



## IMPACT OF COVID-19 ON AIR QUALITY OF INDIAN METRO CITIES UNDER DIFFERENT LOCKDOWN PERIODS: A CASE STUDY

Sneha T. Bankar<sup>1</sup> and Jagdish Gabhane<sup>2</sup>

<sup>1</sup>Post Graduate Teaching Department of Chemistry, RTM Nagpur University

<sup>2</sup>Chintamani College of Art and Science, Gondpipari, Gondwana University

Corresponding Email: [jagdish.24gabhane@gmail.com](mailto:jagdish.24gabhane@gmail.com)

Communicated :10.12.2022

Revision: 20.01.2023 & 24.01.2023

Published: 30.01.2023

Accepted: 26.01.2023

### ABSTRACT:

The outbreak of COVID-19 has caused concerns globally. WHO has declared it as a global health emergency on 31<sup>st</sup> January. Most countries including India have announced some sort of lockdown to reduce the effects of COVID-19 and discontinue the transmission of novel corona virus. In the present study, concentrations of seven perilous pollutants, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, NO<sub>2</sub>, NH<sub>3</sub> ozone and SO<sub>2</sub> during regular and lockdown condition in 4 cities of India; Delhi, Mumbai, Nagpur, Noida were analysed. During lockdown 1<sup>st</sup> and 2<sup>nd</sup> nearly all the pollutants level has decreased in four cities which are under study. Whereas, during 3<sup>rd</sup> and 4<sup>th</sup> lockdown the decrease in pollutant level is marginal. Effect of lockdown on the level of PM<sub>2.5</sub>, NO<sub>2</sub> and CO in Delhi and Mumbai has shown effectual compared to Nagpur and Noida. In Nagpur the effect of lockdown was found marginal as the pollution level in Nagpur is already low. And in Noida pollution level is very high and during lockdown it is lessened. The concentration of PM<sub>2.5</sub>, NO<sub>2</sub> and CO declined during the lockdown phase in comparison to the before lockdown in Delhi and Mumbai. Similar decline in pollutant concentration was observed in other megacities as well. When we compared data of CO and PM<sub>2.5</sub> of Mumbai for the last three year effect of lockdown was clearly seen.

**Keywords:** - COVID-19, PM<sub>2.5</sub>, NO<sub>2</sub>, Pollutant, lockdown.

### INTRODUCTION :

Coronavirus Disease (COVID-19) is the world's deadliest disease which affected 215 countries [1-3]. Outbreak of COVID-19 has been announced as a global health emergency on 31<sup>st</sup> January by WHO [3]. As per recent data (16<sup>th</sup> June 2020) 8,147,658 reported cases and 439,816 total deaths. The USA is the most affected country with 2,183,153 reported cases followed by Brazil (891,556), Russia (545,458) and India (344,527) [4]. India ranks 4<sup>th</sup> position as per reported cases [4]. Though there are some anti-bacterial, antimalarial and anti-HIV medicines such as Hydroxychloroquine and azithromycin, lopinavir; ritonavir remdesivir (GS-5734), tocilizumab, corticosteroids, certain nucleotide as inhibitors, COVID-19 protease inhibitors are proposed for the treatment of COVID-19 [5][7][8], specific vaccine or medicine is not available.

Thus, social lockdown is considered to be an effective means to break the chain of spreading coronavirus [11] [24]. During social lockdown conditions people are allowed to leave their home rarely for the shop of basic necessities such as food and medicine but only if this is absolutely necessary and cannot be done from home [9][11].

As per population concern India ranks second in the world with 17.35% contribution. In Spite of huge population density, poor sanitary and medicinal services, the spread of COVID-19 in India is quite slow. India contributes only 4.22 % of the world's COVID-19 cases. Credit for these goes to government policy for social distancing and lockdown. Definitely COVID-19 is not at all beneficial for us as it kills humans, it severely drops the economy of the country, and it increases unemployment, also badly affects

the whole education system. However surprisingly it shows positive effects on the environment in the form of improving air and water quality. It also acts as a modulator for reduction in waste generation. Overall, it improves the health of humans. Now the question arises that COVID-19 is a deadly disease then how it is a positive modulator for human life. Though there are several reasons, the major is strict lockdown followed by Indian people.

