, only four states Assam, Uttar Pradesh, Orissa and Rajasthan were spending more than 1% of NSDP on health (RBI, 2011; RBI). Trends in the ratio of public health expenditure to the total public expenditure show that it had remained static at 4-5% during 1999 to 2004 in all the major states of India. In 2004, only Jaharkhand allocated 5% of total state expenditure to the health sector (Berman and Ahuja, 2008).The public-private share in health spending also presents an interesting picture. At the national level, the share of per capita public expenditure on health stood at 28% in 2009-2010. The share of per capita public health expenditure varies considerably across the states of India. It varied from as low as 17% in Punjab to as high as 65% in Assam (RBI; NSSO, 2011)).

The Government of India has launched a number of ambitious programmes to arrest the high rates of mortality and morbidity in India. The National Rural Health Mission (NRHM) launched in 2005 is one of those programmes. One of the main aims of this programme was to increase the public health spending from less than 1% of GDP in 2005 to 2-3% of the GDP by 2012. Central Government's assistance to the State Government's health expenditure was supposed to increase by 30% for the first two years and thereafter by 40% until 2012. Recent data suggest that the share of public spending on health has indeed increased after the launch of NRHM (Rao and Chaudhary, 2012). A consistent increase has been recorded in per capita public spending on health in the post NRHM period. To illustrate, the per capita real public spending on health in 1985-86 in Bihar and Kerala were (Indian Rupees) Rs. 97 and Rs. 175 respectively which increased to Rs. 108 in Bihar and Rs. 392 in Kerala in 2009-2010 (RBI). Another important Central Government sponsored health insurance scheme - Rashtriya Swasthya Bima Yojana (RSBY) -was launched in 2008. RSBY aims to protect people living below the official poverty line from income loss and falling into debt trap due to illness. Under the RSBY beneficiaries are entitled to hospitalization coverage of up to Rs.30000 for most of the diseases that require hospitalization.

Why separate analysis for Empowered Action Group (EAG) States?

Summary statistics shown in Table 1 present startling differences between India and EAG states in terms of childhood mortality and socio-economic development. The infant mortality rate in India varies from 10 to 142 with an average of 67. But, in EAG states the lowest value of infant mortality rate is 52 with the average value of 88 infant deaths per 1000 live births. Similarly, the average value of child (age 1 to 4 years) mortality rate in India is 7 per 1000 child population, which varies from 0.5 to 23; whereas among EAG states child (age 1 to 4 years) mortality rate is 10 deaths per 1000 child population (Table 1). Great differences can be observed in childhood mortality between India and EAG States.

Like childhood mortality rates, there are notable differences between India and EAG states in per capita public health expenditure, per capita state income, and female literacy rates (Table 1).The average per capita public health expenditure is Rs. 177 in India which ranges between Rs. 71 and Rs. 392; whereas the average per capita public health expenditure in EAG states is only Rs. 146.Average per capita state income is Rs. 19296 at the national level which is only Rs. 12325 in the EAG states.

About 50% of the females aged seven years or above are literate in India. But in the EAG states only one-third of the females are literate. Population living below poverty line is 30% and 39% in India and the EAG states respectively. Per capita food grain production in India is 250 kilograms in comparison to a per capita food grain production of only 209 kilograms in the EAG states. These statistics provide compelling evidence to suggest that EAG states lag behind the rest of India, and thus call for a separate and dedicated analysis.

[Table 1 about here]

Data and Methods

Data

The data for the present analysis is drawn from various sources. The time-series data on infant and child mortality were derived from the annual reports of the Sample Registration System (SRS) in India starting from 1985 to the most recent report published for 2009(ORGI,1988-2011).SRS is considered as the most reliable source of data on vital events in India since the early 1970s. SRS provides data at the national and state levels. The completeness of registration of deaths in SRS is about 95% (Bhat, 2002), with minor variations across the major states of India. The time-series data on other variables included in the model were compiled from various reports of the Government of India. We describe the source of data for each variable in the subsequent sections. Data on all the variables were compiled at the state level.

Variables used in the analysis

Outcome variable: Extant demographic and health literature has used a number of indicators to measure population health – e.g. infant mortality rate, child mortality rate, life expectancy at birth, incidence and prevalence of infectious/chronic diseases, etc. Infant and child mortality are important measures of population health as these facilitate comparison of population health at a point of time, and also progress over the period of time. Moreover, cost effectiveness of the data collection makes infant and child mortality one of the precise measures of population health (Reidpath and Allotey, 2003). Sensitive measures of population health - like disability adjusted life expectancy (DALE) - are strongly correlated with infant mortality thus implying that determinants of infant mortality are strongly related to factors like economic development, standard of living, social well-being and quality of the environment that affect the health of the entire population (Blaxter, 1981; Reidpath and Allotey, 2003). Therefore, we use infant and child mortality rates to show the association between public health expenditure and childhood mortality.

