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Exploring the Effectiveness of Lockdown and Disaster Preparedness in Combating COVID 19 Pandemic in India

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Abstract

OBJECTIVES: 'Stay Home, Stay Safe' is the till now available effective remedy for novel Coronavirus. India is the first nation compared to other countries affected by COVID-19 to enforce a 'Nationwide Lockdown' at the earliest.
METHODS: Google mobility data and Disaster Preparedness metrics were analysed to evaluate the effectiveness of Lockdown as a social distancing intervention.
RESULTS: Results showed that in India, Lockdown is a useful measure in flattening the epidemic curve. Second, Odisha's disaster preparedness is more efficient in containing and combating COVID 19 pandemic.
CONCLUSION: Further, a brief analysis of the travel histories showed that the period of coming in contact with the virus and being tested is quite long, thus increasing the chances of spreading the virus through contact with others. We suggest, instead of fourteen days of quarantine, thirty five to forty days of quarantine would be more effective in combating the spread.

Keywords: COVID 19, Disaster Preparedness, Lockdown, Pandemic

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1. Introduction

Towards the end of 2019, China has reported pneumonia of unknown cause, which was later termed as COVID-19 caused by novel Coronavirus (WHO, 2019). The symptoms of the disease vary from mild fever to severe respiratory illness leading to death in some cases. It was identified that the virus was spreading through cough, sneeze, and tiny droplets from the affected persons. Within three months of the onset of the virus, it has spread worldwide, including India. Based on the symptoms, having highly contagious, and in the absence of any vaccine, maintaining social distance is the only solution to restrict the rapid spread in an overpopulated country like India. As a result of which Lockdown was imposed all over India. People in India were advised to stay put at their homes or wherever they are throughout the lockdown period. All inter and intrastate movements by any means were suspended instantly. Apart from following the ideal procedure established by the Government of India, different state disaster management department also adopted various other strategies to handle the outspread of COVID-19 in their respective states. There is an eerie of silence across the globe with the Lockdown. The fear of infection and the Coronavirus itself is speeding fast, and faster than we ever imagined. Many have already left us, and many are still struggling hard to be with us. With the insane escalation of the virus, we are shrouded in fear of our vulnerable existence. Superpowers and technological advancements look helpless before the microscopic terrorist. Significant interventions are undertaken to mitigate the epidemic and prevent the persistence of corona infection among the human population. With the vaccines undiscovered and the antibodies under experimentations, non-pharmaceutical intervention seems to be the best way to

cope with the pandemic. Reducing social contacts through several social and physical distancing policies and public awareness actions can help break the coronavirus chain. Stay home; Stay safe is the remedy till now to stop the spread of the virus. Earlier, words like social distancing, containment, and quarantine, which found their place in the dictionary's pages, are now the frontline weapons to fight the virus.

The term 'quarantine' is derived from the Italian 'Quaranta,' which refers to the 40-day sequestration imposed on arriving merchant ships during plague outbreaks in the 14th century (Sheddy, 2002). It ideally means to isolate oneself from the rest. The technique was used to reduce the history of contagious diseases from plague to severe acute respiratory syndrome (SARS) to Ebola during the early onset. However, the number of days for quarantine varies from pandemic to pandemic and population to population (Barbisch, 2015). Coronavirus being a novel virus, the symptoms and the duration was vaguely figured during the initial period. Therefore, the measure of the effectiveness of Lockdown has been a major look through. Further, considering the frequency of the outspread, the preparedness of the disaster management wing of the different state government of India was also in the limelight. The availability of beds, oxygen cylinders, and other vital equipment, maintenance of travel history, prevention plans, number of tests, and involvement of local community leaders, daily media bulletin, and others were some of the measures followed by disaster management units to tackle COVID-19 outspread.

There is also strong evidence that proves the effectiveness of social distancing, as it contained the first wave of COVID 19 outbreak in its birth centre, China, and proved to be effective in Italy and Spain too (Kraemer et al., 2020; Zhang et al., 2020 and Chen et al., 2020). Thus, social awareness and policy intervention's impact on the outbreak cannot be ignored. The pandemic and its after-effects are not limited to any single country or continent; iknstead, they become a severe threat to the whole world. Responsiveness towards social mobility and awareness matters a lot. The application of social distancing interventions like school closure, work from home, increased case isolation, and community contact reduction is highly effective in flattening the epidemic curve and reducing the maximum daily case numbers and lengthening outbreak duration. These were also found to be effective even after ten weeks of delay from index case arrivals (Milne and Xie, 2020). Thus, to evaluate the effectiveness of Lockdown in India concerning the number of confirmed cases from 14th March to 26th April, we used the Google Mobility Data (GMD) for every State in India. We adopted a quasi-experimental approach to measuring the impact of standard policies on people's staying at home and their mobility in public places. Besides getting a brief idea about the effects of Lockdown on social mobility, we have also tried to analyse how human behaviour affects social mobility and the spread of the pandemic. Several countries and their county or states have adopted a number of complementary policies that may have some positive consequences. It is also crucial to determine which interventions have a significant impact on the war against Corona. Therefore, identifying effective policies could help the policymakers around the globe to respond efficiently to the outbreak. If compared to other countries affected by COVID 19, India is the first country that earned applause from the United Nation's Organization (UNO) for its fight against COVID 19. UN praised India's first 21-days nationwide Lockdown as a "comprehensive and robust" response to the raging COVID 19 pandemic. It is not that other countries did not adopt the Lockdown dosage to fight against Corona. But, India is the first nation to enforce a lockdown at the earliest compared to other nations. Here, when we say 'at the earliest' or the 'first nation,' we mean the number of active cases and fatalities India had, compared to other nations, while declaring a lockdown, to stifle the spread of Coronavirus. Other than Lockdown, India made its headway in prevention and containment, including strengthening surveillance, laboratory capacity, contact tracing and isolation, risk communications, and initiating emergency measures, which is the need of the hour. Talking about India and its strategies to fight against Corona, we are talking about 1.3 billion people and her 28 States and 8 Union Territories. Under Lockdown, India has adopted a "cluster containment strategy" to contain the disease within a defined geographic area through early detection of cases, thus, breaking the chain of transmission. Most of the states of India have joined hands with the centre to fight against the virus aggressively. Several Indian states have proactively come up with innovative solutions to contain the deadly virus throughout the country. Kerala is the first Indian state to register COVID 19 patients. It adopted extensive testing of symptomatic cases, followed by a detailed contact-tracing process and then publishing the route map of an infected person so that everyone with the potential to be infected could be put in self-isolation. To create awareness on COVID 19 and to convert educational institutions into hospitals to offset for shortages, the Government of Kerala undertook an initiative called the Corona Safe Network. There are two major components: the Corona Literacy Mission and the Corona Care Centre (Ministry of Health and Family Welfare, Kerala, 2020). Similarly, Odisha, another Indian state, is always counted among the poor and backward states. But, when it comes to containing and combating COVID 19 pandemic, the state has drawn the attention of UNO and the World Health Organization (WHO) for its disaster preparedness and receiving appreciation from the Indian Government too. Proactive preparedness is Odisha's hallmark, with it becoming the first Indian state to impose full Lockdown (before countrywide Lockdown was imposed), and also the first to extend it until 30th April 2020. It was the first state to announce exclusive COVID 19 hospitals and delivered them within a week in two districts, and now every district of Odisha has at least one COVID hospital. The state is further giving free medical treatment to all COVID 19 patients. The state's containment program is rooted in the strategic use of Information Technology. Leading the country, Odisha devised an incentive program by offering INR 15,000 for all people returning from foreign and