The Government of India under Prime Minister Narendra Modi ordered a nationwide lockdown for 21 days on 24<sup>th</sup> March 2020 when restrictive movement of the entire 1.3 billion population of India as a preventive measure against COVID-19 in India[10]. The second lockdown was announced by Prime minister Narendra Modi on 14<sup>th</sup> April until 3<sup>rd</sup> May (Times of India, 14<sup>th</sup> April). During both lockdown periods all kinds of transport, mall, cinema hall etc, are closed. On 14<sup>th</sup> April, Prime Minister Narendra Modi extended the nationwide lockdown until 3<sup>rd</sup> May, with conditional relaxations after 20<sup>th</sup> April for the regions where the spread had been contained or was minimal (Times of India, 14<sup>th</sup> April). Third lockdown was announced on 1<sup>st</sup> May and it lasted for seventeen days. Final and last lockdown announced on 17<sup>th</sup> May and it is up to 31<sup>st</sup> May. On 30<sup>th</sup> May, it was announced that the ongoing lockdown would be further extended till 30<sup>th</sup> June in containment zones, with services resuming in a phased manner starting from 8 June. It is termed as "Unlock 1"[17].

During the lockdown train, aero-plane and all road transport completely stop for the first thirty five day (Lockdown 1 and 2). People are not allowed to go out of the home without necessary reason. Use of vehicles is also banned in several cities in India. The operation of most industries except food and medicine are stopped. Also, agricultural activities slow down, which may be

a reason for reducing pollution. As a result, important environmental indices such as the reduced NO<sub>2</sub>, CO<sub>2</sub> emissions, water pollution, and increasing air quality in many polluted cities have been observed[9].

As per India concern, six out of ten highest polluted cities of the world comes from India including, Delhi, Noida, Gaziabad etc. The air quality of Indian metro cities is drastically reduced[12-13]. Which badly affects the health of humans with increasing respiratory problems. Such vulnerable people are at high risk of COVID-19 attack.

In the present study, concentrations of seven hazardous pollutants, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, NO<sub>2</sub>, NH<sub>3</sub> ozone and SO<sub>2</sub> during regular and lockdown conditions in 4 cities of India; Delhi, Mumbai, Nagpur, Noida were analyzed. The study starts in February when the situation is normal and ends in May. We follow four lockdown periods as our focus of study is to analyze the effects of lockdown on emission of mentioned pollutants.

#### **METHOD :**

##### **Data collection**

In present study we focus on air quality of Mumbai, Delhi, Nagpur and Noida before and after lockdown condition. We also analyzed the effect of lockdown on carbon monoxide (CO), particulate matter (PM) - 2.5, ozone (O<sub>3</sub>), and nitrogen dioxide (NO<sub>2</sub>). The present analysis study was carried out by using data of PM-2.5, PM-10, CO, NO<sub>2</sub>, Ozone, NH<sub>3</sub> and SO<sub>2</sub> for four month (February, March, April, May) as February and 3/4<sup>th</sup> of March are regular conditions whereas, remaining periods are lockdown. Air quality data was collected from the Central Pollution Control Board (CPCB) (National air quality Index, 2020).

#### **RESULT AND DISCUSSION :**

##### **Effect of lockdown on air quality of four cities of India.**

Different lockdown phases, their duration and public movement illustrates in Table 1. Perusal

of study clearly indicates during lockdown 1 and 2 all kinds of movement strictly ban all over the country. Third lockdown gave small relaxation which increased in the fourth lockdown. From 3<sup>rd</sup> of May relaxation further increased, the phase is also called as unlock or reopening (Wikipedia, 2020). Impact of lockdown 1 and 2 was observed on air quality of all Indian cities, however we study only four cities, Delhi, Noida, Mumbai and Nagpur. Delhi and Noida are the most populated cities, whereas Nagpur is low polluted. We choose Mumbai because maximum corona positive patients are found.

The Fig. 1 shows the effect of lockdown on air quality of different cities. Before lockdown all four cities showed high pollution level, Noida and Delhi cross safety level. Noida is ranked 11 on the IQAirVisual World City pollution ranking (2018). Fig 1 clearly shows, during lockdown 1 and 2 concentration of all 7 pollutants are predominantly low. Lockdown 3 also has some good effect whereas lockdown 4 shows marginal effects.

