

WORKING PAPER 18 - Covid-19 in South Asia: Space Matters

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Abstract

Covid-19 undoubtedly poses challenges to our world. The first, being the protection of human lives, a pursuit which will influence and take a toll on economic recovery and trust. Through the implementation of a policy of 'social distancing', governments have tried to delay the spread of infection to help healthcare systems to have the capacity to cope. The implementation of this policy is a fine-tuning exercise, from which deriving effects could prove drastic or beneficial – as the comparison of regions and countries has shown. Success depending not only on local management of the containment exercise and health care quality, but also on the sharing of knowledge and resources. The argument in this Working Paper is that it is crucial to promote and ensure the existence and capacity of mobile healthcare. This, in order to be able to cope with the variations of the peaks of infection across space. The analysis here proposes a logistic function to examine the evolution of the Covid-19 infection in the South Asian countries and within the major regions of India. The main argument here, being that since infection peaks are estimated to occur from July 2020 to the first trimester of 2021, there is a justified need for an international strategy for the building of a capable mobile healthcare structure in South Asia, and of a mobile healthcare system within India.

1. Introduction

The Novel Corona virus disease 2019, or COVID-19, is reported to be a new strain of the Coronavirus causing illness ranging from a common cold, to more severe respiratory diseases and other health conditions (WHO, 2020a). COVID-19 is spreading rapidly around the world (as shown in Figures 1 and 2), infecting around 30,851,288 persons, across 213 countries and taking the death toll up-until today to 2,125,468 (the 28th day of April 2020). On March 11, 2020, the WHO categorised COVID-19 as pandemic (Wikipedia, 2020a).

The virus challenges health structures and security paradigms, provokes economic systems of cities and countries (The Economist, 2020, April 9), and creates a need for the management and restructuring of the way humans relate with the environment (Guterres, 2020, April 22).

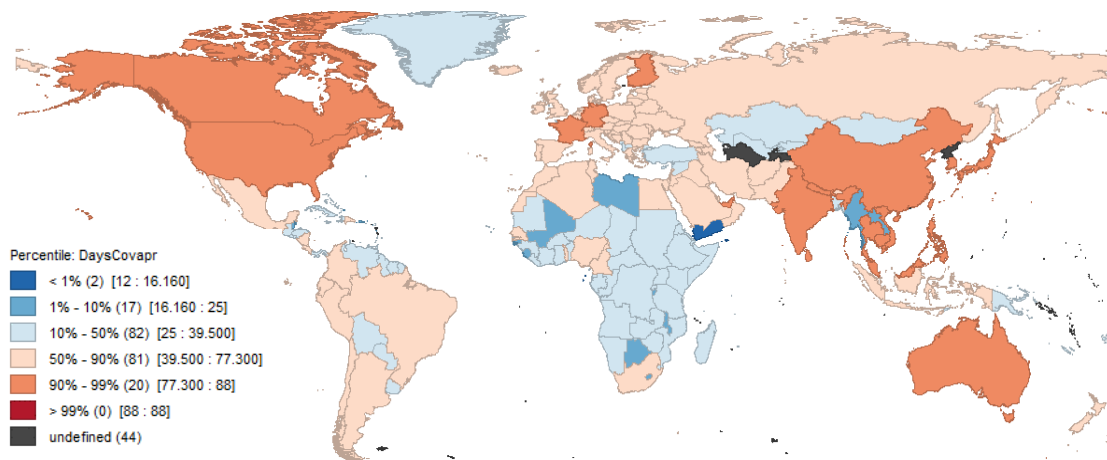


Figure 1: Percentage of infected people by country after the first diagnosed case, calculated on April 16 (based on WHO data)

