COVID-19: An Analysis of Trends in Cases, Deaths and Recoveries in India, USA and Italy

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Abstract: COVID-19, the virus that started spreading from Wuhan, China, has completely changed the way humans perceive the world and live our lives. Things that people couldn't imagine doing everyday such as wearing a mask, social distancing, work from home, online exams, virtual classes and many more have become the new normal. The last few months have shaken everybody from a daily wage worker to nations and their economies. The virus has created havoc amongst different classes of the society and it has been spreading with no remorse. It's been almost a year since all this started and the whole world has been so overwhelmed by it that there is no proper vaccine for the virus yet.

In this paper, a data-driven approach is taken to analyse the impact of COVID-19 on 3 major countries: the United States of America, Italy and India and how this pandemic has overwhelmed the hospitals and medical institutes in these countries thus leading to the rapid growth of the pandemic in these 3 countries. For the analysis, we have used data from January to September 2020.

Index Terms **– COVID-19, Data Analysis, Data Visualization, USA, India, Italy, China.**

I. INTRODUCTION

The first human case of COVID-19, the disease caused by the novel coronavirus causing SARS-CoV-2 was first reported by officials in Wuhan City, China, in December 2019. While some of the earliest known cases had a link to a wholesale food market in Wuhan, some did not. Many of the initial patients were either stall owners, market employees, or regular visitors to this market. Environmental samples taken from this market in December 2019 tested positive for SARS-CoV-2, further suggesting that the market in Wuhan City was the source of this outbreak or played a role in the initial amplification of the outbreak.

Originating from China, the virus then spread to Italy, Spain and Germany. The three countries were leading the COVID-19 charts in the initial period of the pandemic only to slow down later. As of 10/11/2020, the USA was leading the COVID-19 charts with more than 10 million cases and India was second with more than 8 million cases. However, Italy has picked up pace again and is bracing for a second wave of COVID-19.

II. ANALYSIS

The USA

The first case of COVID-19 in the USA was reported on 20th January, 2020, the first death on 26th February, 2020 and the first recovery on 01st April, 2020. As of July 2020, a total of at least 11,079 specimens were tested since January in the USA.

The USA declined to use a test approved by the World Health Organization in January - instead, the CDC developed its own coronavirus test. However, there were manufacturing defects with the initial CDC tests which meant many of the results were inconclusive. New York and Chicago, which saw a surge of coronavirus cases at the start of the pandemic, eventually experienced a decline in cases and began reopening in phases. But that trend did not hold throughout the rest of the country. Other states such as Arizona, South Carolina, Florida, Alaska, Arkansas, California, Kentucky, New Mexico, North Carolina, Mississippi, Oregon, Tennessee, Texas, Utah, and Puerto Rico saw a sudden spike in COVID-19 cases.

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Text(0, 0.5, 'Number of Positive Cases')
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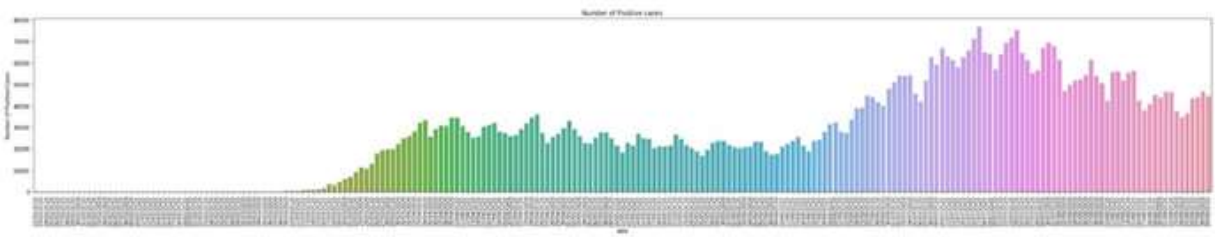

