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### RESEARCH ARTICLE

#### AIR POLLUTION AND COVID-19 PANDEMIC: A REVIEW

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#### Abstract

The air environment is the major medium through which COVID-19 is transmitted, and studies have indicated that air pollution particles could help coronavirus travel further in the air. Regions with significant air pollution problems have matched those where the pandemic has the highest impact. Transmission of the virus from contaminated dry surfaces has also been documented. Paradoxically, the lockdown imposed in many regions as a result of the pandemic has resulted in the improvement in the local air quality now, compared to before the pandemic, thereby drastically decreasing the number of fatalities due to air pollution. However, this seeming improvement in air quality may just be temporary. The COVID-19 pandemic would not just disappear overnight, and we have to learn to live with it. While current measures being taken such as social distancing could have an impact in minimizing the risk, air quality is likely to get worse again as restrictions are lifted and the economy resumes. Countries with high level of air pollution therefore need to take improvement in air quality as the only enduring measure of controlling the pandemic.

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#### Introduction:-

Since the outbreak of COVID-19 caused by the SARS-CoV-2 at the end of 2019, various researches (Chan, et al. 2020; 2020; Wrapp et al., 2020; Dutheil et al., 2020) have been aimed at understanding the character of the virus, the etiology and epidemiology of the disease, its mode of transmission and control. The virus has been understood to be transmitted through the air environment and via surfaces (Quin et al., 2020; Kampf et al., 2020), and air pollution has naturally been a major subject of study in this regard. Other researchers (Ogen, 2020) have indicated that since air pollution also leads to chronic respiratory stress, it could also limit the ability of the human body to defend itself from infections, including that of COVID-19. Even though the lockdown imposed in many cities have, incidentally, resulted in temporary improvement in the quality of the local air environment, this impact could be just a temporary gain (Quin et al. 2020). This paper reviews the impact of air pollution on this pandemic and how it's management can help in controlling it.

#### Air Pollution

##### Sources and Characteristics of Major Air Pollutants

Air pollution refers to the release of a materials into the air that are detrimental to human health and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made. According to Kamal (2017), the major air pollution sources include: **mobile sources** (such as cars, buses, planes, trucks, and trains), **stationary sources** (such as power plants, oil refineries, industrial facilities, and factories), **area sources** ( such as

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agricultural areas, cities, and wood burning fireplaces), **natural sources** (such as wind-blown dust, wildfires, and volcanoes) and **biological sources** (such as pollen grains and airborne microbes - bacteria, virus, fungi).

A biomolecule or biological molecule is a loosely used term for molecules and ions present in organisms that are essential to one or more typically biological processes, such as cell division, morphogenesis, or development (Bunge, 1979). Biomolecules include large macromolecules (or polyanions) such as proteins, carbohydrates, lipids, and nucleic acids, as well as small molecules such as primary metabolites, secondary metabolites and natural products. Pathogenic air borne microbes, or bioaerosol significantly affect air quality and public health and COVID-19 virus aptly falls in to this category.

### **Dispersion of Air Pollutants**

Meteorological factors have a significant impact on the dispersion of air pollutants. For instance, He et al. (2017) found that the highest major pollutant over China was PM<sub>2.5</sub> followed by PM<sub>10</sub>, O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub> and CO, and that meteorological conditions were the primary factors determining day-to-day variations in pollutant concentrations, explaining more than 70% of the variance of daily average pollutant concentrations. Furthermore, the relationship between air pollutants and meteorological parameters suggested that lower primary pollutants were associated with higher wind speed (Zhou, et al. 2018).

In another study, Xie et al. (2017) investigated the effect of air pollution on the concentration of total airborne microbes (TAMs) and their results indicated that the concentration of TAMs showed significant seasonal variation. Importantly, the concentration of TAMs increased firstly and then slightly decreased with the deterioration of air quality, and the maximum concentration was observed at moderate pollution level. The research also found that joint effect of meteorological and environmental factors was an important influence mechanism on bioaerosol concentrations. Furthermore, the results indicated that snowfall was capable of improving air quality by reducing concentration of TAMs.

