Comparative study on air quality status in Golden Quadrilateral cities before and during the COVID-19 lockdown period.

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Abstract

The COVID-19 pandemics have affected every aspect of the human race and world economy. The disease has been contaminated in almost every part of India. A threat for poor standards induced premature mortality from cardiovascular disease and respiratory diseases. Amongst the huge reaching implications of the continuing COVID-19 outbreak, a significant enhancement in air quality was detected all around the globe after lockdowns enforced in several cities in India. The lockdown influenced the environment's pollution level and improved air quality quickly due to very few human activities. The present work scientifically analyses the air pollutants (PM2.5, PM10, NO2 and SO2) with meteorological parameters in the golden quadrilateral cities. The purpose of this paper is to review the analysis of air quality of golden quadrilateral cities (Delhi, Kolkata, Chennai and Mumbai). Data of air quality parameters are collectively taken from different locations from different regions of Delhi, Kolkata, Chennai and Mumbai before lockdown and during lockdown and compared the data of both the periods. Comparison pre-lockdown and 2019 with respect lockdown and 2020 respectively shows huge reduction in amounts of pollutants. Our objective is to find the implication of different lockdown measures on air quality levels in Delhi, Kolkata, Chennai and Mumbai particularly this investigation is focused on PM2.5, PM10, NO2, SO2 which is directly transmitted by human action and formed through chemical reaction in the atmosphere as well as quantify the short range and long-range health impact.

Keywords: **Air quality index, Covid-19, concentrations, Golden Quadrilateral**

1. Introduction

According to the World Urbanization Prospect 2018 Revision Report forecasted that, the megacities of Asia and Africa's are likely to experience about 90% growth of its population by 2050. Delhi is one of the major polluted megacities globally based on the environment performance index. Delhi positions high in the list of PM2.5 concentrations. It is expressed very high-level and it is excessively tolerable limit as per National Ambient Air Quality Standards (NAAQS) (Mohan and Kandya, 2007; Kumar et al., 2017). Kolkata is one of the big metropolitan areas in India. It is the sub-cultural and commercialized Centre of east India. The capital of West Bengal lies on the bank of Hooghly river about 75 kilometers from Bangladesh. The third city which we took in is Chennai, the capital of the state of Tamil Nadu. It is a vital and busy port city.

Apart from business, transportation industry, shipping, chemical industry, medical facilities etc from the origination of the economy for Chennai. Epidemiological studies from India show a high rate of respiratory and cardiovascular disease in general populations vulnerable to particulate matter (PM), Nitrogen dioxide and Sulphur dioxide and Mumbai formerly called Bombay. Mumbai is the capital of Maharashtra. As per stated by the United Nations of 2018 Mumbai is the second most populated city in the country after Delhi as well as seventh most populist city in the world having a population of roughly 20 million. In accordance to Indian government population demographics of 2011, Mumbai was an overpopulated urban area in India with an approximated population of 12.5 million alive under Municipal Corporation of Bombay. Air pollution is one of the major environmental health hazards in the world. Due to exposure to air pollution, globally seven million people die prematurely every year. According to the World Health Organization's recommendation (WHO 2020) more than 91% of the globe lives in places where air pollution exceeds. PM2.5 is a frequent source for negative health effects such as chronic obstructive pulmonary diseases (COPD) and lower respiratory infection (LRI). It causes the death of nearly three million people globally (GBD 2018). NO2 is the preliminary root cause of asthma in children in the urban areas across the globe. (Achakulwisut et al. 2019). Similarly, acute chronic exposures to SO2 and PM10 may injury the human respiratory system, triggering respiratory issues including occasional death (Chen et al. 2007, Brown 2009). Meteorological parameters play an important role in emissions, transportation, formations and depositions of air pollutants. It affects both directly and indirectly the ambient air pollution. A variety of research analyses related to climate and atmospheric contamination set a standard to establish associations with meteorological conditions and air pollutants. These analyses have provided information that air pollution is affected by meteorological factors such as relative humidity and atmospheric temperature. The major significant function of meteorological parameters is the disintegration,, transformation changes and removal of air pollutants from the atmosphere. Meteorological factors and Air quality are closely connected through the atmospheric chemical reactions and dynamic processes. As a result, knowing the transitional enhancement of air quality standards at the planetary scale provides a prominent opportunity to study processes and implications of policy changes to reduce air pollution in the coming time.

