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Original Research Article

Estimating the impact of lockdown on COVID-19 cases in Pune, Maharashtra

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ABSTRACT

Background: The COVID-19 pandemic commenced in China in December 2019 and has since become a major public health problem. To slow this down, countries went into lockdown with different levels of restrictions on movement and mandatory home confinement except for essential requirements and services. It effectively decelerated the pandemic by strengthening the healthcare system and thus averted lakhs of cases and saved thousands of lives. The aim of this study is to analyze statistically that the lockdown plays an important role in preventing COVID-19 and its impact on number of cases per day in Pune.
Methods: This record based descriptive study is conducted after secondary data analysis of number of new cases of COVID-19 per day from the period 27 Apr to 03 Sep 2020 in Pune. Crowdsourced line listing of COVID-19 cases in Pune was obtained from https://www.covid19india.org/ which is Govt portal of COVID data and freely accessible. The data was thus analyzed to calculate effective reproduction number (Reff), growth rate and doubling time.
Results: On plotting weekly reported number of COVID-19 cases, no specific impact of lockdown on COVID-19 cases in Pune were noticed. R_{eff} when plotted on the timeline shows a decline post lockdown. Growth rate also shows a slight declining trend post lockdown.
Conclusions: The importance of lockdown has been quantitatively confirmed to be effective in combating the spread of COVID-19 cases, focus should be placed on its effective implementation by the masses.

Keywords: COVID-19 cases, Lockdown, Reproductive number

INTRODUCTION

COVID-19 is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a novel coronavirus.[1] The COVID-19 pandemic commenced in China in December 2019, was declared as a public health emergency of international concern by the World Health Organization (WHO) on 30 January 2020 and was officially declared a pandemic by the World Health Organization (WHO) on 11 March 2020.[2,3] Although the molecular mechanism of COVID-19 transmission pathway from human to human is still not resolved, the principle of transmission is similar in general to respiratory diseases being spread by droplet scattering.[4] In this form of spread, a sick person exposes this microbe to individuals around him by coughing or sneezing. In other words, environmental conditions play a major role in the spread of the virus. Every day, the COVID-19 outbreak spreads very rapidly and more than 4 million people have been actively infected with this virus.[5]

The most basic measure to reduce the spread of coronavirus or to prevent infection is to follow hygiene rules which includes hand washing, cough etiquettes and social distancing.[6] For this reason, the spread of this virus

is slower in societies that have the habit of washing hands and pay attention to the general hygiene rules.[7] To slow down this epidemic, several countries went into lockdown with different levels of restrictions. This lockdown means important restrictions on movement, with a mandatory home confinement except for essential requirements and services. It also includes closures of schools and colleges as well as all non-essential public places, including shops (except for food shopping), restaurants, cafeterias and cinemas. Governments have begun to apply restrictions under many social constraints to stop this pandemic. Lockdown is at the forefront of these restrictions. The first case of COVID-19 in India was reported on 30 January 2020.[8] For the next six weeks, aggressive contact tracing and containment measures kept the numbers minimal. By the third week of March, however, it became noticeable that the epidemic was approaching the exponential stage. The nationwide lockdown announced by the Prime Minister on March 24, was an intervention to quell the transmission chain of the virus and to gain time for a high level of preparedness.[8] In making this measure successful and effective, the unanimous support of the states was crucial. Although there are many unknowns in dealing with this new disease agent, increasing the physical distance between people decreases the virus transmission chain, thus decelerating and restricting the spread of the virus. In doing so, lives are saved, the infection is controlled and valuable time is gained to strengthen health systems and plan a fitting response. For any country, a lockdown is a very hard choice to make involving tremendous economic and social costs. This choice, however, had to be exercised by many countries during the COVID-19 pandemic to save lives and restore people's trust in the face of an emerging catastrophe. At the end of April, half a billion people were under lockdown imposed by most countries in Europe and Latin America. Almost 300 million people in the US were in some sort of lockdown earlier in the same month. At a point when the epidemic was already immense, most of these nations resorted to lockdowns, their health system capabilities were already depleted, and the burden of deaths was already crippling. To them, lockdown had become an inevitable compulsion. India, on the other hand, was proactive and pre-emptive in its policy and took this action at a time when the outbreak size was manageable and deaths were limited. If it was not for the lockdown, by now, the magnitude of the pandemic would have been astronomically greater with catastrophic consequences. The lockdown effectively decelerated the pandemic, averted lakhs of cases and saved thousands of lives. The time it provided has been utilized effectively to strengthen the health system. Challenges lie ahead, but a timely lockdown gave India an edge in the war against the pandemic.

