

IMPACT OF LOCKDOWN DUE TO COVID-19 ON AQI IN 3 MAJOR HOTSPOTS OF DELHI : A BEFORE AND AFTER STUDY

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ABSTRACT

Gradual lockdown as a measure was forced into action in India for more than 4 weeks after the beginning of Covid -19 pandemic, as a measure to flatten the epidemic curve. Through our study we are trying to interpret the changes in air quality level during the period of lockdown in Delhi by collecting and evaluating the data of pollutants from 3 major hotspots through updated data of DPCB (Delhi Pollution Control Board). It has noted that after a week and more there was a significant decline in air pollutant level in these areas which lead to improvement in air quality, major decline was noted in PM_{2.5} (-28.37%, -25.37% and -25.43%), and NO₂ a traffic emission related pollutant (-91.29%, -13.29% and -55.26%) respectively whereas slight improvement in ozone has been recorded an association of major pollutant (PM_{2.5,10}, NO₂) has shown significant association with impact of lockdown during covid-19 in their decline, whereas further improvement might come in forthcoming days as GOI is going to put more measures to combat the virus spread which came into force from 23rd March 2020. Still there are lots of efforts need to be done to understand impact of lockdown on major polluted level and how a single lockdown could give great result after spending crores of money on project related to same, so it's our recommendation to GOI to look into this impact and plan measure accordingly in future so that Delhites can breathe a easy air than they used to breathe earlier.

KEY WORDS : Air quality index, Corona virus, Lockdown, Hotspot, Delhi, PM 2.5,10 , NO₂

INTRODUCTION

Exponential spread SARS-COV-2 which WHO has declared as a global health emergency and re-named it as Covid-19 which is acting as hanging sword on human survival. A sudden case erupts on December 2019 in Wuhan, China and it led to rapid spread across borders within a time frame of 3 months it became a pandemic by affecting more than 200 countries which led to devastating consequences. To control the impact of this deadly virus many nation's adopted front foot strategy to reduce social interaction by undergoing strict measures like quarantine, ban on public gathering, no transportation with mass lockdown of countries across the globe .

Though these measures would cost hard on all

kind of economies of the world but simultaneously they are also bringing substantial gains like improved environmental condition which in long run would help the mankind through these strict action taken by then government which we have destroyed over years. Although a beautiful image was caught by ISRO and NASA about how a sharp drop of pollution level was witnessed across the globe by these strong action to overcome transmission of the virus.

In this study we aimed to assess how Covid -19 pandemic has influenced air quality in 3 major most polluted hotspots in Delhi, India under enforced lockdown. The reason of considering 3 major hotspots in Delhi was due to the following reason:

1. It is the most polluted city around the globe, according to WHO in 2014

2. Out of whole India, Delhi faces 25% high mortality rates due to air pollution and faces severe respiratory disorders specially during festive season of Diwali
3. Cases of the virus are quite swelling with more than 89 viral hotspots in Delhi even after strict action taken by the state authority which made 2.18 crore individual home quarantine

The purpose of our study is whether lockdown has improved air quality by decline in pollutant levels and help Delhites to breathe fresh air or not. Our research highlights that if strict norms are not invoked in policy related to environmental pollution then challenge to battle air pollution will be really hard. Once lockdown is removed authority must common up with a joint task force to enforce strict action related environment condition so that the present environmental condition could not be reversed.

Objective

The key objective of our study was to monitor the impact of lockdown due to covid -19 on air quality in 3 major hotspot (Sri Aurobindo Marg, Punjabi Bagh and Alipur) of Delhi through decline in major pollutants levels (PM 2.5, 10, NO₂)

Methodology

A before and after study was conducted in a time period of 20 days i.e. from 4th March, 2020 to 12th April, 2020 present case to seek the intervention cause by lockdown in Delhi does affect air quality or not.

To assess this we collected data of 3 most polluted areas from aqicn.com which have past 76 months DPCB data on its website and air quality was measured using air quality calculator from spare the airquality.com on basis of PM 2.5 concentration level in the time period mentioned above. As lockdown was called on 23rd March by GOI and we took data of 20 days before and after lockdown.

