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Original Research Article

Effect of Income Disparities on Healthcare in the COVID-19 Era

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Abstract: The COVID-19 pandemic has renewed the discussion on the importance of health on long term well-being of any economy. It has also been a challenging time, having hurt economies in a world already seeing declining economic growth. While vaccination globally has been picking up speed, this paper is an attempt to establish a relationship between income levels of different Indian states and its empirical effect on healthcare outcomes and policy implementation through the study of indicators such as Infant Mortality rate in the pre-pandemic world and COVID-19 vaccination. Using secondary data, we have developed regression models to understand the effect of COVID-19 on the income-health relationship. Through our research we have been able to identify that income level, and in effect income disparities, do have a significant positive relationship with healthcare, and that the pandemic has deepened this relationship. Further, we have looked into other factors that may help us explain the reasons behind this relationship, including healthcare infrastructure, public health expenditure and other social factors in the context of Indian states.

Keywords: Indian states, public health indicators, income disparity, COVID-19, vaccination, health expenditure.

1. INTRODUCTION

The COVID-19 pandemic has proven to be a global disruption in healthcare availability and accessibility, putting to test the healthcare systems of developed, developing and underdeveloped economies alike. Apart from challenging the most basic of each countries' infrastructure, it has also renewed the importance of public health, from a socio-economic perspective. This has caused many countries, including India, to place due importance towards healthcare in its policy and budgetary measures. The focus has been on widespread penetration of quality healthcare products and services.

Similarly, the Indian public, having seen the weaknesses of the healthcare system exposed in a sea of guidelines, lockdowns and unfortunate mutations of the virus, has begun to value reliability and quality. Apart from the effect COVID-19 had on public health, it also had an undeniably adverse effect on the Indian economy, testimony to which stand negative growth rates, sky-rocketing unemployment rates and deepening poverty.

A promising prospect, however, has been the scientific achievement of one of human history's fastest developed vaccines. In India, which became a distributor for the world, vaccination distribution, although having seen its ups and downs in its initial months, has been accelerating, having achieved the 100 crore doses milestone in a little over nine months (Modi, 2021).

With a long way still ahead for a fully-vaccinated India, which is also slowly recovering from the economic effects of a pandemic in an already declining economy prior to 2020, the challenge of complete penetration still remains. In such a setup, where the need for public healthcare is at its peak and economic disparities have been widening, it becomes all the more important to understand the linkages between economic disparities and healthcare, in the interest of a truly equitable society.

This paper is an attempt to investigate whether systematic or unsystematic economic biases have crept into the process of vaccine distribution, especially studying the relationship between income and healthcare in a post-pandemic world.

2. LITERATURE REVIEW

There is a growing abundance of literature on the relationship between health indicators and income inequality. Extensive research has been undertaken to map the effect of income disparities on health and living conditions of people across countries and Indian states.

Curran & Mahutga (2018) studied effects of income inequality in poor and rich countries and derived that it has a higher degree of negative association with life expectancy, one of the major health indicators in the lower and middle-income countries like India as compared to other-high income countries. Continually, Rajan *et al*., (2013) suggested that it is low poverty and higher literacy rate, another socio-economic indicator than wealth per se that improves public health. The same can also be seen across different states in India, where there is a substantial difference across health conditions.

According to a number of studies, health status is determined and affected by numerous social and economic inequalities. The researchers studied the relation between these inequalities on various health indicators like Maternal and Child Health Services, use of public or private healthcare etc. In general, while social inequalities can have various indicators like power imbalances, macroeconomic factors, rules and norms in societies etc., the economists described three types of economic inequalities that applied to health: Income, wealth and consumption inequalities. These inequalities were measured quantitatively using econometric approaches applied on population datasets by comparing various indicators of health status.

In many Indian states, the gap between rural and urban areas and that between the poor and non-poor have widened since 1992. A few studies (Houweling *et al*., 2013; Kanjilal *et al*., 2010; Pathak *et al*., 2010) highlighted how rich urban households benefited from health interventions meant for poor households. Many studies provided evidence on socio-economics status of Indian states, and their relation with health indicators. One such evidence was provided by Arokiasamy & Pradhan (2011) taking the example of Jammu and Kashmir and Punjab, studying child immunization in the states. While children from economically better off households did similarly in both the states, the poorest children were less likely to be fully immunized in Jammu than in Punjab. Rajan et al. (2013) highlighted wealth and literacy as important predictors while determining child survival and mortality rate.

