

State Wise Analysis of Morbidity - Mortality Pattern and Case Fatality - Recovery Rate of COVID-19 in India

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Abstract: *Morbidity, Mortality, Case fatality rates (CFR) and recovery rates are important readouts during epidemics and pandemics. In this article, State wise analysis was done for coronavirus disease 2019 (COVID-19) in India. Data were retrieved from Worldometer, COVID 19 India/ api: Our database- Github, Ministry of health and family welfare, ICMR and NCDC. Morbidity, Mortality, Case fatality rate and recovery rates were calculated for each state and comparison of CFR and RR among states with total cases was observed from beginning of first case till 30 November, 2020. The morbidity rating first five states are Delhi (3375.3), Goa (3288.4) Maharashtra (1623.0), Puducherry (2959.6) and Tamil Nadu (1083.7) whereas Delhi (54.0), Puducherry (48.7), Goa (47.1), Maharashtra (41.9), Chandigarh (26.2) are for high mortality rate. Punjab (3.16%) and Maharashtra (2.58%), reported highest case fatality rate followed by Sikkim, Gujarat, West Bengal with highest recovery rate in Andhra Pradesh and Dadra and Nagar Haveli, Obtaining definite and precise clinical history from COVID-19 patients, and analyzing morbidity, mortality, CFR alongside the recovery rate, may help in the identification of the highest disease burden areas so that better and necessary medical care may be provided to expand the probabilities of survival of COVID-19 patients.*

Keywords: Morbidity, Mortality, Case Fatality, Recovery, COVID-19

1. Introduction

In today's scenario, the human race is panicked due to an alarming situation of the recent pandemic of COVID-19. A novel coronavirus has spread through China, originating from the city of Wuhan and has caused many deaths so far. It is a highly contagious virus that has spread rapidly and efficiently and causes mild flu-like symptoms, including fever, cough, dyspnea, myalgia, and fatigue, while more serious forms can cause severe pneumonia, acute respiratory distress syndrome, septic shock, and organ failure, which can lead to death. Without a vaccine for COVID-19, transmission of the virus can be reduced with early detection and patient quarantine. Currently, there are no specific vaccines or drugs for Covid-19. Studies suggest that the use of isolation is the best way to contain this epidemic. Thus, countries are racing to reduce the spread of the virus by treating and testing patients, limiting travel, carrying out contact tracing, quarantining citizens, and cancelling large gatherings such as sporting events, concerts, and schools.

The World Health Organization (WHO) announced that this virus can enter into the body when a person comes in contact with droplets produced through cough, sneezing or when the person touches some infected any physical area, then touches their eyes, mouth or nose. But, recently

WHO published that this COVID-19 virus is airborne and can spread through breathing or even just talking (Singh et al., 2020). As of 15 August 2020, a total 17, 989, 715 cumulative cases and 687, 660 deaths had taken place with no respite in geographical spread, mortality, morbidity, and economic loss due to the virus. Among all the countries highest case load was reported in United States of America (USA) i.e. 4, 762, 954 cases followed by, Brazil with 2, 708, 876 cases and India is at 3rd in the list with reported 1, 751,

919 cases and 37, 403 deaths from novel coronavirus (MHofW, 2020).

The case fatality rate (CFR) is a measure of the ability of a pathogen or virus to infect or damage a host in infectious disease and is described as the proportion of deaths within a defined population of interest, i.e. the percentage of cases that result in death. CFRs confers the extent of disease severity and CFR is necessary for setting priorities for public health in targeted interventions to reduce the severity of risk. Initial studies reported an estimation of 3% for the global CFR of COVID-19. Estimating CFR from country-level data requires assessment of information about the delay between the report of the country-specific cases and death from COVID-19, as well as underestimating and under-reporting of death-related cases, which may not be known. Given the importance of CFR and recovery rate (RR), in this current study the CFR and RR of different countries during a COVID-19 ongoing pandemic was observed using up-to-date country-level data (Khafaie and Rahim, 2020).

