SOLAR HUB

The relationship between the spread of Covid-19 and particulate matter in the air

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Introduction

Covid-19

Coronaviruses (CoVs) consist of several viruses that transfer from animals to humans. The novel coronavirus (COVID-19) is the third coronavirus to be declared as a pandemic in 21st century after Severe Acute Respiratory Syndrome (SARS) and the Middle East Respiratory Syndrome coronavirus (MERS) also achieved similar status in 2003 and 2012 respectively. On January 12, 2020, World Health Organization announced that infection in Wuhan belongs to coronaviruses, and on February 11, 2020, it was declared as COVID-19. Moreover, WHO has declared COVID-19 as a global pandemic due to its widespread transmission, a significant number of deaths, and higher infections and mortality rate as compared to previous coronaviruses outbreaks. (Ramadan and Shaib, 2019; Zhong et al., 2003).

How does coronavirus spread?

The coronavirus is thought to spread mainly from person to person. This can happen between people who are in close contact with one another. Droplets that are produced when an infected person coughs or sneezes may land in the mouths or noses of people who are nearby, or possibly be inhaled into their lungs. It can also spread from contact with infected surfaces or objects.

A person infected with coronavirus — even one with no symptoms — may emit aerosols when they talk or breathe. Aerosols are infectious viral particles that can float or drift around in the air for up to three hours. Another person can breathe in these aerosols and become infected with the coronavirus. This is why everyone should cover their nose and mouth when they go out in public.

Atmospheric particulate matter is known to act as a carrier, or as a transport vector, for many chemical and biological contaminants, including viruses. Viruses "stick" (with a coagulation process) to atmospheric particulate matter, consisting of solid and / or liquid particles capable of remaining in the atmosphere for hours, days or weeks, and which can spread and be transported even for long distances.

About particulate matter

Particulates are microscopic solid or liquid particles temporarily suspended in the air. Aerosols, i.e., a combination of liquid droplets and solid particles, are also a form of particulate. The main and anthropogenic sources are volcano emissions, sand, rock erosion, forest fires, leaf litter, sewage manure, pollens, lichen propagules, micrometeorites, quarries, mines, landfills, incinerators, cement plants, crumbled plaster, asphalt, motorized traffic, wear of brakes and tires, exhaust gases incinerators from aircraft engines, industrial fumes, domestic heating, foundries, steel mills, coal or heavy oil power plants...

From a dimensional standpoint, particles that make up particulates are considered “coarse” if they have a diameter greater than 2.5 µm. Below this size, they are called “fine or thin” (< 2.5 µm, “ultrafine” (up to 10 nm), or “nanoparticles” (up to 2 or very few nm). Refer to Figure 1a

comparison between the average diameter of a human hair and some different airborne particles, and to Figure 1b to know the size of Covid-19

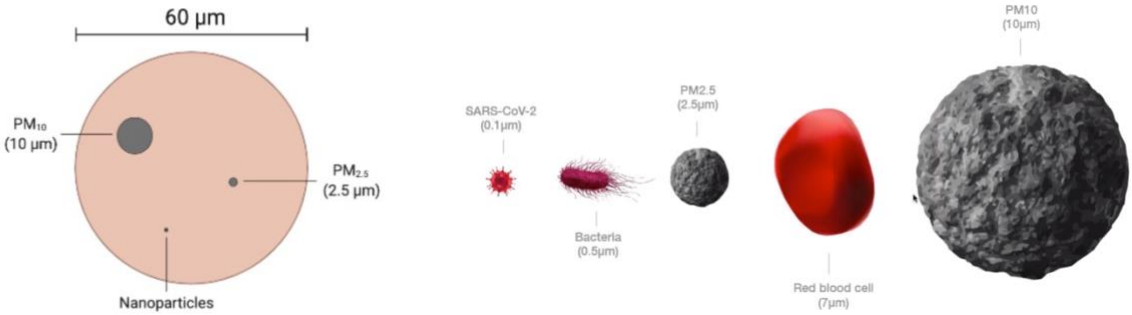

***Figure 1**.a) Schematic dimensional comparison between some particles and the cross-section of a human hair (60 µm). b) Idea of Coronavirus size*