Fig.1 Daily COVID-19 Positive Cases in the USA

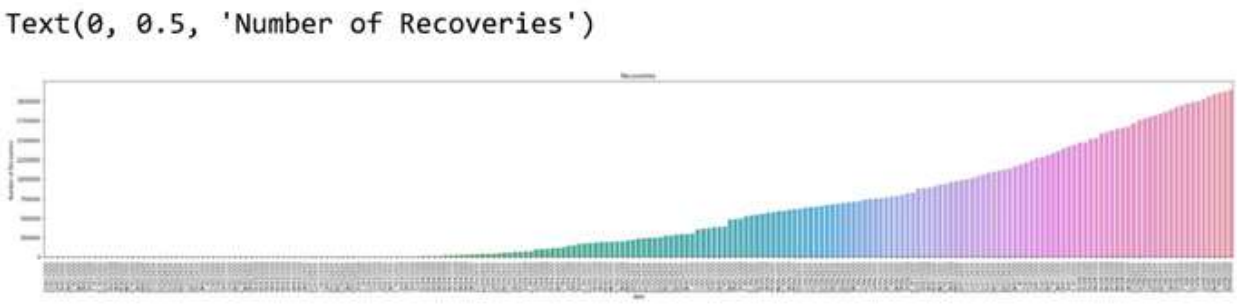

Fig.2 Daily COVID-19 Recoveries (Cumulative) in the USA

In April, the USA Government announced the guidelines to reopen the country, which included a 14-day decline of confirmed coronavirus cases or a decline of positive tests as a percent of total tests within that period. However, some states didn't meet those guidelines before reopening. Florida's first phase began on May 18, which reopened restaurants, retail and museums at half capacity. Not only did the state fail to meet a two week decline in cases, but it actually reported an increase in cases per day a week before reopening. Florida reported 594 cases on May 10. Five days later there were more than 800 cases.

Table 2.1: Percentage of Total Population aged 65 and above in different countries (1-6)

Country	Japan	Italy	Germany	Sweden	France	Spain	Netherlands	Belgium
Percentage	28.10%	22.70%	21.50%	19.90%	19.80%	19.30%	19.00%	18.80%

Table 2.2: Percentage of Total Population aged 65 and above in different countries (7-12)

Country	Austria	Switzerland	U.K.	Canada	U.S.A	Australia	S. Korea	China
Percentage	18.80%	18.40%	18.30%	17.20%	16.00%	15.70%	14.30%	11.20%

Coming to the Hospital Metrics, the number of cases in the USA as of 08/08/2020 was 23,49,423. The number of beds they had in total then was 9373 per 30000 people out of which 8099 were non-ICU beds and 1274 were ICU beds.

Table 2.3: Average Number of Beds in the USA per 30,000 people (as of 08/08/2020)

Total Beds	Non-ICU Beds	ICU Beds	Average Beds being used for COVID-19
8698	7707	1261	910

The total average ventilators they have had per day is 1905. On 08/08/2020, they had 2020 ventilators out of which only 28 were being used for COVID-19. With these number of beds and ventilators, any nation would struggle to combat COVID-19 lest the nation leading the charts in the number of cases. During the dates 02-04-2020 to 16-05-2020, there was a chronic shortage of Intensive Care Unit (ICU) beds in COVID-19 hospitals. During this period, the deaths also increased at a larger rate.

Mechanical ventilation is a vital component of critical services for patients with severe acute respiratory failure. Based on the most recent publicly available data (from 2010), the estimate was that the US Acute Care Hospitals owned approximately 62,000 full-feature mechanical ventilators before the pandemic started. Calculations suggest that about 28,883 of these ventilators (46.4%) could be used to ventilate paediatric and neonatal patients.

There were also an additional 98,000 ventilators that were not full-featured but could still provide basic functions in an emergency if crisis standards of care were invoked. However, the need for ventilation services during COVID-19 quickly overwhelmed many day-to-day operational capabilities.

Italy

The first case of COVID-19 in Italy was reported on 02nd February, 2020, the first death on 22nd February, 2020 and the first recovery on 27th February, 2020.

In Italy, data from the Istituto Superiore di Sanità (ISS) indicated that 1% of the patients in Italy who died had no other disease, 26% had 1 disease, 26% had 2 disease, and 47% had 3 or more conditions. The most common chronic pre-existing disease in the patients who died was arterial hypertension (76%), followed by ischemic heart disease (37%), atrial fibrillation (26%), and active cancer within the previous 5 years (19%). Another cause for the higher lethality rate was that Italy had a higher number of infected individuals who were asymptomatic and hence, infected others unknowingly.

The transmission rate from unreported infections in Italy was 55% of the rate of reported infections, and un-reported infections resulted in 79% of reported cases. Therefore, for each positive COVID-19 case, there were about 8 to 10 undetected cases. Thus, the actual number of COVID-19 cases could have been up to 10 times higher, and recalculation of the mortality rates on this basis would cause the actual national mortality rate of COVID-19 to decrease approximately to the mortality rates of COVID-19 in the People's Republic of China.

It also cannot be ignored that the elderly in Italy have frequent contact with their children and often take care of grandchildren. The percentage of people between the age of 30 to 49 who live with their parents is up to 20%, which is much higher than in other countries. Adult children and grandchildren, who are often asymptomatic, would have infected their elderly parents and grandparents.