A thorough literature review was done from peer-reviewed journals and database like Pubmed, Scopus, Proquest, Research Gate etc, which included 6 studies related to key topic while rest were related to air quality and pollution within a defined period from November 2019 till 12th April 2020.

A statistical analysis was carried out through SPSS software which include:

1. Interpretation of given data in form of figures
2. Mean difference of concentration and, mean percentage to see the variation in trend

3. A paired t –Test was conducted to check the statistical significance of lockdown on air quality.

Inclusion criteria were on the basis of key findings of words like:

1. Impact of Covid 19 on air quality
2. Measures and policy that lead to decline in environmental hazards due to covid 19
3. Statistical assessment of air pollution across Delhi
4. Impact of lockdown on pollution level across globe and key stastical test used to see trend in air quality

Exclusion criteria were:

1. Blogs, letters, non systemic reviews and commentaries that had similar key words
2. No full text
3. No abstract available

RESULTS

Statistical analyses on the data collected from aqicn.org was carried out in order to assess the impact of lockdown on air quality in three major hotspots of Delhi in following 3 ways:

1. A general picture of the distributions that shows observations before and during the lockdown period in form of figures below:

Figure 1, 2, 3, 4, 5 and 6 represents the distribution of observations before lockdown (04th March, 2020 – 23rd March, 2020) and during the lockdown (24th March, 2020 – 12th April, 2020) which indicates the decrease in level of pollutants (PM 2.5,

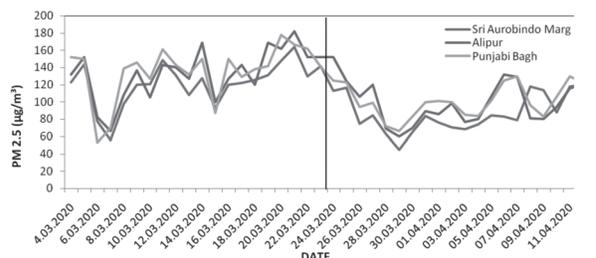


Fig. 1. Distribution of PM 2.5 (µg/m³)

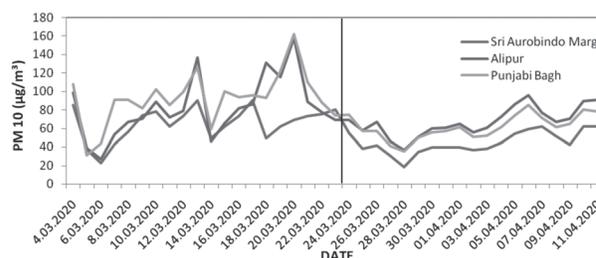


Fig. 2. Distribution of PM 10 (µg/m³)

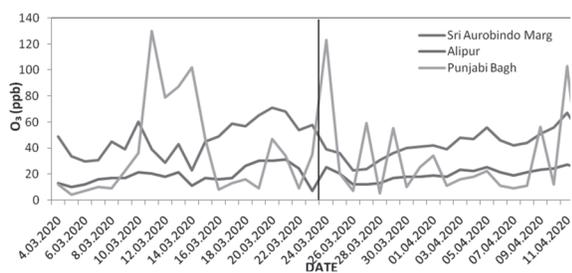


Fig. 3. Distribution of O₃ (ppb)

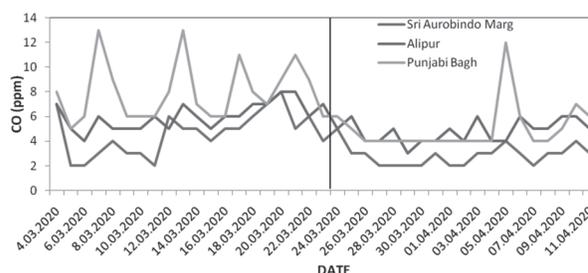


Fig. 5. Distribution of CO (ppm)

