COVID 19

Experiences and Climate Change

COVID experiences and Climate Change

COVID-19 Scenario

Global Scenario

The COVID-19 pandemic has been a very challenging public health crisis globally particularly due to its highly infectious nature, large scale involvement of the populations and placesall across the globe. The unprecedented health crises in the pandemic times were having observations of a rapidly spreading of the new viral infections among the people and rising number of newly and severely affected areas across the world. There wasa continuous worldwide reporting of increasing acute and severe health problems, loss of human lives, extreme hardships to health care facilities,crisis in availability of required healthcare facilities infrastructures and logistics in the form of hospital beds, masks, gloves, PPEs, ventilators, testings, reagents, skills and informations for specific management of the infected cases, awareness and skills of the healthcare professionals and workersacross the countries. This health crisis was following a report of a cluster of atypical pneumonia cases from Wuhan, China, in December 2019but was later designated as Coronavirus disease 2019 (COVID-19) on 11th February 2020. Finally, on 11thMarch 2020, the World Health Organization (WHO) had declared COVID-19 as a Global Pandemic. The causative virus is known as SARS-CoV-2, a novel strain of coronaviruses having 79% genetic similarity with SARS-CoV from the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak.

Indian Scenario

Inspite of the early precautions and preventive health advisory measuresundertaken by the Government of India in the early 2020, the COVID-19 infections started to spread rapidly across different parts of the country after the first case was reported on January 30th, 2020. Keeping public health as the utmost priority, our countryeventually declared a nationwide lockdown on 24thMarch 2020 to control and manage the highly infectious disease among the population. The nationwide

lockdown in the country was meant to control its rapid transmissionand adverse health impacts among the population and gave opportunity instrengtheningseveral public health measures to combat the pandemic crisis in the country. However, it did bring extreme hardships in all dimensions including medically, socially, economically and psychologically to all people particularly to the elderly and those with theunderlyingmedical ailments. COVID-19 pandemic highlighted the unimaginable vulnerability of health sector across the world including our country.The acutely increasing and widespread demand for healthcare services including availability of required infrastructures and logistics for managing the affected populations from across differentplaces in the country was a huge burden for the country. The country responded wholly mobilizing the available resources prioritizing COVID-19 as the utmost agenda to protect, prevent and control the disease for the people across the country.The latest information pertaining to the number of COVID-19 active cases, cured discharged statistics, and other public health-related information is reported on the Ministry of Health and Family Welfare, Government of India website (https://www.mohfw.gov.in/).

COVID-19 and Climate Change

Several studies, experiences and expert opinions on covid-19 infections were reported and sharedglobally to help combat the new pandemic of gigantic proportion. The COVID-19 infection is considered as a disease of zoonotic origin and at the same time, climate change is also known to have its indirect health impacts in the form various climate sensitive diseases like vector borne and zoonotic disease etc. Though there are no conclusive evidences to establish the COVID-19 outbreak as a direct impact of climate change, however,it is considered that there is an indirect relationship between climate change and covid-19 pandemic. Climate change is also manifested as global warming and changes in hydrometeorological conditions including rainfall, temperature, humidity etc. which can impact climate sensitive diseases of potential outbreaks. Increasing deforestation across the world is an example of major cause of climate change and can be one of the largest causes of habitat loss worldwide. This can force animals to migrate and eventually come in closer contact with humans, creating an opportunity for pathogens to get into new hosts. Livestock farms in large numbers can also serve as sources for spillover of

infections from animals to people enabling both emerging and re-emerging diseases to occur and affect the populations. Various other anthropogenic activities are increasingly projected ascontinuously disturbing the natural cycles of many phenomenon occurring in the environment and the planet. As the world adapts to a new normal, it is crucial to address the issues holistically and primarily the public health concerns including negative impacts of climate change making integral to the COVID-19 recovery action programmes.

There were many reports and incidences when the widespread lockdown undertaken during the pandemic times which brought a halt in thehuman activities including vehicular traffics, limited industrial activities etc. impacted the environment and the planetary health. This led to reports of a substantial decrease in pollution levels in the world and the country including air and water quality. In the midst of the pandemic sufferings, people in many Indian cities had the chance to breathe cleaner air again and could regain to seeclear and blue skies. However, these gains in the environmental conditions were short-lived as pollution levels increase once againas life started to return to normalcy with increasing human activities.

