Role of sociometry in determining the spread of Covid-19 cases amidst lockdown strategies

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Abstract

India implemented nationwide lockdown to control COVID-19 pandemic since March 2020. Despite lockdown for 100 days, the incidence of covid-19 does not seem to abate. Lockdown induced productivity loss caused severe economic stress. In any pandemic, initial lockdown is necessary for every country to ensure preparedness and public awareness. India erred in prolonging the initial spell of lockdown. During lockdown infected person will spend more time with family members and neighbours thereby infecting all with increase in k-value. In the absence of lockdown they may not find so much spare time to spend with his/her family or to visit neighbours with decrease in k-value. Although lockdown in India has reduced the rapidity of spread by bringing down R₀ to 1.27, it was achieved at the cost of prolonging the duration of the epidemic. In the absence of adequate herd immunity, lockdown may flatten the curve but area under the curve (AUC) will remain unaltered. The idea of lifting the lockdown with an aim of developing herd immunity in 60% of the younger population appears to be promising. Reverse quarantine of high-risk population appears to be a cost-effective method of containing the COVID pandemic in resource restricted countries like India.

Keywords: Covid-19 pandemic, Lockdown strategies, Sociometry, resource constrained setting


Introduction

“Nothing on earth is more international than disease” - Paul Russell,

COVID-19 (Corona Virus Disease 2019) which started in December 2019 in Wuhan, China has spread to 213 countries.[1] After an initial lag, all the world countries implemented mitigation measures such as face masking, hand washing, social distancing and strict lockdown. Some of the European countries like Italy successfully enforced strict lockdown and achieved deflection of the incidence curve. India too implemented nationwide lockdown since March 2020; Despite lockdown for 100 days, the incidence of covid-19 does not seem to abate (Figure1).[2]

![Figure1: Source. WHO COVID 19 situation by country (2)](image)

On the other hand, lockdown induced productivity loss to the tune of Rs 30.3 lakh crore cause severe economic stress [3] Lockdown associated physical and social distancing has also precipitated mental health issues like domestic violence, suicides, substance abuse and other psychosocial risks like financial stress, bereavement, unemployment, homelessness, and relationship breakdown.[4,5,6,7] This begs a question if lockdown is worth all the negativity associated with it. Should it be continued or not is a question that is very pertinent to the survival and wellbeing of 1.3 billion population of this subcontinent. Did WHO prescribe uniform mitigation measures without considering the variations in the socioeconomic and cultural background of various countries? In this article we analyse the socio-biology of Indian lockdown strategy.

**Lockdown to buy time**

In any pandemic, irrespective of their socio-economic status, initial lockdown is necessary for every country to ensure preparedness and public awareness. This period should be utilized to improve the infrastructure so that the deluge of patients can be effectively handled. Increasing the number of care centres and procuring equipments such as ventilators, mask, sanitizers and supportive drugs are to be accomplished during the initial lockdown period. Public education regarding the nature of infection transmission and preventive measures should also be the goal of this period. India did it correctly. But she erred in prolonging the initial spell of lockdown.

**Concept of Reproductive Rate**

Lockdown may reduce the rate of spread of infection but by itself cannot prevent the spread of infection unless herd immunity of at least 70% is achieved.[8] Therefore, extended lockdown is unnecessary if the transmission dynamics of COVID-19 is understood. Basic reproductive rate (R₀) is the potential of an
infectious disease to spread from person to person in a population. It is determined by 3 factors namely the probability of transmission between infected and susceptible persons (β factor), the frequency of contacts between individuals of the population over unit time (k factor) and the duration of infectivity of patients (D factor). Susceptibility in turn depends upon the proportion of population that is already immune to the infective organism (herd immunity).

**FIGURE 2**

A schematic spread of COVID-19 in a population

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$R_0 = (1+2+0+1+3+1+2+1+2+1+2+1+2+1)/14 = 1.35$

$R_0$ is the average number of susceptible persons directly infected by a patient during the entire period of infectivity. In novel infectious disease like COVID-19 the entire population is susceptible. In the late stages of epidemics, the number of susceptible persons in the population will decrease as more and more people become immune by getting exposed to infection. As a result of this an infected person will more frequently come in contacts with people who are already immune to it. Thus, $R_0$ will decrease thereby ending the epidemic.

When a new infection enters a population, an epidemic will occur if $R_0$ is more than 1; if $R_0$ is equal to 1 it will become endemic and if $R_0$ is less than 1 the community infection will eventually disappear. [9] $R_0$ is also important in predicting the optimal level of herd immunity that is necessary to end the epidemic. [10,11] For example, if initial $R_0$ is 4 and if 25% of the population develop herd immunity, then the index patient will infect three people on an average and the infection will remain epidemic; when 75% are immune the index case will infect only one person on an average and the disease will become endemic. If more than 75% are immune the $R_0$ will drop below one and the disease will eventually die out.

The 3 determinants of \( R_0 \) can be mathematically represented as [12]

\[
R_0 = \beta \times k \times D
\]

\( R_0 \) will become zero even if anyone of the 3 factors becomes naught.

‘\( \beta \)’ is determined by the mode of transmission of infection. For example, \( \beta \) will be higher for air-born droplet infections such as COVID19 than forcontact-spreading infections like scabies. ‘\( \beta \)’ can be tamed by adopting public health measures such as social distancing, wearing mask and hand hygiene.

‘\( k \)’ can be moderated by restricting the number of susceptible persons coming in contact with index patient. Lockdown and isolation of diseased person (quarantine) are aimed to reduce the \( k \)-value. But isolation alone may not be every effective because asymptomatic and mildly symptomatic persons will escape from isolation and continue to transmit the infection.