2. Literature Review

A standardized evaluation of literature on the effect of air quality on human health. Air pollution has increased Exponentially due to overpopulation, industrialization, globalization, urbanization, and a bad transportation system. There are different parameters taken for the analysis effect of complete lockdown. PM2.5, PM10, NO2, SO2. Due to this there are various short term and long-term effects like pneumonia, skin infections, nausea. There are several long-term effects like Lung cancer, bronchitis, respiratory problems. So, we have observed a reduction in 2020 with respect to 2019. The aim of this paper is to evaluate the literature related to the analysis of air quality of golden quadrilateral cities (Delhi, Kolkata, Chennai and Mumbai). Data of air quality parameters are collectively taken from different locations from different regions of Delhi, Kolkata, Chennai and Mumbai before lockdown and during lockdown and compared the data of both the periods. We found in comparison to 2019 data with respect to 2020 there is huge reduction in amounts of pollutants. The main objective carrying out this literature review is to collect the correct information and we more understanding the topic of this research.

3. Material and Methods

3.1 Site selections

Our present study uses a comprehensive air quality data of four Indian cities i.e. Delhi, Kolkata, Chennai and Mumbai. Air quality data was collected from different station (Bawana, Jahangirpuri and Wazirpur) of Delhi city, (Jadavpur, Victoria and Fort William) of Kolkata city, (Alandur Bus Depot, Manali Village, Manali) of Chennai city and (Kurla, Worli and Powai) of city Mumbai. The location is selected on the basis of availability of the data. Data is taken from CPCB and SPCB.

Table 1 shows geographical location, population density and number of monitored stations.

City	Population (in millions)	No. of station Monitor	Geographical Coordinates
Delhi	18.62	3	29º03' N 76º06'E
Kolkata	4.5	3	22.5726°N 88.3639°E
Chennai	11.5	3	13°04′57.7″N 80°16′14.5″E
Mumbai	12.5	3	18°58′30″N 72°49′33″E

3.2 Parameters for analysis

The parameters considered for the analysis of the effect of lockdown are PM2.5, PM10, Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2). These pollutants have a relationship with the meteorological parameters (Kayes et al. 2019).

3.3 Data Collection

To examine the impacts of lockdown on air quality, the data from four different Indian cities Delhi, Kolkata, Chennai and Mumbai located in Indian regions, respectively were analyzed. The air quality data for three stations of Delhi, three stations of Kolkata, three stations of Chennai and three stations of Mumbai from period 28 February 2020 to 31st May 2020 and 25th March 2019 to 31st May 2019 was obtained from Central Pollution Control Boards (CPCB), WBPCB and TNPCB. Delhi, Kolkata, Chennai and Mumbai are metro cities of India that are enlisted in most polluted cities of the world. The industrial emissions and regular traffic are one of the two main factors of air pollution in Delhi, Kolkata, Chennai and Mumbai etc. The health merit described as short term and long term avoided mortality from PM2.5 PM10, NO_2 and SO_2 exposure linked with the intervention carried out to control the COVID-19 pandemic were measured.

3.4 Air Quality Index

Air Quality Index is a device which is a useful connection of air parameters status of a region to an individual in terms that are easy to understand. It is applicable for decision making in several metro cities of Nations. It converts complicated air quality data of diverse contaminants into a singular number (index value) and color, whichever comes under a one of the six AQI categories, namely good, moderately polluted, Poor, Very Poor, Severe and Hazardous with their associated health impacts, which are presented in an easily distinguishable color scheme (Table 2).

Table 2: AQI categories and associated health impacts

AQI Value	Air Quality	Associated Health Impacts
0-50	Good	People are no longer exposed to any risk
51-100	Moderate	Slight breathing inconvenience to sensitive people
101-200	Poor	Respiratory discomfort to people with lungs, asthma and heart illness
201-300	Unhealthy	Respiratory discomforts to most people on longed exposure.
301-400	Severe	Breathing and Respiratory diseases on prolonged exposure.
401-500	Hazardous	Affect healthy people and also seriously affects those having existing disease.