Because of geographical and socio-economic diversity in the country, there is a wide variation in health infrastructure. Preparedness and response to Covid-19 is not same at the state level. Health inequalities, widening economic and social disparities, and distinct cultural values in India, present unique challenges. Thus the study on current health infrastructure is important to meet the pandemic with this background; the specific objectives of the study are as follows:

- 1) Cross state comparisons of morbidity, mortality, case fatality and recovery rate of Covid19.
- 2) To identify the states where the magnitude of active Covid-19 cases are higher.

2. Materials and Methods

1) Data Collection

Data related to COVID-19 in Indian states was retrieved from online available database viz. new cases, total cases, total deaths, and total recovery from the beginning till 30 November 2020 from Worldometer, COVID 19 India/ api: Our database- Github, Ministry of health and family welfare, ICMR and NCDC portals and for total population of India from census 2011. These data were entered into a Microsoft Excel2007 spreadsheet for tabulation, analysis, ranking, and other studies.

2) Measuring The Morbidity, Mortality, Case Fatality and Recovery Rate

The formulas below were used to measure morbidity, mortality, CFR and RR.

- **Morbidity Rate (%)** = (Number of cases observed during study period / total Number of Population) ×100
- **Mortality Rate (%)** = (Number of death observed during study period / total Number of Population) ×100
- **CFR (%)** = (Number of deaths due to COVID-19/ Number of closed cases of COVID-19) ×100
- **RR (%)** = (Number of cases recovered from COVID-19/ Number of closed cases of COVID-19) ×100

3. Results and Discussion

The study was conducted for all COVID-19 affected states and union territories of India. In the year 2020 estimated population of India at 1, 380, 004, 385 as per UN data. The first case of COVID-19 was diagnosed in southernmost state Kerala the situations are more worsen in states with high international migration. Maharashtra is remained the most affected state followed by Delhi. State wise morbidity and mortality pattern are illustrated in Table1.

Table 1: Morbidity and mortality Pattern of COVID-19 in Indian state

S. NO.	STATE/ UT	Morbidity (per lakh)	Mortality (per lakh)
1.	Andaman and Nicobar Islands	1236.00495	16.02812542
2.	Andhra Pradesh	1026.31358	8.266653781
3.	Arunachal Pradesh	1175.7377	3.90250389
4.	Assam	681.8524997	3.143668939
5.	Bihar	226.3374067	1.214223491
6.	Chandigarh	1649.438628	26.24472974
7.	Chhattisgarh	923.8448651	11.11754937
8.	Dadra and Nagar Haveli	967.9699979	0.581887585
9.	Daman and Diu	0	0
10.	Delhi	3375.327564	54.00304897
11.	Goa	3288.414139	47.17029643
12.	Gujarat	347.0897899	6.599967452
13.	Haryana	923.5207027	9.577356919
14.	Himachal Pradesh	582.7431802	9.104679339
15.	Jammu and Kashmir	878.8880134	13.50736949
16.	Jharkhand	330.8795823	2.922262896
17.	Karnataka	1448.388081	19.27807962
18.	Kerala	1805.010773	6.720337366
19.	Ladakh	0	0
20.	Lakshadweep	0	0
21.	Madhya Pradesh	283.8180595	4.488700584
22.	Maharashtra	1623.053905	41.95886974
23.	Manipur	974.3657577	10.93219317
24.	Meghalaya	395.7006818	3.741292647
25.	Mizoram	348.7038897	0.45570294
26.	Nagaland	565.37724	3.234770549
27.	Odisha	759.3351709	4.269287399
28.	Puducherry	2959.646717	48.79991474
29.	Punjab	548.2072849	17.32668218
30.	Rajasthan	391.0563271	3.372797545
31.	Sikkim	816.6046215	17.68818675
32.	Tamil Nadu	1083.779887	16.23351647
33.	Telangana	0	0
34.	Tripura	889.8404618	9.989338355
35.	Uttarakhand	741.551008	12.20468335
36.	Uttar Pradesh	272.1994033	3.884144473
37.	West Bengal	529.6938854	9.229139518

