Review article

A Review of COVID-19: Nature of the Virus and Impact of Lockdown on Air Pollution over India and the World

N.V. Krishna Prasad[1]*, P. Sasikala[2], S. Ramesh[1], M.S.S.R.K.N. Sarma[1], Thomaskutty Mathew[1], T. Anil Babu[1] and N. Madhavi[3]

[1]Department of Physics, GSS, GITAM Deemed to be University, Bengaluru, India
[2]Department of Mathematics, GSS, GITAM Deemed to be University, Bengaluru, India
[3]Department of Statistics, Government College (Autonomous), Rajhamundry, India

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Abstract

A new infection was reported on 31st December, 2019 from the city of Wuhan (China) to WHO. It was later named COVID-19 disease and was declared pandemic on 11thMarch, 2020. Estimates predicted that forty to sixty percent of world population would be affected by this virus. This virus has created an immeasurable crisis in the entire world economically, socially as well as environmentally with adverse effect on health. Worldwide lockdowns have been implemented to curtail virus transmission. Lockdown starting and ending dates have varied depending on the country. These lockdowns have had significant impact on air quality due to sudden reduction in vehicular traffic as well as shutdown of industries. It was reported that thirty percent reduction in air pollution was experienced by Wuhan city due to the lockdown. Many research publications have reported the impact of air pollution on human health for the last few decades. However, for the first time, forced lockdown created a chance to review the air pollution in various cities. In this review, we present some of the published results related to the nature of virus and impact of lockdown on air pollution over India and the world.

Keywords: COVID-19; lockdown; air pollution
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1. Introduction

Huanan Seafood market, a wet market in Wuhan city of China was the origin of an unknown respiratory disease that was identified in December 2019 and named COVID-19. It was reported that this disease had infected the entire world [1-3] and WHO declared it a pandemic on 11th of March 2020 [4]. This type of virus was reported for the first time and is characterized by cough, cold, running nose, fever, body aches and sore throat. Since no vaccine is available right now, wearing masks, social/physical distancing and continuous sanitization is being followed to avoid

*Corresponding author: Tel.: 91-8971199913
E-mail: drnvkprasad@gmail.com

the spreading of virus [5]. As per the data of WHO Corona Virus Disease (COVID-19) Dashboard, World Health Organization confirmed cases of 20.71 millions, recovered cases of 12.58 million and death cases of 0.74 million on 6th August of 2020 throughout the world [4]. The current scenario of lockdown has shown huge impact on air pollution of cities which are urbanized due to almost zero traffic and shut down in industries. This unpredicted situation has brought a change in the local environment which needs to be monitored. In this regard studies related to air quality and its impact on human health have come into the lime light. Emission of air pollutants and particulate matter have been a major contributor to respiratory diseases. As per the data of WHO in 2018 [4], death rate due to respiratory diseases by particulate matter (PM) concentration was reported to be 700 million per year. Nearly ninety percent of world's population was reported to live in areas with poor air quality [6] with 4.2 million premature deaths being recorded worldwide [7]. Controlling of virus transmission started with implementation of lockdown that stimulated improvement in air quality. This lockdown which was made mandatory by all governments is of prime interest in analysing environmental data and may lead to interesting results if any.

2. Nature of COVID-19

This previous unknown respiratory disease named COVID-19 is caused by SARS-Cov-2 virus which was reported for first time, and which is highly contagious in nature. The reason for rapid spread of the disease has not yet been confirmed [8]. Two other corona virus diseases, Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) were reported in 2003 and 2012, respectively [2]. The death rate of COVID-19 is five times less than SARS virus, which might have originated in bats and got transmitted to humans via some intermediate animals. The COVID-19 virus has a better organism sequence identity compared to the SARS and MERS corona viruses [9]. It is reported that the organic compounds that combine to form proteins of this virus differ from other corona viruses based on S-protein [10]. This virus may be treated as another form of SARS and MERS viruses [11]. Mode of action of corona virus involves closeness, penetration, biosynthesis, and formation followed by release. It was reported that on binding to host cells, the virus enters the cells via penetration and RNA enters the nucleus for reproduction. After biosynthesis of viral proteins, viral particles are formed and released by lysis [12]. The symptoms of corona virus infection appear in an individual after an incubation period of about 5.2 days. The gap between onset and death of the infected patients ranges between 6 to 41 days, a period of time that varies depending on the age of the person. The severity of this infection ranges from mild to no symptoms (30%) to severe symptoms (10%) and critical symptoms (5%) cases [1]. Another report confirmed the incubation period to be 5.1 days [13]. This virus can damage central nervous system [11]. Patients with a track record of pre-existing conditions that include surgeries, hypertension, heart disease and so on, are more prone to death [14]. Consumption of alcohol and smoking leads to adverse effects [12]. Diabetes triggers severity of COVID-19 infection and mortality, and diabetic patients are more prone to death when compared to sufferers of other diseases [15]. Reports also indicated that virus transmission from mother to baby was possible [16]. It was reported that children of age between 10 to 19 years were less vulnerable to infection. The percentage of infected children who developed asymptomatic, mild, moderate and severe conditions were reported to be 4.4%, 50.9%, 38.8% and 5.9%, respectively, where as 18.5% of adults developed severe disease [12].

