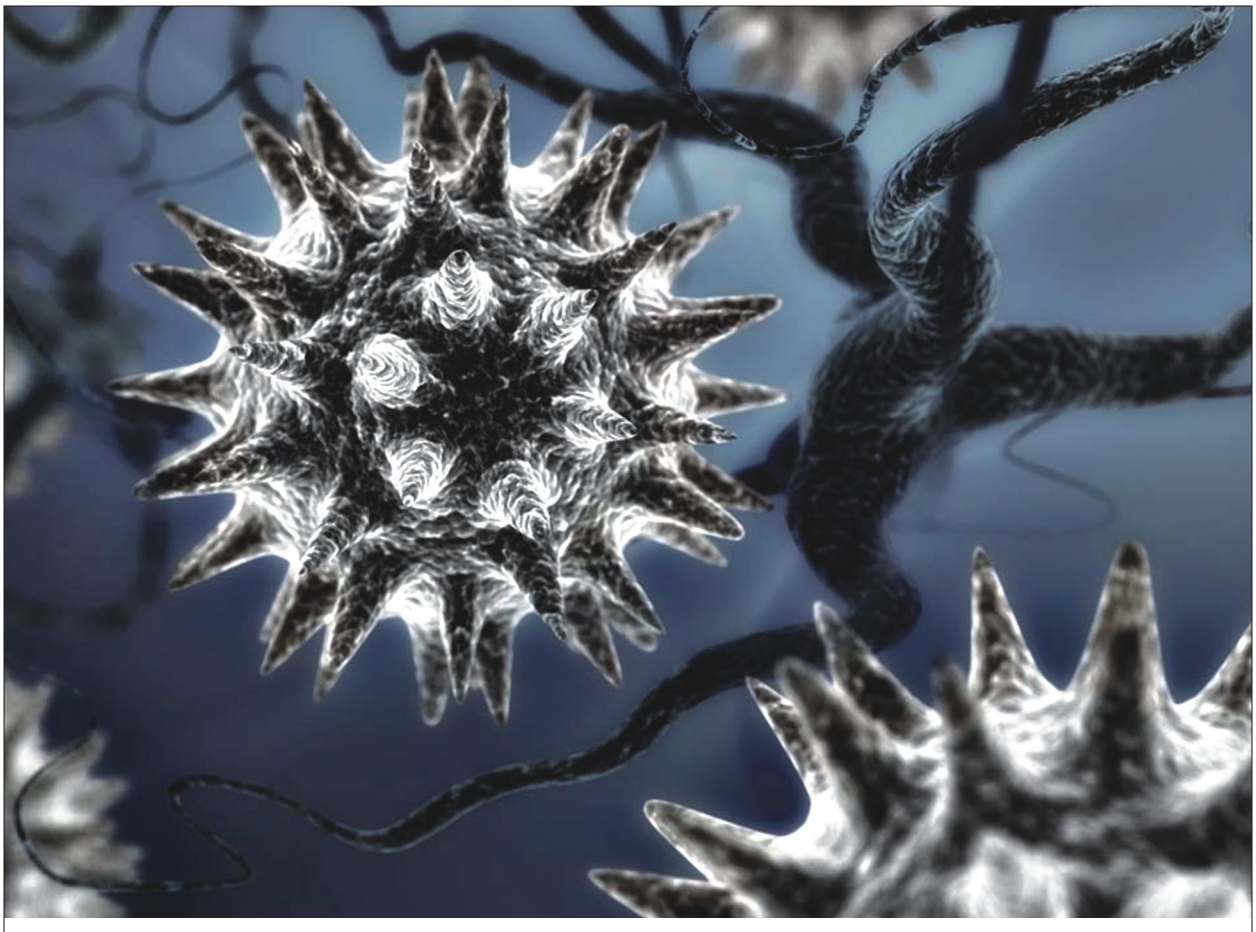

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Perspective
Non Pharmacological Factors in Containment of COVID-19 Virus in India: An Insight

