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## Research Article

# ENVIRONMENTAL IMPACT OF COVID-19: HIGHLIGHTING FACTORS, CONCERNS, AND EVENTS

**[1]Pritika Kandamaran, [1]Soumya Callender, [2]Akil Thiruselvan, [3]Puvin Durairaj, Ila [4]Chauhan, [5]Ravichandran Doraiswamy**

[1]Faculty of Medical Science, Cavehill Campus, University of West Indies
[2] Biology and Medical Sciences, University of Liverpool, UK
[3] Cooper University Hospital, New Jersey USA
[4]Course Director Clinical Skills, Medical University of the America, Nevis, West Indies
[5]Department of Anatomy, Srinivasan Medical College, Dhanalakshmi Srinivasan University, Tiruchirappalli, India

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**ABSTRACT**

Coronavirus disease (COVID-19) has reduced world economies, which has had an adverse effect on the environment. Similarly, the ecosystem, via a variety of circumstances, impacts the transmission of this unique coronavirus. Each country has different population size, as well as different air condition and pollution levels, as well as different land and water conditions, all of which have an influence on coronavirus propagation. Analyses of the underlying factors have been identified: COVID-19 with environmental degradation/ air pollution/ metrological parameters/ water/ climate/ deforestation/ and temperature.



## INTRODUCTION

Coronavirus disease (COVID-19) is expanding around the globe, posing a threat that is not only to human health but also to the global economy and ecology. While COVID-19 is wreaking havoc on businesses and communities, it has had a positive impact on the environment by drastically reducing pollution. Authorities reportedly put limitations on human and vehicular mobility, as well as halted industrial activity, as a result of COVID-19. The impact of such restrictions has been extraordinary, with considerable reductions in pollutant emissions, including greenhouse gas emissions, nitrogen dioxide, black carbon, and water pollution [1].

For instance, even during shutdown time in Barcelona, Spain, pollutant concentrations fell by 50%, with nitrogen dioxide ($NO_2$) and black carbon (BC) concentrations falling by 45–51 percent. Even during lockout, though, ozone ($O_3$) levels in Barcelona rose by 33% to 57%. Even during lockout, China's carbon emissions fell by 25%, or around 1 million tons, compared to the same time the previous year. Throughout Malaysia's shutdown, particle matter (PM2.5) fell by 58.4%. Owing to the lockout, water contamination in Venice, Italy was greatly decreased, and the city's water canals were more translucent than they were before to the lockdown. Similarly, throughout India's lockdown timeframe, the quality of water in the Vembanad Lake improved greatly, with suspended particle matter (SPM) dropping by 15.9% compared to pre-lockdown levels [2].

Furthermore, COVID-19 is having a negative impact on the environment owing to a large volume of household and clinical waste, as well as a shortage of measures to recover medical waste simply out of fear of COVID-19 spreading to individuals who recycle. Whilst benefits and drawbacks of COVID-19 on the environment are well documented, the ecosystem or environment has had many an impact on COVID-19 spread and death. Environmental variables including temperature, due point, humidity, wind speed, rainfall, and COVID-19 emissions and mortality have all been linked in many investigations. Furthermore, studies have reported mixed (positive, negative, and inconsequential) effects on COVID-19 transmissions,

**Corresponding author:* **Dr. D. Ravichandran Doraiswamy**
Professor and Lead of Anatomy, Associate Dean, Srinivasan Medical College, Trichy. Former Director Premed Curriculum, Bridgetown International University, Barbados, North America.

despite the fact that temperature regulates COVID-19 transmissions [3].

COVID-19 infection and fatality rates are also influenced by environmental pollution. COVID-19 hit Northern Italy particularly severely, with much peak prevalence and associated casualties than the rest of the nation. As a result, COVID-19 may have an environmental impact and conversely. Most research that has looked at these phenomena has concentrated on one viewpoint or another. Furthermore, none research yet looked into the bilateral features of COVID-19 as well as the surroundings, to our understanding [4]. The role of various factors in COVID-19 condition influencing environment has been highlighted in Figure 1.