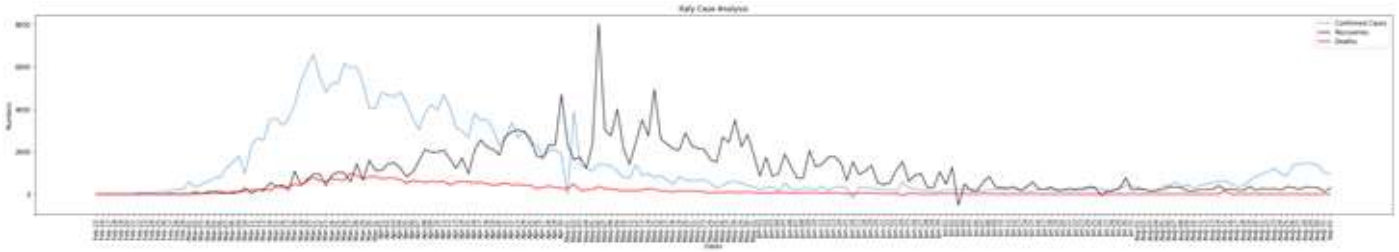

Fig.3 Italy COVID-19 Statistics as of (As of 23/08/2020)

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Text(0, 0.5, 'Number of Positive Cases')
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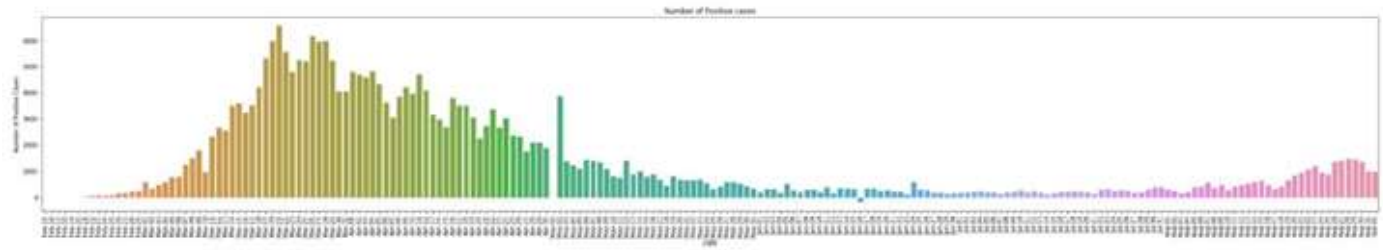

Fig.4 Daily COVID-19 Positive Cases in Italy

For the purpose of this paper, the progression of COVID-19 in Italy was divided into 2 phases:

i. Before May 31
ii. After June 1

After this division, it became much clearer as to what the issue in Italy was.
As the number of COVID-19 patients continued to rise in Italy with the majority of the cases in Lombardy, the doctors were forced to make decisions on who had to be treated first and priority was given to children and young adults because they were having a greater chance of survival since they are healthier.

Table 2.4: ICU Beds Available in Italy before and after COVID-19

	February '20	March '20
Occupied	4,100	4,760
Available	1,000	952

India

The first case of COVID-19 in India was reported on 30th January, 2020, the first death on 12th March, 2020 and the first recovery on 09th March, 2020. In India, the number of new cases that came up every day grew rapidly until mid- September after which the numbers started declining.

For the purpose of this research, the progression of COVID-19 in India was divided into 3 phases:

i. Before March 31
ii. From April 1 to May 31
iii. After June 1

After this division, it was pretty clear that every unlock phase hurt India.

For beds, 6 states in India were mainly targeted namely Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Uttar Pradesh, and Delhi. These states accounted for 55% of the total cases in India (as of 04/09/2020). (All the numbers below are as of 03/09/2020).

- Maharashtra:
  - Active Cases: 2,05,000
  - Healthcare Beds: 1,20,444
- AP:
  - Active Cases: 1,03,000
  - Healthcare Beds: 83,937
- TN:
  - Active Cases: 52,070
  - Healthcare Beds: 1,50,148
- Karnataka:
  - Active Cases: 74,477
  - Healthcare Beds: 1,26,498
- UP:
  - Active Cases: 63,256
  - Healthcare Beds: 1,34,570
- Delhi:
  - Active Cases: 20,543
  - Healthcare Beds: 44,955

When it comes to India, it cannot be completely said that there is no compromise in terms of the ventilators as the population of India is quite large in comparison to Italy and the US.
The number of ventilators in the above mentioned 6 Indian states are:

- Maharashtra - 5793
- Andhra Pradesh - 2081
- Tamil Nadu - 3884
- Karnataka - 6553
- Uttar Pradesh - 9035
- Delhi – 986

Table 2.5: General Hospital Stats of India on 20th May and 31st July 2020

Status	May-20	Jul-31
Total Cases	1,06,750	16,38,870
Active Cases	61,149	5,28,242
Patients in ICU	3%	1.61%
Patients on Ventilators	0.45%	0.28%
Patients on Oxygen Support	2.94%	2.32%
Case Fatality Rate	3.09%	2.18%

On May 20, when the number of active cases in the country were 61,149, 3% of the cases or 1,834 patients were in the ICU, 0.45% or 275 patients were on a ventilator while 2.94% cases or 1,797-patients were on oxygen support, according to details shared by the Union Ministry of Health and Family Welfare. In comparison, on July 31, when the country had 5,28,242 active Covid-19 cases, 1.61% or 8,504 were in the ICU, 0.28% or 1,580 patients were on ventilator and 2.3% or 12,255 were on oxygen support. This improvement in the clinical outcome of many severely sick patients could be attributed to better medical management of patients that included early use of steroids, quick detection of cases owing to increased testing rates, and avoiding the use of invasive ventilators.

III. RESULTS

Table 3.1: Average of Each Parameter per day in each country

	Deaths	Positive Cases	Recoveries
USA	791	26825	9686
Italy	177	1351	1040
India	478	26237	20024

Table 3.2: Standard Deviation of Each Parameter per day in each country

	Deaths	Positive Cases	Recoveries
USA	688	21352	12085
Italy	241	1638	1120
India	1531	94663	78852

In the USA, the average daily new cases (difference between the average daily cases and average daily recoveries) were 17139 which means on a daily basis, the USA had an increase of 17139 active cases per day and this number is only till September. This number has increased tremendously after the US elections result. Cases are going up in lakhs daily and the recoveries still stand in thousands. The USA has been ruthless the way they have handled this situation. Lockdown wasn't properly followed by the public and the states of USA haven't obeyed proper protocols before unlocking leading to a huge increase in cases. Schools and Colleges were also opened in June thus worsening the situation. There was no single day in the USA when there were more recoveries than positive cases. Their major problem has been less attention to the COVID-19 situation.

The number of new cases that come up every day increases much faster than the number of newly hospitalized patients every day. This means that the USA has more people self-isolating and not requiring hospital facilities to get better.

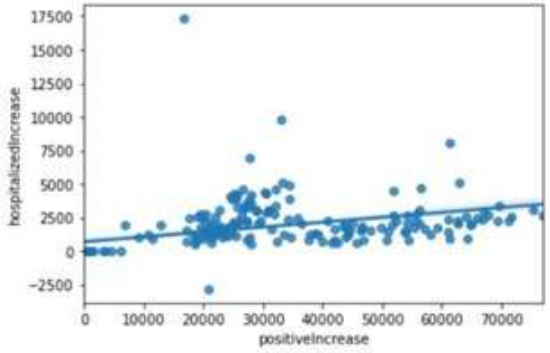

Fig.5 Correlation between the Number of New Cases and the Number of Newly Hospitalized Patients

There is no correlation between the number of patients on Ventilators and the rise in the number of Hospitalized patients. This means that the admitted people can still breathe by themselves and do not require a ventilator right away.

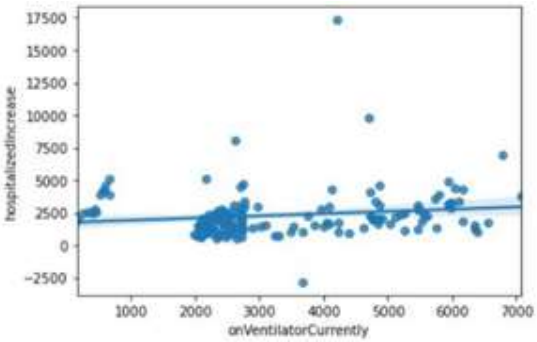

Fig.6 Correlation between the Number of Patients on Ventilators and the Number of Hospitalized Patients

Even though people don't require a Ventilator right away, people who join the hospital are being admitted directly to the ICU. This is evident from the relationship between the daily increase in hospitalized patients and the daily increase in ICUs patients.