Source: CPCB

4. Results and discussion

The data of air quality parameters PM2.5, PM10, NO2 and SO2 were taken for three locations of Delhi, three locations of Kolkata ,3 locations of Chennai and three locations of Mumbai before lockdown and during lockdown period which shows huge reduction of pollutant. In comparison of 2019 data, some percent reduction of pollutants in 2020. Analysis has been done between Delhi, Kolkata, Chennai and Mumbai during lockdown period followed by comparative assessment between four cities.

4.1 Short-Term Effect:
The short-term effect plays an extensive role in public health. Sewer systems, garbage, factories, bad transportation systems and industries produce bad smell and their odors are less serious but still unpleasant which are generally responsible for air pollution. Their effects will be temporary which includes sickness such as bronchitis and pneumonia. They include discomfort for example-irritation to the throat, noses, eyes and skin. Environmental injurious pollution causes dizziness, headache and nausea. Short-term effect on health due to the vulnerability of air pollution which are very critical aspects of environmental epidemiology.

4.2 Long Term Effect:

Environmental deterioration due to anthropogenic pollution has become a chronic problem everywhere on this globe. It is exposures to air pollution which is correlated with chronic bronchitis, lung cancer, mortality, respiratory disease and markers of atherosclerosis (Cropperetal.1997; Kumaretal.2010; Public Health and Air Pollution in Asia [PAPA], 2011; Balakrishnanetal.2013; Ghosh & Mukherjee 2014; Tobolliketal.2015; Gawande etal.2016; & Majietal.2016). A crucial number of new research studies on long-term air pollution exposure, covers an extensive range of the geographic region of India. The recent studies support the positive associations between ambient contaminants PM10, NO2 and SO2 and higher risks of mortality. The consolidated results evaluate that the excess risk per 10 μg/m3 increase in PM10 exposure. The Final research studies provides an evidence that long-term exposure to ambient air pollution in India is linked with asthma case which reduced lung function, cardiovascular deaths, early premature death, non-trauma death, respiratory deaths and lung cancer (Cropperetal.1997; Pandey,et.al. 2005;Sehgalet al. 2015 & Gawande,et al. 2016). In addition, case fatality also depends on age, preexisting cardiovascular disease, obesity, low-socioeconomic status smoking, and other individual factors etc differences affecting exposure (Stockfelt, 2017).

**4.3 Comparative analysis and discussion between Delhi, Kolkata, Chennai and Mumbai**

By several analyses have been conducted of various pollutants (PM2.5, PM10, NO2, SO2,). The contaminants which carry out from many sources concentrate in a particular region. It mostly depends on meteorological factors. Local weather conditions play a vital role to identify the contaminants or the intensity of air pollution. The quantity of air pollution can be changed because of differences in meteorological conditions. The emitting pollution may be identical however weather that can stimulate air pollution incidents. The main factor which influencing the concentration of PM2.5, PM10, NO2, SO2, have been identified as ambient temperature, relative humidity however 12 selected stations in Fig 2 showing pollution level in 2019 and 2020 during lockdown period tend to shows huge amount of reduction in the concentration of PM2.5, PM10, NO2, SO2, caused by lockdown constraint.