Infant mortality rate is defined as the number of infants dying before reaching one year of age per 1000 live births. Child mortality rate (CMR) is defined as the number of children of one year of age dying before completing 5 years of age per 1000 midyear population of age 12 to 59 months. It is important to note that SRS did not provide estimates of CMR for the period 1985-1995. We, therefore, have used dummy variable regression model to estimate CMR for the afore-mentioned period. We fit a dummy variable regression model between CMR (dependent variable) and under-five mortality (independent variable) for the period 1996-2009. The state was included as a dummy variable in the regression model. The R^2 for the fitted model was 0.90 approximately. We utilized this regression model to predict CMR for the period 1985-1995.

Exposure variable: Per capita public health expenditure is treated as the exposure variable in this study. This variable affects the childhood mortality through the proximate determinants of health like socio-economic and demographic status. Per capita public health expenditure is the revenue and capital expenditure incurred by the State and the Central Governments in India in a given financial year at constant price of 2004-05. The data on public spending on health was compiled from the annual reports of the Reserve Bank of India. Since 1950-51 the Reserve Bank of India has been publishing analytical discussion on fiscal position at the sub-national level under the heading “State Finances: A Study of Budgets”. This report serves as a primary source of disaggregated state-wise fiscal data. In order to make the data on public health expenditure comparable over the period of time and between the States, we have adjusted the public health expenditure using wholesale price index (WPI) and States' estimated population. The WPI was compiled from the statistical appendix of Economic Survey 2011-12 (MOF, 2012a). Economic Survey is the annual bulletin published by the Ministry of Finance, Government of India along with the Union Budget for each year. This report is being published since 1957-58, and provides detailed information on the developments in the Indian economy over the previous 12 months.

Control variables: The selection of the control variables was based on the framework proposed by (Filmer and Pritchet, 1999). They have suggested pathways from public spending to health status. The control variables included in the analysis are per capita state income, female literacy rate, per capita public expenditure on water and sanitation, percentage of scheduled castes/scheduled tribes, percentage of population living in urban areas, percentage of population living below the poverty line, and per capita food grain production.

Per capita state income is the per capita net state domestic product at factor costs and constant price of 2004-05 in a given financial year. Per capita state income was calculated by dividing NSDP at factor costs by the States' estimated population for the given year. Per capita state income affects the childhood mortality through a variety of indirect channels like better nutrition, better housing and better sanitation (Filmer and Pritchett, 1999). The NSDP at factor cost (at current prices) was obtained from the 'Handbook of Statistics on the Indian Economy' produced annually by the Reserve Bank of India. In order to make per capita state income comparable over the period of time we have adjusted it using wholesale price index (WPI).

Female literacy rate is percentage of literate female aged 7 years and above to the total female population aged 7 years and above. Data on female literacy rate was estimated using Census of India (1981, 1991, 2001 and 2011). Considering the irreversibility of the literacy rate we have interpolated the female literacy rate between two consecutive census periods. It is the most important individual level factor determining population health (Deolalikar, 2004). Behavioral factors influencing child health are very much affected by female literacy (Filmer and Pritchet, 1999). Moreover, studies have also shown higher utilization of health care by literate women in low economic settings (Govindasamy and Ramesh, 1997; Filmer and Pritchett, 1999).

The per capita public expenditure on water and sanitation at constant price of 2004-05 is the revenue and capital expenditure in Indian Rupees incurred by the State and Central Government on water and sanitation in a given financial year. Public expenditure on water and sanitation is the most important preventive measure to prevent vector borne diseases like diarrhea, cholera, jaundice, etc. According to Gunther and Fink (2010), improved water and sanitation lower the odds of children to suffer from diarrhea by 7–17%, and reduce the mortality risk among children under the age of 5 years by about 5-20%. The data on public expenditure on water and sanitation were compiled from various reports of the Reserve Bank of India. In order to make the per capita state income comparable over the period of time and between states we have adjusted it using the whole sale price index (WPI) and yearly estimated population of the states.

