



A Comprehensive Review on Environmental Factors Influencing COVID-19 Spread and Its Effects: A Global Approach

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ABSTRACT

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The pandemic caused by COVID-19 that is plaguing the whole world at this point is currently a major threat on global health. However, similar to many other respiratory disease outbreaks in the past, this virus also has environmental implications, with its spread being substantially affected by the environmental conditions of a locality. Also, the lockdown measure undertaken as a protective measure against the spread of the disease is affecting the global environment. There have been numerous studies around the world to find the correlation between transmission and severity Coronavirus related disease and mortality with environmental parameters. These parameters included temperature, air pollution, climate factors, humidity, wind speed, atmospheric pressure and many more with COVID-19 outbreak. It was found that meteorological factors may show an independent part in the spread of COVID-19. Considering the other side of the coin, the world prior to this Coronavirus outbreak was facing air pollution, global warming, sound pollution and many more environmental adversities. However, since the beginning of the lockdown period a major change has been noticed in terms of various environmental parameters that measure the quality of the environment around the globe. This study is an attempt to conduct a comparative study on the correlation amid environmental influences and the COVID-19 outbreak around the world.

1. INTRODUCTION

Coronavirus-19 is in a similar family as other human COVIDs that have caused worldwide flare-ups, for example, severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). COVID causes respiratory tract diseases, which can prompt pneumonia furthermore, in extreme cases, death. Known transmission routes for COVID incorporates supported human-to-human transmission by means of respiratory beads created when a contaminated individual hack or then again sniffles. Likewise, with all novel and developing irresistible operators, it is conceivable that the proceeded with spread of the COVID could bring about a pandemic. The total clinical picture as to Coronavirus isn't completely perceived. Reported illnesses have ranged from gentle indications to extreme disease bringing about death. Current understanding about how the infection that causes void-19 spreads is that it is fundamentally from individual-to-individual, between people who are in close contact with each other (inside around 6 feet) and through respiratory dabs when a polluted individual hacks or wheezes. People may be prepared to contract COVID-19 by reaching a surface or thing that has the disease on it and reaching their own mouth, nose, or, possibly, eyes, yet this isn't accepted to be the standard way the contamination spreads [1].

The COVID-19 is a communicable disease for medical society, which is caused by coronavirus of a new kind [2]. On 31 December 2019 the Chinese government originally

uncovered a scene of COVID disease (COVID-19) in Wuhan, the capital of Hubei Province in China. The occurrence quickly spread from Wuhan into all provinces of China and as a minimum of 213 countries. As of 27 September, 27, 2020 33,104,362 cases of COVID-19 were authoritatively established, including 999,434 deaths. On 12 March 2020, the World Health Organization (WHO) pronounced a pandemic of the extreme intense respiratory condition Coronavirus 2 (SARS-CoV-2) infection, the pathogen accountable for the clinical sickness known as COVID-19 [3]. Governments worldwide have been in putting place measures to restrict the spread of the illness, however later recent publications [4, 5] proposed the pandemic could last as long as year and a half. In this type of viral transmission, looking at the spatial spread in the beginning phases is very critical to avoid additional transmission [6]. It is anticipated that the yearly worldwide total national output will decrease by 24%, implying that it is extended to decrease by 2% every month, the forecasts likewise gauge a 13% to 32% decrease in worldwide exchange [7]. Covid-19 has reached its present form through mutations and this mutated form of this virus is responsible for the unavailability of proper medicines of this virus. It has been found that patients are mostly dependent on their natural immunity to combat the severity of the viral infection [8]. This lack of availability of proper medicine or vaccine of this virus and subsequent lack of clinical expertise has caused us to consider the only preventive measure available which is social lock down.

The direction to restrict physical interaction on an individual level in order to escape individual as well as external environment is termed as social lock down. Social lock down allows people to leave their house as rarely as possible. Such as, for the shopping of basic necessities like food, for the purpose of collecting treatment or to attention for a exposed person, also to transportable to and from workplace, but all these are allowed only in the case of absolute necessity that could not be managed from home [9]. However, the atypical outburst of COVID-19 all around the world attacking cities and villages, poor and rich alike in countries like China, USA, UK, Italy, Taiwan, Spain, France, Iran, Turkey, South Korea, Germany, India, Australia, Bangladesh and many more [10]. Because of which the countries around the world went under partial or total lock down for quite a long span of time which is extending from about a limited week to a limited month. So as to evade network transmission, practically all nearby and focal organizations have given a restriction on the free movement of their residents outside of their home. Different ventures and processing plants have quit working for the present, travel have been dropped [11].

In the meantime, these actions taken to restrict the distribution of the SARS-CoV-2, by restriction of mass progress have led to a marvelous effect on the environment. The Environment pollution is a major issue of the present era. In their course of developing the civilization human beings have acted on their desires and whims causing tremendous damage to the natural environment [12]. As a result of this, global warming also came into being by the increase of concentration of greenhouse fumes like, CO₂, CH₄, N₂O etc. in the troposphere. The non-working of the businesses has added to diminishing mechanical waste discharge to an enormous degree [13]. A just about zero emission pace of green-house gases alongside harmful suspended particles in the climate have been seen because of the inaccessibility of vehicles on street. The same aforementioned reasons have also caused a reduction in the utilization of petroleum products and other customary fuel sources to a considerable extent. These factors seemingly are causing a revival in the ecosystems around the world. There have been reports of individuals encountering a spotless clear sky for the absolute first time in their lives in large urban areas [14]. Places like, Sea beaches, forests, hilly areas which are commonly used tourist spots have also seen a reduction in pollution. There was also the revival of the ozone layer to some extent. It can be said that, there was a quite contrasting effect of this pandemic on the human civilization (basing on the destruction and deaths it has caused) and on the natural environment [15]. Basing on the patterns of previous outbreaks of viruses and this recent one, it may be safe to assume that SARS-CoV-2 may turn out to not be the past novel virus to appear that can pose serious threats on global public health.