### **Effects of Air Pollution**

Climate change, the continuous alteration in weather patterns over a long period of time, is generally attributed to air pollution. Greenhouse gases emissions such as carbon dioxide (CO<sub>2</sub>) is known to accelerate this change. CO<sub>2</sub> is a greenhouse gas that absorbs radiation and therefore blocks heat from escaping the atmosphere of earth; resulting in excess heat. The effect of heat energy trapped in the earth surface tantamount to climate change as it prompts the disruption of weather patterns and raises the average temperature (EarthHero, 2017). EDF Energy (2018) noted that thirty percent of the earth species could face extinction if the temperature of earth rises by sheer 2°C. Lindsey & Dalham (2020) suggested that the change in temperature raises the likelihood of extreme weather events such as heat waves, flooding and drought, and rising sea levels that seriously affect food security.

Air pollution is also responsible for many deaths and increased incidences of respiratory disease (Brauer, 2010). According to the World Health Organization, 4.6 million individuals die annually from diseases and illnesses directly related to poor air quality (Cohen et al., 2017). European Environment Agency (2005) had earlier reported that poor air quality is responsible for more deaths each year than motor vehicle accidents. The impact of air pollution is a global problem and includes developed countries, such as the European nations where 193,000 people died in 2012 from airborne particulate matter (Ortiz et al., 2017). As noted by Brauer (2010), air pollution associated deaths include but are not limited to aggravated asthma, bronchitis, emphysema, lung and heart diseases, and respiratory allergies. He et al. (2020) observed that China, where the COVID-19 epidemic started, is also a country severely affected by air pollution; while Rohde & Muller (2015) and Wang et al. (2012) had earlier reported that air pollution in China was responsible for 4,000 preventable deaths each day.

### **COVID-19 Pandemic**

#### **Historical Development of Corona Virus Pandemic**

A pandemic is the worldwide spread of a new disease. Merriam Webster (2020) defined pandemic as “an outbreak of a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population”. According to Lambert (2020), over the last century, there have been four flu pandemics, including the most recent 2009–2010 H1N1 pandemic. The deadliest pandemic, which began in 1918, was also caused by an H1N1 virus, of avian origin. Though often popularly called the Spanish flu, there is no consensus on where that virus originated and it is estimated that the pandemic caused about 675,000 deaths in the United States.

Since its first occurrence, in the very early 21st century, the epidemic of coronaviruses strikes the human population once in a while. The first instance in 2002 and the second instance ten years later in 2012. The third instance now arrived eight years later at the end of 2019. At the end of each epidemic, the virus is vanished among human population as it cannot survive for a long time on nonliving surfaces. However, the virus becomes trans-mutated into a deadlier and more complex strain each time it resurfaces in humans. On 31 December 2019, the WHO China Country Office was informed about cases of pneumonia of unknown cause, detected in Wuhan City, China. The Chinese authorities identified a new type of coronavirus, subsequently named COVID-19. On 30 January 2020, WHO Director-General declared the outbreak of COVID-19 a Public Health Emergency of International Concern (PHEIC), and on 11 March 2020, declared the outbreak a pandemic (WHO, 2020a).

The COVID-19 is not only a novel strain, but the deadliest of coronaviruses. Currently, there is no documented scientifically proven vaccine or treatment for this virus. The chances of survival among victims are therefore, simply a factor of individual immune system response and currently, all treatment and containment attempts are premised around immune response enhancement for patients.

Coronaviruses are a large family of viruses which may cause illness in animals or humans. In humans, several coronaviruses are known to cause respiratory infections ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The most recently discovered coronavirus causes coronavirus disease COVID-19 (WHO, 2019). Together with SARS coronavirus and MERS coronavirus (de Wit et al., 2016), COVID-19 is the third highly pathogenic human coronavirus that has emerged in the last two decades (WHO, 2020b).