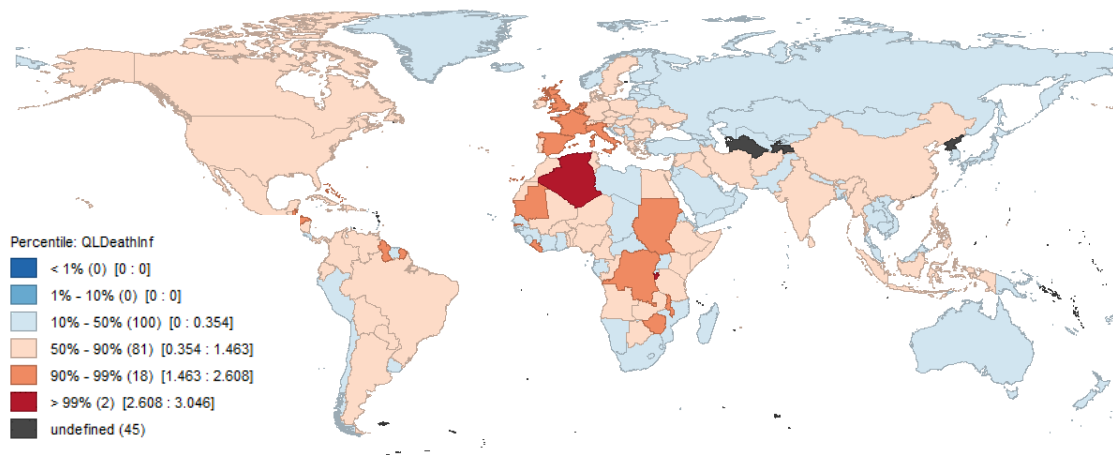


Figure 2: Percentage of deaths of people infected by Covid-19, by country, calculated on April 16 (based on WHO data)

This is a profoundly serious situation, one that stands beyond a point of blaming or accusing China over carelessness or lack of cooperation. Many after the Chinese were careless, concealed data and were either not willing or were incapable of cooperating with each other. As far as it is seen here, there are many to blame and accuse of ignoring the severity and scope of the spread of the epidemic (now pandemic) (Fan et. al., 2018). The virus spread across the globe before society could fathom its rapid and devastating nature - the first common response being to consider it a common cold or flu-like virus -, perhaps the reason for its accelerated transmission wreaking havoc.

Covid-19 is not only a health problem. It is becoming an economic, political and civilisational challenge that will impact everybody, everywhere for the foreseeable future. It is important to understand the problem to be able to advise as to what will be the best possible decisions at personal, local, national, and international levels. In this crisis period, reliable information and knowledge will enable the efficiency and efficacy of urgent decisions. For example, of how long will the personal containment measures need to be followed? How many ventilators and medical teams should be allocated to each hospital? How to establish clear and consistent lines of communications in order to have more control over the spread of the virus and, simultaneously, increase trust between people and governing institutions (Oh et. al., 2020)? How to manage this crisis without jeopardising the basic principles of protection of human lives, freedom, and democracy?

As a bright light at the end of the tunnel comes the existence of reliable data, which when openly available and coupled with unrestricted communication between researchers of different disciplines all over the world has the ability to turn the downward cycle around. It is certain that all estimates have a short-life span, much like the estimates of the economic impacts of Corona Virus made by OECD (2020a) made last March, which predicted a drop in world growth of 0,5% - from 2.9% 2.4% growth. Nevertheless, the OECD report served its purpose as it revealed that the world economy was at risk, reinforcing the focus of governments in ensuring that economic policy measures were taken. Thus, although the magnitude these estimates will soon become obsolete, as pointed out by Craven et. al. (2020), countries will base their management decisions on reports of the local situation and progression of the disease.

There are two main battles in the war against Covid-19. On the one hand, the health battle to control the spread of the epidemic at the national, regional and local level, to delay and lower the peak of infection looking at the evolving capacity of the health systems and the time to find treatments and vaccines. On the other hand, an economic battle to recreate the economy not only to recover from the crises, but also to use the opportunity to create sustainable places and sites all over the world (Guterres, 2020, April 22).

This document analyses the against Covid-19 in South Asia, as it investigates the control of the spread of the epidemic and the stress it places upon healthcare systems¹. The establishment of restrictions on personal contacts have huge costs on the economy, but delaying and lowering the rate of infection, thus preserving the healthcare systems and their resources from facing excessive stress and a possible collapse (Anderson, 2020; Gourinchas, 2020) is a policy, that as argued by Kissler et. al. (2020), could be a viable to pursue and could extend until 2022, or even 2024. Differences in mortality rates between countries, cities and hospitals are strongly dependent upon the relative coping capacities of the respective health systems. Effectively, the sooner adequate healthcare systems are put into place, the sooner it will be possible to lift the constraints imposed on sectors involving greater physical contact - those that have significant economic and social costs, and are estimated to have an impact of around 30% in economic consumption (OECD, 2020b).

¹ In this working paper, we will not focus the sustainable recovery of South Asia.

Contamination by the virus depends on factors such as the early dynamics of the infection, human density and on what appear to be yet rather unknown epidemiological parameters – which have an effect on the variation of virus contamination in different spaces (Atkeson, 2020). Meaning that contamination rates tend to vary across space, even within the same country. The aim of this paper is to show that using the existent data on the variation of contamination across space and combining this with the possibility of a mobile allocation of health treatment facilities, it is possible to reduce the number of fatalities. In the same line as Correia et al., (2020), this paper assumes that places that address the immediate health problem, will host the economies which will have a swifter recovery.