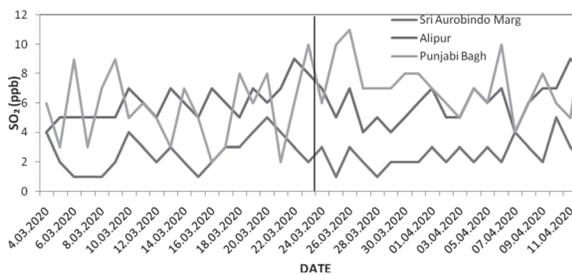


Fig. 4. Distribution of SO₂ (ppb)

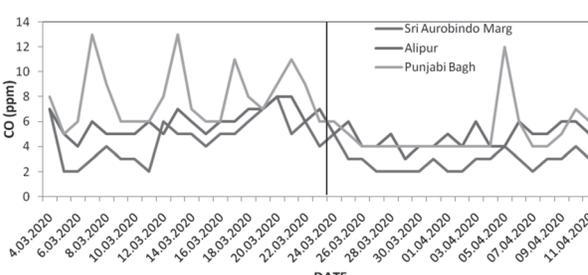


Fig. 6. Distribution of NO₂ (ppb)

PM 10, SO₂, CO and NO₂) which are responsible for the air quality with slight improvement in O₃

2. Assessing the mean concentration between both periods and their relative change

After 20 days of lockdown, PM 2.5 averaged concentrations in Sri Aurobindo Marg, Alipur and

Punjabi Bagh has been decreased by -28.37%, -25.37% and -25.43% (Table 1) which is according to WHO guidelines and further marked reduction in NO₂ was visible due to ban on traffic and commercial activities by (-91.29%, -13.29%, -55.26%) respectively.

Table 1. Mean concentrations and variation of PM 2.5, PM10, O₃, SO₂, CO and NO₂ between March 4th to March 23rd 2020 (before Lockdown) and March 24th to April 12th 2020 (during the Lockdown) in Delhi, India.

Hotspot Areas/ Air Pollutant	Before Lockdown	During Lockdown	Variation	
			Concentration	Percent (%)
Sri Aurobindo Marg				
PM 2.5 µg/m ³	121.6	87.1	-34.5	-28.37
PM 10 µg/m ³	65.1	44.85	-20.25	-31.10
O ₃ ppb	47.4	42.95	-4.45	-9.38
SO ₂ ppb	2.6	2.5	-0.1	-3.84
CO ppm	4.6	2.9	-1.7	-36.95
NO ₂ ppb	14.93	1.3	-13.63	-91.29
Alipur				
PM 2.5 µg/m ³	133.4	99.55	-33.85	-25.37
PM 10 µg/m ³	82.75	67.85	-14.9	-18
O ₃ ppb	18.7	20.05	1.35	7.21
SO ₂ ppb	6	6.05	0.05	0.83
CO ppm	6.05	4.8	-1.25	-20.66
NO ₂ ppb	15.8	13.7	-2.1	-13.29
Punjabi Bagh				
PM 2.5 µg/m ³	135.85	101.3	-34.55	-25.43
PM 10 µg/m ³	92.85	61.8	-31.05	-33.44
O ₃ ppb	35.8	31.1	-4.7	-13.12
SO ₂ ppb	5.65	7.25	1.6	28.31
CO ppm	8	5	-3	-37.5
NO ₂ ppb	28.95	12.95	-16	-55.26

3. The statistical analysis (paired t test) was performed to test the hypothesis that the air pollutants before lockdown is significantly associated with the air pollutants after lockdown. As can be seen in Table 2, 3 and 4 the independent sample t test is statistically significant (p<0.05).