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Abstract

The disease COVID-19 is caused by a novel Coronavirus SARS-CoV-2 from Wuhan, China. The disease has become pandemic, spreading in more than 213 countries. The first report on COVID-19 in India was recorded on 30th January, 2020. Other countries, i.e., Russia, Spain, Brazil, UK, Italy, Turkey and Iran also recorded their first cases either on the same day or later. India being the most populated country with 17.7% of the total population of the world, the number of cases recorded in India was 106,886 as of 20th May, 2020. However, in other countries, infection exceeded the number than India with their meager population. Researchers throughout the world developed an interest to know the reasons in the containment of the disease in India. The aim of this study is to provide an insight on the role of non-pharmacological factors in the containment of COVID-19 in India. The perspectives on the role of the factors like air handling systems, mode of transport, nutritional facts and traditional medicine which are unique to India are highlighted. The role of insects like cockroaches and housefly in spreading the virus and other body fluids of an infected person is also highlighted. It concludes the importance of conducting the studies on the airborne spread of the virus, role of insects and body fluids of the infected subjects in spreading the disease. It is recommended to conduct joint studies representing different geographical zones at the International level. Bringing policies in the containment of SARS-CoV-2 virus as well as for other microbes in all countries is recommended.

Key words: COVID-19, SARS-CoV-2, pandemic, containment, airborne, IAQ, transport, traditional medicine, India

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The disease COVID-19 is caused by a novel virus SARS-CoV-2[1], similar to the virus causing common cold, Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) belonging to the family Coronaviridae[2]. The virus was first reported from Wuhan the capital of Hubei Province in China[3] during December, 2019. The virus was first reported as an epidemic in Wuhan, China and later declared as Pandemic on 30th of January, 2020 by World Health Organization (WHO). The viral spread was recorded in 213 countries worldwide. Around 5 million population of the world is infected by this virus, which is the highest recorded for any virus belonging to the family Coronaviridae. The symptoms of COVID-19 includes sore throat, dry cough, muscle and joint pain, fever, headache, the formation of sputum, shortness in breath, fatigue, nausea and vomiting in few cases[4]. The disease symptom develops into multi organ failure resulting in fatality depending on the immune status of the subjects. Fatality was mostly recorded among immunocompromised subjects.

The disease was first reported in India from the State of Kerala on 30th of January, 2020. Three students from Wuhan, China traveled to Kerala were found to possess the infection of SARS-CoV-2. India being the most populated country with 17.7% of the total population of world, the number of cases recorded in India as of the day this article is written (20 May, 2020) has recorded only 106886 confirmed cases. However, in other countries infection exceeded the number than India with their meager population. When compared with top 11 countries infected with the virus, India was successful in containment of COVID-19. The reasons behind the containment of disease in India develop an interest for researchers throughout the world. Apart from climatic factors like temperature, moisture and wind other unique factors play a major role in the containment of the virus in India. This includes uniqueness in air handling systems, mode of transport, nutritional facts and traditional medicine. Insight on different non-pharmacological factors playing a role in the containment of the disease is provided in this article.

PREVALENCE OF THE DISEASE

The prevalence of the Corona disease is concerned, the country United States (US) was found to be on top with more than 1.57 million cases recorded. Among the countries infected, 31.48% infection is in US, 6.05% in Russia, followed by Spain and Brazil with 5.58 and 5.44%, respectively. India has recorded around 2.14% of infection among the population infected with SARS-CoV-2. Nearly 73% of infection was caused in 11 different countries and all other countries (202) shared the remaining 27% of infection (Fig. 1). The fatality recorded for this disease was around 0.325 million as of 20th May, 2020. The fatality for the disease recorded worldwide was around 6.52% among the infected subjects. The maximum fatality was recorded in France (15.49%) followed by Italy, UK (14.2% each) and Spain (9.96%). The least fatality was recorded in Russia (0.94%). India recorded around 3.09% of fatality among the infected subjects[5]. The fatality recorded for top 11 infected countries is presented in Fig. 2.