India till now (30 November, 2020) has reported 9, 463, 254 numbers of cases, 8, 888, 595 recovered and 137, 659 deaths. The overall estimated morbidity-mortality per lakh, case fatality rates and recovery rate of COVID-19 in India

from 30 January 2020 to 30 November, 2020 were 3450.69, 447.19 and 42.63 percent, respectively. The morbidity rating first five states are Delhi (3375.3), Goa (3288.4) Maharashtra (1623.0), Puducherry (2959.6) and Tamil

Naidu (1083.7) whereas Delhi (54.0), Puducherry (48.7), Goa (47.1), Maharashtra (41.9), Chandigarh (26.2) are for high morbidity rate. States like Maharashtra, Karnataka, Andhra Pradesh, Delhi, Uttar Pradesh, West Bengal and Odisha accounts large proportion of cases than other states. **Sahoo et al., (2020)** studies result revealed that, Maharashtra constitutes more than one-third positive cases in the country. More than a quarter of the active cases in India belonged to the Mumbai district of Maharashtra, followed by the Chennai district (9.4%) and Ahmedabad district (9.1%). **Rath et al., (2020)** stated among epidemic curve of all these states, Maharashtra has rapidly growing

epidemic curve with highest slope, whereas Kerala has the lowest.

All states and union territories of India are currently affected by the pandemic although very few cases were reported in North eastern states like Meghalaya, Mizoram, Nagaland and union territories like Andaman Nicobar islands, Dadra and Nagar Haveli surprisingly Daman Diu and Lakshadweep has no COVID-19 cases. **Mahajan and Kausha, (2020)** stated that total of 10, 815 COVID-19 confirmed cases have been reported in 31 states/union territories as of April 14, 2020 with 9272 active cases (85.73%), 1190 cured/discharged (11%), and 353 deaths (3.23%).

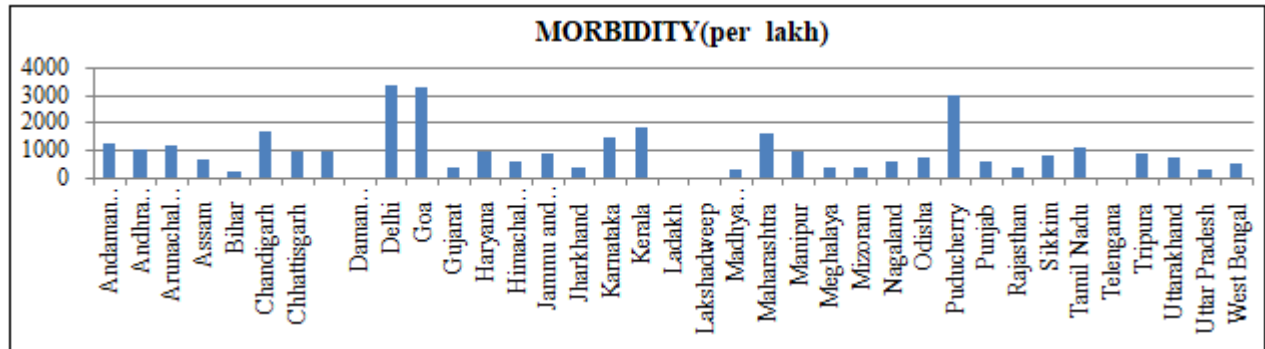


Figure 1: Morbidity Pattern of COVID-19 among Indian States and Union Territories

