

Review Article

Combating corona virus disease 2019 and comorbidities: The Kerala experience for the first 100 days

Kavumpurathu Raman Thankappan

Department of Public Health and Community Medicine, Central University of Kerala, Kasaragod, Kerala, India

ABSTRACT

Kerala, a highly vulnerable state for a virus disease like coronavirus disease 2019 (COVID-19) because of the largest proportion of elderly population in India with an extremely high prevalence of most of the noncommunicable diseases and their risk factors, reported first COVID-19 case in India. Using secondary data available from various search engines and specific websites of Kerala and Government of India, a review was done. Based on the World Health Organization's warning, Kerala anticipated cases from China where the first COVID-19 case was confirmed and was able to detect and isolate the cases as soon as they landed in Kerala. The total number of active cases in Kerala peaked at 262 in the first week of April and then decreased to 16 on May 8, flattening the epidemiological curve within 100 days. The major factors that lead to the success of Kerala in managing COVID-19 are depicted in this review.

Keywords: Corona virus disease 2019, experience in 100 days, flattening epidemiological curve, India, Kerala

Introduction

The coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 has been declared as a pandemic by the World Health Organization (WHO) on March 11, 2020.^[1] It was first detected in Wuhan city of China.^[2] Kerala state reported the first COVID-19 case in India on January 30, 2020.^[3] It has been reported that older adults and those with comorbidities such as diabetes, heart diseases, chronic lung disease, cancers, and other diseases are vulnerable to COVID-19 and mortality rates are significantly higher among them compared to other population.^[4] Therefore, it is important to understand how Kerala, which has one of the highest prevalence of most of the noncommunicable diseases (NCDs) among the Indian states^[5] managed COVID-19.

In this article, the following issues are discussed. The health status of Kerala is compared to India as a whole

and a few selected countries and regions in the world to provide a background of the state. The COVID-19 situation in the State for the first 100 days is given, including the number of confirmed cases, active cases, recovered cases, and deaths due to COVID-19. The number of COVID-19 cases per million population, case fatality rate, and recovery rates of Kerala are compared with the top 10 countries with the highest number of COVID-19 deaths as on May 8 when Kerala completed 100 days after the first case was reported in the state. How Kerala managed to flatten the epidemiological curve of COVID-19 in 100 days is the major part of this article.

Address for correspondence: Dr. Kavumpurathu Raman Thankappan, Department of Public Health and Community Medicine, Central University of Kerala, Tejaswini Hills, Periyar, Kasaragod - 671 320, Kerala, India.
E-mail: kr.thankappan@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com


How to cite this article: Thankappan KR. Combating corona virus disease 2019 and comorbidities: The Kerala experience for the first 100 days. *Int J Non-Commun Dis* 2020;5:36-42.

Submitted: 21-May-2020

Revised: 06-Jun-2020

Accepted: 09-Jun-2020

Published: 29-Jun-2020

Access this article online	
Website: www.ijned.org	Quick Response Code 
DOI: 10.4103/ijned.ijned_26_20	

Methods

This review is based on information collected from various search engines such as PubMed, Google, Websites of Kerala Government Health Department, Ministry of Health and Family Welfare Government of India, WHO, Census of India, National Family Health Survey Government of India and the Sample Registration System. Since the 100 days of COVID incidence in Kerala ended on May 8, the information collected was limited to that date.

Health status of Kerala

Kerala State is well known nationally and internationally for its health at low-cost model.^[6,7] Table 1 provides selected health indicators of Kerala state in comparison to India and a few selected countries and regions of the world. As per these health indicators reported by the WHO^[8] Kerala's indicators^[9-11] were comparable to the European region of the WHO. Kerala accomplished this comparatively better health status with a per capita health expenditure of Indian Rupees 7169 (US \$ 104).^[11] Although this per capita health expenditure was the highest among the Indian states in that year, it was only about 1% of the per capita health expenditure of US\$ 9870 of the United States. The accomplishment of good health status with low health expenditure compared to the developed countries was reported earlier as health at low cost.^[6]