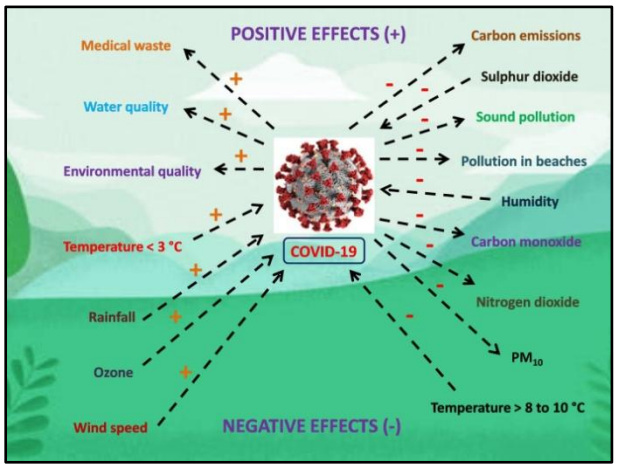


**Figure 1** Positive and negative environment factors in COVID-19 scenario.

### *Air pollution and COVID*

Annually, air pollutants major health problems, and a substantial number of people result in the death of its effects. Air pollution claimed the lives of 4.9 million people worldwide in 2017, with low-income countries bearing the brunt of the toll [5]. Even during COVID-19 shutdown, investigations revealed a considerable decrease in air pollution. Because of the global pause in industrial and transportation activities, air pollutants such as $NO_2$ and $CO_2$ emissions decreased dramatically. Air pollution has decreased dramatically in some nations, including China, Italy, the United States, and India, as a result of lower fossil fuel usage. At the time of the shutdown, $NO_2$ levels in major Indian cities such as Ahmedabad, Mumbai, and Pune dropped by 40 to 50 percent. $CO_2$ levels in Europe are predicted to decline by 390 million tones as a result of the shutdown [6].

Carbon emissions in the United States fell by roughly 40% owing to less transportation during the shutdown. Furthermore, during the worldwide shutdown, CO, $NO_2$, and 'particle pollution with a dimension less than or equal to 10 µm' (PM10) all reduced dramatically, but $O_3$ rose owing to the decline in $NO_2$. $NO_2$ and black carbon (BC) levels were found to be 50% lower during the lockdown period, in keeping with earlier research, whereas PM10 levels were lowered to some degree. During the lockdown in Barcelona, however, the amount of $O_3$ was boosted by more than 50%. Similarly, $NO_2$ and BC levels fell by 45 to 51 percent in Barcelona. A group of researchers also looked at the influence of COVID-19 on pollutants before and after the restricted period. In Malaysia, researchers discovered that the MCO (movement control order) had a considerable impact on PM2.5 reduction. According to experts, the lockout resulted in a 30 percent reduction in air pollution and a 90 percent reduction in movement [7].

### *Climate and Coronavirus*

COVID-19 propagation is affected by the climatic system, much as other infectious illnesses. Temperature, humidity, rainfall, and wind speed are all important aspects of the climate. Meteorological variables and COVID-19 were shown to have a significant relationship in studies. COVID-19 outbreaks propagate much faster in New York City because to poor air quality, according to researchers [8]. Furthermore, in the examples of Turkey and China, researchers looked into the impact of weather and meteorological conditions on COVID-19 propagation. In places with large COVID-19 connection speeds, researchers discovered a positive relationship between wind speed and population. The researchers discovered a positive relationship between COVID-19 emissions and PM2.5, PM10, CO, $NO_2$, and $O_3$, but a negative relationship among $SO_2$, and COVID-19 transmissions. Furthermore, a number of researches have attempted to determine the effects of climate and urbanization parameters on COVID-19 transmissions. The trend of verified COVID-19 instances was shown to be disrupted by climatic influences. The effectiveness of metrological parameters such as temperature and humidity on COVID-19 instances in Chinese cities was also examined [9].

They discovered that humidity and temperature had a substantial negative influence on COVID-19 events on a regular basis, and that the temperature and humidity influence is strong in COVID-19 cases on such a daily basis. When humidity levels was around 67 percent and 85.5 percent, this was discovered that a 1°C increase in average daily temperature reduced the monthly incidence of COVID-19 cases by 36 percent to 57 percent. Similarly, when the mean temperature has been between 5.04°C and 8.2°C, 1°C increment humidity reduced the monthly COVID-19 occurrences by 11 to 22 percent [10].