In Mumbai the level of pollution is high before lockdown i.e. from 5<sup>th</sup> Feb to 25<sup>th</sup> March. And in the lockdown period it is decreasing from 26<sup>th</sup> March and again slightly increasing from 10<sup>th</sup> May. The slight increase is due to some relaxation in lockdown. Overall in Mumbai we can see a clear downward trend in pollution level because of lockdown. The same is seen in Delhi. Delhi is a much polluted city but during lockdown the pollution is reduced. Nearly similar observations also documented by Shrestha et al., 2020; Wang and Su, 2020; Zhang et al., 2020 in China and several European and American countries [19][21][22]. As per their report air pollution, especially in the concentration of NO<sub>2</sub>, has been reduced during the lockdown phase.

#### **Effect of lockdown on PM 2.5 among four cities of India**

Particulate matter 2.5 is an air pollutant that is a concern for people's health when levels in air are high. Outside, fine particles primarily come from cars, trucks, buses and off-road vehicles. PM 2.5 level in four cities in lockdown period is shown in bar chart (Fig 2). It is decreasing during nearly all lockdowns which is probably due to the ban on industries, vehicles and construction sites. The effect is more pronounced during 3<sup>rd</sup> and 4<sup>th</sup> lockdown. In Noida and Delhi compared to other cities reduction is quite low. Similar observation documented by Kanniah et al (2020) while performing PM 2.5 study by Aura-OMI satellite over Southeast Asia [23]. USA and other countries are also experiencing the same trend from their normal level of (PM2.5 and PM10) particulate matter[4][9][25].

#### **Effect Of lockdown on CO among four cities of India**

Carbon monoxide is a toxic air pollutant produced largely from vehicle emissions. Breathing CO at high concentrations leads to reduced oxygen transport by haemoglobin. Fig 3 shows CO concentration of four cities before and during lockdown phase. Emission of CO in Noida is much greater than Mumbai, Delhi, and Nagpur. Effect of lockdown was observed only in Mumbai whereas rest cities show marginal decreases. The Primary source of CO is burning of organic matter. From the result it clearly indicates burning practices still continue during lockdown in the rest of the cities. Kanniah et al (2020) reported reduction in CO is higher (25–32%) at the urban and suburban (25–27%) sites, whereas the rural background sites do not display any significant variability [23].

#### **Effect of lockdown on ozone among four cities of India**

Ozone in the troposphere is one of the main photochemical oxidants. Ozone can irritate the lining of the nose, airways and lungs. It is generated by the chemical reaction of nitrogen

di-oxides and volatile organic compounds and these chemicals react in presence of sunlight. Ozone level in Mumbai is low (Fig 4) as compared to other cities and during lockdown it is lessened. Also in Noida during lockdown there is a slight decrease in Ozone level. But in Delhi and Nagpur there is no effect on pollution by Ozone. Kanniah et al (2020), Paital (2020), Wright (2020) clearly shows effects of lockdown on various pollutant reduction [23-24] [26].

#### **Effect of lockdown on NO<sub>2</sub> among four cities of India**

Nitrogen dioxide is smelly gas. It is an important air pollutant because it contributes to the formation of photochemical smog, which can have significant impacts on human health. The major source of NO<sub>2</sub> is vehicle exhausts, industries, power plants, residential heating e.g. [27], where it is emitted in the form of NO which is further converted into NO<sub>2</sub> by fast oxidation[21]. Fig 3 shows concentration of NO<sub>2</sub> in regular and lockdown phase. Perusal of result shows that, in all the four cities level of nitrogen dioxide is reduced during lockdown period. However the effect is more prominent in lockdown 1 and 2. After the third lockdown it again starts rising the NO<sub>2</sub> concentration especially in Noida and Delhi which is probably due reopening of industries. Reduction in NO<sub>2</sub> concentration was also noted by Kanniah et al (2020) while performing NO<sub>2</sub> study by Aura-OMI satellite over Southeast Asia [23].