However, Kerala had the highest proportion of 12.6% of older adults aged 60 years and above compared to 8.6% for India as a whole.^[12] Along with this, the State reported one of the highest prevalence of NCDs and their risk factors.^[5] In India, Kerala reported the highest prevalence of Type-2 diabetes (19.2%) among adults,^[13] which is more than double the diabetes prevalence in the country.^[14] Definite acute myocardial infarction was 1.4% in 1993,^[15] which doubled to 3.5% in 2016.^[16] Asthma prevalence among the South Indian states was reported to be highest in Kerala.^[17] Among the cancer registries in India, Trivandrum and Kollam population-based

cancer registries along with Bangalore and Chennai cancer registries, reported the highest incidence of any cancer for men and the second-highest cancer incidence for women.^[18] Control rates of hypertension and diabetes were also extremely poor. Hypertension control rate (systolic blood pressure <140 and diastolic blood pressure <90 mm of Hg) was 12.3% and diabetes control rate (fasting blood glucose <126 mg/dl) was 15.3%.^[13] When Kerala health indicators are comparable to the European region of the WHO, these control rates were poorly compared with that of Canada's control rate of 65.4%.^[19] All these indicate to a highly vulnerable population in the state for COVID-19.

Higher mortality rates among the elderly population

The mortality rates in the elderly are much higher than the younger population.^[20] One of the reasons for the higher mortality rates among the elderly is the increased vulnerability of these populations, particularly when they have comorbidities such as diabetes, hypertension, other cardiovascular diseases, chronic lung diseases, and kidney diseases. Older age itself is a risk factor because of the compromised immune systems for them.^[4] Because of the high proportion of the elderly population and with a high prevalence of NCDs and their risk factors, Kerala state is more vulnerable to COVID-19 than any other Indian state.

First phase of coronavirus disease 2019

The first case of COVID-19 in India was reported from Kerala on January 30, 2020. The second and third cases in Kerala were reported on February 2 and 3, respectively. Three Kerala students studying in medical colleges of China returned from Wuhan city of China were detected positive for COVID-19. The first case was admitted in Thrissur Medical College, the second one in Alappuzha Medical College, and the third one in Kasaragod district hospital. Kerala was well prepared to manage COVID cases in the state. On January second half itself, the state developed guidelines^[3] to manage the COVID cases and as

Table 1: A few health indicators of Kerala and selected countries/regions

Country/region	Neonatal mortality rate	Under five mortality rate	Life expectancy	Current health expenditure per capita (US \$)
India	24	39	68.8	62
China	5	9	76.4	398
Sri Lanka	6	9	75.3	153
USA	4	7	78.6	9870
South East Asia Region	21	36	69.5	96
European Region	5	9	77.5	1990
Kerala	4.4	8	75.2	104

Source: World Health Organization Statistics 2019. For Kerala, life expectancy data from SRS 2013-17, neonatal and under five mortality rates from NFHS 4 and per capita health spending from National Health Accounts 2015-16. 1 USD=69 INR. NFHS - National Family Health Survey

soon as the cases were reported, they were isolated and stringent measures were taken not to allow any spread from these initial three cases. All three cases survived without infecting anyone else.

Second phase of corona virus disease 2019

The second phase of COVID-19 in the state started when nonresident Indians from Italy returned to the Pathanamthitta district of Kerala, where a few cases of COVID-19 were reported. As on May 8, on the 100th day of COVID detection in the state, there were a total of 503 COVID-19 cases in Kerala, three of them died and 484 recovered, and the remaining 16 were still in the hospital as active cases.^[3] The number of active cases peaked at 262 in the first week of April and then decreased to 16 on May 8 after 100 days of confirming the first case in the State. The state could almost flatten the epidemiological curve by May 8 [Figure 1]. The weekly number of cases from January 30 to May 8, 2020 is provided in Figure 2. The case fatality rate of 0.6% and the recovery rate of 96.2% were one of the best in the world on that date [Table 2].

Table 2 provides the list of top 10 countries with the highest number of COVID-19 deaths as on May 8, 2020, along with comparative figures for India and Kerala.^[21] France had the highest case fatality rate, and Belgium had the highest number of cases per million population. Although the United States had the largest number of deaths, the case fatality rate of the US was lower than many of European countries. In India, Kerala had the lowest case fatality rate and the number of cases per million population and the highest recovery rate from COVID-19.