The percentage of scheduled castes/scheduled tribes was estimated using the Census of India data (1981, 1991, 2001 and 2011). Studies have reported lower utilization of health care services by scheduled castes/ tribes population in India. Das et al. (2010) in a study found that a disproportionately high proportion of child deaths (especially in the 1-5 age group) are concentrated among *Adivasis* (tribes) and in those states or districts where there is a high concentration of *Adivasis.*

Percentage population living below poverty line (BPL) is a crude measure of income inequality. Income inequality affects the population health directly through the cultural beliefs and restriction and indirectly through the care seeking behavior and utilization of health care (Ghosh, 2012). Population living the below poverty line in a given state for the analysis period was estimated using Planning Commission's estimate of BPL for the periods of 1983, 1987-88, 1993-94, 1999-2000 and 2004-05.

Per capita food grain production is the average measure of nutrition level in a given state. Malnutrition exacerbates the risk of various infectious diseases like diarrhea and pneumonia, and heightens the probability of death particularly among children with low birth weight (Singh et al., 2011). Data on the yearly food grain production was collected from annual agriculture statistics published by the Ministry of Agriculture (MOA), Government of India. In order to make it comparable across the states we have converted total food grain production into per capita food grain production using yearly estimates of the states' population.

The level of urbanization is represented by the percentage of population living in urban area. By virtue of development, the availability of both public and private health care services is better in urban areas than in rural areas. The data on percentage of urban population was derived from the decennial censuses of India conducted in the years 1981, 1991, 2001, and 2011.

Methods

Link between per capita public health expenditure and childhood mortality can be established using the Filmer and Pritchet (1999) framework. The structural equation is:

$$Y_{it} = f(E_{it}, C_{it}) \quad (1)$$

where Y is the childhood mortality indicators of state i at time t, E is the exposure variable, and C is the control variable. The model can be specified as:

$$Y_{it} = \delta E_{it} + \gamma C_{it} + e_{it} \quad (2)$$

where e_{it} is the error term capturing unobserved variables and random effect.

It is important to note that we have taken natural logarithms of the variables before using them into the statistical models. There are two advantages of transforming variables into logs. *First*, non-linear relation between the independent variables and dependent infant and child mortality is adequately captured by a log transformation. *Second*, log transformed absolute value of the variables and regression results in terms of elasticity allows for the comparison with the previous results (Filmer and Pritchett, 1999). In the analysis we have used the following reduced form of equations:

$$\ln(IMR_{it}) = \alpha_0 + \alpha_1 \ln(PHE_{it}) + \alpha_2 \ln(PSI_{it}) + \alpha_3 \ln(FL_{it}) + \alpha_4 \ln(WS)$$
$$\alpha_5 \ln(SC/ST_{it}) + \alpha_6 \ln(UR_{it}) + \alpha_7 \ln(BPL_{it}) + \alpha_8 \ln(FP_{it}) + e_{it} \quad (3)$$

$$\ln(CMR_{it}) = \beta_0 + \beta_1 \ln(PHE_{it}) + \beta_2 \ln(PSI_{it}) + \beta_3 \ln(FL_{it}) + \beta_4 \ln(WS)$$

$$\beta_5 \ln(SC/ST_{it}) + \beta_6 \ln(UR_{it}) + \beta_7 \ln(BPL_{it}) + \beta_8 \ln(FP_{it}) + e_{it}$$

(4)

where *IMR*=infant mortality rate; *CMR*=child mortality rate; *PHE*=per capita public health expenditure; *PSI*=per capita state income; *FL*=female literacy rate; *WS*=per capita public expenditure on water and sanitation; *SC/ST*=percentage scheduled caste and/or scheduled tribe; *UR*=percentage urban population; *BPL*= percentage population living below poverty line; *FP*=food grain production; *ln*=natural logs.

We have used three regression models which give modified estimate over the previous one. *First*, assuming zero mean and constant variance of error term (random shock), $e_{it} \sim iid(0, \sigma^2)$we estimate ordinary least square (OLS) model. Notably, OLS is likely to provide biased estimates if error terms are serially correlated over time (correlated with each time series unit) and variances of error term are not constant (heteroscedastic across each cross-sectional unit).Therefore to account for the time-series autocorrelation and cross-section heteroscedasticity we estimated generalized least square (GLS) estimator in the second stage. Again, the GLS estimator is likely to be biased if the error term encompassed state-specific and time-invariant omitted factors and period-specific intercept. To correct for the biases present in the GLS estimates, we fitted a fixed effect model corrected for autoregression of period one AR(1). Fixed effect model corrected for autoregression of period one AR (1) provides best estimates consistent with the state-specific and time-invariant omitted factors, and period-specific intercept. We present the results from each of the three models and discuss those in the results section. The comparison of the results from the three models will provide robust interpretation of the relationship between public health expenditure and childhood mortality.