#### **Character of COVID-19 Virus**

Coronaviruses are large, enveloped ribonucleic acid (RNA) viruses named after their corona- or crown-like surface projections observed on electron microscopy. They are zoonotic, originally carried among animals, including camels, cats and bats. It was earlier believed among scientists that coronaviruses can only exist in animals as they have never infected humans until the 2002 epidemic of SARS and the 2012 MERS were observed (de Wit et al., 2016).

The novel coronavirus (COVID-19) is a new strain that has not been previously identified in humans. According to John Hopkins University and other researchers (Cui et al. 2019), the virus is not a living organism, but a protein molecule (DNA) covered by a protective layer of lipid, which, when absorbed by the cells of the ocular, nasal or buccal mucosa, changes their genetic code and convert them into aggressor and multiplier cells. The spike protein of the virus has been imaged at the atomic level using cryogenic electron microscopy (Wrapp, et al., 2020 and Mandelbaum, 2020) and Wu et al. (2020) have found that this protein is responsible for allowing the virus to attach to and fuse with the membrane of a host cell.

The virus is not a living organism but a protein molecule (Wrapp et al. 2020). Thus, it cannot be killed, but decays on its own. The disintegration time depends on the temperature, humidity and type of material where it lies. The virus is also very fragile and the only thing that protects it is a thin outer layer of fat.

#### **COVID-19 Transmission**

Coronaviruses are zoonotic, transmitting between animals and humans, with at least seven known species infective to humans. The disease condition can be classified in to four stages: no cases, sporadic cases, clusters (home clusters and small group clusters), and community Transmission. The transmission is usually via aerosols of cough or sneezes from infected person or touching contaminated object. Cascella, et al. (2020) found that aerosol transmission is possible in case of protracted exposure to elevated aerosol concentrations in closed spaces. Person-to-person transmission has been described both in hospital and family settings (Chan, et al., 2020), and symptomatic people are the most frequent source of COVID-19 spread.

Aerosols produced by people when they breathe, talk and cough can easily float in air. These particles are mostly biological fluids from people's mouths and lungs and can contain bits of virus genetic material. Overall, the evidence from a study by Santarpia, et al. (2020) suggests that it is much riskier to be inside than outside due to the lack of airflow in an enclosed environment.

Many researchers (Otter, et al., 2016; Dowell, et al., 2004; and Gelleer, et al., 2012) have also postulated the transmission of coronaviruses from contaminated dry surfaces. Kampf, et al. (2020) found that human coronaviruses can also remain

infectious on inanimate surfaces at room temperature for up to 9 days. Persistence on different materials include plastics: 5 days, paper: 4-5days, glass: 4days, wood: 4days, steel: 48hours, Aluminum: 2-8hours, and surgical gloves: 8hours. At a temperature of 30<sup>0</sup>C or more, the duration of persistence is shorter. Veterinary coronaviruses have been shown to persist even longer than 28 days. Contamination of frequent touch surfaces in healthcare settings are therefore a potential source of viral transmission.

Although data on the transmissibility of coronaviruses from contaminated surfaces to hands are not available, studies by (Bean, et al., 1982) with influenza A virus indicated that a contact of 5 s can transfer 31.6% of the viral load to the hands. Another study (Ansari, et al., 1991), has shown that the transfer efficiency was lower (1.5%) with parainfluenza virus 3 and a 5 s contact between the surface and the hands. Furthermore, observational study by (Kwok, et al., 2015) indicated that students touch their face with their own hands on average 23 times per hour, with contact mostly to the skin (56%), followed by mouth (36%), nose (31%) and eyes (31%).

Recent studies (Qin et al. 2020) have indicated that air pollution particles do harbour microbes and that pollution is likely to have carried the viruses causing bird flu, measles and foot-and-mouth disease over considerable distances. Other researchers (Martelletti and Martelletti,2020) have also suggested that air pollution particles could help coronavirus travel further in the air. These could therefore be an indication that, in a crowded place inhabited by infected persons, the virus can remain suspended in the surrounding air environment, and may lead to widespread mild infections.