declared within 11 hours of their arrival on a government portal. With the help of this declaration portal, over 5,000 international returnees and about 35,000 domestic returnees from COVID 19 affected states, registered, and were asked to observe home quarantine. The Government of Odisha has also taken care of its elderly citizens' economic conditions by securing an advance payment of social pension of four months to around 2.8 million beneficiaries (Ministry of Health and Family Welfare, Odisha, 2020). Life and livelihood both are important. Odisha has set an example in this regard. The state has also proved itself in maintaining all the COVID records, which can be referred for a vivid analysis anytime and making the fight against the deadly virus more robust and transparent. Talking about Bhilwara, a district in Rajasthan, which was worst affected by the virus, adopted a complete lockdown backed by curfew, sealing the borders and undergoing the health screening of the entire population. These measures helped in controlling the spread of the virus throughout the state. Among all the states of India, Maharashtra tops the chart of COVID19 positive cases. The state has come up with a cluster containment plan to deal with the contagion. It uses data analytics, drones, and traditional patrolling methods to survey crowded places and control the spread. Thus, different states of India come up with several COVID fighting strategies that need to be analysed to record the efficiency of the states and to adopt and replicate the same to increase the preparedness during the time of an outbreak. With this, we have undergone a state-wise analysis of the strategies undertaken in the fight against COVID 19 in India. The state with strategic soundness, disaster preparedness, and efficient management of human resources, maintenance, and transmission of information to tackle the condition can set an example for others and help the country win the global fight against COVID 19. All the disaster preparedness parameters undertaken by all the states of India are thus used in developing an index, which can be further used by any smart city, state, or nation to combat the pandemic or similar situations in the future.

2. Data and Method

COVID 19 as the infectious disease spread from one person to another through direct or indirect contact. In this context, contact tracing and mobility of the individuals play a significant role in fighting Corona's spread. In a vast country like India, with a population of 1.3 billion, the response against Corona depends a lot on tracing the mobility and the contact spread. Therefore, to evaluate the effectiveness of the spread of COVID-19, both qualitative and quantitative analyses have been incorporated. To understand the movement of people and their mobility behaviour in relation to various government regulations concerning different states of India from 14th March 2020 to 26th April 2020, a timeline study of Google mobility data (GMD) was used.

Further, the disaster management strategies of different States have been populated from the respective state's disaster management website, social networking accounts, country's COVID-19 information portal, etc. Since the transmission of infection has an exponential trend, social contact tracing soon became a massive and practically impossible task within the time available for response. In the later period of the corona days, many countries came up with smartphone apps to track the suspected individuals and notify otherwise healthy ones to take precautions. India too has an indigenously developed app by the name Aarogya Setu App. The development of such apps was also critical as it involved a lot of personal user data. The intrusion level into private data, security, and many more aspects had to be considered to launch the app, which took time to be installed to trace the spread.

Moreover, the availability of the data from these apps is also an awkward reach. Hence, Google Mobility Data (GMD) is used in the current study. As Google was already collecting similar data since long through the Google Map Application, the users had elegance and trust, so we deployed the same mobility information in Corona's fight. Google mobility data is a part of google map users on various smartphone platforms. In the early days of Corona, google started releasing global community-level data to help the researchers and government machinery use them in policy-making decisions. These Community Mobility Reports are used in the study as a tool in combating COVID 19. The reports, chart, movement trends over time by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential areas helped study various aspects of the spread of the virus. A simple time series analysis is performed to map the mobility data with the number of confirmed cases from 14th March to 26th April 2020 (6 weeks or 43 days) to measure the effectiveness of Lockdown, which is the essential measure undertaken to reduce the mobility and spread of the virus. Various states of India have adopted several strategies to combat the spread of the Coronavirus. We need to understand how controlling the mobility of people, proactive planning to prevent a disaster from happening through the collection of travel and contact histories of individuals and human behaviour interact in spreading or controlling the virus.

3. Result

3.1. Lockdown in Combating COVID 19

With the execution of nationwide Lockdown in India from 24th March 2020, a significant change was marked at the mobility trends. The analysis that follows discusses the effect of Lockdown in containing the spread of COVID 19 through GMD (See Figure-1).

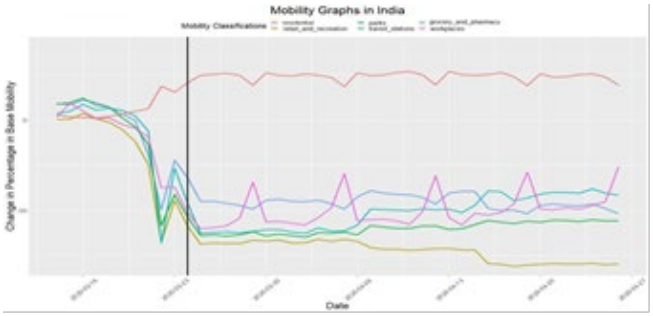

Figure 1. Google Mobility Trends in India

The x-axis represents dates, and the y-axis represents the percentage change in the mobility compared to the base rate of movement clustered at a specific region level. Changes in residential mobility have a positive trend, while others have a negative direction as stay home stay safe is the only preventive measure available to fight against Corona. The purpose of nationwide Lockdown was to force all the citizens to remain at their respective homes, to break the chain of social contamination, avoiding social gatherings, and maintaining social distancing are the essential mechanisms of the process. As a result, maximum people stayed at home, showing a positive trend in residential mobility.