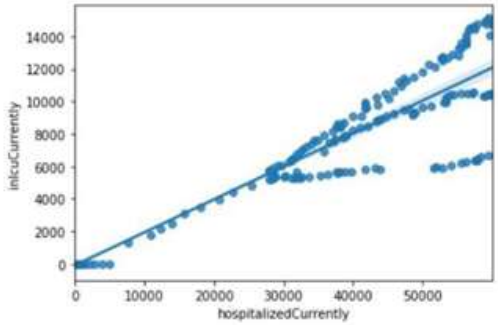

Fig.7 Correlation between the Number of Patients in ICU and the Number of Hospitalized Patients

Coming to Italy, the daily cases of Italy were divided into two parts (as mentioned earlier):
Phase I: Upto May 31
Phase II: June 01 Onwards

After this division, it can be seen that in Italy, it was more of a preparedness problem, both mentally and medically. Italy is known to have some of the best medical resources. Given their medical prowess, the population of Italy would never have thought that COVID-19 is going to have such a large-scale impact. But, they declared an emergency and locked down the nation on 09th March, 2020. Their daily positive cases started to fall in April and by June, they were very low. Their average number of daily positive cases since June (up to August end) is 399 which is pretty low as compared to their global average of 1351. Their average number of cases in Phase 1 (i.e. till 31/05) is 2177 which is pretty high as compared to their global average of 1351. However, Italy has entered its second wave of COVID-19 which seems to be much more lethal than Wave 1.

```
count     107.000000
mean     2177.514019
std      1859.403233
min         0.000000
25%       585.500000
50%      1492.000000
75%      3594.500000
max      6557.000000
Name: confirmedIncrease, dtype: float64
```

Fig.8 Major Parameters for Daily Confirmed Cases in Phase 1 (before 31/05)

```
Text(0, 0.5, 'Number of Positive Cases: Phase I')
```

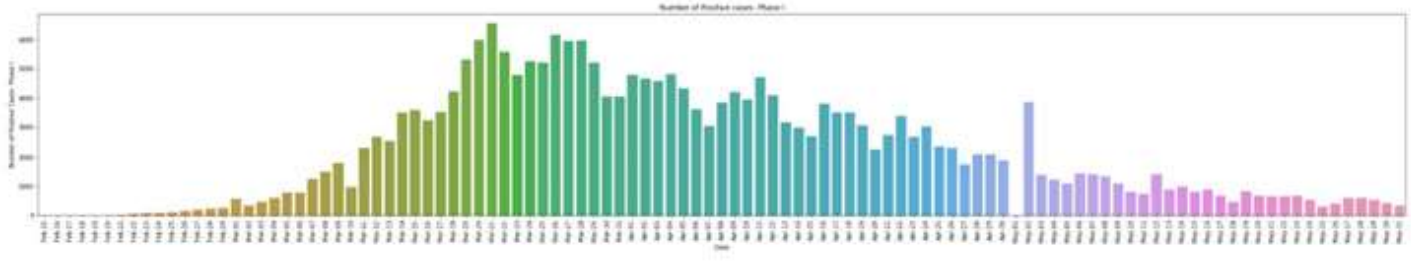

Fig.9 Daily COVID-19 Positive Cases in Italy in Phase 1 (before 31/05)

```
count      93.000000
mean      399.913978
std       338.033432
min      -189.000000
25%       201.000000
50%       276.000000
75%       412.000000
max      1460.000000
Name: confirmedIncrease, dtype: float64
```

Fig.10 Major Parameters for Daily Confirmed Cases in Phase 2 (after 01/06)

```
Text(0, 0.5, 'Number of Positive Cases: Phase II')
```

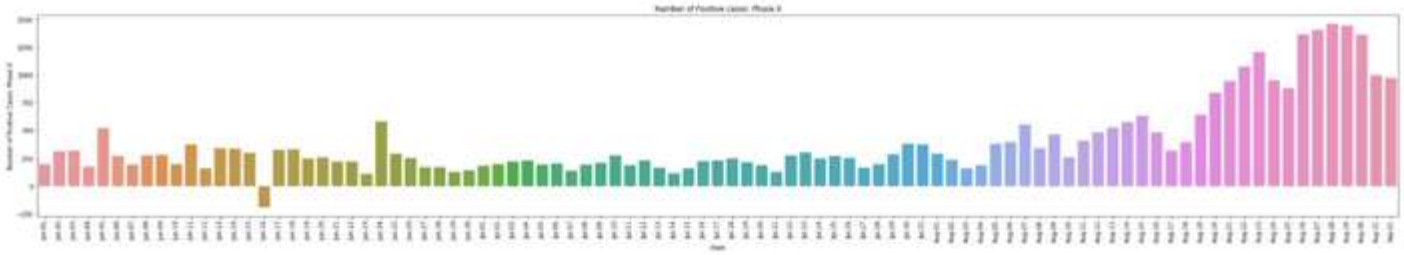

Fig.11 Daily COVID-19 Positive Cases in Italy in Phase 2 (after 01/06)

There is a strong correlation between the number of new cases per day and the number of deaths per day.