Therefore; Section 2 proposes a model to analyse the infection and death patterns related to Covid-19. Section 3, in turn, calibrates the model for the countries of South Asia and shows that in the scale of the sub-continent, the spread of the virus changes from country to country. Section 4 looks at India specifically and highlights the varied diffusion of Covid-19 within the country. Section 5 outlines the conclusions of this study and suggests recommendations related to the spatial allocation of means to combat Covid-19 in South Asia and India.

2. Model to analyse the infection and death patterns

There are a number of models to explain the Covid-19 epidemic phenomena (Benvenuto et. al., 2020; Fong et. al., 2020). The biological model we adopted is a logistic model (Gordon, 1954) that explains cumulative infections as a function of time and the reproductive capacity of the virus depending on where the epidemic occurs. The number of cumulated infections (X_t) depends on the maximum number potentially infected (K), usually a percentage of the total population, and the reproduction rate of the virus (r) that can change due to contention measures:

$$(1) X_t = k / (1 + (k-1) \cdot \exp(a-rt)).$$

The number of people infected requiring hospital treatment (D_t) is a percentage (p) of those who are ill (I_t), which equals the total number infected on each day (t) minus the total number infected in a day ($t-d$), where (d) is the average number of days ill people require special treatment ($t-d$).

$$(2) I_t = [X_t - X(t-d)]/d$$

The number of Deaths (M_t) is, a percentage (a_t) of the infected (I_t). This depends on the quality of the health services (Q_t) evaluated by the number of medical doctors per 1000 residents, and the stress related to the Health System (Z_t), when the capacity of the health system reaches its limits.

$$(3) \quad v_t = m + b \cdot Z_t - c \cdot Q_t$$

$$(4) \quad M_t = v_t \cdot I_t$$

$$(5) \quad M = \sum_{t=1}^T M_t$$

Using the model of expression (1) to (5), one can calibrate and understand what would have happened on the cruise ship 'Diamond Princess' (3711 people, 634 infected without containment, 77 more after containment and 7 deaths) for different scenarios of containment and treatment. The estimated model of expressions (1) with real data and the computation of expression (2) assuming being infected for an average period of 11 days -, it is possible to design the infection curves and gauge mortality rate per day as 0,0032%, reaching a result of 7 deaths which occurred in reality. The estimate of the mortality rate in a system under severe stress is 3.42 times higher².

² The estimate of expression (4) that relates the lethality rate (Cumulative Deaths from Covid-19 / Cumulative Infected of Covid-19) with the number of doctors per 1000 residents and with the stress of the health system. It indicates that the lethality rate can increase 3.42 times if the health system is under stress. Furthermore, each extra doctor per 1000 residents can decrease the lethality rate by 0,7 percentage points meaning that with 4 doctors per 1000 residents and no stress on the health system, the lethality rate related to those recorded as infected can be lower than 2%.