Workplace mobility, even though it is negative, but has not decreased by 100% as compared to residential mobility. Some cyclic variation is observed in the workplace mobility, as the emergency workers, frontline fighters like the police force, doctors, paramedical staff, hospital workers, and other individuals engaged actively on the ground to fight with the pandemic and supposed to go to their respective workplaces. Besides, some emergency production and manufacturing industries like medicines, ventilators, Personal Protective Equipment (PPE), masks, sanitizers, and even movement of construction workers engaged in building emergency COVID hospitals across the country made the trend for workplace mobility a cyclic one. Other than these groups, some others provide emergency services like banking, internet, telecom, and entertainment sectors also contributed to the cyclic trend of workplace mobility.

The black vertical line in Figure-1 represented the date when the lockdown policy was announced. We can observe an instant spike in mobility just before the enactment of Lockdown. This spike indicates that citizens responded to speculation of the nationwide Lockdown before it was imposed and showed the citizens' fast reaction to the change. The day before the official declaration of nationwide Lockdown by the Government of India, India's prime minister had appealed for Janata Curfew as on 22nd March. As the number of positive cases and the number of deaths were increasing at an alarming rate worldwide, people of India speculated the Lockdown to be followed in India with an immediate action that can last for an indefinite period. As such, with the declaration of a nationwide Lockdown for 21 days from 24th March Midnight, people started to collect all necessary items for the next 21 days. As such, we can see an instant spike in grocery, pharmacy, transit stations, and retails. People gathered at the stores collecting groceries, medicines, and other necessary items as they feared the essential things for a living would go out of stock due to nationwide Lockdown. Even though the items will be available, they won't get out of their places to fetch them. So, apprehending the uncertainties, people want to store essential items resulting in a higher mobility trend in grocery, pharmacy, and retail stores. But, immediately after the Lockdown, there is a fall in mobility at these places as recorded by GMD.

From the above observations, we can infer that the enforcement of nationwide Lockdown had its effect on the social mobility of the population. Moreover, the main focus of the country like India was to curtail the social gatherings and social contaminations to combat the pandemic. India is a highly populous country, and obeying social distancing without legal enforcement of nationwide Lockdown would not have been possible. Indeed, nationwide Lockdown played a significant role in reducing the speed of the spread of the virus instead of the current phase of Unlock-1.0 beginning 08th June 2020 (till the writing of this article), where we see a sharp rise in the COVID 19 cases. In the later part of this paper, the effectiveness of Lockdown in the fight against the deadly virus based on simple regression is discussed. Next, we present a state-wise mobility status post lockdown.

Figure -2 and -3 represents the state-wise change in residential, retail, and recreation-related mobility due to nationwide Lockdown. The X-axis in the figures represents the dates. The left of the Y-axis represents the percentage change from baseline mobility. The right of the Y-axis tracks the red line, indicating the date when Lockdown began. However, there is some data unavailability for Lakshadweep. From Figure-2, we can observe a difference in residential mobility while comparing the states like Manipur and Mizoram with Delhi, Chandigarh, Maharashtra, Telangana, Tamilnadu, Gujarat, Kerala, and Karnataka. From among all the states, Manipur showed a notable trend in residential mobility. The state adhered to Lockdown in a significant way of staying at homes even earlier than the declaration of the nationwide Lockdown. Therefore, the number of reported cases of COVID 19 is much lower in Manipur compared to other states like Delhi, Chandigarh, Maharashtra, Gujarat, Kerala, Tamilnadu, Telangana, and Karnataka. These states showed a late response to Lockdown by not staying at respective residents. There is a similar trend in recreation and retail mobility (Figure-3) too. Initially, there is a fall in retail and recreation mobility due to Janata curfew. Then we can see a spike that shows the mass moving to gather necessary items just before complete Lockdown. This trend is almost similar to the countrywide retail and recreation mobility data. Then, gradually with the enforcement of Lockdown, there is a significant adherence to the policy.