It was seen through numerous studies and observations that the pandemic nature of this virus has close connections with the environment. They seem to highly affect each other [16]. As it was found on a study conducted in the early phase of the pandemic, the endemic caused by COVID-19 tended to spread rapidly in regions with ambient temperature and thus making people confined indoor more susceptible [17]. This correlation between natural environment and this pandemic is still under study for the revelation of the correct nature of the relationship. However, the social lock down imposed for the sake of restriction of the spread of virus has definitely impacted the nature in various ways [18]. Past examinations

demonstrated that freezing and dehydrated climate is useful for the endurance and spread of bead intervened viral maladies like influenza [19]. The SARS pandemic was progressively blurred with the warming climate coming, and was fundamentally finished in July, 2003 [20]. The infection was profoundly steady for an all-encompassing period at 4°C [21]. It has been following a 7-day brooding at 22°C (Room temperature, RT) and no irresistible infection could be identified on Day 14. They additionally watched no irresistible infection could be identified following a 30-minute brooding at 56°C or a 5-minute hatching at 70°C. Lock down, including limited social contact and keeping open as it were those organizations basic to the nation's flexibly chains have had a helpful impact in nations [22]. For SARS-CoV-2, 1h half-life may be sufficient long for a compelling transmission, where temperature or dampness just applies seven days impact to the viral ingenuity [23]. Coronavirus is an intense respiratory ailment and could stay plausible in pressurized canned products for quite a long time [24]. Air contamination is mindful for some passing and expanded frequencies of respiratory illness [25]. SARS infection and other respiratory illnesses, for example, COPD (ceaseless obstructive aspiratory illness) find rich "region" in air poison elements and, in a straight connection, they endure extensive and become further forceful in a resistant framework previously irritated by these unsafe substances [26]. An expansion in rainfall by 1% decreases recuperation events 0.07% and increments affirmed events and passing through 1% and 0.86%, separately. A rate increment in outward weight heightens affirmed incidents and passing by 62% and 48% while it decays recuperation events by 0.07% [27].

From one point of view, climate experts foresee that ozone draining substance (GHG) releases could drop to degrees at no other time saw since World War II [28]. This outcome is generally a result of the social isolating game plans got by the governing bodies following the presence of the pandemic [29]. Despite the positive indirect ramifications for nature, the new Covid has in like manner made negative meandering ones. For example, in the USA, a couple of metropolitan networks have suspended reusing programs since specialists have been stressed over the threat of spreading the disease in reusing centers [30]. Of course, in the European nations particularly affected, the sensible waste organization has been restricted. For model, Italy has limited polluted tenants from masterminding their waste. Then again, a couple of endeavors have exploited the godsend to revoke superfluous pack blacklists. Associations that once upheld clients to bring their packs have logically changed to single-use packaging. For example, a notable coffee association announced a short limitation on the use of reusable cups. Finally, online food mentioning has extended. These improvements are achieving the extension of local waste, both regular and inorganic [31].

In a study by exploring the matter by considering both edges of the scenario as, the effect put by COVID-19 (transmission, mortality and preventive measures) on the environmental factors and vice versa it was concluded that COVID-19 pandemic had led to an improvement in the environmental quality [32]. Many countries including USA, Italy China and Spain who had severe cases of COVID-19 transmission have noticed a large reduction in air pollution, carbon emissions, sound pollution and also pollution in beaches. This came about because of the actions taken by the governments of the countries around the world, majorly due to the standstill caused by social lock down. However, the persistence of these

affects in the long run is still under observation and subject to study [33]. Considering the threats posed by the viruses in the past and focusing on the challenges that lie ahead it is imperative that environmental science researchers and the scientist community in general yield a long-term, broader and more quantifiable method in understanding the viruses that spread throughout the environment [34]. It is important for us to understand and communicate our knowledge on how environmental influences effect and form the possible viral spread routes in the air, on surfaces and in solutions. In that way, we will be able to provide a more informed description on the persistence and transmission of the virus and may be able to recommend on how to mitigate the spread of the virus [35]. Therefore, in this review paper we have aimed to conduct a comparative study on how Environmental Factors are influencing COVID-19 spread as well as the way the spread of COVID-19 is affecting the environment from a global point of view.

2. REVIEW METHODOLOGY

2.1 Criteria for considering studies for review

The first step was to find the topic of interest for reviewing the studies. We consider a series of analysis of COVID-19 and the environment, how they're interlinked and if there's any relationship between this two. To review this topic there is need for already published research which are more reliable enough to gather information for our studies. There are many environmental factors which can be responsible for spreading of coronavirus, such as meteorological parameter, air pollutant, temperature, or the entire environment. It is more beneficial if we consider them as individual criteria. We relied on the Scopus indexed journals for information gathering. Figure 1 shows the review methodology of this study.

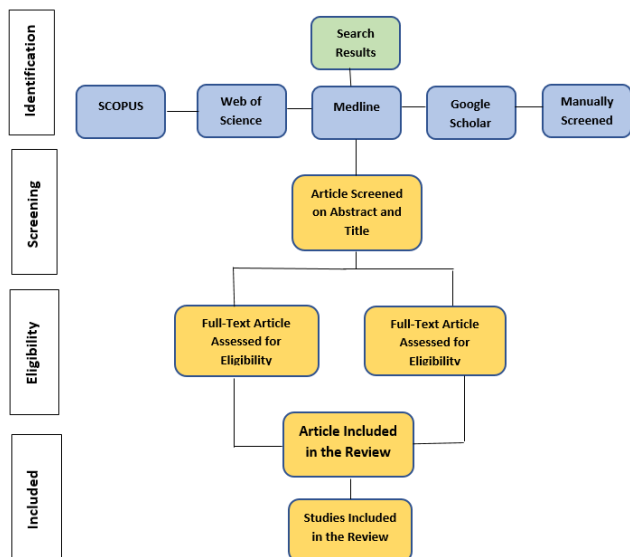


Figure 1. Review methodology of this article

2.2 Search methods for identification of studies

Initially, we searched “COVID-19 and the environmental factor”. After thorough screening we consider the studies which are related to ours by reading abstract and conclusion.

As we are doing a global approach we decided to have enough database for the most corona affected countries or enough to find a pattern globally. So, we decided to add countries with the factors in the search criteria.

2.3 Selection of studies

Finally, we have been able to find research closest to our interest and which we manually separated by title, keywords, abstract and when we were still hesitant about it, we gave a full read text, finally excluding studies which are inequivalent to our review paper.

3. RESULTS

It is essential to understand the co-relation between COVID-19 and each element of environment. For better understanding we divided the results into seven individual clauses, where we'll be discussing if they follow any patterns, numerical value which will provide exact information and so on. Table 1 (See Appendix) shows a comprehensive insight of all literature. Figure 2 shows the top 15 countries considering to take literatures in this study.