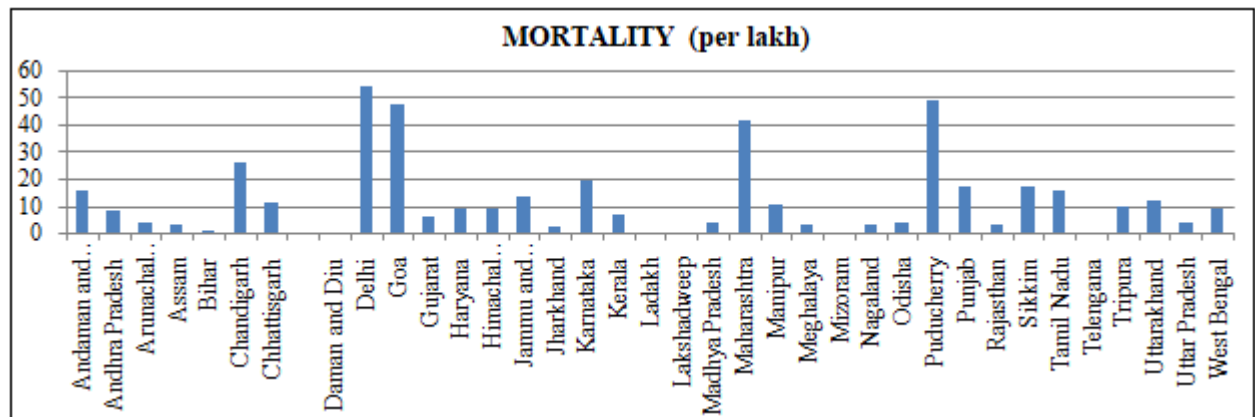


Figure 2: Mortality Pattern of COVID-19 among Indian States and Union Territories

Table 2: Morbidity and Mortality Due to COVID-19 in India during Various Phases of Outbreaks

S.NO.	Phases	Morbidity (per lakh)	Mortality (per lakh)
1	Before	0.04716788	0.000826
2	Lock1	0.948726968	0.032712
3	Lock2	3.533708508	0.120852
4	Lock3	7.90520447	0.2498
5	Lock4	15.74870245	0.446567
6	Unlock1	48.39003169	1.438249
7	Unlock2	140.1875644	3.020562
8	Unlock3	223.1689991	4.290295
9	Unlock4	521.2650426	8.105440793
10	Unlock5	675.9889875	10.04147161
11	Unlock6	781.7128574	11.32260409

Phases wise morbidity and mortality pattern revealed that unlock 6 has both highest morbidity and mortality rate followed by other unlock phase-5, 4, 3, 2, 1. While in lockdown phases, 4 have highest morbidity and mortality. Highest mortality rate occurred during unlock 6 while lockdown phases had lesser mortality than unlock phases. **Kumar et al., (2020)** findings indicate that the strategy of lockdown has contributed in flattening the curve of infection and is also likely to reduce the burden of infection tremendously in India.

