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Attenuation of Air Pollutants: A Blessing during COVID-19 Outbreak

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***Abstract*: A novel infectious coronavirus disease (COVID-19) identified in late 2019 has now been considered as a global pandemic by World Health Organization (WHO). The COVID-19 outbreak has shown some positive impacts on the natural environment and nature gets a time to assimilate human annoyance. During lockdown air quality was significantly improved due to shutdown of industrial operation and lower traffic. Emission of NO2 and carbon dioxide (CO2) dropped significantly worldwide. NO2 levels in India decreased between 40 and 50% at the time of lockdown. In Europe, CO2 levels are expected to drop by 390 million tons. In the USA, carbon emissions also dropped around 40% during lockdown. A decrease in key air pollutants (PM2.5, NO2, SO2, and CO) in different cities in China from 5.93 to 24.67% during the lockdown. In Bangladesh, the Air Quality Index (AQI) has also been decreased by more than one-third compared to its extent in the previous year. Ozone (O3) concentration in Bangladesh has increased during the lockdown period. An increment in ozone concentration was observed due to a drastic reduction in NO2 up to 50% worldwide. It is widely perceived to dump contaminated PPEs and healthcare waste due to improper management of waste resultant the spread of viral disease in the environment. It showed the pollution source control can attenuate the air quality and a significant improvement in air quality can be achieved in future if better pollution control policy are strictly executed.**

***Keywords*: Air pollutants, Emissions, Covid-19, Lockdown**

1. Introduction

COVID-19 pandemic is an ongoing pandemic of Corona Virus Disease 2019 (COVID-19) caused by Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2) (2222) On January 30th, the World Health Organization declared this outbreak a Public Health Emergency of International Concern and on March 11th 2020, WHO's Director-General announced that COVID-19 can be characterized as a pandemic. The virus causes inflammation in lungs which damage the pulmonary cells by initiating an inflammatory reaction1. The oxygen level in the blood may drop while other organs such as kidneys or the heart might be affected in severe cases. The recent outbreak of coronavirus disease, has raised global concerns and led to total lockdown in many countries delimited by maintaining proper social distance, personal hygiene, avoiding gatherings, and visiting places like hospitals, meetings, and public transportations, which have a high risk of such virus contamination. At the time of writing, April 9th, 2021, there have been more than 130 million confirmed cases and around 2.9 million deaths reported globally2. A study in air pollution from China suggests that there is a statistically confirmed relationship between air pollution by means of elevated concentrations of PM 2.5, PM 10, CO, NO2 and O3 and the COVID-19 infection rate. Another study from Italy supports the insight by providing causal relationships between the COVID-19 spread and air quality2-3. On the other side, lockdowns have caused significant changes in air quality. A study on 44 Chinese cities showed a decrease in main air pollutants from 5.93 to 24.67% during the lockdown. A study on PM2.5 in capital cities showed concentration drops of 20-60% during the COVID-19 crisis. According to NASA NO2 emissions were reduced in central China up to 30%. CO2 emissions, another common tracer of air pollution, decreased by 25% in China and by 6% worldwide3. Air pollution is responsible for many deaths and increased incidences of respiratory disease. Like asthma, bronchitis, emphysema, lung and heart diseases, and respiratory allergies. China, where the COVID-19 epidemic started, is also a country severely affected by air pollution. Air pollution in China was responsible for 4000 preventable deaths each day i.e. 1.6 million fatalities in 20164. The quarantine imposed due to COVID-19 is unprecedented in human history as all the markets are shutdown, places of worships are closed, public gathering is banned, travel restrictions have been imposed, construction

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work halted and economy as well as stock exchange crashed worldwide. But from climate perspective the coronavirus pandemic brings about many positive aspects which the world is witnessing during the lockdown. This poses a unique opportunity to study the inverse connotation between air pollution and COVID-19, thus motivating our study [2-4].

2. Materials and Methodology

This study was performed by reviewing the available published literatures, concerning an inverse connotation of the connection between air pollution and COVID-19, case studies, and different government and non-government organizations information from reports and official websites. We obtained a total of 40 eligible published research articles using different search portal like PubMed, Research Gate, Springer, Google Scholar, Nature, and Lancet etc. After proper literature review only 15 literatures and web portals information which were related to this study were taken for this systemic review purpose. This study compiles and presents the data and information which are relevant to an inverse association between air pollution and COVID-19 and meet the study goals.