3. Impact of Lockdown on Air Pollution in India

India imposed a nationwide lockdown from 24th March to 3rd May 2020. The strict lockdown during this period definitely reduced air pollution in all cities throughout the country; however, this was not a permanent solution in controlling air pollution problems. Literature published in 2020 that reported air pollution data during lockdown period. Analysis of different pollutants between 16th March to 14thApril of 2017, 2018, 2019 and 2020 for 22 cities that included Bhopal and Dewas (Central India), Patna, Jorapokhar, Brajrajnagar, Kolkata, Gaya (East India), Amritsar, Faridabad, Agra, Jodhpur, Delhi, Varanasi, Kanpur (North India), Chennai, Thiruvanthapuram, Bengaluru, Amravati (South India), Mumbai, Ahmedabad, Pune, and Nagpur (West India), were reported. Hourly concentrations of NO_2, O_3, SO_2, CO, NO_x, PM_{10}, and $PM_{2.5}$ along with temperature, relative humidity, wind direction and wind speed obtained from the official Pollution Control Board of India website [17], were analysed. Decreases in PM10 (31%), PM2.5 (43%), CO (10%), NO_2 (18%), increase in ozone by 17% and negligible change in SO_2 during lockdown period in comparison with previous years for all the cities mentioned above, were reported. Air Quality Index (AQI) was reported to be lower by 44%, 33%, 29%, 15% and 32% in North, South, East, Central and Western India, respectively [18]. Table 1 shows the decline in Air Quality Index (AQI) in India during lockdown.

Table 1. Percentage decrease in AQI in India during COVID-19 lockdown [18]

Location	% Decrease of AQI
Northern India	44
Southern India	33
Eastern India	29
Central India	15
Western India	32

Analysis of in-situ measured ambient air quality for Delhi, Hyderabad, Chennai, Mumbai and Kolkata between 2015 to 2020 indicated substantial reductions in $PM_{2.5}$ concentration of 41%-53% (Delhi), 26%-54% (Hyderabad), 19%-43% (Chennai), 10%-39% (Mumbai), and 24%-36% (Kolkata) [19]. It is a known fact that cities with high volumes of traffic record high values of $PM_{2.5}$ concentration. Studies related to the impact of lockdown on air pollutants and aerosol concentration in analysing pre-monsoon cloud-to-ground and inter-cloud lightning activity reported a reduction of more than 40% in these pollutants due to lockdown which reduced the lightning activity around Kolkata [20]. Air quality data of $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, NH_3, and O_3 from 34 monitoring stations spread over most polluted capital city, Delhi, were analysed. The results demonstrated a remarkable improvement with 50% reduction in PM_{10} and $PM_{2.5}$ levels compared to pre-lockdown phase, while other pollutants showed a reduction of CO by 30.35% and NO_2 by 52.68%. Air quality improved by 40% to 50% with four days after commencement of lockdown. Reductions in National Air Quality Index (NAQI) were found to be 49%, 37%, 31%, 43%, and 54% in the Eastern, Western, Northern, Southern and Central parts of Delhi, respectively [21].

4. Impact of Lockdown on Air Pollution around the World

As per WHO [22], yearly mean concentration of air quality should not exceed 10 mg/m^3. Meteosim [23] reported that Delhi, the capital of India, was the most polluted capital with yearly mean of 113.5 mg/m^3 $PM_{2.5}$ concentration for the year 2018 [23]. It was reported that 27% of the

