

A fine grained modelling of Covid-19 epidemic for Pune city: Insights from the model analysis

The Covid-19 epidemic in India is going to be heterogeneous in nature.

The Covid-19 pandemic has created an unprecedented humanitarian crisis globally. Given India's huge population size, complex diversity and high population density, there are great concerns about its impacts. The epidemic in India is going to be quite heterogeneous in nature. The metro cities have seen rapid spread of disease during last few months, overburdening the health care systems. While the epidemic is yet to peak in many cities, some are showing signs of decline. Relatively smaller cities, towns and villages are yet not affected severely, but have started getting affected. The way the epidemic will further evolve in these places will depend on the local dynamics – such as demographic characteristics, population density, people's mobility and migration, testing and quarantine interventions and societal compliance to preventive behaviors (eg mask use, social distancing, etc). This heterogeneity demands decentralized decision making and action.

There is a need for decentralized action and therefore predictions at granular level.

The planning processes heavily depend on assessment of future trends. Many a time, even in our day to day life we take decision based on our 'mental model' of what lies in future. For the pandemic of this scale with significant impact on life and livelihood every attempt must be made to forecast how the epidemic will unfold using the available data about the agent (virus), host and the environment. The end user of the planning is also very important. For example, the model built using aggregate country level data will not be useful at a city level given a very different dynamics affecting the epidemic. It is therefore important that prediction information specific to local area is available to decision-makers right from the beginning. It also needs to take into account dynamic nature of the epidemic as things unfold over the time.

A fine grained analysis would be useful as decision making tool to prioritize interventions

Responding to this need, Tata Consultancy Services Research (TRDCC), Pune in collaboration with Prayas (Health Group), Pune has undertaken an exercise in **fine grained modelling**. This model creates a digital twin of a particular area. This area could be a city, a town or a district. The model captures granular details of population characteristics and people's movements of that area while estimating the disease burden. This unique feature enables the comparative analysis of various non-pharmacological interventions over the time. The model **can serve as a decision making tool to prioritize interventions** most appropriate to that area.

Digital twin model for Pune city

We have developed this model for Pune Municipal Corporation jurisdiction. The primary objective was to have a tool that provides Pune specific insights about appropriate interventions as the epidemic unfolds in the city. Ward level analysis was done to arrive at city level picture. It considered all administrative decisions related to lockdown and reopening until now (5th August,2020).

The salient findings for Pune city are as follows.

A. Model prediction about progression of the epidemic in the city

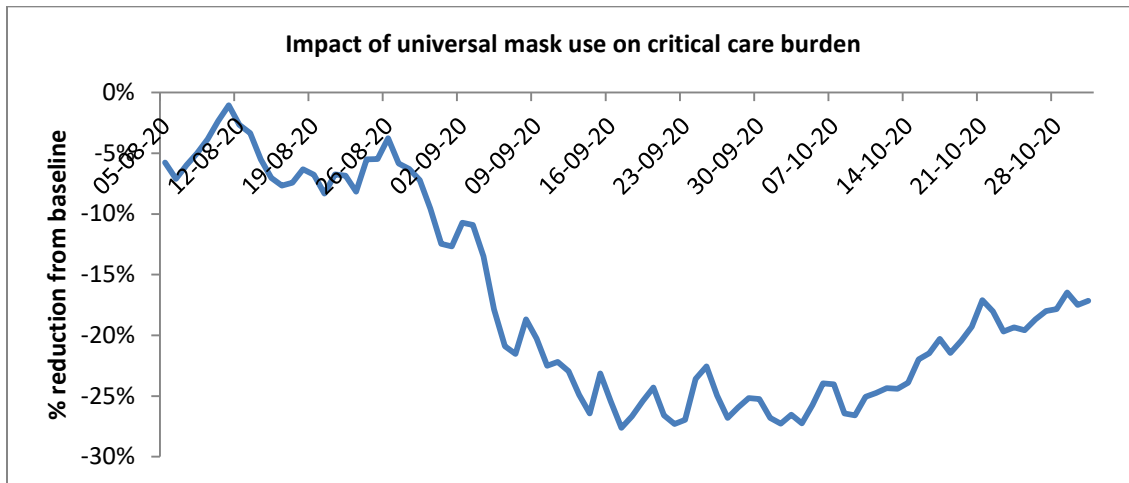
The months of June and July have seen a rapid rise in cases in Pune. With the recent opening up, the number of cases are expected to increase further. The model predicts that with the current level of relaxation, the peak load on critical health care (oxygen beds, ICU, ventilators etc) will be sustained until end- October.

Our analysis shows that different wards are at different stages of epidemic. By mid-August, in some wards with crowded dense localities, around 35-40% were already infected. As against in some wards (eg Kothrud, Warje, Aundh) this proportion is likely to be as low as 15%.