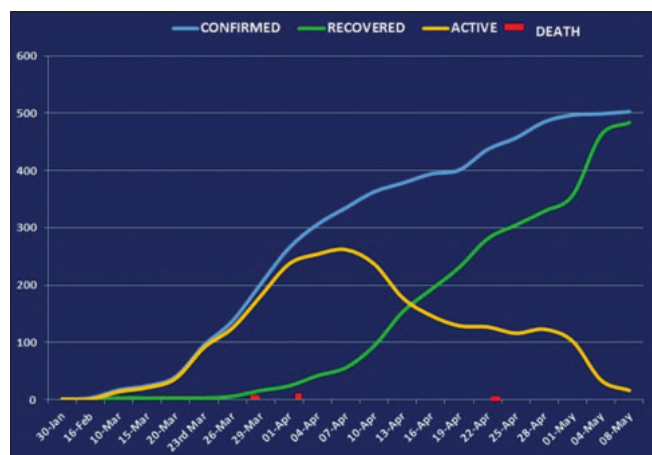


Figure 1: Confirmed, recovered, active coronavirus disease 2019 cases and deaths in Kerala Jan 30-May 08, 2020. Government of Kerala, Department of Health Services coronavirus disease 2019 Kerala. <https://dhs.kerala.gov.in/public-health-2019-n-corona-virus/>

How did Kerala manage coronavirus disease 2019 in the first 100 days?

Various factors contributed to this outstanding achievement of flattening the epidemiological curve in 100 days.

Experience of managing NIPAH virus epidemic and the Kerala floods

In the NIPAH virus outbreak that occurred in the state in 2018, there were 17 deaths and 18 confirmed cases as of June 1, 2018. Although the outbreak was limited to two districts in the state, namely, Kozhikode and Malappuram, the entire state health system had to be actively involved in all the 14 districts of the state.^[22] This helped the state health system to prepare standard operating procedures for similar outbreaks of infectious diseases in the future. Skills for sample collection, transportation of sample to the laboratory, tracing of contacts, and infection control were strengthened for the health system personnel,^[23] which turned out to be extremely useful for the management of COVID-19 in the state. This was one of the major reasons for the early detection and effective management of the first three COVID cases in the State. In the same year of 2018, severe floods affected Kerala in the month of August due to unusually high rainfall during the monsoon season. This was another opportunity for strengthening the public health system, including surveillance of communicable diseases such as Tuberculosis,^[24] which again were useful in the management of COVID-19.

Adherence to the World Health Organization guidelines

As soon as the WHO declared COVID 19 as a pandemic, Kerala Government issued an order in January itself for detailed planning for COVID management in the state. This was extremely useful in detecting the first COVID-19 case in the State. It also helped to trace the contact of the first three cases and keeping them in quarantine.

Testing of suspected cases

As on May 8, 35,000 tests were conducted in the State. The suspected individuals in the state were selected very judiciously since the number of test kits available was

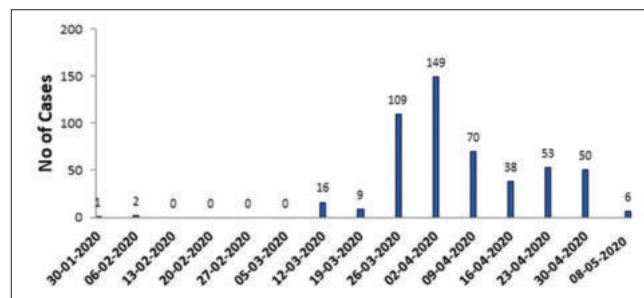


Figure 2: Weekly number of cases January 30–May 08

Table 2: Number of cases per million, death rates and recovery rates of coronavirus disease 2019 in selected countries and Kerala State as on May 08, 2020

Country/province	Total population (million)	Total number of cases	Number of cases/million	Number of deaths	Case fatality rate	Recovery rate (%)
USA	324.46	1,215,571	3746	67,146	5.52	18.7
UK	66.18	206,719	3124	30,615	14.81	N/A
Italy	59.36	215,858	3636	29,958	13.88	48.0
Spain	46.35	221,447	4778	26,070	11.77	66.7
France	64.98	135,980	2093	25,946	19.08	31.8
Brazil	209.29	125,218	598	8536	6.82	39.9
Belgium	11.43	51,420	4499	8415	16.37	25.6
Germany	82.11	167,300	2038	7266	4.34	84.7
Iran	81.16	104,691	1290	6541	6.25	80.1
China	1417.51	84,416	60	4643	5.50	94.2
India	1339.18	56,342	42	1886	3.35	31.2
Kerala	33.41	503	15	3	0.60	96.2

Source: WHO, coronavirus disease 2019 situation report - 51 (2020) Census of India (Kerala population), Government of Kerala DHS COVID. COVID - Coronavirus disease, N/A - Not available, WHO - World Health Organization

limited. This was highly appreciated by the Indian Council of Medical Research Team.^[25] Kerala also established the first COVID testing Kiosk in India, learning from the South Korea experience.

