Impact of COVID-19 Lockdown on the Risk of Breast Cancer: A Case Study

Akriti Sharma1*, Nishtha Hooda2, Nidhi Rani Gupta3 and Renu Sharma1

1 Chandigarh University, Mohali 140413 (Punjab), India
2 Indian Institute of Information Technology, Una 177220 (Himachal Pradesh), India
3 Multani Mal Modi College, Patiala 147001 (Punjab), India

* Corresponding author: akriti.7799@gmail.com

Abstract. Air pollution is among the world's major environmental concerns. It remains a major health threat in India and is the leading environmental cause of morbidity in the country. There is considerable evidence that heavy and prolonged exposure to several air contaminants increases the cancer risk. The prevalence of breast cancer in citified environments with high exposure to air pollution has been seen to be elevated. Among various Indian cities, the Delhi cancer registry is having a high breast cancer incidence (28.6%). Owing to the recent and unprecedented global outbreak of coronavirus infectious disease (COVID-19), India is exploring every possible way of controlling its vigorous human transmission. Work from home culture is adopted so as to maintain social distancing during the lockdown. This momentary stoppage is substantially reducing the level of air pollution in several city areas across India dramatically. This paper (i) Overviews the breast cancer and air pollution association; (ii) Compiles the air quality data of Delhi monitored by CPCB during the COVID-19 pandemic lockdown time and compares it with pre-lockdown air quality data; (iii) Explores the reduced threat of breast cancer in Delhi during the nationwide lockdown. This work concluded that Air pollution serves a significant part in breast cancer occurrence. The countrywide lockdown in an attempt to prevent Covid-19 transmission has greatly improved the air quality of various Indian cities like Delhi. Also, with an unprecedented drop in rates of air pollution over Delhi, breast cancer occurrence may also decrease.

Keywords: Breast cancer; Risk analysis; COVID-19; Air pollution

1. Introduction
Cancer incidence has continued to rise in India over the last 20 years, as it has in other developing nations. The pattern has also changed along with the incidence of cancer. Changes in food habits, lifestyle, and increased life expectancy have made a significant contribution to this transition. Among various types of cancer, breast cancer incidence is rising and is expected to be the most widely known cancer amongst women in India in the coming years [1]. Although the majority of features and underlying causes are uniform throughout the world there is uniqueness for particular cancer in every region. Most Indian cities have seen breast cancer as the most prevalent cancer. Every four minutes in India 1 female is identified with breast cancer and 1 female dies every eight minutes from breast cancer. Approximately 70,218 women passed away from breast cancer in India, the highest in the world for the year 2012 [2].

As per the Globocan 2012, India collectively counts for approximately one-third of the global burden of breast cancer, along with the USA and China. India is confronting a challenging situation owing to
a rise of 11.54 percent in incidence and a rise of 13.82 percent in breast cancer mortality during the period 2008–2012 [3]. As per the individual registries, breast cancer is ranked as highest (Dibrugarh, Bangalore, New Delhi, Mumbai, and Chennai) in the 2012-2014 periods. Growing westernization and urbanization coupled with dietary preferences and changing lifestyles have led to breast cancer hitting a top place in all major urban registries [4]. Based on all the PBCRs, Delhi held top place with an age-adjusted rate of 41.0/lakh proceeded by Chennai (37.9) in second, Bangalore (34.4) in third, and Thiruvananthapuram District (33.7) in the fourth position, as shown in Figure 1. The ratio of mortality/incidence (MIR) is a novel indicator for determining incidence-related cancer deaths. It is used to determine whether there is a higher death in an area than could be estimated on the basis of its incidence. Delhi registry had a minimal mortality/incidence ratio of 8.0 without being affected by elevated incidence (28.6%), likely due to awarded population, better medical facilities, and high literacy in metropolitan cities [4].

Figure 1. Comparison of Age-Adjusted Incidence Rates (AARs) of all PBCRs BREAST (ICD-10: C50) - Females [5].

