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Environment—lockdown, air pollution and related diseases: could we learn something and make it last?

Marija Jevtic[1,2,3,4], Vlatka Matkovic[4,5], Peter van den Hazel[4,6], Catherine Bouland[3]

1 Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia
2 Institute of Public Health of Vojvodina, Novi Sad, Serbia
3 Research Centre on Environmental and Occupational Health, School of Public Health, Université Libre de Bruxelles, Brussels, Belgium
4 EUPHA Environment and Health Section, The Netherlands
5 Health and Environment Alliance (HEAL), Brussels, Belgium
6 International Network on Children's Health, Environment and Safety—INCHES, Ellecom, The Netherlands

Correspondence: Marija Jevtic, Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia and Institute of Public Health of Vojvodina, Novi Sad, Serbia, Tel: +381643222506, e-mail: marija.jevtic@uns.ac.rs

Although the pandemic has caused substantial losses in economic prosperity and human lives, it has also some positive impacts on the environment. Restricted mobility, complete closure, less traffic and industry have led to improved air quality especially in urban settings. Not only is air pollution an important determinant of chronic diseases, such as heart and lung disorders, but it has also been shown that poor air quality increases the risk of COVID-19.
In this article, we review some of the findings on changes in air quality during the pandemic, and its potential effects on health. We need to continue to monitor the effects of change in air quality, due to COVID-19 lockdown or other factors, but also keep all our efforts to improve air quality even faster and more persistent, bringing the pollution levels below what WHO recommends are safe to live with.

Introduction

The COVID-19 pandemic crisis has brought us many unknowns, inconveniences, fears, struggles on all systems, not only body systems but also global systems, health, economic and all others. The fight against COVID-19 meant a series of measures: lock-downs, limiting personal exchanges and activities, stopping mobility or drastically reducing mobility, with all personal, non-pharmaceutical interventions and preventive measures. Lockdown of the world has led to an acute effect on the quality of life in most, but especially in urban areas. Despite numerous negative effects, a few unexpected positive effects were observed around the globe. Restricted mobility, complete closure, less traffic and industry have led to a change in air quality—for the better. There is abundant evidence that air quality has improved, in a short period of time and in urban areas primarily.

A year ago, wearing masks was a symbol of protection against air pollution in smoggy cities. Now, they are a prevention measure against the virus. Can this be a collective alert that we need to act: against the virus and the air pollution?

The World Health Organization (WHO) expressed great concern and estimated that globally, 7 million deaths were attributable to household and ambient air pollution in 2012. Clinical and epidemiological studies demonstrate that exposure to air pollution increases mortality due to respiratory and cardiovascular diseases.[1–3] With increased industrialisation and urbanisation, air pollution has become a key public health issue.[4] In Europe, air pollution is a major cause of premature death and disease and is the single largest environmental health risk in Europe responsible for more than 400 000 premature deaths per year. Heart disease and stroke are the most common reasons for premature deaths attributable to air pollution, followed by lung diseases and lung cancer.[5,6]

The aim of this study is to summarize some of the considerations that connect the decrease of air pollution with health consequences and highlight some of the lessons learned from this period of the COVID-19 pandemic. Using selected keywords (air pollution, COVID-19, respiratory diseases), we reviewed the articles that were published during COVID-19. We included the studies that were large scale or coming from well-established research groups. As most researchers nowadays, in the midst of the pandemic, air pollution researchers also saw enormous amounts of studies and opinion pieces published. The flux of published articles is overwhelming.[7] This study does not aim at synthesizing all the evidence to date published, but at focusing on some lessons learned that could be of most relevance in a European context, thus providing added value to already existing individual papers. The results were discussed based on their clinical and public health significance.

Air pollution trends and COVID-19 pandemic—open questions and challenges

In years to come and in parallel with the complex fight against the pandemic, a number of questions and issues related to the connection between air quality and the COVID-19 pandemic will remain important.

- To what extent has lockdown contributed to the reduction of air pollution in urban areas and globally?
- Is there a link between this short-term reduction of air pollution and a long-term impact on the decrease of respiratory diseases?
- What can be deduced from research on the connection between air pollution and COVID-19 infection?

In the attempt to shed light on the link between air pollution and COVID-19, there are many studies: some of them investigate air quality in different locations, ranging from megacities to whole

countries. Furthermore, research is aimed at the possible link between air quality and respiratory diseases, but a majority of all studies looks at the connection between air pollution and infections caused by coronavirus. All the studies have some limitations, such as the short period of investigation, the lack of confirmation of COVID-19 diagnosis or other methodological limitations.

