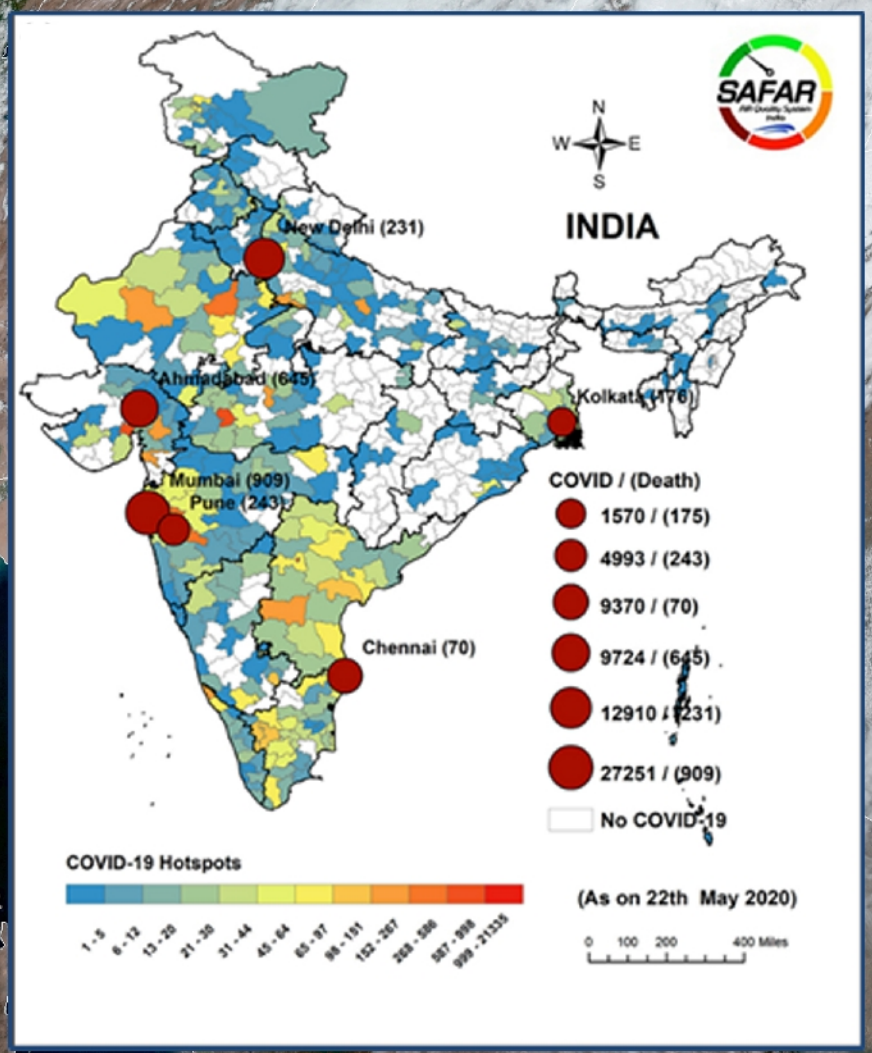
ENVIS-IITM NEWSLETTER

Indian Institute of Tropical Meteorology, Pune

Atmospheric Pollution & Climate Change

(The project of Ministry of Environment, Forest & Climate Change, Govt. of India)

Environmental Weather Marker & Covid 19



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Contents

Editorial

Air pollution is a major problem of recent decades, which has a serious toxicological impact on human health and the environment. The global outbreak of coronavirus disease 2019 (COVID-19) is affecting every part of human lives, including the physical world. The measures taken to control the spread of the virus and the slowdown of economic activities have significant effects on the environment. Therefore, this document aims to explore the positive and negative environmental impacts of the COVID-19 pandemic with reference to environmental weather markers explored in Indian mega cities.

- Dr. Gufran Beig

Environmental-weather markers and COVID 19

Air Pollution and COVID 19

The COVID-19 is a highly transmittable and pathogenic viral infection caused by Severe Acute Respiratory Syndrome Corona virus- 2 (SARS-CoV-2), which said to be emerged in Wuhan, China and spread around the world. To slow down the spread of virus, whole world adopted the lockdown by means of restriction of human mobility.

The imposition of lockdown stopped all the commercial activities that greatly affect the various environmental parameters which are directly connected to human health. As all types of social, cultural, economic and industrial activities suddenly shut off, nature took the advantages and showed improvement in the quality of air, cleaner rivers, less noise pollution, undisturbed and prospering wildlife.

