Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Letter to the Editor

Regional air pollution persistence links to COVID-19 infection zoning ☆

To the Editor

In this Journal, Tian and colleagues have described the clinical features of COVID-19 in the highly urbanised environment of Beijing[1].

There is a strong established link between severe viral respiratory disease, which causes infection in 10~20% of the population, and air pollution.[2] Fine particulate matter with an aerodynamic diameter of 2.5m or less (PM2.5), 10m or less (PM10), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and ozone (O_3) affect airways through inhalation and exacerbate the susceptibility to and severity of respiratory virus infections[3]

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Notable research conducted in this field has demonstrated that PM2.5 levels in the air of Beijing directly influences the transmission of influenza virus.[4] O_3 has been found to be significantly negatively associated with influenza transmissibility while CO levels had a positive association.[5] In particular, fine particles, such as PM2.5, tend to stay longer in the air than heavier particles and their minute size increases the chances to let them penetrate deep into the lungs, bypassing the nose and throat. This leads to progressive and chronic inflammation of the respiratory airways with excessive mucus production and decreased ciliary activity with subjects chronically exposed to air pollutants more prone to develop severe respiratory diseases after viral infections.

At the time of this letter, the countries with the highest number of COVID-19 infections were China and Italy. There is a com-

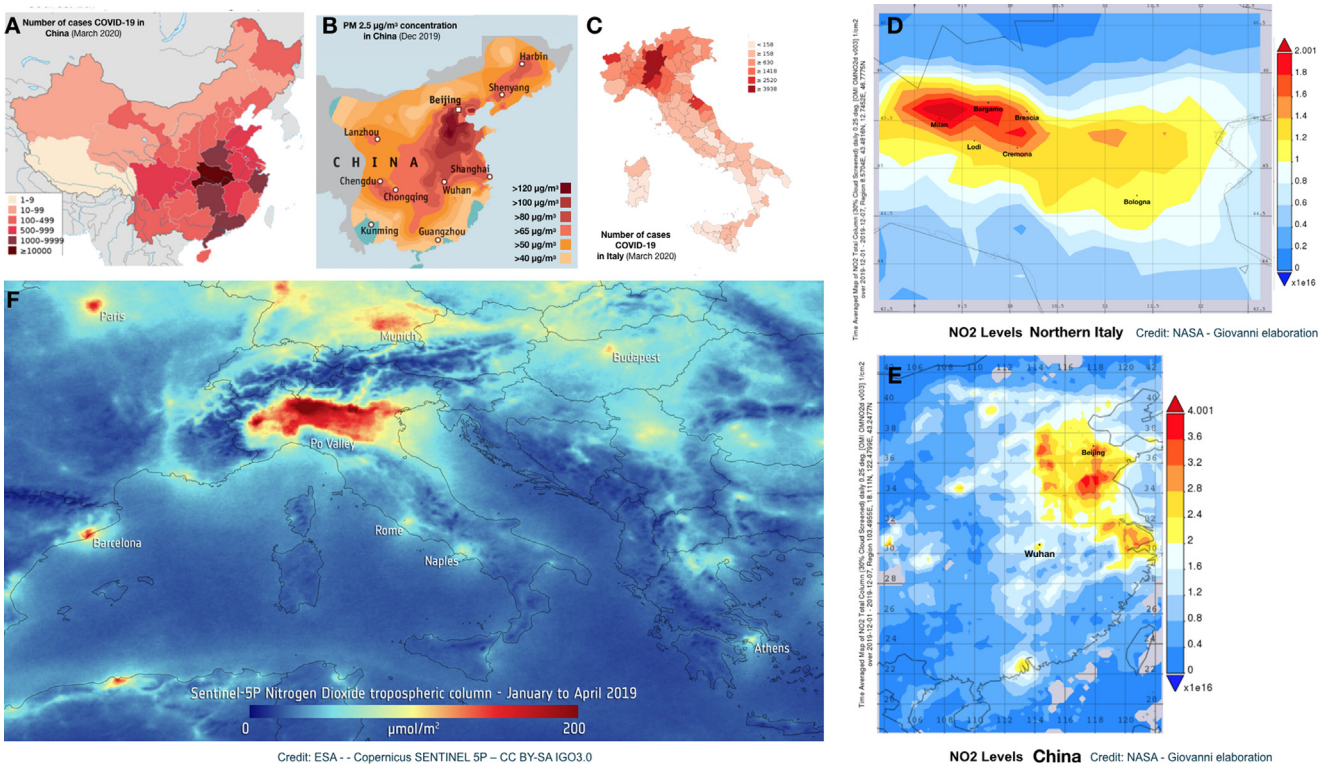

Fig. 1. Top panel (A, B): Covid-19 outbreak in China compared to concentration of particulate matter (PM 2.5) (Wikipedia.org; CC BY-SA 4.0). Panel C: Italian distribution of COVID-19 cases. Top right and bottom right panel (D,E): Levels of NO2 air pollutant (Month of December) in China and North Italy (Source: NASA G.I.O.V.A.N.N.I. - see https://giovanni.gsfc.nasa.gov/giovanni/). Bottom panel F: Nitrogen Dioxide pollution map over EUROPE as seen by Copernicus SENTINEL 5P satellite (Jan to Apr 2019). (Credit: ESA - Copernicus SENTINEL 5P CC BY-SA IGO3.0, https://www.esa.int/ESA_Multimedia/Images/2019/05/Nitrogen_dioxide_over_northern_Italy).