#### **CONCLUSION :**

Mega cities of India are frequently listed within the world's topmost polluted cities that exceed the ambient air quality standard. In the present study the effect of lockdown (since the third week of March 2020) executed in order to control the rapid spread of COVID-19 pandemic in India on the air quality of the four cities has been evaluated based on the National Air Quality Index.

Pollutant levels have decreased in all four cities. In Delhi, there is a significant decrease in PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and CO concentrations, whereas marginal increase in O<sub>3</sub> concentrations during the lockdown phase in comparison to before lockdown phase. A significant decrease in concentrations of PM<sub>2.5</sub> was observed between March–April 2019 and March–April 2020 in Delhi.

In March-April 2020, the concentrations of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, CO, and O<sub>3</sub> in Mumbai was estimated to be lower in comparison to the concentration levels in March–April 2019. From the data it is seen that lockdown has been followed strictly in Mumbai.

In future, the government can encourage e-governance initiatives, encourage work from home policy for corporates and various other businesses, and improve health infrastructure to tackle such issues. And also the government should think about such lockdown day once a week even after the COVID-19 issue to decrease the pollution level.

#### **REFERENCES:**

- C.D.C., 2020. CDC Website. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinicalguidancemanagement-patients.html> (2020), retrieved on 22.04.2020.
- FDA, 2020. Emergency Preparedness and Response to Coronavirus Disease 2019 (COVID-19). <https://www.fda.gov/emergency-preparedness-and-response/mcmissues/coronavirus-disease-2019-COVID-19>.
- WHO, 2020a. Rolling updates on coronavirus disease (COVID-19). <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen> (retrieved on 10.04.2020). <https://www.worldometers.info/coronavirus/#countries>
- GautretP, LagierJC, ParolaP, et al. (2020) Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of