One such important parameter is particulate matter (PM) called PM2.5 which is one of the most dangerous air pollutants and also a group-I carcinogens. PM2.5 is so small that it can travel from lungs to blood stream which will not only cause respiratory problems but also heart attack and can also cause early deaths. 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).

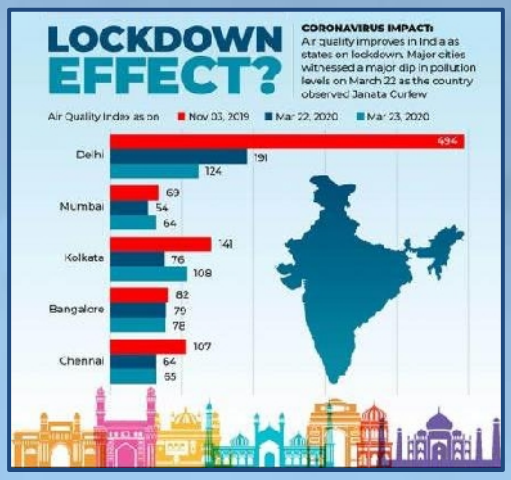
The baseline concentrations of PM2.5 in many cities in the world is above one hundred, measured in micrograms per cubic meter. After COVID-19-induced lockdown, the level of PM2.5 has decreased drastically and thousands of lives have been protected from its worse impacts. This could only be made possible for the first time due to the unprecedented COVID-19 lockdown emission scenario. This newsletter will give you the observations regarding baseline permanent

levels of two most toxic air pollutants in top ranked mega cities of India and association of COVID-19 spread with different environmental weather markers.

Many research studies found that, several confounding factors for the pandemic has strong association of COVID-19 mortality with baseline PM2.5 levels (80% correlation) to which the population is chronically exposed and may be considered as one of the critical factors. It was found that COVID-19 morbidity is found to be moderately anti-correlated with maximum temperature during the pandemic period (- 56%).

Air pollution is a major concern of new civilized world, which has a serious toxicological impact on human health and the environment. It has a number of different emission sources, but motor vehicles and industrial processes contribute the major part of air pollution. However, in recent times, the outbreak of novel coronavirus (COVID-19) has become a global public health challenge and it's ever-increasing in India. The spreading influences of COVID-19 have been diverse across the state of India. This could be due to various factors like population, testing capabilities, and enforcement of lockdown measures, etc. Recent study reported the association of COVID-19 with air pollutants such as NO2, PM2.5 and its obvious link as population density. In other countries e.g. in London the level of nitrogen oxide is reported to be closely associated with traffic density, which is correlated with population density, so that's exactly the association one would expect to find.

The latest report (World Air Quality Report, 2019) suggests that India has the most cities with high air pollution levels. Although, there are many factors which regulates the lethality of COVID-19 like underlying health conditions, age, their sex, variation in prevention policies across regions, reporting system of infects/deaths and strategy to deal with crisis.



Nevertheless, the majority of European cities and western world have much lower levels of ambient air pollution but still the death rates reported are found to be relatively much lower in India. What is more shocking is if we go by the reported logic then the population who have spent decades living in a polluted city such as Delhi should be more susceptible to virus mortality. However, data so far indicates that it is not true as many less polluted Indian cities have much higher rates of COVID-19 related deaths as compared to Delhi. As for example, Mumbai where pollution level is significantly lower as compared to Delhi the COVID-19 related deaths are higher. Hence, more research is needed in India to explore the actual cause and understand the role of other environmental markers in Indian environment.

To better understand the adverse health effects associated with air pollution, accurate exposure assessment is essential. Some cities may be highly polluted but the health outcome will depend on the exposure. In general, pollution exposure greatly varies from person to person based on his/her movement and activity levels. Hence, the population is not necessarily exposed to uniform ambient high or low levels all the time.

On the other hand, the changes in the prevailing weather conditions may be a considerable factor to have a contribution in COVID-19 related mortality and morbidity. Several studies have been done to understand the impact of weather parameters such as temperature, winds, humidity, and solar radiation on the COVID-19 related cases in recent time. However, no detailed investigation is done in Indian tropical environment. In Indian mega cities PM2.5 and NO2 which are hazardous and major air pollutants. As per the recent research information which focuses on understanding the association of COVID-19 related mortality and morbidity with various other environmental and weather parameters like temperature and long-term ambient levels of pollution in search of an environmental marker which can be considered closely associated with COVID-19. In India 6 major mega cities considered to be pollution hot spots namely, Delhi, Mumbai, Ahmedabad, Pune, Kolkata and Chennai.