The COVID-19 pandemic has furthered income disparities. Chen et al. (2021) found the impact of COVID-19 to be drastic on the income disparities, especially along countries with different income levels which has further solidified its effect on health conditions and disrupted health services including vaccination and immunization attempts across states and territories.

Clear patterns of socio-economic disadvantage with respect to healthcare access and services were highlighted across the country, showcasing differences within and across states. This general pattern was seen across population sets, geographies and healthcare services, i.e., maternal and child health, immunization etc., and brought out a global disadvantage faced by the poor. Income and wealth may contribute to social status, but the broader idea of status is socially determined and varies from one society to another. The current available literature focused mainly on wealth and income disparities to highlight health conditions and access. While the studies confirmed that the effect of these inequalities is high on the poor and lower class of the society, there were very few studies that discussed the reason behind this.

We also observed that there is not a lot of research and literature available on the relation between income and health in the post-pandemic era, given the novelty of the situation. This paper is an attempt to bring the same into discussion.

3. RESEARCH OBJECTIVE

The objectives of this paper are as follows:

- To establish a relationship between health indicators and income disparities between different Indian states,
- To study the above relationship in the light of the COVID-19 pandemic and compare that with the pre-pandemic era,
- To investigate the reasons behind the relationship derived between the above variables,
- To derive insights from the above analysis, especially into healthcare policy inputs and outcomes.

4. RESEARCH METHODOLOGY

Data

The data used in this research is secondary data, collected from various datasets published by the Government of India and other bodies constituted under the same. It includes health and income data for the majority of Indian states and union territories. The econometric analysis has been divided in two phases, that is, before and after the COVID-19 pandemic.

Further qualitative and descriptive analysis has been done for the factors that may affect the public healthcare system and availability of various healthcare facilities to various sections of the society, based on their per capita income. The data for the number of doctors per ten thousand people, number of private and public hospitals in different Indian states, availability of hospital beds and ventilators per ten thousand people, and state wise per capita healthcare expenditure has been taken from the Reserve Bank of India (2021) and the Central Bureau of Health Intelligence (2019). To enable analysis, many variables have been converted to per unit of population terms throughout this paper using population figures from Unique Identification Authority of India (2021).

Regression Variable Selection

To understand the dependence of healthcare indicators on the level of income, the analysis before COVID-19 consists of the Net State Domestic Product (NSDP) Per Capita, acting as an indicator of income, of different Indian states for the year 2018-19, extracted from Reserve Bank of India (2020), and the Infant Mortality Rate (IMR) for the same year, extracted from the Reserve Bank of India (2020). For the purpose of this research, IMR is selected since it is an important indicator of the health outcome in an area. For the analysis after COVID-19, the gross number of vaccine doses per capita has been calculated up to 11 October, 2021 using data made available through the CoWin portal maintained by the Government of India (2021). This is not only a core indicator for healthcare in light of the pandemic, but also represents healthcare as a policy prerogative, given the governmental nature of distribution of vaccines. Here, to signify income, the latest Gross State Domestic Product per capita 2019-20 has been considered, extracted from the Reserve Bank of India (2020).

Ideally, the regression analyses should have taken place with NSDP per capita or GSDP per capita for both the periods. However, faced by paucity of data available, we have considered NSDP per capita for the pre-pandemic analysis and GSDP per capita for the post-pandemic period. Moreover, our analysis is based on the level of income and not the measure of income, making the chosen variables reasonably acceptable to draw meaningful conclusions and results. For the post-pandemic regression, latest income measures (GSDP per capita) have been taken into account from the year 2019-20, which in part captures the effects of a slowing and COVID-19 hit economy. Lastly, we have considered gross vaccination doses per capita up until 11 October, 2021 due to lack of systematic data, as well as the fact that vaccination distribution has stabilized in these months. This eliminates biases arising from the initial disruptions in vaccine distribution.