‘\( D \)’ can be reduced if there is effective treatment. ‘\( \beta \)’ and ‘\( k \)’ can also be tamed by reducing the number of susceptible persons if there is effective vaccination. Unfortunately both are not the case with COVID 19.

![FIGURE 3: SOCIOMETRY DURING LOCKDOWN AND ITS EFFECT ON k](image-url)
Effect of sociometry on kappa (k) factor

Sociometry is a measure of human behaviour and interpersonal interactions. It is a key determinant of ‘k’ factor. To understand the sociometry of COVID-19 let us assume the case of a carrier ‘A’ in two hypothetical settings. During lockdown he/she will spend more time with family members thereby infecting all of them. Due to the availability of more leisure time ‘A’ is also more likely to visit his/her neighbours, which is not prohibited during lockdown. Thus ‘A’ will infect many households in his/her locality and create a cluster of infected population. When members of the community move out for essential needs such as food and fuel, they spread the infection beyond their locality thereby creating additional cluster formations. Thus, the k-value and hence $R_0$ increases. (Figure 3) On the other hand, in the absence of lockdown ‘A’ may not find so much spare time to spend with his/her family or to visit neighbours. Thus k-value will decrease. Although ‘A’ may come in contact with susceptible persons at his/her workplace typically the contacts are of short duration. As a result viral load which is directly proportional to the duration of contact will reduce. Hence the risk of infection ($\beta$), as compared to that of lockdown setting, will be minimal especially if social distancing and masking are maintained. (Figure 4)

Indian Lockdown Strategy

India implemented total lockdown on March 25, 2020 for 54 days, after which it was partially relaxed. Lockdown can be compared to speed breakers on the road which reduce the speed of car but cannot be expected to bring it to ultimate halt. Actually, lockdown is meant only to improve infrastructural preparedness. When surge of hospital admission occur, brief periods of lockdown may help as speed breakers. But too much reliance on speed breakers to halt the car will be futile. Extending the lockdown will be counterproductive by causing disproportionate economic loss and other health-related problems.
According to the India Today Data Intelligence Unit (DIU) $R_0$ was 3.36 before intense lockdown, became 1.71 by the end of it, 1.46 by May 3 and further came down to 1.27 by June 2020. [13] The improvement observed cannot be attributed solely to lockdown. First of all, different methodologies and models have been used at different point of time. Secondly, testing strategies and definitions changed over time. Thirdly concurrent change in $\beta$ factors such as the use of face mask, hand hygiene, and social distancing are also responsible for the improvement.

Although lockdown has reduced the rapidity of spread by bringing down $R_0$ to 1.27, it was achieved at the cost of prolonging the duration of the epidemic. In the absence of adequate herd immunity, lockdown may flatten the curve but the area under the curve (AUC) will remain unaltered. AUC can be reduced only when 60% of the population (i.e. 0.78 billion of the 1.3 billion population) develop immunity either by getting exposed to infection or by vaccination. Indian lockdown strategy can be called a failure as the $R_0$ is still above 1 even after 12 weeks. The ‘trace-test-treat’ model recommended by professor Mukherjee of Michigan university is not a cost-effective method for resource limited countries like India. Cost of testing at least 20% of the Indian population will be double that of its GDP.[14]

Way forward

Asymptomatic carriers are often cited as valid reason for implementing extended lockdown. It is often pointed out that asymptomatic and mildly symptomatic individuals, who are more ambulant than sick patients, are more likely to spread the infection and the only way to restrain them is lockdown. In our view, it is exactly the reason as to why lockdown should be lifted. These mild and asymptomatic patients on the other hand help to build herd immunity by spreading the infection among the healthy and physically fit population. Therefore, strict isolation of vulnerable high-risk population such as elders (reverse quarantine) is preferable over total lockdown.

A balance between covid-19 mortality and economic crisis can be struck if the lockdown is selectively lifted for healthy young people along with controlling ‘$\beta$’ factors by masking, social distancing and hand hygiene. Low mortality rate among young age-groups is also encouraging to adopt this policy. [15,16]‘$k$’ factors can be controlled to some extent by implementing restrictions on social gatherings and overcrowding in public places.

Case fatality rate of COVID19 for elders more than 60 years of age is 96.5% in Italy, 80.8% in China and 63% in India. [17,18] On the other hand mortality of children and young adults below 40 years of age is between 1.2 and 0.7%. [18]Hence, reverse quarantining of the elders who form 8.6% of the general population will be easier than locking down the entire population.

Ultimate success can be achieved only when a zero ‘$D$’ is achieved. It is possible only when specific treatment is discovered. Until then, it can be compensated by strengthening ‘$\beta$’ and ‘$k$’ factors by early diagnosis, isolation of infected sick individuals, and public education regarding the proper use of masks and hand hygiene.
Conclusion

We conclude that extending the lockdown will only prolong the epidemic and also adversely affect Indian economy. The idea of lifting the lockdown with an aim of developing herd immunity in 60% of the younger population appears to be promising. Reverse quarantine of high-risk population appears to be a cost-effective method of containing the COVID pandemic in resource restricted countries like India. All the predictive models on the effectiveness of lockdown strategy are largely dependent on the cultural and socio-economic behaviour of the population. We cannot equate human behaviour of one country with high literacy rate with that of another with poor socio-economic conditions. Therefore, country specific lockdown strategy is highly desirable in reducing the 'k' factor.

REFERENCES


