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MINI REVIEW

Air Pollution and Meteorological Parameters in SARS-CoV-2 Virus Spread and Transition

Mojtaba Ehsanifar[1]* and Mehravar Rafati[2]

[1]Anatomical Sciences Research Center, Kashan University of Medical Sciences, Kashan, Iran & Department of environmental health engineering, School of public health Iran University of medical sciences, Tehran, Iran
[2]Department of Medical Physics and Radiology, Faculty of Paramedicine, Kashan University of Medical Sciences, Kashan, Iran

ABSTRACT

The purpose of this small study is to evaluate the meteorological parameters and air pollutants on the prevalence of SARS-CoV-2 in urban areas to identify conditions that can prevent or prevent future infection waves. According to studies, all meteorological parameters are significantly associated with SARS-CoV-2 cases. (Temperature, mainly affects solar radiation, UV Index (UVI), and wind speed) as well as air pollution parameters (Especially O_3, SO_2, and CO), but to a lesser extent. CO, SO_2, and NO_2 (mobility markers that refer to human interaction) it was reported all year round. It can be inferred that meteorological phenomena mainly affect the virus, both in its spread and inactivation: High relative humidity, low temperatures, low solar radiation, and low Wind speed can cause the virus to persist in the air, then, cold and dry rainy seasons can be dangerous for people who are outdoors. CO, SO_2 and NO_2 can be used to predict and reduce infections in the new wave of SARS-CoV-2 transmission. Adequate outdoor face masks should be considered to prevent inhalation of air pollutants and SARS-CoV-2.

*Corresponding author

Mojtaba Ehsanifar, Anatomical Sciences Research Center, Kashan University of Medical Sciences, Kashan, Iran & Department of environmental health engineering, School of public health Iran University of medical sciences, Tehran, Iran

E-mail: ehsanifar@gmail.com

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INTRODUCTION

The SARS-CoV-2 virus spreads relatively rapidly and infects individuals, and each type has a different rate of spread among the population. Alpha and beta variants were first identified by the WHO, followed by gamma, delta, lambda, mo, and finally, Omicron and its subsidiaries from November 2021 [1]. It has been reported to be resistant to antibodies produced by a single dose of current vaccines [2]. Therefore, new strains of SARS-CoV-2 can be expected to prevail and other waves of infection to appear worldwide [3].

WHO strategies or recommendations for minimizing or preventing SARS-CoV-2 transmission include hand hygiene, avoiding crowds, avoiding hand contact, maintaining a physical distance of at least 1 m from others, ventilated areas, wearing face masks indoors or in crowded places covering the mouth when sneezing [4], however, these measures are not sufficient because the ventilated and exhaled areas of infected people spread the virus outdoors [4,5]. Previous reports around the world indicate the effect of meteorological and atmospheric pollution parameters on the spread of SARS-CoV-2 over-pollution. Has not fully understood how it spreads outdoors in the presence of air pollutants and various meteorological conditions, where they can affect its behavior [6-10]. Parameters such as temperature and humidity have been studied [5,11,12].

In addition, the effects of particulate matter and wind speed on SARS-CoV-2 infections from March 10, 2020 to October 4, 2020 in Pakistan and its provinces

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were investigated. They found a positive and negative correlation between PM2.5 and infection. In addition, the wind speed had a U-shaped curved effect, was proportional at first, and when the wind speed was more than 4 km/h, the ratio was reversed (reduced cases) [13]. Another study looked at the concentrations of particulate matter and ozone on infections in Italy from February to August 2020. The findings showed that the number of infected people increased in cities that had more than PM10 or ozone for more than 100 days [14]. Analysis of data models shows that air pollution and meteorological parameters (temperature and wind speed) affected virus transmission in Saudi Arabia from March 9, 2020 to November 19, 2020 [15]. However, it is unclear whether these results are due to the disclosure of histories of pollutants that predispose individuals to health complications or airborne viruses. In another work, researchers used statistical approaches to particle analysis and SARS-CoV-2 cases in nine Asian cities and found a positive correlation between PM10 and PM2.5 for infection cases [15]. Following the COVID epidemic, major cities around the world experienced a difficult scenario that led to an increase in SARS-CoV-2 infections. In addition, the WHO and most researchers have reported that the virus is transmitted through the air [16]. Assessing environmental conditions is essential to understanding the virus's infectivity in polluted air environments and different meteorological conditions. This study seeks to investigate the role of meteorological conditions and air pollutants that affect the spread of the SARS-CoV-2 virus as a reference for exposure to new transmission waves.

SARS-CoV-2 meteorological parameters effect

One of the most important aspects of COVID-19 pandemic is its behavior over time. CO and NO_2 are the primary and standard pollutants produced in incomplete fuels burned from industrial activities and engine exhaust - cars, trucks, buses, power plants and off-road equipment [17]. CO and NO_2 are used as indicators to determine whether people are sheltered at home. Therefore, they can be considered as indicators of anthropogenic processes and indicators of mobility [18,19].