All the independent variables were tested for possible multi-collinearity before putting them into the statistical models. The statistical analysis was carried out in STATA 10.0.

Results

Results presented in Figures 1 (a) and 1 (b) show a consistent decline in infant and child mortality in India in the last two decades. Although an increase was registered in per capita public health expenditure during this period, the increase was not smooth and did not follow a consistent pattern. The bivariate association between infant mortality and per capita public health expenditure presented in Figure 1 (a) clearly depicts a negative association between infant mortality and per capita public health expenditure in India. Figures clearly depict a decline in infant mortality with an increase in the per capita public health expenditure. The association of child mortality with per capita public health expenditure was also in the expected direction (Figure 1 (b)).

[Figure 1 (a) and 1 (b) about here]

Table 2 presents the adjusted effects of per capita public health expenditure, per capita income and female literacy on infant mortality in India. The ordinary least square (OLS) results adjusted for selected control variables suggest a significant negative association between per capita public health expenditure and infant mortality in India thus indicating that the increase in per capita public health expenditure was accompanied by a significant decrease in infant mortality in the last three decades. Results translated into simple language suggest that a 10% increase in per capita public health expenditure during this period resulted into 3% decline in the infant mortality rate. However, the association between per capita public health expenditure and infant mortality rate became insignificant when the results were adjusted for heteroscedasticity and autocorrelation of the error term. The association remained insignificant even in the fixed effect model. Likewise, the association between per capita public health expenditure and child mortality rate also became insignificant when the results were adjusted for heteroscedasticity and autocorrelation of the error term.

[Table 2 about here]

Interestingly, the per capita state income was significantly associated with both infant and child mortality. Fixed effects results suggest that a 10% increase in average per capita state income resulted into 1.3% reduction in infant mortality rate and 7% reduction in child mortality rate. Female literacy rate was also negatively associated with both infant and child mortality in each of the three models thus indicating that female literacy has an independent effect on infant and child mortality in India. Surprisingly, an increase in the per capita food grain production was associated with an increase in infant and child mortality.

The regression results for the EAG states are presented in Table 3. As in the case of all-India, per capita public health expenditure was not associated with infant and child mortality after the results were adjusted for auto-correlation and state-specific fixed effects. However, the per capita state income was significantly associated with infant mortality in the fixed effects model. Like the earlier case, female literacy was significantly and negatively associated with both infant and child mortality. Interestingly, the percentage of scheduled castes/tribes population was significantly associated with child mortality in the fixed effects model. An increase in the percentage of scheduled castes/tribes population was accompanied with an increase in child mortality in the fixed effects model. Percentage of population living below poverty line and per capita food grain production were also associated with both infant and child mortality in the EAG states.

[Table 3 about here]

Discussion

Our findings suggest no association between per capita public health expenditure and infant and child mortality in India after the results were adjusted for auto-correlation and state-specific fixed effects. However, the per capita state income was significantly associated with both infant and child mortality in the fixed effects model. The findings of our study are consistent with the findings of earlier studies. Like our finding, Filmer and Pritchett (1999) also found a small and statistically insignificant impact of public spending on health on infant and child mortality. The studies by Wagstaff and Claeson (2004) and the World Bank (2004) also revealed insignificant effect of public health spending on infant and under-five mortality. A number of Indian studies have also come out with a similar finding (Deolalikar, 2004; Bhalotra, 2007; Farahani et al., 2010).

Surprisingly, we found inconsistent relationship between the percentage of population living below poverty line and infant and child mortality in India. Similar finding was also observed in the case of the EAG states. This could be due to the severity of poverty at the bottom quintile. Although, the population living below poverty line has reduced in India in the last two decades, the poverty gap ratio has increased with high incidence of infant and child mortality in the bottom quintile (IIPS & ORC Macro, 2007). We also found inconsistent relationship between per capita food grain production and infant and child mortality in India. A plausible reason for this relationship could be the sharp fluctuations in per capita food grain production in most of the major states of India over the last two decades (results not shown).

