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COMBATTING COVID-19- ON RELATIVE PERFORMANCE OF THE INDIAN STATES

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Combatting Covid-19- On Relative Performance of the Indian States

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The Abstract

The purpose of this paper is to construct a relative performance index for the States in India in terms of their performance in combatting Covid-19 pandemic. The data is analyzed up to August, 2020, though the methodology used can be readily extended to update the index. The methodology can be applied to other developing countries with similar background. We use population density and the extent of tests conducted to fine tune the index. The association between per capita health expenditure and relative performance indices reveals that there are states where relatively sound health infrastructure has not ensured better performance in curing patients and those relatively weak have done better. But with a multi-dimensional health infrastructure index such anomaly tends to disappear.

JEL Codes-I120, I150

Keywords- infectious disease, morbidity, mortality, human development, population health

1. INTRODUCTION

The purpose of this paper is to construct a simple relative performance index for the States in India in terms of their performance in combatting Covid-19 pandemic. The data is analyzed up to August, 2020, though the methodology used can be readily extended to update the index. India is an interesting and rather unique case, as a hugely populous developing economy, with a democratic federal structure, being one of the fastest growing nations, but also with historically inadequate public health system, quantitatively as well as qualitatively. The association between health and several relative performance indices reveals that there are states where sound health infrastructure has not ensured better performance in combatting the pandemic.

According to National Health Profile 2018, India's public health expenditure which has remained stagnant at 1.02% of GDP since 2009 and is among the lowest in the world. Whereas, the equivalent proportion of GDP spent on healthcare in the Maldives is 9.4 percent, in Sri Lanka 1.6 percent, in Bhutan 2.5 percent and in Thailand 2.9 percent. According to a 2018 India Spend Report, India's per capita spending on public health is as low as Rs. 1112 per year or Rs. 93 per month or Rs. 3 per day.

As a greatly diverse nation with a large number of sub-national governments fighting to cope with pandemic , it is important to devise a simple method to reflect on their success and failure so far. This is more important because most of the initiatives to face the challenge are undertaken by the state governments, even if some of them are schemes of the federal or the Central government. They are the ground level agencies which have to handle the situation. Anywhere in the world wherever one is interested in measuring a yardstick for regional performance , our method and measures should be of good help.

Two factors are very important in this context. First, the varying population density across states and second, variation in Tests conducted in each state. On top of these the problem is one of using official data as there might be misreporting and unlike in some other cases it is impossible to match data from two different and officially authentic sources (Footnote- Such as in the case with the same international trade data available from two countries. But misreporting is a complex problem there also. See Biswas, Marjit and Sarkar (2019)). A state doing equally well as another but with a much higher population density and much better test record must be given more credit than the other one. Another important issue is how the track record so far is correlated with the simple health expenditure index i.e. the proportion of state level expenditure to state level GDP. As we show there are interesting anomalies which need further explanation. We plan to go on updating the data and create a database of HDI type indices as the pandemic evolves and unfolds.

Another purpose of this work is to focus on some structured analysis with whatever data we have at our disposal rather than letting our judgment depend entirely on fly by night, politically loaded and motivated and sometimes deliberately designed incorrect news and information in the media. Especially for that reason we keep it simple and refrain from complex and fine- tuned statistical analysis, so that stakeholders can use it as a ready reckoner. Let us now discuss briefly the relevant literature as a backdrop to our work. The studies, as will be evident further are quite distinct from ours in the sense that none has considered relative performance of states in combatting the pandemic so far in terms of a simple index which takes into account, the population density and testing as normalizing factors for a cross-state analysis of responses to the pandemic.

Behera (2020) examines the relationship between the spreads of Covid-19 and health system spending in the South-East Asia Region (SEAR) of the World Health Organization (WHO) which by taking a cross-sectional observation of the

11 countries including India at a particular time in April. The findings show that there is a negative association between the death rate and government health expenditure as a ratio of general government expenditure and thus recommends increased funding on health infrastructure as well as human resources to enhance the detection and testing capacity of a health system irrespective of the infectious disease concerned.

Gerritse (2020) uses daily infection rates at the country level with data from U.S. with the aim to explore how population density and the organization of the city correlate to the speed of transmission of the Covid-19 virus. For that purpose, primarily, the author introduces density and correlated urban variables in an epidemiological regression equation of the workhorse Kermack and MacKendrick SIR model and derives an estimate of the coefficient which is conditional on state-day fixed effects and is robust across different definitions of density such that higher population density is associated with higher rates of Covid-19 transmission. However, the value of the estimate considerably varies over time – density matters more during the initial phase of the epidemic and more so in places with very high density but as the epidemic progresses this strength of association between density and transmission of the virus becomes weaker.

Ghosh (2020) takes up data covering all states and union territories, except Ladakh, to study the effects of the lockdown on the number of active Covid-19 cases. The paper finds that quarantine measures exerted a statistically significant impact only in states with health infrastructure in the second top quartile and was overwhelmed by adverse impact in states with medium health infrastructure.

Ghosh et al. (2020) considers data up to 16 April 2020 and employs the exponential, the logistic and the Susceptible Infectious Susceptible (SIS) models along with daily infection-rate (DIR) to provide three different perspectives about the spread of pandemic in the states.

Jalan and Sen (2020) studies and analyses the remarkable performance of Kerala in handling the Covid-19 crisis for the first wave of the pandemic in the state which stretches from late-January to mid-May. The authors opine that the Kerala government strategized so as to confront the pandemic by leveraging and strengthening its advantages while overcoming its disadvantages. To that end, early in the timeline of the pandemic in India, the state utilized and reinforced the hard-earned public trust in the state to preemptively formulate a comprehensive set of pro-active strategies like contact tracing, intertemporal and sensible allocation of testing, quarantining, treating the infected, disseminating information, properly structuring and implementing lockdown and providing assistance in cash and kind to the vulnerable sections of the population including the migrant workers, which can be considered as 'public actions' according to the notions of Dreze and Sen (1989).

Sinha (2020) has investigated the transmissibility of Covid-19 in various countries around the world where there have been major outbreaks with special focus on India to obtain an understanding of the spatio-temporal diversity in the spreading dynamics of the disease within India as well as between India and other parts of the world.

In contrast to the literature presented, our study first of all considers different states and UTs of India and compares their performances in tackling Covid-19 among themselves which gives a picture of the relative situations of the states and UTs. This paper normalizes the various parameters for population characteristics and testing characteristics as well as searches for the extent of correlation between public health expenditure and the relative performance in different states. In addition to this our method is substantially fluid and dynamic in the sense that it allows the analysis to be easily updated upon as the timeline of the pandemic progresses.

The structure of the paper is as follows : Section 2 presents the data sources and the methodology of analysis and the results of the analysis have been discussed in **Section 3**. Finally, **Section 4** presents the concluding remarks along with some policy prescriptions.

Section-2

2.1 Data Sources:

Due to the fact that Indian states and UTs and their political boundaries have been redefined frequently in the recent past and since the 2011 Census, the availability of data for the various parameters like population, population density, per capita Net State Domestic Product (NSDP) and even per capita public health expenditure 2017-18 on states and UTs have been compromised. For that reason, we had to impute the missing data on the basis of best available figures by the methods which have been described in the Appendix : A1.

Primarily, the various sources of data are given below:

Data for population of States/UTs (except redefined state of Andhra Pradesh, newly formed state of Telengana, 'Dadra & Nagar Haveli and Daman & Diu', newly formed union territory of Jammu & Kashmir and newly formed union territory of Ladakh including erstwhile states of Jammu & Kashmir and Andhra Pradesh and separate union territories of Dadra & Nagar Haveli and Daman & Diu) : 2011 Census figures, A-2 Decadal Variation In Population Since 1901, Population Enumeration Data (Final Population), Office of the Registrar General & Census Commissioner, India, Ministry of Home Affairs, Government of India (https://censusindia.gov.in/2011census/population_enumeration.html)\

N.B. Population data given for 'NCT Delhi' taken to be the population data for the union territory of Delhi

- *Data for population of the newly formed state of Telengana* : Total Population (as per 2011 Census), Demographic and Other Key

Characteristics of the State, Table-1.1, Statistical Year Book 2015, Directorate of Economics and Statistics, Government of Telengana, Hyderabad

- *Data for population density (person per sq. km.) (except redefined state of Andhra Pradesh, newly formed state of Telengana, 'Dadra & Nagar Haveli and Daman & Diu', newly formed union territory of Jammu & Kashmir and newly formed union territory of Ladakh)* : NITI Aayog database
- *Data for population density (person per sq. km.) of the newly formed state of Telengana*: Density of Population, Demographic and Other Key Characteristics of the State, Table-1.1, Statistical Year Book 2015, Directorate of Economics and Statistics, Government of Telengana, Hyderabad
- *Data for the population density (person per sq. km.) of the newly formed union territory of Ladakh* : https://en.wikipedia.org/wiki/Ladakh#cite_ref-egazette.nic.in_1-0 (approximately taken as 5)
- *Data for the area of the union territories of Dadra & Nagar Haveli and Daman & Diu*: https://knowindia.gov.in/
- *Data for the area of the redefined state of Andhra Pradesh* : https://www.ap.gov.in/
- *Data for the total area and area of the districts and divisions (i.e. including the districts of Kargil and Leh which now constitute the newly formed union territory of Ladakh) the erstwhile state of Jammu & Kashmir* : https://jk.gov.in/jammukashmir/?q=divisions
- *Data for Covid-19 statistics* : www.covid19india.org (as of 31.08.2020)
- *Data for Per Capita Net State Domestic Product (At Constant Prices) of 2017-18 on States/UTs (except 'Dadra & Nagar Haveli and Daman & Diu' and the newly formed union territory of Ladakh and including the erstwhile*

state of Jammu & Kashmir) : Part I : Annual Series – National Income, Saving And Employment, Table 10, Handbook of Statistics On Indian Economy 2019, Reserve Bank of India

