Review Article: COVID-19 in Kerala: The Dynamics of Spread and Health Index Theory

ABSTRACT

Background: The number of novel coronavirus cases is different in various states of India. In the second wave, the state of Kerala has the highest number of cases in India. The “Health Index Theory” established first in this article has explained such a high susceptibility of Kerala’s population to the virus.

Methods: The data of sero-survey and health index score have been used to explain the high surge in the cases. The dynamics of the COVID-19 virus spread in Kerala has been applied to study the high virus surge in Kerala.

Results: On February 21, 2021; the caseload share of Kerala was 48% of India’s total cases. The two sero - survey results conducted in August 2020 and December 2020 - January 2021 show that the antibodies prevalence in Kerala’s population was 0.8 and 11.6%, respectively; while India’s national sero-prevalence was 6.6 and 21.0%, respectively.

Conclusions: The higher infection rate in Kerala compared to the other states of India has been interpreted by the first established “Health Index Theory”. The population of Kerala is more susceptible and less immune to the virus compared to other states as the score of Kerala on the health index is the highest. However, better healthcare in Kerala kept the case fatality rate (CFR) lowest in India.

Keywords: COVID-19 in Kerala, Sero-survey, Health index theory, Herd immunity, Dynamics of COVID-19 spread

1. Introduction

In the review article [1] and references cited therein, important aspects of the COVID-19 pandemic and SARS-CoV-2 virus have been described. Recently, at the onset of spring, there is a large increase in coronavirus cases in many countries. A drastic increase in cases is being witnessed in Tokyo, Osaka, and small regional areas of Japan [2]. The experts raised the concern that a “fourth wave” of infections has started. A series of infections by highly transmissible variant strains have also been confirmed in Japan. The detection of highly transmissible SARS-CoV-2 variants is also a matter of concern. There is also a surge [3] in COVID-19 cases in Southeast Asia country Philippine where one in nearly five tests are positive. India detected [4] 115,736 cases of coronavirus in a single day on April 6 in a second wave of the outbreak. Again on April 7, 126,260 new Covid-19 cases were recorded in India; the number is highest ever in both the first and second waves [5]. In March 2021, in India nearly half (48%) COVID-19 cases reported [6] were from urban areas which have only 14% population. Again in April 51.9% of cases came from these urban areas. Not following 3Cs protocol (closed spaces, crowded places, and close-contact settings) can be the reason for the higher infection rate in densely populated urban areas. Another important reason for higher COVID-19 cases in urban centers is due to better hygiene and health facilities exist in big cities. At the onset of the second wave [7, 8] of novel coronavirus in India, the state of Kerala alone had 45% [9] of total cases with just 2.6% population share was surprising. On the other hand, the case fatality rate (CFR) in Kerala is the lowest (0.4%) while in the rest of India is higher at 1.4%. The higher infection rate in Kerala and low CFR have been explained by the newly established “Health Index Theory” in a very recently published article [1]. In this article, the dynamics of
The virus spread in Kerala has been studied in the context of the health index theory.

2. Results and discussion

Figure 1 compares the dynamics of the novel coronavirus spread during the period June 20, 2020-February 26, 2021 of the state Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, and Uttar Pradesh. Initially, Kerala effectively controlled the pandemic by strong COVID-19 specific measures. Figure 1 shows that the total number of cases is lowest in Kerala on June 20. Novel coronavirus cases started increasing sharply around September 5 and on February 3 Kerala surpassed Karnataka and became the second worst affected state in India; Maharashtra (plot not shown) had the most cases. On February 21, Kerala’s caseload was 48%, Maharashtra 23%, and 29% was of rest of the India [1]. In Figure 1, the plot of Kerala is different from other states as indicated by an arrow. Kerala’s plot is a clear two slopes plot with a breakpoint at September 5. The second slope is larger than the first. A less steep first slope indicates that Kerala contained the pandemic in the initial days. However, the virus spread faster after September 5. Unlike Kerala’s plot, the initial slopes of the other four states’ (Karnataka, Tamil Nadu, Andhra Pradesh, Uttar Pradesh) plots were steeper and plots became less steep in the later days of the pandemic. The pattern of these plots showed that the virus spread was more in earlier days and transmission slowed down afterward. In Kerala, the spread of the virus was fast after September 5, due to fewer antibodies prevalence in Kerala’s population than in other states. The results of the August and December 2020-January 2021 sero-survey showed that the antibodies prevalence in Kerala’s population was 0.8 and 11.6%, respectively. While India’s national average was 6.6 and 21.0%, respectively. At the beginning of the pandemic, the virus did not spread widely and deeply in Kerala which later spread faster in unuptapped population.