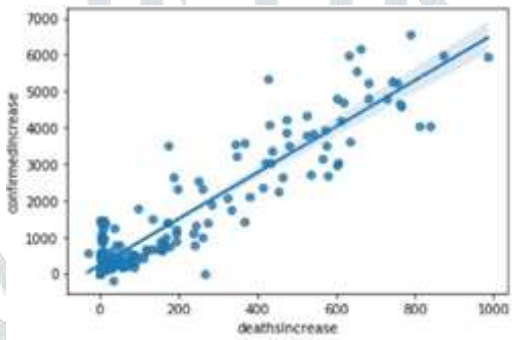

Fig.12 Correlation between Number of New Cases and Number of Deaths in Italy

In Italy, a strong correlation can be found between the 7-day moving average of Daily New Cases and the Active Cases.

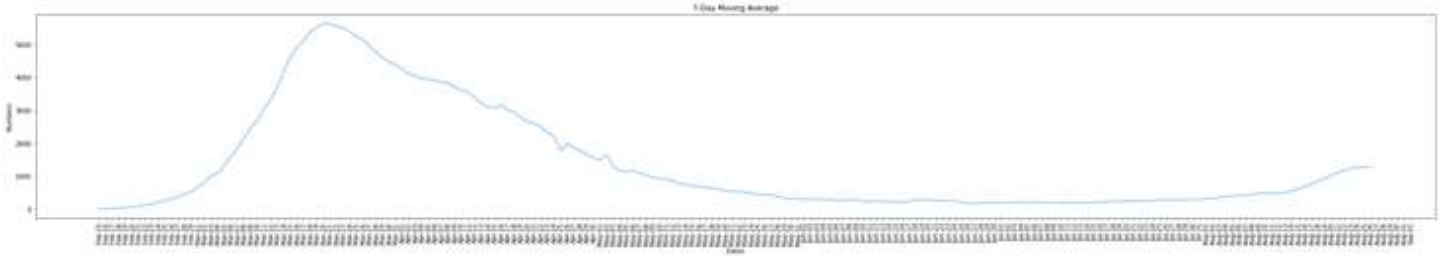

Fig.13 7-day moving average of Daily New Cases in Italy

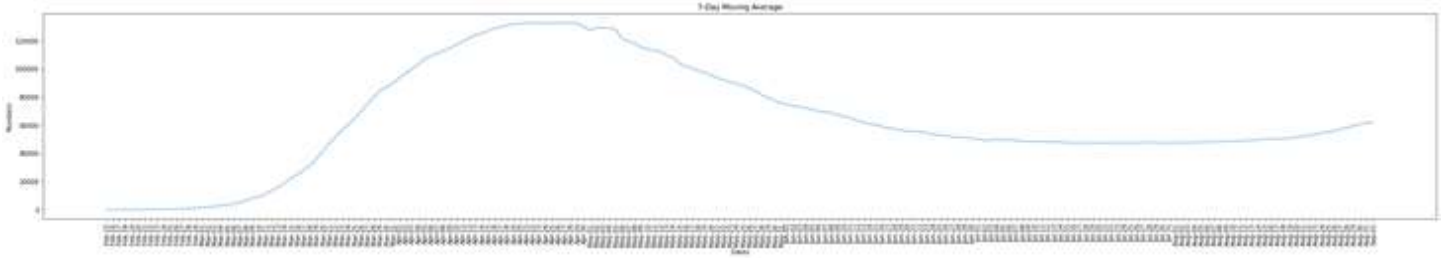

Fig.14 Active Cases in Italy

Coming to India, the daily cases of Italy were divided into three parts (as mentioned earlier):
Phase I: Upto March 31
Phase II: From April 01 to May 31

Phase III: June 01 Onwards

After the above break-up of phases, it can be seen that every Unlock Phase hurt India. There were a negligible number of cases till the end of Phase 1 (about the time when the lockdown started). The cases started increasing a bit by the end of May but the situation was still under control. The total number of active cases as of May 31 were under 1 lakh. One of the main reasons for this small spike at the end of May was because people stuck at different places (including migrant workers) across India started

travelling back to their homes thus increasing the chances of spreading the virus. Then came Unlock 1.0 (and eventually 2.0, 3.0 and 4.0). This is where the actual problem started. Since June 01, the number of cases started increasing tremendously. As it can be seen in the following figure, the average number of daily cases in India is 26237 whereas the average number of recoveries in the same period is only 20024. So, on an average, the increase in the daily number of active cases in India is 6213 in Phase 3.