Delhi pollution % reduction in 2020 with respect to 2019 during lockdown of PM 2.5, PM10, NO2, SO2 are 41.84%, 60.48%, 36.78% and 63.46% respectively good. Initially the lockdown was implemented for only three weeks, starting from March 2020, the pollution level of Delhi has considerably reduced as in fig 1 (a). During the period of study, the level of PM2.5, PM10, NO2, SO2 concentration have shown significant declining trends as in (Table 3 Delhi average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 2020). Some studies show that higher temperature promotes the photochemical reactions with PM2.5 but in case of lockdown it little promotes the photochemical reaction. Nitrogen dioxide along with VOCs combined with ultra fine dust and other oxidants became one of the serious air contamination issues in metro cities across the globe. The situation will improve again in the coming days due to strong wind and rain. Delhi is anticipated to breathe comparatively cleaner air till November. Delhi Air quality Index is significantly improved. By analyzing it is concluded that the concentration of Nitrogen dioxide in the sky of New Delhi is clearly visible during the lockdown than a few months ago.
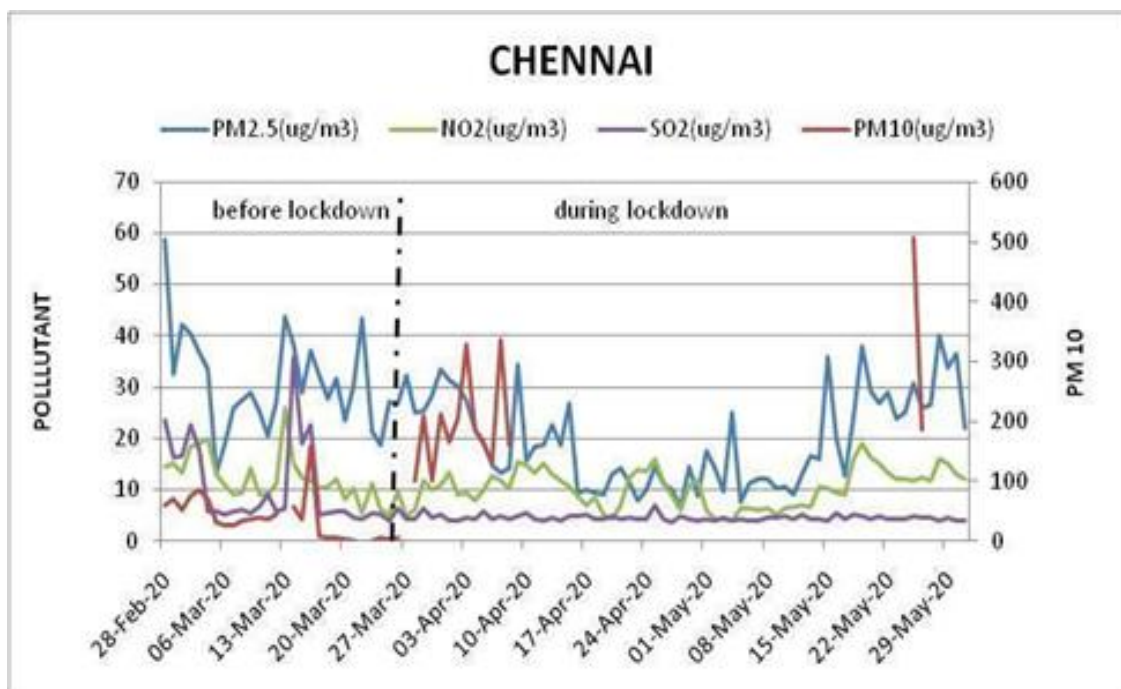
People are now breathing pollution free air. India. Wind speed, temperature are moderately correlated which shows considerable decline during lockdown.
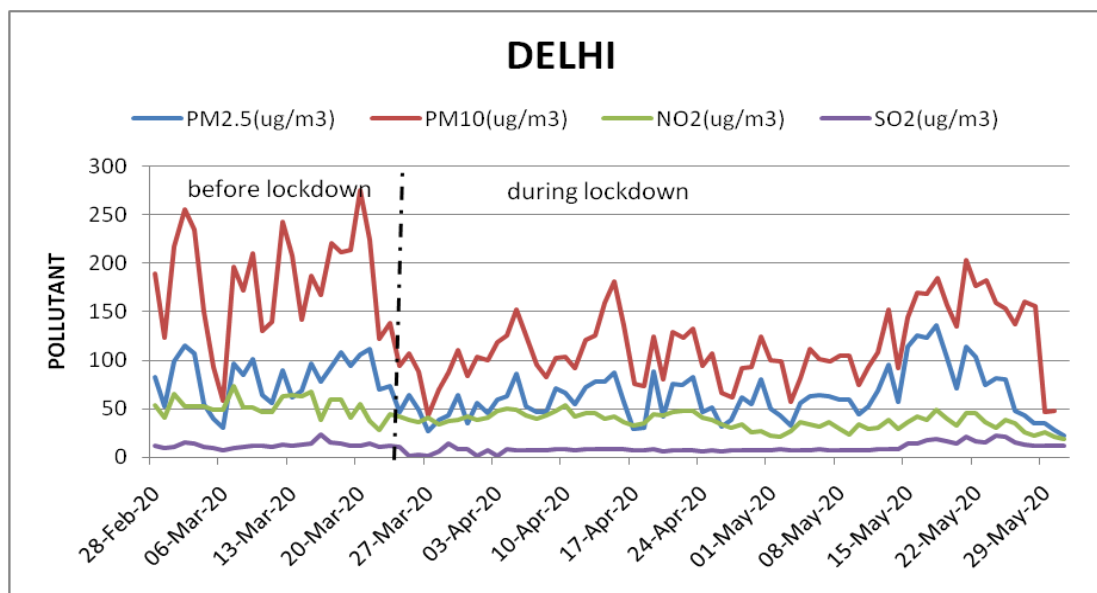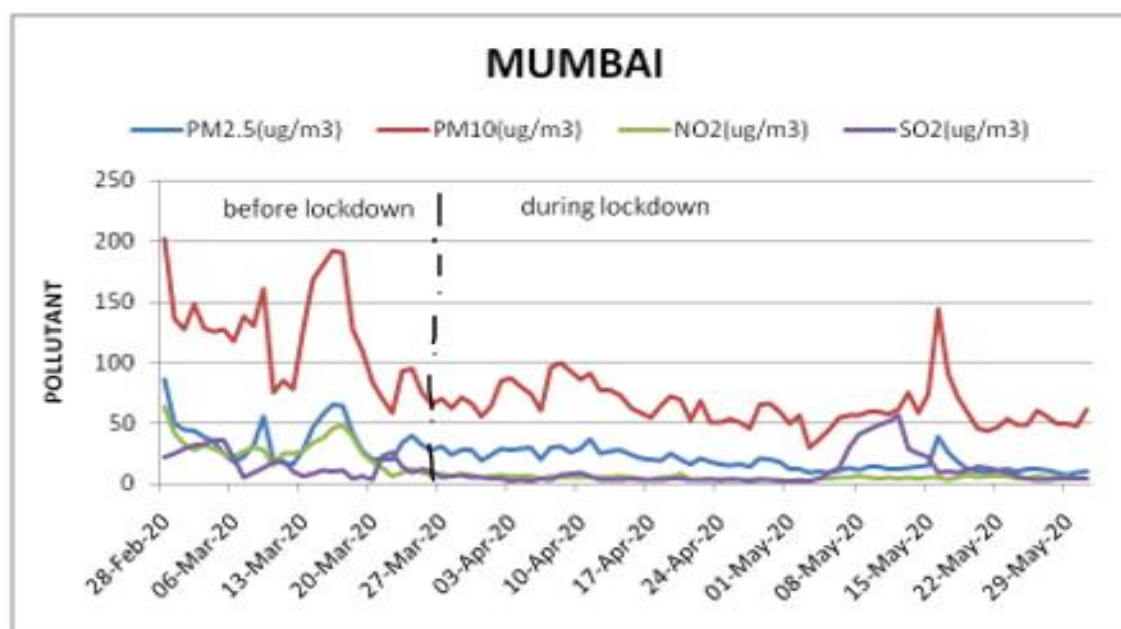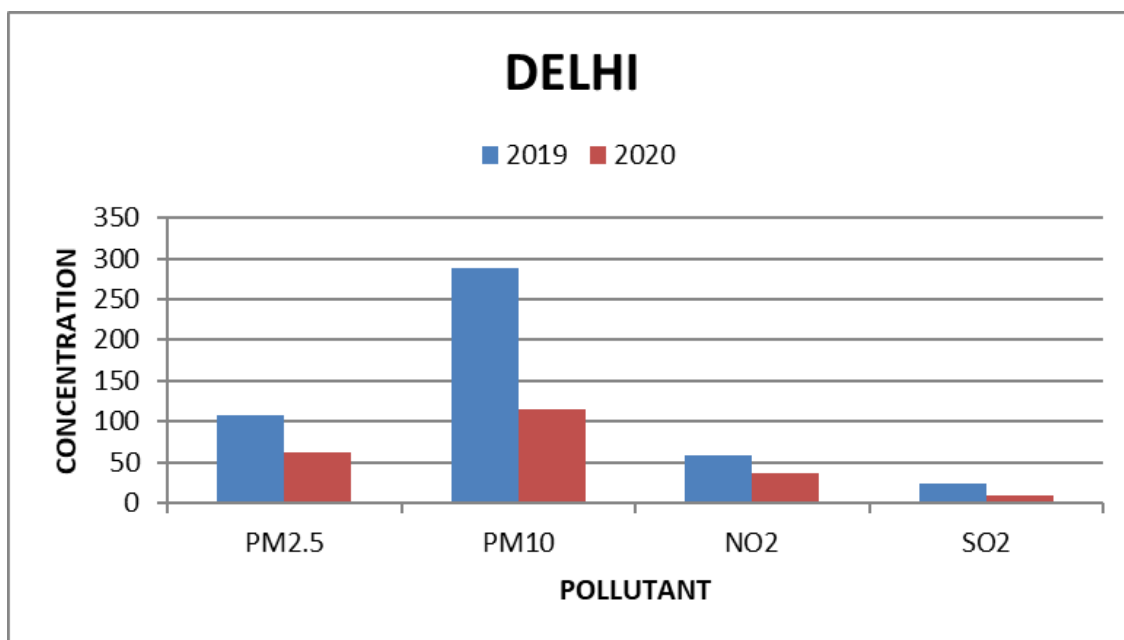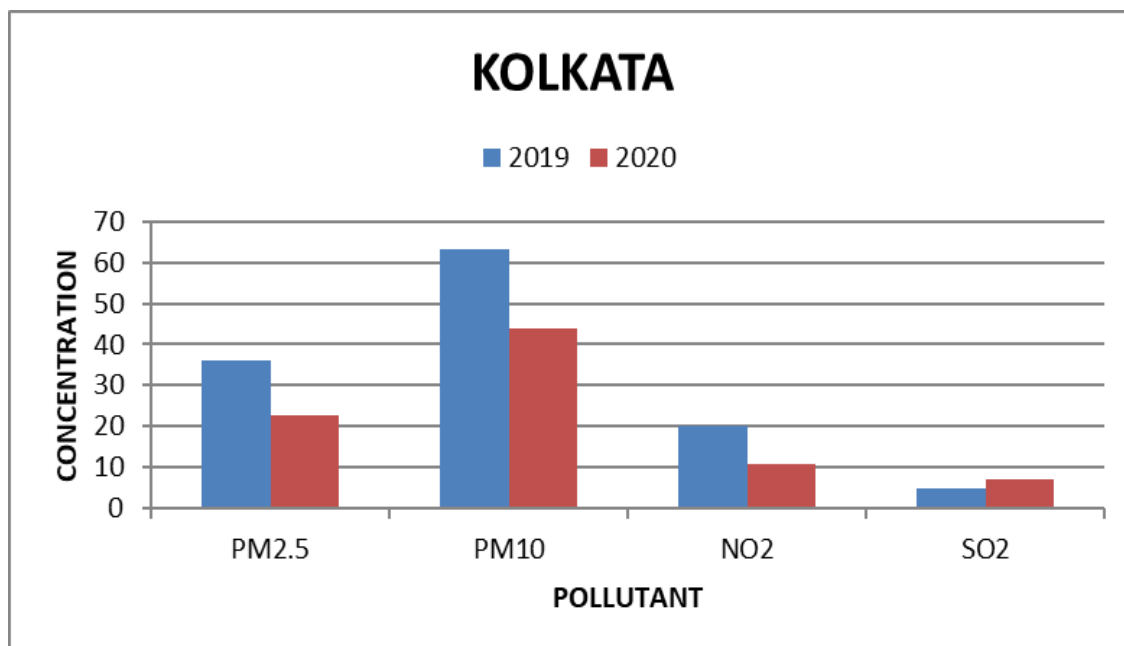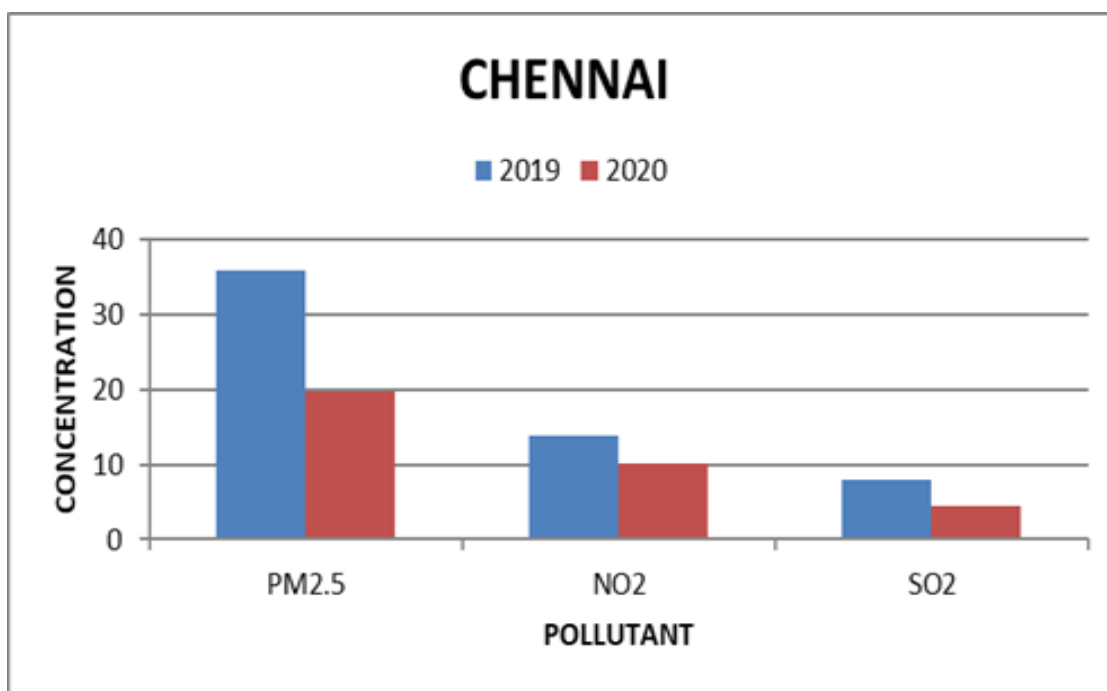