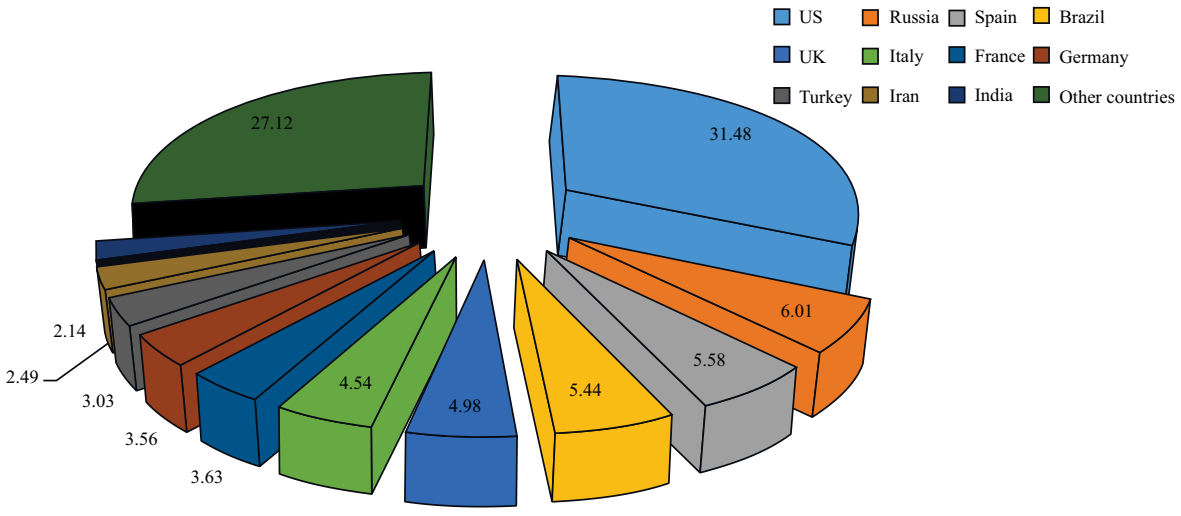

Fig. 1: COVID-19 infection (%) in different countries as on 20 May, 2020

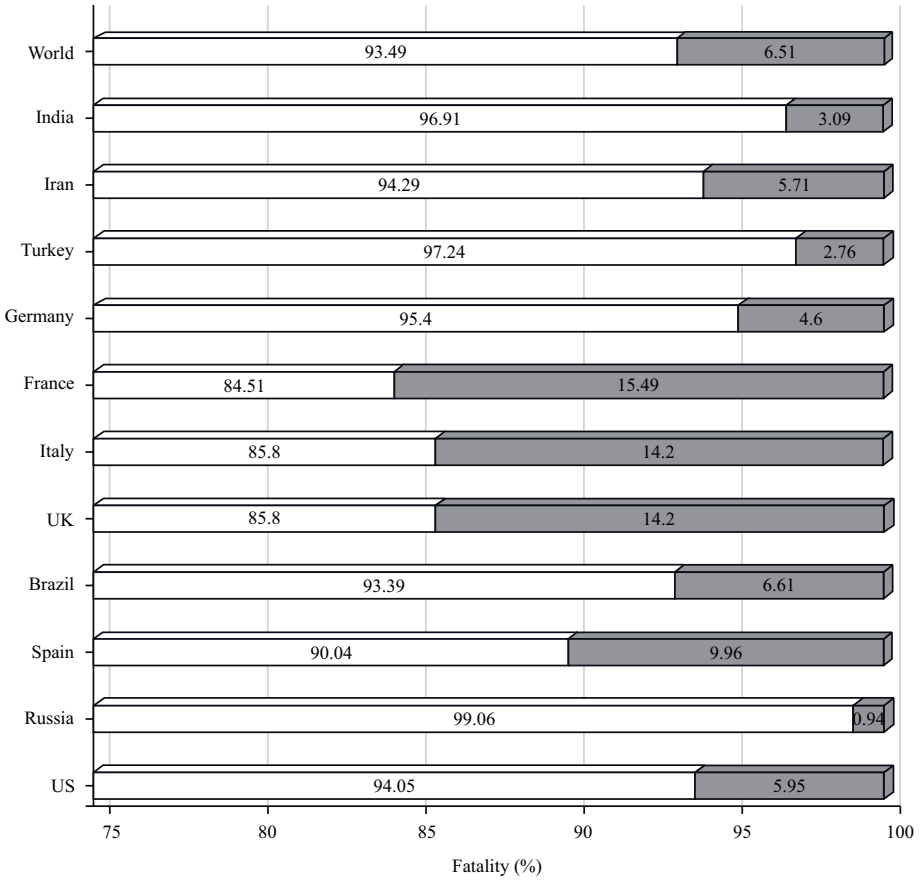

Fig. 2: Fatality recorded for COVID-19 in different countries (%)