Quarantine of all contacts

The most effective strategy for controlling the spread of the infection was quarantining of all the contacts. Kerala followed an aggressive strategy of quarantining people arriving from hotspots such as Wuhan, China, after obtaining information from the immigration department. Those who arrived from hotspots were quarantined for 28 days and those who developed symptoms among them were tested. Those tested positives were shifted to hospitals and isolated. All primary contacts (those who come in contact with a laboratory-confirmed case of COVID-19) were quarantined. Secondary contacts (Any person who has come in contact with a primary contact) were given strict instructions to follow social distancing, wearing masks, and handwashing and to report to the health system in case they develop any symptoms. Since there was a shortage of test kits initially, Kerala tested only the symptomatic to optimize the tests. Four weeks quarantine was recommended by the expert committee appointed by the Government of Kerala to make sure that even those rare cases who get an infection after the usual incubation period of 14 days were also identified. The district-wise number of people quarantined in the State is given in Figure 3. The largest number of 171,355 people quarantined in the state was on April 4, 2020. Of these 170,621 (99.6%), people were quarantined in their homes and the remaining in hospitals. This number came down to 20157 on May 8. Among them, 19,810 (98.3%) were quarantined in their homes. Keeping these people

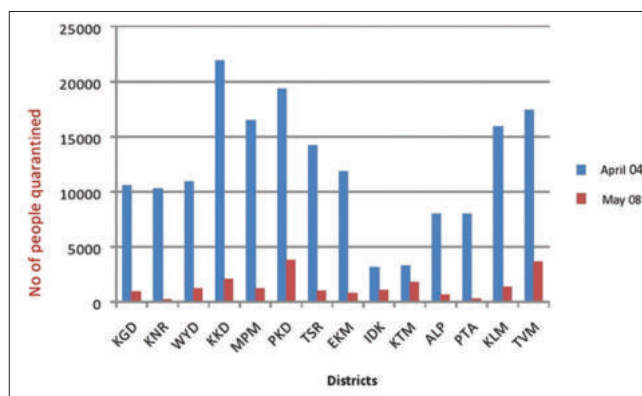


Figure 3: Number of people quarantined on April 4 and May 8, in the districts of Kerala

without any symptoms of disease in quarantine for up to 28 days was not an easy task. This was successful only because of the huge support provided to them by various departments and volunteers.

Enhancing health infrastructure in the state on a war footing

In terms of COVID special hospitals, each of the 14 districts in Kerala has at least two COVID special hospitals indicating the facilities for managing COVID-19 cases. The state was planning to build up the infrastructure for managing COVID-19 patients. The government of Kerala has also appointed 276 doctors in a single day to manage COVID patients and various activities related to managing the pandemic of COVID-19.^[26] In addition, several private hospitals were identified to provide critical care to COVID patients. The Deccan Herald reported that the Kerala model is worthy of emulation.^[27] As reported earlier, Kerala has one of the best, if not the best, health-care facilities in the country, which helped to achieve excellent health

indicators, as shown in Table 1. Out of the best health care facilities, as judged by the national Government, the first 12 belonged to Kerala, indicating the quality of care provided in the state.^[28]

Kerala was the first State in India to start Tele-Medicine consultation for patients. This was required because many of the private hospitals in the state were almost closed for regular outpatients, and they were looking after only emergency patients.^[3]

Enforcement of the Kerala epidemic disease act

Kerala was the first State in India to make law on Epidemic Control (Kerala Epidemic Diseases Act).^[29] This was required to enforce the law, particularly in the lockdown situation. The act helped to control people in various ways to control the epidemic and the transmission of the disease from one person to another.