### **COVID-19 and Air Pollution**

#### **Impact of COVID-19 on Public Health**

The common symptoms of COVID-19 are fever, dry cough (after 2-7 days), mild breathing difficulties at the onset, gastrointestinal issues, diarrhea, and general body aches. The severe symptoms include high fever (100<sup>0</sup>F or higher), pneumonia, kidney failure, and death. According to WHO (2020a,b), most people infected with the virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness. WHO further stated that at this time, there are no specific vaccines or treatments for the disease, but there are many ongoing clinical trials evaluating potential treatments.

As at 16th May 2020, there are over 4.67 million infections around the world, with over 310,000 deaths and over 1.78 million recoveries. The US has highest number of confirmed cases, followed by Spain, Russia, UK, and Italy. At the same time, the US recorded the highest number of deaths, followed by UK, Italy, Spain, and France (WorldOMeter, 2020). The WHO Director-General Dr Tedros Adhanom Ghebreyesus reported that there are about 3.4% deaths out of the global reported COVID-19 cases (WHO DG, 2020). However, considering that a large number of cases are asymptomatic (or present with very mild symptoms) and that testing has not been performed on the entire population, only a fraction of the infected population is detected, confirmed through a laboratory test, and officially reported. The number of actual cases could therefore be several multiples above the number of reported cases. The number of deaths also tends to be underestimated, as some patients are not hospitalized and not tested. Thus, basing the assessment on the number of reported cases, rather than on the actual ones, could actually greatly overestimate the fatality rate.

#### **Impact of Air Pollution on COVID-19 Pandemic**

Air quality can have a significant impact on the pandemic. People who live in polluted environment are chronically exposed to contaminated air, and this exposure can compromise their lungs and hearts. Under these conditions, the rate of chronic illnesses increases, and so does the likelihood of developing a serious respiratory disease like Covid-19. The American Lung Association estimates 141.1 million people live in counties that have unhealthful levels of ozone or particle pollution (Miller, 2020). Furthermore, the association's list of cities with dirtiest air overlaps with several where Covid-19 has taken a firm hold, including Chicago, Detroit, and Los Angeles. Ogen (2020) reported that the most polluted regions of Europe are also those where Covid-19 kills the most, and that a total of 78 percent of coronavirus deaths in Europe are concentrated in the most-polluted areas of mainland Europe.

Research conducted in the US (Wu et al., 2020) shows that communities of color are disproportionately impacted by air pollutants and are more likely to face a "pollution burden." These findings are particularly true for hospitals in poor neighborhoods and communities of color, which tend to be exposed to higher levels of air pollution than affluent, white communities. The report concluded that just a slight increase in long-term pollution exposure could have serious coronavirus-related consequences, even accounting for other factors like smoking rates and population density.

If a human body is overloaded briefly, the system sometimes responds with asthmatic episodes or heart attacks. Long-term exposure can also kickstart chronic diseases, including cancer, chronic obstructive pulmonary disease (COPD), asthma, and diabetes. Strain on the lungs passes on to the heart. According to Miller (2020), if a virus adds on to an already damaged system, organs can fail. Moreover, early research on Covid-19 suggests risk of hospitalization and time in intensive care units correlates to preexisting health conditions even more than to age. The report concluded that chronic pollution exposure contributes to the burden of those conditions, and then Covid-19 becomes a stressor that causes those systems to fail.

#### **Air Environmental Impact of COVID-19 Lockdown**

After the reported case of COVID-19 in Wuhan in December 2019, the Chinese authorities shut down transportation and travel in and out of the city (Huang, et al. 2020). The authorities also curtailed and reduced local business travel, closed down schools, colleges and universities in order to reduce the spread of the disease and established numerous quarantines. As a response to the situation, many countries and regions initiated the Lockdown protocol by closing their boundaries and halting routine activities. In the Lockdown, all activities related to industrial, commercial, institutional category and transportation are totally restricted. People are required to stay at home and in extreme cases even the supplies are provided by the government. Only the emergency and essential services are allowed to function (WHO, 2020b).