Due to the COVID-19 lockdown, the majority of sources of high pollution was shut down or decreased their activities, which led to significant short-term improvements in air quality. The European Environment Agency (EEA) report 2020 showed up to 60% reductions of certain air pollutants in many European countries where lockdown measures were implemented in the spring of 2020. The largest decreases in monthly averages of up to 70% in NO2 are seen compared with expected concentrations in the absence of lockdown measures (Spain, Italy). Reductions in background NO2 concentrations for selected countries ranged from an average of 61% in Spain to 20% in the Czech Republic. In some cities, NO_2 levels remained relatively low even after lockdown measures were lifted (Milan, Italy), while in others (Athens, Greece) they rapidly returned to the level as seen before lockdown. While for PM2.5, the decrease was lower, 30% in Spain to 9% in the Czech Republic. Reductions in PM2.5 levels were smaller and less consistent than those for NO2 due to the generally more varied sources of PM2.5, especially in urban areas.[8] Srivastava et al. confirm that a significant reduction in the concentration of air pollutants was observed by the monitoring programme. All these reductions occurred for a short period of time. The levels increased as economic activity re-started again.[9,10]

In the major cities in the UK combustion-related emissions were reduced, for example, in central London, the reduction was 55%. While in other urban areas of the UK, NO_2 was reduced by 20–30% which is similar to reductions in other major developed cities.[11]

The importance of the association between air pollutants, the transmission and the severity of the effects caused by the virus that causes the COVID-19 is confirmed by the results which indicate that chronic exposure to air pollutants complicates recovery of the COVID-19 patient and leads to more severe and lethal forms of this disease.[12] Cole et al.[13] show evidence of a positive relationship between air pollution, particularly PM2.5 concentrations, and COVID-19 cases, hospital admissions and deaths. Lockdowns in 2020 have had a significant impact on the environment and on the air quality of cities as recently reported by available data, with reductions of up to 30% in some of the epicenters such as the city Wuhan. PM2.5 emissions from the 50 most polluted capital cities in the world, decrease averaged 12% of PM2.5 in these cities.[14]

China implemented 'the largest quarantine in human history' in Wuhan and other Chinese cities within days. Rui Bao et al. concluded that the reduction of air pollution was strongly associated with travel restrictions during this pandemic. On average, the air quality index (AQI) decreased by 7.80%, and five air pollutants (SO_2, PM2.5, PM10, NO_2 and CO) decreased by 6.76%, 5.93%, 13.66%, 24.67% and 4.58%, respectively. Lockdowns of 44 cities reduced human movements by 69.85%, and a reduction in the AQI, PM2.5 and CO was partially mediated by human mobility, and SO_2, PM10 and NO_2 were completely mediated.[15] Lockdown showed, according to Copat et al.[16] in their study in 176 countries, clear environmental changes of reduced human activity, and a global average reduction in PM2.5 concentrations of 35–45%. It is therefore important to study the interaction between infections and environmental factors of chronic diseases such as chemical toxicants, air pollution, climate change and socio-economic determinants.[17]

In the study of Zheng et al., they found a significant positive association between long-term exposure levels to PM2.5, PM10, NO_2, and the risk and severity of COVID-19 infection in China. Interventions to control the COVID-19 outbreak in China reduced air pollution levels and potentially prevented further cases of acute respiratory disease. The link between COVID-19 and air pollution deserves a more definitive and global data analysis.[18] Zhu et al. not only gave similar conclusions but also reported that short-term exposure to a higher concentration of SO_2 is related to the decreased risk of COVID-19 infection. Consequently, further studies are needed to explore these findings and investigate limitations.[19] The study of Li et al.[20] also have limitations: there are only two cities enrolled, and the study period is relatively short compared to other epidemiological studies. As earlier studies have shown that exposure to NO_2 is associated with inflammation of the lungs, it is now necessary to examine whether the presence of an initial inflammatory condition is related to the response of the immune system to the coronavirus. More studies should focus on additional factors such as age, pre-exposure to NO_2 in order to verify their impact on fatalities due to the COVID-19 pandemic.[21] During the COVID-19 epidemic, PM pollution suggests that exposure may affect COVID-19 prognosis.[22] Hypothesis is that the atmosphere, rich in air pollutants, together with climatic conditions promote a longer presence of the viral particles in the air, so it is important for public health measures to limit the spread of COVID-19 and other infections.[23] The higher rates of COVID-19 in Metropolitan Lima are attributable, among others, to the increased PM2.5 long-term exposure.[24]

Assessing the relationship between surface levels of PM2.5 and PM10 particulate matter impact on COVID-19 in Milan (Italy), the study of Zoran M. et al showed a positive correlation with air temperature. This might support the hypothesis that the warm season will not stop COVID-19 spreading.[25]

Lombardy was the first Italian contagious region. Reported data there highlight the fact that PM10 concentration trends in Northern Italy cities cannot be directly associated with COVID-19 reported infection cases.[26] Based on the study of COVID-19 outbreak in Italy, the acceleration of transmission dynamics of COVID-19 has a high association with air pollution of cities measured with days exceeding the limits set for PM10 or ozone. Moreover, cities with more than 100 days of air pollution have a very high average number of infected individuals.[27] The actual pandemic is demonstrating that infectious diseases represent one of the key challenges for human society. The role of atmospheric pollution should be considered in a long-term perspective. Adoption of mitigation measures taken during a viral outbreak could be of limited usefulness. Given limitations, findings should be interpreted as more hypothesis-generating rather than confirmatory.[28] Short-term health effects of air quality changes during the pandemic (Novi Sad, Serbia) confirmed positive effects of the improved air quality on public health. This could also include raising collective resistance to mass non-communicable and infectious diseases such as COVID-19 and reducing economic costs.[29]

