Air Quality during Covid-19 Lockdown

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Air pollution exposure is one of the greatest risks to health worldwide. It is estimated to be responsible for about 4.2 million deaths around the world every year owing to many serious diseases such as heart disease, stroke, acute and chronic respiratory diseases, and lung cancer. The WHO guideline limits are exceeded in several areas around the world, and it is estimated that about 90% of the world's population is exposed to high air pollution levels, especially in low- and middle-income countries. The COVID-19 pandemic has forced governments to implement severe mobility restriction measures to limit the spread of the virus. This represented a unique opportunity to study the impact of mobility on urban air quality. Several studies which have investigated the relations between the quality of the air and such containment measures have shown the significant reduction of the main pollutants in the urban environment so to encourage the adoption of new approaches for the improvement of the quality of air in the cities. The aims of this entry are both a brief analysis and a discussion of the results presented in several papers to understand the relationships between COVID-19 containment measures and air quality in urban areas.

Covid-19 lockdown air pollution

Air pollution is a mixture of particles and gases whose sources and composition vary spatially and temporally. Air pollution in the environment derives both from anthropogenic and natural sources. While natural sources contribute mainly to air pollution in not anthropized regions (e.g., forest fires and dust storms), the contributions from human activities from anthropized regions far exceed the ones from natural sources [1].

The major anthropogenic sources of air pollution are [1]:

- Combustion of fuel in vehicle engines
- Heat and power plants
- Industrial facilities
- Waste incineration facilities
- Residential activities such as cooking, heating, and lighting with energy produced with the use of polluting fuels

The uncontrolled expansion of urban areas owing to the need to favor the then-nascent automotive industry represents one of the major factors for the acceleration of pollutants' emissions and diffusion.

Short- or long-term exposures to ambient air pollution represent high risks of both morbidity and mortality and contribute heavily to the global burden of disease. The most dangerous air pollutants are particulate matter (PM), nitrogen dioxide (NO2), ozone (O3), and sulfur dioxide (SO2).

The main problem with most ambient air-polluting emissions is that, even if they derive from localized point sources, their effects are not confined to limited areas. In fact, it has been demonstrated that pollutants can travel long distances in a matter of days under favorable meteorological conditions. Therefore, health and air quality in remote areas can be affected by windblown dust, which contains high levels of particles, bacteria, and fungal spores, from desert regions like Mongolia, Africa, China, and Central Asia. Since air pollutants cross national borders over time, it seems clear that it is necessary to address this problem by adopting both global and local control policies to reduce emissions.

It is estimated that about 7 million individuals die worldwide each year due to high air pollution exposure. Ambient air pollution exposure is one of the greatest risks to health worldwide. It is estimated to be responsible for about 4.2 million deaths around the world every year owing to many serious diseases such as heart disease, stroke, acute and chronic respiratory diseases, and lung cancer. From an economic point of view, the total welfare loss in 2013 amounts to more than US$5 trillion in total welfare. According to the WHO, there is already ample evidence that children are more vulnerable to air pollution because they breathe more often, taking in more pollutants, and their nose and mouth are closer to the ground, which is where some pollutants are present in higher concentrations [2]. It is estimated that about 90% of the world's population is exposed to high air pollution levels, especially in low- and middle-income countries. [3]. WHO guideline values (**Table 1**) are set for the protection of health and are generally stricter than the comparable politically agreed-upon government standards [4]. WHO guidelines apply globally and are based on expert evaluation of current scientific evidence for the following pollutants: particulate matter (PM), ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2) [5]. Most sources of outdoor air pollution are well beyond the control of both individuals and local authorities and require concerted actions from national and regional level policy-makers working in sectors like transports, energy productions, waste management, urban planning, industry, and agriculture [6].

Table 1. WHO air quality guidelines.

Guideline Levels ($\mu g/m^3$)		
PM2.5	1 year	10
	24 h (99th percentile)	25
PM10	1 year	20
	24 h (99th percentile)	50
NO2	1 year	40
	1 h	200

Guideline Levels (μg/m^3)		
O3	8 h, daily maximum	100
SO2	24 h	20
	10 min	500

The set of mobility restrictive measures to limit the spread of COVID-19 imposed by the governments gave a unique opportunity to improve our understanding of the impact of mobility on air pollution in urban areas. Most governments have tried to contain the diffusion of COVID-19 through lockdowns, quarantines, and curfews, which have restricted people's movement, but for indispensable needs such as buying foods, work, and health-related issues. Moreover, all non-essential industries in most countries have been shut down, and people's movements were further restricted by imposing requirements for citizens to provide a signed justification to the authorities to be able to move both between and within cities. The effect of the lockdown on mobility was very relevant, and several studies have measured how lockdowns have modified mobility patterns at both country and local scales. For example, lockdown measures in France caused a 65% reduction in a countrywide number of displacements and were particularly effective in reducing work-related short-range mobility, especially during rush hours, and long-range recreational trips [7]. Another study highlighted that the adoption of strong and severe measures for the containment of the spreading of COVID-19 during the period from March to April 2020 generated a significant reduction in private vehicle trips in the city of Rome (−64.6% during the lockdown) [8]. Community Mobility Reports, which were created with aggregated, anonymized sets of data from users who have turned on the Location History setting from their Google Account, provide useful information for the researchers who want to study the relationship between air pollutants levels and lockdown measures. These Community Mobility Reports aim at providing insights into what has changed in response to the policies aimed at contrasting COVID-19. The reports chart movement trends over time by geography across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential [9]. Several studies used human mobility data collected from Google (at country-scale) mobility reports to examine the status of improved air quality in world cities due to COVID-19 that led to a temporary reduction in anthropogenic emissions [10]. For example, the analysis of the changes in air quality during the COVID-19 lockdown in Singapore used human mobility trends from Google [11], as well as a study that found empirical evidence for a relation between global vehicle transportation declines and the reduction of ambient NO2 exposure [12].

This entry aims at obtaining a broad perspective on the impact of lockdown measures during the COVID-19 pandemic on the air quality in urban environments. For this purpose, we discussed the results reported by several studies in order to better understand the relationships between COVID-19 lockdown measures, the levels of the major pollutants in urban environments, and possibly identify which sectors contribute most to determining the levels of the pollutants. We included in this entry the following pollutants: PM2.5, PM10, NO2, O3, SO2.

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