The significant value was seen for main pollutants like PM 2.5, 10, NO₂ in the above t-test performed, whereas with respect to O₃ and in certain area SO₂ the value was not found to be significant

We state that there is strong evidence that the impact of lockdown is significantly associated with decrease in level of air pollutants to improve the AQI in 3 major hotspots of Delhi on the basis of significant value of main air pollutants (PM2.5, 10, NO₂)

DISCUSSION

As it has been noted that due to lockdown, that

includes restricted social gathering, closure of shops, restaurants, large industries and companies has temporarily has marked decrease in level of main pollutants the one which determine AQI. The most significant variation was observed in case of PM 2.5, 10 which are released out from heavy industries, construction work, power generators, dust resuspension and traffic emission and simanteously their was significant decrease in NO₂ which was emitted from road traffic especially diesel, gasoline, power generation and train activities.

Whereas, SO₂ has also shown reduction as large cargo, textile industry are called off, finally the key thing is noted that O₃ level has improved slightly in the areas due to combined causes like marked reduction of NO₂, increase in temperature and ban on rural activities around rural district in the major hotspots, although a study conducted in Barcelona has soon staying at home show 40% reduction in NO₂ emission.

Table 2. Paired t test of Air pollutants and AQI before and during the Lockdown of Sri Aurbindo Marg, Delhi

Paired Variables	Mean ± SD	t	df	p-value
PM 2.5 Concentration (µg/m ³) before lockdown - PM 2.5 Concentration (µg/m ³) during lockdown	34.5±26.16	5.89	19	<0.001
PM 10 Concentration (µg/m ³) before lockdown- PM 10 Concentration (µg/m ³) during lockdown	20.25±17.98	5.03	19	<0.001
O Concentration (ppb) before lockdown- O Concentration (ppb) during lockdown	4.45±12.3	1.61	19	0.122
SO Concentration (ppb) before lockdown- SO Concentration (ppb) during lockdown	0.1±1.25	0.35	19	0.725
CO Concentration (ppm) before lockdown- CO Concentration (ppm) during lockdown	1.7±1.75	4.34	19	<0.001
NO Concentration (ppb) before lockdown- NO Concentration (ppb) during lockdown	13.63±25.59	2.38	19	0.028
AQI before lockdown - AQI during lockdown	21.1±19.21	4.91	19	<0.001

Table 3. Paired t test of Air pollutants and AQI before and during the Lockdown of Alipur,Delhi

Paired Variables	Mean±SD	t	df	p-value
PM 2.5 Concentration (µg/m ³) before lockdown- PM 2.5 Concentration (µg/m ³) during lockdown	33.85±40.42	3.74	19	0.001
PM 10 Concentration (µg/m ³) before lockdown- PM 10 Concentration (µg/m ³) during lockdown	14.9±33.23	2.00	19	0.059
O Concentration (ppb) before lockdown- O Concentration (ppb) during lockdown	-1.35±7.45	-0.81	19	0.428
SO Concentration (ppb) before lockdown- SO Concentration (ppb) during lockdown	-0.05±1.39	-0.16	19	0.874
CO Concentration (ppm) before lockdown- CO Concentration (ppm) during lockdown	1.25±1.07	5.22	19	<0.001
NO Concentration (ppb) before lockdown- NO Concentration (ppb) during lockdown	2.1±3.62	2.59	19	0.018
AQI before lockdown- AQI during lockdown	21.75±26.42	3.68	19	0.002

Table 4. Paired t test of Air pollutants and AQI before and during the Lockdown of Punjabi Bagh, Delhi

Paired Variables	Mean±SD	t	df	p-value
PM 2.5 Concentration ($\mu\text{g}/\text{m}^3$) before lockdown- PM 2.5 Concentration ($\mu\text{g}/\text{m}^3$) during lockdown	34.5±34.26	4.51	19	<0.001
PM 10 Concentration ($\mu\text{g}/\text{m}^3$) before lockdown- PM 10 Concentration ($\mu\text{g}/\text{m}^3$) during lockdown	31±29	4.78	19	<0.001
O Concentration (ppb) before lockdown- O Concentration (ppb) during lockdown	4.7±53	0.39	19	0.696
SO Concentration (ppb) before lockdown- SO Concentration (ppb) during lockdown	-1.6±2.85	-2.5	19	0.021
CO Concentration (ppm) before lockdown- CO Concentration (ppm) during lockdown	3±3.1	4.31	19	<0.001
NO Concentration (ppb) before lockdown - NO Concentration (ppb) during lockdown	16±5.57	12.84	19	<0.001
AQI before lockdown- AQI during lockdown	20.9±23.05	4.05	19	0.001

Although, the lockdown may not be permanent but still closure of a country for a small time frame has indicated that even after spending crores of rupees on schemes and activities related to environment we could not sustain it but a lockdown which has marked a clear line of demarcation between mother nature and human activities which speaks out that if we stay away from them without crossing that line our planet can survive very well without devastation.

