Fact sheet on ambient Air-Pollution and COVID-19

➢ On a global, and high-level regional view, correlations between COVID-19 incidence and death rate and air pollution are hard to discern.

➢ On a local level however, both **particulate matter and other ambient air pollutants** such as nitrogen- and sulphur oxides **are significantly positively correlated with the severity and frequency of COVID-19 cases.**

➢ **Air pollution is often higher in socio-economically underprivileged areas.** Higher death rates that have been observed for example in the US among the poor and people of colour reflect existing health, economic and environmental inequalities that both contribute to and result from greater exposure to air pollution.

➢ However, replicating these findings with simplistic correlation analysis is complicated, as there are many confounding variables, varying data quality and data resolution.

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From smog hanging over cities to smoke inside the home, **air pollution poses a major threat to health and climate**. The combined effects of ambient (outdoor) and household air pollution cause about 7 million premature deaths every year, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO guideline level of 10µg/m3, with low- and middle-income countries suffering from the highest exposures.[1]

The major **outdoor pollution sources include vehicles, power generation, building heating systems, agriculture/waste incineration and industry**. In addition, more than 3 billion people worldwide rely on polluting technologies and fuels (including biomass, coal and kerosene) for household cooking, heating and lighting, releasing smoke into the home and leaching pollutants outdoors. [2]

Since the start of the COVID-19 pandemic, researchers have been looking into connections between ambient air pollution, underlying cardiovascular damage and COVID-19 incidence and death rates. This video by the WHO explains the how air pollution can influence the severity of COVID-19. A whole **host of studies has found significant correlations between higher levels of particulate matter pollution and COVID-19 death and incidence rates** (see Appendix on for a literature review table of the 14 most cited papers from 2020 and 2021).

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[1] WHO: https://www.who.int/airpollution/ambient/about/en/ [accessed 13.1.2020]
[2] WHO: https://www.who.int/airpollution/ambient/about/en/ [accessed 13.1.2020]
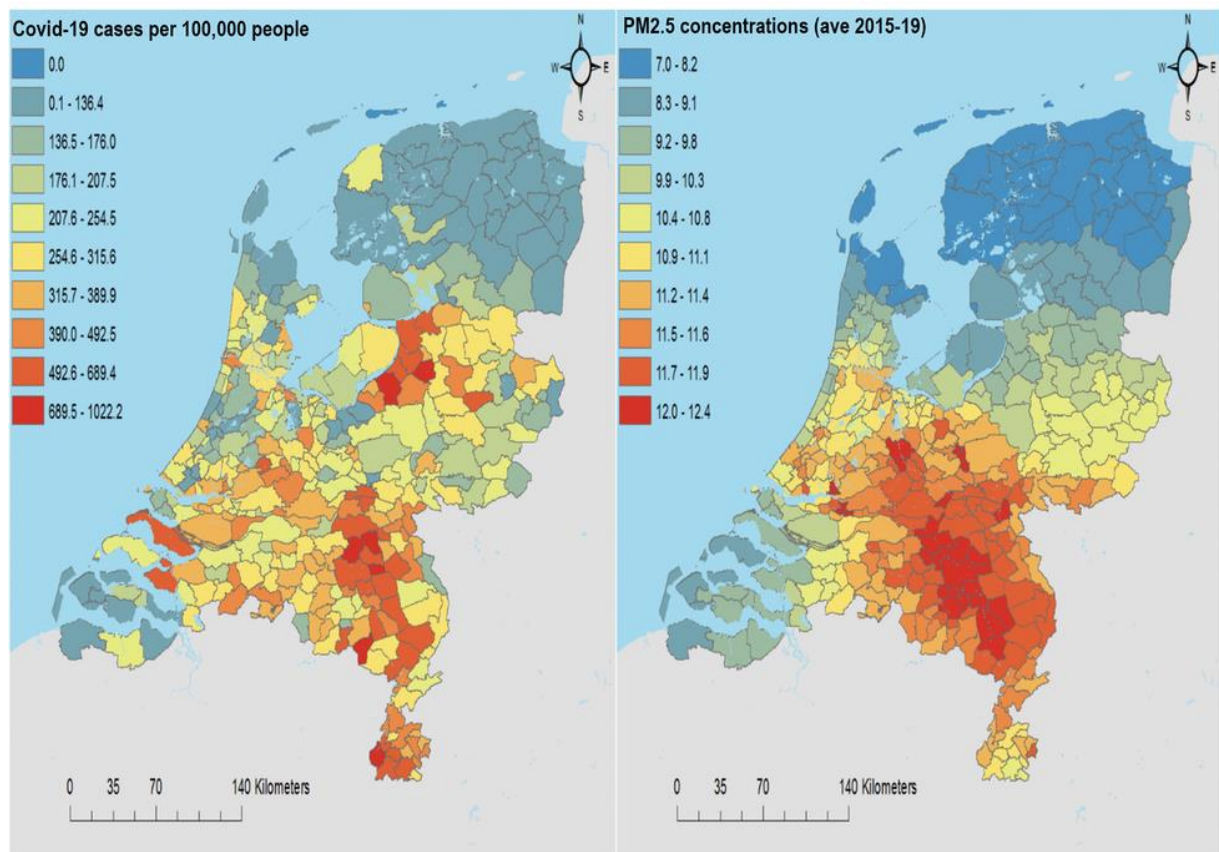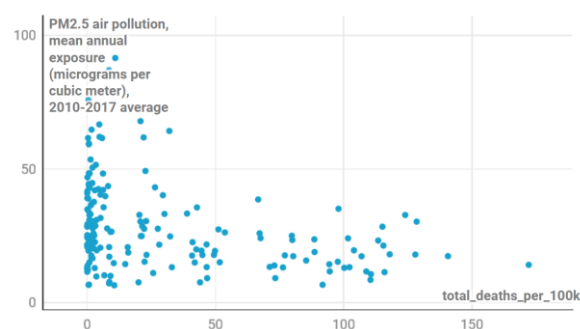
Figure 1: Exemplary finding of a local correlation between Particulate Matter Pollution and COVID-19 incidence rate. Cole, Ozgen et al., 2020