Recent works report that the virus decreases its infectivity when exposed to solar radiation [20] and UV-C radiation [21,22] at ground level. Even when the virus is exposed to UV-A (the terrestrial UV radiation) over 15 min, the virus inactivation happens [23], even in aerosols [24]. UV radiation damages genetic material, achieving the virus inactivation. The temperature has been correlated to SARS-CoV-2 cases; based on findings, the temperature is a key parameter [25,26]. Researchers found a negative association between daily SARS-CoV-2 cases and temperature. Solar radiation as a physical phenomenon includes UV radiation in its spectra and infrared radiation, mainly responsible for rising temperature [27]. Therefore, it could be expected that solar radiation, temperature, and UV Index (UVI) are correlated with SARS-CoV-2 simultaneously. A negative and positive correlation of temperature and relative humidity, respectively, with SARS-CoV-2 cases, has been reported in the Indian city of Mumbai [28], and relative humidity has been found to spread different kinds of viruses, including SARS-CoV-2 [29]. Water vapor is a precursor of droplets (> 100 µm), aerosols (< 100 µm), and airborne (< 5 µm), and on the other hand, these particles can also be produced from infected people respiration and be spread due to relative humidity. High relative humidity values indicate the presence of water vapor over-dry air. It is hypothesized that at low temperatures, aerosols, and small particles (airborne) could linger in the air and potentially transport viruses [4,30,31]. Wind speed is inversely correlated with infection cases [32,33]. Thus, meteorological conditions such as high relative humidity, low temperatures, low solar radiation, and low wind speed values may propitiate the virus to be spread or persist for a long time in the air.

SARS-CoV-2 cases and pollution parameters effect

Almost all air pollutants are significantly correlated with SARS-CoV-2 cases, except for PM10, but ozone was found to be inversely correlated with SARS-CoV-2 cases [10,34]. This correlation could be explained by the oxidative effect of ozone over virus and bacteria [35,36] due to the damage provoked in nucleic acids. Some previous studies have confirmed ozone inactivate SARS-CoV-2 [36,37], this could indicate ozone technologies are adequate to degrade the virus indoors and prevent infection cases. Because CO could be taken as a marker of people's mobility (because of the use of cars), this pollutant could indicate that people kept interacting and getting infected regardless of the lockdown politics of the Government. NO, NO_2 and NOx show also positive correlations [12,38]. Since NO and NO_2 are emitted from the exhaust and oxidized to other nitrogen oxides (NOx) by solar radiation and free radicals, these contaminants are expected to be associated with the infectivity of SARS-CoV-2 (due to people mobility). In one Study, SO2 was positively correlated with SARS-CoV-2 cases [12] but this contradicts the results reported in another study, however, they studied COVID deaths instead of SARS-CoV-2 cases [12,38]. NO_2, SO_2, and CO are common products of burned fuels, and as they rise together and are correlated positively to infection cases, they could be used to predict SARS-CoV-2 spread [11,39]. One of the most reported pollutants correlated with this virus in papers is PM [5,40]. It has been found that PM2.5 was negatively correlated with SARS-CoV-2 cases while PM10 demonstrated not to be significant with infection cases [41,42]. This could indicate that PM does not act as a carrier of virions, but airborne derived from water vapor does.

Recommendations to decrease or avoid SARS-CoV-2 infections

To prevent or reduce infections that come with a new wave of infections, the following considerations are helpful that authorities can send to people in cities as a warning or advice. Cold dry seasons, which include low solar radiation and UVI and consequently low temperatures, as well as rainy seasons can be dangerous for many people in outdoor activities. Months with less wind speed are more likely to provoke more infections with the virus. Due to air pollution parameters, they have less correlation with SARS-CoV-2 than meteorology. In general, the more polluted the air, the more infections there are, which means that strategies must be developed to prevent short-term exposure to pollutants. Although ozone is produced from SOx and NOx, its presence, on the contrary, due to its oxidative capacity, reduces viral infections and aggravates health problems, so people with cardiovascular disease should be exposed to avoid it. Pollutants should be used as markers to regulate mobility and interaction. Finally, even if no one is around, it is recommended to use an outdoor face mask to prevent new infections due to the spread of the virus through the air.

CONCLUSION

In conclusion, geographical location can alleviate various specific meteorological conditions that can have multifactorial effects on virus behavior. Therefore, contagion reduction policies must take into account the specific requirements of the geographical area. Regardless of government efforts to shut down, the presence of CO, SO_2, and NO_2 produced from the exhaust indicates mobility as an indicator of mobility and thus explains the increase in SARS-CoV-2 cases, so it can be concluded that there was no real isolation or trade disruption. All meteorological parameters were significantly associated with SARS-CoV-2 cases, mainly temperature, solar radiation, UVI and wind speed, with relationships ranging from weak to strong. High relative humidity, low solar radiation, low temperature and low wind speed values can cause the virus to persist in the air for a long time. Air pollution parameters (except PM10) are significantly associated with SARS-CoV-2 cases. Therefore, it can be inferred that meteorological phenomena mainly affect both the spread and inactivation of the virus. Cold and rainy dry seasons can be dangerous for people who work outdoors. In terms of contamination parameters, CO, SO_2, and O_3, are better associated with SARS-CoV-2 cases. Therefore, CO, SO_2 and NO_2 can be used to predict and prevent the release of a new type of SARSCoV-2. Ozone can have an inactive effect on the virus, but it can predispose or worsen people's health. The more polluted the air, the more infections there are, so the use of adequate masks, even outdoors, should be considered to prevent inhalation of air pollutants and SARS-CoV-2.

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