



Mini Review

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# Can Climate and Environmental Factors Putatively Increase SARS-Cov2 Transmission Risks?

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## Abstract

After the identification of the first SARS-COV-2 infected cases in China, the virus was rapidly disseminated among the distinct continents and the COVID-19 pandemics was announced by the WHO in March 2020. Over time, the epidemiological sceneries varied among countries, according to the adopted mitigation measures and epidemic phase. Recently, a recrudescence of the epidemics has been observed in distinct countries. SARS-CoV-2 can be transmitted by direct or indirect contact. The viral RNA has been detected in stool and other clinical specimens from infected patients and a putative fecal-oral transmission has been argued. Viruses are shed in human excreta, further disposed into the sewerage system or into the environment, in poor sanitation settings. Thus, SARS-CoV-2 RNA has been regularly detected in wastewater and surface water impacted by the direct discharge of sewage. Some studies have reported an association between climatic parameters and an increase in COVID-19 incidence. However, conclusive evidence based in full seasons is needed so far.

This mini-review briefly discusses the putative role of climate and environmental factors on SARS-CoV-2 exposure, transmission and circulation patterns. Moreover, some additional challenges in middle and low-income settings are highlighted. Efforts must be driven to categorically understand the relationships between SARS-CoV-2 infection, circulation patterns and climate parameters, as the putative implications of viral persistence and viability in distinct environmental matrices. This information is crucial for COVID-19 control and prevention, especially in middle and low-income settings, already wedged by social inequality, inadequate sanitation and deficient healthcare admission.

**Keywords:** SARS-COV-2 transmission; COVID-19; Climate; Wastewater; Surface water; Public health

## Introduction

After the identification of the first severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) infected cases in Wuhan, China, in December 2019 [1,2], the virus was rapidly disseminated among the distinct continents and led the World Health Organization to announce the COVID-19 pandemics in March 2020 [3]. Over time,

the epidemiological sceneries varied among countries, according to the adopted mitigation measures and epidemic phase [4-7]. Recently, a recrudescence of the epidemics has been observed in Europe [8] and in the Americas, where the highest new case and deaths figures has been reported in the United States, followed by Brazil, Mexico, Columbia and Argentina [9].



SARS-CoV-2 infected droplets and aerosols are released from symptomatic or asymptomatic subjects during events such as coughing, sneezing and talking. Afterwards, the virus can infect new hosts via direct or indirect contact. The close contact favors the inhalation or direct exposure of mucous membranes from susceptible persons to infected discharged particles. Viral exposure can also occur by the contact with contaminated surfaces or fomites [10], where the virus is able to remain viable and infectious for hours or even days, depending on the concentration of the inoculum and the nature of the investigated surfaces [11–13]. Increasing evidence suggests a role of viral airborne transmission via aerosols [11,14–18], particularly in indoor and crowded settings [18,19].

SARS-CoV-2 RNA has been detected in stool and other clinical specimens from infected patients [20-23], despite the presence of gastrointestinal symptoms [24]. Although, information on viable and infective viruses in feces is still limited [21,23,25,26], this context raised the current debate on a putative fecal-oral transmission role in viral dissemination [23,27,28]. As viruses are shed in human excreta [29,30] – which is further disposed into the sewerage system or directly into the environment, in poor sanitation settings - viral RNA has been detected in waste- and polluted surface water [31-36]. Under the climate perspective, some studies have reported an association between climatic parameters and an increase in COVID-19 incidence [37,37-40]. However, conclusive evidence based in full seasons is needed so far. In addition, confounding factors – such as socioeconomic variables are also critical in middle and low income areas [41]. This mini-review briefly discusses the putative role of climate and environmental factors on SARS-CoV-2 exposure, transmission and circulation patterns. Moreover, some additional challenges in middle and low-income settings are highlighted.

### **SARS-Cov-2 and the Environment**

SARS-CoV-1 can survive for 4 days in diarrheal stool samples [42,43]. Other coronaviruses (CoV) remain infectious in water and sewage for days to weeks [44,45] and their inactivation depends on temperature, level of organic materials, UV exposure and microbial community [46-48]. Thermodynamic studies revealed that SARSCoV-2 is able to survive for approximately 10 hours in environments under a temperature of 35°C [49] and, in laboratory conditions, the virus is highly stable at 4°C [50]. At room temperature (22°C), virus remains viable for 3 days in wet or dry environments, despite a wide range of pH values [51]. As other CoV, SARS-CoV-2 is susceptible to antiseptics containing ethanol, and disinfectants with chlorine or bleach [50,52,53]. A recent study had shown that treated wastewater effluents present a 100 times reduction in SARS-CoV-2 load compared to the corresponding raw wastewater samples [54].