- *Data for Net Domestic Product(At Constant Prices) of 2017-18 on the district of Leh**: Total Expenditure ending 03/2018, Capex Budget 2018-19 of Leh District, Annual Report, District Leh, Union Territory of Ladakh
- *Data for Net Domestic Product (At Constant Prices) of 2017-18 on the district of Kargil** : Annual Plan Expenditure 2018-19, Statistical Hanbook 2018-19, Office of the District Statistics & Evaluation Officer Kargil, Directorate of Economics & Statistics Planning, Development & Monitoring Department, The Administration of Union Territory of Ladakh
- *Data for Per Capita Net State Domestic Product (At Constant Prices) of 2017-18 on 'Dadra & Nagar Haveli and Daman & Diu'** : Per Capita Income (At Current Prices) of 2012-13 in USD units from www.investindia.gov.in (3898 USD) converted to INR units at the rate of 1 USD = 63.875 INR (exchange rate on 29 December, 2017 as given in www.poundsterlinglive.com)
- *Data for per capita public health expenditure on States/UTs (except the newly formed union territory of Ladakh and including the erstwhile state of Jammu & Kashmir) in India* : 2017-18 Budget Estimate for Public Expenditure in Health by States & Union Territories, Health Sector Financing by Centre And States/UTs in India [2015-16 to 2017-18], National Health Accounts Cell, Ministry of Health & Family Welfare, Government of India (divided by the population of states/UTs to arrive at the per capita figures)
- *Data for public health expenditure on district of Leh district* : Total Approved Outlay 2017-18 for Health, Capex Budget 2018-19 of Leh District, Annual Report, District Leh, Union Territory of Ladakh

- *Data for public health expenditure on district of Kargil district** : Total Budget for 2011-12, Budget Summary, District Health Action Plan for Kargil, December 2007, Government of Jammu & Kashmir

* Figures for different years taken as a proxy for study-year data due to unavailability of reliable data of the concerned units for the study-year.

2.2 Notations and methodology

To gauge the Covid-19 performances of the states, we have taken four parameters – number of cases, recoveries, deaths and sum of active cases and deaths in context of Covid-19 and we take them as percentages of the respective total national figures for the five months: April, May, June, July and August. The notations used in this regard are:

- Covid-19 deaths of the state as percentage of national Covid-19 death toll : **Y**
- Covid-19 cases reported in state as percentage of total cases in the nation : **N**
- No. of Covid-19 recoveries in the state as percentage of total recoveries in the nation : **C**
- Sum of active cases and deaths (i.e. Infection-Cure) in the state as percentage of that in the nation : **I**

Now, since in epidemiological context, transmission of the disease largely depends on the population as well as population density of the regions being considered both of which vary widely across India, we construct two types of normalized Covid-19 performance indicators: Normalized_1 and Normalized_2, defined as follows:

- Normalized_1 Y/X = Y/X
- Normalized_1 N/X = N/X
- Normalized_1 C/X = C/X

- Normalized_1 I/X = I/X
- Normalized_2 Y/X = (Y/X)*(D/d)
- Normalized_2 N/X = (N/X)*(D/d)
- Normalized_2 C/X = (C/X)*(d/D)
- Normalized_2 I/X = (I/X)*(D/d),

where **X** is the population of the state as a percentage of total national population, **d** is the population Density of each state expressed as number of persons per sq.km. and **D** is the national Average Population Density expressed as number of persons per sq.km. The idea is that if rate of infection is the same in each state , the one with a higher density will be given more credit and hence the quantity of a bad outcome will be discounted favorably relative to a lower density state.

Again, all the four Covid-19 parameters considered here depend crucially on the proper and accurate diagnosis of the inflicted persons which can be done through a high number of testing. To account for the testing rates of the states as relative to the national figure, we form the following test index:

$$\text{Test Index} = \frac{(No.of\ tests\ in\ a\ state)/(State\ Population)}{(No.of\ national\ tests)/(National\ Population)}$$

With the help of this test index, we construct another set of normalized Covid - 19 performance indicators called the Normalized_3 indicators which are defined as follows:

- Normalized_3 Y/X = (Normalized_2 Y/X)*(1/Test Index)
- Normalized_3 N/X = (Normalized_2 N/X)*(1/Test Index)
- Normalized_3 C/X = (Normalized_2 C/X)*(Test Index)
- Normalized_3 I/X = (Normalized_2 I/X)*(1/Test Index)

To measure the average performance of the states over the five months considered, we also form average Normalized_3 indicators defined as follows:

- Average Normalized_3 Y/X = Average of (Normalized_3 Y/X)'s for the April, May, June, July and August
- Average Normalized_3 N/X = Average of (Normalized_3 N/X)'s for the April, May, June, July and August
- Average Normalized_3 C/X = Average of (Normalized_3 C/X)'s for the April, May, June, July and August
- Average Normalized_3 I/X = Average of (Normalized_3 I/X)'s for the April, May, June, July and August.

Now, for each of the Normalized_2 and Normalized_3 performance indicators, we construct a relative performance index so as to compare the position of the states and UTs among themselves for each of the months as well as average values (for Normalized_3 indicator, we consider relative performance index only for the average figures). We define the Relative Performance Indices (RPI) for the different states and UTs as follows:

- RPI of Covid-19 deaths for i-th state = $\frac{\left\{\left(\frac{Y}{X}\right)_i - \left(\frac{Y}{X}\right)_{min}\right\}}{\left\{\left(\frac{Y}{X}\right)_{max} - \left(\frac{Y}{X}\right)_{min}\right\}}$ for both Normalized_2 and Normalized_3 values
- RPI of Covid-19 cases for i-th state = $\frac{\left\{\left(\frac{N}{X}\right)_i - \left(\frac{N}{X}\right)_{min}\right\}}{\left\{\left(\frac{N}{X}\right)_{max} - \left(\frac{N}{X}\right)_{min}\right\}}$ for both Normalized_2 and Normalized_3 values
- RPI of Covid-19 cases for i-th state = $\frac{\left\{\left(\frac{C}{X}\right)_i - \left(\frac{C}{X}\right)_{min}\right\}}{\left\{\left(\frac{C}{X}\right)_{max} - \left(\frac{C}{X}\right)_{min}\right\}}$ for both Normalized_2 and Normalized_3 values
- RPI of total of Covid-19 active cases and deaths for i-th state = $\frac{\left\{\left(\frac{I}{X}\right)_i - \left(\frac{I}{X}\right)_{min}\right\}}{\left\{\left(\frac{I}{X}\right)_{max} - \left(\frac{I}{X}\right)_{min}\right\}}$ for both Normalized_2 and Normalized_3 values

Now, due to the differences among of UT/Special Category States and the remaining states in terms of administrative nature, population, area as well as exposure to the virus from external sources, we have grouped the states and UTs of India into two catergories – Special Category States & UTs and the remaining states in the following way:

- Special Category States & UTs : Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Chandigarh, Dadra & Nagar Haveli and Daman & Diu, Delhi, Himachal Pradesh, Jammu & Kashmir, Ladakh, Manipur, Meghalaya, Mizoram, Nagaland, Puducherry, Sikkim, Tripura and Uttarakhand
- Remaining States : Andhra Pradesh, Bihar, Chattisgarh, Goa, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telengana, Uttar Pradesh and West Bengal

Thence, on the basis of the values of the Relative Performance Indices, we have ranked the states and UTs among themselves separately for the two categories and termed these ranks as Relative Performance Ranks (RPR).

Further, the performance of the various Indian states in tackling Covid-19 which requires high rate of testing, efficient critical care treatment which reduces fatality rate, proper contact tracing to reduce community transmission and identification of asymptomatic cases, general prevalence of measures of hygiene, sufficient availability of doctors and other healthcare workers relative to the population and also provision of enough Personal Protective Equipment (PPE) kits for them. All these critical public health factors, in turn, depend on the historical public health expenditure of the states as health is primarily a state subject in India. To measure the importance given by the states historically to the public healthcare infrastructure, we have thus constructed a health index as follows:

Health Index

$$= \frac{\text{Per Capita Public Health Expenditure of 2017–18 on States/UTs}}{\text{Per Capita Net State Domestic Product (at constant prices) of 2017–18 on States/UTs}}$$

Subsequently, we have ranked the states and UTs among themselves on the basis of the values of the Health Indices separately for the Special Category States & UTs and the remaining states. To measure the extent to which the public health expenditure has influenced the relative performance of the states and UTs, we have further calculated the Spearman's Rank Correlation Coefficient between the RPRs and these Health Ranks.

There is one more Health Index that we have used in this paper. In June,2019 a report was published based on the study conducted by Ministry of Health and Family Welfare, Niti Aayog and The World Bank. The title of the report was 'Healthy States Progressive India; Reports on the Ranks of States and Union Territories'(http://social.niti.gov.in/.). In this report, the respective States and Union Territories have been ranked. However there is a specific method in doing so by calculating dimension indices of several health parameters and then obtaining the weighted average of them (page number 13-15 of the report). So we have taken the value of the health index of the respective states and union territories from the report and ranked them separately for 18 states and 17 union territories. Then, we have derived the rank correlation coefficient between this index and the respective RPRs for the States and the UTs.