The associations detected in ecological regression analyses provide strong justification for the importance of follow-up investigations, with more and higher-quality COVID-19 data with different variables and outcomes, such as hospitalization.[30] Several studies in the USA showed that urban air pollutants, especially NO_2, enhance the population's susceptibility to death from COVID-19. Reduction in air pollution would have avoided a lot of deaths, public health actions needed to protect populations from COVID-19 in areas with historically high NO_2 exposure. Results support targeted public health actions to protect residents from COVID-19 in heavily polluted regions with historically high NO2 levels. Continuation of current efforts to lower traffic emissions and ambient air pollution levels may be an important component of reducing the population-level risk of deaths from COVID-19.[31–34]

A study by Pozzer et al. estimates that particulate air pollution contributed ∼15% (95% confidence interval 7–33%) to COVID-19 mortality worldwide, 27% (13–46%) in East Asia, 19% (8–41%) in Europe and 17% (6–39%) in North America. Globally, ∼50–60% of the attributable, anthropogenic fraction is related to fossil fuel use, up to 70–80% in Europe, West Asia and North America. Results suggest that air pollution is an important cofactor increasing the risk of mortality from COVID-19.[35] Most of the research proposals require transdisciplinary approaches and are embedded in a planetary health perspective.[36–38] Although the evidence cannot be considered to be quite solid, the results of studies support the view that air pollution has adversely influenced the COVID-19 related burden.

Conclusion

There are a lot of limitations in studies. But it is very important to underline that all research confirms that environmental factors, such as air pollution, have an important role in the morbidity and mortality of COVID-19. There is inconsistent data showing a correlation between PM2.5 and PM10 and getting COVID-19. The main limitation of many recent studies is the short time of observations and confounding factors (such as lifestyle, different variables, demographics, etc.).

The pandemic highlights the fact that environmental research is fundamental to improve the knowledge concerning infectious diseases and to put level-up intellectual and economic resources to accelerate actions aimed to implement environmental policies in order to reduce air pollution and develop new urban planning interventions.

The impact of poor air quality on COVID-19 morbidity and mortality causes considerable and unexpected additional cost in the health sector. Although the pandemic has caused substantial losses in economic prosperity and human lives it has also some positive impacts on the environment. The large heterogeneity in the relationship between economic activity and air quality suggests that improving the environmental conditions, such as better air quality may not require big sacrifices but rather shifts in behaviours and the ways we operate things.

Reviewed studies highlight the importance of understanding the role of green production and consumption. Improving air quality is a very complex process, and economic growth may not necessarily lead to environmental degradation.

Short-term and long-term exposures to PM2.5 and long-term exposures to NO_2 appear to be most consistently associated with COVID-19 epidemiological and clinical data worldwide. But studies assessing the effects of acute exposures presented substantial risks of bias.[39] Some studies proposed that PM operates as a virus carrier, promoting its transport through the air. Exposure to ambient PM may also reduce the resistance to infection in the population although the degree of influence may depend on the particulate composition. PM concentration is not the only environmental factor involved in the spreading of COVID-19 infection.[40]

This unexpected situation and lockdown measures demonstrated that—worldwide—we could achieve long term improvement of air quality. Also, it is necessary to consider all other circumstances and influences of COVID-19 pandemic on mental health, economy, inequality and quality of life in general.

Future steps for policies, research and assessments

Air quality policy measures should be ambitious and go forward despite the pandemic crisis, insisting to be one of the post-covid crisis priorities for public health recovery, using the Green Deal and Climate Pact as roadmaps. The zero-pollution ambition for Europe was announced in the European Green Deal as part of the European Commission's strategy to implement the United Nations Sustainable Development Goals agenda. The EEA will be a key partner in these activities, using health policies strategies and adding the public health community as a partner in actions.

Implications for future research are given by numerous studies during this crisis. The EEA does not yet have estimates on the potential positive health impacts of the cleaner air during 2020, but long-term exposure to air pollutants causes cardiovascular and respiratory diseases, which both have been identified as risk factors for death in COVID-19 patients. Further epidemiological research is essential.

European public health policies could use this global crisis to merge infectious and non-infectious factors under one policy-umbrella, with the aim to improve air quality and quality of life for all European citizens.

WHO is currently revising its Air Quality Guidelines, and the EU has pledged to follow the new guidelines for its policies regarding abatement of air pollution. Air quality guidelines should include new circumstances and experiences of COVID-19 pandemic.[41,42]

It is important to motivate the research community and young researchers to conduct a systematic investigation regarding air pollution and its impact on respiratory diseases, including COVID-19, as well as other health consequences.

We need to continue to monitor the effects of change in air quality (due to COVID-19 lockdown or other factors), but also at the same time we should keep all our efforts to make the change for better air quality even faster and more persistent, bringing the pollution levels to below what WHO recommends is safe to live with.

Conflict of interest: None declared.

Additional Content

A video to accompany this paper is available at https://youtube.com/playlist?list=PLv5eq4ZCoNWubJurAJ-7Ht33cjNshLw7R.

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