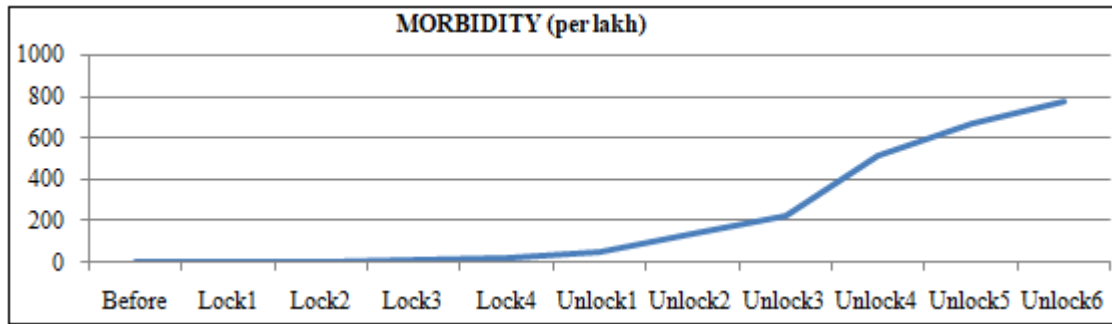


Figure 3: Morbidity Due to COVID-19 in India during Various Phases of Outbreaks

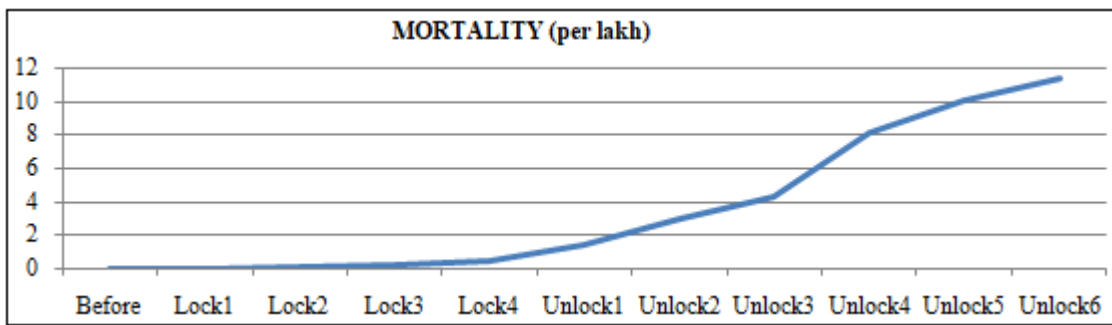


Figure 4: Mortality Due to COVID-19 in India during Various Phases of Outbreaks

Table 3: Case Fatality and Recovery Rate of COVID-19 in Indian States and Union Territory

S.N	STATE	Population	Total Case	Total Recovered	Total Death	CFR	RR
1.	Andaman and Nicobar Islands	380581	4704	4537	61	1.296769	96.44983
2.	Andhra Pradesh	84580777	868064	853232	6992	0.805471	98.29137
3.	Arunachal Pradesh	1383727	16269	15364	54	0.33192	94.43727
4.	Assam	31205576	212776	208393	981	0.461048	97.94009
5.	Bihar	104099452	235616	228798	1264	0.536466	97.10631
6.	Chandigarh	1055450	17409	16070	277	1.591131	92.30858
7.	Chhattisgarh	25545198	235998	212517	2840	1.2034	90.05034
8.	Dadra and Nagar Haveli	343709	3327	3271	2	0.060114	98.3168
9.	Daman and Diu	243247					
10.	Delhi	16787941	566648	522491	9066	1.599935	92.20733
11.	Goa	1458545	47963	45940	688	1.434439	95.78217
12.	Gujarat	60439692	209780	190921	3989	1.901516	91.01011
13.	Haryana	25351462	234126	213336	2428	1.037048	91.12017
14.	Himachal Pradesh	6864602	40003	30693	625	1.562383	76.72675
15.	Jammu and Kashmir	12541302	110224	103565	1694	1.53687	93.95867
16.	Jharkhand	32988134	109151	106171	964	0.88318	97.26984
17.	Karnataka	61095297	884897	849821	11778	1.331002	96.03615
18.	Kerala	33406061	602983	538713	2245	0.372316	89.34132
19.	Ladakh		8403	7409	116	1.380459	88.17089
20.	Lakshadweep	64473					
21.	Madhya Pradesh	72626809	206128	188097	3260	1.581542	91.25252
22.	Maharashtra	112374333	1823896	1685122	47151	2.58518	92.39134
23.	Manipur	2570390	25045	21566	281	1.12198	86.109
24.	Meghalaya	2966889	11740	10861	111	0.945486	92.51278
25.	Mizoram	1097206	3826	3440	5	0.130685	89.91113
26.	Nagaland	1978502	11186	10086	64	0.572144	90.16628
27.	Odisha	41974218	318725	312065	1792	0.56224	97.91042
28.	Puducherry	1247953	36935	35846	609	1.648843	97.05158
29.	Punjab	27743338	152091	139442	4807	3.160608	91.68327
30.	Rajasthan	68548437	268063	237098	2312	0.862484	88.44861
31.	Sikkim	610577	4986	4521	108	2.166065	90.67389
32.	Tamil Nadu	72147030	781915	759206	11712	1.497861	97.09572
33.	Telangana		269816	258336	1458	0.540368	95.74525
34.	Tripura	3673917	32692	31707	367	1.122599	96.98703
35.	Uttarakhand	10086292	74795	67827	1231	1.645832	90.68387
36.	Uttar Pradesh	199812341	543888	512028	7761	1.426948	94.14218
37.	West Bengal	91276115	483484	450762	8424	1.742353	93.23204