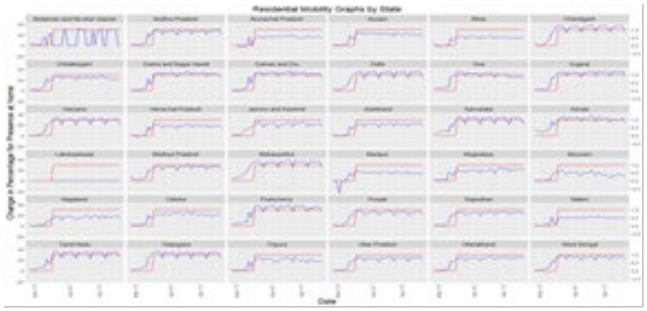

Figure 2. State-wise Residential Mobility Trend in India

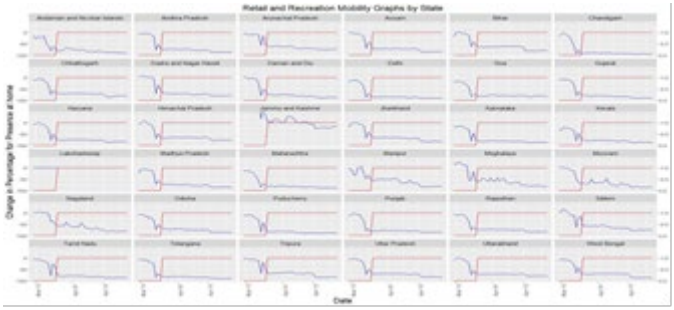

Figure 3. State-wise Retail and Recreation Mobility Trends in India

Since the level of adherence to lockdown policy is different in different regions of India, to measure the effectiveness of Lockdown as a measure to combat COVID 19, we checked for the correlation between the mobility and rate of growth in the number of COVID cases. The reported positive COVID cases were collected from the government website (https://www.covid19india.org/). Next, we attempted to see whether people's movement and the rise in the new cases go together. As the states differ with the population density, rather than looking at the number of COVID cases only, we need to normalize it to the population. Hence, we used a fixed effect control for controlling the variation in the state data and have logged the people in that. It is also marked that there is a certain gestation period between the infection and the symptoms to appear. Hence, if we want to look at the impact of mobility and growth of cases, we have to use the lagged data. One of the major issues faced during the analysis was the cyclic tendency of the mobility data, i.e., on some days, it increased; some other days, it decreased, as discussed earlier. So, if the proper lag duration was not chosen, we might have ended up in precisely opposite effects of mobility on the number of cases. Hence, we experimented with the number of lag days during various regressions. We used regression with (Log of a number of new cases +1) as the dependent variable and the percentage change in different types of mobility as the covariates. We chose the lag that represented the actual average of duration when the symptoms started appearing. Moreover, depending on whether the length is also different for different countries since the lockdown policy was implemented nationwide, we assumed that the rate of transmission was mostly similar. We chose an average of 14-21 days as followed for the quarantine as well as to detect the symptoms of the cases.

A positive magnitude represents a positive impact (See Table-1). With an increase in 1% of mobility for retail and recreation, there is a 0.96% increase in the number of cases. The same happens with the rise in the movement for grocery & pharma, transitk & stations, i.e., a 1% increase in mobility increases the number of cases by 0.29% and 0.5%. The movement to parks shows an increase in mobility for parks. It reduces the number of cases, as the people were homebound, they visited the gardens in their apartments or the community making the impact skewed. However, it is weird if we look at the no lag regression (Table-1). Residential mobility has a positive effect (1.01). Regression equation –

$$\begin{aligned} Log(Number\ of\ new\ cases + 1) &= \beta_0 + \beta_1 Date \\ &+ \beta_2 Log(population) \\ &+ \beta_3 retail\ and\ recreation \\ &+ \beta_4 Grocery\ and\ pharmacy \\ &+ \beta_5 parks + \beta_6 Transit \\ &+ \beta_7 workplaces \\ &+ \beta_8 residential \end{aligned}$$

Where-

(i) We have explained why we have regressed lag6 and lag 0.

(ii) We have taken Log (new cases + 1) as the dependent variable; in some states, the new cases were zero new cases some days, the distribution of new cases had long thin tails.

That suggests staying at home also increases the number of cases. But how does this happen? This is where the lag comes in. The detection of transmission of the disease is not instantaneous. If we observe an increase in the number of cases, the transmission for the said case has occurred at least a few days earlier. To capture the impact of change in residential mobility, we need to lag the mobility data. The question comes then, what is the best lag period to test (2, 3, 5, 6, 8, 9,? ? how many days). Unlike Odisha, where the testing facility is much faster with the average period of detection being four days, the average day of screening in Maharashtra is 13 days. As per the literature and Indian Council for Medical Research reports, the average detection period in India is six days. We also found that the date has a positive coefficient (3.37), which means cases increase by days, which is quite apparent.

Since the average national detection period is six days, we took the lag of six days to see what happens to the number of positive cases with the announcement of Lockdown. By examining the values of Table-2, we found a 1% increase in mobility for retail and recreation and parks increase the number of cases by 0.44% and 0.19%, respectively. In contrast, a 1% increase in mobility for grocery and pharmacy reduces the number of cases by 0.12%. Such a result may be explained by increasing mobility to those places to avail the masks, sanitizers, and

hand washes to prevent the infection. For this reason, the increase in mobility is reducing positive cases. An increase in movement to parks by 1% increases the number of cases by 0.19%, as visiting the parks increases the risk of social gatherings and transmission of the infection. Mobility for transit and stations if increases by 1%, it is also expanding the number of cases by 0.56%, as this makes more and more people prone and vulnerable to the virus due to high social gathering and less social distancing. kAn increase in mobility for workplaces by 1% increases the number of cases by 0.7%. The results found are also very significant. Workplaces encourage a higher degree of social gathering and a higher risk of infection. In addition to this, the COVID frontline workers are bound to go to their respective workplaces that increase the risk of disease, which is quite apparent. With this regard, we can justify 'work from home' as a better initiative of Nationwide Lockdown to combat COVID 19. Not only 'work from home,' but 'stay home, stay safe' is also an essential mechanism of Lockdown. These mechanisms work significantly in combating COVID 19, which is in our findings. One percent increase in residential mobility reduces the number of cases by 0.55%.

During six lag (Table-2), the impact on residential mobility is negative, and retail & recreation, parks, grocery and workplace, transit, and station like confirmed mobility is positive, which help us to defend the fact that Lockdown is a move in a right direction to fight against the pandemic. Since the covariates are significant in lag6 regression, we can interpret that the number of new cases is more than 0 (n case of retail and others), and we reject the null hypothesis. Similarly, for residential mobility, the impact is significant and less than 0.

Table 1. Regression with No Lag

	Estimate	Std. Error	t value	Pr(>|t|)	Significance
(Intercept)	-6.224e+02	5.702e+01	-10.916	< 2e-16	***
Date	3.374e-02	3.107e-03	10.861	< 2e-16	***
Log population	5.290e-01	2.905e-02	18.208	< 2e-16	***
Retail and Recreation	9.660e-03	2.659e-03	3.633	0.000289	***
Grocery and Pharmacy	2.947e-03	1.833e-03	1.608	0.108090	*
Parks	-7.117e-03	1.156e-03	-6.154	9.56e-10	***
Transit stations	5.019e-03	2.103e-03	2.387	0.017100	*
Workplaces	-1.247e-02	2.025e-03	-6.155	9.49e-10	***
Residential	1.018e-02	4.243e-03	2.400	0.016500	*

Significance codes: '***' 0.001 '**' 0.01 '*' 0.05
Residual standard error: 0.9589 on 1574 degrees of freedom (1 observation deleted due to missing) Multiple R-squared: 0.3562, Adjusted R-squared: 0.3529, F-statistic: 108.9 on 8 and 1574 DF, p-value: < 2.2e-16