As people comply with the lockdown orders and limit their visits to essential places they reduce their chances of being infected by COVID-19. This also appears to decrease human-to - human communication, which is COVID-19's main channel of transmission. The aim of this study is to analyze statistically that the lockdown plays an important role in preventing COVID-19 and its impact on number of cases per day in Pune.

METHODS

This record based descriptive study is conducted after secondary data analysis of number of new cases of COVID-19 per day from the period 27 April to 03 September 2020 in Pune. Crowdsourced line listing of COVID-19 cases in Pune was obtained from https://www.covid19india.org/ which is Govt portal of COVID data and freely accessible. Data triangulation was done and checks were made from Pune Municipal Corporation (PMC) and Pune Chinchwad Municipal Corporation (PCMC). Minor inconsistencies in the dataset were corrected upon tallying the data. A database was created and the data was checked for missing data, errors, outliers and duplicate reports. Epidemic curve was constructed using daily incidence data.

The date column was converted in UTC (Coordinated Universal Time) format for time series processing. Cumulative number of cases were calculated from daily reported case data. Also, weekly incidence and cumulative incidence was calculated.

Selection criteria and sample size

All new COVID-19 cases during the study period were included in the study for analysis.

Model

The Bayesian approach was adopted to quantify the transmissibility situation at a given point in time, as indicated by R_{eff}. Based on two major parameters, the model estimated the average or mean transmissibility of COVID-19 in a given region. A discrete serial interval distribution, defined as the time difference between the onset of symptoms in the infector (index) and the infectee (secondary) cases, was the first parameter. It was assumed that the probability (pi) of an infector transmitting the infection to a susceptible infectee follows gamma distribution and is thus dependent upon the time since infector is infected, but is independent of the stage of pandemic. Thus, an infected person becomes most infectious when pi is maximum. The number of infected individuals in a region at that point of time, indicated by daily incidence data of COVID-19 was the second parameter. The infectivity of a given population therefore depends on the number of infectious individuals in the population at a given time, as well as the time since each of them became infected.

Statistical analyses

The analysis was carried out in R version 4.0.2 software. The Effective reproduction numbers were estimated using “EpiEstim_2.2-3” package. "Lubridate_1.7.9" and the

metapackage "tidyverse_1.3.0" were additional packages used for pre-processing and tidying of results. There are a total of five algorithms in “EpiEstim_2.2-3” package for configuring serial interval distributions. In this analysis, the procedure for calculating the effective reproduction number was based on the "uncertain-si" algorithm for serial interval parameter.

The data was thus analyzed to calculate Effective reproduction number (R_{eff}), growth rate and doubling time.

RESULTS

The total number of COVID-19 cases reported during the period under study is $1.8507x10^5$. Daily reported COVID-19 cases were plotted against time (Figure 1) and it could be seen that during the lockdown period, there was a dip in occurrence of COVID-19 cases but the same has shown a reversal within the lockdown period. The dip in the dataset can further also be seen in subsequent time period suggesting a seasonality component in the time series. This seasonality can be attributed to multiple background processes; for instance, the working pattern of laboratories such as weekly closure on Sunday’s.

