SHORT ARTICLE

Impact of Lockdown 1.0-4.0 on spread of COVID-19 Pandemic in India

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Citation

Ranjan A, Ayub A, Kumar A, Pandey S, Kumar P, Agarwal N. Impact of Lockdown 1.0-4.0 on spread of COVID-19 Pandemic in India. Indian J Comm Health. 2020;32(3):598-600.

Source of Funding: Nil **Conflict of Interest:** None declared

Article Cycle

Received: 02/07/2020; **Revision:** 05/08/2020; **Accepted:** 13/09/2020; **Published:** 30/09/2020

Introduction

Novel Coronavirus Outbreak (COVID-19) was declared as a pandemic on 11th March 2020 by World Health Organization (WHO). This was a call for immediate action to be taken on by all countries in terms of stepping up treatment, detection, and reduction of transmission. A total of 26472012 confirmed cases with over 873229 deaths were reported as on 4th September 2020 worldwide. (1)

Government of India, initiated various Non-Pharmaceutical Intervention (NPI) to break the chain of transmission and prevent the spread of COVID-19, which included social distancing, and restricted public mobility like lockdown.

The largest COVID-19 national lockdown in India started on 25th march 2020. Still, India's population of 1·3 billion across diverse states, health inequalities, widening economic and social disparities, and distinct cultural values present unique challenges.(2) Meanwhile nationwide lockdown was extended till 31st may 2020 by Ministry of Home Affairs, Government of India (Lockdown 4.0).(3) This lockdown strategy adopted by the country to curtail the impact and flatten/delay the peak of the COVID-19 pandemic, and it's quantification may aid to plan future intervention strategies.

Aims & Objectives

The scope of this analysis is to estimate the basic/effective reproduction number (R0) and the comparison of the number of cases in both the presence and absence of lockdown. In other words we have tried to elucidate the impact of lockdown had, recently in the numbers. The cases as on 31st may (till lockdown-4.0), 2020 were chosen for this analysis.

Material & Methods

Study design: Record Based Study

Study setting: Department of Community & Family Medicine, AIIMS, Patna

Data Source: The data source is a crowd-sourced database maintained at www.covid19india.org/.(4) We used the data from the line-listing of the cases reported as positive for COVID-19. The last access to database was made on 1st July, 2020. We truncated the data up to 31st May 2020 for the purpose of this study.

Data Collection: We have collected data of confirmed covid19 infected cases, recovered cases

and deaths on daily and cumulative basis from March 4 2020 onwards. The first case of Covid19 was reported on 30th Jan 2020 after that until 3rd March 2020, no cases were reported. The Covid cases have been reported regularly from 4th March 2020 onwards. We have collected all information from the web page of Covid19.org (1).

Mathematical Method: We used the most common disease epidemic SIR model (5) to estimate the parameters, the infection transmission rate (a) and the recovery rate from the actual data using the differential equations. Out of three differential equations of the model, we used the differential equation for the infected (I) with making some mathematical manipulations as follows:

$$dI/dt = aSI - bI = I(aS - b)$$

$$\Rightarrow I(t) = I(0) * Exp(aS - b) * t \quad \text{-----(1)}$$

which is very similar to the general exponential growth equation i.e.

$$I(t) = I(0) * Exp(r*t) \quad \text{----- (2)}$$

where r is the rate of increase in I(0) over the time t. By comparing the equations I and 2, we get

$aS - b = r$, now dividing both side by b,

$(aS/b) - 1 = (r/b)$, the term aS/b = Basic reproduction rate R0, hence replacing aS/b with R0, we get

$$R0 - 1 = (r/b)$$

$$\Rightarrow R0 = (r/b) + 1$$, now putting R0 in equation (1) we get the equation

$$I(t) = I(0) * Exp[(R0 - 1) * b * t] \quad \text{----(3)}$$

Where I(0) = Total infected on day 0 i.e. at baseline

I(t) = Total infected after t days

b = Recovery rate from infection i.e inverse of average incubation time

t= number of days after baseline

It is reported that the incubation period of corona virus is 1-14 days. Taking 14 days the rate of recovery per day (b) = 1/14 = 0.0714

Using equation (2), we estimated the rate of infection per day (r) from the actual data set from 4th March to 24th March i.e. before the lockdown date of 25th March 2020 (563 cumulative cases).