Table 2. Regression with Lag 6

	Estimate	Std. Error	t value	Pr(>|t|)	Significance
(Intercept)	-6.191e+02	5.696e+01	-10.868	< 2e-16	***
Date	3.357e-02	3.106e-03	10.805	< 2e-16	***
Log population	5.060e-01	2.884e-02	17.544	< 2e-16	***
lag(retail and recreation)	4.450e-03	1.685e-03	2.640	0.008372	**
lag(grocery and pharmacy)	-1.260e-02	1.861e-03	-6.769	1.82e-11	***
lag(parks)	1.907e-03	1.194e-03	1.597	0.110504	*
lag(transit stations)	5.627e-03	2.173e-03	2.589	0.009704	**
lag(workplaces)	7.035e-03	2.082e-03	3.378	0.000747	***
lag(residential)	-5.583e-03	4.254e-03	-1.313	0.189517	*

Significance codes: '***' 0.001 '**' 0.01 '*' 0.05
Residual standard error: 0.9806 on 1568 degrees of freedom (7 observations deleted due to missing) Multiple R-squared: 0.3286, Adjusted R-squared: 0.3251 F-statistic: 95.91 on 8 and 1568 DF, p-value: < 2.2e-16

Thus, with all the above mobility graphs and the mobility regression with the number of positive cases, it is proved that Lockdown had a positive impact on combating the spread of the virus. Our result is "lockdown helped counter the rate of spread." The drastic change in mobility was due to forced Lockdown with the cooperation from the state administration. Reduction in mobility is due to the same; offices are closed, people started working from home, and many more. It was enforced to reduce interaction among the population and reduce infectious contact. Hence, we can easily establish causation validating our results.

Lockdown being a lawful action was seriously adhered to by maximum Indians to control the spread of the pandemic. Lockdown, along with several other measures like telecasting of several entertainment programs on the national entertainment channels, helped India observe a fruitful lockdown nationwide and ensure that people stayed in their respective homes.

3.2. Disaster Preparedness and Corona Fight

World Health Organization declared Corona a Public Health Emergency of International Concern on 30th January 2020, without any prescribed cure for the epidemic and preparedness as the only way to restrict COVID 19. Odisha is the first State of India to declare COVID 19 a 'disaster' under the provisions of the Disaster Management Act, 2005 on 13th March 2020, to empower public officials to combat the spread of COVID 19 adequately. It becomes most important to measure the preparedness of several other states to fight the pandemic. To know the readiness to fight against Corona, we have analysed all the preparedness parameters adopted by different states of India. Each metric was allotted a weight (Table-3) to develop an index to measure how preparedness for the pandemic can be useful in the fight and

control the spread of Corona. Further, the weights can help examine each state's relative standing in the battle against Corona. The weights allotted have been validated with the expert consultations working in this field, the frontline line warriors and health workers, and researchers.

Table 3. Parameter to Measure the Disaster Preparedness

Preparedness Parameters	Allotted Weights
Testing Data- RT PCR Tests / Rapid Antibody Tests	5
Gender-Wise COVID cases	4
Age-Wise COVID cases	4
District Wise Summary	4
Number of General Beds	7
Number of ICUs	9
Number of Doctors Deployed (3 shift)	10
Number of Nurses Deployed (3 shift)	10
Number of Paramedics Deployed (3 shift)	10
Number of Group D (3 shift)	10
Number of New Patients admitted in General Beds (Gender wise segregation)	5
Suspected Cases	5
Gender-Wise Suspected Cases	5
Confirmed COVID cases	3
Gender-Wise Confirmed COVID Cases	3
Gender-Wise Suspected Cases in General Beds	7
Gender-Wise Confirmed COVID Cases in General Beds	7
New Patients Admitted in ICU Beds	7
Gender-Wise Number of New Patients admitted in ICU Beds	7
Number of Recovered cases	2
Number of Deaths	2
Daily Record of Number of N95 masks available	9
Daily Record of Number of Surgical masks available	9
Daily Record of Number of PPE kit availability	9
Daily Record of Amount of Hand Sterilizers available in all COVID Hospitals	9
Daily Record of Availability of Oxygen in all COVID HOSPITALS	9
Daily Record of Number of Ventilators Available in all COVID HOSPITALS	9
Number of Medical Ambulance Available	9
Case -Wise Travel History	8
Day- Wise Number of Reported Cases	3
Every Day Press Release On COVID 19 from 19th March, by specially designated COVID 19 spokesperson	1
Information Education and Communication materials for COVID 19 available in English and concerned state's language	1
Disable Friendly and Bilingual (State language and English)	1
Helpline Numbers for COVID19	1
Updates in the social accounts	1
Number of testing centers	1
Government hospitals involved	1
Mental Well Being and Emotional Support	6
Quarantine facility	6
Government helpline numbers (Category wise)	6

With the allotted weights, we calculated the state-wise weighted preparedness (Table-4) to see which state is more prepared in the fight against the pandemic.

Table 4. State-wise Ranking of Disaster Preparedness for the Pandemic

Rank	STATE	Weights for Disaster Preparedness
1	Odisha	225
2	Bihar	90
3	Maharashtra	75
4	Uttarakhand	58
5	Tamil Nadu	53
6	Madhya Pradesh	49
7	West Bengal	44
8	Chhattisgarh	41
9	Kerala	38
10	Karnataka, Puducherry	37
11	Jharkhand	34
12	Delhi, Gujarat	33
13	Rajasthan	30
14	Andhra Pradesh & Chandigarh	29
15	Meghalaya	26
16	Punjab	25
17	Jammu & Kashmir & kLadakh	19
18	Haryana	18
19	Goa	16
20	Himachal Pradesh	15
21	Assam	14
22	Telangana	10
23	Arunachal Pradesh	6
24	Tripura	5

Almost all out of 28 Indian states and eight union territories have been ranked for their preparedness. Some states and union territories like Andaman & Nicobar Island, Manipur, Mizoram, and Uttar Pradesh counted the preparedness below five and are thus, not undertaken in the list of readiness for the pandemic. Odisha occupied the first rank among all the states and is the first state to declare COVID 19 a disaster; the Government adopted all preparedness measures to face the hard times of COVID 19 firmly. Having faced super cyclone in 1999, Odisha has managed many natural calamities in the past very effectively. Though COVID 19 situation demanded a different strategy than previous disasters, the experience of managing disasters helped the state maintain all records by adopting a transparent regulation of systems for which the state leads the preparedness for the COVID 19 list. In the latter part of this paper, we have also analysed the travel histories of positive cases, one of the special measures undertaken by the state to combat the pandemic. Other than this, states like Bihar, Maharashtra, Uttarakhand are also well prepared. It is interesting to note that the states like Bihar and Odisha, always listed as underdeveloped and poor states of India, are on the top when it comes to the administration of the state during the time of the COVID 19 crisis. Indeed, these states know something better than other

states regarding disaster management because of their repeated exposure to other natural calamities. There is a scope for these states to develop and lead the disaster preparedness guidelines for the entire country. Learning the knowhow of disaster preparedness could be an asset for any progressive and forward-looking government.