Data Treatment

The Ordinary Least Square method or the OLS method under the Classical Linear Regression Model has been used for econometric regression. The testing of the model as well as for the coefficients has been done at a 5% level of significance. The CLRM assumptions of linearity in parameters, no perfect collinearity and random sampling have been satisfied before presenting the regression analysis.

5. DISCUSSION AND REGRESSION ANALYSIS

This part of the paper examines the pre and post pandemic regressions, deep diving into quantitative insights and deriving meaningful inferences from the same. After that, we make an attempt to discover reasons behind the relationship derived between health and income variables.

5.1. Pre-Pandemic Regression

The regression prior to the pandemic explores the relationship between income and a major healthcare indicator - Infant Mortality Rate in the year 2018, specifically the dependence of health outcomes on the level of income in Indian states. To enable such analysis, IMR has been assumed as the dependent variable (Y) and Per Capita NSDP as the independent variable (X).

Null Hypothesis

There is no significant relationship between the NSDP Per Capita and the Infant Mortality Rate, or the intercept/slope is equal to zero.

Alternative Hypothesis

There is a significant relationship between the NSDP Per Capita and the Infant Mortality rate or the intercept or slope is not equal to zero.

Level of Significance

The level of significance considered in this research is 5% (corresponding to 95% level of confidence). Given the assumption, we would reject the null hypothesis if the P value is less than 0.05, and fail to reject the null hypothesis if the P value is greater than 0.05.

Results

The quantitative relationship between the selected variables have been captured in the equation:

$Y = -0.0000743 X + 36.5889191$

The results of the regression have been summarized below.

Table 1

Statistic	Magnitude	Analysis
P Value	0.000617	The calculated P value is lower than the required 0.05 level of significance, in which case we reject the null hypothesis. This points towards the existence of a significant effect of the level of income in a state on a key healthcare indicator in that region.
Multiple R	0.572	This multiple R or coefficient of correlation value indicates the extent of the above found relationship between income and health to be fairly strong.
R Squared	0.327	This R squared value or coefficient of determination depicts that 32.77% of the variance in the Infant Mortality Rate can be accounted for by the NSDP Per capita measures. This also shows that the remaining 67.23% can be accounted for by other factors, considering the multi-dimensional modern world.
Slope Coefficient	-0.0000743	The slope coefficient indicates the direction of the relationship between income and IMR to be negative, i.e., the mortality rate decreases with an increase in income. Quantitatively, it denotes a decrease of close to 7 infant deaths per 10 crore live births for every extra rupee increase in the per capita NSDP.
Intercept Coefficient	36.588	Keeping in consideration that the IMR is affected by a multitude of variables, the intercept coefficient indicates that based on the mathematical relationship derived, the IMR would be 36.58 per 1000 live births in the hypothetical situation that NSDP per capita were zero.
Standard Error	10.368	This value of the standard error for the regression shows that the average distance that the observed values fall from the regression line, is approximately a measure of 10 infant mortalities per thousand live births.

The graphical representation of the relationship derived through the regression is as follows:

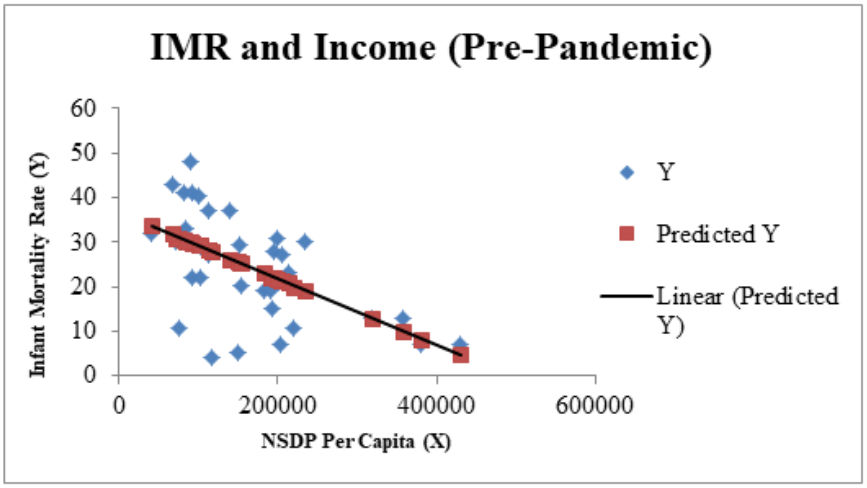

Figure-1:
Source: Reserve Bank of India (2020)