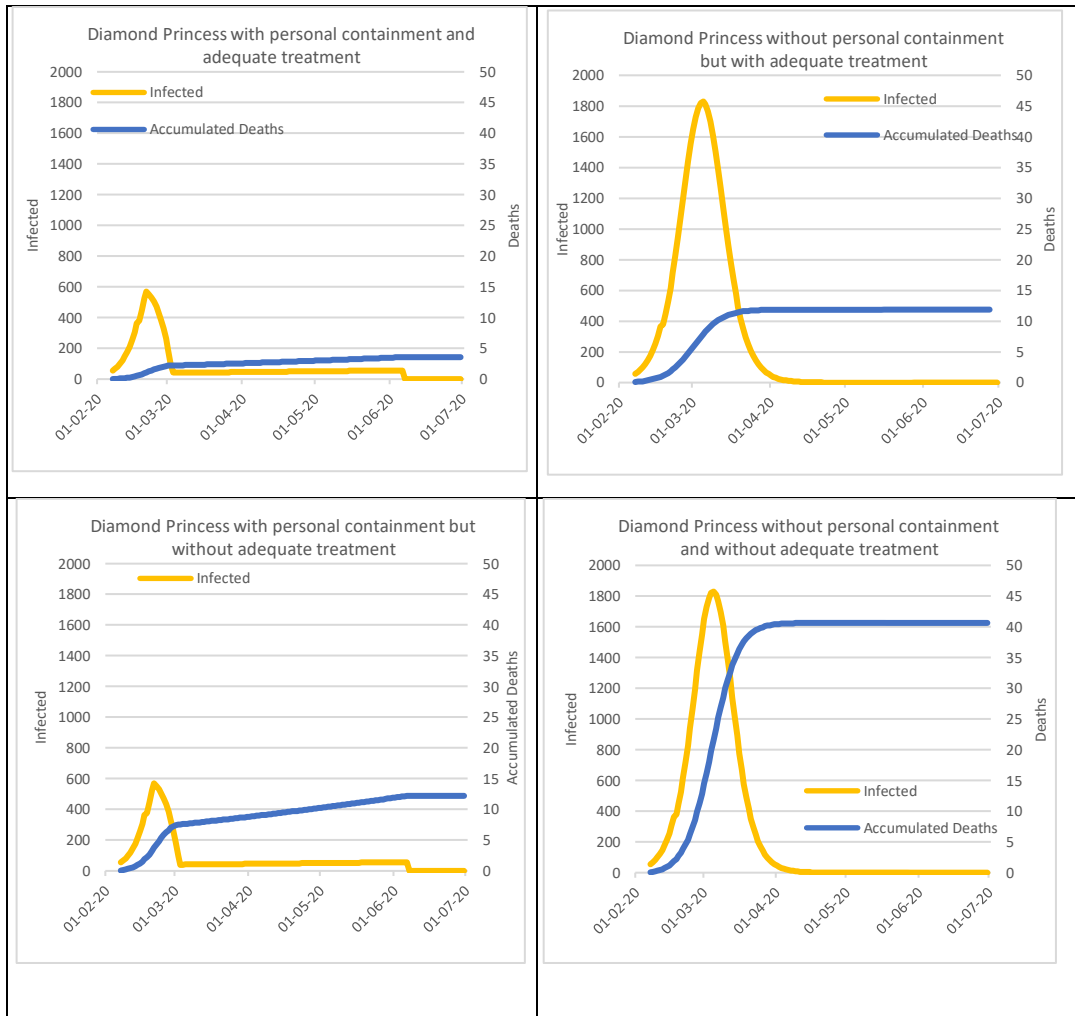


Figure 3: Simulation of the Infection and Deaths in the 'Diamond Princess'

With proper containment and good treatment, there would have been 4 deaths. With poor containment and good treatment instead, 12 deaths would be expected. With good containment and bad treatment, the result would also be 12 deaths. Finally, with inadequate containment and poor treatment there would have been 40 deaths. From that perspective with adequate containment and good treatment it is possible to avoid the death of 0,9% of the World Population. From the example of "Diamond Princess", the results would be between 0,1% and 1% deaths.

3. Infection in South Asia

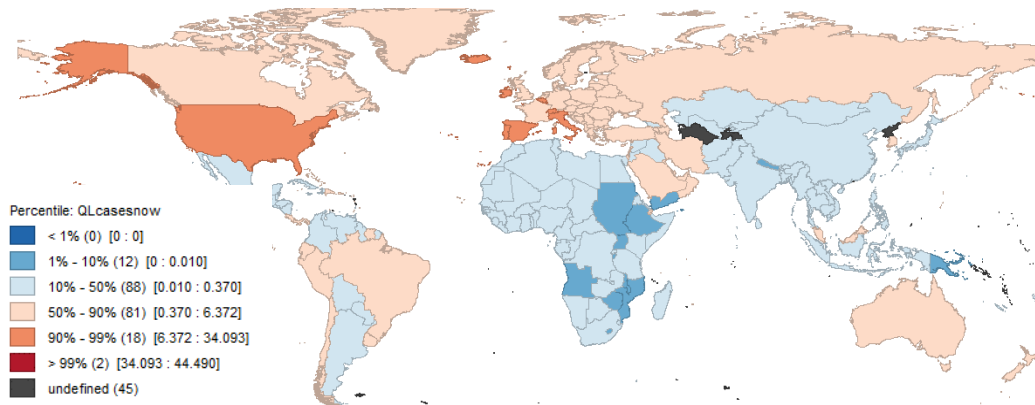


Figure 4: Location quotient of the infection on April 16 with data coming from reports of the World Health Organization (WHO, 2020b)

It indicates that although the diffusion of the virus between countries followed the pattern of economic and geographical proximity as highlighted in Figure 1, the spread within each country depends on the personal contacts, leading to a higher concentration on April 16 in Italy, Spain, Portugal, Belgium, Ireland, Iceland and the United States of America.