Finally, we have constructed a comorbidity index for the year 2018,taking the respective States and UTs(except Delhi as data are not available for all the indicators). In this case, we have taken the number of persons got infected due to Acute respiratory Infection, Blood Sugar, Cancer and Hypertension. Having obtained the percentage figure(out of total population) of infected persons for each disease, we have normalized each of the indicator by calculating the ratio, (Actual Value-Minimum Value)/(Maximum Value-Minimum Value).Thereafter, we have obtained the average value of the respective indicators for the respective

States and UTs and ranked them. Finally, we have calculated the Rank correlation coefficient value between this co-morbidity index and the (Case-Cure) Index. Also, we have checked the association between co-morbidity index and the health indices used in this study.

Section-3

The rank and correlation coefficient values of the study obtained through the above methodology are presented in Table 1 to Table 6 at Appendix A2.

We analyse the results in the following sections:

3.1 PUBLIC HEALTHCARE SITUATION OF STATES

According to the ranks on the basis of value of health indices computed, among the Special) Category States and UTs, the union territory of Ladakh (0.158) fares the best followed by Arunachal Pradesh (0.091) and Andaman & Nicobar Islands (0.069) and Delhi (0.013) fares the worst followed by Dadra & Nagar Haveli and Daman & Diu (0.014) and Uttarakhand (0.015). Again, among the remaining states, Chattisgarh (0.026) fares the best followed by Uttar Pradesh (0.0231) and Bihar (0.0228) whereas Maharashtra (0.008) fares the worst followed by Karanataka (0.008) followed by Gujarat (0.01).

3.2 SITUATION OF TESTING STATISTICS IN STATES

Among the Special Category States and UTs, the highest number of tests at the end of August was conducted in Assam (2262827) followed by Delhi (1583485) and Jammu & Kashmir (966412) whereas the least number of tests was conducted in Chandigarh (30377). In terms of ranks on the basis of test index, Ladakh fared the best followed by Dadra & Nagar Haveli and Andaman & Nikobar Islands whereas Meghalaya became the worst followed by Nagaland and Mizoram.

Among the remaining states, the highest number of tests, at the end of August, was conducted in Uttar Pradesh (54,90,354) followed by Tamil Nadu (48,13,147) and Maharashtra (41,45,123) whereas the least number of tests was conducted in Goa (1,99,224). In terms of ranks on the basis of test index, Goa fared the best

followed by Andhra Pradesh and Tamil Nadu whereas Bihar performed the worst followed by West Bengal and Madhya Pradesh.

We visualize the breakup of the total tests conducted in India at the end of August by Special Category States & UTs and the remaining states separately in Figure 1 and Figure 2.

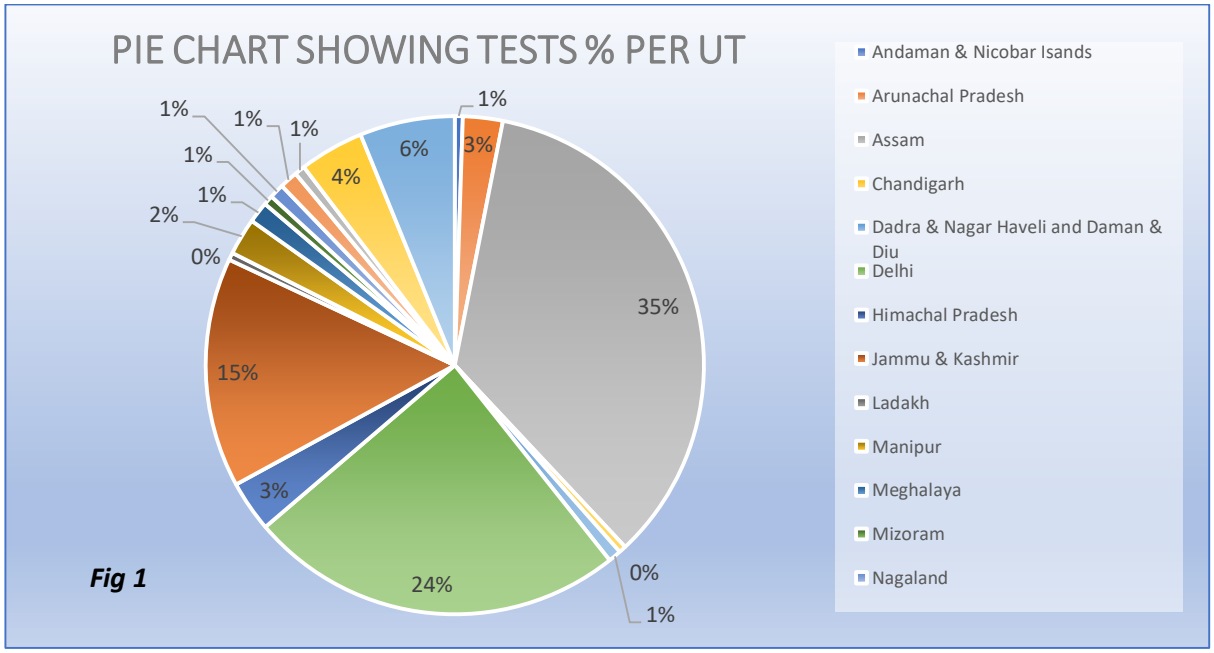


Fig 1

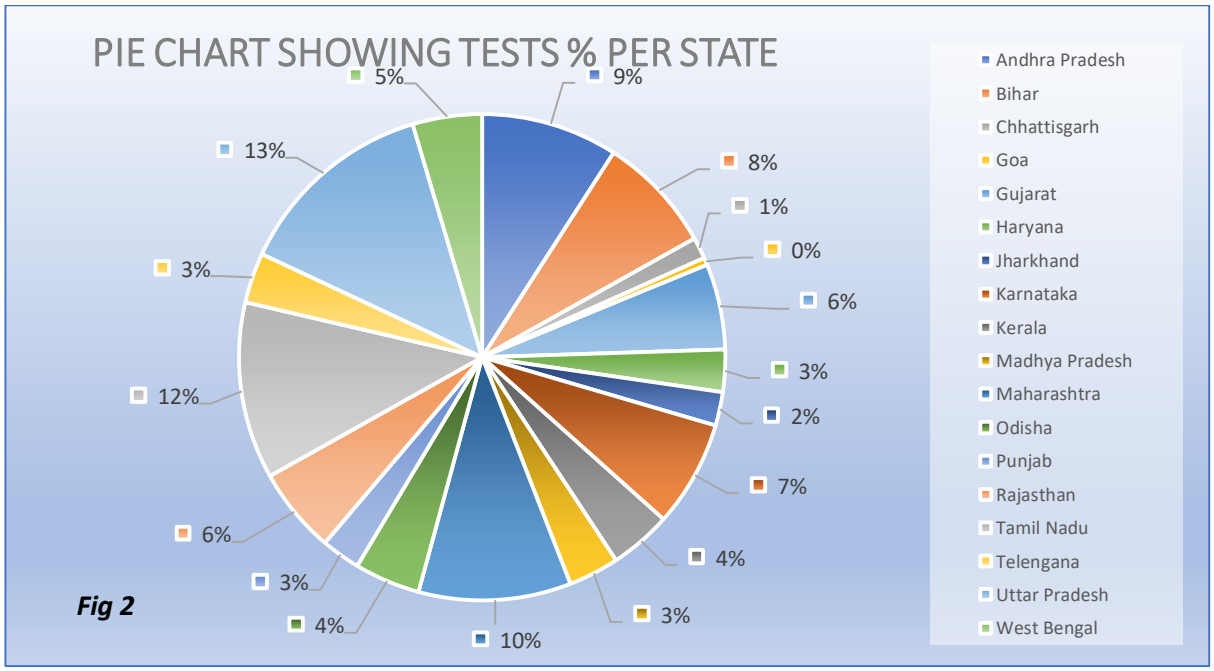


Fig 2

3.3 SITUATION OF CONFIRMED CASES STATISTICS IN STATES

Among the Special Category States and UTs, the highest number of cases at the end of August was recorded in Delhi (1,74,628) followed by Assam (1,09,040) and Jammu & Kashmir (37,643) whereas the least number of cases was recorded in Mizoram (1010). In terms of Normalized_2 average relative performance ranks for cases, Chandigarh fared the best followed by Delhi and Puducherry whereas Ladakh performed the worst followed by Andaman & Nicobar Islands and Arunachal Pradesh. Again, in terms of Normalized_3 average relative performance ranks for cases, Chandigarh fared the best followed by Delhi and Puducherry whereas Ladakh performed the worst followed by Andaman & Nicobar Islands and Arunachal Pradesh.

Among the remaining states, the highest number of cases, at the end of August, was recorded in Maharashtra (7,92,239) followed by Andhra Pradesh (4,34,727) and Tamil Nadu (4,27,917) whereas the least number of cases was recorded in Goa (17,413). In terms of Normalized_2 average relative performance ranks for cases, Bihar fared the best followed by Uttar Pradesh and West Bengal whereas Maharashtra performed the worst followed by Goa and Andhra Pradesh. Again, in terms of Normalized_3 average relative performance ranks for cases, Kerala fared the best followed by Uttar Pradesh and Bihar whereas Telengana performed the worst followed by Maharashtra and Gujarat. It is hard to explain why in spite of better health facilities and better testing, Goa and Gujarat are performing worse than the likes of Uttar Pradesh and Bihar.