The amount of particulate matter in certain volume of air is indicated by an index called PM (witch stand for "particulate matter"). The most common PM indices are PM_{10} and $PM_{2.5}$, indicate the total concentration of particles with a diameter of less than 10 and 2.5 µm, respectively. The United Nations Environmental Program predicts that from 2020 the number of deaths in the world from air pollution could exceed 8 million (whilst in 2001 they numbered around 3 million).

Unfortunately, little or nanoparticles, although they can in fact have a devastating impact on human health. However, one thing is clear: fine, ultrafine, and nanoparticles are like gases, and tend to remain in suspension almost indefinitely. Simply put, a particle with a diameter half that of another, settles four times slower than the first. Indeed, the smaller the particles, the deeper they penetrate tissues and cells (even in our lungs), causing serious damage and/or carrying toxic substances, spores, viruses, bacteria and in general anything that should not normally enter the body. Figure 2 shows the penetration of different size of particles in the body.

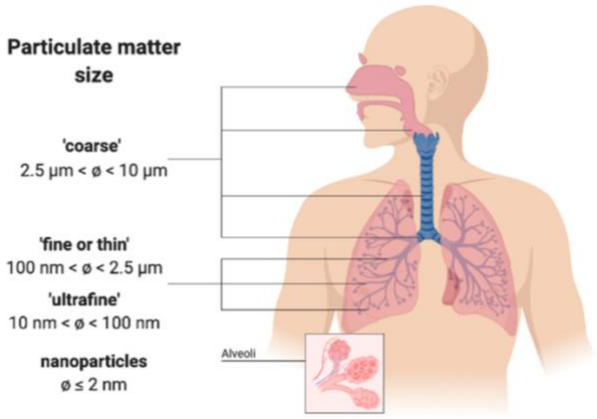

***Figure 2**. Particulate matter of various sizes can penetrate the respiratory tract.*

Objective

Many studies had found a relationship between the spread of Covid-19 and particulate matter in the air. In this study SIARQ is going to analyze all the papers and authors who support this relationship to find, evidence and to know the importance of the emissions of particulate matter in the air due to pollution.

Studies Analysis

1. Exposure to air pollution and COVID-19 mortality in the United States

The study titled "*Exposure to air pollution and COVID-19 mortality in the United States*" found that an increase of only 1 μg/m3 in $PM_{2.5}$ is associated with an 8% increase in the COVID-19 death rate. The results were statistically significant and robust to secondary and sensitivity analyses. Despite the inherent limitations of the ecological study design, the results underscore the importance of continuing to enforce existing air pollution regulations to protect human health both during and after the COVID-19 crisis. Based on the result, the authors anticipate a failure to do so can potentially increase the COVID-19 death toll and hospitalizations, further burdening our healthcare system and drawing resources away from COVID-19 patients."

2. Effects of air pollutants on the transmission and severity of respiratory viral infections

Particulate matter, sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) are among the outdoor air pollutants that are major factors in diseases, causing especially adverse respiratory effects in humans. On the other hand, the role of respiratory viruses in the pathogenesis of severe respiratory infections is an issue of great importance

The link between severe viral respiratory diseases, which cause infection in 10–20% of the population and air pollution, is well established. A number of the studies already above discussed corroborates this statement. Air pollutants such as $PM_{2.5}$and PM_{10}, sulfur dioxide, nitrogen dioxide, carbon monoxide and ozone, can affect airways through inhalation, exacerbating the susceptibility to respiratory virus infections, as well as the severity of these infections.