| Country | Location Quotient Infected | Location Quotient Deaths | Population | Infected on April 16 | Days of Infection on April 16 | Infection Rate (-r) | R in April 16 |
|-------------|----------------------------|--------------------------|------------|----------------------|-------------------------------|---------------------|---------------|
| Afghanistan | 0,14 | 0,23 | 37760219 | 1398 | 52 | -0,155 | 1,2 |
| Bangladesh | 0,03 | 0,02 | 162542290 | 1452 | 31 | -0,235 | 2,2 |
| Bhutan | 0,03 | 0,00 | 754394 | 7 | 42 | -0,053 | 0,0 |
| India | 0,02 | 0,10 | 1362215745 | 7539 | 78 | -0,129 | 0,9 |
| Iran | 17,23 | 21,55 | 82591361 | 372082 | 57 | -0,145 | 1,0 |
| Maldives | 0,19 | 0,00 | 528242 | 27 | 40 | -0,036 | 0,0 |
| Myanmar | 0,01 | 0,03 | 53928716 | 74 | 24 | -0,134 | 0,9 |
| Nepal | 0,00 | 0,00 | 28465118 | 6 | 83 | -0,029 | 0,0 |
| Pakistan | 0,39 | 0,19 | 215240342 | 21982 | 50 | -0,189 | 1,6 |
| Sri Lanka | 0,04 | 0,13 | 21295828 | 247 | 80 | -0,090 | 0,6 |

Table 1: Location Quotients, Cases, Rate of Infection and R on April 16

On April 16, the concentration of the virus was low among the populations in South Asia and Africa and controlled in China. Notwithstanding this, the evolution of the disease per day allows, the estimation of expression (1) presented in Table 1. This includes the Location Quotients of infected and deaths, population, number infected on April 16, the growth rate of the infection and factor R, or the number infected generated by one infected in the incubation period of the disease that is 4.7 days.

Table 1 shows that Iran has the largest concentration of the disease regarding population, although India and Sri Lanka were infected earlier. Iran also has the highest concentration of deaths per area. The rates of infection indicate a fast growth in Bangladesh and Pakistan, a moderate diffusion in India, Iran, Afghanistan and Myanmar and a much lower infection rate in Sri Lanka, Maldives, Bhutan, and Nepal. Countries that curtail the virus and prevent higher peaks are the ones that will receive herd immunisation sooner, but also those that have a higher risk of placing stress on the health system and higher number of deaths related to Covid-19.

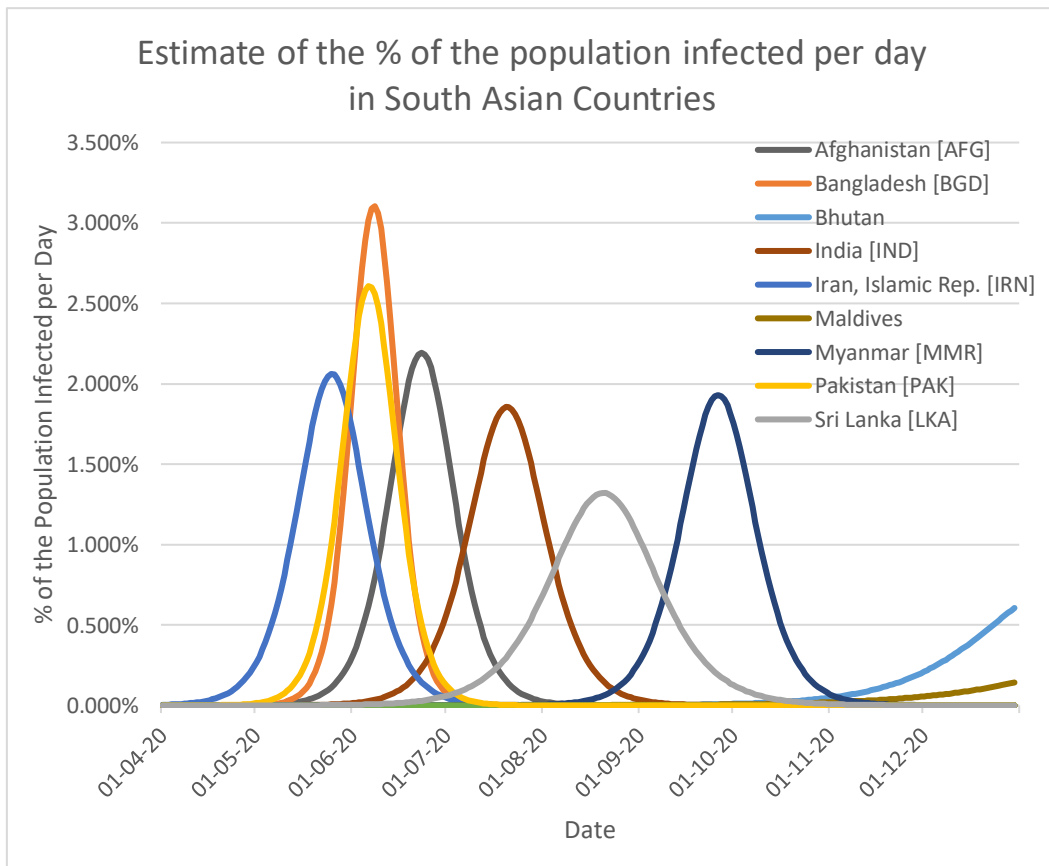


Figure 5: Extrapolation of Infection Model for South Asian countries.