There are enough experiences and lessons learnt during the global health crisis of COVID-19 pandemic and strengthening the public health concerns both globally and nationally in our country can be considered among the priorities. As the country moves ahead in the new decade, it must strengthen public healthcare facilities and infrastructures, early warning systems and disease surveillance systems etc. Various environmental factors related to climate change like air pollution, water contamination, vector-borne diseases, and natural calamities are presently emerging as threats to India’s public health. All populations are affected by climate change though some are more vulnerable like elderly population, those with chronic health conditions, lower-income communities, etc. Thesegroups of vulnerable population are also disproportionately impacted by COVID-19 infections. Strengthening public health facilities and infrastructures will require considerations of building resilient healthcare systems to help protecthealth and cope adverse negative health effects from both climate change and emerging and remerging outbreaks like COVID-19.

Air pollution and COVID-19 infection

Climate change impact air pollution and conversely air pollution also impacts climate change and both can impact immensely the health of the people across the places.
One of the major environmental factors prominently seen to be reported having associated with covid-19 infections is about air pollution which itself is recognized as the identified as a major environmental risk to human health.Studies were reported that both COVID-19 infection and air pollution can have potential synergistic effect which can affect the respiratory system of our body. It has been observed that long-term exposure to air pollution is associated with an increased prevalence of health problems particularly respiratory diseases and deaths.As the pandemic spreaded and affectedvarious populations from a large number of cities and areas across the world, many researchers were increasingly reporting on the association between air pollution and COVID-19 infections. Global and Indian studies by leading academic and medical institutions have reported that people living in poor air quality areas are more likely to get affected from COVID-19. These studies have accounted for other factors that may influence death risks, such as pre-existing medical conditions, socioeconomic status, and access to healthcare services.

Some of the significant findings on the association between air pollution and COVID-19 infections are reported from studies across the world particularly from China, Italy, England, France, Spain, Germany, USA including India etc. These were the major countries where COVID-19 infections were reported large in number and severe among the affected populations. A compilation of these related studies on COVID-19 and air pollution is briefly described in the annexure

1. Air Pollution and Transmission of and infection by COVID-19

- Air pollution has exerted a positive impact on the transmission of and infection by COVID-19
- Ambient NO2 in polluted air may contribute to the spread ability of COVID-19

- COVID-19 infections are positively correlated with ground-level ozone.
- Outdoor airborne aerosols might be possible carriers of COVID-19
- Some meteorological conditions like Dry air, low winds and precipitation rates support COVID-19 virus diffusion.
- Warm-season will not stop COVID-19 from spreading.

2. Air Pollution and Hospital admissions of COVID-19 cases

- A positive relationship between air pollution and particularly PM2.5 concentrations, and Covid-19 cases, **hospital admissions** and deaths

3. Air Pollution and Mortality in COVID-19 patients

- Severe air pollution is reported to have a link to higher mortality in COVID-19 patients. This result is based on the “double-hit” hypothesis, which states that chronic exposure to PM2.5 causes alveolar ACE-2 receptor overexpression. This may increase viral load in patients exposed to pollutants, depleting ACE-2 receptors and impairing host defenses. High atmospheric NO2 may provide a second hit causing a severe form of SARS-CoV-2 in ACE-2 depleted lungs resulting in a worse
- An association is found between increases in PM concentrations and mortality rates due to COVID-19 observed in Northern Italy and the peaks of particulate matter concentrations, frequently exceeding the legal limit of 50 µg/m3 as PM10 daily average
- A positive correlation between the level of air pollution of a region and the lethality related to COVID-19

4. Long term exposure to air pollution and morbidity & mortality of COVID-19 cases

- Long-term exposure to NO2, which primarily arises from urban combustion sources such as traffic, may enhance susceptibility to severe COVID-19 outcomes, independent of long-term PM2.5 and O3 exposure.
- Long-term exposure to air pollution, especially PM2.5, has also been found to be associated with COVID-19 mortality

Some of the major health action points which may be considered in the health sector-

1. Strengthening public health facilities and infrastructures considering also climate sensitive disease or problems which can be an emerging and re-emerging health problems

2. Strengthening surveillance system for infectious and communicable diseases (ARI, febrile illness etc.) using information technology

2. Capacity building of State level programme officer/ nodal person in health responses in emergency situations

3. Identifying/ designating District level nodal person for implementation of actions mentioned in State Climate health action plan

4. Multi-stakeholder based behaviour change communication Outreached activities for reduction of emissions, climate appropriate behaviour