Nitrogen dioxide (NO<sub>2</sub>) is a common tracer of air pollution/industrial activity, associated with morbidity and mortality (He et al., 2020). NASA (2020) report indicated that the NO<sub>2</sub> concentrations, resulting primarily from the burning of fossil fuels, prior to and following the quarantine, show a massive reduction in concentrations after the corona virus outbreak. The report indicated that the reduction in NO<sub>2</sub> pollution first apparent near Wuhan, but spread across the rest of the country, and eventually worldwide. In Central China, NO<sub>2</sub> emissions were reduced by as much as 30% (NASA, 2020). Carbon dioxide (CO<sub>2</sub>) emissions, another common tracer of air pollution, decreased by 25% in China and by 6% worldwide (CarbonBrief, 2020).

Several researchers have attempted to predict mortality due to air pollution (Chiusolo et al., 2011; Hoek et al., 2013; and He et al., 2020). Dulheil et al. (2020), using a hypothetical scenario, predicted a 6% reduction in mortality, considering only a time period of two months with a decrease in NO<sub>2</sub> air pollution in China. Similar predictions could apply to other countries. The same research (Dulheil et al. 2020) also postulated that, considering the huge decrease in air pollution following the quarantine (China's CO<sub>2</sub> emissions decreased by a quarter), the COVID-19 pandemic might paradoxically have decreased the total number of deaths during this period, by drastically decreasing the number of fatalities due to air pollution. Moreover, in addition to the reduced number of deaths due to air pollution, the reduction in air pollution itself could also have positive benefits in reducing preventable non communicable diseases (Chen and Bloom, 2019; Neira et al., 2018).

Calma (2020) also reported that air quality dramatically improved in nine major cities across the globe (including Delhi, London, Los Angeles, Milan, Mumbai, New York City, São Paulo, Seoul, Wuhan, and Rome) as people shelter in their homes to help curb the spread of the novel coronavirus. Furthermore, places typically choked with worse air pollution saw the most extreme drops in fine particulate matter, or soot. Delhi saw a 60 percent reduction in pollution over a three-week period while its stay-at-home order took effect, compared to the same period last year. Seoul, South Korea, saw a 54 percent decrease. Soot in Wuhan, China, dropped by 44 percent.

However, even though with road and air travel ground to a halt, the skies in many cities are less polluted now than they were before the pandemic, the effects of decades of exposure won't simply disappear, and this seeming improvement in air quality may be temporary.

#### **Environmental Management of COVID-19 Pandemic**

##### **Proactive Measures**

Currently, the only proven protection against the deadly COVID-19 are the widely publicized WHO (2020a,b) precautionary measures, which include; washing hands regularly with soap under running water or using alcohol-based hand sanitizers; avoidance of touching face when hands are not washed; practicing distance socializing; and avoiding handshakes and hugging as much as possible. People are also required to report to the nearest hospital immediately they feel unwell and practice self-isolation while undergoing treatment.

Since the virus is more active in people low immune system, individuals that are immune-compromised should avoid public gatherings. People should also undertake to frequently wash their hands and use portable hand sanitizer and avoid contact with their face and mouth after interacting with a possibly contaminated environment.

Healthcare workers caring for infected individuals should utilize contact and airborne precautions to include PPE such as N95 or FFP3 masks, eye protection, gowns, and gloves to prevent transmission of the pathogen.

Although the viral load of coronaviruses on inanimate surfaces is not known during an outbreak situation, it seems plausible to reduce the viral load on surfaces by disinfection, especially of frequently touched surfaces in the immediate patient surrounding where the highest viral load can be expected. The WHO recommends people to ensure that environmental cleaning and disinfection procedures are followed consistently and correctly. WHO (2020b) also noted that thoroughly cleaning environmental surfaces with water and detergent and applying commonly used hospital-level disinfectants (such as sodium hypochlorite) are effective and sufficient procedures.