On a global level, looking at average data from countries, this relationship is hard to replicate (see Figure two). This has multiple reasons: Firstly, air pollution is mostly caused by point sources, making it a local phenomenon. Averaging values of an entire country or states as large as US states blurs local distinctions. Secondly, COVID testing rates vary significantly between states, making death and incident rate data partially unreliable.
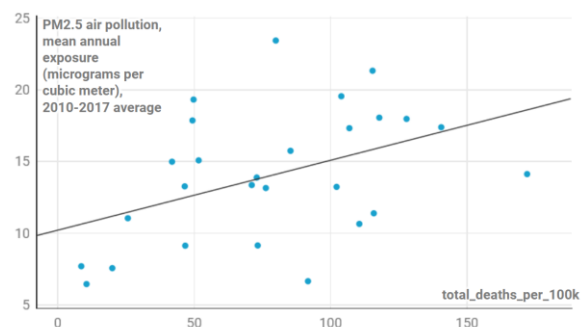

Figure 2: Country-level correlations are weak at best

On a local level, the analysis remains complicated. Simplistic correlations between air quality and COVID-19 are not suited to replicate the findings of the literature. The studies we scanned and that are summarised in the appendix all control for multiple variables, such as age distribution, population density, median income and testing rates. Only with these controls does a correlation become visible.

Appendix: Overview of key findings of the 14 most cited papers from 2020 and 2021

Title	Authors, Date	Key Findings	Link
"Is air pollution aggravating COVID-19 lethality? Exploration in Asian cities using statistical models"	Gupta, Bherwani et al., 2020	Looking at data from nine Asian cities, the paper finds that "past exposures to high level of PM2.5 over a long period [...] significantly correlate[s] with present COVID-19 mortality per unit reported cases (p < 0.05)".	https://bit.ly/2XFOY7c
"Air Pollution and COIVD-19: The Role of Particulate Matter in the Spread and Increase of COVD-19's Morbidity and Mortality"	Comunian, Dongo et al., 2020	Meta study on several correlation studies. Two potential causal links need further investigation: 1) long-term exposure to high PM2.5 levels increases the COVID death rate by causing underlying cardiovascular diseases and (b) short-term exposure to PM2.5 levels could cause a faster spreading of the virus and PM particles can carry virus load	https://bit.ly/38Mw2Ku
"Initial evidence of higher morbidity and mortality due to SARS-CoV-2 in regions with lower air quality."	Pansini, Fornacca	The authors correlated geographical expansion of infections with the annual means of PM10, PM2.5, sulfur dioxide, carbon monoyide, nitrogen dioxide and ozone. The found significant positive correlations in all examined regions in China, Italy and the US and "concluded that higher mortality was also correlated with high PM2.5, carbon monoxide and nitrogen dioxide values"	https://bit.ly/3oMAHlg
"Particulate matter and SARS-CoV-2: A possible model of COVD-19 transmission"	Tung, Cheng et al., 2020	SARS-CoV-2 has "a high affinity of the angiotensin-converting enzyme 2 (ACE2). Idirectly, exposure to PM increases ACE2 expression in the lungs which facilitates SARS-CoV-2 viral adhesion. [...] PM could be both a direct and indirect transmission model for SARS-CoV-2 infection"	https://bit.ly/39wKXHX
"Links between air pollution and COVID-19 in England"	Travaglio, Yu, Popovic et al., 2020	Controlling for population density, age and median income, the autors show "a positive relationship between air pollutant concentrations […] and COVID-19 mortality and infectivity" in the UK. Futher, "an increase of 1 m3 in the long-term averageof PM2.5 was associated with a 12% increase in COVID-19 cases. The correlation remains significant after adjusting for socioeconomic, demographic and health-related variables.	https://bit.ly/2XKkNMe
"Assessing the relationship between surface levels of PM2.5 and PM10 particulate matter impact on COVID-19 in Milan, Italy"	Zoran, Davastru et al., 2020	The study investigates the correlation between the degree of accelerated diffusion and lethality of COVID-19 and the surgace air pollution in Milan, Italy. Its gfindings suggest, that outdoor airborne aerosols might be possible routes of COVID-19 diffusion and that the warm season will not stop COVID-19 spreading.	https://bit.ly/3oLBvXH
"Air pollution exposure and COVID-19"	Cole, Ozgen et al., 2020	Looking at 355 municipalities in the Netherlands, and controlling for a wide range of explanatory variables, the authors	https://bit.ly/2LTdsas