5.2. Post-Pandemic Regression

The regression post the pandemic deep dives into the relationship between Gross State Domestic Product (GSDP) per capita for different Indian states and gross number of vaccination doses administered per capita. To establish this relationship, Gross State Domestic Product per capita for the Indian states has been assumed as an independent variable (X), and the per capita vaccination doses have been assumed as the dependent variable (Y).

Null Hypothesis

There is no significant relationship between the GSDP per capita and number of vaccines per capita, i.e., the intercept/slope is equal to zero.

Alternative Hypothesis

There is a significant relationship between the GSDP per capita and the number of vaccines per capita, i.e., the intercept/slope is not equal to zero.

Level of Significance

The level of significance considered in this research is 5% (corresponding to 95% level of confidence). Given the assumed requirement, we would reject the null hypothesis if the P value is less than 0.05, and fail to reject the null hypothesis if the P value is greater than 0.05.

Results

The quantitative relationship between the selected variables have been summarized in the equation:

$Y = 0.00000167 X + 0.4929$

The results of the regression have been summarized below.

Table 2:

Statistic	Magnitude	Analysis
P Value	0.00009586	The calculated P value is lower than the required 0.05 level of significance, in which case we reject the null hypothesis. This points towards the existence of a significant effect of the Gross State Domestic Product per capita on the gross number of vaccination doses per capita given in different Indian states.
Multiple R	0.7234	This multiple R or coefficient of correlation value indicates the extent of the above found relationship between GSDP per capita and number of vaccination doses per capita given to be very strong.
R Squared	0.5233	This R squared value or coefficient of determination depicts that 52.33% of the variance in the per capita vaccination doses administered can be accounted for by the Gross State Domestic Product measures. This also shows that the remaining 47.67% can be accounted for by other factors.
Slope Coefficient	0.00000167	The slope coefficient indicates the direction of the relationship between GSDP per capita and per capita vaccination doses administered to be positive, i.e., the vaccination rate is higher in states with higher GSDP per capita. Quantitatively, it denotes an increase of 0.00000167 doses per person with an increase of 1 Rupee of GSDP per capita
Intercept Coefficient	0.4929	Keeping in consideration that the per capita number of vaccination doses given is affected by a multitude of variables, the intercept coefficient indicates that based on the mathematical relationship derived, the vaccination doses administered would still be 49.29 per hundred people in the hypothetical situation that GSDP per capita is zero.
Standard Error	0.1293	This value of the standard error for the regression shows that the average distance that the observed values fall from the regression line, is approximately a measure of approximately 13 doses per hundred people.

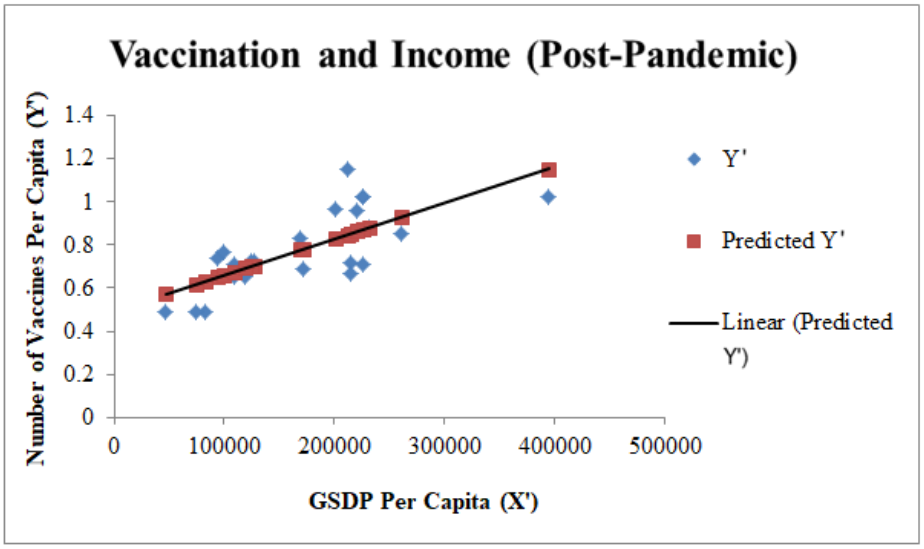

Figure-2

Source: Government of India (2021), UIDAI (2019), Reserve Bank of India (2020), Authors' calculations