We expect positive values of Spearman Rank Correlation Coefficient here among the RPR and Health Rank which we obtain for the remaining states for all the time periods considered and on average for Normalized_2 and Normalized_3 ranks. However, for the Special Category States & UTs the association has been found to be negative in both the cases. (Table 1 and Table 2 in the Appendix A2)

We visualize the breakup of the total confirmed cases recorded in India at the end of August by Special Category States & UTs and the remaining states separately in Figure 3 and Figure 4.

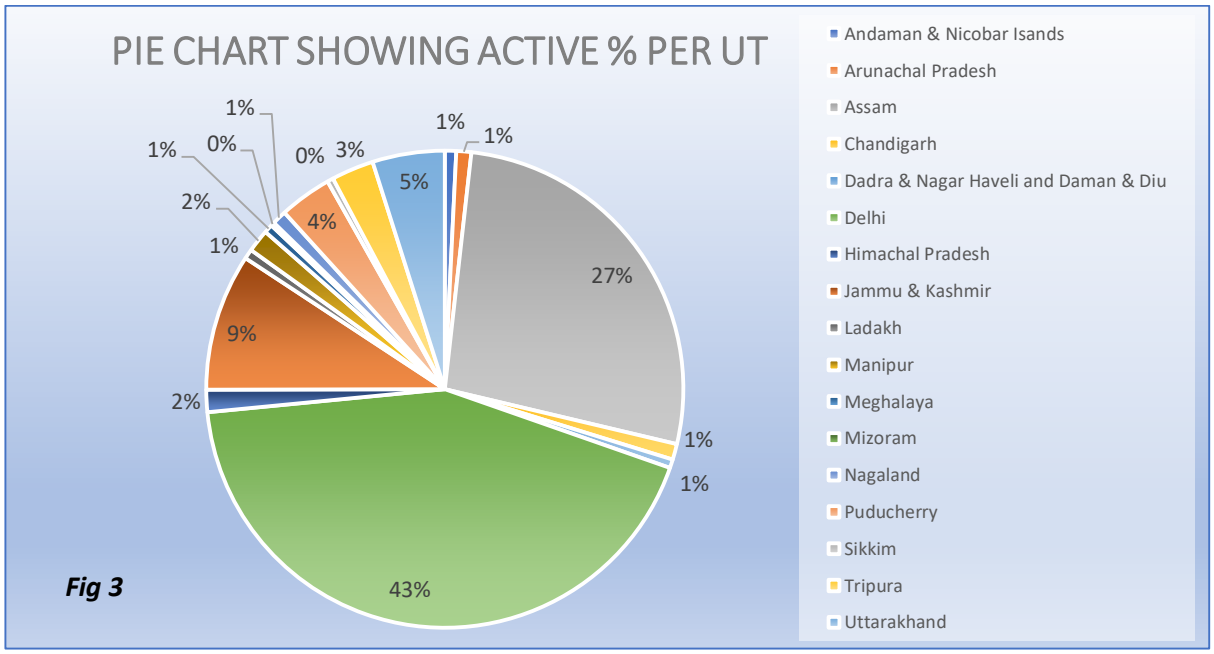


Fig 3

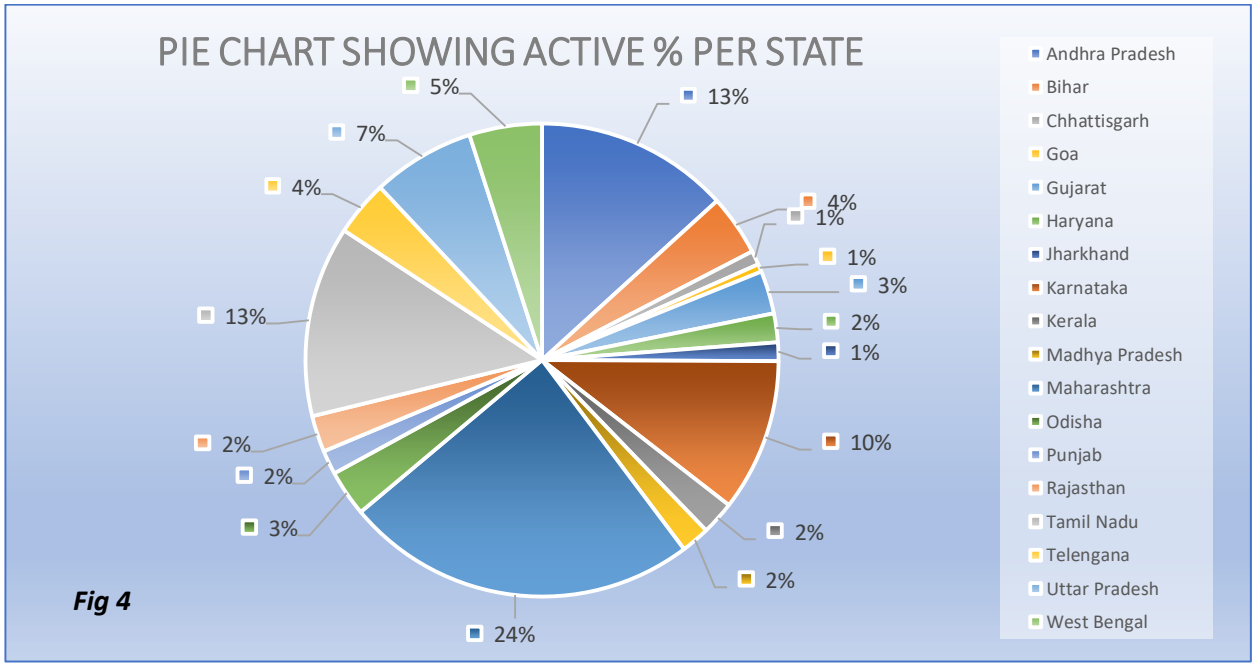


Fig 4

3.4 SITUATION OF RECOVERY STATISTICS IN STATES

Among the Special Category States and UTs, the highest number of recoveries at the end of August was recorded in Delhi (1,55,672) followed by Assam (85,459)

and Jammu & Kashmir (29,014) whereas the least number of recoveries was recorded in Andaman & Nicobar Islands (589). In terms of Normalized_2 average relative performance ranks for recoveries, Delhi fared the best followed by Chandigarh and Puducherry whereas Arunachal Pradesh performed the worst followed by Mizoram and Meghalaya. Again, in terms of Normalized_3 average relative performance ranks for recoveries, Delhi fared the best followed by Chandigarh and Puducherry whereas Meghalaya performed the worst followed by Mizoram and Arunachal Pradesh.

Among the remaining states, the highest number of recoveries, at the end of August, was recorded in Maharashtra (573520) followed by Tamil Nadu (368135) and Andhra Pradesh (330525) whereas the least number of recoveries was recorded in Goa (13577). In terms of Normalized_2 average relative performance ranks for recoveries, Tamil Nadu fared the best followed by Maharashtra and Goa whereas Chhattisgarh performed the worst followed by Jharkhand and Madhya Pradesh. Again, in terms of Normalized_3 average relative performance ranks for recoveries, Goa fared the best followed by Tamil Nadu and Maharashtra whereas Chhattisgarh performed the worst followed by Jharkhand and Madhya Pradesh. This indicates that while Maharashtra has been recording the highest number of cases, it has a very good recovery rate too. Goa is another state which has also fared better in case of recoveries in spite of poor performance in case of confirmed cases. The performances of Bihar and Uttar Pradesh does not remain well-performing in case of recoveries.

We expect positive values of Spearman Rank Correlation Coefficient here among the RPR and Health Rank which we surprisingly do not obtain for any of the time periods or average values considered in case of both Special Category States & UTs and the remaining states for Normalized_2 as well as for the average Normalized_3 ranks. (Table 1 and Table 2 in the Appendix A2)

We visualize the breakup of the total recoveries recorded in India at the end of August by Special Category States & UTs and the remaining states separately in Figure 5 and Figure 6.

