Statistical Study on Impact of Lockdown on Covid-19 Pandemic and its Variability

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Abstract

COVID-19 pandemic has greatly affected almost each life. The virus spread swiftly and had created serious damage on global economy. The disease is caused by SARS-CoV-2 virus and started spreading in December 2019 from Wuhan city, China. As the virus started spreading across the world, countries had taken major interventions and preventive measures to hold and reduce the cases and also to minimize the mortality rate. Strict social distancing, lockdown and sanitization are some of the preventions that have been clasped by the countries against COVID-19 pandemic. Though lockdown has prevented the spread to some extent but it also harmed the global economy. Therefore, after ensuring and acquiring necessary and sufficient health care facilities and equipment, countries started practice of unlock in different phases. In order to analyse the before and after lockdown effect of COVID 19 cases on 5 countries, the current study considered top 5 countries for comparison. Additionally, the study has also analysed the rate of reported cases w.r.t each selected countries. The data has been collected from WHO official daily reports and T-test and F-test has been applied in Spyder IDE, Python to analyse the effect and rate of COVID cases for each of the selected country.

Keywords: COVID-19, Corona virus, Pandemic, Epidemic, WHO, T-test, F-test, Python.

INTRODUCTION

SARS-CoV-2 virus found to be the cause of first COVID-19 disease [WHO, 2020]. World Health organization declared COVID-19 as pandemic on March 11, 2020. COVID-19 epidemic has caused severe loss to human life and portrayed unusual challenges to health, food and work. It has also

caused economic, political as well as social damage to each country. In order to control the spread of virus, countries led down lockdown restrictions as well as testing. Number of preventive measures such as wearing masks, sanitization, social distancing etc. and awareness to public about the same has been also devised. After ensuring allowed number and future demands for healthcare services the countries has started the practice of unlock in phases. Phase

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wise unlock led down dramatic increase in number of cases. The current data from John Hopkins Coronavirus Resource Center COVID-19 dashboard reveals that top 5 countries having maximum number of reported cases till December 18, 2020 are: US, India, Brazil, Russia and France. The current study focuses on the data, retrieved from WHO of these 5 countries before and after the lockdown. The comparison has been done among these 5 countries as well as rate of increase in everyday cases has been also analysed.

BACKGROUND OF STUDY

Social distancing has been found as one of the effective measure in minimizing the rate of corona cases and mortality [Thu, T. P. B, 2020]. Some of the past studies have been conducted to identify and analyse the rate of incidences based on the preventive measures such as social distancing, wearing masks and sanitization. One of the studies which have been carried out in two cities of China i.e. Hubei and Guangday identified that strict social distancing reduces the Corona positive cases as well as minimizes the rate of mortality. With the help of Time Series analysis the researchers have identified and analysed the effect of lockdown and strict social distancing measure on rate of Corona cases and mortality rate [Medeiros de Figueiredo A et.al. 2020]. To measure the effect of socio demographic factors on COVID 19 pandemic another study based on weighted regression model has been implemented. The study revealed that there has been a variation in COVID 19 cases depending upon the geographical disparities among 342 cities of China. The study also suggested interventions strategies on COVID 19 local transmission w.r.t. specific site or city [Zhang, H.et.al. 2020]. There are other countries that did not waited for spread of Corona virus and imposed lockdown as preventive measure. Portugal has also followed the same practice and imposed lockdown, when there were only 62 cases per million. The study estimated the effect of lockdown on minimizing the need and overhead of health services. To analyse and see the effect exponential smoothing model

along with ARIMA model has been implemented. The result of analysis shown that early action on lockdown has significantly reduces transmission of corona virus, demand of health services and also 80% reduction in mortality rate. Additionally, early action on lockdown had allowed Portugal to arrange health facilities and equipment considering future healthcare service demands [Peixoto, V. R et.al. 2020]. A number of other studies have been conducted based on number of dimensions such as diagnostic and treatment methods, socio-demographic, geographical characteristics and epidemiology characteristics for analyzing the impact of COVID-19 globally or within country.[Han Y et.al. 2019; Hung IF-N et.al.2020; Pan A et.al. 2020; Wu Z and McGo gan JM,2019; Xie J et.al.2020]. In middle September, 2020, 29 million cases has been reported with 8,20,000 number of deaths in 188 countries comprehensively. The rate has been exponentially increasing and by middle December 2020 global cases increased to 74,983,475 and 1,662,679 global deaths in 191 countries. The top three countries w.r.t. COVID-19 cases are US with 17,212,496 reported cases followed by India with 9,979,447 and after that Brazil having 7,110,434 reported cases. Russia and France comes thereafter with 2,736,727 and 2,483,524 reported cases respectively [JHCRC COVID 19 Dashboard, 2020]. Field of Medical research have been extensively using traditional regression methods for predicting and modeling the impact of COVID-19 [Zheng XY et.al. 2017; Takele K et.al. 2019; Choi M et.al., 2017]. In order to bring forth value addition to the past studies related to COVID-19 pandemics, the current research focuses on comparing and analyzing the before and after effect of lockdown on COVID-19 cases and also analysed the everyday cases with respect to top 5 countries in terms of maximum reported cases.