3. Bangladesh Scenario

This is not good news, because air quality in Bangladesh was the worst in the world and Dhaka was the 2nd most polluted city, according to 2020 World Air Quality Report5. The global experts have opined that health damage caused by continued exposure to high levels of air pollution in cities can potentially increase the death rate from coronavirus infections6. The COVID-19 pandemic in Bangladesh is part of the worldwide pandemic of coronavirus disease 2019. The first three known cases were reported on 8th March 2020 by the country's epidemiology institute, IEDCR5-6. Bangladesh is the third most affected country in South Asia, after India and Pakistan. In Bangladesh, from 3rd January 2020 to 9th April 2021, there have been 666,132 confirmed cases of COVID-19 with 9,521 deaths6. As of 6th April 2021, a total of 5,568,703 vaccine doses have been administered (to be update more with latest data).New strains of the virus have spread fast within and across countries. The initiation of vaccination had brought hope for humanity to be done with the pandemic gradually7. But it seems the virus is still here to stay for some time more. In order to protect the population, the government declared "lockdown" throughout the nation from 23rd March 2020 to 30th May 2020. On 5th April 2021, a seven-day lockdown was announced by the Bangladeshi government, including all domestic travel suspended and shopping malls shut alongside a curfew between 6pm and 6am7-8. Air pollution is strongly associated with respiratory diseases such as asthma, chronic obstructive pulmonary disease (COPD), and lung cancer. Ischemic heart disease and stroke are also caused by air pollution. Like other countries, COVID-19 forced to lock down industries, mass transportation, and other anthropogenic activities in Bangladesh. Hence, it is assumed that the complete or partial lockdown may result in improved air quality, as it is correlated with the amount of emissions. Dhaka is the world's most densely populated city, the city dwellers combust a significant amount of fossil fuel (natural gas and charcoal, especially in slum area) that might be a noteworthy source of air pollution8.

A study conducted in Dhaka found that all pollutants, including PM2.5, NO2, SO2, and CO, have been decreased during the lockdown period compared to their concentration in the previous year. The AQI has also been decreased by more than one- third compared to its extent in the previous year9. During the lockdown period (i.e. 26 March–30 May 2020) in Bangladesh due to the COVID-19 pandemic, a drastic reduction in NO2 (nitrogen dioxide) concentration has been observed10. Study reveals that urban areas experienced the most decrease in NO2 concentrations than the rural areas due to restricted traffic and shutdown of industries10. Like other pollutants, partial or complete lockdown measure also has a noticeable impact on O3 (ozone) concentration, study reveals that O3 concentration in Bangladesh has increased during the lockdown period. Contrary to these positive factors, household emissions might have increased during the lockdown period in Bangladesh which may have a negative impact on air. It is widely perceived to dump solid waste in poorly managed and open landfills in Bangladesh. This is an example where improper management of contaminated PPEs and healthcare waste may increase the spread of viral disease in the environment, especially in the air [11].

4. Results

So far, many studies have been conducted across the globe to understand the connection between air pollution and COVID-19. While the COVID-19 pandemic has had an unprecedented effect on society and the economy, to the contrary, it has helped repair some environmental damage. It has also come as the silver lining for the environment with some positive impact.

- *Improvement of air pollution and reduction of GHGs emission;* as industries, transportation and companies have closed down, it has brought a sudden drop of greenhouse gases (GHGs) emissions
- *Reduction of water pollution*; during the lockdown period, the major industrial sources of pollution have shrunk or completely stopped, which helped to reduce the pollution load
- *Drop of noise pollution;* it is the elevated levels of sound, generated from different human activities like machines, vehicles, construction work. However, the quarantine and lockdown measures mandate that people stay at home and reduced economic activities and communication worldwide, which ultimately reduced noise level in most cities.
- *Ecological restoration and assimilation of tourist spots;* Local administration imposed a ban on public gathering and tourist arrivals at different sea beach in the world. As a result of restriction, the color of sea water is changed, which usually remain turbid because of swimming, bathing, playing and riding motorized b attenuate oat [12].