The daily average number of cases in Phase 1 was 20. It jumped in Phase 2 to 2552. In Phase 3, the average number of daily positive cases in India went up to a staggering value of 38367.

```
count      63.000000
mean       19.857143
std        42.398972
min         0.000000
25%         0.000000
50%         1.000000
75%        11.500000
max       207.000000
Name: confirmedIncrease, dtype: float64
```

Fig.15 Major Parameters for Daily Confirmed Cases in Phase 1 (before 31/03)

```
Text(0, 0.5, 'Number of Positive cases: Phase I')
```

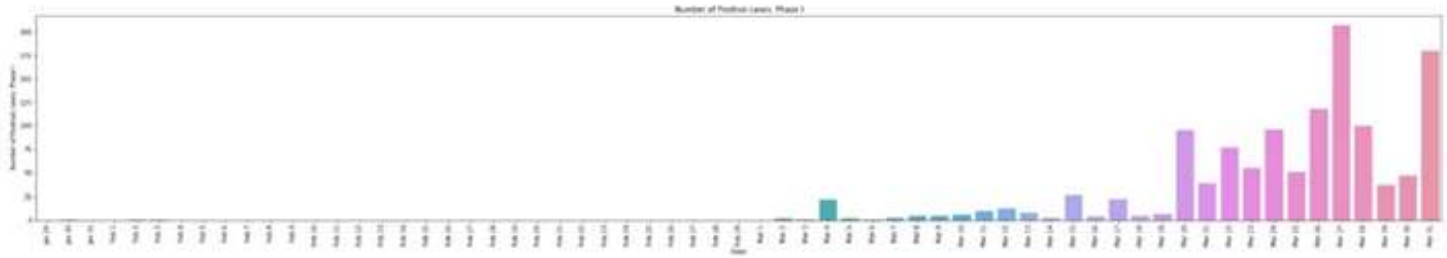

Fig.16 Daily COVID-19 Positive Cases in Italy in Phase 1 (before 31/03)

```
count       54.000000
mean      2551.814815
std       2348.932131
min          0.000000
25%        734.250000
50%       1887.000000
75%       3598.750000
max      11631.000000
Name: confirmedIncrease, dtype: float64
```

Fig.17 Major Parameters for Daily Confirmed Cases in Phase 2 (from 01/04 to 31/05)

```
Text(0, 0.5, 'Number of Positive cases: Phase II')
```

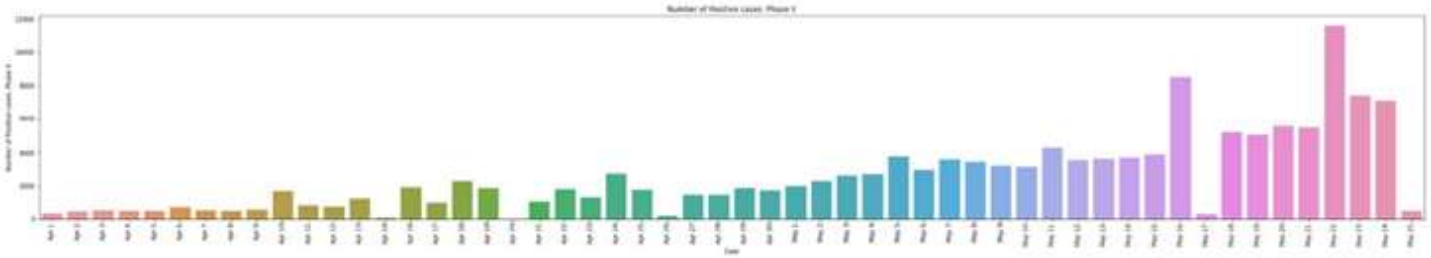

Fig.18 Daily COVID-19 Positive Cases in Italy in Phase 2 (from 01/04 to 31/05)

```
count        12.000000
mean     270460.583333
std      180248.104320
min       68566.000000
25%      121375.000000
50%      223378.500000
75%      364948.750000
max      618173.000000
Name: confirmedIncrease, dtype: float64
```

Fig.19 Major Parameters for Weekly Confirmed Cases in Phase 3 (after 01/06)

Coming to the Hospital Metrics, the number of beds in Maharashtra and Andhra Pradesh were scarce. While there had been some improvement in the number of beds in Maharashtra post-COVID-19, Andhra Pradesh had failed to have any improvement in that aspect (83,230 beds as of 20/04/2020 which makes it an increase of only 700 beds).

```
Text(0, 0.5, 'Number of Positive cases: Phase III')
```