Community kitchens

Kerala was the first Indian state in India to start community Kitchens across the state. As on May 8, there were >2500 community kitchens in the state.^[3] These were mostly run by the local self-governments. The idea was that no one in the state should be left without food during the lockdown period. This was particularly useful for guest workers in the state. There were close to four million guest workers in the state before the lockdown and close to four hundred thousand guest workers were still in Kerala after the start of the lockdown. Since they had no work and most of the restaurants were closed due to lockdown it was essential to start the community kitchens so that not only the guest workers but also those without any job were also able to utilize the community kitchens for their food. The guest workers were in labor camps in the state. There were more than 5000 such labor camps in the state and they were all provided food in the camp. There were 19764 Camps and shelters in Kerala, setting an example for rest of India.^[30] Food preparation and supply were mostly managed by the members of one of the largest women's groups in India, the Kerala Kudumbasree Mission (KSM).

Stimulus package of Rs. 20,000 crores (Rs. 200,000 million) financial aid

Kerala was the first State in India to declare a stimulus package of 20,000 crore Financial Aid.^[31] This was to make sure that people belonging to the vulnerable population get some money in their hands to meet the day to day expenses during the lockdown period. This package included loans worth Rs. 2000 crores through KSM, 2000 crores for employment guarantee scheme,

two months welfare pensions in advance and 500 crores health package.

Kerala was the first state in India to provide 1 month food without any consideration of their income status. This was done to make sure that nobody in the state starved during the lockdown period. The state also provided mid-day meal at home for Kindergartens. These are children belonging to the lower socioeconomic groups, and they were supplied with food at home to provide adequate nutrition in times of stress and difficulties.

Break the chain campaign

"Break the Chain Campaign" for Hand washing, Sanitizing and Social Distancing was advertised through all the media and was one of the most effective strategies to contain the spread of the virus. Due to the aggressive quarantine strategy, all contacts were traced and quarantined effectively so that the spread of infection to others was avoided. It was ensured by the police that people going out were wearing masks and keeping social distancing. Those who did not wear masks were fined. This also helped the state to flatten the epidemiological curve, as shown in Figure 1. This Break the Chain campaign was redesigned subsequently as SMS (sanitization with soap or sanitizer, mask, and social distancing). All these could work in the state because of the high level of education and health consciousness. This was also supported by the local self-governments in the state, and they could make sure that people in their area comply with these instructions of the Government.

Expansion of internet bandwidth and connectivity

Kerala was the first State in India to expand Internet bandwidth and connectivity for Lockdown situation. Since most people were asked to work from home, particularly in the Information Technology sector, it was essential to increase the bandwidth and connectivity during lockdown.^[32]

Political commitment

Some of the newspaper reported that Kerala Chief Minister's strategic thinking was better and faster than any CEO's.^[33] The chief minister lead from the front, and the entire machinery of the state worked like a team, which helped to control the spread of the virus in the state and thereby reducing the spread of the infection substantially. There was overwhelming praise for the State, such as "What Kerala thinks today, India must think tomorrow."^[34] This was an indication that there are several COVID management lessons from Kerala, which could be implemented in other states and other regions

of the world. One of the national dailies The Indian Express wrote an editorial on the performance of the Chief fighters against COVID-19 in which it was written that “CM Pinaray Vijayan is the Standout Performer and a Seasoned Administrator.”^[35] The newspaper Telegraph wrote about the reasons why good administrators like Pinaray Vijayan and Andrew Cuomo, Governor of New York City, were getting the admiration they deserve.^[36]

There were very positive reports by international media such as the Washington Post. It reported that the Indian State of Kerala flattened the epidemiological curve of the COVID-19 virus by aggressive testing, contact tracing, and cooked meals.^[37]

Kerala was the first State in India to conduct daily situation analysis headed by Chief Minister. This was done after a meeting with the expert committee for COVID management in the State. Chief Minister, in his daily media briefing, communicated the situation in very simple language so that everybody could understand the situation. He never created any panic due to the increase in the number of COVID-19 cases. Instead, he provided guidance to everyone on how to manage the situation.

Role of media

Media has played an extremely important role for combating COVID-19 in Kerala. All visual media in the state focus on COVID-19, and most of the people are watching them carefully and following instructions from the authorities. The support of visual, print, and social media to the Government's initiative in effectively communicating the daily situation and everyday, preventive measures played a vital role.