Furthermore, research reveals that COVID-19 transmission in the United States may be predicted by temperature and humidity. While many other researchers have focused on the effects of climate variables on COVID-19 infections, others have looked at the phenomena from the opposite viewpoint and found a mixed (positive and negative) influence of climatic variables on COVID-19 fatalities. The impact of climate variables on COVID-19 mortality was investigated, and scientists observed a substantial positive relationship among diurnal temperature and COVID-19 mortality, as well as a weak relation among moisture and COVID-19 death. By using geographical assessment, climate scientists investigated the impact of $NO_2$ on COVID-19 mortality in Italy, Spain, France, and Germany, finding that long-term $NO_2$ exposed to at least COVID-19 deaths. There was no link discovered amongst COVID-19 mortality and temperature or precipitation. Notwithstanding the conflicting outcomes, country policy makers should consider climate indications in their battle against the epidemic and act swiftly depending on each country's climatic features [11].

### *Temperature and Corona virus*

Many nations are fighting to keep COVID-19 from spreading further. While anticipating the emergence of COVID-19 in some warm nations, there is now a lot of conversation over the impact of temperature on COVID-19 infections. The warm and

humid weather in India have indeed been cited as a potential explanation for the lower transmission of COVID-19 infections. It has also been suggested that stringent lockdown is a key factor in the minimal propagation of COVID-19 instances. The unfavorable impact of climate on COVID-19 emissions has been a source of contention. Temperature has been shown to have potentially harmful and beneficial impacts on COVID-19 emissions, according to researchers. "The virus is very persistent at 4°C, but susceptible to warmth," scientists said [12].

On day 14, at 4°C, there was just a 0•7 log-unit drop in infection titer. The period for viral inactivation was lowered to 5 minutes when the incubation temperature rises to 70°C." Whenever the temperature is below 3°C, studies found a significant linear relationship between COVID-19 instances and temperature. In China, however, researches have shown that degrees of 8°C to 10°C minimize the regular occurrence of COVID-19 cases. They also anticipate that the epidemic will spike in Wuhan in early March 2020, then fall even by end of April, to use a "modified susceptible-exposed-infectious-recovered (M-SEIR)" model. The authors maintain that the M-SEIR model gives superior recommendations for COVID-19 epidemic mitigation. When the temperature was less than 25.8°C, a 1°C rise in temperature was connected to a 4.9 percent decrease in daily COVID-19 emissions, according to studies. Nevertheless, when the temperature exceeds 25.8°C, the same research revealed no indication of a decrease in COVID-19 transmissions. Conversely, using 'spatio-temporal modelling' methodologies, researchers found that temperature had a little influence on COVID-19 transmits in Spain. They also included non-meteorological characteristics like age, frequency of visitors, population numbers, and quantity of enterprises in their research. Researchers looked at the impact of 'temperature range' and 'population numbers' on COVID-19 emissions and discovered that 'ambient temperature' has a poor susceptibility to COVID-19 broadcasts, whilst 'population size' has a good sensitivity [13].

***Environmental Influence of Corona virus***

The COVID-19 has wreaked havoc on community health and life throughout the globe. In January 2020, the World Health Organization declared a worldwide national emergency. The epidemic has expanded to about 112 million individuals and killed over two million people since about February 2021. After the breakout became a pandemic at the end of March, 50% of the global total was placed under lockdown, culminating in a global halt of industrial operations. Since individuals are unable to move, road and air transportation have come to a halt. Reduced transportation operations, on the other hand, result in decreased energy usage and petroleum usage, which has a large beneficial influence on the environment. Furthermore, $NO_2$ (nitrogen oxide) is a harmful pollutant that is released often from fossil fuel consumption and is accountable for 3 million asthma cases throughout India each year. Many nations, including Italy, India, Spain, France, and China, have seen considerable reductions in $NO_2$ levels as a result of quarantine. According to recent investigations, air pollution in the COVID-19 epicentre, such as Italy, Wuhan, the United States, and Spain, has decreased by 30%, demonstrating that the pandemic has a transitory benefit [14].

Furthermore, researchers claim that decreases in industrial operations, energy requirement, carbon footprints, road travel, and modifications throughout the lockdown period have resulted in favorable improvements in air quality owing to lower concentrations of $CO_2$, PM2.5, NOx, PM10, as well as other contaminants. Authorities should also brainstorm on ways to limit pollution after COVID. Caused by social separation caused by the pandemic spread, coastlines all across the globe, even those in Spain, Ecudaor, Mexico, and other countries, has become significantly cleaner [15].