So we would like to recommend GOI and government of Delhi that a simple lockdown for few days and strict measure should come into practice.

Finally various literatures we have gone through for review have shown similar result and suggestion. Across globe with clear images from reputed organization like NASA and ISRO speaks out how devastating we human are and sudden lockdown which have kept a ban on our activities has led to improve in health of AQI and other environmental factors across globe.

Limitation of our studies

1. Small sample size
2. Less literature available in short time scale
3. O₃ association due to impact of lockdown could not be proven by our statistical test on the basis of data collected

CONCLUSION

In past 40 years air quality keeps on getting worse in Delhi and with an intervention in form of lockdown for a span of few weeks led to improved AQI where key pollutants like PM 2.5,10, NO₂, SO₂, CO remains at their minimal level according to the WHO

guidelines. During coming weeks more restrictive action are going to be taken up by GOI to reduce viral spread and simultaneously it will provide us a great opportunity to evaluate the affect of lockdown on emission standards and how to monitor our policy and regulation related to air pollution, though its long marathon to regulate our policy as we haven't learn from the emergency we faced in past still we hope that government may keep a watchdog like view on the lesson we have learned from this pandemic and follow those in future.

Abbreviations

GOI: Government of India

AQI: Air quality index

ISRO: Indian space research organisation

NASA: National Aeronautics and Space Administration

DPCB: Delhi pollution control board

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REFERENCES

- Alipur, Delhi, Delhi Air Pollution: Real-time Air Quality Index.* (n.d.). Retrieved April 25, 2020, from <https://aqicn.org/city/delhi/alipur/>
- Analysis of the impact of lockdown on the evolution Covid-19 epidemics in Spain.* (2020). <https://doi.org/10.1101/2020.04.18.20070862>