Indian mega cities and geographical distribution of COVID 19

In India **Delhi** is a highly urbanized landlocked city situated at an elevation of 216 m above sea level and covers an area of 1483 sq. km. with a population of about 17 million and it is rapidly growing. Due to the proximity to the Arabian sea **Mumbai** has a humid weather, Mumbai is at an elevation of about 14 m above sea level and has a population of 12 million and surrounded on 3 sides by ocean.

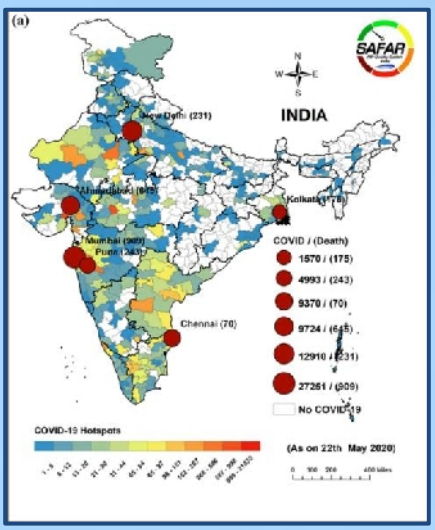


Figure.1 The geographical distribution of COVID-19 infectious counts in India as on 22nd May' 2020. The mortality counts in all six major Indian mega cities are represented by filled circles. The number in the bracket after the city name and after the infection counts in legend represents the total mortality count as on 22nd May 2020.

Pune is located in the Western Ghats of Sahyadri mountain range and at 559m above mean sea level with a population of approximately 9 million. **Ahmedabad** has a tropical semiarid climate located at an elevation of about 53 m above mean sea level having a population of over 5 million.

Kolkata is located in the eastern part of India. It has spread linearly along the banks of the Hooghly River. The city is near sea level, with the average elevation being 17 feet. The

whole area in the Ganges Delta starts within 100 km south of the city. Most of the city was originally marshy wetlands, remnants of which can still be found especially towards the eastern parts of the city. Kolkata has a subtropical climate with a seasonal regime of monsoons. It is warm year-round, with average high temperatures ranging from about 27 °C in December and January to nearly 38 °C) in April and May.

Another mega city of India, **Chennai** is located at 13.04°N 80.17°E on the southeast coast of India. It is located on a flat coastal plain known as the Eastern Coastal Plains. The city has an average elevation of 6 m. Chennai features a tropical wet and dry climate. Chennai lies on the thermal equator and near the coast, which prevents extreme variation in seasonal temperature.

Association of COVID-19 with air pollution led by PM2.5, NO2 in Indian mega cities

Due to rapid globalization and urbanization, megacities in developing nations are facing severe health issues due to ambient air pollution. Numerous epidemiological studies in the past two decades have highlighted outdoor air pollution as a cause of various respiratory diseases such as asthma, premature deaths and cardiovascular diseases. These have been identified as primary causes of mortality. In such cases, the population living in the vicinity of major roadways in metropolitan cities suffers the most. In urban areas, 80% of people live in concentrations exceeding the WHO limits. Motor-vehicle emitted compounds in urban areas which include carbon monoxide (CO); nitrogen oxides (NOx); coarse (PM10), fine (PM2.5), and ultrafine (PM0.1) particle mass, black carbon, polycyclic aromatic hydrocarbons and benzene which are found in elevated concentrations in metropolitan cities.