References studies (2020) from which inferences taken of the linkage between Air Pollution and COVID-19 infection(Inference, Source)

1. Assessing nitrogen dioxide (NO2) levels as a contributing factor to corona virus (COVID-19) fatality regional scale and combined with the number of death cases taken from 66 administrative regions in Italy, Spain, France and Germany by YaronOgen

   - *Highest NO2 concentrations combined with downwards airflow prevent an efficient dispersion of air pollution. These results indicate that the long-term exposure to this pollutant may be one of the most important contributors to fatality caused by the COVID-19 virus in these regions and maybe across the whole world*
   - . https://doi.org/10.1016/j.scitotenv.2020.138605

2. Ambient nitrogen dioxide pollution and spread ability of COVID-19 in Chinese cities by Ye Yao, Jinhua Pan, Zhixi Liu Weidong Wang, HaidongKan, Weibing Wang
   - *A significant association between NO2exposure and R0, suggesting that ambient NO2 may contribute to the spread ability of COVID-19*
   - *Effects of NO2 on host defenses that prevent the spread of the virus.*
   - https://doi.org/10.1101/2020.03.31.20048595.

3.Two mechanisms for accelerated diffusion of covid-19 outbreaks in regions with high intensity of population and polluting industrialization: the air pollution-to-human and human-to-human transmission dynamics Mario CocciaCnr -- national research council of Italy

   - *The results reveal that accelerated transmission dynamics of COVID-19 in specific environments is due to two mechanisms given by air pollution-to-human transmission and human-to-human transmission; in particular, the*

means of air pollution-to-human transmission play a critical role rather than human-to-human transmission.

- https://doi.org/10.1101/2020.04.06.20055657

4.The Potential Role of Particulate Matter in the Spreading of COVID-19 in Northern Italy: First Evidence-based Research Hypotheses by Leonardo Setti1, Fabrizio Passarini, Gianluigi De Gennaro, Pierluigi Barbieri, Maria Grazia Perrone, Andrea Piazzalunga 6, Massimo Borelli, Jolanda Palmisani3, Alessia Di Gilio, PriscPiscitelli, Alessandro Miani 8

- *Association between higher mortalityrates due to COVID-19 observed in Northern Italy and the peaks of particulate matter concentrations,frequently exceeding the legal limit of 50 µg/m3 as PM10 daily average*
- https://doi.org/10.1101/2020.04.11.20061713.

5.SARS-Cov-2 RNA found on Particulate Matter of Bergamo in Northern Italy: First Preliminary Evidence

- *An association is found between increases in PMconcentrations and mortality rates due to COVID-19.*
- https://doi.org/10.1101/2020.04.15.20065995

6. Risk of COVID-19 and long-term exposure to air pollution: evidence from the first wave in China

- *Long-term exposure to air pollution,especially PM2.5, has also been associated with COVID-19 mortality.*
- https://doi.org/10.1101/2020.04.21.20073700

7. Urban Air Pollution May Enhance COVID-19 Case-Fatality and Mortality Rates in the United States

- *Long-term exposure to NO2, which largely arises from urban combustion sources such as traffic, may enhance susceptibility to severe COVID-19 outcomes, independent of long-term PM2.5 and O3 exposure*.

- https://doi.org/10.1101/2020.05.04.20090746

8.Effects of meteorological conditions and air pollution on COVID-19 transmission: Evidence from 219 Chinese cities

- *Air pollution has exerted a positive impacton the transmission of and infection by COVID-19*
- https://doi.org/10.1016/j.scitotenv.2020.140244

9.Assessing the relationship between ground levels of Ozone (O3) and nitrogen dioxide (NO2) with coronavirus (COVID-19) in Milan, Italy

  - *COVID-19 viral infections are positivelycorrelated with ground-level ozone.*
  - *Ground level nitrogen dioxide is inverselycorrelated with COVID-19 infections.*
  - *Dry air, low winds, and precipitation rates support COVID-19 virus diffusion.*
  - *Warm-season will not stop COVID-19 from spreading.*
  - *Outdoor airborne aerosols might be possible carriers of COVID-19.*
- https://doi.org/10.1016/j.scitotenv.2020.140005

10. Air Pollution Exposure and Covid- 19 in Dutch Municipalities Matthew A. Cole, CerenOzgen, Eric Strob

  - *A positive relationship between air pollution,and particularly PM2.5 concentrations, and Covid-19 cases, hospital admissions, and deaths*
  - https://doi.org/10.1007/s10640-020-00491-4

11. Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study Xiao Wu, Rachel C Nethery, M Benjamin Sabath, Danielle Braun, Francesca Dominici

- *A small increase in long-term exposure to PM2.5 leads to a large increase in the COVID-19 death rate*
- https://doi.org/10.1101/2020.04.05.20054502

12. Coronavirus (COVID-19) related mortalityrates and the effects of air pollution in England. The research report examines the potential relationship between long-term air pollution exposure and coronavirus (COVID-19) mortality rates.