Among all the states of India Punjab reported highest case fatality rate around (3.16%) followed by Maharashtra (2.58%), Sikkim (2.16%), Gujrat (1.90%), West Bengal (1.74 %), Puducherry and Utrakhand (1.64%), Chandigarh and Delhi (1.59%) and Madhya Pradesh (1.58%) and proportion of highest cases-recovery from the disease among states were Dadra and Nagar Haveli (98.3%) Andhra Pradesh (98.2%), Assam and Bihar (97%), Jharkhand, Odissa, Puducherry and Tamil Nadu (96%) followed by Telengana and Goa (95.7%), U.P (94.1%) and West Bengal (93.2%) while lowest recovery rate of around (76.7%) reported by Himachal Pradesh. However Daman Diu and Lakshadweep did not reported any cases of COVID-19. **Dhillon et al., (2020)** stated that among the most affected states, Maharashtra and Madhya Pradesh stand at the top with higher levels of CFR as against Kerala and Tamil Nadu with significantly higher levels of recovery rates. **Rath et al., (2020)** the day wise comparison of cumulative case fatality rate, found that Maharashtra, Madhya Pradesh and Rajasthan showed decrease in the case fatality rate over the period (**Samaddar et al., 2020**) reported as of July 3, 2020, India has a case positivity rate of 6.5% and a fatality rate of 2.8%, which are among the lowest in the world. The CFR

per total cases in India is 11.00% and per closed cases is 76.72%, which indicates that the recovery rate of COVID-19 is more than the fatality rate in India (**Mahajan and Kausha, 2020**).

Italy’s CFR was the highest of all countries studied for both time points (12th March, 6.22% versus 23rd March, 9.26%) Spain and France had the highest CFR of 6.16 and 4.21%, respectively, on 23rd March, which was strikingly higher than the overall CFR of 3.61%. reported by (**Khafaie and Rahim, 2020**). **Dehkordi et al. (2020)** Calculated the total case fatality rate (CFR) of Italy (4th April 2020), about 13.3% compared with South Korea's rate of 1.8% (seven times lower than Italy) and China's 4% (69% lower than Italy), the CFR of Italy is too high.

As of 2 April official statistics showed that 872 deaths from covid-19 had been recorded in Germany from 73522 confirmed cases, translating to a fatality rate of 1.2%. This compares with fatality rates of 11.9% in Italy, 9% in Spain, 8.6% in the Netherlands, 8% in the UK, and 7.1% in France (**Stafford, 2020**).