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mon link between these countries which is the very high level of air pollutants. For instance, in the areas of these countries most affected by COVID-19 outbreaks, mean PM2.5 concentrations vastly exceed the hourly standard of 75 μg/m3. In Italy, the outbreaks were focused in the North, exactly in the Po valley, cities of Lodi, Cremona and Bergamo, which are in the five Italian cities with highest pollution levels. The region, which is often referred as the "Industrial Triangle" after the economic boom of the sixties of the twentieth century, is characterized by a high density of factories, traffic and intensive agriculture. Such dense anthropic activity produces a significant pollutant emission in the region, which along with its specific topography its and climatic features, produces a hood where fine particulates are trapped. Indeed, Po Valley is a plain surrounded by Alps, characterised by weak winds and frequent episodes of climatic inversion, inhibiting the air recycling and thus the pollutants dissolution. In the last month of December and January, the concentrations of PM 2.5 over this region reached unprecedented values that are similar to those characterizing the Hubei Region, China,[6] where the first peak of COVID-19 infection was registered Fig. 1.

This discloses a potential correlation between the distribution of severe COVID-19 outbreaks and the pollutants stagnation resulting from a combination of specific climatic conditions, local human emissions and regional topography. Such a potential relation has been not taken into account so far, although many scientific reports from China stated that viral particles may be suspended in the air for several minutes in contrast to the current knowledge about virus diffusion[7]. Even though these reports have been object of criticism for their methodology, here we reconsider such a possibility, at least for those region like Hubei Region or Po valley, where it might actually justify the on-going outbreaks and the associated high rate of contagion.

Our hypothesis is that the atmosphere, rich of air pollutants, together with certain climatic conditions may promote a longer permanence of the of viral particles in the air, thus favoring an "indirect" diffusion in addition to the direct one (individual to individual). We therefore encourage further investigations focusing on the role of these aspects in the development of the COVID-19 outbreaks over highly industrialized areas. If confirmed, our hypothesis may imply a higher level of control on the risk of infection spread. Indeed, its potential evolution may be partly anticipated by weather forecasting and seasonal prediction systems, thus allowing for timely measures of mitigation over critical regions. Also, it may further strengthen the need to reduce the level of air pollutants as part of public health measures to curb the spread of COVID-19 and other infections.

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