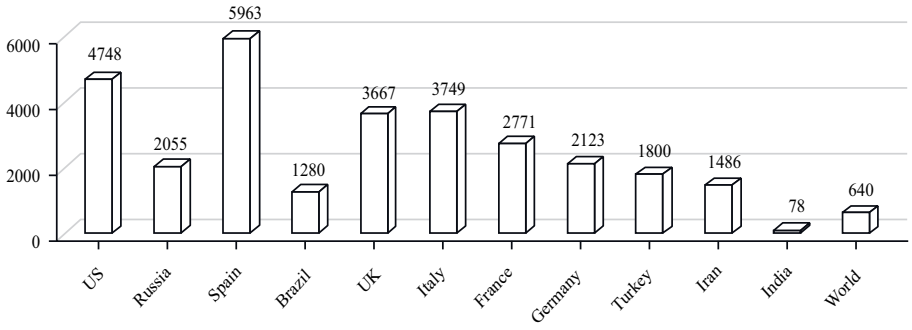

Fig. 3: Number of COVID-19 infected person per million in different countries

Total number of cases recorded per million was maximum for Spain (5963/million population) followed by US (4748/million) and Italy (3749/million). Nearly 640 people per million population was recorded for world on an average as of 20 May, 2020. However, the cases recorded in India was only at 78/million population. The number of cases recorded per million of population for top countries infected with COVID-19 is presented in Fig. 3. The disease spreading rate (In days) from 100 cases to 100 thousand cases revealed that only 25 days were required in US, 31 days in Spain and 37 days in Germany. In Iran it took more than 75 days to reach 100 thousand cases from 100 cases. The same was recorded in India for 64 days. The number of days required for different countries to reach 100 thousand cases from 100 cases is represented in Fig. 4.

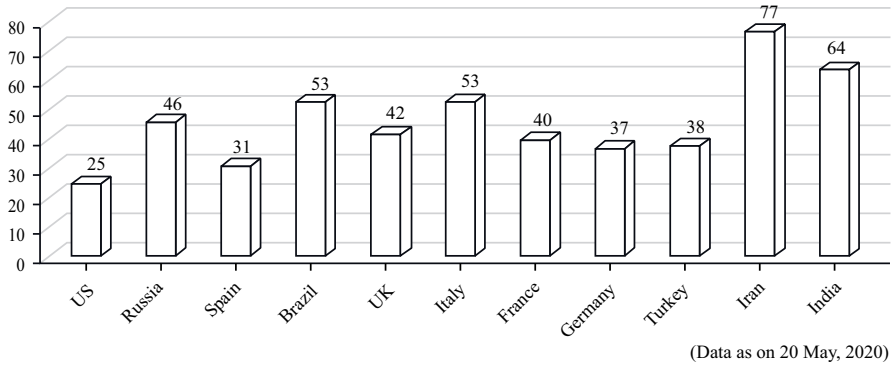

Fig. 4: Disease progression rate of COVID-19 from 100-100 thousand subjects (days)

SARS-COV-2 TRANSMISSION

The Aerosols of SARS-CoV-2 are generated from the subjects infected through sneeze and cough. It is known that particles are released from larynx, mouth, throat during exhalation while breathing. Sneeze and cough releases droplets at higher level from the patients infected. The nasal secretion and mucus present in respiratory system are thrown into the atmosphere at greater speed during sneezing[6]. Millions of aerosol particles are generated while sneezing. The other morphological features like the spherical or elliptical shape of virus and their size of 60-140 nm in diameter[7] of virus functioning as a Bio nanomaterial helps in their transmission through air. Due to their size and morphology, they are buoyant in the atmosphere, sustain for longer time and easily transported to longer distance. The airborne nature of SARS-CoV-2 was highlighted by Morawska and Caw[8]. In India spitting is a common habit. It is found that India, China and South Korea are significant spitting nations in the world[9]. The spitting in common place by infected subjects serve as an inoculum source of the virus. This moisture rich sputum along with mucus and saliva become dry and virus becomes airborne. The airborne viral particles are carried to longer distance depending upon the air temperature, wind and humidity. It is noticed that airborne transmission is most potent when compared to the transfer of virus through direct contact. The authors raise the doubt that the insects like a housefly, cockroach and other insects sitting and feeding on the spitted phlegm, mucus and sputum may spread the disease. Thus, their role need to be probed. The spread of virus through contact and isolation of virus from even sewages proves that they may be transmitted through bodily fluids.