Now, to equate the disaster preparedness of the states with the pandemic, we calculated the best fit exponential rate of growth of the number of new cases in every State (Table-5). Then we evaluated the correlation between the Disaster Preparedness and the number of COVID cases. The correlation is low (0.21) and positive. This suggests that if the states are more prepared, the numbers of positive cases reported are also high, and this is obvious because there are more testing and early detection of the corona cases.

Table 5. States with the Exponential Rate of Increase in Number of COVID Cases & their Weights for the Preparedness

State	Rate of Exponential Increase Till 25th April	Weighted Preparedness
Odisha	0.1269	225
Andhra Pradesh	0.1781	29
Bihar	0.1175	90
Chandigarh	0.0531	29
Chhattisgarh	0.1015	41
Delhi	0.1569	33
Goa	0.0224	16
Gujarat	0.1614	33
Haryana	0.083	18
Himachal Pradesh	0.1005	15
Jammu & Kashmir	0.1416	19
Karnataka	0.0998	37
Kerala	0.07	38
Ladakh	0.0163	19
Madhya Pradesh	0.1749	49
Maharashtra	0.143	75
Puducherry	0.0671	37
Punjab	0.1272	25
Rajasthan	0.1567	30
Tamil Nadu	0.1903	53
Telangana	0.1372	10
Uttarakhand	0.0935	58
West Bengal	0.1511	44
Assam	0.0494	14
Jharkhand	0.1688	34
Tripura	0.0306	5
Meghalaya	0.1499	26
	Correlation (r) = 0.213008719	

Data source 2 – The rate of exponential increase is taken from https://api.covid19india.org/COVID INDIA Org API website directly. We use historical data until 25th April and compute the exponential best fit line. The best fit line is calculated with the help of the least squared error technique. Arunachal Pradesh, even though it had six as the weighted preparedness value, but is not taken for further calculation due to the unavailability of data required for finding its correlation with COVID 19.

To further examine the effectiveness of the Disaster Preparedness Index, we have undertaken three more indicators: 1) states having more than 7000 tests, 2) states having more than 15000 tests, and 3) states having more than 100 Corona cases. The relation of the preparedness with these indicators was found to be negative [indicator-1= -0.03, indicator-2 -0.05, indicator-3 -0.04] (Table-6). The results suggest that disaster preparedness (including testing and other measures) reduces COVID cases. The states having more than 15000 tests seem to be highly prepared as the rate of growth of the number of cases is negatively correlated. If it is compared with the states having more than 7000 tests, the correlation is high, i.e., -0.054824653 > -0.035355195.

Table 6. Measuring the Effectiveness of Disaster Preparedness Index

States Having More Than 7000 tests	Rate of exponential increase till 25th April	Weighted preparedness	States Having More Than 15000 tests	Rate of exponential increase till 25th April	Weighted preparedness	States Having More Than 100 Corona Cases	Rate of exponential increase till 25th April	Weighted preparedness
Odisha	0.1269	225	Odisha	0.1269	225	Odisha	0.1269	225
Andhra Pradesh	0.1781	29	Andhra Pradesh	0.1781	29	Andhra Pradesh	0.1781	29
Bihar	0.1175	90	Bihar	0.1175	90	Bihar	0.1175	90
Chhattisgarh	0.1015	41	Delhi	0.1569	33	Delhi	0.1569	33
Delhi	0.1569	33	Gujarat	0.1614	33	Gujarat	0.1614	33
Gujarat	0.1614	33	Haryana	0.083	18	Haryana	0.083	18
Haryana	0.083	18	Karnataka	0.0998	37	Jammu & Kashmir	0.1416	19
Jammu & Kashmir	0.1416	19	Kerala	0.07	38	Karnataka	0.0998	37
Karnataka	0.0998	37	Madhya Pradesh	0.1749	49	Kerala	0.07	38
Kerala	0.07	38	Maharashtra	0.143	75	Madhya Pradesh	0.1749	49

Madhya Pradesh	0.1749	49	Rajasthan	0.1567	30	Maharashtra	0.143	75
Maharashtra	0.143	75	Tamil Nadu	0.1903	53	Punjab	0.1272	25
Punjab	0.1272	25	Telangana	0.1372	10	Rajasthan	0.1567	30
Rajasthan	0.1567	30				Tamil Nadu	0.1903	53
Tamil Nadu	0.1903	53				Telangana	0.1372	10
Telangana	0.1372	10				West Bengal	0.1511	44
West Bengal	0.1511	44						
Correlation= -0.035355195			Correlation= -0.054824653			Correlation= -0.049605683		

Hence, with the increase in the number of tests as a parameter of preparedness, the positive cases are reducing. Increased testing prompts an early detection of the cases, thus reducing the contact cases and the spread of the virus. A similar result was also observed with the states having more than 100 confirmed corona cases. All these results show the efficiency of the Disaster Preparedness index in combating COVID 19. Further, this index can be replicated by any state, smart city, and nations to be prepared during the pandemic like COVID 19 or other disasters.

3.3 Travel and Contact Histories in Combating COVID 19: A Case of Odisha

The travel and contact history of all COVID positive cases maintained by the Government of Odisha proved highly effective in knowing several COVID 19 dynamics. In the current study, 73 positive cases and their travel and contact history as of 20th April 2020 were analysed. Initially, the travel history gives us an idea about the origin and causes of the spread of the virus in the state. Out of 73 positive cases, 43 have a travel history, and 28 positive cases did not have any history of traveling but diagnosed positive through contact with other positive cases. There was neither any travel history nor any contact tracing for two cases. These two cases were suffering from cold, visited the hospitals, and were tested COVID positive. Analysing the 43 COVID positive cases having a record of travel history, we can see 28 cases (65%) (See Figure-4) are returnees from Kolkata (Table-7).