capitals of Asian countries had a tendency of decreasing $PM_{2.5}$ concentration, excepted Tokyo (Japan), Kathmandu (Nepal), Jakarta (Indonesia) and Singapore which showed an increasing trend. The highest weekly averages of 183mg/m^3 and 140mg/m^3 $PM_{2.5}$ for Dhaka (Bangladesh) and Delhi (India) with 24% and 40% reductions during lockdown week were reported. At the same time seventeen European capitals recorded a decrease of $PM_{2.5}$ concentration by 23% on average while Bogota (Colombia), one of the four capitals in American continent analysed, exhibited the highest $PM_{2.5}$ reduction (57%) [24]. Moreover, it was reported that CO_2 emissions reduced by 25% in Asian country such as China, and by 6% worldwide [25]. Comparison between annual deaths due to NO_2 emissions with that of deaths due to COVID-19 indicated that home isolation during Covid pandemic was an appropriate decision [26]. Compilation of information from NASA and ESA reported that home isolation benefited North America, China and Europe environmentally on a temporary basis [27]. A regression model was developed with thirty-five variables from socioeconomic to environmental that were related to the disease in first three months of the outbreak in the USA [28]. Reports indicate that 78% of 4443 deaths occurred in a single day on 19th March, 2020 in Europe, were from five highly contaminated areas and indicated long term exposure to particulate pollutants acted as a major contributor to corona virus mortality in the entire world [29]. Significant reduction in CO and NO_2 levels in Rio de Janeiro (Brazil) were reported. They also reported reduction in PM10 and increase in ozone (attributed to increase in NMHC/NOx ratios) in all locations of study during first partial lockdown [30]. Hourly air pollution for fine particulate matter, ozone, oxides of nitrogen and nitrogen dioxide was measured in the air monitoring network of Ontario (Canada) for 2020 as well as for previous five years and reported. This report indicated no significant reduction in fine particulate matter with reduction in ozone concentration at twelve of the thirty-two monitors compared to the previous years. Nitrogen oxide and nitrogen dioxide show the lowest concentrations at 22 of 29 monitors. However, they observed no variation in fine particulate matter from historic values [31]. Studies related to temperature effect on COVID-19 for Canada using daily meteorological data with statistical model along with 77,700 plus cases between January to May 2020 indicated no dependence of virus on ambient temperature [32]. The impact of traffic reduction and reduced industrial emissions on air quality during lockdown in China was reported. AQI and concentrations of six pollutants (O_3, CO, NO_2, SO_2, $PM_{2.5}$ and PM_{10}) during COVID-19 control period in northern China were studied. The improvement in air quality because of reduced emissions from transport and secondary industrial sector was observed. Reduction in CO, NO_2, SO_2 and $PM_{2.5}$ concentrations, with increase in O_3 was reported. However, these reductions could not eliminate air pollution completely [33]. The correlation between the extent of increased diffusion, capacity of causing virus and surface air pollution in Milan (Italy) was investigated. Daily average concentrations of $PM_{2.5}$, PM_{10}, Relative Humidity, Temperature, PBL Height, Wind Speed and Atmospheric Pressure between January-April 2020 were collected and analysed. It was reported that increase in confirmed COVID-19 cases was due to the high level of urban air pollution, instead of indoor transmission or direct human-to-human contact [34]. The occurrence of severe air pollution in North China in spite of reduced activity due to COVID-19 was analysed. It indicated that the benefits of reduced emission were masked by adverse meteorology and severe air pollution, factors that could not be avoided [35]. A report on impact of COVID-19 virus on ultra-fine particles was first of its kind which reported the impact of virus on air pollution related to traffic for a US city. The data were collected five weeks before and ten weeks after lockdown and showed significant decrease in ultra fine particles by 4% to 29%, $PM_{2.5}$ (33%), NO (33%), NO_2 (29%), NO_x (30%) and CO (17%) [36]. Table 2 displays the % decrease in particulate matter concentration and air pollutants during lock down in the U.S city during lockdown.

Table 2. Percentage decrease in particulate matter concentration and air pollutants during lock down in a U.S city [36]

Parameter	% Decrease
PM2.5	33
NO	33
NO_2	29
NO_x	30
CO	17

The decline in $PM_{2.}5$ concentration in major cities around the world including Mumbai and Delhi (India), Shanghai and Beijing (China), Rome (Italy), Zaragoza (Spain), Dubai (UAE), New York and Los Angeles (USA) during COVID-19 lockdown was reported [37]. Investigation of change in source contributions, chemical composition and local transport of $PM_{2.5}$ particles during lockdown was done and compared with 2019 for the city of Wuhan which indicated a decrease of $PM_{2.5}$ concentration with 92% emission reduction [38]. An analysis of air quality based on NO_2 during lock down in two big cities, Madrid and Barcelona, Spain, showed reductions in NO_2 concentration by 62% and 50%, respectively [39]. The dependence of PM concentration on Relative Humidity was also reported in a detailed manner [40].

5. Conclusions

In this review paper, we explored some of the results published very recently after the COVID- 19 outbreak. The idea was to bring all the results related to lockdown impact on air pollution around the globe into a single entity. From the review of available literature, it is very clear that almost 90% of cities all over the world experienced an improvement in air pollution due to forced lockdown. Even though this is a good sign or indication in terms of improved air quality which acts as major contributor to respiratory diseases, this cannot be adopted on continuous basis when keeping the socioeconomic conditions of human beings into consideration. This lockdown may be helpful for this year's monsoon to give adequate rainfall due to drastic reduction in air pollution as we have seen in the above results. However, this also depends on various local factors. Many reports indicated that increase of air pollution prevents rainfall. However, an alternative in reducing air pollution may be investigated on permanent basis. This restricted lockdown may be implemented as policy decision keeping the existence of mankind in terms of good health and other factors.

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