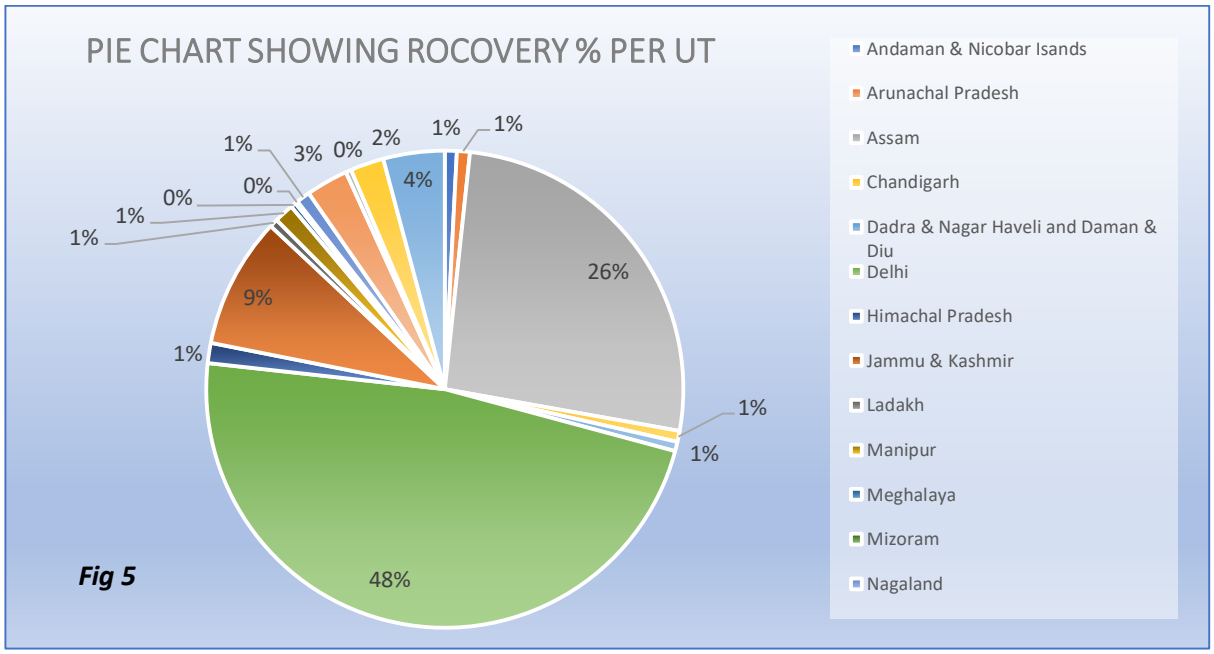


Fig 5

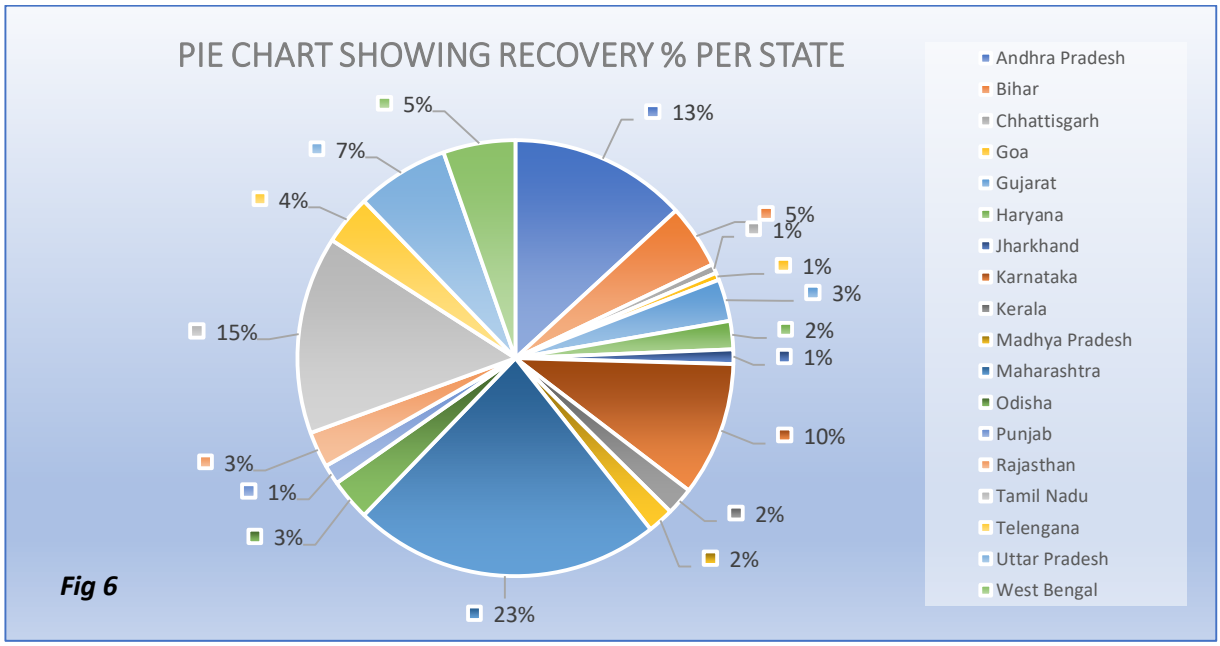


Fig 6

3.5 SITUATION OF FATALITY STATISTICS IN STATES

Among the Special Category States and UTs, the highest number of deaths at the end of August was recorded in Delhi (4442) followed by Jammu & Kashmir (701) and Assam (306) whereas the least number of deaths was recorded in Mizoram (0). In terms of Normalized_2 average relative performance ranks for deaths, Mizoram fared the best followed by Dadra & Nagar Haveli and Chandigarh whereas Ladakh performed the worst followed by Andaman & Nicobar Islands and Arunachal Pradesh. Again, in terms of Normalized_3 average relative performance ranks for deaths, Mizoram fared the best followed by Dadra & Nagar Haveli and Daman & Diu and Chandigarh whereas Ladakh performed the worst followed by Andaman & Nicobar Islands and Uttarakhand.

Among the remaining states, the highest number of deaths, at the end of August, was recorded in Maharashtra (24,572) followed by Tamil Nadu (7321) and Karnataka (5699) whereas the least number of deaths was recorded in Goa (192). In terms of Normalized_2 average relative performance ranks for deaths, Bihar fared the best followed by Kerala and Uttar Pradesh whereas Maharashtra performed the worst followed by Gujarat & Karnataka. In terms of Normalized_3 average relative performance ranks for deaths, Kerala fared the best followed by Bihar and Jharkhand whereas Maharastra performed the worst followed by Telengana and Gujarat.

We expect positive values of Spearman Rank Correlation Coefficient here among the RPR and Health Rank which we observe for all the time periods and on average for the remaining states in case of both Normalized_2 and Normalized_3 values. For Special Category States and UTs, the correlation values are found to be negative for both Normalized_2 and Normalized_3 cases. (Table 1 and Table 2 in the Appendix A2)

We visualize the breakup of the fatalities recorded in India at the end of August by Special Category States & UTs and the remaining states separately in Figure 7 and Figure 8.