Figure 2 is the plots of daily new cases (7-day average) in different states of India from June 20, 2020-February 26, 2021. As indicated by the arrow, the plot of Kerala is different from rest of the states. In Kerala, initially until September 5, daily new cases were less than the rest of the states. Afterward, cases increased more steeply. After the peak arrived on October 13, cases started decreasing slowly. Cases did not decrease fast as in other states of Andhra Pradesh, Tamil Nadu, Karnataka, and Uttar Pradesh. The shape of Kerala’s plot and the peak position are also different from other states. The peak arrived late in Kerala and after the peak, the decline was not strong as in other states. A relatively large number of novel coronavirus cases were detected giving a different shape to the plot compared to other plots. A large number of cases in Kerala had been due to the higher score of Kerala on the health index as described in a previously published article in detail [1]. The health index score of each state is: Kerala (76.55), Tamil Nadu (63.38), Andhra Pradesh (60.16), Karnataka (58.70), and Uttar Pradesh (33.69). Because of better health infrastructure in Kerala, more people are susceptible to the coronavirus pathogen. However, developed health facilities keep Kerala’s people living longer. The life expectancy of the people living in the states Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, and Uttar Pradesh is 75.2, 71.7, 69.7, 69.2, and 65.0 years, respectively. The average Indian lives up to 69.0 years. The up-to-date health infrastructure of Kerala is keeping the coronavirus the lowest in India as mentioned in Introduction section.

Figure 3 compares the plots of total virus caseloads in Kerala, Uttar Pradesh, Germany, and France. The shape of Kerala’s plot resembles more with Germany and France than Uttar Pradesh. The plots of Kerala, Germany, and France mainly have two slopes with one break point. On the other hand, the Uttar Pradesh plot has several gradients. The individual caseloads of Kerala, Germany, and France are more than Uttar Pradesh. Uttar Pradesh’s viral caseload remained low because the population of the state is less susceptible and more immune to the virus due to unhygienic living conditions as the state is at the bottom of the health index score as suggested by the health index theory.

The shapes and trends of the plots of daily new cases (7-day average) of Kerala, Uttar Pradesh, Germany, and France have been compared in Figure 4. In the case of Uttar Pradesh, the peak came earlier than Kerala, Germany, and France. After the peak, the cases decreased faster in Uttar Pradesh than in Kerala, Germany, and France. The late arrival of the peak is due to the better non-pharmaceutical interventions in Kerala, Germany, and France and the new cases not decreasing rapidly is due to the puation is more susceptible to the virus.

The viral caseload and daily new cases (7-day average) of India are shown in Figure 5. The peak position and trends of the plots are different than Kerala, Germany, and France. The healthcare facilities and hygiene in India are less compared to Kerala, Germany and France. Thus, following the health index theory, the Indian population is less susceptible and more immune to the novel coronavirus. The number of cases per million is the lowest (as on February 11, 2021) in India (7,827) compared to Kerala (27,608), Germany (27,704), and France (50,859) [1].

**Statements:** The data and results in this article are very reproducible. Author (Zameer Shervani, Ph.D.) is Director of Food & Energy Security Research & Product Center, Sendai, Japan.

**Plot smoothening:** For daily new cases plots 7-day average was taken. The plots were smoothened in Origin Software by taking 5 points.

**Figures:**

![Figure 1. Comparison of the COVID-19 caseload of different states of India](image)
Figure 2. Comparison of COVID-19 daily new cases of different states of India (7-day average and 5 points smoothening in Origin Software)

Figure 3. Comparison of COVID-19 caseload of Kerala, Uttar Pradesh, Germany and France

Figure 4. Comparison of COVID-19 daily new cases of Kerala, Uttar Pradesh, Germany and France (7-day average and 5 points smoothening in Origin Software)

Figure 5. Total and daily number of COVID-19 cases in India (daily new cases plot, 7-day average and 5 points smoothening in Origin Software)

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