Likewise, the coronavirus epidemic has resulted in a reduction in contaminants in water in various regions of the globe; for example, in Venice, where there is less tourist traffic, the canals are clearer and types of pollution have decreased significantly. Exclusion regulations, on the other hand, have resulted in a surge in garbage, particularly healthcare wastes. By example, due to such epidemic, institutions in Wuhan create an estimated of 240 tons of hazardous material nearly every day. In an instance, the epidemic has changed the focus towards another model based on online business, skilled workforce, economic vitality, and manufacturing 4.0, which has a lower environmental impact, while simultaneously demonstrating its unfriendly impact on human civilization. The epidemic has effectively restored the ecosystem in recent months, having a favorable impact on global warming. This even emphasized the need of improving human-nature coexistence [16].

***Environmental degradation and Corona virus***

Whilst COVID-19 epidemic has already had a far-reaching impact on social and economic life, it has also aided in the restoration of certain environment degradation. Owing to complete or partially lockdowns and rigorous movement control orders (MCO) by several governments around the world, greenhouse gas emissions (GHG), $NO_2$, water pollution, noise pollution, and pollution in beaches have all decreased dramatically. Such limits have aided nations in reducing pollution, improving air quality, and improving overall standard of living. Nevertheless, the data do not support a long-term emissions reductions even though, once the curfew is lifted, business output and power usage will probably rebound as large-scale industrial actions recommence, resulting in increased energy consumption and GHG emissions, which would probably exceed the lockdown restriction even during lockdown time frame. Furthermore, investigations have shown the secondary impacts of lockdown just on environment, suggesting that this really decreased sound impact and ocean pollution while also reducing environmental impact. Large-scale industrial activity created sound pollution, which affected human health and destroyed natural ecosystems [17].

Lockdown stopped all industrial activity and limited public transportation, resulting in a massive decrease in excessive noise throughout the globe. Similarly, owing to lower tourist visits, pollution on beaches like Acapulco, Barcelona, and Salinas has significantly decreased, and the sea has gotten much clearer. In Wuhan, China, $NO_2$ and PM2.5 levels fell by 22.8 $g/m^3$ and 1.4 $g/m^3$, respectively, as a result of the rigorous lockdown. Unfortunately, owing to the rising volume of household and medical waste that may be dangerous and possibly spread illnesses to others if not properly managed, such containments have severe environmental repercussions. Health care facilities in Wuhan, by instance, created 240 metric tons of medical waste per day, up from 50 tonnes per day before to COVID-19. Conversely, the dependence on internet shopping and parcel delivery has raised household garbage. In

order to prevent further spread of COVID-19 as well as other infectious diseases, the post-lockdown phase is critical for maintaining low levels of environmental contamination and taking the appropriate actions to dispose of hazardous biological waste [18].

***Effect of air quality factors in the spread of COVID-19***

Insufficient and overwhelming defense mechanisms are at the root of a variety of diseases, thus knowing the impact of contaminants on the immune system is crucial to comprehending pollution's consequences. Owing to ambient air pollution, particulate emissions health impacts mostly affect developing nations. Researchers examine the quantities of six particulate pollution, PM10, PM2.5, CO, $NO_2$, ozone, and $SO_2$, throughout India and discover that now the lockdown triggered by the propagation of COVID-19 lowers the air quality level. Particulate matter has been implicated in the transmission of SARS-COV-2, according to research. In addition, researchers in French cities investigated the link between both the COVID-19 epidemic and air pollution, concluding that PM10 and PM2.5 concentrations cause COVID-19-related fatalities. Gaseous elements and particle pollution in urban air pollution include $O_3$, volatile organic compounds (VOC), CO, and nitrogen oxide (NOX), all of which have been shown to cause inflammation in the respiratory tract. Using a generalized incremental approach, scientists investigate the relationship between six air contaminants and everyday COVID-19 occurrences in China and discover a substantial association. The connection between COVID-19 and climatic variables in New York City was further investigated using Kendell and Spearman rank correlation tests to demonstrate a strong link between air pollutants and the breakout of COVID-19. Covid-19 lockout has also been linked to lower levels of pollutants, according to research [19].

***Effect of deforestation in the spread of COVID-19***

Seasonal changes, or a pathogen's capacity to propagate, are determined by the weather season, which may be seen in the instance of several infections. Similarly seasonal fluctuation is likely for COVID-19 as well as other coronaviruses like SARS if humidity and temperature have such a stable annual or pulmonary viral circulation. Scientists use a meteorological model to examine the relationship between climatic factors and the transmission of COVID-19 infections and forecast an epidemic condition in high-latitude cities. Inside the climatological zone, a substantial link between COVID-19 distribution and environment temperature and latitude has also been detected [20].