3.1 COVID-19 and air pollution

Air contamination is an overall issue and its paraphernalia can be seen even transversely developed nations for example, Europe where 193,000 individuals died because of air contamination in 2012 [36]. Well-being of environment is a significant factor to maintain human health also, and well-being will be maintaining properly if the surrounding atmosphere remain pollution-free [37]. Most of our surrounding environment is filled with air, which is easily polluted by the industrial activity [38]. However, because of lockdowns and modern terminations as an impact constrained by COVID-19, contamination in city air and water bodies is getting a depressed mode because of nonappearance of enormous utilization of petroleum derivatives and arrival of mechanical effluents. Among numerous other areas, transportation is the utmost hard-hit portion due to lockdown [39]. Highway and inflight transport reached halt as individuals are not allowed or falter to travel. Presenting to report, air travel fell by 96% because of COVID-19, least in 75 years. NASA (National Aeronautics and Space Administration) and ESA (European Space Agency) unconfined new suggestion which proposes that ecological eminence enhanced and the release of NO₂ decreased up to 30% [40].

Higher PM_{2.5} levels are related with higher number of cases and passing of COVID-19. The case-casualty rate (Deaths/cases*100) didn't increment with the expansion in PM_{2.5} levels [41]. In the paper [42], any proof for the impact of air contamination was not found. There was no proof of a relationship between long-term introduction to PM_{2.5} and death rate at the region level in Colombia [43]. The high centralization of viral RNA has been seen when the submicron, as well as super submicron particles having topped in the vaporized size dissemination bend, the connection between COVID-19 morbidity and mortality cases and air quality file, was not linear [44]. The most probable clarification is that the degrees of PM₁₀ and PM_{2.5} found in their investigation create a fiery reaction in the lungs. In any case, key atomic occasions

in reaction to PM introduction are engaged with changing the homeostasis of cardiovascular physiology [45]. Coronavirus would appear to help a comparative instrument, initiating the fast beginning of a condition of aggravation, with a similarly fast increment in incendiary cytokines, equivalent to that brought about by momentary introduction to PM [46]. The outcomes demonstrated that 78% of the passing from COVID-19 were moved in five regions situated in northern Italy and

central Spain. In these zones, there was an elevated level of nitrogen dioxide [47]. (Figure 3) Coronavirus actuated social lockdown versus contamination in a few countries. NO₂ level (red lines) and atmospherical particulate issue (PM_{2.5}, blue lines) in a) Italy, b) Spain, c) France, d) Los Angeles, USA, e) Wuhan city, f) China and g) India as an element of lockdowns [48].

Top 15 Countries Considering Number of Literatures

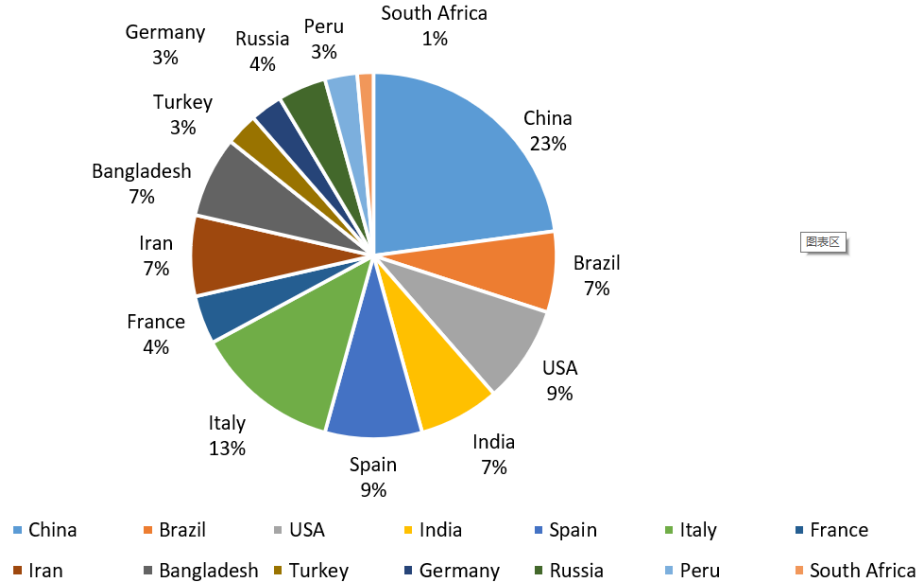


Figure 2. Top 15 countries we have considered while taking literatures to review

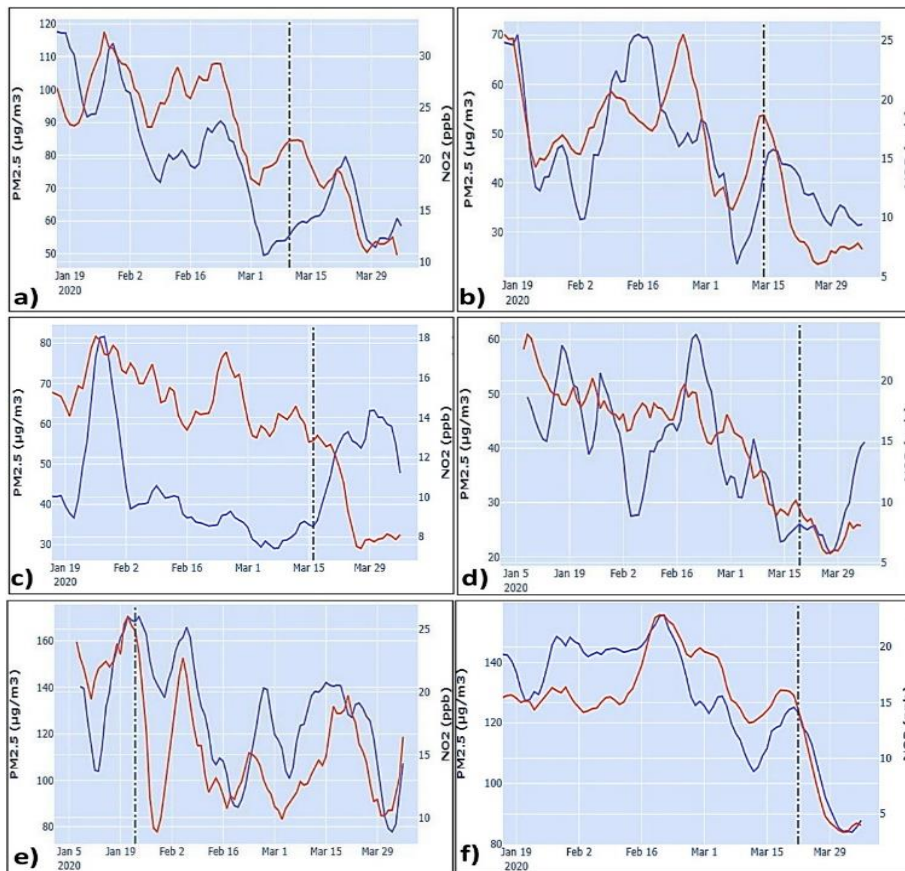


Figure 3. Coronavirus actuated social lockdown versus contamination in a few countries. NO₂ level (red lines) and atmospherical particulate issue (PM_{2.5}, blue lines) in a) Italy, b) Spain, c) France, d) Los Angeles, USA, e) Wuhan city, f) China and g) India as an element of lockdowns [11]