- AQI delhi | COVID-19 impact: Delhi breathes third week of clean air.* (n.d.). Retrieved April 25, 2020, from <https://m.economictimes.com/news/politics-and-nation/covid-19-impact-delhi-breathes-third-week-of-clean-air/articleshow/75001969.cms>
- AQI india: Lockdown clears up India's air—The Economic Times.* (n.d.). Retrieved April 25, 2020, from <https://economictimes.indiatimes.com/news/politics-and-nation/lockdown-clears-up-indias-air/articleshow/74942627.cms?from=mdr>
- aqi of alipur—Google Search.* (n.d.). Retrieved April 25, 2020, from https://www.google.com/search?xsrf=ALeKk03-swZE6gcVLLaJ4ZDSmO2kMqoMCw%3A1587818293506&ei=NS-kXu_BHsKCyaO FjZiY&q=aqi+ofalipur&oq=aqi+o falipur&gs_lcp=CgZwc3ktYWIQAzIHCCCEQChCgAToECAAQRzoECCMQJzoCCAA6BAgAEEM6BwgAEBQQhwI6BwgjELACECc6BAgAEA06BggAEA0QHICNH1jYL2DiMmgAcAJ4AIABwgWIAe0RkgENMC4xLjQuMC4xLjAuMZgBAKABAoBB2d3cy13aXo&scient=psy-ab&ved=0ahUKEwivsOiKzIPpAhVCAIXKHVYGBgsQ4dUDCAw&uact=5
- As cities wake up to cleaner air, pollution statistics become clearer.* (n.d.). Retrieved April 25, 2020, from <https://www.livemint.com/news/india/as-cities-wake-up-to-cleaner-air-pollution-statistics-become-clearer-11586720133306.html>
- Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic. - PubMed—NCBI.* (n.d.). Retrieved April 25, 2020, from <https://www.ncbi.nlm.nih.gov/pubmed/32302810>
- Coronavirus lockdown lifts Delhi's March air quality to 5-year high—The Hindu.* (n.d.). Retrieved April 25, 2020, from <https://www.thehindu.com/news/cities/Delhi/coronavirus-lockdown-lifts-delhis-march-air-quality-to-5-year-high/article31252221.ece>
- Coronavirus: Air pollution has fallen dramatically for these cities.* (n.d.). Retrieved April 25, 2020, from <https://www.cnn.com/2020/04/22/coronavirus-air-pollution-has-fallen-dramatically-for-these-cities.html>
- Effect of restricted emissions during COVID-19 on air quality in India | Request PDF.* (n.d.). Research Gate. <http://dx.doi.org/10.1016/j.scitotenv.2020.138878>
- Ijaz, M. 2020. Covid-19 and Air Quality of Lahore. <https://doi.org/10.13140/RG.2.2.35604.04482>
- India under COVID-19 lockdown. (n.d.). Retrieved April 25, 2020, from https://www.researchgate.net/publication/340883039_India_under_COVID-19_lockdown?_sg=iZHoiABJVkvCr516pBBDyVGENIthMgACRvNvvTub5oI_qXMfQ114khZCxeA3pWtX2A_hzsw_6a4WUo
- India's Air Pollution Plummet in COVID-19 Lockdown. (2020, April 2). EcoWatch. <https://www.ecowatch.com/india-air-pollution-coronavirus-2645617908.html>
- India's coronavirus lockdown is having a dramatic impact on pollution—CNN. (n.d.). Retrieved April 25, 2020, from <https://edition.cnn.com/2020/03/31/asia/coronavirus-lockdown-impact-pollution-india-intl-hnk/index.html>
- Indoor Air Quality, Volume 3—1st Edition. (n.d.). Retrieved April 25, 2020, from <https://www.elsevier.com/books/indoor-air-quality/maroni/978-0-444-81642-9>
- Khan, N. 2020. An Exploratory Study of Impact of Lockdown on Air Quality of Delhi.
- Lau, H., Khosrawipour, V., Kocbach, P., Miko³ajczyk, A., Schubert, J., Bania, J. and Khosrawipour, T. 2020. The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. *Journal of Travel Medicine.* <https://doi.org/10.1093/jtm/taaa037>
- Martelletti, L. and Martelletti, P. 2020a. Air Pollution and the Novel Covid-19 Disease: A Putative Disease Risk Factor. *SN Comprehensive Clinical Medicine,* 1-5. <https://doi.org/10.1007/s42399-020-00274-4>
- Martelletti, L. and Martelletti, P. 2020b. Air Pollution and the Novel Covid-19 Disease: A Putative Disease Risk Factor. *SN Comprehensive Clinical Medicine,* 1-5. <https://doi.org/10.1007/s42399-020-00274-4>
- McNeill, V. 2020. COVID-19 and the Air We Breathe. *ACS Earth and Space Chemistry,* XXXX. <https://doi.org/10.1021/acsearthspacechem.0c00093>
- Part 'I: Impact of the COVID-19 Event on Air Quality in Wuhan, Jingmen, and Enshi Cities, China. (2020). *Aerosol and Air Quality Research.* <https://doi.org/10.4209/aaqr.2020.04.0150>
- Punjabi Bagh, Delhi, Delhi Air Pollution: Real-time Air Quality Index. (n.d.). Retrieved April 25, 2020, from <https://aqicn.org/city/delhi/punjabi-bagh/>
- Spare The Air: AQI Calculator: Concentration to AQI. (n.d.). Retrieved April 25, 2020, from <http://www.sparetheair.com/calculatorc.cfm>
- Sri Auribindo Marg, Delhi, Delhi Air Pollution: Real-time Air Quality Index. (n.d.). Retrieved April 25, 2020, from <https://aqicn.org/city/delhi/sri-auribindo-marg/>