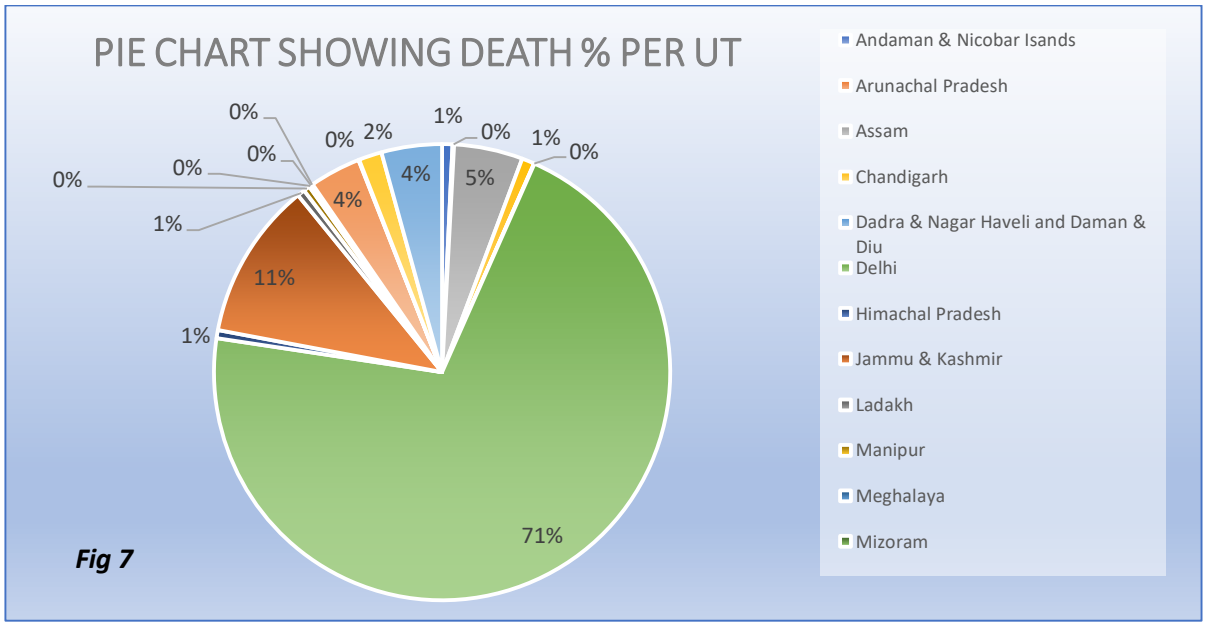


Fig 7

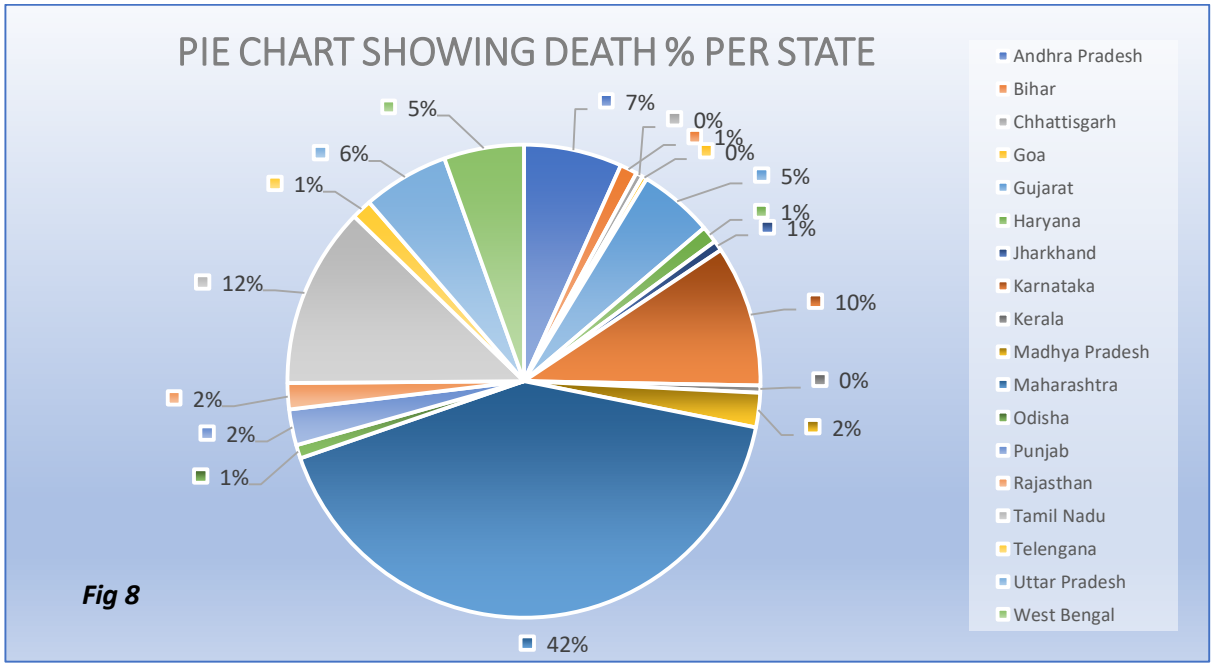


Fig 8

3.6 SITUATION OF (CASES – CURE) STATISTICS IN STATES

Among the Special Category States and UTs, the highest number of (cases - cures) at the end of August was recorded in Assam (23,581) followed by Delhi (18,956) and Jammu & Kashmir (8629) whereas the least number of (cases - cures) was recorded in Dadra(286). In terms of Normalized_2 average relative performance ranks for (cases - cures), Chandigarh fared the best followed by

Delhi and Dadra whereas Ladakh performed the worst followed by Arunachal Pradesh and Andaman & Nicobar Islands. Again, in terms of Normalized_3 average relative performance ranks for (cases - cures), Dadra& Nagar Haveli fared the best followed by Delhi and Chandigarh whereas Ladakh performed the worst followed by Arunachal Pradesh and Andaman & Nicobar Islands.

Among the remaining states, the highest number of (cases - cures), at the end of August, was recorded in Maharashtra (2,18,719) followed by Andhra Pradesh (104,202) and Karnataka (92,863) whereas the least number of (cases - cures) was recorded in Goa (3836). In terms of Normalized_2 average relative performance ranks for (cases - cures), Bihar fared the best followed by West Bengal and Uttar Pradesh whereas Maharashtra performed the worst followed by Goa and Andhra Pradesh. Again, in terms of Normalized_3 average relative performance ranks for (cases - cures), Kerala fared the best followed by Uttar Pradesh and Bihar whereas Telengana performed the worst followed by Maharashtra and Chhattisgarh.

We expect positive values of Rank Correlation Coefficient here among the RPR and Health Rank which we observe for all the time periods and average values considered for the remaining states for Normalized_2 as well as average Normalized_3 ranks and only for April ranks in case of Special Category States & UTs. The association between average Normalized_2 and Normalized_3 ranks for the Special Category States & UTs and the Health rank has been found to be negative. (Table 1 and Table 2 in the Appendix A2)

The rank correlation co-efficient between the value of health index (taken from the Report of Niti Aayog-2019) and the respective RPRs obtained by Normalized_2 and Normalized_3 performances in terms of Fatality, Cases and (Cases-Cures) calculated for the other states, are found to be negative whereas it is positively correlated with the RPRs obtained from the Recovery. However, we have found the positive association in each case for Normalized_2 and

Normalized_3 Average performances for the UTs. (Table 3 and Table 4 in the Appendix A2)

We also have constructed a co-morbidity index taking the data of Hypertension, Cancer, Acute Respiratory Infection and, Blood Sugar for the Special Category States & UTs and hence obtained the value of correlation coefficient with RPR's for (Case-Cure) category. We have found positive association in the case of Normalized_2 rankings and negative association for Normalized_3 rankings for the states. However, it is observed to be negative in the both cases for the Special Category States & The UTs. (Table 5 and Table 6 in the Appendix A2)

3.7 DISCUSSION ON THE RESULTS

Let us first discuss the nature of association between health indices used in the paper and the Average Normalized_2 as well as Normalized_3 recovery index. A higher rank in health index based on Per Capita State Health Expenditure does not guarantee a corresponding good position in the recovery index. States like Chhattisgarh, Uttar Pradesh, Bihar and Madhya Pradesh possess top four position in this health index but we find that both in Average Normalized_2 and Normalized_3 rank of recovery their respective positions are not so commendable, in fact they are amongst the poorest performers. Similarly, bottom four states in health index are Tamil Nadu, Gujarat, Karnataka and Maharashtra. We observe that in terms of Average Normalized_2 and Normalized_3 rank of recovery other states are not that much poorly placed except Karnataka. So it is evident that higher recovery ranks may not always be accompanied by higher ranks in health index and vice-versa. That actually explains the negative association between recovery index and health index in this particular context.

On the other hand, the rank difference is much less if the multidimensional health index calculated from the Niti Aayog report is considered. For instance, Kerala, Andhra Pradesh, Maharashtra and Gujarat are the top four ranked states. They have done reasonably well in average normalized_2 and average normalized_3

recovery index, in particular, in the later one. Madhya Pradesh, Odisha, Bihar and Uttar Pradesh are the bottom four states in this health index ranking. In this case, the rank differences with the Average Normalized_2 and Normalized_3 recovery index are even less. This explains the reason behind getting positive rank correlation between them.

Now let us discuss other results. States like Bihar, Haryana, Jharkhand, Kerala, Uttar Pradesh and West Bengal have performed better than other states in terms of Normalized Average_2 and Normalized Average_3 ranks obtained for fatality,(cases-cures) and case statistics. If we look at the health rank found from the ratio of per capita state level health expenditure and per capita state domestic Product and the other one from the Niti Aayog Report(2019) it is evident that not every one of them has a very high rank in both cases. Bihar, Uttar Pradesh and Kerala are substantially well placed either in terms of previous health index or from the 2019's report published by the Niti Aayog. On the other hand, though Maharashtra, Gujarat, Andhra Pradesh are relatively better placed expressed by these health indices, in most cases, their average relative performances have not gone so well expressed by the fatality, cases and (case-cure) results.

Again, if we consider the same thing for the UTs and other Special category States, there we find that Assam, Chandigarh, Delhi, Puducherry and Dadra& Nagar Haveli& Daman and Diu can be cited as the better performers than others. Apart from Chandigarh and Dadra &Nagar Haveli, none of them fared quite well in either of the health ranking.

So from here, it can be said that better health infrastructure does not always necessarily imply a better health management in tackling the covid-19 pandemic. Basically, it depends upon the individual state's efficiency during the pandemic that helped combatting this extremely hard situation. For example, in West Bengal, despite having to deal with too many obstacles in health infrastructure from the beginning of the pandemic, the state finally has managed to make up the

earlier gaps too some extent and now they are doing better than many other states known for their better health facilities.

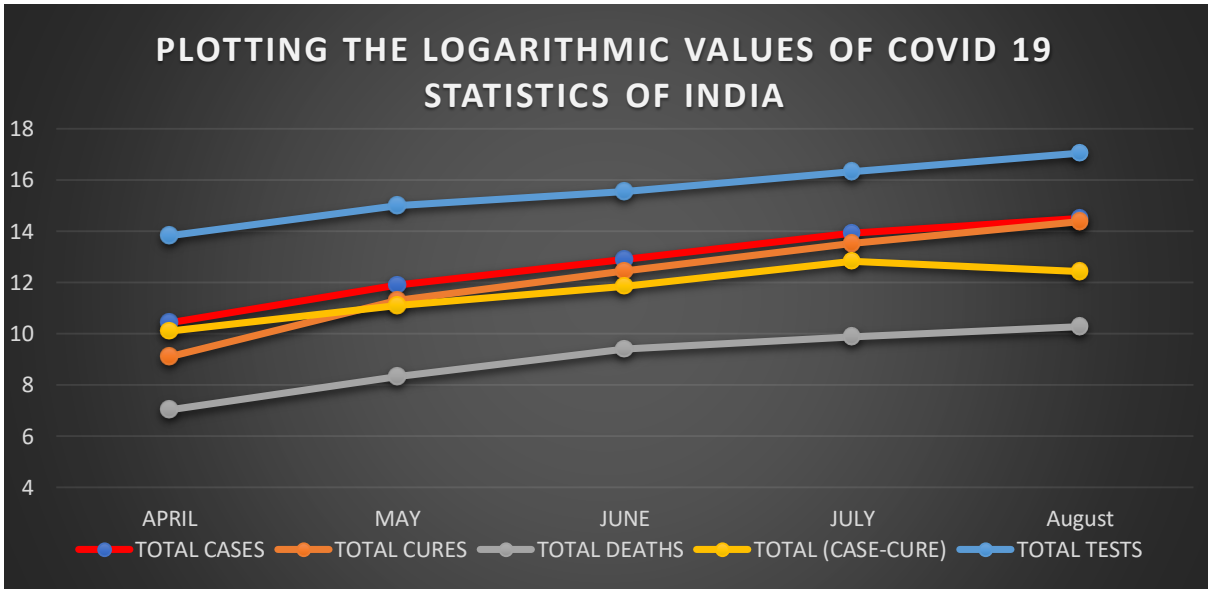
However, the exactly opposite sign of rank correlation coefficients derived from the association between two different health index and other average relative performance indicators may show some misleading impression. We believe, that can be attributed to two differently constructed health index. Unlike the first one, there are lot more variables taken in the Niti Aayog Report in order to capture the overall health scenario in the country. This leads to an altogether different rank of the respective states and UTs than what we have earlier.