Objectives of Study

- To evaluate the impact of lockdown on the spread of Covid-19
- To study the variability in spread of the pandemic among top 5 worst affected countries

Data Description

As on 25th July, there were 1,61,36,340 confirmed cases of covid-19 worldwide. Government of different countries imposed lockdowns in different phases to control the spread. The data has been collected from World Health Organization's official daily reports to analyze the spread of virus and the impact of lockdown on its spread. The data gets updated every day for the 213 affected countries.

We used the mentioned variables for the analysis -

Date	Date on that day
country	Affected country
confirm	Total number of confirmed cases till that particular day
Death	Total number of deaths till that particular day
Recover	Total number of recovered cases till that particular day
Active	Total number of active cases till that particular day
New cases	New cases reported on that particular day
New deaths	New deaths reported on that particular day
New recovered	New recoveries reported on that particular day

Based on the confirmed cases in July, 2020, the top 5 worst affected countries with maximum number of cases have been selected.

Figure 1 : Distribution of new cases from January-July

Fig. 1 is the summarized view of number of new cases reported every month for Brazil, India, Russia, South Africa and US. These were the top5 countries worst affected from the pandemic during July 2020.

RESEARCH METHODOLOGY

Parametric tests have been used to derive conclusions by studying and comparing the pattern of spread of Covid-19. The research has been initiated with collection of data for 213 countries

from WHO's official page. After extracting the data top 5 countries worst affected with covid19 as on 27th July 2020 have been filtered out. The worst affected country was USA with 41,48,011 cases on 27th July 2020. After US, Brazil followed with 23,94,513 cases, then India reported 14,35,453 cases, Russia 8,12,485 and South Africa 4,34,200 respectively.

Two hypotheses have been framed and tested using T test and F test respectively.

T test

Student's t test is used when the population standard deviation is unknown and the sample size is small. [Kim, Tae. (2015)]. The test name Student in T test was the pen name of Chemist William Sealy Gosset who devised the test in 1908 [Raju, 2005]. It is used to estimate the mean of small sized samples. It is majorly used to access the significance of difference between two sample means [Poli & Back, 2010]. The basic formula to calculate the t value is

$$t = \frac{|\bar{x} - \mu|}{s/\sqrt{n}}$$

X bar - sample mean

μ - Population mean estimate

s - Standard error

n - Number of samples

Paired sample t test has been used for the analysis and testing of following hypothesis.

H₀: *There is no significant difference in mean cases of the same country before and after lockdown*

H_a: *There is a significant difference in mean cases of the same country before and after lockdown*

F- test

F- test is used to test the equality of variances of two populations. [Gąsiorek, Edward et.al. 2000]. Like t- test it can also be a two tailed as well as one tailed test. For F-test following hypothesis has been framed and as the following –

H₀: *There is no significant difference in the variance of cases before lockdown for 2 countries*

H_a: *There is a significant difference in the variance of cases before lockdown for 2 countries*

Table 1 : Start and end date of lockdown for worst affected countries

Country	Start date	End date	Level
US	19/03/2020	13/06/2020	State
Brazil	17/03/2020	10/05/2020	State
India	25/03/2020	31/05/2020	National
Russia	28/03/2020	08/06/2020	National
South Africa	26/03/2020	30/04/2020	National

Table 1 shows top 5 countries, US, Brazil, India, Russia and South Africa worst affected with covid-19 during July 2020. These countries had maximum number of cases. In the table 'Start date' is the date when lockdown was imposed in that country and 'End date' marks the last day of the lockdown. Many countries underwent state level lockdown where in the lockdown was imposed in different cities of those countries one after the other based on the number of cases getting reported in those particular cities. India, Russia and US underwent a lockdown at national level. Lockdown is a state in which people have to stay wherever they are. Due to the

highly contagious nature of Covid-19 virus, leaders across the world suggested to impose Lockdowns in order to break the chain of transmission.