There could be many reasons for the insignificant impact of public spending on health on childhood mortality in India. *First*, public health expenditure may be too small to generate an effective health system. Furthermore, if a significant proportion of the public health expenditure is used to pay for the salaries of the health personnel, then there is a fair chance that the public spending on health will have no effect on childhood death. Rao and Chaudhary (2012) have shown that an overwhelming portion of public health expenditure goes to the wages and salary, leaving little for non-salary (complementary) expenses like drugs and other material supplies in some of the poor performing states. Wages and salaries constituted around 83% and 85% of total health spending in the states of Madhya Pradesh and Orissa—the two states with the worst health indicators. Moreover, the most needed primary health care services account for only 41% of the total public health expenditure in India. Furthermore, 43% of the public health expenditure in India goes on curative care compared to only 21% on preventive care and public health needs. In addition, the public spending on health is pro-urban in the country (MOHFW, 2009; HLEG, 2011).

Second, studies have also shown that public spending favors mostly the better-off rather than the poor (Castro-Leal et al., 2000; Wagstaff, 2002), and that the delivery of health care services remains extremely unequal (Almeida et al., 2000; Sheridan et al., 2011). A study by Mahal et al. (2001) revealed that public financed curative health care services in India are more likely to serve richer segments of the population than the poor. Furthermore, the quality of institutions (like stability of the political system, degree of public sector accountability, etc.) also influences the effectiveness of the public spending on health, particularly in developing countries (Wagstaff and Claeson, 2004; Rajkumar and Swaroop, 2008). It is needless to mention that the stability of the political system and the accountability of the public sector in EAG states lag much behind the more developed South and West Indian states.

Third reason could be the stark differences in the public health expenditure across the states of India. Evidence suggests that the per capita public health expenditure in most of the EAG states constitutes insignificant proportion of the total health expenditure of the respective states (RBI, NSSO, 2011). Due to such low shares, the effect of public health spending on infant and child mortality is not significantly different from zero. It is important to note that EAG states lag much behind the national average and it is the EAG states that decide the national average.

Fourth, there may be missing link between public health expenditure and childhood deaths. This missing link could be the accessibility and affordability of the public health services. Evidence from India shows significant constraints towards accessibility and affordability of public health services (Navaneetham and Dharmalingam, 2002; Sunil et al., 2006; Backmanet al., 2008). There are also studies that reveal that the Indian health system is not prepared to manage medical emergencies that lead to adverse outcomes in a majority of cases (Ramarao et al., 2001; Hunt, 2010; Ram et al., 2006; CE-NRHM, 2011). Although, the Government of India has invested a lot in developing public health infrastructure under the National Rural Health Mission (2005-2012), there is a clear lack of training to the public health workers to deal with medical emergencies

(CE-NRHM, 2011). It is needless to mention that better institutional capacity enhances the effectiveness of the public health services (Filmer et al., 2000).

Fifth, the impact of public health expenditure on childhood mortality depends on the way in which public health services are delivered. There are numerous evidence from India that show that the public health system in India treats its clients according to their socio-economic conditions (Singh et al., 2012a; Singh et al., 2012b; Malhotra and Do, 2012). There is also evidence to show that the public health personals provide services to their clients based on their own perceptions and beliefs rather than based on the needs of the clients (Pallikadavathet al., 2004; Matthews et al., 2001; Dhandapany et al., 2008).All these reduce the effectiveness of the public health services in India.

Sixth, mere supply of health services will not be able to reduce childhood death. The supply of services must also be accompanied by demand for services. The demand for services will clearly depend on the knowledge and awareness about the public services among the general masses. This issue calls for a greater focus on promoting health education among the general masses. Our study also shows greater impact of female literacy on infant and child mortality compared to the public spending on health. Findings suggest that a 10% increase in female literacy led to 3.6% and 8.3% decrease in infant and child mortality respectively at the national level. The same was 2.1% and 10.6% in the case of EAG states.

The limitations of our study must also be noted. First, we could not include immunization coverage and income inequality into the statistical models presented in the study due to the unavailability of time-series data. Gani (2009) had shown that immunization plays a pivotal role in reducing infant and child mortality particularly in developing countries. However, this should not bias our results because immunizations against six preventable diseases is provided free of cost by the public health sector in India. Therefore, the potential benefits of immunization coverage are likely to be captured by the public spending on health (Moreno-Serra and Smith, 2011). Furthermore, Ghosh (2012) has found that income inequality affects the child mortality through cultural belief and health seeking behavior. To some extent, we have captured the effect of income inequality by including percentage of population living below poverty line and percentage of population belonging to scheduled castes/scheduled tribes in our statistical models.