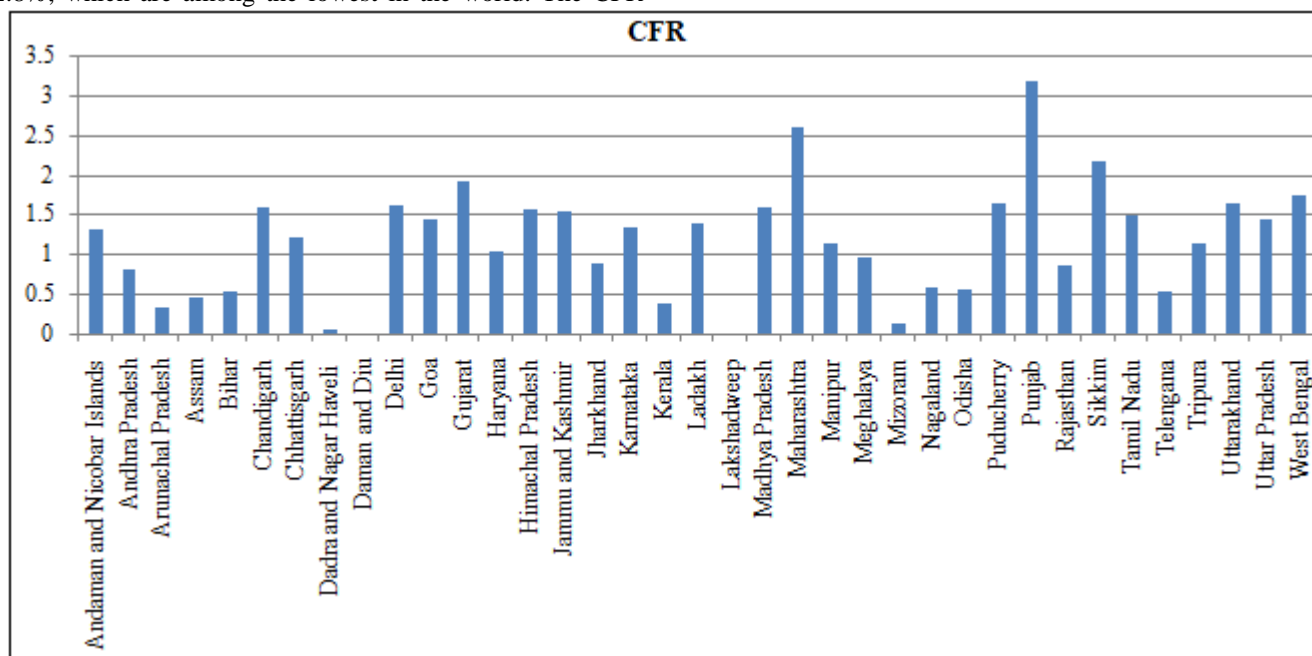


Figure 5: Case Fatality Rate Due To COVID-19 in Various States and Union Territory of India

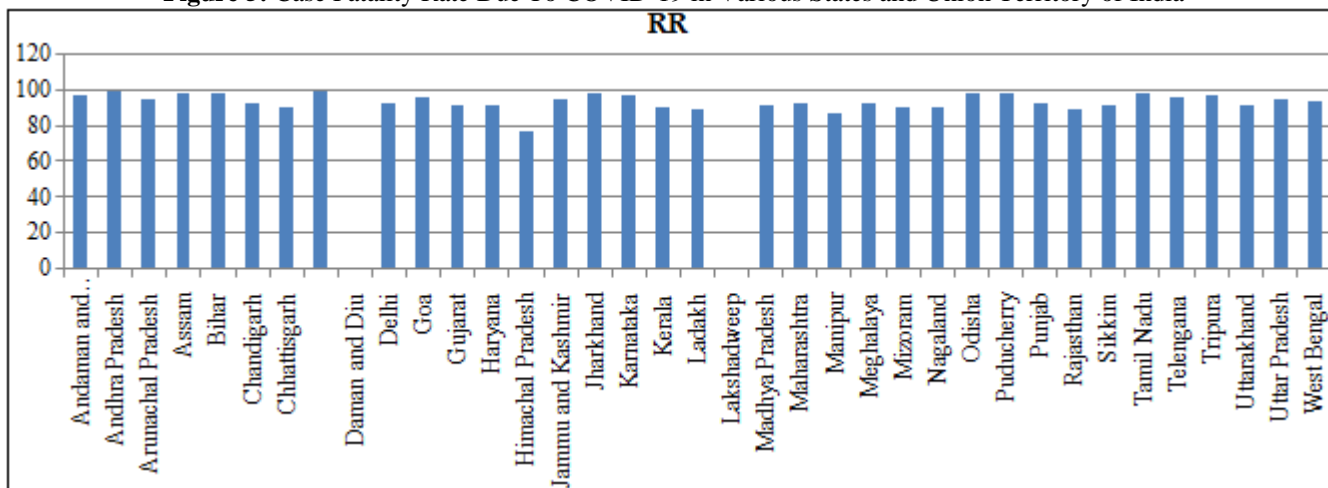


Figure 6: Recovery Rate Due To COVID-19 in Various States and Union Territory of India Table 4: Phases wise case fatality rate and recovery rate of COVID-19 in India

S.NO.	PHASES	CFR (%)	RR (%)
1	Before	1.751313	7.005254
2	Lock1	3.447976	11.88507
3	Lock2	3.419982	27.49778
4	Lock3	3.159941	38.44908
5	Lock4	2.835577	48.18384
6	Unlock1	2.9722	59.37913
7	Unlock2	2.154657	64.55475
8	Unlock3	1.922442	73.15033
9	Unlock4	1.554956	83.51446
10	Unlock5	1.485449	91.52066
11	Unlock6	1.448435	93.92645

Overall CFR and RR during different Phases of lockdown and unlock in COVID-19 Pandemic were lockdown 1 showed highest CFR (3.44) followed by lockdown 2, 3, 4 and unlock 1, 2, 3, 4, 5 and 6 whereas RR is highest during unlock 6 followed by 5, 4, 3, 2, 1 and lockdown 4, 3, 2 and 1.