There are also some negative consequences of COVID-19,

such as:

- *Increase of biomedical waste generation*; presently peoples are using face mask, hand gloves and other safety equipment, which increase the amount of healthcare waste
- *Safety equipment use and haphazard disposal*; Due to lack of knowledge about infectious waste management, most people dump these (e.g., face mask, hand gloves etc.) in open places and in some cases with household wastes. Such haphazard dumping of these trashes creates clogging in water ways and worsens environmental pollution.
- *Solid waste generation, and reduction of recycling*; Due to the pandemic many countries postponed the waste recycling activities to reduce the transmission of viral infection. Overall, due to disruption of routine municipal waste management, waste recovery and recycling activities, increasing the landfilling and environmental pollutants worldwide.
- *Other effect*; Extensive use of disinfectants may kill non-targeted beneficial species, which may create ecological imbalance. So, additional measures in wastewater treatment are essential, which is challenging for developing countries like Bangladesh, where municipal wastewater is drained into nearby aquatic bodies and rivers without treatment. In the context of COVID-19, studies found a significant reduction of air pollution during the lockdown. Air pollutants, such as NO2 and carbon dioxide (CO2) emissions dropped significantly due to the halt in industrial and vehicle operations worldwide. NO2 levels in India decreased between 40 and 50% at the time of lockdown. In Europe, CO2 levels are expected to drop by 390 million tons due to lockdown. In the USA, carbon emissions also dropped around 40% during lockdown due to lower traffic12-13.

Carbon monoxide (CO), NO2, and 'particulate matter with a diameter small or equal to 10 μm' (PM10) decreased significantly during the global shutdown, while ozone (O3) increased due to reduction in NO2. NO2 and black carbon (BC) reduced by 50% during the lockdown period, while PM10 was reduced to some extent. Conversely, the level of O3 was increased by more than 50% during lockdown in Barcelona. Likewise, in Barcelona, NO2, and BC declined between 45 and 51%2, 11.

A study from northern China shows that a reduction in NO2 and PM was most likely caused by a reduction in traffic and industrial activities. Another study from China reveals a reduction of NO2 up to 60%12.

A study from the UK, which employed also a historical comparison shows a reduction of 48% in NO2 concentration and an average increase in O3 concentration of 11% across 126 urban sites. A study from Austria for PM10 and NO2, the predicted values were found to be above the measured concentrations during the lockdown. O3 was under-predicted during the period of lockdown which can be explained with the inverse relationship with NOx concentrations. NOx emissions (and concentrations) were substantially reduced during the lockdown because of much lower traffic volumes across the city of Graz13. A study conducted in Dhaka found that all pollutants, including PM2.5, NO2, SO2, and CO, have been decreased during the lockdown period compared to their concentration in the previous year. The highest degree of concentration reduction occurred in NO2, followed by PM2.5, SO2, and CO. The AQI has also been decreased by more than one-third compared to its extent in the previous year. During the lockdown period (i.e., 26 March–30 May 2020) in Bangladesh the reduction in NO2 concentrations in different time slots indicates that lockdown measures due to the COVID-19 pandemic have considerable impacts on changing NO2 concentrations in Bangladesh [14].

A study reveals that O3 concentration in Bangladesh has increased during the lockdown period. Interestingly, a slight decrease in O3 concentration has been found in Rangpur during the lockdown period compared with before the lockdown (i.e., 294.12 vs. 293.56 DU).This study assumes some reasons behind the decreasing O3 levels in Rangpur and it might be due to the lack of proper implementation of lockdown. Contrary to these factors, household emissions might have increased during the lockdown period in Bangladesh which is a factor for polluting the air [14-15].

Ideally, medical wastes must be incinerated at 700 °C scrubbing and filtering particulate matter. However, some hospitals in Dhaka and other cities were found to burn their medical wastes in their backyards without proper treatment facilities polluting the air [11, 13].

5. Discussion

1) Positive aspects of COVID 19

Coronavirus lockdowns across the world seem to have a number of positive effects on the environment. The World Health Organization (WHO) estimated that the outdoor air pollution kills 7 million people each year world- wide and more than 80% urban population is exposed to unhealthy air. Since people stayed home, these last few months have paved significant improvement in air quality, especially in hard-hit areas like Wuhan, as well as in northern Italy and a number of metropolitan areas throughout the USA.