Predicting the rate of infection and the related treatment allows the countries demonstrated above to, to perceive that the peak of demand for treatment varies across the region³. If there are no containment measures and the temperature and humidity does not affect the virus, Iran will be the first to peak in the beginning of June, Pakistan and Bangladesh will follow, Afghanistan will peak in early July, India in late July and Sri Lanka will peak mid-August. At the present rates, Covid-19 will hit Myanmar in early October and Bhutan and Maldives, if they remain contained as they are and will only face a peak in infection at the end of the year. The update of these estimates is important not only to alert the national government, but also to allocate the scarce international resources to tackle the infection.

4. A look into India

Trend of spread of the pandemic in India

The virus made its appearance in India for the first time on 30 January 2020 and the first infected case was from Kerala, in Southern India. There were two further infected cases from Southern India by 3 February. However, the rest of the country did not record any cases until 1 March, 2020. Thereafter, both, the cases of infection and deaths emerged gradually in almost all the regions of India, with the number steadily rising almost each day. Within a span of one month from 26 March to 26 April, the number of infected persons rose from 694 to 26918, which is close to 40 times and a daily average of 875 persons. Today 33 of 36 States and Union Territories (UTs) of India recorded cases of infection.

Western India recorded the highest number of cases so far, which comprises of only 4 States and UTs of India, of f which, two States have the largest share of the record. Islandic regions and North Eastern regions of India recorded the lowest cases of infection. Eastern India is displays a slower pace in rising cases. However, the concern remains on the consistency of this spread, where most of the regions are showing new cases of infection regularly.

³ Notice that we are dealing with the peak of infected, comparable with the capacity of the health systems, and not with the peak of infection growth appraisable by factor R.

Apart from the total number of infected persons, tens of thousands of people in India are quarantined at home or in hospitals and/or government established quarantine centres. Experts are of the opinion that there may be several people already infected, but have not been recorded yet, because of the slow pace of testing in the country (Wikipedia, 2020b). Until now (28 April 2020) only 716733 Corona Virus tests were conducted. The testing of 530 people per million population which is considered among the lowest number of tests conducted around the world. A more distressing situation is displayed through the increasing number of asymptomatic cases, where the infected person does not show any symptoms of infection or in certain cases, the symptoms are mild, even after contracting the virus. As per the Indian Council of Medical Research (ICMR) report, almost 80% of the cases are asymptomatic in India (Economic Times, 2020b, April 21). This silent spread is being considered more daunting for India, due to the high population density in most of the regions, especially in cities and urban areas where the rate of spread is escalating each day.

Covid-19 and People's perception - the Indian story

In comparison to many other countries, it could be assumed that India has been disadvantageous, due to the delay in encountering the virus, as well as the procedures to tackle it. Until the WHO declared the disease as a pandemic on 11 March, India was at the stage of inception with no casualties. However, soon the Central and State Governments began adopting precautionary measures to prevent the spread of the virus. Within two-week time, the country went into a complete lockdown for 21 days from 25t March midnight, which was further extended into a second phase of lockdown from 15 April to 3 May 2020. Despite multiple efforts to curtail the spread, the rate of infection in India has been on a steady rise.

The perception about the spread of the virus by people in India is quite diverse and is evolving with time. Initially, there was a clear picture of the urban-rural dichotomy, with urban masses more responsive to combat the situation than rural populations. However, there are also exceptions to the situation as found from several incidents, like religious gatherings at the capital even when the government had declared a lockdown (India Today, 2020, March 31). Quite a few people attending the meeting were infected and in turn contaminated several others. This undoubtedly would be considered as an irresponsible act. However, through strict administrative policies for lockdown, the situation is being managed well in several parts of the country.

