# Impact and Management of Covid-19 in Kerala: A Systematic Review

Anil Babu A[1], Hema S[2], Reshma VB[3]

[1,2]*Department of Pharmacology, Westfort College of Pharmacy, Kerala, India*
[3]*Department of Pharmaceutics, Westfort College of Pharmacy, Kerala, India*

***Abstract:*** **The coronavirus outbreak emerged as a severe pandemic, claiming more than 0.8 million lives across the world and raised a major global health concern. The study aimed to explore the current developmental status and management of coronavirus in Kerala. The pandemic that hit Kerala was looking like a striking outlier in the battle against the coronavirus in India. The virus had been in a controlled situation when the state borders were closed. In January, Kerala reported the first covid-19 case and the number of cases increasing steadily and it became a hotspot. In mid-July, it reported around 800 infections a day. The objective of this paper is to analyze the Kerala model to achieve the goal. It will examine the legacy of the Kerala model such as a robust healthcare system, safety measures, quarantine system, and mechanism of the spike protein. It also looks into the democratic strategy of Kerala and the combined effort of the healthcare system, public, and Government. We conclude that the Kerala model is still relevant and effective when compared to others.**

***Keywords:*** **SARS-CoV, Spike protein, Kerala state, Covid -19, pandemic.**

## I. INTRODUCTION

The novel coronavirus 2019-n CoV has emerged as a human pathogen in the city of Wuhan in China's Hubei province, causing fever, severe respiratory illness, and pneumonia- a disease named COVID-19 (According to the World Health Organization (WHO), as of 16 February 2020, there had been >51,000 confirmed cases globally, leading to at least 1600 deaths. There was an exponential increase in spread of disease during the initial stages in China. The mode of transmission is through close contact with an infected person and respiratory droplets. The World Health Organization declared COVID-19 as a pandemic on 11th March 2020 considering the situation all over the world. Coronavirus disease 2019 has emerged as a global health threat and every nation is facing unique challenges during the coronavirus outbreak. India recently crossed 50,000 cases and is undergoing a historic nationwide lockdown in an attempt to control the outbreak. Most epidemiologists believe that Kerala has done a good job for the overall control of the infection. [1, 2, 3]

## II. PATHOGENESIS

To infect a human host, viruses must be able to gain entry into individual human cells. They use this cell's machinery to produce copies of themselves, which then spill out and spread to new cells. The virus binds to host cells through its trimeric spike glycoprotein, making this protein a key target for potential therapies and diagnostics. 2019-nCoV trimeric spike protein binds at least ten times more tightly than the corresponding spike protein of severe acute respiratory syndrome (SARS)-CoV to their common host cell receptor. Wrapp *et al.* tested three antibodies known to bind to the SARS-CoV spike protein but did not detect binding to the 2019-nCoV spike protein. These studies provide valuable information to guide the development of medical countermeasures for 2019-nCoV. [4]

The emerging pathogen was rapidly characterized as a new member of the beta coronavirus genus, closely related to several bat corona viruses and severe acute respiratory syndrome corona virus (SARS-CoV). Compared with SARS-CoV, 2019-nCoV appears to be more readily transmitted from human to human, spreading to multiple continents and leading to the WHO's declaration of a Public Health Emergency of International Concern (PHEIC) on 30 January.

The molecular bond between SARS-CoV-2's spike protein and ACE2 looks fairly similar to the binding pattern of the corona virus that caused the outbreak of SARS in 2003. There are some differences, however, in the precise amino acids used to bind SARS-CoV-2 to that ACE2 receptor compared with the virus that causes SARS (severe acute respiratory syndrome). [5]

Once SARS-CoV-2 gets inside the human respiratory tract, infect and multiply in cells lining the airway, causing damage that kicks the immune system into action. In most people, it should trigger a wave of local inflammation, recruiting immune cells in the vicinity to eradicate the pathogen. The immune response then recedes, and patients recover.