One more issue needs to be discussed here. Even if we look at the co-morbidity index, we find that Bihar, Jharkhand, Haryana and Punjab are the states whose position does not differ too much with the (case-cure) Normalized_2 and Normalized_3 ranks. But in the case of Kerala, West Bengal, Chhattisgarh and Goa the respective rank differences are quite big.In other words, a better performing state in terms of co-morbidity index may not always become a state with improved position in (Case-Cure) RPR and vice-versa. For the Special category States and UTs we find less differences in ranking for Andaman& Nikobar Islands, Assam, Manipur, Nagaland and Uttarakhand while the difference is more for Chandigarh, Dadra& Nagar Haveli, Puduchchery, Sikkim, Meghalaya and Tripura. The rank difference can be further looked at by comparing the position of the health index computed by us and also the data taken from the Niti Aayog report. We observe that there is a negative rank correlation coefficient between co-morbidity index and the health index constructed based on Niti Aayog Report though the association between the health index calculated by per capita state health expenditure and the co-morbidity index is positive.

This analysis is based on for the first five months of the pandemic. The detail calculations of all the intermediate steps are readily available and can be submitted once it is asked for.

In many of the cases, we observe surprising results in terms of rankings and correlation values. For example, Kerala and Odisha are two states which have consistently performed well in managing the Covid-19 crisis according to various news reports. This can be attributed to good health infrastructure, better social mobilisation and efficient local governance in case of Kerala while efficient disaster management, proactive local governance and swift response to crisis has helped Odisha to tackle the pandemic well. However, the results of our analysis show that although Kerala has consistently good rankings, Odisha's rankings are fluctuating with poor rankings for many of the cases being considered here. Similarly, perplexing are the impressive figures for Bihar and Uttar Pradesh in spite of the poor public health infrastructure and socio-economic indicators prevalent there as well as the huge influx of migrant workers to these states.

To present an overall picture of the country, in Figure 9 below, we have plotted the natural logarithm of the five Covid-19 statistics for the country – total Covid-19 cases, total Covid-19 recoveries/cures, total Covid-19 fatalities/deaths and total Covid-19 tests for five months – April, May, June, July and August .



It can be seen from the graph that although the number of cases in the country is steadily increasing, the number of recoveries is steeply increasing too and the gap

between the two is narrowing down fast. Another positive observation from the graph is that the curve denoting the total deaths is still not flattening down while the number of tests seem too increase.

Section-4

This is the first study on state level performance index which takes into account state wise Population, Population Density, Tests Rate, as normalizing factors for a macro look across states. Secondly, it can be continuously updated, hence will be a useful tool to the policy makers. Thirdly, we cross check how far Health Index i.e. the initial preparedness of states and comorbidity are correlated with the index, a concern raised always but no quantitative approximation is available. There are cases where the performance index and those two indices do not move together. For example, we can see the positions of Chhattisgarh, Andhra Pradesh, Bihar, Rajasthan. Also, there are sharp rank differences if we compare the positions of the respective states in terms of co-morbidity index and two health index. If we look at the rank of Kerala, Karnataka and Maharastra both in terms of co-morbidity index and the health index found from the Niti Aayog Report the rank differences are quite evident. But we have used standard official data source and taken the information from the Niti Aayog data set. Fourthly, we are not proposing any policy deliberately because we are preparing a data set of performance with facts and policy makers will use this as a guiding factor. We cannot un Econometric tests because the data is not large enough and creating high frequency data is meaningless in this case and the facts should be presented as they appear. Fifthly, misreporting in official data is a problem. But this is the best we can do in India, since there is trust issue with private sources. Hopefully we will come up with a similar study after six months.

APPENDIX A1: CALCULATION OF MISSING VALUES IN DATASET

- Population of the newly formed state of Andhra Pradesh = (Census 2011 figure for the population of the erstwhile state of Andhra Pradesh – Population of newly formed state of Telengana) = 84580777 – 35003674 = 49577103
- Population of 'Dadra & Nagar Haveli and Daman & Diu' = (Census 2011 figure for the population of the union territory of Dadra & Nagar Haveli + Census 2011 figure for the population of the union territory of Daman & Diu) = 343709 + 243247 = 586956
- Population of the newly formed union territory of Ladakh = (Census 2011 figure for population of the district of Leh + Census 2011 figure for population of the district of Kargil) = 133487 + 140802 = 274289
- Population of newly formed union territory of Jammu & Kashmir = (Census 2011 figure for the population of erstwhile state of Jammu & Kashmir – Population of the newly formed union territory of Ladakh) = 12541302 – 274289 = 12267013
- Population density (person per sq. km.) of the redefined state of Andhra Pradesh = {(Population of the redefined state of Andhra Pradesh)/(Area of the redefined state of Andhra Pradesh) = (49577103/160205) person per sq. km. = 309 person per sq. km. (approx.)
- Area of 'Dadra & Nagar Haveli and Daman & Diu' = (Area of the union territory of Dadra & Nagar Haveli + Area of the union territory of Daman & Diu) = (491 + 112) sq. km. = 603 sq.km.
- Population density (person per sq. km.) of 'Dadra & Nagar Haveli and Daman & Diu' = {(Population of 'Dadra & Nagar Haveli and Daman & Diu')/(Area of 'Dadra & Nagar Haveli and Daman & Diu') = (586956/603) person per sq. km. = 973 person per sq. km. (approx.)

- Area of the newly formed union territory of Jammu & Kashmir = [(Total Area of the erstwhile state of Jammu & Kashmir) – {(Area of the district of Kargil) + (Area of the district of Leh)}] = {101387 – (14036 + 45110)} sq. km. = 42241 sq. km.
- Population density (person per sq. km.) of the newly formed union territory of Jammu & Kashmir = {(Population of the newly formed union territory of Jammu & Kashmir)/(Area of the newly formed union territory of Jammu & Kashmir) = (12267013/42241) person per sq. km. = 290 person per sq. km. (approx.)
- Area of the newly formed union territory of Ladakh = (Area of the Kargil district + Area of the Leh district) = (14036 + 45110) sq. km. = 59146 sq. km.
- Population density (person per sq. km.) of the newly formed union territory of Ladakh = {(Population of the newly formed union territory of Ladakh)/(Area of the newly formed union territory of Ladakh) = (274289/59146) person per sq. km. = 5 person per sq. km. (approx.)
- Per capita Net State Domestic Product (At Constant Prices) of the newly formed union territory of Ladakh for 2017-18 = {Net Domestic Product (At Constant Prices) of the district of Leh for 2017-18 + Net Domestic Product (At Constant Prices) of the district of Kargil for 2017-18}/(Population of the newly formed union territory of Ladakh) = 9351.03 + 8160.73)/(Population of the newly formed union territory of Ladakh) (in lacs) = (1751176000/274289) = 6384 (approx.)
- Net State Domestic Product (At Constant Prices) of the newly formed union territory of Jammu & Kashmir for 2017-18 = [{Per Capita Net State Domestic Product (At Constant Prices) of the erstwhile state of Jammu & Kashmir for 2017-18} * (Population of the erstwhile state of Jammu & Kashmir)] – (Net State Domestic Product (At Constant Prices) of the newly

formed union territory of Ladakh for 2017-18) = {(63995*12541302) – 1751176000} = 800829445500

- Per Capita Net State Domestic Product (At Constant Prices) of the newly formed union territory of Jammu & Kashmir for 2017-18 = (Net State Domestic Product (At Constant Prices) of the newly formed union territory of Jammu & Kashmir for 2017-18)/ (Population of the newly formed union territory of Jammu & Kashmir) = (800829445500/12267013) = 65283 (approx.)
- Public health expenditure of the newly formed union territory of Ladakh = (Public health expenditure on the district of Leh + Public health expenditure on the district of Kargil) = {40000000 + 236875952 (approx.)} = 276875952 = 276876 (Rs. in 000) (approx.)
- Public health expenditure of the newly formed union territory of Jammu & Kashmir = (Public health expenditure for the erstwhile state of Jammu & Kashmir – Public health expenditure of the newly formed union territory of Ladakh) = (35454949 – 276876) (Rs. in 000) = 35178073

APPENDIX A2:

The Rank Position of Special Category States &Union Territories and Other States in terms of Cases, Recovery, Fatality and Cases-Cures as well as the Rank Correlation Coefficient Results

Table-1: The Rank Position of Special Category States &UTs With Correlation Results Taking The Original Health Index of This Study

UNION TERRITORIES	Normalised Avg Y/X		Normalised Avg N/X		Normalised Avg C/X		Normalised Avg I/X		H RANK
	$R(Y/X)_2$	$R(Y/X)_3$	$R(N/X)_2$	$R(N/X)_3$	$R(C/X)_2$	$R(C/X)_3$	$R(I/X)_2$	$R(I/X)_3$	HI
Andaman & Nicobar Islands	16	16	16	16	8	6	15	15	3
Arunachal Pradesh	15	12	15	15	17	15	16	16	2
Assam	4	5	6	5	6	8	5	5	10
Chandigarh	3	3	1	1	2	2	1	3	14
Dadra & Nagar Haveli & Daman & Diu	2	2	4	4	4	4	3	1	16
Delhi	6	4	2	2	1	1	2	2	17
Himachal Pradesh	12	11	8	9	12	13	6	8	13
Jammu & Kashmir	14	14	12	8	5	5	9	6	7
Ladakh	17	17	17	17	14	9	17	17	1
Manipur	9	10	13	10	10	10	13	13	6
Meghalaya	11	13	5	7	15	17	7	12	8
Mizoram	1	1	11	12	16	16	14	14	4
Nagaland	5	8	10	14	11	14	11	11	5
Puducherry	8	7	3	3	3	3	4	4	9
Sikkim	7	6	14	13	13	12	12	9	11
Tripura	10	9	7	6	7	7	8	7	12
Uttarakhand	13	15	9	11	9	11	10	10	15
Value of R	**-0.434**	**-0.453**	**-0.760**	**-0.750**	**-0.630**	**-0.463**	**-0.826**	**-0.836**	