Thus, the behaviour of humans is varying on an individual level over space and time. For instance, there are individuals and families who have accepted and preferred staying at home to combat the spread of the pandemic, more so in areas where the outbreak of the disease is greater. In contrast, in areas with less or no contamination yet, it is apparent that a large number of people have been violating the rules imposed. The behavioural pattern may also be indicative of the citizens' perception about the government's response to the pandemic: where many are in appreciation of the government's roles and responsibilities, others have disagreed (Firstpost, 2020), citing issues of economic and social crisis. There have also been problems related to the millions of migrant labourers stranded in places away from their homes during this lockdown in the country (BBC, 2020a, April 21). There has been rising anguish and protests as they experienced the worst uncertainty without food and shelter. The country has also been battling to provide relief and shelter to the 40 million migrant workers during this crisis.

Furthermore, issues of social discrimination and stigmatisation as many families in India went into quarantine have also developed (BBC, 2020b, April 8). With the government posting stickers outside the houses, which read, 'Do not visit. Home under quarantine', there are many families undergoing 'stress and psychological pressure'. There are incidents of doctors being attacked, to health workers attending to corona patients being refused tenancy in fear of being contaminated. This undoubtedly presents a few of the multifarious insights on the spread of the Coronavirus in the country.

Impact on health systems

With the rising cases of infection in India, the healthcare system is experiencing a trying time to keep a grip on the situation. Although, the governments have claimed a ready to fight spirit even in a situation of further spread and a rise in the number of infected patients, several incidents have already displayed a discomfoting picture. Hotels and trains in India have been turned into quarantine shelters, to manage with the shortage of hospital quarantine facilities. Several hospitals have shut down for days reporting the contamination of several patients and medical staff.

This adds further to the shortage in hospitals. Additionally, as revealed from the daily reports, doctors and healthcare staff are still not receiving adequate protective gear or Personal Protective Equipment (PPE) to attend to patients (Economic Times, 2020a, April 5). This is generating greater risk for all, while revealing a problem in the healthcare system. Moreover, it could be inferred, that the lack of protective gear for medical staff, is another reason for the continuing daily spread of the virus. . This could be the reason for

the daily spread of the virus. The country's poor healthcare system continues to be spotlighted as an inadequate service at the outbreak of the Covid-19 pandemic (Business Today, 2020, April 20).

Now, we focus on the health situation of the country. The outbreak of the virus has also invited pressing concerns regarding the physical and mental health of the average person and patients suffering from other health issues. With hospitals being converted into exclusive corona treatment centres, the treatment of the patients suffering from other health problems in the hospitals, are at times hindered. There is also a risk of infecting existing hospital patients, as they are more vulnerable. Moreover, there are reports of rising issues of psychological stress as people are confined to their homes. Middle- and lower-income groups are undergoing further stress due to economic challenges, that have already hit many. Thus, the entire healthcare system is under serious scrutiny.

The changing economy and the impending crisis scenario

Despite the current situation being contrarily placed forth as an opportunity to reform the economy, the immediate effect of the pandemic and resultant lockdown of the economies has signalled massive recession, job losses, and possible starvation of the poor masses. The government had projected a budget deficit of 3.5% of gross domestic product in the year 2021, whereas, there are others who estimated that it would rise to a high of 6.2% (Economic Times, 2020c, April 9). However, due to the current economic situation, capital growth in all possibility would face a drought and there would also be stagnancy in certain sectors of the economy. For instance, automobile and real estate sectors are predicted to enter a slump phase.

The crisis of the masses would be many folds. High-income groups, with sufficient financial backup would seemingly sustain themselves through the crisis. The low-income groups would continue to face challenges, soon when, the free rations would cease, these people would encounter severe hardships. The situation for the middle-income groups is more sandwiched. Majority is not provided with free rations. With the liquid capital being exhausted every day, the masses among this group without a permanent job, are slowly entering a severe phase of economic uncertainty. Demonstrating a greater likelihood for the middle-income groups to encounter the same fate of scarcity as the low-income group.

Forecast to manage saving lives and livelihoods

The simplicity of the model and the availability of data by region (Covid-19 Tracker, 2020; CovidIndia.Org, 2020; Wikipedia, 2011a; Wikipedia, 2011b) allows the estimation and

extrapolation of the infection to be very useful to allocate the scarce health resources for the regions more in need. The exercise made here for the seven regions of India is adaptable to any region on a more disaggregated scale, which resources, reinforced or migrated, can save lives and resources.