Next, seven positive cases (16%) related to people moving in and out of Odisha state. Third, five cases have a connection with the Delhi Nizamuddin Markaz Congregation (See Table-7), who later became the source of the spread of the virus in their region. Out of 2 from Delhi, 1 had a connection to Nizamuddin. So, out of 43 positive cases, a count of 6 (i.e., 14%) had links to Nizamuddin Congregation. If we focus on the histories of those 28 positive cases that did not have any travel history, we can still find the nature and source of infection. All the 28 persons are either a close relative or the neighbours, or somehow had in contact with the earlier positive cases (Table-8). It is observed that case no-61 is regarded as the super spreader who infected seven other persons by contacting them.

From Table-8, we can see that out of 28 cases without travel history, 46.42% (n=13) got infected through close relatives, 21.42% (n=6) each got infected through close contact and neighbours, and finally, 10.71% (n=3) got infected through co-passengers. Hence, people need to maintain safe physical and social distance from others even if they do not have any travel history.

Further, it was observed that in Odisha, individuals in the age group of 31-40 years are the most affected by COVID 19, followed by the 51-60 years of age group. A similar trend is observed throughout India, with 31-40 years of the age group being the most affected one. As between 31-40 years, it is the productive age, and they are also exposed to several works, places, and people, thereby becoming the most vulnerable group. The trend of positive cases at different ages in Odisha and India is the same (Figure-5).

Table 7. Delhi Nizamuddin Markaz and the Spread of COVID 19 in Odisha

Area to which the Person from Nizamuddin Congregation Belonged to	Count of Nizamuddin Traveler
Bhadrak	2
Cuttack	1
Puri	1
Rourkela	1
Total	**5**

Table 8. Contact Tracing and Spread of COVID 19 in Odisha

Case No. Who Tested COVID Positive	Nature of Contact With Other Persons	Number of Persons Infected Through Contact (Contact Cases)
41	Close Contact	2
42	Close Contact	1
61	Close Relative	7
69	Close Contact	2
73	Close Relative	2
74	Close Relative	1
42	Close Relative	3
42	Close Contact	1
64	Co-Passenger	3
7,8,22,39	Neighbours	5
101,102	Neighbours	1
Total		**28**

A gender-wise, Corona positive cases in Odisha state and India also shows the same trend, where the males are affected the most (India-66.8% & Odisha-79.4%) as compared to the females (India-33.2% & Odisha-20.5%). Comparing the males of Odisha and the nation as a whole, the males of Odisha have a higher percentage of positive cases (India-66.8% < Odisha-79.4%). However, the females of Odisha have lower positive cases compared to the whole of India (Odisha-20.5 % < India-33.2%) [Figure-6].