Second limitation relates to the selection of (NSDP) as an indicator of average state income. A challenge while using NSDP is that it is not adjusted for the remittances between the states. However, this should not affect our results because of two reasons. *First,* NSDP is the monetary value of goods and services produced in a state in a given financial year (MOF, 2012b). *Second,* migrants' health care seeking behavior and utilization of health services is usually affected by the socio-economic profile of the migrants at the place of origin (Chatterjee, 2006). Moreover, we adjusted the public health expenditure and NSDP by the WPI instead of consumer price index because NSDP is calculated at the time of production rather than consumption or expenditure (MOF, 2012b). Although our study has certain limitations, it has a number of strengths. The use of time-series data makes the study unique in its class. Furthermore, the use of generalized least squares and fixed effects models make the findings more robust and generalizable. The strengths of our study clearly outweigh the limitations.

Conclusion

Our findings clearly suggest that just increasing public spending on health is not going to improve population health in India. There is an urgent need to remove the disparities in the public spending on health across the different states. There should be a higher provision for public spending on health in the EAG states as these are the states that are facing relatively poorer health compared to other states. The government, along with developing public health infrastructure, must take steps to promote health education in the country. The government must also focus more on building capacity of the health personals, and must also sensitize the health personnel towards the needs of special groups. All these are likely to increase the effectiveness of the public health care system in the country. There is also a greater need for increased spending on preventive measures like improved water and sanitation. Finally, the fruits of public health expenditure on population health will only be realized when the benefits of public health expenditure reach to the needy and the socially marginalized groups. Strong political will, minimal diversion of funds and appropriate selection of beneficiaries for the publically financed schemes is likely to pay immediate and larger dividends in terms of improved population health.

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Figure 1 (a) Trend of infant mortality by per capita public health expenditure over the period time 1985-2009, India

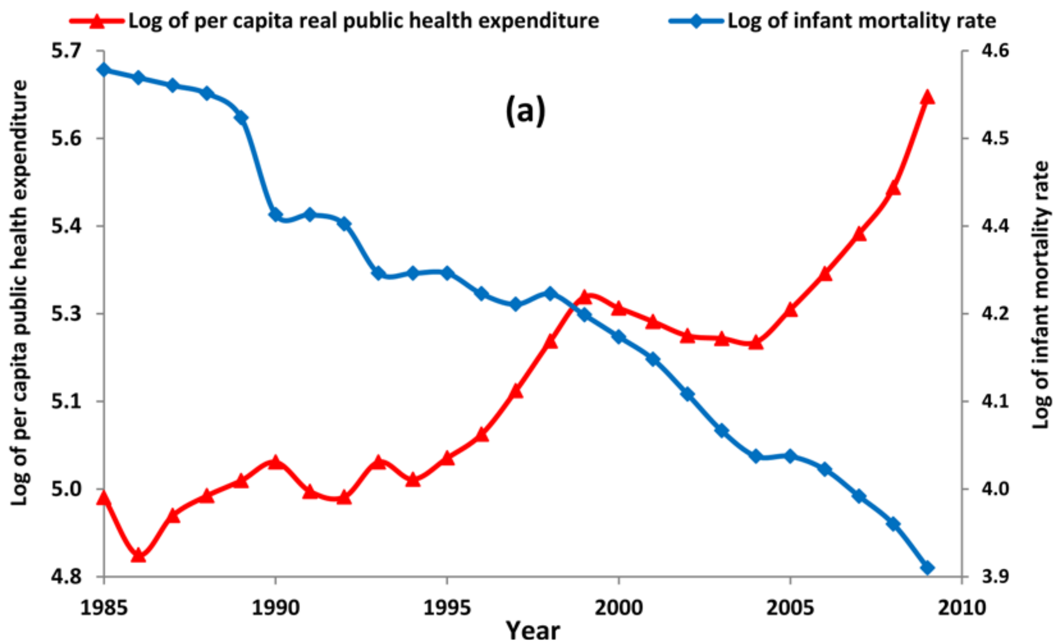

Figure 1 (b) Trend of child mortality by per capita public health expenditure over the period time 1985-2009, India