Future directions

The virus is likely to spread until 50%–70% of the population gets immunity either through vaccination or through infection. The latter way needs to be managed carefully so that the vulnerable people are protected from the virus by social distancing. One of the mechanisms for social distancing is to reverse quarantine of the elderly population aged 60 years and above. Those with comorbidity above the age of 50 also need to be quarantined. This is not that easy, and efforts would be made to implement this meticulously so that there will be herd immunity and the virus will not be able to survive in the population. One of the major challenges for the state is the influx of a large number of migrants from all over the world and other states. Earlier, those countries were not affected much and the probability of infected people returning to Kerala was less. However,

the infection rates in those countries have increased, and the people returning to Kerala will have more number of infected people.

Conclusions

In spite of Kerala having a vulnerable population compared to the rest of India because of its larger proportion of elderly and high prevalence of NCDs and their risk factors, the state managed to reduce the spread of COVID-19 infection in the first 100 days almost flattening the epidemiological curve. Case fatality rate and recovery rates were one of the best in the world. There were several reasons for this great achievement. Testing, isolating those who were infected, quarantining the suspected people mostly in their own homes, political commitment providing a stimulus package of Rs. 20,000 crores focusing the poorer sections of the society, committed political leadership coordinating the activities in the entire state, and the proactive media were some of the factors that contributed to the success story of Kerala.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. WHO. Novel Corona Virus (2019-nCoV) Situation Report – 11. WHO; 2020.
2. Tian H, Liu Y, Li Y, Wu CH, Chen B, Moritz U, *et al.* An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China. *Science* 2020;368:638-42.
3. Government of Kerala. Department of Health Services COVID -19 Kerala. Available from: <https://dhs.kerala.gov.in/public-health-2019-n-corona-virus/>. [Last accessed on 2020 May 01].
4. Martins-Filho PR, Tavares CSS, Santos VS. Factors associated with mortality in patients with COVID-19. A quantitative evidence synthesis of clinical and laboratory data. *Eur J Intern Med* 2020;76:97-9.
5. Thankappan KR, Shah B, Mathur P, Sarma PS, Srinivas G, Mini GK, *et al.* Risk factor profile for chronic non-communicable diseases: Results of a community-based study in Kerala, India. *Indian J Med Res* 2010;131:53-63.
6. Nath I, Reddy KS, Dinshaw KA, Bhisey AN, Krishnaswami K, Bhan MK, *et al.* Country profile: India. *Lancet* 1998;351:1265-75.
7. Thankappan KR. Some health implications of globalization in Kerala, India. *Bull World Health Organ* 2001;79:892-3.
8. World Health Statistics 2019: Monitoring Health for the SDGs, Sustainable Development Goals. Licence: CC BY-NC-SA 3.0 IGO. Geneva: World Health Organization; 2019.
9. Government of India. Sample Registration system. SRS Based Abridged Life Tables 2013-2017.
10. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS; 2017.
11. Government of India. Ministry of Health and Family Welfare. National