(a)
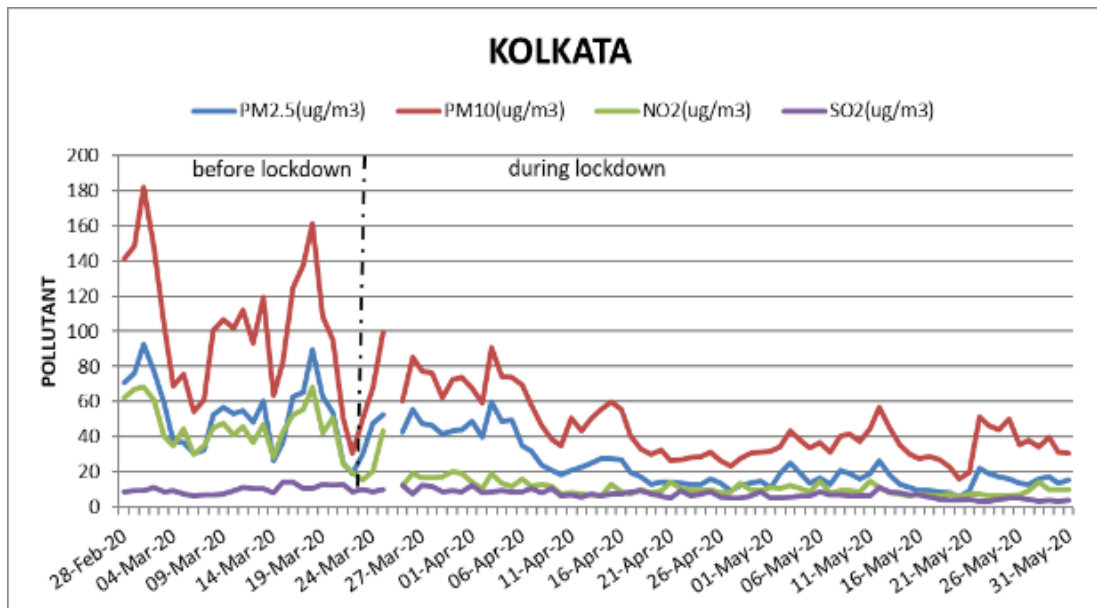
(b)