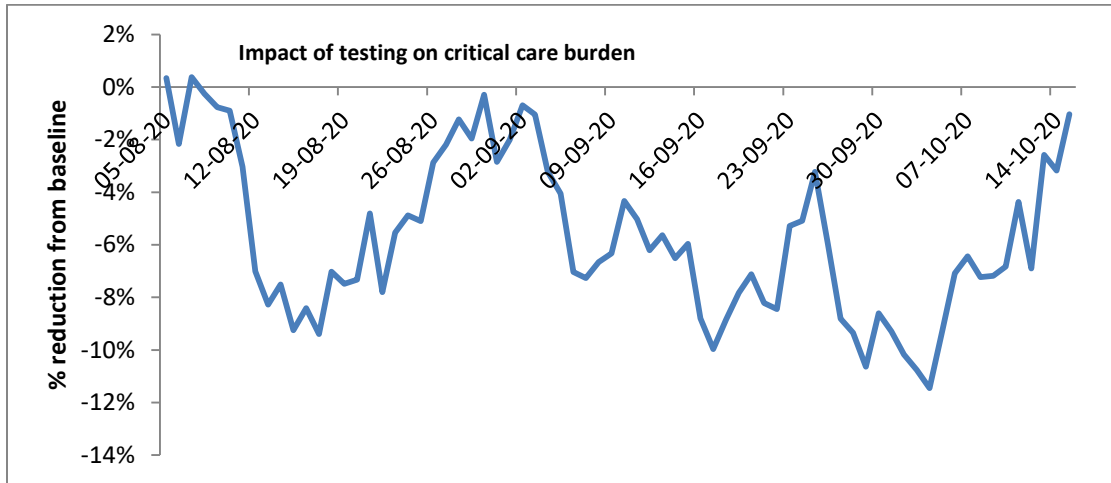
Majority of the infections are being seen to occur through household contacts. Along with that, longer interactions in enclosed and crowded places is likely to increase transmission risk (places such as banks, offices, factories, eateries etc).

B. Model findings on efficacy of non-pharmacological interventions

Universal use of masks - Behavioral intervention in terms of mask use was found to be an effective strategy. At baseline we considered no use of mask. Compared to baseline, if majority (80%) of population wore masks (when out of home) then it reduced the hospital load of critical cases up to 25 % during peak months.

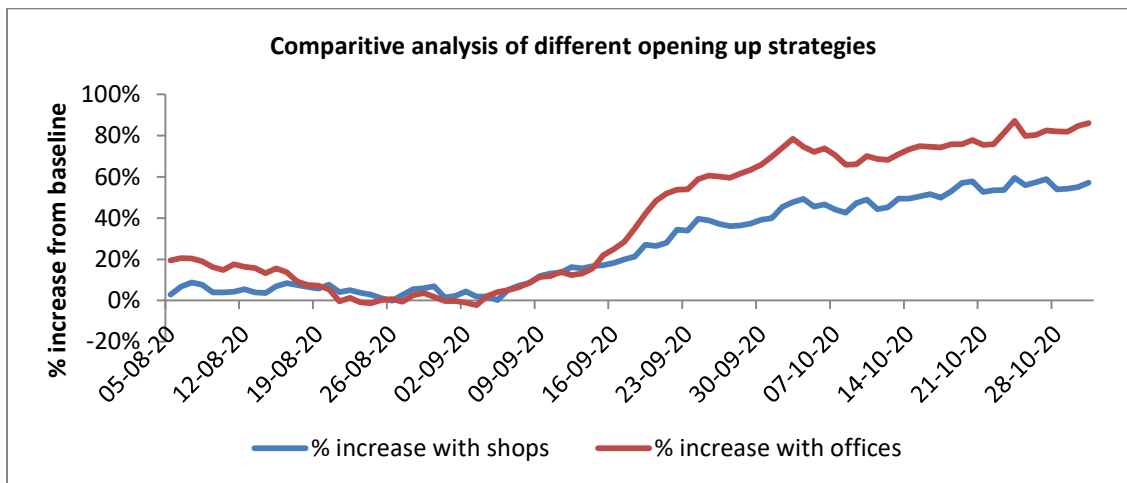


Testing and Isolation - Testing and isolation of infected cases also helped in slowing down the epidemic. The model results show that doubling the current testing rate is likely to reduce the hospital load upto 10% during peak months. Screening of symptomatic cases was found to be a better strategy compared to increasing contact tracing efforts among non-household contacts. Increasing testing also means increased burden on institutional isolation facilities and home isolation almost by 35-40%.