5.3. Results and Learnings

Comparing the above regressions, we can see that the relationship between health and income has strengthened post the pandemic, in terms of higher coefficients of correlation and determination. This points to the fact that the impact of income disparities has deepened. Keeping in consideration that the pandemic was a time when economic disparities became starker with over 230 million people slipped into poverty after the first wave itself (Azim Premji University, 2021), healthcare accessibility evidently became more unequal. Further, this effect was disproportionately spread across different regions in India, with rural areas facing the burden of reverse migration in an already stressed economy (Inani, 2021), hence worsening the effect of the pandemic.

The significant difference between results from both the regressions can also be attributed to the fact that Infant Mortality Rate in 2018 would be the cumulative effect of income, health, education and many other indicators over decades, while COVID-19 vaccination is a relatively recent phenomenon. Hence, the impact of current income would be more pronounced on the latter, as is supported by regression results.

Another important result that can be derived from our analysis is that the effect of income on policy inputs for health, such as vaccination, is stronger than the effect of income on health outcomes, such as Infant Mortality Rate. The effect is dampened in the process of implementation because there are many other variables that come into play while determining health outcomes, including health infrastructure and many other social factors.

5.4. Analyzing Possible Reasons

Having established direction and magnitude for the relationship between income level and healthcare indicators, and deriving insights into the effect of the pandemic on the same, we now make an attempt to identify reasons behind said relationship.

Healthcare Infrastructure

The first possible reason behind the income-health relationship could be significantly differing health infrastructure across states with different income levels. To test our intuition, we gathered information about the availability of healthcare infrastructure across different Indian states through data pertaining to the number of doctors, hospitals, hospital beds and ventilator beds available. To enable benchmarking of this data with GSDP per capita, we have converted these figures into per unit of population (ten thousand or one lakh). The following table shows this data state-wise.

Table 3:

States	GSDP Per Capita	Number of Doctors per 10 thousand	Number of Hospitals per 1 Lakh	Number of Hospital Beds per 10 thousand	Number of Ventilators per 1 Lakh
Haryana	2,60,286	8	7.62	12.81	3.21
Telangana	2,25,047	11	10.44	25.38	6.35
Gujarat	2,24,896	9	2.20	10.15	2.54
Delhi	394216	10	0.94	21.09	5.27
Karnataka	232874	9	15.81	38.79	9.70
Kerala	225484	42	9.36	27.80	6.95
Uttarakhand	220257	8	11.46	21.19	5.30
Maharashtra	216169	8	2.60	18.82	4.70
Tamil Nadu	215049	12	3.13	19.96	4.99
Himachal Pradesh	211325	6	13.90	21.52	5.38
Jammu & Kashmir	199,769	21	1.15	5.88	1.47
Punjab	172149	6	7.70	20.24	5.06
Andhra Pradesh	168,083	12	1.72	15.44	3.86
Rajasthan	123,343	5	6.97	11.50	2.87
West Bengal	119637	15	2.27	11.40	2.85
Odisha	109,416	5	5.40	5.53	1.38
Chhattisgarh	108,058	7	1.35	5.92	1.48
Madhya Pradesh	99025	11	1.14	7.61	1.90
Assam	94385	5	4.86	6.79	1.70
Jharkhand	82,430	4	3.53	6.87	1.72
Uttar Pradesh	74402	8	7.19	11.83	2.96
Bihar	47541	8	2.43	2.47	0.62

Source: Reserve Bank of India (2020), Central Bureau of Health Intelligence (2019), UIDAI (2019), Authors' calculations

While inferences about a positive relation between income and health infrastructure is visible from the table, we have further segmented states into high, middle and low income and calculated the average of each of the above health infrastructure metrics for each segment to facilitate analysis. The following line graph depicts the same.