(c)

(d)

Fig 1 showing pollution level before and during lockdown period

(a)

(b)

(c)

Fig 2 showing pollution level in 2019 and 2020 during lockdown period

Mumbai pollution % reduction in (Table 4 Mumbai average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 2020) has seen. A huge source of anthropogenic factors was shut down as a result of a decrease in the tropospheric NO2 concentration was analyzed in Mumbai because of lockdown.

Kolkata pollution % reduction in 2020 with respect to 2019 during the lockdown period in fig 1(b).and (Table 5 Kolkata average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 2020) shows average AQI. The main source of NO2 emission is anthropogenic during the month of March. PM2.5 is reduced by 37.64%, PM10 is reduced by 83.15% and No2 conc. is reduced by 46.66% but at the same time we observed So2 concentration is increased by 43.86In this study we have observed that the transport sector may not be major source of ambient SO2 in Kolkata.

Chennai pollution % reduction in fig 1(c) PM2.5is 45.04%, NO2 is 26.52%, SO2 is 43.37% .It is because cutting down of anthropogenic sources of various pollutants as well as influenced by oceanic air mass that can be helpful in minimizing the AQI. In the month of march biomass combustion dominates the southern parts of India as resulting high NO2 concentration over Chennai is noticed. The fossil fuel consumption adds to the pollution level. (Sarkar et al. 2018)

but in (Table 6 Chennai average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 2020) we observed that all stations displayed a gradual decrease in PM2.5, PM10 and NO2 concentrations and it results in greater improvements in Chennai city.

Table 3 Delhi average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 20)

pollutant	2019	2020	Before lockdown	During lockdown
$PM_{2.5}$	107	63	78	22
PM_{10}	288	114	177	36
NO_2	57	36	51	29
SO_2	24	9	12	25

Table 4 Mumbai average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 20)

pollutant	Before lockdown	During lockdown
$PM_{2.5}$	37	22
PM_{10}	177	36
NO_2	51	29
SO_2	12	25

Table 5 Kolkata average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 20)

pollutant	2019	2020	Before lockdown	During lockdown
$PM_{2.5}$	36	22	52	22
PM_{10}	63	45	100	4
NO_2	20	11	43	11
SO_2	5	7	10	7

Table 6 Chennai average AQI of $PM_{2.5}$, PM_{10}, NO_2, SO_2 (CPCB-CRR 2019 & 20)

pollutant	2019	2020	Before lockdown	During lockdown
$PM_{2.5}$	36	20	31	20
NO_2	14	10	13	10
SO_2	8	5	11	5

5. Conclusion and Recommendations

The decline of all air contaminants was detected due to the limitations on constructional activities, lesser amount of road dust, fine particles resuspension and industrial activities. Our study shows a prominent reduction in air borne contaminants during lock-down specifically in Delhi and Kolkata. These metropolitan areas are well-known to be extremely contaminated metro cities within the country. There has been a combination of cases where respiratory infection, heart disease with Covid-19 has triggered a cardiac arrest but population that are exposed to pollution over prolonged period will find their immunity is compromised, the expert said chronic exposure to air pollutant such as PM2.5, PM10, Nitrogen dioxide and Sulphur dioxide is bound to irritate our lungs and also a chance of this pandemic. There is an indirect relation between air pollution and Covid 19. If air pollution is reduced there will be increased recovery of coronavirus patients. People who stay in highly polluted cities like Delhi, they have more asthma or chronic diseases that's why studies have found higher mortality among high pollution areas. Ambient air pollution has significant effects on mortal health, stimulating, and triggering numerous illnesses linking to highest morbidities and mortalities, especially in India. Thus, air pollution prevention is crucial; it should be on the peak of the priority list of the government even if India controls to meet the national air quality standard in all the metro cities exceeding Indian standards, every year premature death will decrease to some extent. The rule makers and policy legislators must update each and every laws, rules and regulations associated with air quality. An adequate environmental protection organization must have ample funds for research and development, monitoring, administrations and control of the environment in ambient air pollution. Further research on the health impacts of ambient air pollution became very helpful to the research analyzer, public health leaders, industrialists, and the common public. The result will draw the attentions of the Indian governmental body to review the approaches to abate vehicular and industrial pollution which helps to improve air quality as well as motivates better public health's in India.

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