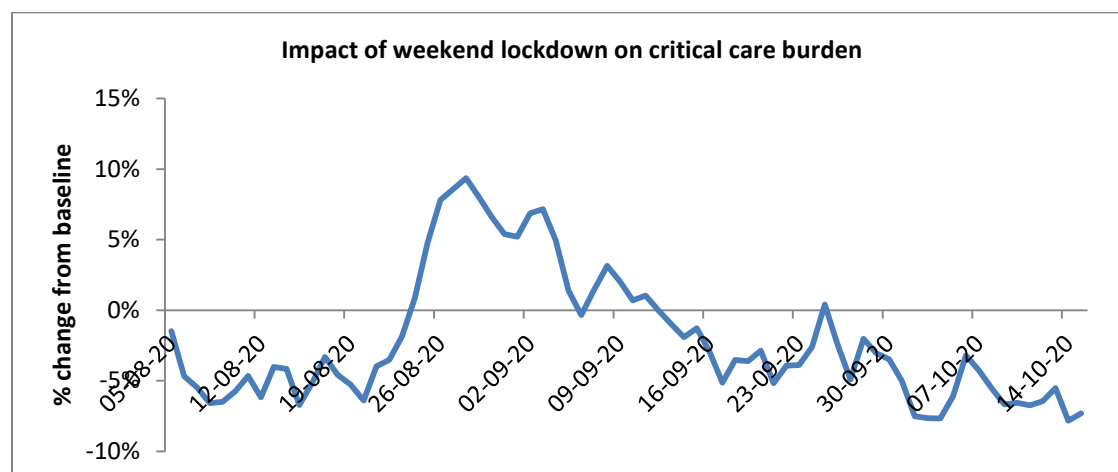


C. Model findings on impact of opening up and lockdowns

Opening up – We undertook comparative analysis to assess the impact of different opening up options. We looked at impact on hospitalizations (critical cases) with opening up of all shops compared to opening up of all offices. The analysis showed that opening of offices leads to more burden on hospitals compared to opening of shops.



Weekend lockdowns: Weekend lockdowns (allowing only essential services and imposing restriction on all other movement on weekend) has limited efficacy in reducing the burden. This efficacy will be further reduced if there is overcrowding during the weekdays.



What are the implications of these findings?

Our analysis indicates that a significant number of populations from Pune still are susceptible to infection. If appropriate preventive care is not taken, there is a risk of rapid rise in infections in these wards, which will further add burden on health care. Gradual opening up and continued efforts to ensure compliance with preventive behaviors will be crucial. Public health measures such as universal use of masks and testing are key interventions. Intermittent lockdown has limited role.

Strengthening health care access - As the city enters a crucial stage of epidemic, there is no doubt that ramping up health care facilities is important to meet the growing demand. Additional preparation will be needed as the critical case load coming in from outside PMC areas rises during these months. This would not only mean expanding the access to health infrastructure but would also need additional force of trained health care providers. There have been significant planning efforts done to increase the capacity of health system (such as creating or acquiring facilities having beds with oxygen and ICUs ventilators) to cater for the surge in the need. However, it is important to ensure that they are available and accessible to people. Several interventions can be thought of for smooth and effective linkages of people to health care such as increasing real time updating on information about bed availability on the dash-board and involving community based organization etc.

Awareness about mask use and social distancing - Universal use of masks yields significant benefits. People should be sensitized about appropriate use of masks when they are at places such as offices, banks, post offices, shops, and when they are with friends and relatives. If there are vulnerable people at home (elderly, with other illnesses) and some of the family members go out for work, then masks and distancing at home too may be prudent. With opening up of shops,

it is important to prevent overcrowding at these places. Several micro-management strategies at the shops can be experimented to ensure social distancing such as restriction of the entry of customers in the shops, limiting number of customers at any given point in enclosed shops such as super-markets and shops.

Strengthening testing and isolation - As indicated by our model testing is an important strategy. The gains are achieved if there is strict compliance to isolation of positive cases. In these regards steps such as proactive efforts in the form of screening of symptomatic and high risk people, ensuring psycho-social support to infected cases and their families, appropriate guidance and counseling to home isolated cases, improving quality of institutional quarantine facilities and reducing apprehension and stigma associated with it – all these actions are of paramount importance. Looking at the resource constraints, prioritization for testing may also be needed. Having high suspicion of covid-19 cases and advising quarantine of all suspected cases would be a prudent strategy in this situation. This would require high levels of awareness and trust among communities.

Community engagement - Community participation will play a crucial role for better adoption of prevention measures and improved uptake of testing. It gains more importance as we attempt the process of opening up while keeping the epidemic under control.

There is a need for close monitoring as things unfold in coming times.

Every model has its own limitations based on the input data. This model is no exception. Like all other models, this model too relies on a set of assumptions going forward in time. The estimated statistics needs to be read in this light. The model predictions are likely to change with unaccounted change in people's movements (eg. Increased movements during festival times and lack of adoption of preventive measures). Despite these limitations these models provide important insights to base our interventions for curbing the spread of the epidemic and mitigating its impact.

It is important to note that, as observed in this analysis, majority of the city population is still susceptible at this stage. As things unfold dynamically over the coming month, keeping a close watch on the situation is extremely crucial. One cannot stress more about the need for data that can be easily accessed by people. In such a situation, a model such as Digital Twin would be useful in making pragmatic intervention choices.

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