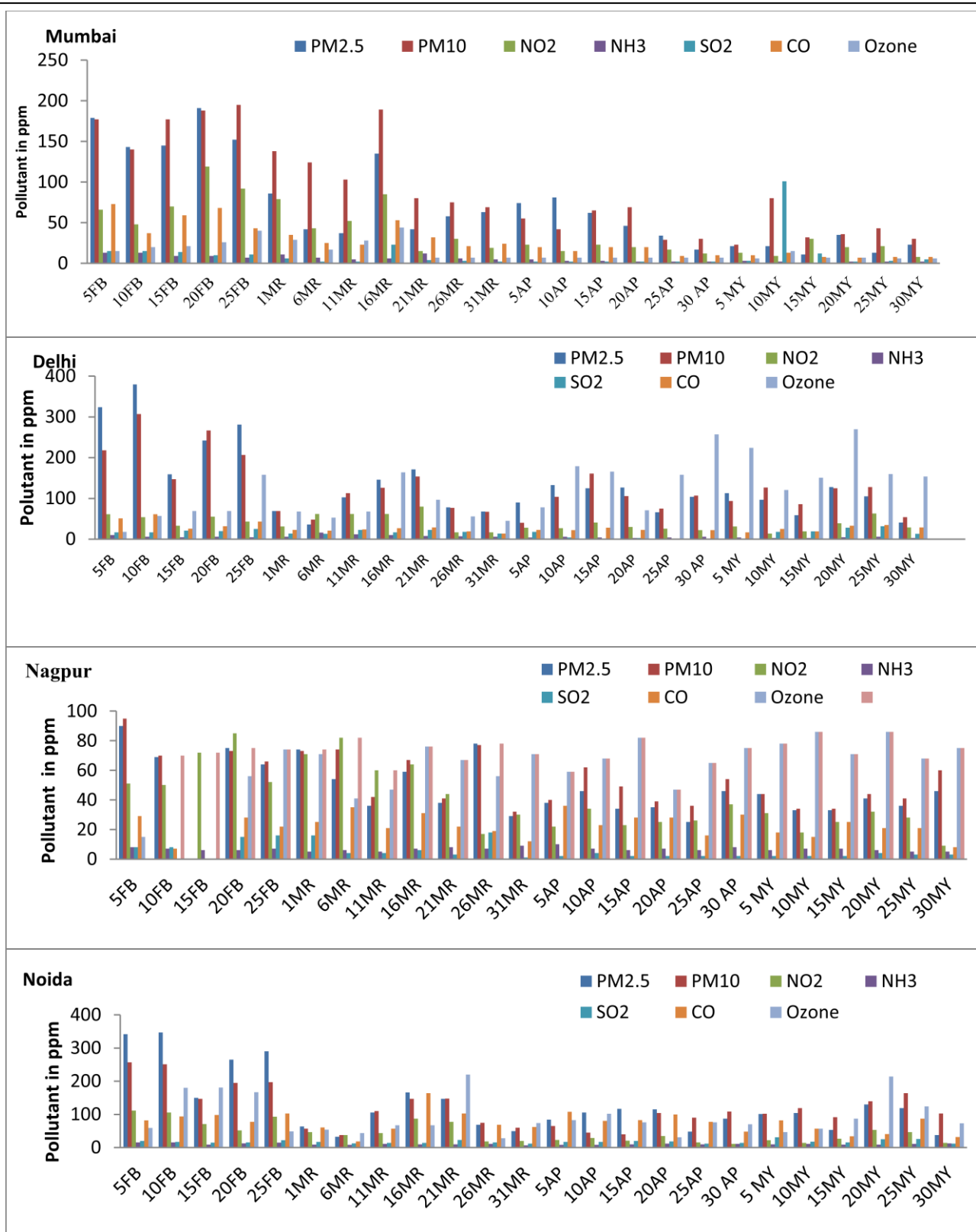
- an open-label non-randomized clinical trial. *Int. J. Antimicrob. Agents*, 105949 <https://doi.org/10.1016/j.ijantimicag.2020.105949>.
- SmithT, BushekJ, ProsserT (2020) COVID-19 Drug therapy – potential options, clinical drug information | clinical solutions. [https://www.elsevier.com/\\_data/assets/pdf\\_file/0007/988648/COVID-19-Drug-Therapy\\_Mar-2020.pdf](https://www.elsevier.com/_data/assets/pdf_file/0007/988648/COVID-19-Drug-Therapy_Mar-2020.pdf).
- SwainSS, SahooA, PaitalB, PandaM (2020) Vitamin-C and anti-HIV drug darunavir as combinatorial drug against COVID-19. *Front. Biosci.* (2020) (accepted).
- PaitalB, DasK, ParidaSK (2020) Inter nation social lockdown versus medical care against COVID-19, a mild environmental insight with special reference to India. *Sci. Total Environ.* 138914 PII S0048-9697(20)32431-1.
- Gettleman, Jeffrey, SchultzKai (24 March 2020). "Modi Orders 3-Week Total Lockdown for All 1.3 Billion Indians". *The New York Times*.
- DasK, PaitalB (2020) The synergy between philosophy and science, need of the contemporary society. *Int. J. Humanities Soc. Sci. Res.* 6 (1), 45–51. *ork Times*. ISSN 0362-4331. <https://www.iqair.com/world-most-polluted-cities>
- <https://www.weforum.org/agenda/2020/03/6-of-the-world-s-10-most-polluted-cities-are-in-india/>
- [https://en.wikipedia.org/wiki/COVID-19\\_pandemic\\_lockdown\\_in\\_India](https://en.wikipedia.org/wiki/COVID-19_pandemic_lockdown_in_India)
- PM Modi announces extension of lockdown till 3 May". *Livemint*. 14 April 2020
- "Centre extends nationwide lockdown till May 31, new guidelines issued". *Tribuneindia News Service*. 17 May 2020. Retrieved 17 May 2020
- Sharma, Neeta (30 May 2020). Ghosh, Deepshikha (ed.). "'Unlock1': Malls, Restaurants, Places Of Worship To Reopen June 8". *NDTV*. Retrieved 30 May 2020.
- [https://app.cpcbcr.com/AQI\\_India/](https://app.cpcbcr.com/AQI_India/) ShresthaAM, ShresthaUB, SharmaR, BhattaraiS, TranHNT, RupakhetiM (2020)
- Lockdown caused by COVID-19 pandemic reduces air pollution in cities worldwide. *Environ. Pollut.* (submitted paper).
- ZhangR, ZhangY, LinH, FengX, FuT-M, WangY (2020) NOx emission reduction and recovery during COVID-19 in east China. *Atmosphere* 11 (4), 433. <https://doi.org/10.3390/atmos11040433>.
- WangQ, SuM (2020) A preliminary assessment of the impact of COVID-19 on environment—a case study of China. *Sci. Total Environ.* 728, 138915. <https://doi.org/10.1016/j.scitotenv.2020.138915>.
- Kanniah KD, Zaman NAFK, Kaskaoutis D G, Latif MT (2020) COVID-19's impact on the atmospheric environment in the Southeast Asia region, *Science of the Total Environment* 736 (2020) 139658
- Paital B (2020) Nurture to nature via COVID-19, a self-regenerating environmental strategy of environment in global context. *Science of the Total Environment* 729 (2020) 139088
- WHO, 2020b. Ambient (outdoor) air pollution. [https://www.who.int/news-room/factsheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/factsheets/detail/ambient-(outdoor)-air-quality-and-health).
- Wright R (2020) The world's largest coronavirus lockdown is having a dramatic impact on pollution in India. <https://edition.cnn.com/2020/03/31/asia/coronavirus-lockdown-impact-pollution-india-intl-hnk/index.html> (retrieved on 23.042020).
- DumkaUC, TiwariS, KaskaoutisDG, SoniVK, SafaiPD, AttriSD (2019) Aerosol and pollutant characteristics in Delhi during a winter research campaign. *Environ. Sci. Pollut. Res.* 26, 3771–3794.