3.2 COVID-19 and meteorological factors

As implicated by many studies, meteorological factors are found to show an independent part in the spread of COVID-19 [49]. The two most significant weather factors are temperature and humidity. Temperature and humidity influence the Earth's climate, human wellbeing and human prosperity [50]. Air temperature changes influence how much water fume the air can hold. Qualities, for example, relative humidity and dew point help portray these impacts on climate. So, these two factors should be highly valued in terms of meteorological parameters studies.

3.3 COVID-19 and temperature

One of the major meteorological parameters is temperature. Numerous studies have been conducted around the world to find out the correct nature of correlation between COVID-19 spread and temperature. A study conducted in China found that, a weather with mild diurnal temperature and low temperature range are most probable to help the transmission of COVID-19. An obvious tendency was found amid established case counts and ambient temperature. A temperature rises in the range of -20°C to 20°C seemed to cause a surge in the number of confirmed cases. It was likewise demonstrated that the confirmed cases check declined with the expansion of in the Diurnal Temperature range of about 5°C - 15°C by the regression model. However, ambient temperature and Diurnal Temperature range both were found to be not positively associated with the surge of transmission of COVID-19 [51].

Another study in China found a positive association between daily Temperature range and newly death counts of COVID-19. A stable measure of temperature is represented by DTR, which acts as an indicator variability of temperature so that the effects on humanoid health, with morbidity and mortality can be evaluated [52]. A negative connection was demonstrated among temperature and COVID-19 mortality. As per another review it was found that, that lower temperature may repress the function of immunity [53]. However, a study conducted in the US found temperature to be an underprivileged metric for the study of the climate-based expand in the US, as it was not possible to identify any restricted weak scope of temperature. They found among an amount of test cases in a particular time interval to fall in a wider range of 4°C - 11°C temperature. Which was found to be in league with other studies around the world, where the majority of spread was found in temperature range of 5°C to 11°C and 3°C to 17°C [54]. A study conducted in Mexico found that, locally confirmed positive cases of COVID-19 was associated negatively with Temperature. There was a crucial role played by the climate characteristics on the regional infection throughout the phase 1 of transmission. Where the tempered regions (19.65°C) were more vulnerable than that of the dry (20.57°C) or the tropical areas (mean temperature around 25.95°C). An investigation led in Mainland China believes that, Countries and locales with lower temperature should give more consideration as temperature demonstrated negative relationship with COVID-19 [55]. A temperature increments in the scope of -20°C to 20°C appeared to cause an expansion in the quantity of affirmed cases. It was likewise demonstrated that the affirmed cases tally declined with the expansion of in the Diurnal Temperature scope of around 5°C - 15°C by the relapse model. Be that as it may, encompassing

temperature and Diurnal Temperature range both were discovered to be contrarily connected with the expansion of transmission of COVID-19 [56].

A Global report found that, there was a negative connection among temperature and COVID-19 mortality, since at lower temperatures, the exhibition of the safe framework, and the liver declines. Subsequently, the circumstance will be helpful for the movement of irresistible specialists and viral transmission. An investigation in China reasoned that, Temperature is functioning as an ecological driver of the COVID-19 episode in China. Likewise, that, with the expansion of temperature a decline in the frequency of COVID-19 happens. A biphasic relationship was likewise found between temperature (with a top at 10°C) and every day affirmed cases pace of COVID-19. It was likewise discovered that at values beneath or more these qualities the day by day occurrence of COVID-19 diminished [57].

Temperature and the short-wave radiation were discovered to be the most affected factors in a Chinese report, where, the affirmed cases were discovered to be the most affected instances of climate factors. Then another Chinese examination found that, to clarify why cases spread quicker on specific days than others temperature could be a critical informative variable. On an average 1.2 rate point decline in the rate increment in affirmed cases is corresponded with each extra centigrade over 5 degrees of temperature. An examination in Indonesia found that, temperature normal ($^{\circ}\text{C}$) was altogether associated with Coronavirus among five climate factors that were considered [58]. Another investigation discovered Temperature to be around the world contrarily identified with the everyday new passing and day by day new instances of COVID-19. Aftereffects of an investigation in China propose that, there is a positive straight connection between mean temperature and the quantity of COVID-19 cases with a limit of 3°C . A 4.861% expansion in the everyday affirmed cases were related with 1°C ascend in the mean temperature of a week ago. A Global report found that, development rates crested in areas that had a mean temperature of $\sim 5^{\circ}\text{C}$ all through the episode month, while diminishing both in colder and hotter atmospheres.

In Turkey temperature upon the arrival of the case were found to impact the affect COVID-19 cases. In any case, an alternate report in Turkey found that, Air temperature and the quantity of bright days didn't influence the quantity of cases. A worldwide report discovered, negative relationship between COVID-19 diseases and nation normal temperature while watching no relationship among deaths and nation temperature. In an examination the quantity of cases analyzed appeared to increment under a most extreme temperature of 10°C and were found to straightly diminish a while later. The highest spread of COVID-19 appeared to happen in Bangladesh at a normal temperature of 26°C . It was likewise discovered that, under a straight linear regression framework, the transmission of COVID-19 was discovered to be altogether decreased by high temperature. An investigation in Spain found no proof of a connection among temperature and COVID-19 cases [59].

In Bangladesh COVID-19 confirmed illness and death cases were found to have a strong confirmed correlation with average temperature and minimum temperature. Though they mention that, the relationship between COVID-19 cases and climate variables is still not understood well. The results of a study in Russia show that transmission in the humid continental region highest contribution for COVID-19 is of temperature seasonality ($29.2 \pm 0.9\%$). While, in the sub-arctic

region temperature seasonality ($14.6 \pm 0.8\%$) and the diurnal temperature range ($26.8 \pm 0.4\%$) had the maximum impacts.