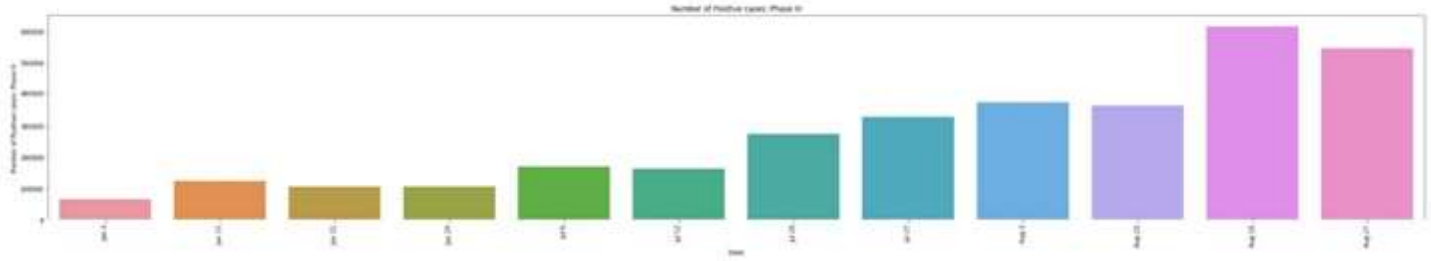

Fig.20 Weekly COVID-19 Positive Cases in Italy in Phase 3 (after 01/06)

In Delhi, even though the active cases reduced significantly, there was a time (in mid-July) when the active cases there were about 35,000 and hence, there was a difference of only 9,000 beds between the active cases and the total number of beds which eventually led to a shortage in beds in hospitals. There were also small states like Tripura which had about 7,000 active cases with only 9,312 beds. Such a small difference between the number of active cases and hospital beds made it difficult for medical authorities to accommodate patients (both COVID and non-COVID). Combine all this with the costs of the COVID-19 test (Rs.4,500), the PPE kit (Rs.3,000) and if a person tests positive, an average bill of about 50,000/day (both private and public hospitals included). An average Indian earns about Rs.356.30/day. So, an average Indian cannot manage with these costs of curing COVID-19.

In India, there is a strong correlation between the number of new cases per day and the number of deaths per day.

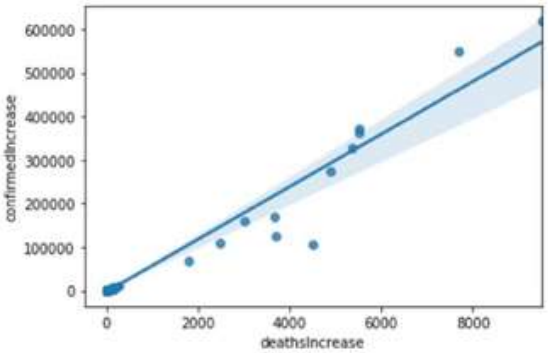

Fig.21 Correlation between Number of New Cases and Number of Deaths in India

One positive sign for India is that there is a strong correlation between new cases and new recoveries. There have been quite a few days where new recoveries cross new cases hence decreasing the total number of active cases even though the new cases for a day is pretty high.

Fig.22 Correlation between Number of New Cases and Number of New Recoveries

The graphical representation for the 7-day Moving average of the total new cases and the active cases looks almost identical. So, if the average number of cases for a moving week has a dip, so do the number of cases.

Fig.23 7-day Moving Average of the Total New Cases in India

Fig.24 Active cases in India

IV. Conclusion

The USA has been struggling to cope up with the pandemic right from the first case. The number of cases have grown right from the word go. The analysis was done on data till September but the conditions in the USA have only deteriorated after the results of the Presidential Elections. Positive cases are coming in Lakhs whereas the recoveries still stand in thousands. The only way the USA can come out of these conditions is a vaccine.

Italy surpassed its first wave with the help of a lockdown. As mentioned earlier, the lack of preparedness led to this first wave of COVID-19 in Italy. But once they locked the country down and started proper care and treatment of patients, the first wave came to an end. However, Italy's second wave has been more lethal (the wave after the first lockdown got lifted).

India was under control of the situation until the first unlock. The cases were minimal (under 1 Lakh) as of May 31. But, after each unlock, the condition of India became severe and the situation got out of hand. However, India has managed to overcome the first wave and the cases have come down drastically. Its only time that will tell whether India has a second wave or not.

The COVID-19 numbers of all the three countries support the above conclusions.

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