In China, emissions of harmful gases and other pollutants dropped 25% at the start of the year 2020 and the quality of air improved up to 11.4% with respect to start of the last year, in 337 cities across China. WHO estimated that this change has saved 50,000 lives in China. The World Health Organization (WHO) has estimated that every year, worldwide, more than 4 million deaths occurred due to PM2.5, causing heart diseases, strokes, lung cancer, chronic lung diseases and respiratory infections (WHO 2019). The baseline of PM2.5 in many cities in the world is above one hundred, measured in micro- grams per cubic meter (Table 1). After COVID-19-induced lockdown, the level of PM2.5 has decreased drastically and thousands of lives have been protected from its worse impacts. (IQAir 2020).

Nitrogen dioxide (NO2) is a toxic gas that is emitted from the engines of automobiles and factories. The World Health Organization stated that if the concentration of this gas exceeds

200 μg/m3, then it can cause inflammation in respiratory track which ultimately leads to asthma. Now, due to current lockdown the transport is restricted and factories are closed, hence, in cities all over the world the concentration of NO2 in air has dropped drastically (from 5.6 μg/m3 to 0.2 μg/m3)6.

The emission of CO2 has decreased worldwide. The experts are predicting this to be the biggest decline in anthropogenic CO2 emissions after World War-II. During the period of lockdown, global air traffic reduced by 60% which have led to a temporary dip in CO2 emissions from their pre- crisis levels. CO2 emissions in China have minimized by around 200 million metric tons. Scientists estimated that this reduction may have saved at least 77,000 lives8. Researchers at NASA reported that ozone concentration above Arctic regions of the globe decreased by around 240 Dobson units on March 12, 2020 as compared to ozone concentration in March 12, 2019. Such low levels are very rare and happen about once per decade. The Ongoing COVID-19 lockdown across the world is showing a direct relation between air pollution levels. This suggests that clean energy-based system has to be adopted as the corona outbreak ends11, 15.

2) Negative aspects of COVID 19

Air pollution may increase COVID-19 morbidity and mortality through its action on associated comorbidities. Experimental studies conducted for other respiratory viruses support the hypothesis that air pollution exposure may facilitate the occurrence of COVID-19 infection through a decrease in immune response. World Health Organization (WHO) and the US Centers for Disease Control and Prevention, the National Centers for Disease Control and local governments have announced various guidelines, including frequent hand washing, social distancing and quarantine (home, local and state quarantine), to reduce the spread and health risks associated with COVID-19. They also announced that, infectious medical waste generated by the COVID-19 outbreak has posed a major environmental and health concern in many countries. In particular, inadequate and improper health care waste management may pollute the environment especially the air11-15. Medical wastes must be incinerated at 700 °C scrubbing and filtering particulate matter. Without proper treatment facilities emitting different flue gases and harmful particles in the atmosphere12.

6. Conclusion

During Covid-19 induced lockdown, many locations around the world have observed visibly cleaner air with less pollution and presence of toxic elements. This gave us a glimmer of hope that finally we will get fresh air to breathe. But, it is again very frustrating that we have been more careless and back to square one. Our own negligence may turn deadly for our own survival. Following social distancing, lockdown and restricted human interaction with nature proved to be a blessing for nature and environment during the crises. There are positive indications from all over the world that COVID-19-induced lockdown is improving environmental conditions including air quality and causes a significant concurrent reduction in PM2.5, NO2 and CO concentration which resulted in a significant increase in O3 concentration. This recovery of lost environment is an indicator that the environmental degradation caused by human is reversible and polluted air may accelerate the COVID-19 severity. Also, standardization, procedures, guidelines and strict implementation of PPEs, medical masks and other health care waste management for the COVID-19 pandemic should be carefully considered to reduce the risk of polluting the environment.

7. Table

Table 1
PM 2.5 levels in some of the most polluted cities of the world during the period of COVID-19-induced lockdown

City	Average PM 2.5 during lockdown 2020 (μg/m3)	Reduction Comparedto 2021	Average reduction comparedto prior 4years	Lockdown period, 2020
Delhi, India	32.8	-60%	-55%	March 23–April 13
London, UK	16.2	-9%	+6%	March 23–April 13
Los Angeles, US	5.5	-31%	-51%	March 23–April 13
Madrid, Spain	6.4	-11%	+2%	March 23–April 13
New York City, US	4.4	-25%	-29%	March 23–April 13
São Paulo, Brazil	10.1	-32%	-26%	March 23–April 13
Seoul, South Korea	24.1	-54%	-32%	Feb 26–March 18
Wuhan, China	35.1	-44%	-50%	Feb 3–Feb 24
Lahore, Pakistan	2.5	-63%	-59%	March 23–April

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