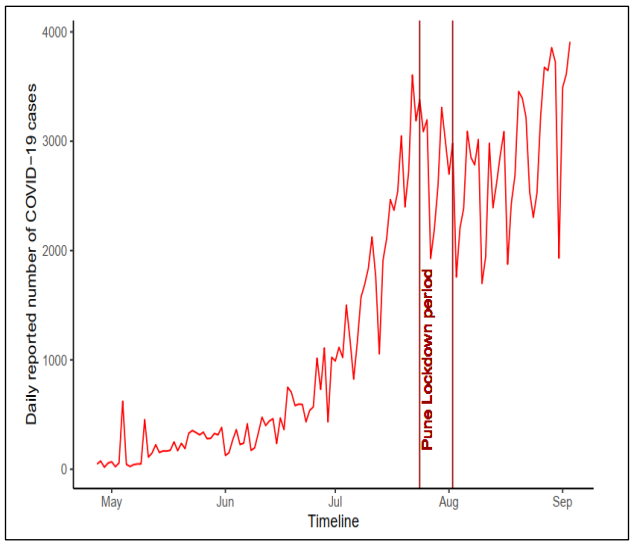

Figure 1: Daily reported number of COVID-19 cases.

Cumulative incidence of COVID-19 cases were also plotted against time (Figure 2) and it was seen that the trend line of the time series data from COVID-19 cumulative cases does not seem to have a striking change in the slope during the lockdown period suggesting that lockdown is not evident on the disease pattern in due course of time.

On plotting weekly reported number of COVID-19 cases, no specific impact of lockdown on COVID-19 cases in Pune are being noticed.

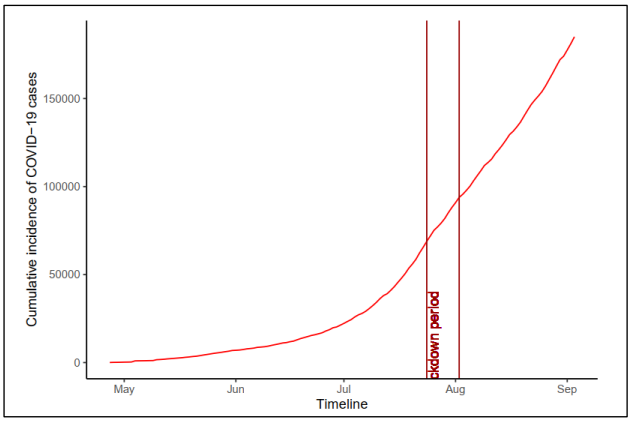

Figure 2: Cumulative incidence of COVID-19 cases.

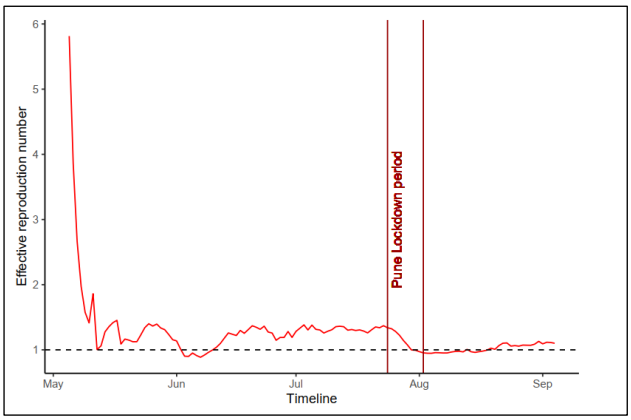

Figure 3: Effective reproduction number.

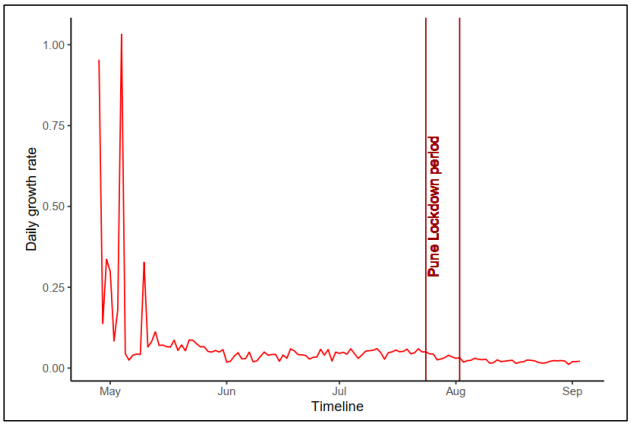

Figure 4: Daily growth rate of COVID-19 cases.