Worldwide, SARS-CoV-2 RNA has been regularly detected in wastewater [31] and rivers impacted by the direct discharge of sewage [35,55,56]. In this context, it is essential to emphasize that the detection of viral nucleic acid does not indicate the presence of active and infectious SARS-CoV-2. To date, there is no evidence of viral infection through drinking water, food or other matrices [48,57] and, so far, the studies addressing the SARS-CoV-2 viability in untreated and treated wastewater, surface water and soil were not able to recover and demonstrate the presence of infectious viruses in these samples [35,56,58,59]. Nonetheless, cumulative evidence is critical to effectively understand the putative role of these elements as potential sources of viral exposure [27,47,60-65], particularly in limited/poor sanitation settings, which comprise about a third of the global population [66]. In these backgrounds, waterways are used as open sewers and sources of water for domestic purposes [61,62] and the proximity of latrines or septic tanks and surface or groundwater uses to be common [66].

Under a complementary perspective, the increasing frequency of strong rainfalls, storms and flooding, as a consequence of climatic changes [67], adds additional challenges to this scenario. Excessive water volume can overload sewer's and wastewater treatment plants' capacity, resulting in overflows and sewage discharge, threatening the water distribution systems, water sources and surface waters [68]. Hence, the presence of viral RNA in wastewater demands additional information to elucidate a supposed viral role in water pollution [47,62]. Lastly, considering that distinct animal hosts are permissive to SARS-CoV-2 infection [69-72] and that spillover events are frequent among CoV [73], the introduction of viable SARS-CoV-2 into natural aquatic environments could putatively affect livestock and wildlife. Hence, there are still knowledge caveats to be fulfilled, demanding further exploration [27,31,65].

### **SARS-Cov-2 and the Climate**

Mostly, respiratory viruses (RV) present seasonal patterns of circulation [74-79]. The seasonality of RV infections can be mainly attributed to the environmental and weather effects on the virus, and to factor associated with the host's immune response and behavior [80]. In temperate regions, an increase in influenza, respiratory syncytial virus (RSV) and seasonal CoV activities has been associated with cold and dry winters. In contrast, in the tropical and subtropical regions, epidemics occur in rainy seasons or along the year [74,75,81-89]. Time series analyses suggest that the likelihood of airborne transmission is favored by the presence of low relative humidity and lower temperature conditions [90-92]. These events have been attributed to the effects of these variables on viral stability and transmissibility. RV are able to survive longer on surfaces or in droplets in a context of cold and dry air [75,93] and the mechanism of virus survival in the cool-dry or humid-rainy

conditions is determined by the presence of salts and proteins in the respiratory droplets [94]. Thus, climate conditions may play a crucial role in driving epidemics caused by these viruses. Under this perspective, a key question consisted of the putative influence of environmental and climatic variables on the seasonality and dynamics of SARS-CoV-2 epidemics.

Some authors reported a positive association between climate parameters and COVID-19 incidence [38-40]. found a positive correlation between low relative humidity and disease severity among Chinese and European hospitalized patients [38], in line with findings from who revealed a correlation between mortality and precipitation [95]. [39] Explored possible relationships between SARS-CoV-2 and Influenza infections with atmospheric variables and socio-economic conditions among tropical and subtropical climates in Brazil. The authors found that temperature combined with humidity were risk factors for COVID-19 and Influenza in both climate regimes, and the minimum temperature was also a risk factor for subtropical climate [39]. In addition, a cohort study conducted in 50 cities worldwide revealed that the distribution of substantial community outbreaks of COVID-19 along restricted latitude, temperature, and humidity, resembled the circulation patterns of the seasonal respiratory viruses [96]. In contrast, studies carried out in China and in United States [93,97], did not find a clear correlation between environmental conditions and SARS-CoV-2 infection, in such a way that weather changes would not lead to a significant rise or decline in the number of infected cases [98-100]. Thus, it is still unclear if viral circulation is effectively associated to environmental and climate parameters and if SARS-CoV-2 will eventually become seasonal or will continue to circulate along all the year, as other RV.

## Conclusion

Presumed factors that could drive the spread and severity of SARS-CoV-2 infection comprise the viral biology, genetic variability, fitness, stability, transmissibility and environmental persistence, natural and acquired hosts, virus-host interactions and anthropogenic interventions. Social determinants of health, including health equity, vaccine acceptance, and age-related illness, could play a role in disease occurrence and viral spread. Besides the demographic transition, the climate changes compose a major global challenge in Public Health, with potential and relevant impact on the current epidemiological scenario. It favors the emergence/reemergence of pathogens and the potential occurrence of outbreaks of distinct magnitude [101-105]. Therefore, efforts must be driven to categorically understand the relationships between SARS-CoV-2 infection, circulation patterns and climate parameters, as the putative implications of viral persistence and viability in distinct environmental matrices. This information is crucial for COVID-19 control and prevention, especially in middle and low-

income settings, already wedged by social inequality, inadequate sanitation and deficient healthcare admission.

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## Conflict of Interest

The authors declare no conflict of interests.

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