Deforestation has been connected to a variety of disease epidemics caused by viral infections spread by birds and bats. People in India will require food and housing as a result of overcrowding and wealth creation, which will contribute significantly to deforestation, implying that India will be the origin of the next pandemic. As a result, understanding the value of forests and encouraging afforestation across the globe is critical to preventing an epidemic of this sort. In their analysis of land surface temperature following the COVID-19 shutdown, studies found a rise in hotspots and a decrease in thermal comfort index in the city of Dehradun [21].

***Effect of meteorological factors in the transmission of COVID-19***

The bulk of research point to weather variables among the most critical elements in forecasting future COVID-19 pandemic trends. Temperature, humidity, wind speed, visibility, and rainfall are among meteorological elements that impact the survival of environmental viruses and help spread epidemics. The relationship between new COVID-19 case numbers and weather parameters in Chinese cities was investigated using a meta-analysis, and the findings show that the independent meteorological factors have a favorable transmission impact. Researches established the substantial link between wind speed and pressure and the transmission of the COVID-19 illness by analyzing the impact of meteorological factors in nine Turkish cities [22].

Furthermore, experts investigate the relationship among meteorological factors and epidemic intensity in China, Italy, Japan, and 51 other nations, concluding that a combination of temperature, wind speed, and humidity may best forecast contagious circumstances. In subtropical parts of Seoul, Korea, researchers explored the impact of temperature, humidity, and cyclical temperature on pandemic prevalence and find substantial growth in the prevalence of low and high humidity impacts. Findings in New York City and Wuhan, correspondingly, revealed a substantial association among humidity levels and disease mode of transmission. The association among meteorological elements and COVID-19 in Jakarta was also found, with a substantial relationship among COVID-19 dispersion and temperature. Temperature and humidity have been proven to play a crucial impact in the transmission of the illness. To explore the correlation among climatic conditions and dissemination in COVID-19 situations, the bulk of researches have used generalized additive modeling approaches. For example, a team of researchers used the generalized incremental approach and random-effect meta-analysis to examine the impact of temperature and relative humidity on the COVID-19 epidemic dynamics in China, confirming substantial negative temperature dependence and humidity and COVID-19 instances [23].

To use a generalized additive modeling approach, scientists investigated the relationship between coronavirus disease fatalities and meteorological conditions, concluding that an increase in warmth and humidity resulted in a drop in the COVID-19 fatality rate. Furthermore, although current research suggests that weather and COVID-19 instances are inextricably linked, other studies dispute such results, claiming that temperature and moisture independently may not be enough to cut down on the number of instances. Researchers look at the association among SARS-CoV-2 transmission and temperature in countries and Chinese regions that have at most 100 cases but discover no indication that levels of dissemination decline at high temperatures, concluding that COVID-19 is expected to be a seasonally respiratory virus. Researchers investigate the effect of weather in the transmission of the COVID-19 virus in India, concluding that states with unfavorable weather cannot be linked to the newly diagnosed cases in such areas. As a consequence, there are so many contradictory findings in the literature in this topic. The influence of meteorological conditions on COVID-19 dispersion is unclear. To explore such correlational data, it is necessary to investigate the combined influence of various factors such as demographic

variables, healthcare infrastructure, social policies including such closings, and so on [24].

***Effect of non-meteorological factors in the spread of COVID-19 worldwide***

Multiple researches explored meteorological and non-meteorological elements to investigate potential influence on the development of the COVID-19 illness in order to improve the authenticity and generalizability of the results. For example, it was found about the use of a Spatio-temporal model to analyze the influence of temperature and non-meteorological variables such as population density, population-by-age, number of travelers, and business numbers on COVID-19 diffusion, and find that COVID-19 is somewhat more prevalent in people of said age group, as it affects older people more severely and leads to international mobility [25].