In Singapore a study found that, temperature shows a positive significant association with SARS-CoV-2 transmission [60]. A study conducted in China and Italy showed that, relationship of spread of coronavirus disease with maximum temperature is ranging between negligible to moderate. Results of a Brazilian study showed that higher mean temperatures favored the COVID-19 transmission. An examination in New York, USA indicated that base temperature and normal temperature have huge connection with COVID-19 scourge. An examination in the quantity of affirmed COVID-19 cases in the Russian Federation with temperature-most extreme, least, and normal found a solid relationship between normal temperature ($r_s = 0.75^{***}$) and furthermore a noteworthy connection for different variations of temperature. Subsequently, validating the theory of climate initiated COVID-19 spread. Another examination proposed that ecological temperature influences transmission instead of the disease severity. This examination demonstrated that, lower temperature may cause an expansion of SARS-CoV-2 transmission (estimated as an expanded assault rate), however there was no proof that temperature influences the disease severity of the ailment (estimated as case casualty rate) [61].

3.4 COVID-19 and humidity

As drawn up by numerous investigations, meteorological variables are found to assume an autonomous function in the transmission of COVID-19. An indicator to describe the mass of water fume per volume of air is Absolute humidity. One of the most significant climate boundaries in anticipating heat-related mortality among a range of climate boundaries is Absolute Humidity. A major meteorological parameter to correctly indicate the condition of the environment is Humidity. Studies have been conducted around the world to find out the correct nature of correlation between COVID-19 transmission and Humidity. It was indicated by many studies that, a superior pointer of humidity in intense wellbeing impacts is Absolute Humidity [62].

In China, the coronavirus outbreak happened in the wintertime and initial spring season with lesser Absolute Humidity. As specified by the results in this study, there might cohabit an optimal low humidity for the spread of COVID. There might be a possibility that, low Absolute humidity may favor the transmission and stability of coronavirus like influenza. It was confirmed by the researchers that respiratory contamination was found to be boosted during uncommonly frozen and subtle humidity conditions. Which indicates that, slight humidity might be a significant risk factor for the lung diseases [63].

The results of an analysis in Wuhan, China also indicate that with the increase of absolute humidity, the consequence of dying from COVID-19 decreases. The susceptibility of the host towards to respiratory virus infection may increase due to reduction of mucociliary clearance or epithelial damage caused by breathing dry air. It was found from a global study that; elevated humidity may decrease COVID-19 passing and surge recuperation rates. As, relative humidity may render coronaviruses to be inactive particularly on inanimate objects. According to reports, a higher relative humidity was found to diminish the determination and practicality of the infections contrasted with that in lower relative humidity. Coronaviruses were found to survive in a low relative humidity environment

and thus prolonging its stability and viability on contaminated surfaces. It was found that, in an environment with low relative humidity and low temperature coronavirus contamination can be retained for 14 days. An US based study that claimed to be consistent with worldwide observations, found that the spread of COVID-19 was significantly upheld by climate boundaries in the reaches 3 to 8 g/m^3 of Absolute humidity. In another study greater part of the new cases far and wide were discovered to be in nations with 4 to 9 g/m^3 of Absolute humidity [64].

A study on Hubei province and in some other provinces of China suggested that, relative humidity and daily temperature both influenced the occurrence of COVID-19. A study conducted in Bangladesh suggests that, relative humidity reduces the transmission of COVID-19. Higher humidity was found to help prevent infection by keeping the layers in the nose and throat damp, which would empower them to catch infections, microscopic organisms, and earth before they can arrive at the lungs.

In Dhaka city of Bangladesh, a solid straight relationship has been watched for the COVID-19 aggregate and passing cases with relative humidity. An examination in Russia found that, in the sub-cold locale, diurnal temperature range, humidity positively affects the COVID-19 spread. It was additionally settled by this examination that, on the power of the COVID-19 transmission the function of normal relative humidity was modestly related and reliable. According to the outcomes, 75-80% relative moistness in the sub-arctic locale and 60-65% in the humid mainland district is more appropriate for the infection and decently related [65]. The COVID-19 transmission in a mild zone was discovered to be commonly appropriate in the states of high relative moistness additionally in tropical territories, high relative humidity is connected with the transmission of COVID-19 cases however not as unequivocally related as a temperate area. These discoveries are in accordance with another investigation from China that expressed that normal relative humidity running between 50%-80% comprise a fitting condition for the network transmission of this infection [66].

An investigation in Singapore discovered relative humidity, absolute humidity, and water fume to show positive noteworthy connection with COVID-19 pandemic. A study in Iran found an opposite relationship of humidity within the disease outbreak speediness. In Brazil intermediate relative humidity was found to influence the COVID-19 transmission rate. Thus, it was shown that, average relative humidity preferred the COVID-19 transmission, which was different from reports from most arctic countries or ages of time below calm temperatures.

A study combining four of the most concerned places of China and five of the most concerned places of Italy, it was found that, the relationship with maximum relative humidity is mostly negligible. While a study in Jakarta, Indonesia found humidity to not be significantly correlated with COVID-19 [67].

3.5 COVID-19 and wind speed

Wind is an essential factor in the transmission of respiratory irresistible sicknesses and it might adjust the elements of different vectors and microbes [68]. Wind speed has a huge and converse relationship with the pace of COVID-19 contamination rate. In this way, in the lower speed of the breeze, the contamination rate is higher [69]. Both breeze

speed and surface weight are found to increase attested occurrences of SARS-CoV-2 across countries. If the airborne factor of Covid holds, by then, both breeze speed and surface weight controls fast track the spread of the contamination, by enlivening the strategy for adventure out beginning with one territory then onto the following [70]. Wind speed clarified 9% difference of the coverage or the quantity of cases. This clarification demonstrates that wind is a reasonably significant factor. It is hard to control the spread of the infection in blustery climate. Contingent upon the power of the breeze and the bearing of stream, the COVID-19 infection can be moved. In Turkey, the ordinary breeze speed in 14 days has the most significant relationship with the number of cases [71]. The higher the breeze speed is, the more the number of cases is. The results moreover show that the most reasonable time span is 14 days, which implies that the breeze speed in 14 days of the case should be considered for choosing the right relationship. Wind is a significant factor in irresistible infections transmission and it can regulate the elements of different microorganisms and vectors. Wind speed indicated noteworthy of negative correlation relationship with coronavirus cases over Singapore. Like this examination, negative connection between Coronavirus and wind speed was likewise detailed over Iran. Wind speed was not negatively associated with COVID-19 case over Oslo, Norway [72]. Also, wind speed and precipitation likewise demonstrated a huge positive connection with COVID-19 cases in Dhaka, Bangladesh. In Italy inspects shows that metropolitan territories with low wind speed have more critical degree of tainted individuals than metropolitan networks having higher breeze speed [73].