AIR HANDLING SYSTEMS

The air circulation in other countries are maintained by a centralized system using Air Handling Units (AHUs) and not with open windows. Theatres, malls, shopping complexes, corporate offices and other residential buildings and apartments in other countries are maintained by centralized AHUs which are termed as Air Tight Buildings. The diseases associated with such buildings are widely reported as Building Related Illness (BRI) or Sick Building Syndrome (SBS). The air circulation maintained by AHUs are having a single point of source and air is continuously circulated within buildings[10]. Thus, if any subject occupying the building is infected with SARS-CoV-2 sneeze or coughs indoor, the inoculum is dispersed within and is circulated throughout the building which in turn affects the other occupants. Thus, exposure to the virus is manifold in such buildings. However, in India, the Majority of the buildings use open windows for air circulation. Few possess air condition systems as a single unit. In India, except malls, theatres and few corporate offices all other buildings rarely possess AHUs for air handling. Even in those buildings, attention was paid to clean the surfaces. These offices were closed by the Federal Government as Lockdown from the date of 24th March, 2020. Thus, the spread of SARS-CoV-2 in India is contained.

TRANSPORT

The countries which report more number of COVID-19 use Flight, Buses and Trains provided with central air-conditioned systems for their transport. A huge number of the population use personal car switched on with Air condition system. These transport systems are considered as air tight as there is no external transaction of air as their doors are closed. This

develops a microenvironment within the transport system and exposure risk associated with the nature of microbe present within[11]. Thus, the transmission of virus is easy and exposure to SARS-CoV-2 virus is more when co traveler is infected with the virus in such modes of transport. However, in India, the commuting system used by the general public are often of the open type. The majority of population, i.e., nearly 70% in India use two and three-wheelers like scooters, mopeds, bikes and autos as a mode of transport when compared to Japan (17%), Germany (10%) and USA (2-3%)[12]. The remaining population use public transport system like Non A/c buses and Non A/c coaches in the train which are of open types. This helps in air transaction between outdoor air along with the atmosphere within trains and buses. Even if any passenger positive for COVID either sneezes or coughs, the inoculum will be diluted and dispersed outward. Very few among the population use buses with Air conditioning system and A/c train coach. Usage of flight for transport is far less in India when compared with other countries due to economic status of the general public. This favors the containment of virus in India.

FOOD HABITS

India is the most populated country with vegetarians due to religious belief and caste system followed. The number varies from 300-400 million people being vegetarian[13]. Other 40% consumes non-vegetarian meats with less frequency which is attributed to economic status. However uncooked or raw meat are never consumed in India. The style of consuming meat in India is different from other countries as they are well cooked and added with more spices and condiments. The spices and condiments used in Indian culinary is widely found to possess antiviral properties and boosting the immune system. To mention a few, (1) Star anise is found to possess antioxidants and rich in Vitamins A and C. Effective as an antiviral and easing sore throats and cold. (2) Curcumin is a well-known antiviral compound present in Turmeric which is an effective antioxidant and anti-inflammatory in nature. (3) Fenugreek is used to treat sore throat as they are antiviral in nature. (4) Nutmeg used in Biriyani as a flavoring agent is found to boost immune system. (5) Cinnamon was found to possess rich antioxidants and mixed with ginger to treat common cold. (6) Black pepper contains various anti-oxidants, (7) Cloves are found to possess anti-inflammatory, antiseptic and pain-relieving properties. (8) Mustard for common cold, (9) Cardamom rich in antioxidants, vitamins and minerals, (10) Ginger is widely used which provides immunity against the common cold. (11) Onion is rich in antioxidants and anti-inflammatory activities and (12) Garlic is used as antiviral and against the common cold. Thus, the immune system of the population, in general, is strong when compared to other countries which recorded more number of SARS-CoV-2 viral infections. Further, the leaves of Murraya (Curry leaf) and Coriander is reported as an antiviral culinary herb. These herbs are used widely in Indian culinary. To name, Rasam (A boiled aqueous extract of different spices, condiments and culinary herbs) is a unique culinary item of India which is not prepared in other countries. Thus, it is predicted that food habits of the Indian population provide innate or acquired immunity against SARS-CoV-2 when compared to other countries.