The elderly and sick may have dysfunctional immune systems that fail to keep the response to particular pathogens. This could cause an uncontrolled immune response, triggering an overproduction of immune cells and their signaling molecules and leading to a cytokine storm often associated with a flood of immune cells into the lung. [6]

Local inflammation can turn into widespread inflammation of the lungs, which then has ripple effects across all organs of the body. This could also happen if the virus replicates faster than the immune system can respond, so that it then has to play catch-up to contain the pathogen-a

situation that could also cause the immune defense to spiral out of control. Genetic and environmental risk factors might help explain the severity of infections. Environmental factors, such as smoking or air quality, may also play a role in disease severity. [7]

## III. EPIDEMIOLOGY

From Jan 30, 2020, to December 31, 2020, 760,933 cases were reported in Kerala. During this period was 21,783 per million were affected. The hike of cases was seen between September and October 2020 and the test positivity was highest during October month 2020. There were 3072 deaths reported during this period and deaths were reported among males (67%) and in the age group >80 years (4.2%). Of the reported cases, 656,616 (86.3%) were reported among traced contacts. The highest incidence (28,982 per million) rate was seen in the Pathanamthitta district. [8]

*Men might be more affected by COVID-19 than women*

The sex and age interaction is a key factor in explaining the observed sex differences in case mortality. COVID-19 cases found that the fatality ratio between men and women was not uniform across different age groups: risk of mortality was significantly higher among women than men, particularly in the 40–49 year age group. [9]

The death rate for men was 2.8 percent and 1.7 percent for women. The difference could have something to do with the fact that the gene for the ACE-2 receptor, which is used by both SARS-CoV-2 and the SARS virus to enter host cells, is found on the X chromosome. It is a particular variant of the protein that makes people more susceptible to the virus, and then females could compensate for that one bad variant because they'd have two copies of the X chromosome, whereas men would be stuck with only one copy. And in the case of smokers, their chances are high because their lungs are already a bit compromised. Patients develop antibodies after SARS-CoV-2 infection that will not protect them against future infections. [10]

*Coronaviruses vary in severity*

There are coronaviruses known to infect people. Four of them-229E, NL63, OC43, and HKU1-typically cause a cold and only rarely result in death. The other three-MERS-CoV, SARS-CoV, and the new SARS-CoV-2 have varying degrees of lethality. In the 2003 SARS outbreak, 10 percent of infected people died. Between 2012 and 2019, MERS killed 23 percent of infected people. Although the case fatality rate of COVID-19 is lower, the virus has already killed the other two outbreaks combined, which some have attributed to the pathogen's fast transmission. [11]

The cold-causing coronaviruses, as well as many other viruses that cause common colds, are typically restricted to the upper respiratory tract, that is, the nose and sinuses. Both SARS-CoV and SARS-CoV-2, however, are capable of invading deep into the lungs, something that is associated with more severe disease. [12]

One possible reason for this is that the virus binds to the ACE-2 receptor on human cells to gain entry. This receptor is present in ciliated epithelial cells in the upper and lower airway, as well as in type II pneumocytes, which reside in the alveoli in the lower airway and produce lung-lubricating proteins. Type II pneumocytes are important for lung function, so this is part of why the lower respiratory disease can be so severe. The new coronaviruses use the ACE-2 receptor, which may help partially, explain why, like SARS, it is more deadly than the other four coronaviruses. Those pathogens use different receptors, except for NL63, which also uses the ACE-2 receptor but binds to it with less affinity. [13]

The first case of the COVID-19 pandemic in Kerala was confirmed in Thrissur on 30 January 2020. As of 17 August, there have been 46,140 confirmed cases with 30,029 (65.05%) recoveries and 169 deaths in the state. A high number of cases were seen in March, by April 30, Kerala had reduced the rate of increase of new cases to less than 0.25 percent per day. After that, the state has seen a second wave in the daily new case rate following the return of Keralites from other countries and within the nation. By July 2020, more than 70% of known cases were due to community spread with more than 21% of the state's cases in the Thiruvananthapuram district. Kerala reported the highest single-day spike (1725 cases) on August 17 and the state has the 16th highest number of confirmed cases in India. The first death in Kerala due to coronavirus was reported on 28th March 2020, a 69-year-old patient. The oldest patient recovered was a 105-year-old female patient in Kerala. [14]