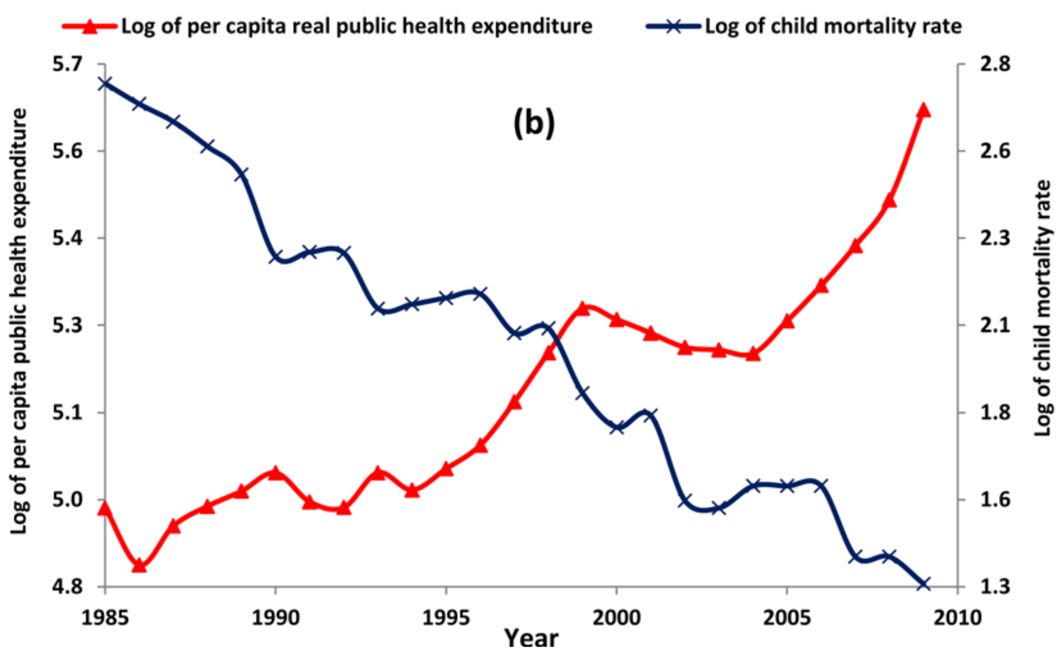

Figure captions

Figure 1 (a) shows the bivariate association between log of per capita real public health expenditure and log of infant mortality rate over the period of 1985 to 2005

Figure 1 (b) shows the bivariate association between log of per capita real public health expenditure and log of child mortality rate over the period of 1985 to 2005

Table 1: Summary statistics

	India (all major states) (Observation=375)					EAG (all major EAG states) (Observation=125)				
	Mean	**Std. Dev.**	**Min**	**Max**	**States**	**Mean**	**Std. Dev.**	**Min**	**Max**	**States**
Outcome variable										
Infant mortality rate	67.08	24.73	10.00	142.00	15	87.92	20.28	52.00	142.00	5
Child mortality rate	6.83	4.67	0.50	22.99	15	10.44	4.81	2.70	22.99	5
Exposure variable										
Per capita public health expenditure	177	54	71	392	15	143	37	71	272	5
Per capita state income	19296	10495	4713	61409	15	12325	4555	4713	26212	5
Female literacy rate	50.37	16.33	16.58	91.16	15	37.32	12.26	16.58	61.68	5
Control variable										
Per capita public expenditure on water and sanitation	95	73	0	490	15	98	83	0	429	5
Percentage SC/ST population	24.57	7.41	10.90	38.85	15	28.79	8.11	12.17	38.85	5
Percentage urban population	26.79	9.33	10.37	47.57	15	18.97	5.27	10.46	27.40	5
Percentage population living BPL	30.00	12.07	6.16	60.44	15	39.88	9.77	15.28	60.44	5
Per capita food grain production	251	233	16	1,073	15	223	66	87	380	5