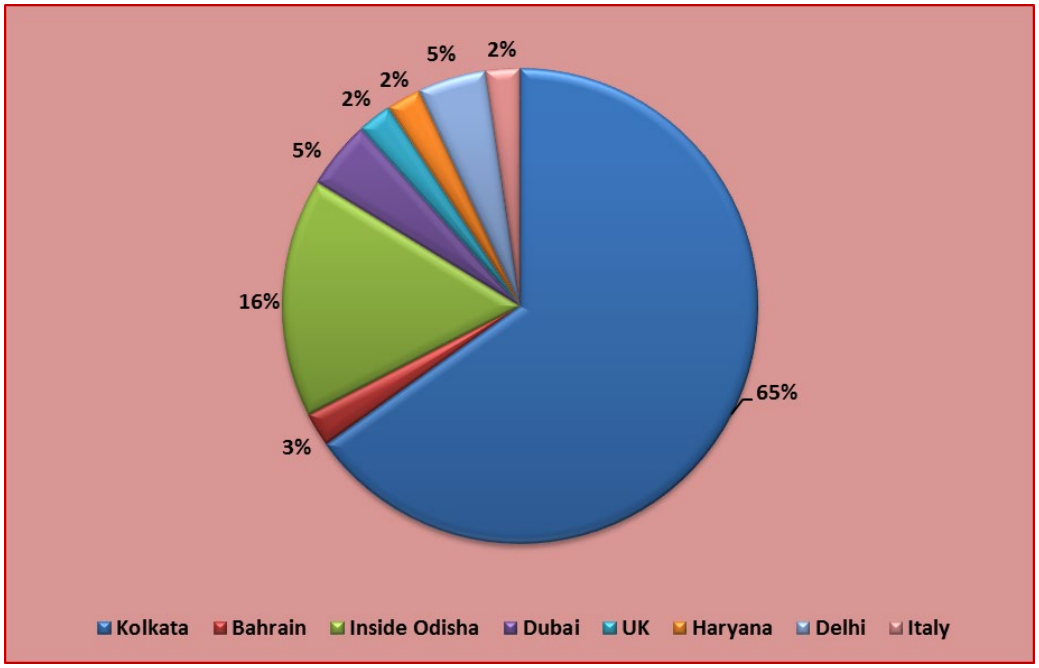

Figure 4. Travel history contributing to COVID 19 spread in Odisha

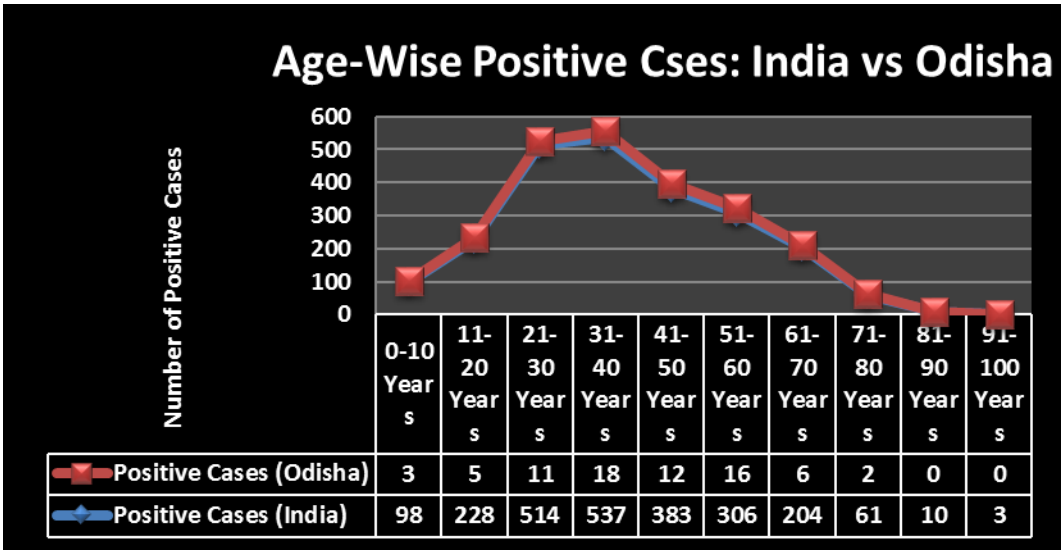

Figure 5. Age-wise Distribution and COVID 19 Infections

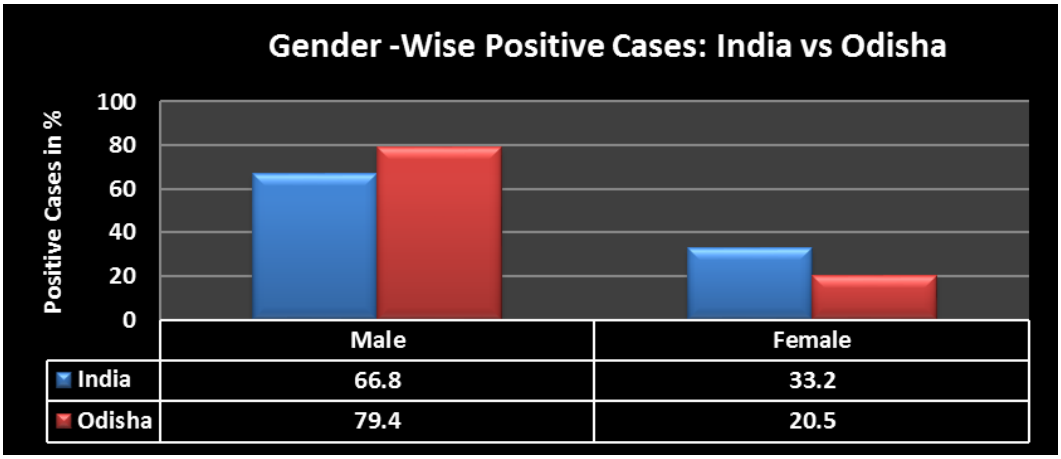

Figure 6. Gender-wise Distribution of COVID 19 Infections

The first exposure or contact with the virus is crucial to understand the spread. As we do not know the source of infection every time, we are prone to this infection at every step outside the house and coming in contact with the carrier directly or indirectly. Therefore, the time between the first exposure and the date of getting to know about it seems essential. The travel and contact histories of positive corona cases, as maintained by the Government of Odisha, indicates before getting tested for Corona, an individual used to roam freely for more than 20 days, which may or can be the source of spread (Table-9).

Table-9. Positive Cases and Time Lag between First Contact & Confirmation of Corona
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No of Corona Positive Cases	Time Period (in Days) between First Contact and Corona Positive Confirmation
1	1 day to 36 days
2	24 to 34 days
3	4 to 30 days
4	18 to 21 days
6	27 to 31 days
7	23 days
9	22 days

Table-10. Tested Samples and Type of COVID Cases

Sample Tested	No. of Cases
Asymptomatic	61
Symptomatic	4
Sample Collected as a Part of Contact Tracing	6
Neither Symptomatic nor Asymptomatic/ Contact cases	2
Total Confirmed cases	**73**

The history of the positive cases confirmed in Odisha vividly shows a higher number of asymptomatic cases than symptomatic and other cases (Table-10). The higher numbers of asymptomatic cases have a higher window of spreading the virus by contacting others. More frequent and random tests may hold the key to trace positive cases quickly. Further, as the maximum days of being tested and finding to be COVID positive is 36 days, the quarantine period may be increased to 40days for the suspected and contact cases (Table- 9). Meanwhile the Govt. of Odisha had increased the quarantine period from 14 days to 21+7 days (21 days at quarantine centres and seven days of home quarantine) (The Indian Express, 9th May 2020). But, keeping in view the rate of random tests done per day, it is advisable to increase the period up to 40 days. As the tests increase, the quarantine days may be reduced accordingly. Further, home sample collection or sample collection at community centres where the physical distancing norms can be followed should be encouraged.

4. Conclusion

Novel Coronavirus (nCov-19 or COVID 19) is a household name now. With no immediate preventive or curative in sight, precaution is our best bet. Lockdown, shutdown, isolation, quarantine, and sanitization like behavioral interventions have proved their efficiency in the fight against the virus. We have analyzed the movement-related information of people, effectiveness of Lockdown, disaster preparedness, and effectiveness of maintaining travel and contact histories in combating the

spread of infection. The quantitative analysis of the Google Mobility Data proved Lockdown as an efficient and effective way to combat the epidemic and containing the spread. The sharp rise in the number of cases after the relaxation of Lockdown is proof of it. The rate of spread is much faster during the relaxation or unlock phase. Staying prepared during disasters saves life and wealth. However, it has been assumed that there are negligible false-positive cases in the data reflected by the country's COVID-19 information portal and Google Mobility Data.

Odisha state in India has set an example in the entire country by adopting a proactive approach to tackle the situation. Incidentally, it may be noted that the variation in the density of the population in a state, the nature of travel, and the frequency of individual interaction may differ from state to state even during Lockdown. The mobility data assumes a uniform distribution of population and hence, infection. However, efforts can be made to improve the strategy to tackle the outspread of the virus. One of the strategies involved in this process is maintaining a record of the travel and contact histories that helped the government chalk out specific and measurable actions. The travel history of all COVID 19 positive cases maintained by the Government of Odisha proved highly useful in knowing the origin and the causes of the spread of the virus in the state. A qualitative, as well as a quantitative analysis of the travel histories helped to gather in-depth knowledge about the origin, causes, and direction of the infection and several other aspects, which is very resourceful in assessing Corona, the pandemic. The findings of the current study suggest that preventing an epidemic is possible with the adoption of the right strategies that are based on authentic information, documentation, and preparedness. Policymakers must utilize the successful strategies adopted to manage the pandemic like situations in the future by documenting it systematically. The authentic data acquisition and data management seem very crucial in controlling infectious diseases in smart cities.

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