Thankappan: Combating COVID-19, the Kerala experience

- Health Accounts Estimates for India 2015-16. Available from: [http://nhsrindia.org/sites/default/files/NHAEstimates Report November 2018.pdf](http://nhsrindia.org/sites/default/files/NHAEstimates%20Report%20November%202018.pdf). [Last accessed on 2020 May 05].
12. Government of India. Ministry of Statistics and Program Implementation, Central Statistical office. Elderly in India Profile and Programs 2016. Available from: http://mospi.nic.in/sites/default/files/publication_reports/ElderlyinIndia_2016.pdf. [Last accessed on 2020 May 01].
 13. Sarma PS, Sadanandan R, Thulaseedharan JV, Soman B, Srinivasan K, Varma RP, *et al.* Prevalence of risk factors of non-communicable diseases in Kerala, India: Results of a cross-sectional study. *BMJ Open* 2019;9:e027880.
 14. India State-Level Disease Burden Initiative Diabetes Collaborators. The increasing burden of diabetes and variations among the states of India: The Global Burden of Disease Study 1990-2016. *Lancet Glob Health* 2018;6:e1352-62.
 15. Kutty VR, Balakrishnan KG, Jayasree AK, Thomas J. Prevalence of coronary heart disease in the rural population of Thiruvananthapuram district, Kerala, India. *Int J Cardiol* 1993;39:59-70.
 16. Krishnan MN, Zachariah G, Venugopal K, Mohanan PP, Harikrishnan S, Sanjay G, *et al.* Prevalence of coronary artery disease and its risk factors in Kerala, South India: A community-based cross-sectional study. *BMC Cardiovasc Disord* 2016;16:12.
 17. India State-Level Disease Burden Initiative CRD Collaborators. The burden of chronic respiratory diseases and their heterogeneity across the states of India: The Global Burden of Disease Study 1990-2016. *Lancet Glob Health* 2018;6:e1363-74.
 18. Mohan S, Asthana S, Labani S, Popli G. Cancer trends in India: A review of population-based cancer registries (2005-2014). *Indian J Public Health* 2018;62:221-3.
 19. Leung AA, Williams JV, McAlister FA, Campbell NR, Padwal RS; Hypertension Canada's Research and Evaluation Committee. Worsening hypertension awareness, treatment, and control rates in Canadian women between 2007 and 2017. *Can J Cardiol* 2020;36:732-9.
 20. US Department of Health and Human Services/Centers for Disease Control and Prevention. Severe Outcomes Among Patients with Corona Virus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020. *Morb Mortal Wkly Rep* 2020;69:343-6.
 21. WHO. Corona Virus Disease 2019 (COVID-19) Situation Report- 51. WHO; 2020.
 22. WHO. Outbreak of Nipah Virus Encephalitis in the Kerala State of India. Available from: <https://www.who.int/southeastasia/outbreaks-and-emergencies/health-emergency-information-risk-assessment/surveillance-and-risk-assessment/nipah-virus-outbreak-in-kerala>. [Last accessed on 2020 May 05].
 23. Arunkumar G, Chandni R, Mourya DT, Singh SK, Sadanandan R, Sudan P, *et al.* Outbreak investigation of Nipah virus disease in Kerala, India, 2018. *J Infect Dis* 2019;219:1867-78.
 24. Sadanandan R, Sarita RL, Mrithunjayan S, Valamparambil MJ, Balakrishnan S, Suseela RP. Ensuring TB services during major floods-Kerala, India, August 2018. *Disaster Med Public Health Prep* 2020; p.1-5. [doi: 10.1017/dmp.2020.1].
 25. Editorial. The Mark of Zero: On Containment of COVID-19 Cases in Kerala May 05, 2020. *The Hindu*; 05 May, 2020.
 26. Special Correspondent. Kerala Ramps up Strength of Govt Doctors, Appoints 276 to Tackle Rising Corona Virus Cases. *Economic Times*; 24 March, 2020.
 27. Deccan Herald News Service. A “Kerala Model Worthy of Emulation”. *Deccan Herald*; 11 April, 2020.
 28. Special Correspondent. Kerala tops among the Primary Health Centres in Kerala. *The Mathrubhumi*; 10 April, 2020.
 29. Express News Service. Kerala Takes Legislative Route to Toughen Prohibitive Measures. *The New Indian Express*; 26 March, 2020.
 30. Press Trust of India. Kerala Sets an Example for Rest of India with its Exceptional Treatment of ‘Guest Workers’. *The Week*; 20 April, 2020.
 31. BS Reporter. Corona Virus: Kerala Govt declares Rs 20,000-cr package to Revive Economy. *Business Standard*; 22 March, 2020.
 32. Babu G. COVID-19 Impact: Internet Providers in Kerala to Increase Speed by 30-40%. *Business Standard*; 12 March, 2020
 33. Srinivasaraju S. CM Pinaray Vijayan's Strategic Thinking was Better and Faster than Many CEO's. *Mumbai Mirror*; 18 March, 2020.
 34. ENS. What Kerala Thinks Today, India may Think Tomorrow. But here is the Problem. State Erred in Testing and Enforcing Quarantine, Says Experts. *The New Indian Express*; 29 March, 2020.
 35. Editorial. Chief fighters. Chief Ministers from South and West Lead Fight against Virus, their Efforts Boosted by Past Investments in Public Systems. *The Indian Express*; 07 April, 2020.
 36. Balakrishnan P. Why Straight-Talking Pinaray Vijayan and Andrew Cuomo are Getting the Admiration they Deserve. *The Telegraph*; 07 April, 2020.
 37. Masih N. Aggressive Testing, Contact Tracing, Cooked Meals: How the Indian State of Kerala Flattened its Corona Virus Curve. *Washington Post*; 14 April, 2020.