*Surveillance activities*

The framework of the health care system in Kerala includes primary health centers, community health centers, taluk-level hospitals, district hospitals, general hospitals, and medical colleges run by the government. Apart from this, ample private hospitals are present. This was the main reason for the successful eradication of the Nipah virus. [15]

After the initial reporting in late January and early February, the Government took various steps to strengthen the guidelines and categorization of risk involved in reducing the transmission of the virus in any outbreak. With no new case reports, the health emergency was withdrawn on February 12, 2020. At that time travelers and student returnees from Wuhan, China was quarantined, and their names were registered to keep a record of travelers entering the state from COVID 19 affected countries. In mid-February 2020, the number of positive cases increased when Keralites returned from the affected countries. After the recurrence of cases in mid-march of 2020, the Government introduced safety precautions, non-medical educational institutions shutdown, and followed screening and follow-up of those who reached from different parts of the world by air, sea, rail, or road.

Passengers who showed symptoms were taken to COVID-19 hospitals, admitted, tested, and treated. Others were advised to follow home quarantine. Travelers must register their information in the Covid19 Jagratha portal to agree to the quarantine norms to resume domestic flights. Asymptomatic travelers were advised to follow home quarantine and those with symptoms are referred to either a hospital or a COVID care center. [16]

The mass hand washing campaign named 'break the chain' was introduced on 15th March 2020 to make people aware of the importance of public and personal hygiene. An emergency fund was allotted by the State Disaster Response Fund (SDRF) to control the COVID-19 outbreak as it was declared as a disaster. The state lockdowns were more effective than the national curfew that was declared 1 week later (March 25, 2020). On April 6, 2020, the number of active cases in the state peaked at 266. At that time, there was a gradual reduction in active cases to date. On 1st May 2020, 27,150 samples were tested, out of which 26,225 were found to be negative. [17] By geographical tracking and mapping of confirmed cases, it is easy to track positive cases to the health system to arrange quarantine. And containment zones were considered as "LSG Needing Special Attention" and 82 hotspot regions were identified. The daily address of the state's Chief Minister made awareness and confidence among the society. [18]

*Routine Measures Followed By Government During Peak Time Of Covid 19*

- ✓ Sample Collection Teams moves to selected places on fixed days
- ✓ Subjects for sample collection will be identified from Community and Hospitals
- ✓ All Samples from the field reaches District Surveillance Unit and further transported to Laboratory
- ✓ Samples Processed at Laboratories
- ✓ Real-Time Data transfer of Results to State and Districts
- ✓ Clinical Management, Isolation and Public Health Actions at Field Level
- ✓ Epidemiological Investigation of positive cases
- ✓ Further actions based on Investigations and Results

Kerala police and health workers ensured a healthy quarantine with the help of local panchayat leaders. A quarantined individual gets the initial counseling, education, and timely support from qualified persons in the health sector. People-friendly police also monitored quarantine violations. People don't have proper quarantine facility at their home were taken to various institutions arranged for the quarantine purpose by the government and they were periodically monitored. [19]

Kerala continuously focused on educating every citizen. Volunteer's services were used for screening of passengers, addressing needs of place under quarantine including community kitchens, medicine delivery, and the care of elderly/palliative care patients. Kudumbashree and Asha members visited all households with adequate precautions, educated senior citizens, ensure psychological support, and care for them. [20]

## IV. CONCLUSION

The Kerala model Covid 19 pandemic was a topmost discussed topic globally. The quarantine, isolation, and protection of high-risk individuals helped to decrease the positive cases. Kerala's model underlines the importance of a strong public healthcare system with active community participation for the management and control of the COVID-19 pandemic. Kerala could control the death rate. The fight is still on and the state is already preparing for a possible second wave.

## CONFLICT OF INTEREST

On behalf of the authors, the corresponding author states that there is no conflict of interest.

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