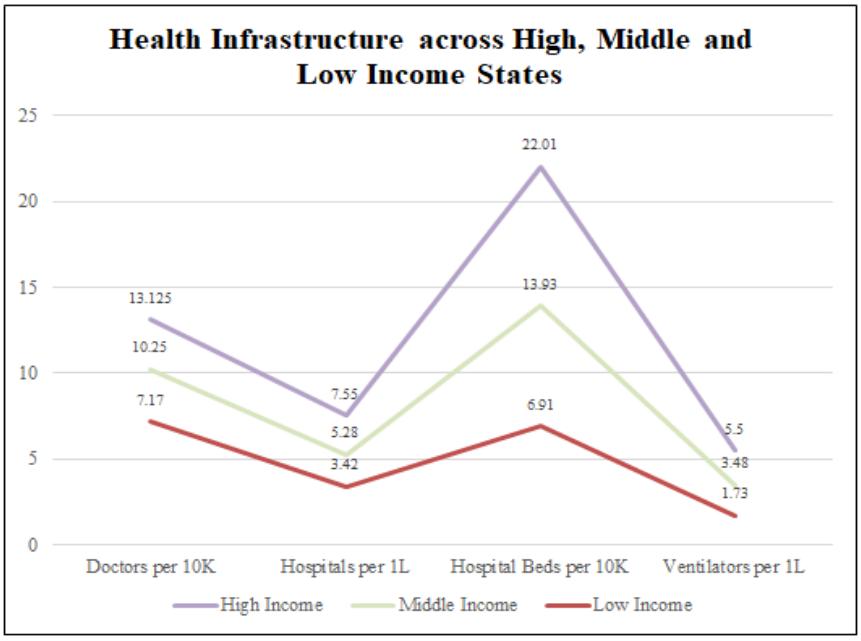

Figure-3

Source: Reserve Bank of India (2020), Central Bureau of Health Intelligence (2019), UIDAI (2019), Authors' calculations

Further confirming the discussed relationship between income level and health infrastructure, we can infer that the states which have higher per capita income also tend to have better healthcare infrastructure. High income states such as Haryana, Telangana, Karnataka, Kerala and Uttarakhand have better healthcare infrastructure and capacity as compared to the low-income states such as Chhattisgarh, Jharkhand, Bihar and Madhya Pradesh. Following this analysis, we can safely conclude that the reason behind high income regions showcasing better health outcomes, as derived from the pre-pandemic regression model, attributes to higher availability of healthcare institutions and infrastructure. A stronger healthcare system provides better support for mitigation of morbidity, improving health outcomes in the region.

The presence of better healthcare capacity in high income regions can further be explained by the strong presence of the private sector in Indian healthcare. The profit-led private sector invests in regions which would be more profitable, which also tends to be regions which are densely populated, with the public having high disposable incomes. With a private sector reluctant to enter low-income areas, the only other way is to establish public health systems. Riddles with many internal roadblocks and lack of efficiency, public health infrastructure in low-income areas is unable to upkeep health outcomes.

In a pandemic affected world, this disparity also translated into inequality in distribution of vaccine doses. Low-income states witnessed lower per capita vaccination doses administered as compared to the high per capita income states. We can, hence, conclude that the positive relation between income level and healthcare infrastructure is one of the reasons behind the pronounced effect of income disparities on health outcomes and implementation of healthcare policy.

Public Health Expenditure

While it is obvious that low-income states would translate into lesser out-of-pocket private expenditure, a substitute for the same is public expenditure on healthcare. Our second hypothesis pertains to a possible difference in public health expenditure across states with different income levels. To understand whether such an effect is in play, we have collected data about the State Health Expenditure per capita, and calculated the average levels of the same for each segment of states (low, middle- and high-income level), as identified in the previous section. The following bar graph depicts the same.