TRADITIONAL MEDICINE

India is rich in its own traditional system of medicine in healing the patients. This is also popularly termed as an alternative system of medicine. The Indian system of medicine has three major divisions namely Ayurveda, Siddha and Unani based on their origin. The Ayurveda system of medicine dates back to 1500 BC. It is a well-developed system of medicine with two major divisions as a school of medicine and school of surgery. The other system is Siddha, which originates in southern part of India. This system has a specialty in the usage of drugs of metals and minerals in origin along with that of vegetation (Herbs) dependent drugs as Ayurveda. Unani system of medicine came into existence in India by the time period of 1350 AD[14]. All the above system use plants in general.

The following plant species are widely used throughout India for the treatment of cold, flu and asthma-related respiratory diseases. They include, *Andrographis paniculata* (Cold and Flu); *Piper longum* and *P. nigrum* (Cough, Asthma and Fever); *Clerodendrum serratum*, *Saussuria lappa* and *Solanum xanthocarpum* (Asthma); *Zinziger officinale* (Asthma and Fever); *Ocimum sanctum* (Immunomodulator); *Allium sativum*, *Boerhavia diffusa*, *Calotropis gigantea*, *Curcuma longa*, *Eugenia jambolana*, *Ficus religiosa*, *Myristica fragrans*, *Rubia cordifolia* and *Vitex negundo* (Anti-inflammatory). The plants like, *Lycoris radiata*, *Artemisia annua*, *Ocimum basilicum*, *Terminalia chebula*, *Piper longum*, *Polygonum cuspidatum*, *Curcuma longa*, *Melia azadirach*, many species of *Phyllanthus*, *Calophyllum brasiliense*, *Caesalpinia sappan* and *Cajanus cajan* are found to possess antiviral properties[15]. Due to the wide practice of traditional system of medicine in India and plenty of usage of antiviral plants provide protection to the population thus, preventing the infection of COVID-19.

CONCLUSION AND FUTURE RECOMMENDATIONS

The article provides insight on non-pharmacological factors behind the successful containment of the infection of virus SARS-CoV-2 in India which is attributed to the following reasons, i.e., (a) the uniqueness of buildings and maintenance of air circulation system as individual units rather than centralized AHUs. (b) Timely intervention and declaration of lockdown by the Government of India which arrests the spread of virus through Indoor Air. (c) Mode of Transport used by the general public in India, (d) Food habits and the culinary system of India and (e) Massive usage of Traditional System of Medicine in India when compared to other countries. Policy on studying SARS-CoV-2 as an airborne virus, their spread through other body fluids, role of insects in the dispersion of disease-causing virus is recommended. Expansion of such policy to other microbes will prevent future challenges.

Based on the insight provided on the non-pharmacological factors in the containment of COVID-19, few recommendations are made:

- Government of India and Government of different states need to develop a policy to monitor indoor for the presence of SARS-CoV-2. This has to be expanded to other microbes too
- The spread of SARS-CoV-2 through perspiration or other body fluids of the subjects having COVID-19 need to be monitored as there is no solid evidence stating that the virus will not spread through sweat or other body fluids
- The role of insects like houseflies and cockroaches on spreading the viral inoculum of COVID-19 from the sputum and phlegm spitted on common places by the infected people need to be established
- To combat the spread of COVID-19 it is strongly recommended that each individual buildings, malls, theatres, corporate offices of India need to be monitored for the presence of SARS-CoV-2 on surfaces, indoor air, air ducts, air vents and AHU filters. People must be allowed to occupy such buildings only after getting clearance certificates from the Government bodies
- Specialized individuals or IAQ specialists must be appointed for regular monitoring of indoor environments
- Involvement of Aerobiologists, Environmentalists, Microbiologists, Occupational hygienists, IAQ specialists, Epidemiologists, Medical Councils, Pollution control boards, Environmental bodies, Department of Science and Technology and Department of Biotechnology in studying SARS-CoV-2 in the atmosphere. The study can be carried as a Multicenter study throughout the world

SIGNIFICANCE STATEMENT

This study provides insight into the role of non-pharmacological factors in the containment of COVID-19 in India. The role of factors like uniqueness in air handling system, mode of transport, food habits and the traditional system of medicine followed in India in controlling the spread of the disease is highlighted. This study will help the researchers to uncover the involvement of non-pharmacological factors in controlling the disease spread in India of which many researchers were not able to explore. The study also recommends the importance of study on the airborne spread of the virus, role of insects and body fluids of the infected subjects in spreading the disease. Conducting joint studies representing different geographical zones at the International level and bringing policies in the containment of SARS-CoV-2 virus as well as for other microbes is recommended.

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