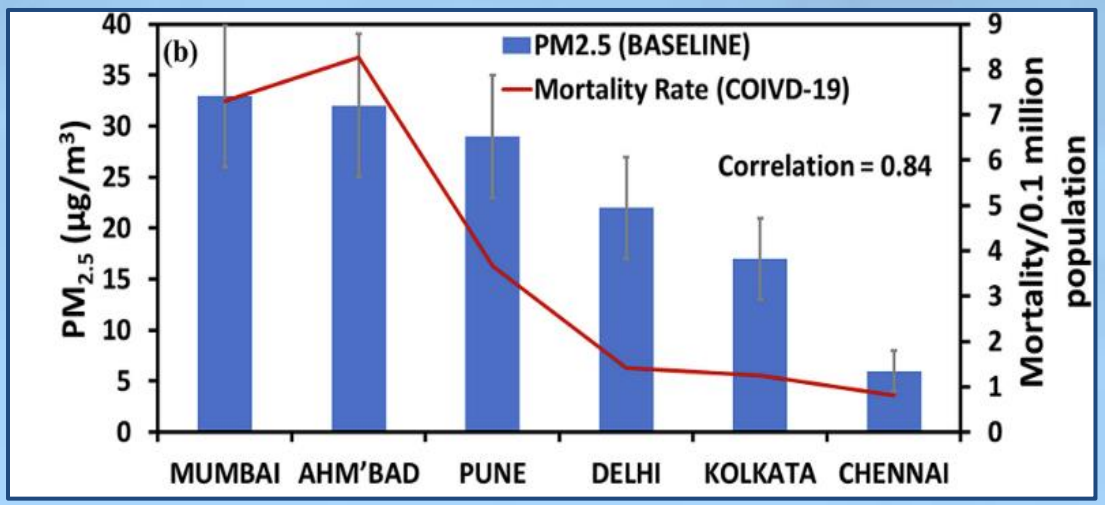


Figure.2 The PM2.5 baseline level and mortality per 0.1 million population in each of 6 city where the correlation is found to be 0.84 with 95% confidence level

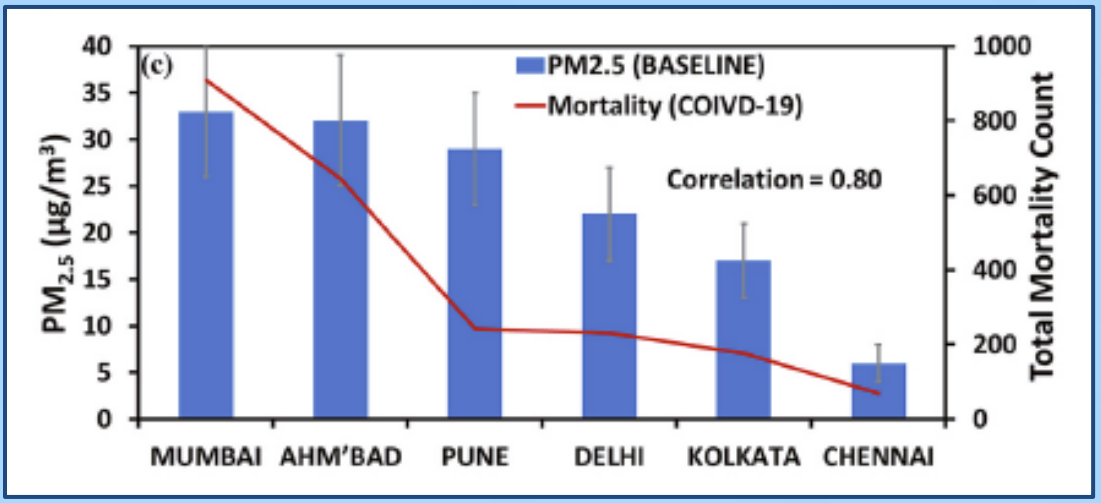


Figure. 3 The PM2.5 baseline level and total mortality counts in each city. The correlation in these 2 parameters is found to be 0.80 with 90% confidence level.

Moreover, studies suggest that particulate matter and NO2 levels are higher in cities with greater transportation activity and urban backgrounds. PM10 and PM2.5 are the two primary particulate matters monitored all over the world. However, PM2.5 possesses a higher health risk as compared with PM10 because of its high retention time and ability to penetrate deep into the lungs and enter the bloodstream. The WHO ambient air quality guidelines suggest an annual mean PM2.5 concentration limit of 10 µg/m3 and 25 µg/m3 for the 24-hourly mean. The NO2 limit is 40 µg/m3, and 200 µg/m3 for the annual and 1-h mean, respectively (World Health Organization 2005).