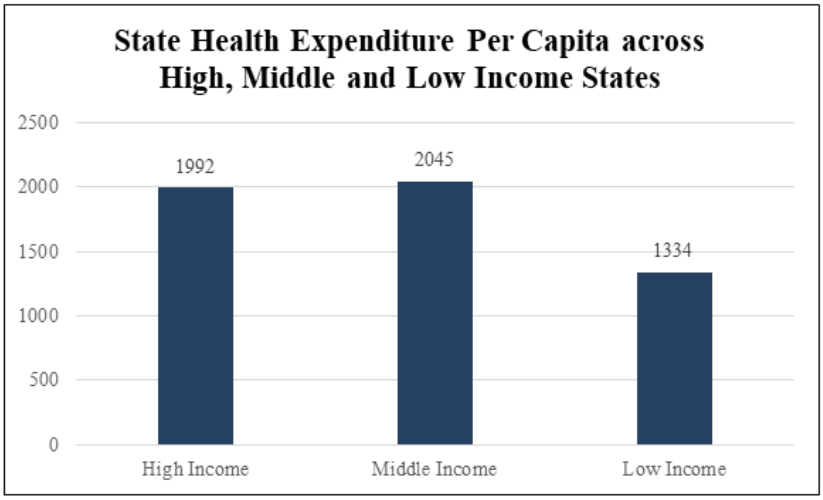

Figure-4
Source: Reserve Bank of India (2020), Authors' calculations

Counter-intuitive to our expectation the per capita state health expenditure in middle income states is higher than that in high income states. This could be explained by the fact that the private sector tends to have much stronger presence in high income states, hence reducing the government's burden in healthcare expenditure. Moreover, people in high income states have higher capability to bear health expenses, supported by health insurance and other systematic support.

In line with our hypothesis, however, we discover that low-income areas, which arguably have a higher need for public health expenditure, witness significantly lower levels of the same. This highlights the fact that low-income areas are doubly affected with existing low income to bear health expenses, and additionally receiving lower state support for the same. This phenomenon explains our observed positive relationship between income level and healthcare to a significant extent.

Social Reasons

Our final expectation on the possible reasons behind the income-health relationship relates to other factors such as education level. It has been observed in various studies that there exists a positive relationship between income level and education. Higher income, and subsequently wealth accumulation over years, raises the willingness of parents to educate their children, initiating a virtuous cycle. Extending this argument, we can easily visualize that high income areas are accompanied by better education availability and accessibility.

Further, improvements in education and literacy promotes the importance of healthcare and hygiene for an individual along with removing barriers to accessibility arising from lack of education. Hence, education plays a role in our observed income-health relationship.

Specifically talking about the COVID-19 era, there has been widespread misinformation about any negative effects of the vaccine. A lack of proper education robs people of the skills necessary to arrive at factual information about benefits of vaccination, causing vaccine reluctance. While we have already spoken at length about the supply-side roadblocks in vaccine distribution, this reluctance could be one of the demand-side factors at play causing lesser vaccine penetration in low-income areas.

6. CONCLUSION

Through our analysis we were able to identify a definite positive impact of income level on healthcare outcomes and policy implementation. Higher income states in India observe better health outcomes as well as higher penetration of the effects of healthcare policies. With the advent of the COVID-19 pandemic, this relationship has deepened further, with the effect of income inequalities becoming more and more evident in healthcare. This puts lower income areas in a disadvantaged position, combined with the fact that income inequality itself has widened due to the pandemic.

We have been able to identify various reasons contributing to this effect, such as the positive relationship between income level and healthcare infrastructure, public health expenditure and education in different Indian states. While income, translating to purchasing power, already has a direct effect on accessibility towards healthcare, our analysis also shows that it also has a direct effect on the availability itself of healthcare resources. Low-income areas receive a higher burden on their healthcare systems and receive lesser public support at the same time, worsening health outcomes. Lack of such infrastructure and education puts low-income areas at a disadvantage in policy implementation as well.

On the basis of our findings, we would recommend investment of resources in capacity building of healthcare systems, especially in low-income states, which would also act as a measure to raise state support towards healthcare expenditure. Apart from this, providing a systematic boost to auxiliary healthcare services such as insurance, and education capabilities, would contribute to long-term improvements in health outcomes as well.

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