3.6 COVID-19 and precipitation

In our course to discovery the correlations among climatic factors and COVID-19 spread we studied the relation between an important climatic factor, precipitation and spread of COVID-19 as presented by many studies around the world. A global study found that, there is a sturdy correlation and interconnection between confirmed cases and moisture-based weather factors, like precipitation. Rather it was found that precipitation and other moisture-based meteorological factors convert dehydrated environment to a humid and freezing condition by lessening temperatures to low levels establishing a climate positive for the endurance and transmission of the infection. A report demonstrated that, human COVID make due for a couple of hours in a dry climate yet in a sodden suspension can remain alive for a few days.

It was likewise discovered that, precipitation had caused an expansion in the pace of number of passing from COVID-19 and has additionally nullified the pace of recuperation [74]. Another worldwide examination found a positive connection between SARS-CoV-2 transmission and precipitation, with the end goal that, an expansion of 56.01 cases/day happened for every 1-in. increment in precipitation/day [75].

A study conducted in Dhaka, Bangladesh shows that, rainfall showed a substantively positive association with the number of COVID-19 cases [76]. However, a study in China has shown more varying results as rainfall having a negative movement with confirmed and recovered cases in Shanghai while showing a strong positive movement with Deaths cases in Fujian. Some studies also found precipitation to not be significantly correlated with COVID-19 [77]. While some studies claimed that they did not find precipitation to be related

with COVID-19 [78]. In some studies precipitation was not evaluated as a sole parameter but in combination with temperature as a combined weather condition [79].

Such a study showed that, the regional climate of states in Mexico had statistically significant association with LCPC and LTR. Where dry and mild virus atmospheres with the most reduced temperatures and precipitations enrolled (19.65°C and 8.48 mm individually) were the more appropriate natural conditions for transmission and watched the quickest local onsets. Notwithstanding, in locales with lower temperatures and higher precipitations (20.57°C and 20.87 mm separately) beginning happened sooner than in different areas in dry atmosphere [80]. While the heat and humidity with mean temperature around 25.95°C and mean precipitation around 8.74 mm encountered a deferral in the local beginning [81].

3.7 COVID-19 and other factors

Noise pollution affects around 100 million people all over Europe, as per the WHO. Much health degrading issues can arrive due to noise pollution including low to extreme level of stress, mental discomfort, rise of blood pressure as well as heart rates. Every single source of noise contamination at present are because of some type of humanoid actions, from traffic to residential or industrial and many more [82].

During this lockdown period, street and inflight traffic has fallen considerably in most counties. For example, in the Indian main cities of Mumbai, New Delhi, Chennai and Bengaluru the foot print (estimated as the everyday normal changeover of impressions (%) regarding walk-ins from home to food supplies, petroleum pumps, diagnostic hubs and bank) to corresponding sectors has noticeably decreased during lockdown [83]. With this decrease in human movement, the planet is said to have calmed down. Seismologists have been known to be reporting lower levels of vibration from “cultural noise” than they did prior to the pandemic [84].

As the COVID-19 induced lockdown has pushed about one third of the human population indoors, the wild animals seem to be taking advantage of this absence, they are found affecting across human inhabitation roads, cities etc. Overall population have come to watch some unconstrained changes happening in nature and in this manner seeing its self-restoration. Air Quality Index (AQI) is one of the strong measurements which appear to be changing for the nature and its solid environment [85].

4. CONCLUSIONS AND FUTURE DIRECTIONS

With the destruction of an ongoing pandemic that the world is already dealing with, there is also a threat that looms over the global population. The threat is of this novel virus not being the last to cause a large outbreak leading to worldwide panic and death. At this point it is imperative for the scientists, researchers and policy makers to try to understand the behavior of this virus. To understand what kind of environmental conditions caused the origination and worldwide spread of this pandemic. Also what kind of environmental conditions, (if any) may help reduce its severity and effects. So that, the world community may be able to come together to create the optimum conditions for their survival or take optimum precautions in case of high vulnerability areas. In this paper we have tried to collectively conduct a comparative study on environmental factors that are

influencing the COVID-19 spread. So that, the global researcher, scientist, and policy maker community can take help from this work while trying to take decisions regarding this pandemic and trying to understand its correlation with various environmental parameters.

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APPENDIX

Table 1. Summary of literature reviews

Author (s)	Objectives	Countries	Major Findings
[1]	To investigate non-linear connection between COVID 19 case tallies and meteorological components.	China	<ul style="list-style-type: none"> •The climate with low temperature, gentle diurnal temperature extends and low humidity probably favors the transmission of COVID-19. •The epidemic may steadily ease halfway because of rising temperatures in coming months.
[4]	To examine irregularity in absolute humidity and spread of COVID-19.	China	<ul style="list-style-type: none"> •Equally absolute humidity and temperature are related through homegrown exponential progress of COVID-19. •Absolute humidity and temperature yielded a positive relationship and a slight negative relationship respectively. •First attempt to track the impact of the COVID-19 spread on the hydrosphere.
[8]	To analyze the status of water pollution in Vembanad Lake, the longest freshwater lake in India, and to evaluate the effect of the lockdown on the water quality.	India	<ul style="list-style-type: none"> •Business lockdown due to the COVID-19 spread improved adjacent lake water quality. •Suspended particular matter concentration in Vembanad lake decreased by 15.9%. •Eleven out of 20 zones showed the lowest April SPM in 2020. 34% from the previous minima. •Business activities have a significant impact on the lake water quality.
[19]	To examine the numbers of basic reproductivity of COVID-19 on the basis of spatial variability and to show that this variability cannot be explained only by environmental variables.	Iran, Italy, Singapore, Japan, and South Korea and 345 cities in China	<ul style="list-style-type: none"> •Only changes in the weather will not necessarily cause the case count to decrease if the extensive public health interventions are not implemented.
[20]	To find the effect of Ambient Temperature over the Infection Rate of COVID-19	China	<ul style="list-style-type: none"> •There is a massive effect of temperature on the rapidness of the spread of Coronavirus in certain conditions. •It is recommended that countries in the southern hemisphere prepare for an increase in caseload, and countries in the northern hemisphere limit in air conditioning. •Conflicting evidence was found that, there is a relation between humidity and infectiousness of COVID-19 which is, it does not affect infectiousness. •Environmental COVID-19 does not have temperature resistivity and starts breaking down at high temperatures. •With each 1 C increase of temperature above the scale of 5 degrees is correlated to the transmission rate that can reduce by 10%. This suggests keeping temperature high can be a very effective strategy of management. •All air conditioning systems indoor to be operated around or above 25 degree Celsius. •Countries should get prepared for COVID-19 on seasonal basis.
[27]	To explore the relationship between concentrations of six air pollutants and daily confirmed COVID-19 cases.	China	<ul style="list-style-type: none"> • There was a significant relationship between air pollution and COVID-19 infection after controlling for confounding factors. • Positive associations of PM_{2.5}, PM₁₀, CO, NO₂ and O₃ with COVID-19 confirmed cases were observed. •However, SO₂ was negatively associated with the number of