R_{eff} when plotted on the timeline shows a decline post lockdown (Figure 3). R_{eff} 10 days before the beginning of lockdown (24 July 2020) ranged from 1.26 to 1.37 whereas post lockdown (02 Aug 2020) it ranged from 0.947 to 0.978 and remained <1 till 18 August 2020 after which R_{eff} gradually increased to >1.

Growth rate was calculated and plotted against time showed a slight declining trend post lockdown (Figure 4).

DISCUSSION

Many studies focused on the estimation of the basic reproductive number R_0 of the COVID-19 epidemic, based on data-driven methods and mathematical models describing the epidemic from its beginning. In average, the estimated value of R_0 is about 2 to 3.[9-11] We focused here on an observation period that began after the lockdown was set in Pune.

The present study documents and demonstrates the use of instantaneous reproduction number in a reproducible framework as public health decision support tool for COVID-19 in Pune. Instantaneous reproduction number also called the effective reproduction number or time-dependent reproduction number has the potential to strengthen COVID-19 disease surveillance programmer. Also, being a composite indicator of the transmissibility status in an epidemic situation, R_{eff} provides a critical feedback mechanism for assessment of on-ground public health interventions in real-time settings. Reproduction number in a population is based on three major parameters viz. infectivity of a disease agent, duration of infectiousness and the probability of an effective contact resulting in successful transmission of infection.[12]

We obtained an effective reproduction number <1, compared to the R_{eff} of >1 in Pune before lockdown. This indicates that the restriction policies were very efficient in decreasing the contact rate and therefore the number of infectious cases. In particular, if R_{eff}<1, it suggests that the epidemic is in decline and may be regarded as being under control at time t (vice versa, if R_{eff}>1).[13] As emphasized by Angot, a too fast relaxation of the lockdown-related restrictions before herd immunity is reached or efficient prophylaxis is developed), would expose the population to an uncontrolled second wave of infection.[10] To prevent the exhaustion of health care services, it is therefore important to maintain a low value of R_{eff}.

Biologically, there are limited variations in infectivity and infectiousness for a given disease agent in populations across the globe, but the likelihood of effective contact relies heavily on social factors such as population density, socio-economic profile, age structure, gender norms, individual behaviours and among others. Therefore, reproduction numbers vary from place to place. In the present study, we estimated that the maximum mean R_{eff} for Pune was 1.25 and had reduced to 0.947 during the lockdown and increased to more than 1 fifteen days after lockdown. Calculation of reproduction numbers for Indian context previously also have documented value of 2.6 (95% CI=2.34, 2.86) in the initial stages and 1.57 (95% CI=1.3, 1.84) for the post lockdown period.[14] Also, very high R_{eff} is difficult to attribute retrospectively to true changes or changes resulting from strengthening of prevention and control measures such as enhanced testing rates, increased awareness, increased reporting efficiency, and modified reporting criteria among others during an ongoing pandemic.[15] Thus, the need for strict lockdown measures, its geographical extent, the timeline of implementation, alternative non-pharmacological interventions, and unlock procedures need assessment with robust epidemiological indicators.

Some methodological limitations were present in this study. The data was taken from publicly available datasets, however real-time use of National Surveillance Data should be used for public health decision making.[16] The study did not take into account emigration and immigration.

CONCLUSION

This study examines the extent to which lockdown measures impact on COVID-19 confirmed cases in Pune. Since the importance of lockdown has been quantitatively confirmed to be effective in combating the spread of COVID-19 cases, focus should be placed on its effective implementation by the masses. Public enlightening programs, education initiatives and increasing the general awareness play an important role on the need to comply with lockdown measures.

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