| Region | Location Quotient Cases | Location Quotient Deaths | Population | Cases in April 26 | Days of Infection in April 26 | Infection Rate (-r) | R (5 days) in April 16 |
|----------------------|-------------------------|--------------------------|------------|-------------------|-------------------------------|---------------------|------------------------|
| Northern | 0,96 | 0,57 | 368517170 | 7732 | 56 | -0,135 | 1,9 |
| Southern | 0,88 | 0,59 | 252477118 | 4874 | 60 | -0,149 | 2,0 |
| Eastern | 0,17 | 0,13 | 270337920 | 1025 | 42 | -0,160 | 2,1 |
| Western | 2,19 | 3,82 | 174858334 | 10706 | 48 | -0,163 | 2,1 |
| North Eastern | 0,05 | 0,06 | 45486784 | 54 | 34 | -0,128 | 1,8 |
| Central | 0,99 | 1,48 | 98172007 | 2134 | 39 | -0,190 | 2,4 |
| Islandic | 3,38 | 0,00 | 445054 | 33 | 32 | -0,049 | 1,3 |

Table 2: Location Quotients, Cases, Rate of Infection and R on April 26

Looking at Table 2 it is clear that on 26 April 2020, the infection was more concentrated in Western and Islandic India, although the location quotient of deaths indicate that Western India and Central India are more in need of healthcare resources on that date. In fact, although Western India has more cases per capita, the growth in Central India is expected to be sooner and higher, resulting in a more intense peak in that area of the country (Figure 4). The same graph indicates that the second peak is in Western India in late June, the third peaks in South India in early July, and the fourth and fifth in East and North India, in mid-July. Another one in North-East India in early August and finally in the islands by mid-November. All these estimations are based on the initial estimated profiles of the infection curves.

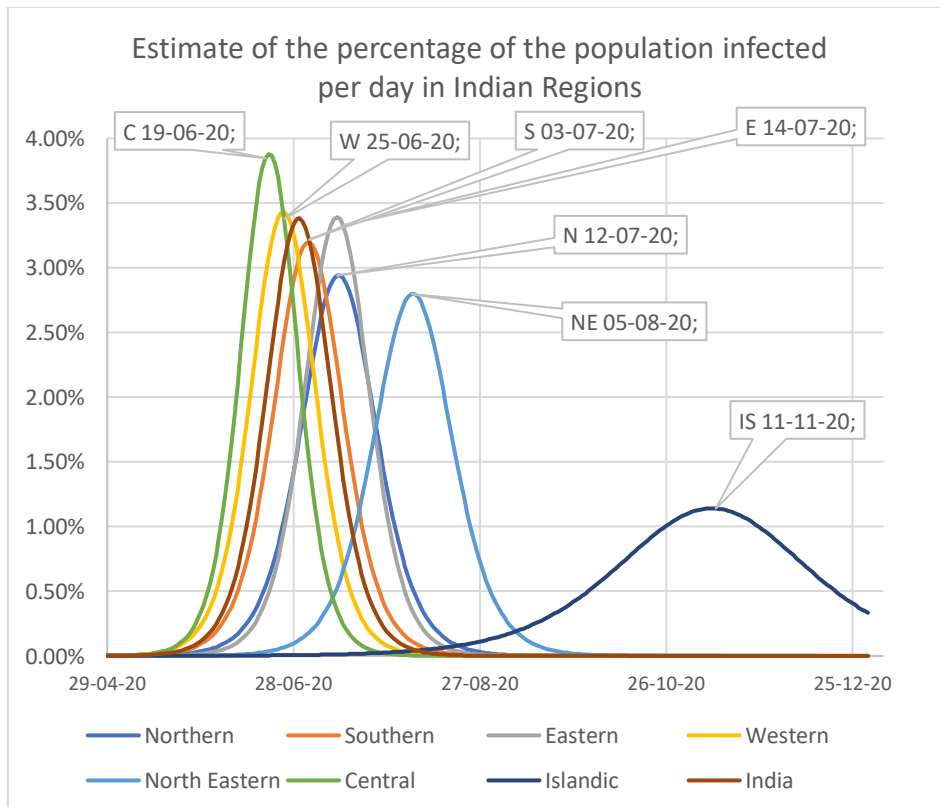


Figure 6: Estimate of the percentage of Population Infected per day in Indian Regions.

5. Conclusion

Due to the steady increase in the number of Covid-19 cases in India, the healthcare system is experiencing a major challenge. The containment measures have a very high economic cost, but the measures may not be adequate to avoid a sharp increase in the number of deaths due to the limited capacity of healthcare facilities.

The salient point is that, due to the peaks of infection varying across the territory between regions, states, cities, and human settlements, it would be most efficient and possible to reduce the scale of deaths through mobile allocation of health teams and equipment. The issue is not only to influence the rate of infection along time with personal containment, but also to mobilise health teams and equipment where they are most required. Thereby, optimising the utilisation of health equipment in order to attend to the varying peaks of infection around the country.

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