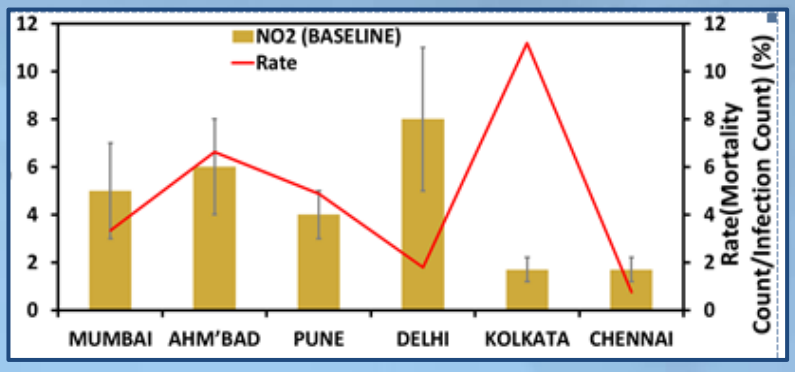


Figure. 4 The PM2.5 baseline level and mortality rate counts in each city

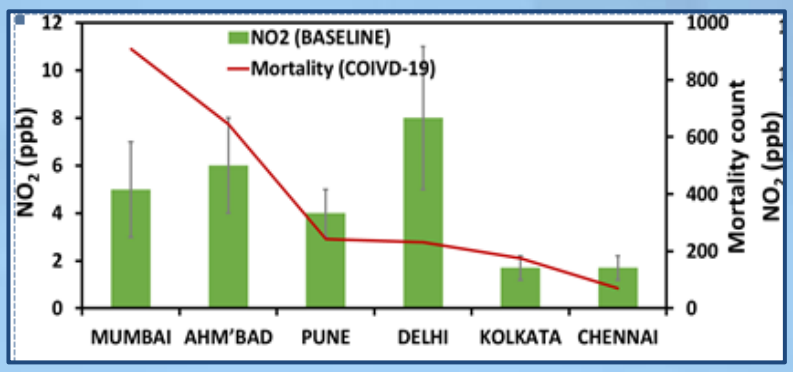


Figure. 5 The correlation plots of NO2 with COVID-19 related mortality and infection counts, mortality and infection rate per 0.1million population in six different Indian mega cities

In the lockdown period, PM10, PM2.5, and NO2 concentrations were reduced gradually. During the unlock period, the Indian government allowed limited resumption of many activities including opening up of shopping malls and restaurants and running of road and rail transport on a few selected routes to gear up economic growth. People came out of their homes and got involved in many activities, which affect on pollutant concentration which results increased air pollution. In this pandemic major findings are consistent, highlighting the important contribution of PM2.5 and NO2 as triggering of the COVID-19 spread and lethality. According to recent research, a 1 µg/m3 increase in air PM2.5 corresponds to a 15% increase in the mortality rate from COVID-19.

Therefore, patients who have been exposed to polluted air for a prolonged period of time are at higher risk of death from complications related to coronavirus than others who have lived in areas with cleaner air. PM2.5, therefore, can greatly aggravate the symptoms of COVID-19 infection, significantly increasing the risk of mortality in patients affected by the virus. The correlation between concentrations of PM2.5 and COVID-19 deaths is closely connected.

Covid-19 and Environmental weather markers

With the help of epidemiological data, recent research indicates that the environmental conditions may possibly affect the COVID-19 outbreak. The data which is shown in table below which has taken from the project- "System of Air Quality and Weather Forecasting and Research (SAFAR)" of Ministry of Earth Sciences, Government of India that is also adopted as a pilot project of World Meteorological Organization (WMO).

Table 1 COVID-19 &Environmental weather markers

MARKERS	MUMBAI	AHM'BAD	PUNE	DELHI	KOLKATA	CHENNAI
Latitude, Longitude	19.07°N, 72.87°E	23.02°N, 72.57°E	18.52°N, 73.85°E	28.70°N, 77.10°E	22.57°N, 88.36°E	13.08°N, 80.27°E
Population Density (per km²)	20482	4217	5600	11297	24252	26903
Mortality Counts	909	645	243	231	176	70
Infection Counts	27251	9724	4993	12910	1570	9370
Mortality/0.1 million population	7.3	8.3	3.7	1.4	1.3	0.8
Infections/0.1 million population	219	125	75	79	11	108
$PM_{2.5}$ (µg/m³) Baseline Level	33 ± 7	32 ± 7	29 ± 6	22 ± 5	17 ± 4	6 ± 2
NO_2 (ppb) Baseline Level	5 ± 2	6 ± 2	4 ± 1	8 ± 3	1.7 ± 0.5	1.7 ± 0.5
Temperature-Max (March-May 2020) (°C)	32.5	40	37	37	35.5	36
Wind speed (Average) (23 Mar- 22 May 2020) (km hr⁻¹)	11.4	8.3	2.6	6.4	10.5	11.9
Relative Humidity (Average) (23 Mar - 22 May) (%)	69	35	51	56	70	75

The SAFAR data is used for 4 Indian cities, namely, Delhi, Mumbai, Ahmedabad and Pune. Data of Chennai and Kolkata are collected as part of SAFAR national wide network project MAPAN (Modeling Atmospheric Pollution and Networking) and that of Central Pollution Control Board. The data of mortality and infectious cases related with COVID-19 in India are taken from India's Ministry of Health and Family Welfare.