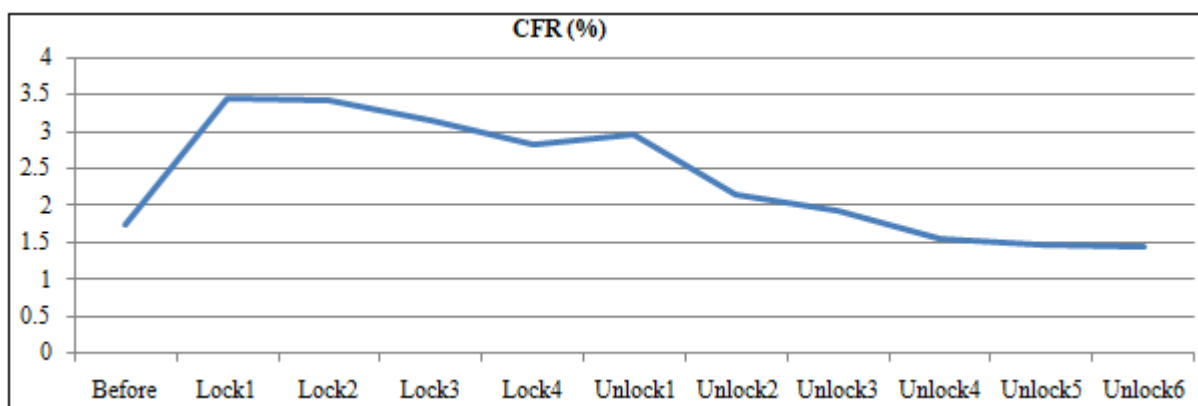


Figure 7: Case Fatality Rates Due to COVID-19 in India during Various Phases of Outbreaks

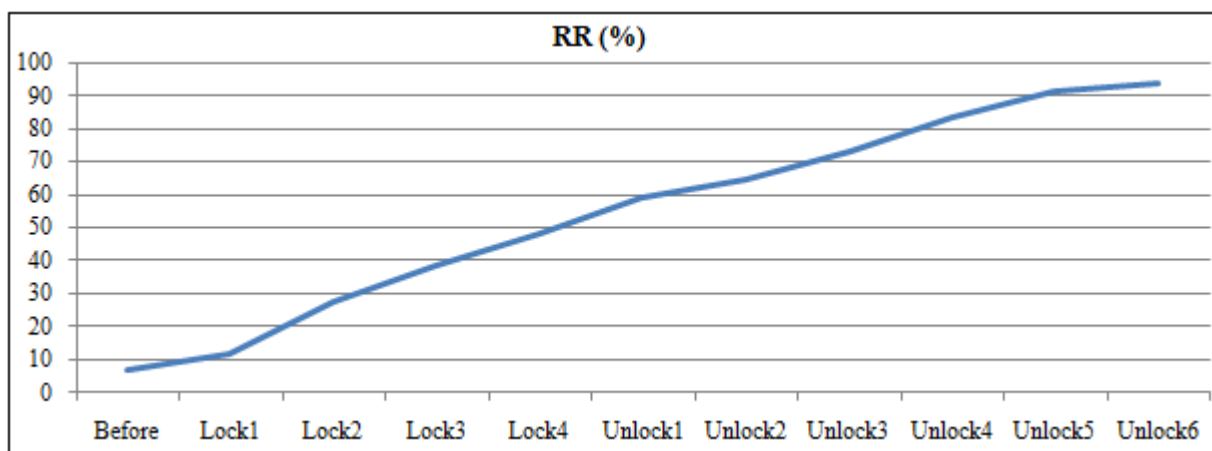


Figure 8: Recovery Rates Due to COVID-19 in India during Various Phases of Outbreaks

4. Conclusion

Morbidity, mortality, case fatality rates (CFR) and recovery rates are important readouts during epidemics and pandemics which are not only threat to human’s life, but also brings tremendous impact on economy which indirectly affecting us. Analyzing the morbidity, mortality, CFR alongside the recovery rate may help in the identification of the highest disease burden areas so that better and necessary medical care may be provided to expand the probabilities of survival of COVID-19 patients.

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