In relation to this recently hypothesized that an atmosphere with a high content of air pollutants, together with certain climatic conditions, might promote a longer permanence of the viral particles in the air. It would favor an indirect diffusion of SARS-CoV-2, in addition to the direct diffusion individual to individual. This year Martelletti and Martelletti have noticed how the Italian Northern Regions, which are the most affected by COVID-19, match those areas showing also the highest concentrations of PM_{10} and $PM_{2.5}$.

These authors have suggested that the SARS-CoV-2 could find suitable transporters in air pollutant particles. In addition, in a linear relationship, the viruses would survive longer and could become more aggressive in an immune system already aggravated by the air pollutants themselves.

3. Association between COVID-19 Infections and Air Pollution: Evidence from Portugal.

Ribeiro and Barros have recently tested the hypothesis that air pollution increases susceptibility to COVID-19. For this, the authors used publicly available data on the cumulative number of COVID-19 confirmed cases by municipality in Continental Portugal until the May 2, 2020 and the average annual levels of PM_{10}, $PM_{2.5}$ and NO_2 in the same municipalities. Adjusted models revealed a positive and significant association between COVID-19 notification rates and PM_{10} and $PM_{2.5}$.

4. Transmission Dynamics of COVID-19 in Polluting Environment: Mechanisms of Air Pollution-To-Human Transmission and Human-To-Human

Coccia (2020) has recently examined the mechanisms of transmission dynamics of COVID-19 in the environment for a possible strategy to cope with future epidemics similar to coronavirus diseases. The study was focused on case study of Italy, one of the countries with the highest level of deaths worldwide. The results revealed that accelerated transmission dynamics of COVID-19 in specific environments was due to two mechanisms given by: air pollution-to-human transmission, and human-to-human transmission in a context of high density of population. The two main findings were:

1) the acceleration of transmission dynamics of COVID-19 in North Italy has a high association with air pollution of cities.

2) cities having more than 100 days of air pollution (exceeding the limits set for PM_{10}), show a very high average number of infected individual (about 3340 infected individuals), while cities having less than 100 days of air pollution show a lower average number of infected (about 1450 infected individuals) on April 27, 2020.

5. How Atmospheric Particulate Affects Our Environment and Health

The spread of viral respiratory diseases is facilitated in polluted environments, an example of which is the respiratory syncytial virus bronchiolitis. Thispaper, consider the possible relationship between air pollution, primarily airborne $PM_{10–2.5}$, and the spread of the novel coronavirus in Northern Italy. If it is true that the novel coronavirus remains active from some hours to several days on various surfaces, it is logical to postulate that the same can occur when it is adsorbed or absorbed by the atmospheric particulate matter, which may also help carry the virus into the human respiratory system

Sanità di Toppi et al. (2020) have hypothesized that the SARS-CoV-19 might be using a species of “highways”, which would be made up of atmospheric particulates, in- creasing its indirect transmission. For these authors, this is an issue that deserves further, immediate, and in-depth experimental investigations.

6. Report on the effect of air pollution and the spread of viruses in the population

Preliminary studies conducted by research groups headed by Bologna University and the "A. Moro" University of Bari, Italy, together with the Italian Society of Environmental Medicine (SIMA) have resulted in the publication of an interesting "position paper" offering strong support to the possible correlations between atmospheric particulate matter and the spread of coronavirus among the population.

In previous cases of viral infections, scientific research has highlighted some features of the spread of viruses in relation to atmospheric particulate matter concentrations. There is a relationship between the spread of human respiratory syncytial virus (RSV) in children and concentrations of particulate matter. This virus causes pneumonia in children and is carried through particulate matter deep into the lungs. The spread rate of the infection (Average RSV positive rate %) is related to the concentration of PM_{10} and $PM_{2.5}$ (µg m^3)