[28]	To show that climate plays a key role in the transmission of COVID-19	Chile	<p>daily COVID-19 confirmed cases.</p> <ul style="list-style-type: none"> • Mean temperature (negative effect), relative humidity (negative effect) and wind speed (positive effect).
[30]	To assess the changes in air quality during the implementation of the Lockdown.	Spain	<ul style="list-style-type: none"> • NO₂ and BC concentrations were reduced by half during the lockdown (more windy and wet) period. • PM₁₀ decreased but in a much lower proportion, causes for the lower abatements are still unknown. • O₃ concentrations increased by around 50%. • The relationship among the yearly average of temperature compensation and confirmed cases of COVID-19 was approximately linear whole in the less than 25.8°C range which changed above 25.8°C according to the dose-response relationships.
[34]	To investigate how the Brazilian tropical weather effects the transmission of the coronavirus through the exploration of the relationship between confirmed cases of COVID-19 and yearly average temperature.	Brazil (sub) tropical cities of Brazil	<ul style="list-style-type: none"> • When average temperature was under 25.8°C, each rise of 1°C was associated with a -4.8951% reduction in the daily number of Cumulative confirmed COVID-19 cases. • No evidence that the case counts of COVID-19 could show a decline when weather becomes warmer, in case of temperatures above 25.8°C.
[38]	To conduct investigation on the effect of reduction of lockdown and human activities on the environmental indicators and variation in air quality in the USA and China then to correlate that with spread of COVID-19 and the pollutants in the environment in those respective provinces and states.	USA and China	<ul style="list-style-type: none"> • Restricted human-activities have caused significant reduction in the environmental pollutant's concentrations in both the countries. • A significant correlation was observed between COVID-19 disease and pollutants PM_{2.5}, PM₁₀ and NO₂.
[39]	A review on International social lockdown versus the medical care to be provided against COVID-19. (a mild insight into environment with special Reference to India).	Global (with special Reference to India)	<ul style="list-style-type: none"> • COVID-19 has globally become the most lethal pandemic. • Immense positive impact of social lockdown on environment was observed. • Suggesting the regular conductance of such activity to save the environment in the future • COVID-19 improved China's air quality in the short term.
[41]	To enriched the theoretical research on the relationship between economy and pollution from an emergency-economy-environment perspective.	China	<ul style="list-style-type: none"> • Satellite data show a sharply decline in NO₂, an indicator for environment. • Declining economic activities leads to reduction in energy consumption and NO₂ emissions. • Strict quarantine measures benefit to the environment.
[46]	To find Influence of airborne transmission of SARS-CoV-2 on COVID-19 pandemic.	Italy	<ul style="list-style-type: none"> • Certain air pollutants might lead to more severe and lethal forms of COVID-19 and delays/complicates recovery of patients.
[47]	To investigated the relationship between meteorological factors, especially the average temperature and humidity and the daily number of probable COVID-19 patients in	Bangladesh	<ul style="list-style-type: none"> • Warm and humid weather may curb the spread of the coronavirus infections. • More than four-fifths (84.2%) of the total cases were clustered within the average temperature range 26°C-28°C so that we can guess that average temperature 26°C-28°C may be the optimal temperature for COVID-19 prevalence • Significant association between contingency measures and improvement in air quality, clean beaches and environmental noise reduction.
[49]	To show the positive and negative indirect effects of the SARS-CoV2 coronavirus on the environment.	China, USA, Italy, and Spain	<ul style="list-style-type: none"> • Negative secondary aspects such as the reduction in recycling and the increase in waste • Global economic activity is expected to return in the coming months in most countries (even if slowly), so decreasing GHG concentrations during a short period is not a sustainable way to clean up our environment
[50]	To analyze before and after situation about air pollution during Lockdown	Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa, United States	<ul style="list-style-type: none"> • The data can be useful for researchers dealing with the environmental and tropospheric changes occurring during the COVID-19 restrictions • The data can be used to assess the relationship between the perceived and the quantified change in air quality and air pollution during the COVID-19 restrictions. • The data can be of interest to both citizens and policymakers to realize the tremendous lesson learned during COVID-19, being air quality a key indicator for sustainable development
[52]	To investigates the relationship between the spread of COVID-19 with climatic factors. To develop a scenario-based map of weather-related increment in the spread of	Russia	<ul style="list-style-type: none"> • In the humid continental regions, the highest contribution for COVID-19 transmission was shown by temperature seasonality (29.2 ± 0.9%). • In the sub-arctic region temperature seasonality (14.6 ± 0.8%)