Table 2: Regression result for India (all major states), 1985-2009

	Robust ordinary least square[a,b]		Generalized least square (Prais-Winsten transformation)[a,b]		Fixed effect corrected for AR(1) errors[b]	
	Infant mortality rate *ln(IMR)*	**Child mortality rate *ln(CMR)***	**Infant mortality rate *ln(IMR)***	**Child mortality rate *ln(CMR)***	**Infant mortality rate *ln(IMR)***	**Child mortality rate *ln(CMR)***
Per capita public health expenditure: *ln(PHE)*	-0.298 (-4.010)***	-0.265 (-1.800)*	-0.007 (-0.280)	0.025 (0.250)	-0.002 (-0.080)	0.088 (0.970)
Per capita state income: *ln(PSI)*	-0.130 (-2.080)**	-0.660 (-7.130)***	-0.245 (-3.680)***	-0.499 (-3.400)***	-0.293 (-5.680)***	-0.690 (-5.660)***
Female literacy rate: *ln(FL)*	-0.430 (-6.260)***	-0.574 (-6.040)***	-0.473 (-3.850)***	-0.948 (-5.300)***	-0.363 (-3.540)***	-0.832 (-5.810)***
Per capita real public water and sanitation expenditure: *ln(WS)*	0.077 (2.840)***	0.104 (2.480)***	-0.001 (-0.110)	0.009 (0.460)	0.004 (0.410)	0.023 (0.710)
Percentage of scheduled caste and/or scheduled tribe population: *ln(SC/ST)*	0.369 (10.180)***	0.296 (4.070)***	0.030 -0.580	0.209 (1.280)	-0.052 (-0.520)	-0.128 (-0.590)
Percentage of population living below poverty line: *ln(BPL)*	0.170 (4.090)***	0.268 (3.620)***	-0.140 (-2.000)**	0.191 (1.350)	-0.187 (-3.030)***	0.112 (0.940)
Per capita food grain production: *ln(FP)*	0.197 (7.930)***	0.299 (7.520)***	0.067 (3.570)***	0.187 (3.570)***	0.073 (4.020)***	0.195 (3.470)***
Percentage urban population: *ln(UR)*	0.022 (0.530)	0.019 (0.250)	-0.203 (-0.990)	-0.193 (-0.920)	0.053 (0.260)	-0.297 (-0.780)
F *statistic*	151	223	701	172	17	60
F *statistic* (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
R-square	0.821	0.806	0.834	0.604	0.286	0.588
Number of observations	375	375	375	120	120	120
Durbin-Watson statistic			2.08	2.224		

[a] Robust standard errors, adjusted for heteroscedasticity.
[b] T-statistics are given in parenthesis.
*** $p < 0.001$, ** $p < 0.05$, $p < 0.10$

Table 3: Regression result for major EAG states of India, 1985-2009

	Robust ordinary least square[a,b]		Generalized least square (Prais-Winsten transformation)[a,b]		Fixed effect corrected for AR(1) errors[b]	
	Infant mortality rate *ln(IMR)*	**Child mortality rate *ln(CMR)***	**Infant mortality rate *ln(IMR)***	**Child mortality rate *ln(CMR)***	**Infant mortality rate *ln(IMR)***	**Child mortality rate *ln(CMR)***
Per capita public health expenditure: *ln(PHE)*	-0.202 (-3.550)***	-0.158 (-1.530)	-0.024 (-0.700)	-0.105 (-0.880)	-0.018 (-0.560)	-0.051 (-0.440)
Per capita state income: *ln(PSI)*	-0.041 (-0.600)	-0.202 (-1.880)*	-0.159 (-2.020)**	-0.265 (-1.700)*	-0.155 (-3.020)***	-0.207 (-1.490)
Female literacy rate: *ln(FL)*	-0.299 (-6.090)***	-0.802 (-8.500)***	-0.360 (-3.380)***	-0.809 (-6.760)***	-0.209 (-1.760)*	-1.060 (-6.480)***
Per capita real public water and sanitation expenditure: *ln(WS)*	-0.091 (-6.130)***	-0.114 (-2.700)***	-0.013 (-1.770)*	-0.061 (-1.920)*	0.002 (0.190)	0.081 (1.230)
Percentage of scheduled caste and/or scheduled tribe population: *ln(SC/ST)*	0.601 (12.660)***	0.548 (5.350)***	0.454 (3.050)***	0.467 (3.050)***	0.299 (1.070)	0.829 (2.060)**
Percentage of population living below poverty line: *ln(BPL)*	-0.130 (-3.040)***	0.076 (0.660)'	-0.184 (-2.010)**	0.230 (1.490)	-0.272 (-2.390)**	-0.501 (-2.370)**
Per capita food grain production: *ln(FP)*	0.159 (4.400)***	0.446 (5.670)***	0.051 (2.360)**	0.268 (2.970)***	0.046 (2.560)**	0.142 (1.820)*
Percentage urban population: *ln(UR)*	-0.020 (-0.430)	0.168 (1.820)*	-0.195 (-1.170)	0.321 (2.150)**	-0.895 (-1.950)*	-0.535 (-0.890)
F *statistic*	75	93	1253	1203	8	55
F *statistic* (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
R-square	0.823	0.8641	0.976	0.833	0.380	0.800
Number of observations	375	375	375	120	120	120
Durbin-Watson statistic			1.855	1.949		

[a] Robust standard errors, adjusted for heteroscedasticity.
[b] T-statistics are given in parenthesis.
*** $p < 0.001$, ** $p < 0.05$, * $p < 0.10$