Paired sample t-test has been used to interpret the results. Hypothesis test results can be interpreted by comparing the p- values or comparing t critical values with t calculated values.

ANALYSIS AND INTERPRETATION

In this section, we have talked in detail about the analysis undertaken and the results from the same.

Figure 2 : Daily distribution of new cases for Russia before and after lockdown

Figure 3 : Daily distribution of new cases for South Africa before and after lockdown

Figure 4 : Daily distribution of new cases for India before and after lockdown

Figure 5 : Daily distribution of new cases for US before and after lockdown

Fig. 6 Daily distribution of new cases for Brazil before and after lockdown

Fig.2, Fig.3, Fig.4, Fig.5 and Fig.6 shows the number of new cases reported every day for the countries Russia, South Africa, India, US and Brazil respectively. The dotted line in all of the given figures is shown to distinguish between the two phases of spread for the respective countries. Area before the dotted line is the phase when lockdown was implemented. Area after it indicates the phase immediately after lockdown was uplifted. There has been a spike of cases in the countries after relaxation of lockdown.

Table 2 : t-test results for worst affected countries

Country	Significance level	T critical	T calculated	P	Result
US	0.05	1.67	-9.83	0.00	Reject
India	0.05	1.67	-14.48	0.00	Reject
Brazil	0.05	1.67	-17.96	0.00	Reject
Russia	0.05	1.67	4.74	0.00	Reject
South Africa	0.05	1.67	-19.8	0.00	Reject

Hypothesis testing was performed to test the difference in mean before and after lockdown. Looking at the t test results from table 2, it can be clearly inferred that there has been a spike in cases after the lockdown was relaxed in the top 5 worst affected countries as per table x. Null hypothesis has been rejected based on the criterion $absolute(t_{calculated}) > t_{tabulated}$. The results in table x indicate the difference in means before and after lockdown but are not statistically significant at 0.05 level of significance. The mean number of new cases as can be seen from the table is always more after lockdown for all 5 observations. Hence it can be clearly inferred that the number

of cases increased in all the top 5 countries at a rate higher than what it was during the imposition of lockdown. It can be concluded that implementing the lockdown strategy did help in controlling the spread of virus to a great extent.

F distribution results

Table 3 : F-test results for worst affected countries

Country	Significance level	P	Result
US vs. India	0.05	0.9	Accept
India vs. Brazil	0.05	0.06	Accept
Brazil vs. Russia	0.05	0.97	Accept
Russia vs. South Africa	0.05	0.00	Reject
India vs. South Africa	0.05	0.00	Reject
India vs. russia	0.05	0.003	Reject
Russia vs. US	0.05	0.004	Reject
Us vs. brazil	0.05	0.001	Reject
Us vs. sa	0.05	0.0	Reject
Brazil vs. sa	0.05	0.0	Reject

F test has been used to test the variability in the spread of disease amongst the top 5 countries. Hypothesis testing was used to test if the variances of two populations were different. Observations considered for comparison were before lockdown in both the countries. Each of the top 5 countries has been taken in pairs to perform the experiment. P value is greater than the significance level for US vs. India, India vs. Brazil and Brazil vs. Russia hence null hypothesis has been accepted stating no significant difference between the variations in cases for these countries. However, for all the other pairs of countries it can be seen that the variability in cases is different.

CONCLUSION AND FUTURE SCOPE

The results suggest a rise in infections after lockdown relaxation. However for developing nations it impacted the economy to a large extent. The pandemic continues to affect the world but implementing a second lockdown will lead to further challenges.

Like the other things associated with COVID-19, role of lockdowns remain uncertain. The spread highly

depends on choices and actions of people to maintain social distancing and proper sanitization around the globe. Benefits of lockdown will be more visible depending on its duration and the period over which it will be imposed during any contagious Pandemic.

It was also observed that some of the countries showed similar variations in the spread of infection. Nevertheless, there are many factors which have to be considered in order to study the inter country variations such as population and economy of the countries. Testing statistics plays a major role here as during the initial stage of Pandemic, countries took time to provide required number of testing centers due to which many of the cases have gone unreported.

Careful consideration of cross-country variations is hence required to focus on different policy approaches to the pandemic taken by all nations.

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