Possibility of a correlation between PM2.5 exposure and coronavirus (COVID- 19) related mortality of a similar scale to that found by Wu et al. (2020)

13. Air pollution aggravating COVID- 19 lethality? Exploration in Asian cities using statistical models Ankit Gupta, Hemant Bherwani, Sneha Gautam, Saima Anjum, Kavya Musugu, Narendra Kumar, Avneesh Anshul

- *A positive correlation between the level of air pollution of a region and the lethality related to COVID-19*
- https://doi.org/10.1007/s10668-020-00878-9

14. Severe air pollution links to higher mortality in COVID-19 patients: The “double-hit” hypothesis. Antonio Frontera, Lorenzo Cianfanelli, Konstantinos Vlachos, Giovanni Landoni

- *“double-hit hypothesis”: chronic exposure to PM2.5 causes alveolar ACE-2 receptor overexpression. This may increase viral load in patients exposed to pollutants, depleting ACE-2 receptors and impairing host defenses. High atmospheric NO2 may provide a second hit causing a severe form of SARS-CoV-2 in ACE-2 depleted lungs resulting in a worse*
- www.elsevier.com/locate/jinf

Summary of some the study findings related to air pollution effects on COVID-19 from across the world (China, Italy, US, France, India, Iran, Spain,Germany,England)

References	Study region	Study design	Period of study	Outcome
Zhang et al.	219 prefecture cities in China	Retrospective	January 24 to February 29, 2020	A positive correlation was observed between air pollution indicators and new COVID-19 confirmed cases. The SARS-CoV-2 spreading was between 5 and 7% when the air quality index (AQI) was increased by 10 units.
Zhu et al.	120 cities in China	Retrospective	January 23 to February 29, 2020	A significant positive association was found for $PM_{2.5}$, PM_{10}, NO_2, and O_3 with newly COVID-19 confirmed cases. A 10-$\mu g/m^3$ increase (lag0–14) in $PM_{2.5}$, PM_{10}, NO_2, and O_3 was associated with a 2.24, 1.76, 6.94, and 4.76% increase in the daily counts of COVID-19 cases, respectively.
Li et al.	Wuhan and XiaoGan in China	Retrospective	January 26 to February 29,	A significant correlation was observed between COVID-19 incidence and AQI in both cities

References	Study region	Study design	Period of study	Outcome
			2020.	(p < 0.01). The incidence of COVID-19 was highly correlated with $PM_{2.5}$ and NO_2 in both cities.
Lin et al.	29 Provinces in China	Retrospective	January 21 to April 3, 2020	Higher ambient CO concentration was a risk factor for the increased spreading of SARS-CoV-2, while higher temperatures, efficient ventilation and air pressure reduced its transmissibility.
Yao et al.	Whuan in China	Retrospective	January 19 to March 15, 2020	After adjusting to temperature and relative humidity, SO_2, NO_2, CO, and O_3, the case fatality rate (CFR) was positively associated with $PM_{2.5}$ and PM_{10}.
Jiang and Xu	Wuhan in China	Retrospective	January 25 to April 7, 2020	A significant positive correlation (p < 0.01) was observed between AQI especially $PM_{2.5}$ and the daily COVID-19 deaths.