Delhi recorded relatively fewer deaths as compared to many cities in India. Although normal ambient pollution level is highest in Delhi but the baseline levels of PM2.5 is much lower in Delhi as compared to Mumbai, Pune, and Ahmedabad. The death count is maximum (909 as on 22nd May) in Mumbai as PM2.5 baseline level is highest (~33 µg/m3) where as it is comparatively very low (22 µg/m3) in Delhi where Death counts is relatively low at 231 around the same period.

This mortality count of Delhi is even lower than that of relatively less polluted cities like Pune or Ahmedabad because the baseline levels of later 2 cities are higher than that of Delhi. It shows a significant rise in the fatality in people with underlying conditions because of chronic exposure to baseline air pollution levels rather than averaged ambient air pollution levels for PM2.5 and shown in Figure 2 & 3.

Baseline air pollution level seriously weakens the immune system, compromising people's ability to fight off infection as they are chronically exposed to it. Further, such chronic exposure represents one of the most well-known causes of prolonged inflammation, eventually leading to an innate immune system hyper-activation. It's also making people more vulnerable to infection, illness, and premature death.

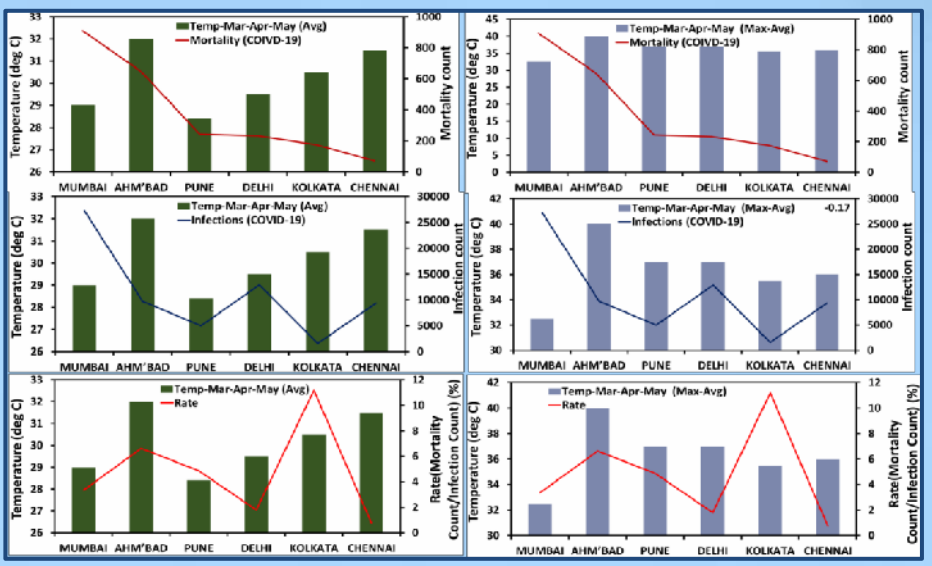


Figure. 6 The correlation plots of averaged temperature during the lockdown with that of COVID-19 related mortality and infection counts, mortality and infection rate per 0.1million population in six different Indian mega cities

This implies that people with the greatest long-term chronic pollutant exposure are the most vulnerable to COVID-19 related mortality.

The morbidity and maximum temperature of the day during the pandemic period so far (March to May) in different cities of India are found to be anti-correlated. It indicates that higher the maximum temperature, probability of infection due to COVID-19 reduces and the population is less susceptible to be infected.

However Mumbai is the hot spot region for infections with a maximum count of 27,251 where Time of maximum concentration observed is lowest among these 6 cities. It also shows the the inverse relationship between temperature and humidity along with COVID-19. As per the recent study the colder and drier atmospheres are more favorable conditions for virus survival and temperature and relative humidity are negatively associated with the daily new infection cases and daily new mortality due to COVID-19 and the association of COVID-19 with rest of the weather markers are insignificant and no correlation is noticed with wind speed.

However, that the low wind speed in the atmosphere support to viral transmission and severity in several proposed ways. As per the analysis the respiratory droplets remain suspended for a long time and can make aerosol transmission at low relative humidity. One of the reasons the study does not show significant correlation of COVID-19 with wind speed may be attributed to higher wind speed during summer months in India mega cities as evident from Table 1.

It concluded that, people having exposure to higher baseline levels of particulate pollution are at greater risk of dying from COVID-19.

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