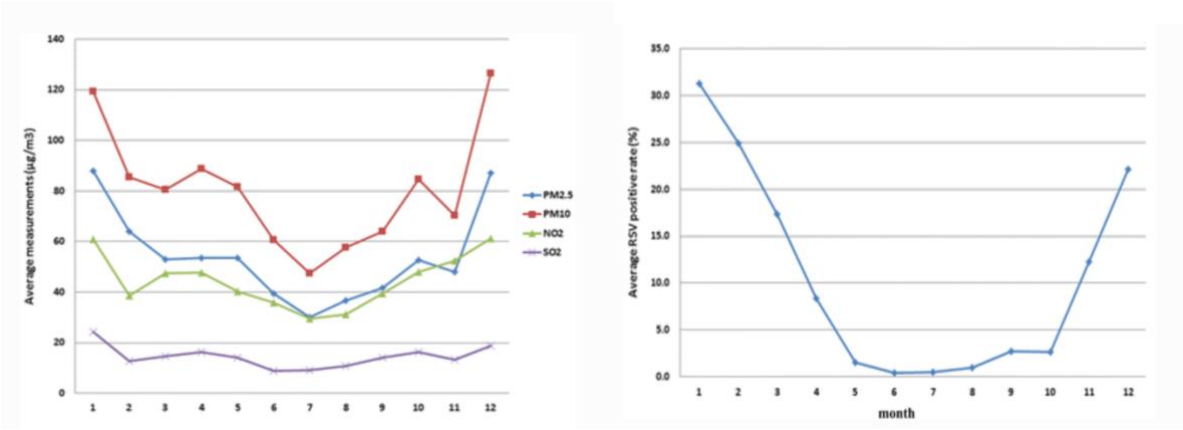

Fig 3. *The spread rate of the infection of RSV related to the concentration of PM10 and PM2.5 (µg m^3)*

The researchers have in fact highlighted "*a relationship between the exceedances of the legal limits of PM_{10} concentrations recorded in the period 10–29 February 2020, and the number of cases infected with COVID-19 updated to 3 March 2020*". In particular, their paper stresses the direct relationship between the number of COVID-19 cases and the PM_{10} pollution status of each Italian province. To this end, the authors state, "*The expansion curves of the infection show anomalous accelerations precisely in the regions located in the Po Valley, where the outbreaks are particularly virulent, and reasonably suggest a carrier-mediated spread. These analyses seem therefore to demonstrate that, in relation to the period 10–29 February, high concentrations above the PM_{10} limit in some provinces of Northern Italy may have exerted an impulse to the virulent spread of the epidemic in the Po Valley, which was not observed in other areas of Italy that had cases of contagion in the same period. In this regard, the case of Rome is not observed in other areas of Italy that had cases of contagion in the same period. In this regard, the emblematic in which the presence of contagions was manifested in the same days as the Po regions case of Rome is emblematic in which the presence of contagions was manifested in the same days as without, however, triggering such a virulent phenomenon*"

Conclusions

The Acting Secretary General of the European Public Health Alliance (EPHA) has declared: "*The air may be clearing in Italy, but the damage has already been done to human health and people's ability to fight off infection. Governments should have tackled chronic air pollution long ago but have prioritized the economy over health. Science tells us that epidemics like COVID-19 will occur with increasing frequency. So, cleaning up the streets is a basic investment for a healthier future*".

Indeed, administrators and governments must view potential interactions between exposure to pollutants (not only particulate matter, but also other solid, liquid, and gaseous contaminants) and the onset of pathologies (including those generated by respiratory viruses) as a tangible risk.

The hypothesis that the novel coronavirus might exploit the "highways" made up of atmospheric particulates is a challenging point that, in our opinion, deserves further, immediate, and in-depth experimental investigations. It is to be hoped that steps will be taken promptly to clarify the dynamics involved in the current pandemic.

This study shows that there is a need for enforcement of air pollution regulations in order to protect the lives of humans both before as well as after the crisis arisen from the COVID-19 pandemic.

Due to the lockdowns and the reduced number of vehicles on the roads, the air quality seems to have improved temporarily. However, the laws need to be in place for continued maintenance and improvement of the air quality.

Based on the results from recent papers, here discussed, SIARQ is fully agree with this recommendation.

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