	COVID-19 from June to end of the year.		and diurnal temperature range ($26.8 \pm 0.4\%$) were shown to have the highest impacts.
[54]	To evaluate the status of air quality during the 2020 Malaysia Movement Control Order (MCO) Because of the 2019 novel coronavirus (2019-nCoV) pandemic	Malaysia	<ul style="list-style-type: none"> • September along with October have the climatic conditions favorable for the spread of COVID-19 in the humid continental and sub-arctic regions respectively. • From the month of June to August the highly favorable zone for the spreading of the disease will shift from the humid continental region towards the sub-arctic region. • Implementation of strict measures is necessary for these months so that second wave of COVID-19 in Russia can be prevented. •The Air Pollutant Index (API) in Malaysia was dominated by the concentrations of PM_{2.5}. •Concentrations of PM_{2.5} showed several reductions during (MCO). •An approximate 28.3% reduction of concentrations of PM_{2.5} was shown by several red zone areas. •On average the highest reduction of concentrations PM_{2.5} was shown by Northern Region of Peninsular Malaysia with 23.7%. •The threat of COVID-19 outbreak is not limited to any single country or region. Strong and sustainable international collaborative work and data sharing is required for the response, control and prevention of novel infectious diseases.
[58]	On the ‘Need for Research on the Role of Environmental Factors’	Global	<ul style="list-style-type: none"> •It is imperative to conduct further research to fill the knowledge gaps on COVID-19. •Along with the expertise in the fields of public health, medicine and computer science the contribution of the environmental scientists in collaborative research for combating the infectious disease threat at a global scale is urgently warranted.
[59]	To identify and to categories the climatic and sociobiological factors that globally influence the super-spread of the epidemic using a theory building approach, ‘Total Interpretive Structural Modelling’ (TISM).		<ul style="list-style-type: none"> •11 factors were found to globally influence the epidemic characteristics of COVID 19. •The driving or key factors in this model are social distancing and community consciousness, air temperature, age, ventilation, airflow and population density and humidity. •Transmissibility and lethality of SARS-CoV-2 is high. Vulnerability could be increased by exposure to air pollution and have detrimental effects on the prognosis of that are patients affected by the COVID-19. •In translating high values of conventional metrics, such as PM_{2.5} and PM₁₀ concentrations, into a direct measure of vulnerability caution should be used.
[60]	To find if Air Pollution Influences the outbreak of COVID-19	Global	<ul style="list-style-type: none"> •In specific environments airborne transmission mediated by virus-laden aerosols that are emitted during expiration and speech is plausible. •In particular indoor environments, such as hospitals and areas where the patients are quarantined. It is advisable to use periodic ventilation of environments, air conditioning systems, decontamination of surfaces and appropriate technologies for mechanical ventilation/conditioning to limit the circulation of virus-laden bioaerosols in air to mitigate the risk for people who are vulnerable.
[61]	To develop and assess the method for Investigation of the Impact of Urban and Climate Parameters in Confirmed COVID-19 Cases and to propose a multivariate linear regression (MLR) model for the improvement of the prediction.	Italy	<ul style="list-style-type: none"> •The result of the analysis demonstrates the effectiveness of the proposed model and the impact of climate parameters on the trend of confirmed cases. •The research hypothesis approved by the MLR model and the present assessment method could be applied by considering several variables that exhibit the exact delay of them to new confirmed cases of COVID-19
[66]	This Opinion Paper wishes to provide a summary of recent findings and solutions for a better understanding of the environmental and health problems associated with COVID-19. (An environmental and health perspective for COVID-19 outbreak: Meteorology and air quality influence, sewage epidemiology indicator, hospitals disinfection, drug therapies and recommendations)	Global	<ul style="list-style-type: none"> •Provide a summary of recent findings and solutions for a better understanding of the environmental and health problems associated with COVID-19. •The list of topics covered is large: meteorology and air quality factors with correlation number of infections, sewage waters as a way to reveal the scale of COVID-19 outbreak, current hospital disinfection procedures and new eco-friendly technologies and list of drug therapies recommend waiting for the desired vaccine to come •This Opinion Paper can serve as multipurpose document, not only for scientists of different disciplines but for social media and citizens in general.

[68]	To highlight the impacts of COVID-19 on environment & society, and attempt has been made to point out the preventive routes for minimizing the risk factors.	Global	<ul style="list-style-type: none"> •Covid-19 disease originated in December 2019, Wuhan, Hubei Province, China. •COVID-19 pandemic has been declared as a global health emergency by WHO. •Society and global economy were affected. •It also affected global environment. •The virus was found to be highly stable at 4°C but it is sensitive to heat. •With the increase of incubation temperature to 70°C, the time for inactivation virus was reduced to 5 mins. •SARS-CoV-2 was found to be more stable on the smooth surfaces.
[69]	To study in different environmental conditions the stability of SARS-CoV-2.		<p>No infectious virus could be discovered from smooth treated surfaces on day 4 (banknote and glass) or day 7 (plastic and stainless steel). Conspicuously, infectious virus of a detectable level could still be present on the outer layer of a surgical mask on day 7 (~0.1% of the original inoculum).</p> <ul style="list-style-type: none"> •A biphasic decay could be found in samples recovered from the smooth surfaces, of the infectious SARS-CoV-2. •SARS-CoV-2 was found to be extremely stable in a wide range of pH values at room temperature (pH 3–10). •On the whole, SARS-CoV-2 in a favorable environment can be highly stable. <p>But it is also susceptible to standard disinfection methods.</p> <ul style="list-style-type: none"> •A substantial reduction of gaseous and particulate pollutants was found.
[75]	To statistically evaluate the effects of COVID-19 lockdown (26 March to 26 April 2020) on selected air quality pollutants and air quality index.	Bangladesh	<ul style="list-style-type: none"> •The more notably the reduction of PM_{2.5}, PM₁₀ and NO₂ were 40%, 32% and 13% compared to the mean concentrations of these for previous 8 years dry season. •Except NO₂ other pollutants showed decreasing trends during COVID-19 lockdown and similar trend was revealed for AQI. •The average SO₂ and NO₂ concentrations were decreased by 43 and 40%, respectively.
[77]	To explore the possible impacts of COVID-19 lockdown activities on ambient air quality	Bangladesh	<ul style="list-style-type: none"> •while tropospheric O₃ were found to be increased with a maximum of > 7%. •In Dhaka, NO₂ and SO₂ concentrations were decreased approximately by 69 and 67%, respectively. •The obtained results confirm that AT and PS have low sensibility and high sensitivity, respectively.
[78]	To investigate the sensitivity of AT and PS on the transmission rate of the novel coronavirus in different provinces of Iran.	Iran	<ul style="list-style-type: none"> •Thus, there is no scientific reason to confirm that the number of COVID-19 cases in warmer climates is less than that of moderate or cold climates.
[82]	To provide expedient information to the policymaker, which can help to lower the COVID-19 infection rate.	Bangladesh	<ul style="list-style-type: none"> •Among the seven indicators, only three indicators (air quality, minimum temperature and average temperature) have a significant relationship with new COVID-19 cases. •Higher correlation is observed for air quality. •The climate factor is one of the factors that influence the fast spread of COVID-19.