**Table 1: Different lockdown phases and public movement**

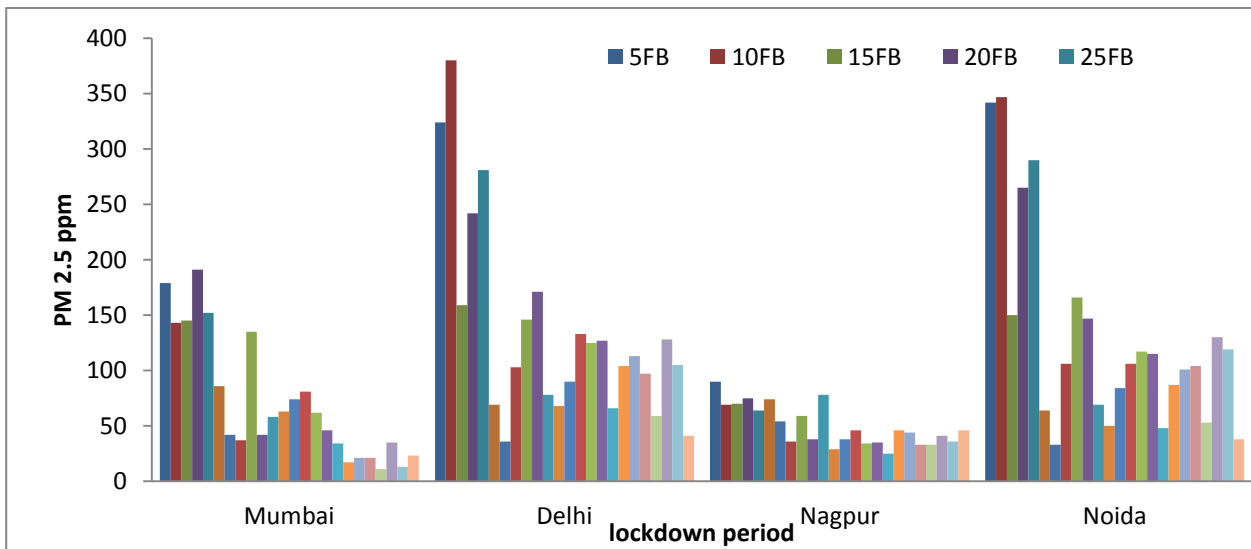
Phases	Period	Movement during lockdown
Lockdown 1	24 <sup>th</sup> March to 14 April	<ul style="list-style-type: none"> <li>Nearly all services and factories were suspended</li> </ul>
Lockdown 2	15 <sup>th</sup> March to 3 <sup>rd</sup> May	<ul style="list-style-type: none"> <li>Ban on people from stepping out of their homes</li> <li>All type of transport stopped</li> <li>Food and medicine shop are open but for limited time period</li> </ul>
Lockdown 3	4 <sup>th</sup> May to 17 <sup>th</sup> May	<ul style="list-style-type: none"> <li>Whole country divided in to red, orange and green zone based on number of corona positive cases.</li> <li>Normal movement is permitted in green zones with buses limited to 50 percent capacity.</li> <li>Orange zones would allow only private and hired vehicles but no public transportation.</li> <li>The red zones would remain under lockdown.</li> <li>The zone classification would be revised once a week</li> </ul>
Lockdown 4	18 <sup>th</sup> May to 31 May	<ul style="list-style-type: none"> <li>Unlike the previous extensions, states were given a larger say in the demarcation of Green, Orange and Red zones and the implementation roadmap.</li> <li>Red zones were further divided in to <i>containment and buffer zones</i>.</li> <li>The local bodies were given the authority to demarcate containment and buffer zones</li> </ul>
Unlock 1	1 <sup>st</sup> June to 30 June	<ul style="list-style-type: none"> <li>The phases of reopening would "have an economic focus.</li> <li>Lockdown restrictions would only be imposed in containment zones, while activities would be permitted in other zones in a phased manner</li> <li>Permits shopping malls, religious places, hotels and restaurants to reopen from 8 June.</li> <li>Large gatherings are still banned</li> <li>No restrictions on inter-state travel.</li> <li>However migrant from other state or Red zone are kept in institutional or home quarantine fourteen days.</li> </ul>