WHO (2014) has suggested the typical use of bleach at a dilution of 1:100 of 5% sodium hypochlorite resulting in a final concentration of 0.05% for disinfection of surfaces. Studies by Kampf et al (2020) summarizing data with coronaviruses suggest that a concentration of 0.1% is effective in 1 min and recommended a dilution 1:50 of standard bleach in the coronavirus setting. Thus, surface disinfection with 0.1% sodium hypochlorite or 62 - 71% ethanol significantly reduces coronavirus infectivity on surfaces within 1 min exposure time, and a similar effect is expected against the SARS-CoV-2.

### **Treatment / Management of Patients**

Presently, there is no specific antiviral treatment recommended for COVID-19, and no vaccine is currently available. The current treatment is therefore symptomatic, with oxygen therapy as the only major treatment intervention for patients with severe infection. WHO (2020) has released guidelines based on scientific evidence derived from the treatment of previous epidemics from HCoV, addressing measures for recognizing and sorting patients with severe acute respiratory disease; strategies for infection prevention and control; early supportive therapy and monitoring; as well as a guideline for laboratory diagnosis; management of respiratory failure and ARDS; management of septic shock; prevention of complications; treatments; and considerations for pregnant patients.

During the provision of clinical care to an infected patient, preventive strategies should focus on the isolation of patients and careful infection control, including appropriate measures to be adopted during the diagnosis. In this regard, droplet, contact, and airborne precautions should be adopted during specimen collection, and sputum induction should be avoided.

### **Corona Pandemic Management Planning**

Since the virus is not a living organism but a protein molecule, it is not killed, but decays on its own. Good personal hygiene and proper environmental management practices are therefore essential in the control and management of the pandemic (WHO, 2020a,b). Since the virus is very fragile and the only thing that protects it is a thin outer layer of fat, any soap or detergent is the best remedy, because the foam cuts the fat. By rubbing so much for 20 seconds or more, to make a lot of foam, the fat layer dissolves, and the protein molecule disperses and breaks down on its own.

Kampf et al., (2020) and WHO (2020) have indicated that alcohol or any mixture with alcohol over 65% can dissolve any fat, especially the external lipid layer of the virus. Washing hands before and after touching mucosa, food, locks, knobs, switches, remote control, cell phone, watches, computers, desks, TV, and the like, and when using the bathroom, are also recommended. Keeping finger nails short would also reduce the chances of the virus hiding there.

Another important management tool is for the responsible authorities to consider, among others, the following measures to control the pandemic: Early identification of risk zones and districts, the affected people, and the patient-associated groups/ networks; Establishment of home-based prevention services, home-based quarantine, and open quarantine centers. Improvement of welfare services, building a strong public opinion, as well as proper counselling of quarantine patients especially those that are asymptomatic, in order for them to understand the essence of the quarantine for the protection of public health.

### Conclusion and Recommendations: -

Aerosols are the major pathway of COVID-19 transmission. Thus, wearing a face mask in any public setting where social distancing is hard to do is highly recommended. Even though masks may not be perfect, current evidence generally supports their use, and taking this small precaution could help slow the pandemic. Many commonly used items, toilet facilities, and air samples had evidence of viral contamination. This indicates that SARS-CoV-2 is shed to the environment as expired particles, during toileting, and through contact with surfaces. Hence disease spread through both direct and indirect contact are confirmed, supporting the use of airborne isolation precautions.

Following common sense and the guidance of public health officials is also important, including avoiding crowded indoor spaces as much as possible and practicing social distancing both inside and outdoors. Washing hands frequently and ensuring personal and environmental hygiene is of paramount importance in minimizing the risks.

The COVID-19 would not just disappear overnight, and we have to learn to live with it by taking the necessary precautions to control its spread. Even though lockdown have made the skies in many cities are less polluted now than they were before the pandemic, the effects of decades of exposure to air pollution would not simply disappear. The seeming improvement in air quality resulting from the lockdown may be temporary. Again, while social distancing could have an impact, and minimize the risk of COVID-19 transmission, air quality is likely to get worse again as restrictions are lifted and the economic activities resumes, unless other steps are taken. Thus, countries that have high level of air pollution need to take environmental measures as the only enduring step in controlling the pandemic.

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