References	Study region	Study design	Period of study	Outcome
Pansini And Fornnaca	China,France, Germany, Iran,Italy, Spain,UK and the USA	Retrospective	NA	Increased SARS-CoV-2 infections were observed in the regions where high levels of $PM_{2.5}$ and NO_2 were present. A significant correlation was found between the levels of air quality with COVID-19 spread and mortality in six countries except for Spain and Germany.
Travaglio et al.	England	Retrospective	As of April 10, 2020	The markers of poor air quality, such as NO and SO_2 were associated with an increased rate of COVID-19 related deaths across England, after adjustment of population density.
Konstantinoudis et al.	England	Retrospective	As of June 30, 2020	An increase of 0.5% and 1.4% in COVID-19 mortality rate was observed for every 1 µg/m3 increase in NO_2 and $PM_{2.5}$,

References	Study region	Study design	Period of study	Outcome
				respectively.
Magazzino et al.	3 cities in France	Retrospective	NA	This study showed a direct relationship between air pollutants ($PM_{2.5}$ and PM_{10}) and COVID-19 fatality.
Ogen	France, Germany, Italy, Spain	Retrospective	January to February 2020	About 78% of deaths occurred in just five regions of northern Italy and central Spain, where NO_2 were present at the highest concentrations combined with downward air pressure.
Mele and Magazzino	25 cities in India	Retrospective	January 29 to May 18, 2020	In machine learning (ML) analysis with Causal Direction from Dependency (D2C) algorithm, a direct relationship was found between the concentration of $PM_{2.5}$ and COVID-19 mortality.
Zoran et al.	Milan, Italy	Retrospective	January 1 to April	COVID-19 infections showed a positive

References	Study region	Study design	Period of study	Outcome
			30, 2020	correlation with ground level O_3. However, ground level NO_2 was inversely correlated with COVID-19 infections. Outdoor airborne aerosols might be the possible carriers of COVID-19 transmission.
Zoran et al.	Milan, Italy	Retrospective	January 1 to April 30, 2020	Daily new cases of COVID-19 were positively related to PM and AQI. Dry air supports SARS-CoV-2 transmission. Warm-season may not have a role in spreading viral infection.
Fattorini and Regoli	Italy	Retrospective	As of April 27, 2020	Long-term air-quality data showed a significant correlation with COVID-19 cases in 71 provinces in Italy, provided further evidence that chronic exposure to air pollution may influence the viral spreads.

References	Study region	Study design	Period of study	Outcome
Setti et al.	110 Provinces in Italy	Retrospective	February 24 to March 13, 2020	A significant association has been observed between the geographical distribution of daily PM_{10} exceedances and the initial spreading of COVID-19 in the Italian provinces.
Coker et al.	Northern Italy	Retrospective	January 1 to April 30, 2020	A positive association was observed between ambient $PM_{2.5}$ concentration and excess COVID-19 related mortality. A one-unit increase in $PM_{2.5}$ concentration (µg/m3) was associated with a 9% increase in the COVID-19 related fatality.
Frontera et al.	Italy	Retrospective	As of March 31, 2020	A high number of COVID-19 cases were found in the most polluted regions and the affected patients required ICU admission. The mortality was two-fold

References	Study region	Study design	Period of study	Outcome
				higher in these polluted regions than the other regions.
Coccia	Northern Italy	Retrospective	As of March 17, to April 2020	An association was observed between accelerating and vast diffusion of COVID-19 and air pollution. This study demonstrated that contaminated air accelerates the transmission of the SARS-CoV-2 to humans other than the transmission from human to human.
Vasquez-Apestegui et al.	20 districts in Lima (Peru)	Retrospective	As of June 12, 2020	The higher rates of spread of COVID-19 in Lima were associated with the previous long-term $PM_{2.5}$ exposure.
Andree BPJ	355 municipalities in the Netherlands	Retrospective	As of March 31, 2020	$PM_{2.5}$ was a highly significant predictor of COVID-19 cases and the related hospital admissions. It was also observed that COVID-19 cases were increased by almost

References	Study region	Study design	Period of study	Outcome
				100% when pollutant concentrations were increased by 20%.
Hendryx and Luo	USA	Retrospective	As of May 31, 2020	In regression analyses, COVID-19 prevalence and mortality rates were significantly associated with greater diesel particulate matter (DPM).
Wu et al.	3000 counties in the U.S.A.	Cross-sectional	As of April 04, 2020	An increase of only 1 $\mu g/m^3$ in long-term $PM_{2.5}$ exposure is associated with an 8% increase in the COVID-19 fatality rate.
Adhikari and Yin	New York, USA	Retrospective	March 1 to April 20, 2020	Short-term exposures to ozone and other meteorological factors could be associated with COVID-19 transmission and initiation of the disease, but disease aggravation and fatality depend on other factors.
Bashir et al.	California,	Retrospective	March 4	Air pollutants such as

References	Study region	Study design	Period of study	Outcome
	USA		to April 24, 2020	PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO showed a significant correlation with the COVID-19 epidemic.