When looking at the effects of heat just on COVID-19 epidemic behaviors, it was discovered that external conditions have a greater impact on the pathogenic virus than that of the domestic population, which fluctuates depending on the situation. Human-to-human interaction and community movement are regarded important elements in predicting the pandemic's future trajectory. The influence of temperature and population size on Iran's COVID-19 transmission rate was also investigated, with the recommendation that cities with populations above 1.7 million should follow their management strategies more closely and correctly. In Wuhan, scientists found the relationship between the environment, COVID-19 cases, and the Chinese economy, as well as the lack of relevance of temperature in new COVID-19 disorders. With the Wuhan COVID-19 outbreak, the exchange rate has a negative but little influence on China's export market. Researchers also gathered socioeconomic, environmental, demographic, and topographical variables that affect the natural changes of COVID-19 disease occurrence, and the results indicate the modeling of the key explanatory factors (income inequalities, household incomes, the proportion of black women, and the percentage of nurse practitioners) [26].

The influence of the COVID-19 surprise upon GDP, energy consumption, and global warming is studied, which revealed a decrease in GDP, reduced energy consumption, and a decline in mean temperature. Coronavirus propagation has indeed been presumed from contaminated objects, emphasizing the significance of demonstrating coronavirus retention on inert surfaces. Researchers compare the aerosol and interface durability of SARS-CoV-2 and SARS-CoV-1, concluding that SARS-CoV-2 transmission is precise since the virus remains on surfaces for days after exposure. Epidemiologists have discovered that the Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) coronaviruses may survive on surfaces and equipment for approximately 10 days before being destroyed by surface cleaning [27].

***Effect of water-based epidemiology in the spread of COVID-19 worldwide***

With the very first research describing the finding of SARS-CoV-2 in feces, it is evident that human wastewater might carry new coronavirus. As a result, it's possible that symptomatic (and asymptomatic) infected persons might transmit the viruses via their excrements, necessitating more efficient waste-water and sewage-sludge treatment, as well as the spread of the infections into the ecosystem. Water supply is one of the most common ways that people are exposed to contaminants. This draws attention to certain key toxins in drinking water that are recognized to be immune-toxic, as well as drinking water pathways that may affect people' ability to respond effectively to infection [28].

Researchers use two remote-sensing methods to investigate variations in freshwater resources and verify an improvement in spectral reflectance (SR) and Forel-Ule colour index (FUI), implying less pollution. Wastewater-Based Epidemiology (WBE) is a useful technology which can be used to supplement existing infectious disease monitoring systems and serve as an alert system for epidemics. It consists of analyzing pooled effluent and communicable diseases to typical example the creation of a new communicable disease. Due to the cost and practicality of medical COVID-19 testing around the world, reserchers have been using computer data to evaluate local survivability, opportunities, and obstacles of recognized active coronaviral infectious diseases with WBE, and categories temperature, average time, and water per capita as the main factors. The paper-based gadget might also identify SARS-CoV-2 in wastewater sites and track viral carriers, according to the researchers. By finding wastewater SARS-CoV-2 RNA in an Australian sample and then using Monte Carlo simulation to estimate the number of persons affected, studies highlight the efficiency of the WBE. Wastewater is also regarded an indirect impact of COVID-19 on the ecosystem; for instance, China has requested that treatment facilities enhance their decontamination pathways in order to avoid the transmission of new coronaviruses to wastewater [29].

## CONCLUSION

Efforts made by governments throughout the globe in response to COVID-19 having resulted in considerable decreases in contamination and increases in air sustainability, especially in nations with high COVID-19 propagation, such as China, the United States, Italy, and Spain. Carbon emissions, air pollution, sound pollution, and beach pollution all decreased significantly in such nations. Such decreases, on the other hand, were caused by lockout and lasted throughout the shutdown. It's unclear if the quality of air will last in the long term. COVID-19 transmission and fatality rates were shown to be influenced by environmental conditions. The impact of meteorological parameters such as temperature, wind speed, and moisture on COVID-19 spread and morbidity has been studied and has shown positive, negative, mixed, and inconclusive findings. To give additional definitive data, future studies must conduct a deeper analysis. The bulk of study focuses on how climatic variables affect COVID-19 spread and death. Carbon dioxide emissions and air quality are dramatically reduced as a result of lockout. Nevertheless, it's critical to see if the emission reductions would persist when the lockout is lifted. Similarly, there is little evidence of study into how to manage with a significant number of medical garbage, and also how to reuse and breakdown garbage after the shutdown. It is obvious that appropriate policy suggestions and a comprehensive approach for controlling contamination of the environment and recycling hazardous material during the post-lockdown period should be provided to policy and relevant organizations.

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