Here, I(t) = 563, I(0) = 22 , t = 21 days using these values in equation (2) above, we estimated rate of infection per day (r) = 0.1543

Hence, the basic reproduction ratio R0 = (r/b) + 1 = 3.1614.

Results

We assumed that if the same R0 would have continued till 31st May, 2020 if the lockdown was not implemented from 25th March 2020 onwards, Under this condition, we estimated expected number of infected individuals from 25th March till 31st May 2020. The predicted number of infected during 25th March till 31st May 2020 is presented in [Figure-1].

Discussion

The [Figure 1] shows a comparison of cases during lockdown i.e. till 31-05-2020 with the number of predicted cases that would have occurred in the absence of lockdown. It can be clearly seen that after 13/05/2020 the graph rises and goes on rising exponentially and reaches a whopping number of 20418510. So it can be said that the lockdown has prevented the number of positive cases from achieving a certain peak.

The variation of R0 can be clearly seen that after lockdown (after 24/3/2020) it starts to drop, rises once again during 31/03/2020 to 7/4/2020 and then goes down to 1.56 as shown in [Figure 2]. The rise/peak during lockdown can be attributed to the reckless behavior of citizens across India as more than 950 confirmed cases were detected across 14 states and union territories in the country during that period. Also a little rise in R0 can be seen after the liquor shops opened in the country (after 4/5/2020).(6) A constant decrease in R0 after the implementation of lockdown (From 3.03 to 1.56) was observed. Also the average R0 remained as high as 2.79 before the lockdown was started and remained 2.90 during LD (lockdown) 1.0 ,1.99 during LD-2.0 , 1.71 during LD-3.0 and 1.59 during LD-4.0.

In India's favor are its young population (65% aged <35 years) and, till date, a less severe pandemic we have faced than was feared.(7) Although the lockdown is already having the desired effect of controlling the epidemic curve which would have gone to exponentially high if lockdown was not enforced. When the lockdown in the origin place of the dangerous virus (Wuhan-China) was seen, a significantly decreased growth rate and increased doubling time of cases was observed, which is most likely due to the lockdown measures there.(8) Also when some restrictions were lifted in Hong Kong the cases started to rise and remained a flattened curve in other Chinese regions where lockdown was continued.(9) In the United States of America, late and less stricter steps for social lockdown by the government, apart from the initial casual attitude of its citizen towards this social move was one of the main reasons for whopping number of cases.(10)

Many international news agencies made propaganda against the strict lockdown in India, by calling it harsh, intensive and mismanaged.(11) However, the result from social lockdown is still encouraging as we are far less affected compared to the mammoth population.

Conclusion

Lockdown has played an important role in controlling the cases and also has given the opportunity to buy some extra time for preparedness. This pandemic is the much needed wake-up call to the necessity of long-term changes to health system in India.

Limitation of the study

Since the pandemic is ongoing, there is a lot of dynamic change in the data, with each passing day, the analysis changes the calculated values. Hence providing the latest statistics in current scenario was quite difficult.

Authors Contribution

All authors have contributed equally.

Acknowledgement

We acknowledge the team behind covid19.org who have made their data source open and accessible and providing a huge data set for all.

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Figures

FIGURE 1 COMPARING ACTUAL CASES (DURING LOCKDOWN) WITH THOSE OF THE PREDICTED CASES THAT WOULD HAVE OCCURRED IN THE ABSENCE OF LOCKDOWN

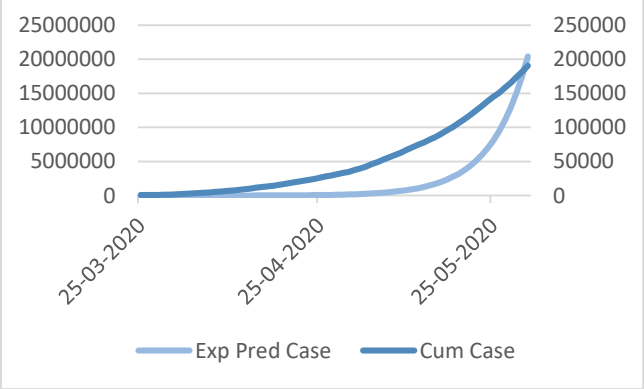

FIGURE 2 A VARIATION OF R0 BEFORE AND AFTER LOCKDOWN