How air pollution worsens the COVID-19 pandemic

Past and current air pollution exposure around the world is worsening the unfolding COVID-19 epidemic. Air pollution increases the risk of many pre-existing conditions that make COVID-19 more severe and deadly, including diabetes, lung diseases, asthma, heart disease and cancer. These health conditions substantially increase the risk of hospitalization and death for COVID-19 patients. This means that millions of people were already suffering from chronic diseases and disabilities or undergoing treatments like chemotherapy because of their past exposure to air pollution, and this is making them more vulnerable to COVID-19. It's also likely that the risk of infection is affected by the impact of air pollution on the immune system, and the respiratory symptoms for infected people are made worse by air pollution - there is evidence of this for respiratory infections in general but not yet specifically for COVID-19.

COVID-19 is a new disease and much remains uncertain or unknown, but we can already say that:

- High levels of air pollution affect the natural defenses of the body against airborne viruses, making people more likely to contract viral diseases, and this is likely to be true for SARS-CoV-2 as well. This means that it is likely that air pollution exposure is contributing to the spread of the disease.
- Air pollution exposure is a key risk factor for many of the chronic diseases that make people more likely to get severely ill, require intensive care and ventilation, and die from COVID-19. A strong body of existing scientific research shows that a significant part of the burden of diseases like chronic respiratory disease, heart disease, asthma and diabetes worldwide is attributable to air pollution. This means that past air pollution exposure is now contributing to the death toll and the enormous pressure on healthcare systems from the disease.
- For many respiratory infections, air pollution exposure on infected people can worsen their symptoms and increase the risk of hospitalization and death. This is likely to be true for COVID-19 patients as well but has not yet been confirmed with specific studies. This means that current air pollution levels, which remain dangerous in much of the world despite reductions caused by measures to control the virus, are likely contributing to the number

of severe cases and deaths from COVID-19. What we know for sure is that current air pollution levels are contributing to illness and need for health care services from other diseases, adding to the pressure on health care systems.

Air pollution is a key risk factor for deaths from Lower Respiratory Infections. Globally, one death in six related to these infections is attributed to PM2.5 air pollution, amounting to approximately 400,000 deaths per year (GBD 2017).

Air pollution likely increases the risk of infection

Multiple studies exist showing that elevated levels of air pollution affects cells in a way that makes it easier for a virus to infect humans and start spreading (Harrod et al 2003, Jaspers et al 2005, Lee et al 2014). A large study of more than 100,000 patients in the U.S. found that short-term spikes in PM2.5 air pollution increased acute lower respiratory infections requiring medical care, in both children and adults (Horne et al 2018). The same effect has been observed during smog episodes in e.g. in Beijing (Feng et al 2016, Liang et al 2014), Rome, Italy (Nenna et al 2017) and Brunei (Yadav et al 1998).

However the scientific literature also contains examples of studies which have not found this relationship, so we can expect variability depending on factors such as the type of virus or population demographics (e.g. Bhatt and Everard 2004, Cheng, et al. 2019). It is likely that the relationship is dependent on factors such as the type of virus, location, and/or population demographics.

There appears to also be a long-term, chronic impact, as small children growing up in areas with higher air pollution levels had a higher incidence of flu (Brauer et al 2007).

The suggested mechanisms that may link air pollution to virus transmission and likelihood of infection include damage to human airways and epithelial barriers (Donaldson and Tran 2002, Li et al 1996, Lee et al 2014), and pollution acting as “condensation nuclei” to which virus droplets attach allowing them to be transported in the air (Lee et al 2014) among others. These mechanisms are hypothesised, not certain, however early experimental evidence suggests that SARS-CoV-2 may remain viable as an aerosol for a number of hours (van Doremalen 2020).

Air pollution is a significant cause of "pre-existing" conditions in COVID-19 patients

Air pollution is a major risk factor and contributor to the major chronic diseases that increase the severity and risk of death from COVID-19, including chronic respiratory diseases, cardiovascular diseases, hypertension, diabetes, strokes and cancers. People undergoing cancer treatments are at a higher risk because their immune system is compromised. (CDC 2020.)

A study on Chinese patients found that the risk of severe symptoms requiring intensive care or ventilation, and the risk of death was elevated by 170% for people with chronic respiratory disease, by 60% for people with hypertension or diabetes, by 250% for people with cancer and by 80% for people with any of the pre-existing conditions listed above (Guan et al 2020). Another analysis of data from eight different studies on Chinese patients found that severely ill COVID-19 patients were 2.4 times as likely to suffer from hypertension, 2.5 times as likely to suffer from respiratory diseases and 3.4 times as likely to have cardiovascular diseases (Yang et al 2020).

Globally, air pollution is responsible for about 18% of the global disease burden from diabetes, 14% of lung cancer, 34% of chronic obstructive pulmonary disease, 11% of ischemic heart disease and 7% of stroke (Global Burden of Disease Study 2017). Studies in China (Lin et al 2017) and the U.S. (Coogan et al 2016) have found strong associations between air pollution exposure and hypertension. This means that past air pollution exposure has made people around the world much more vulnerable to COVID-19 and is now contributing to the death toll and the enormous pressure on healthcare systems from the disease.

This impact is highlighted by a pre-print study on COVID-19 deaths in the U.S., indicating dramatically higher risk of death in areas with higher past average PM2.5 pollution levels (Wu et al 2020).

Studies concerning previous pandemics indicate that air pollution can cause severe symptoms or eventually death for some patients who have contracted the viral disease. For instance, when analyzing the early 2000s SARS outbreak, a positive association was found between air pollution and the SARS (SARS-CoV-1) fatality within the Chinese population (Cui et al 2003).

A study by Clay et al (2018) focused on the relationship between air pollution and the 1918 Spanish influenza mortality. They found that American cities that burned more coal saw higher mortality rates during the 1918 pandemic than neighboring cities that burned less coal.

In another study, mice were exposed to high levels of pollutants and then infected with influenza. The researchers found that PM caused increased levels of pulmonary oxidative stress in the mice

and a compromised immune system to fight off the virus. Ultimately, this resulted in higher mortality rates (Lee et al 2014).

Does ambient particulate matter facilitate the spread of the virus?

Atmospheric particulate matter has been linked to the spread of viruses and other contaminants in general. Particulate matter works as a carrier since it has been noted that viruses might be able to attach or stick to them (Setti et al 2020). However, the role of airborne transmission as small droplets or aerosols in the COVID-19 epidemic is still uncertain.

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