Table-2: The Ranking Positions of Other States With Correlation Results Taking The Original Health Index of This Study

STATES	Normalised Avg Y/X		Normalised Avg N/X		Normalised Avg C/X		Normalised Avg I/X		H RANK
	$R(Y/X)_2$	$R(Y/X)_3$	$R(N/X)_2$	$R(N/X)_3$	$R(C/X)_2$	$R(C/X)_3$	$R(I/X)_2$	$R(I/X)_3$	HI
Andhra Pradesh	13	12	16	14	7	4	16	12	10
Bihar	1	2	1	3	10	13	1	3	3
Chhattisgarh	6	7	7	11	18	18	12	16	1
Goa	15	8	17	8	3	1	17	10	6
Gujarat	17	16	15	16	8	8	13	13	16
Haryana	8	4	8	7	4	5	6	5	14
Jharkhand	4	3	5	5	17	17	5	8	8
Karnataka	16	14	13	13	12	7	15	15	17
Kerala	2	1	4	1	5	6	4	1	9
Madhya Pradesh	14	15	10	15	16	16	8	14	4
Maharashtra	18	18	18	17	2	3	18	17	18
Odisha	5	6	9	10	15	15	10	11	5
Punjab	9	10	6	6	11	9	7	7	13
Rajasthan	11	13	11	12	14	12	9	9	7
Tamil Nadu	12	11	14	9	1	2	11	6	15
Telengana	10	17	12	18	9	10	14	18	11
Uttar Pradesh	3	5	2	2	13	14	3	2	2
West Bengal	7	9	3	4	6	11	2	4	12
Value of R	**0.598**	**0.505**	**0.501**	**0.352**	**-0.602**	**-0.662**	**0.381**	**0.201**	

Table- 3 The Rank Position of Special Category States &UTs With Correlation Results Taking Health Index of The Niti Aayog Report(2019)

UNION TERRITORIES	Normalised Avg Y/X		Normalised Avg N/X		Normalised Avg C/X		Normalised Avg I/X		H RANK
	R(Y/X)$_2$	R(Y/X)$_3$	R(N/X)$_2$	R(N/X)$_3$	R(C/X)$_2$	R(C/X)$_3$	R(I/X)$_2$	R(I/X)$_3$	HI - New
Andaman & Nicobar Islands	16	16	16	16	8	6	15	15	14
Arunachal Pradesh	15	12	15	15	17	15	16	16	13
Assam	4	5	6	5	6	8	5	5	11
Chandigarh	3	3	1	1	2	2	1	3	2
Dadra & Nagar Haveli & Daman & Diu	2	2	4	4	4	4	3	1	6
Delhi	6	4	2	2	1	1	2	2	10
Himachal Pradesh	12	11	8	9	12	13	6	8	3
Jammu & Kashmir	14	14	12	8	5	5	9	6	4
Ladakh	17	17	17	17	14	9	17	17	17
Manipur	9	10	13	10	10	10	13	13	5
Meghalaya	11	13	5	7	15	17	7	12	7
Mizoram	1	1	11	12	16	16	14	14	1
Nagaland	5	8	10	14	11	14	11	11	16
Puducherry	8	7	3	3	3	3	4	4	9
Sikkim	7	6	14	13	13	12	12	9	8
Tripura	10	9	7	6	7	7	8	7	12
Uttarakhand	13	15	9	11	9	11	10	10	15
Value of R	**0.468**	**0.510**	**0.353**	**0.475**	**0.125**	**0.051**	**0.395**	**0.358**	

Table- 4 The Rank Position of Other States With Correlation Results Taking Health Index of The Niti Aayog Report(2019)

STATES	Normalised Avg Y/X		Normalised Avg N/X		Normalised Avg C/X		Normalised Avg I/X		H RANK
	R(Y/X)$_2$	R(Y/X)$_3$	R(N/X)$_2$	R(N/X)$_3$	R(C/X)$_2$	R(C/X)$_3$	R(I/X)$_2$	R(I/X)$_3$	HI - New
Andhra Pradesh	13	12	16	14	7	4	16	12	2
Bihar	1	2	1	3	10	13	1	3	17
Chhattisgarh	6	7	7	11	18	18	12	16	11
Goa	15	8	17	8	3	1	17	10	12
Gujarat	17	16	15	16	8	8	13	13	4
Haryana	8	4	8	7	4	5	6	5	10
Jharkhand	4	3	5	5	17	17	5	8	13
Karnataka	16	14	13	13	12	7	15	15	6
Kerala	2	1	4	1	5	6	4	1	1
Madhya Pradesh	14	15	10	15	16	16	8	14	15
Maharashtra	18	18	18	17	2	3	18	17	3
Odisha	5	6	9	10	15	15	10	11	16
Punjab	9	10	6	6	11	9	7	7	5
Rajasthan	11	13	11	12	14	12	9	9	14
Tamil Nadu	12	11	14	9	1	2	11	6	7
Telengana	10	17	12	18	9	10	14	18	8
Uttar Pradesh	3	5	2	2	13	14	3	2	18
West Bengal	7	9	3	4	6	11	2	4	9
Value of R	**-0.441**	**-0.360**	**-0.451**	**-0.284**	**0.552**	**0.645**	**-0.439**	**-0.207**	

Table-5 The Rank Position of Special Category States &UTs With Correlation Results Taking Normalized Average of (Case-Cure) Index and Co-Morbidity Index

UNION TERRITORIES	Normalised Avg I/X		Co-Morbidity Disease
	$R(I/X)_2$	$R(I/X)_3$	DI
Andaman & Nicobar Islands	15	15	1
Arunachal Pradesh	16	16	9
Assam	5	5	13
Chandigarh	1	3	5
Dadra & Nagar Haveli & Daman & Diu	3	1	3
Delhi	2	2	8
Himachal Pradesh	6	8	16
Jammu & Kashmir	9	6	15
Manipur	13	13	6
Meghalaya	7	12	10
Mizoram	14	14	7
Nagaland	11	11	4
Puducherry	4	4	14
Sikkim	12	9	2
Tripura	8	7	11
Uttarakhand	10	10	12
Value of R	**-0.274**	**-0.203**	

Table-6 The Rank Position of Other States With Correlation Results Taking Normalized Average of (Case-Cure) Index and Co-Morbidity Index

STATES	Normalised Avg I/X		Co-Morbidity Disease
	$R(I/X)_2$	$R(I/X)_3$	DI
Andhra Pradesh	16	12	15
Bihar	1	3	3
Chhattisgarh	12	16	5
Goa	17	10	1
Gujarat	13	13	18
Haryana	6	5	6
Jharkhand	5	8	2
Karnataka	15	15	11
Kerala	4	1	12
Madhya Pradesh	8	14	4
Maharashtra	18	17	10
Odisha	10	11	8
Punjab	7	7	7
Rajasthan	9	9	17
Tamil Nadu	11	6	16
Telengana	14	18	9
Uttar Pradesh	3	2	13
West Bengal	2	4	14
Value of R	**0.106**	**-0.067**	

REFERENCES :

Behera, D. (2020). "Does the Higher Level of Health System Spending Speed Up the COVID-19 Detection Rate? : Evidence from South-East Asia Region." Munich Personal RePEc Archive Paper No. 100554.

Dreze, J., & Sen, A. K. (1989). *Hunger and Public Action.* Oxford: Clarendon Press.

Gerritse, M. (2020). "Cities and COVID-19 infections: Population density, transmission speeds and sheltering responses." *Covid Economics : Vetted and Real-Time Papers. 37 (14 July 2020).* 1-26. The Centre for Economic Policy Research.

Ghosh, S.(2020)."Lockdown, pandemics and quarantine: Assessing the Indian evidence." *Covid Economics : Vetted and Real-Time Papers. 37 (14 July 2020).* 73-99. The Centre for Economic Policy Research.

Ghosh, P., Ghosh, R., and Chakraborty, B. (2020). "Covid-19 in India : State-wise Analysis and Prediction."https://www.medrxiv.org/content/10.1101/2020.04.24.20077792v3. Accessed on 01.09.2020.

Jalan, J., Sen, A. (2020). "Containing a pandemic with public actions and public trust : the Kerala Story." *Indian Economic Review (2020). (28 July 2020).*

Sinha, S. (2020). "Epidemiological Dynamics of the Covid-19 Pandemic in India : An Interim Assessment." *Statistics and Applications, 18(1),* 333-350.

Yadavar,S(2020): "Uttar Pradesh and Bihar worst in Covid reporting, Karnataka best, Stanford study finds", *The Print*,26th July.

Yadavar,S(2018):"Rs 3 per day: That's how much India spends for each Indian's health", *Business Standard*, 23rd June.

https://cdn.downtoearth.org.in/ -National Health Profile- 2018.

www.social.niti.gov.in - 'HEALTHY STATES PROGRESSIVE INDIA, A Report on the Ranks of States and Union Territories'; HEALTH INDEX - June 2019.