Source: wikipedia.org

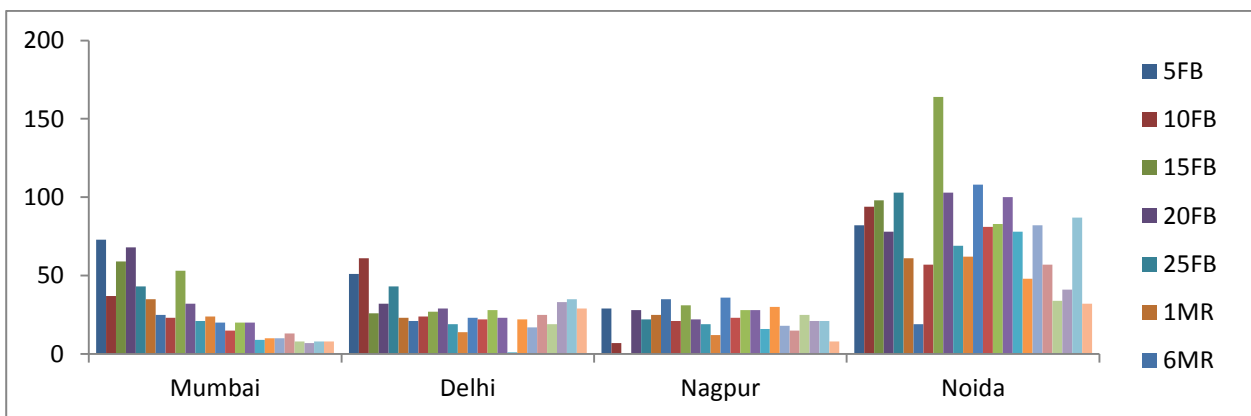




**Fig 1: Effect of lockdown on air quality of Mumbai, Delhi, Nagpur, and Noida.(FB-February, MR-March, AP-April, MY-May)**