		find that "a 1u/m3 increase in PM2.5 concentration is associated with 9.4 more Covid-19 cases, 3.0 more hospital admissions, and 2.3 more deaths". The relationship "withstands [tests like] instrumental pollution to mitigate potential endogeneity and modelling spatial spill overs using spatial econometric techniques"	
"Regional and global contributions of air pollution to risk of death from COVID-19"	Pozzer, Dominici et al., 2020	The authors conclude that air pollution "is an important cofactor increasing the risk of mortality from COVID-19. this provides extra motivation for combining ambitious policies to reduce air pollution with measures to control the transmission of COVID-19"	https://bit.ly/38Iz4Q2
"How do low wind speeds and high levels of air pollution support the spread of COVID-19?"	Coccia, 2020	High air pollution can interact with viral agents and increase infection numbers and death rates. Conversely, high wind speeds improve the dispersion of particulate matters mixed with viral agents. Cities with high wind speed and low air pollution have a lower number of infected individuals of COVID-19.	https://bit.ly/39tXyM0
"COVID-19 prevalence and fatality rates in association with air pollution emission concentrations and emission sources"	Hendryx, Luo, 2020	Controlling for state testing rates, population density and population covariate data, the study finds significant correlations between different pollutants types and COVID prevalence and fatality. "Results are consistent wich previous research indicating that air pollution increases susceptibility to respiratory viral pathogens."	https://bit.ly/3bHkkCU
"Methodological Considerations for Epidemiological Studies of Air Pollution and the SARS and COVID-19 Coronavirus Outbreaks"	Villeneuve, 2020	Common shortcomings of existing studies on the topic include "possible cross-level bias in ecological studies underreporting of health outcomes, using grouped data, the lack of highly spatially resolved air pollution measures, inadequate control for confounding and evaluation of effect modification, not accounting for regional variations in the timing of outbreaks' temporal changes in at-ris populations, and not accounting for nonindependence of outcomes"	https://bit.ly/2LPCWpt
"Association between short-term exposure to air pollution and COVID-19 infection: Evidence from China"	Zhua, Xie et al., 2020	"There was a significant relationship between air pollution and COVID-19 infection after controlling for confounding factors. Positive associations of PM2.5, PM10, CO, NO2 and O3 with COVID-19 confirmed cases were observed."	https://bit.ly/3stzT6T
"Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis"	Wu, Nethery et al., 2020	Limitations in COVID-19 data availability and wuality remain obstables in conducting conclusive research on the relationship between air pollution andCOVID-19. At present, publicly available COVID-19 outcome data "are available only as area-level counts.	https://bit.ly/3ssEOoY

		Therefore, studies [..] must use an ecological regression analysis, which precludes controlling for individual-level COVID-19 risk factors"	
"Loss of life expectancy from air pollution compared to other risk factors: a worldwide perspective"	Lelieveld, Pozzer et al., 2020	Ambient air pollution is on eof the main global health risks - independent of COVID19. It "causes significant excess mortality and LLE" - LLE cause by ambient air pollution "rivals that of tobacko smoking" and "strongly exceeds that by violence (all forms together), i.e. by an order of magnitude"	https://bit.ly/38LfsuE