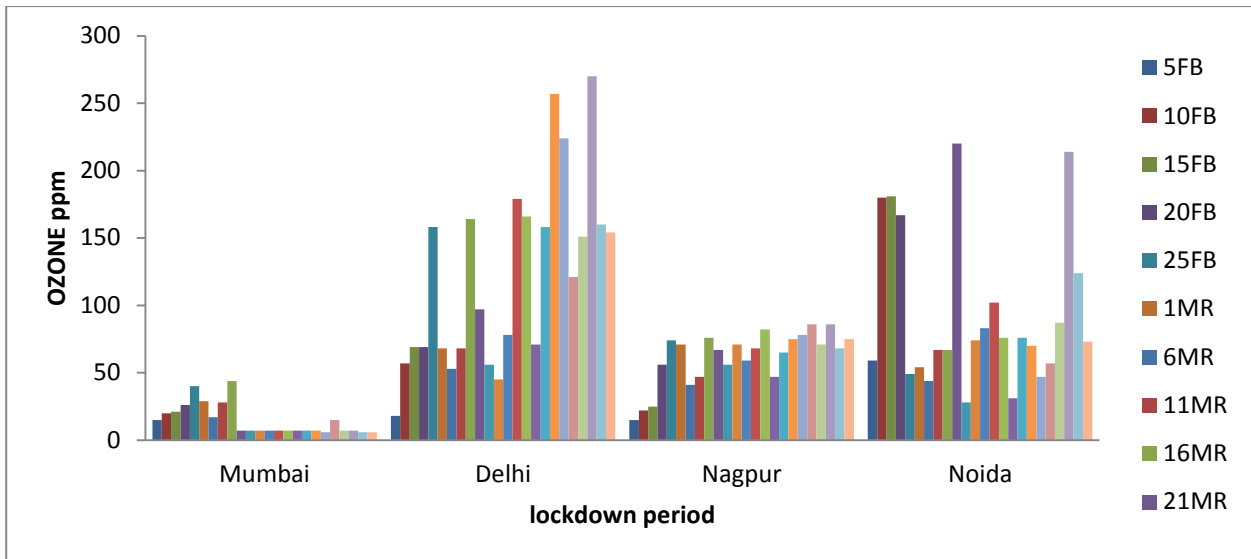


**Fig 2: Effect of PM 2.5 on Mumbai, Delhi, Nagpur, and Noida.**

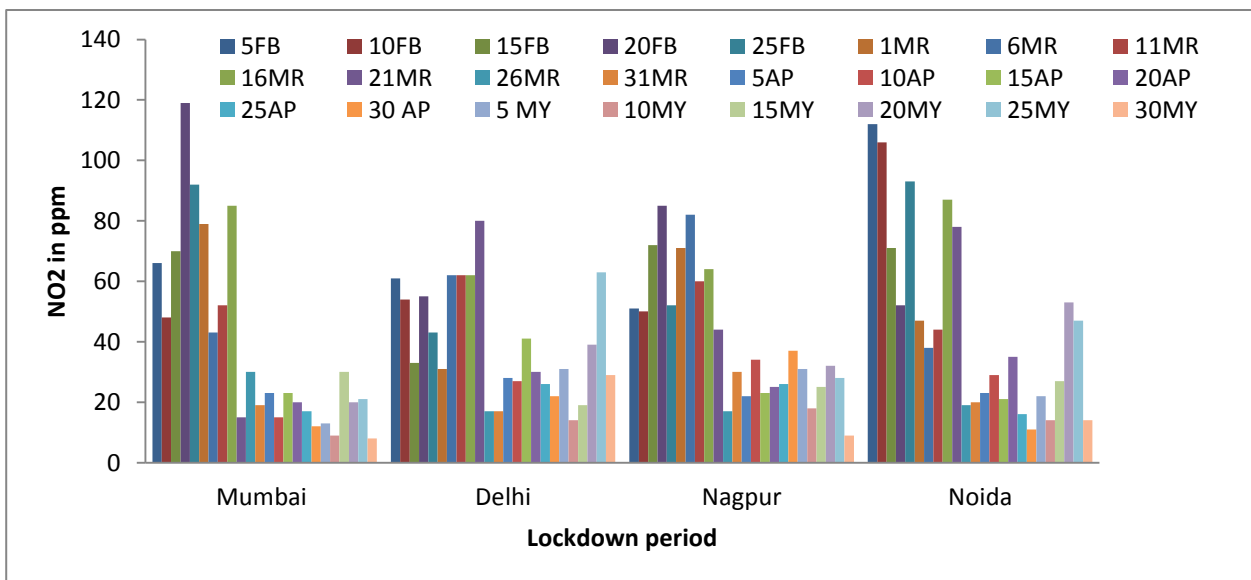


**Fig 3: Effect of CO on Mumbai, Delhi, Nagpur, and Noida.**





**Fig 4: Effect of Ozone on Mumbai, Delhi, Nagpur, and Noida.**



**Fig 5: Effect of NO<sub>2</sub> on Mumbai, Delhi, Nagpur, and Noida.**