In Delhi, the leading cancer sites among males were: lung-10.5 percent, mouth-6.9 percent, prostate-6.7 percent, tongue-6.5 percent, and larynx-5.7 percent. The corresponding AAR and CR per 100,000 for the sites were: lung (17.2 and 11.8), mouth (9.5 and 7.8), prostate (12.4 and 7.6), tongue (9.3 and 7.3), and larynx (8.9 and 6.4) [5]. The leading cancer sites among females were: breast-28.6 percent followed by cervix uteri-10.8 percent, gall bladder-7.9 percent, ovary-7.2 percent, and corpus uteri-3.5 percent. The respective AAR and CR per 100,000 population for the sites were: breast (41.0 and 34.8), cervix uteri (15.5 and 13.2), gall bladder (11.8 and 9.6), ovary (10.0 and 8.7), and corpus uteri (5.5 and 4.3) [5] as shown in Figure 2.
Breast cancer etiology is complex, and its occurrence is attributed to many risk factors. They contain elements linked to reproductive health, genetic mutations, family history, environmental, and occupational exposures to contaminants [6]. Environmental factors are considered to perform an important part in the pathophysiology of the disease. Findings have identified the possible risk of breast cancer with susceptibility to toxicants in ambient air [7].

Rapidly increasing rates of air pollution are of significant concern to public health, especially in the cities, and have been directly linked to a variety of health hazards, including cardiovascular disease, childhood asthma, and lung cancer [8]. Outdoor air pollution has been listed as a carcinogen of category-1 by International Agency for Research on Cancer [9] and air pollution linked to vehicles covers multiple carcinogenic substances, such as polycyclic aromatic hydrocarbons (PAHs) [8]. PAHs generated through partial burning of organic content are suspected to be carcinogens for the lungs and can be of particular interest to breast cancer as they can adhere to DNA and form DNA adducts in breast tissue. Furthermore, animal-based research has also revealed that polycyclic aromatic hydrocarbons are capable of causing mammary tumors [10].

In a database monitored and presented by World Health Organization in April 2018, which includes 100 nations, India holds fourteen of the leading fifteen cities accounting for the worst PM2.5 levels. Delhi tops among the world’s megacities for PM10 pollution [11]. Also, the Delhi cancer registry is having the highest breast cancer incidence (28.6%) [4]. The World Health Organization (WHO) has considered the recent and unprecedented worldwide emergence of a contagious coronavirus disease (COVID-19) as a global health emergency [12]. A nationwide lockdown of twenty-one days was imposed in India from March 25, 2020, to April 14, 2020, to prevent its spread. All institutes, factories, offices, and transport facilities were closed, except for essential services [13]. The nationwide halting of industrial activities and transportation systems has resulted in an apparent substantial decline in the level of a variety of gases released from the transport and energy sectors [12].

The remaining part of the work discusses the research related to the correlation of ambient air pollution with breast cancer and the COVID-19 lockdown influence on air quality. Then compiles AQI data of Delhi during the lockdown time and compares this with the AQI value before lockdown. The last section concludes the study while presenting further research concerns.
2. Literature Review

This section summarizes the related literature on the correlation of air pollution with breast cancer and COVID-19 lockout influence on air quality.

2.1 Related work on the association of air pollution with breast cancer

Nearly one out of three emerging instances of breast cancer are attributed to familiar factors and most of the pathophysiology persists to be uncertain [14]. The prevalence of breast cancer has been observed to be more in big cities with greater air pollution levels [15]. Local vehicle traffic is the leading source of air pollution in citified environments. Exhaust from the transport sector includes gases, VOCs, and particulate matter, most of these are deemed as potential/accepted carcinogens [16]. Studies indicate that elevated vehicle emissions in the US are linked to higher breast cancer risk [17].

Research findings have revealed that outdoor and indoor air contamination correlates with the possibility of breast cancer [7]. Toxic metals have demonstrated estrogenic and carcinogenic properties. Another research assessed the possibility of breast cancer occurrence in a large U.S.-wide cohort with respect to proximity to toxic metallic pollutants in the air. Increased levels of certain airborne metals, namely cadmium, lead, and mercury are linked to a greater probability of postmenopausal breast cancer [19].

Another research investigated data to ascertain if ambient air pollution has an influence on breast cancer prevalence. Geographic differences and trends referring to time in the rate of breast cancer have been examined with respect to the release of air pollutants [20]. There was a remarkable rise in the overall breast cancer prevalence in the US during the period 1986 to 2000, which could emerge as a consequence of the increased level of air pollution from automobiles and industrialization. The prevalence of breast cancer in metropolitan and heavy-emission areas has been noted to increase. This research finds a possible link across the United States between air pollution and breast cancer [20]. Table 1 presents the literature review showing association of air pollution with breast cancer.

| TITLE OF PAPER | DESCRIPTION | FINDINGS | RISK FACTORS OF BREAST | REFERENCE |
|----------------|-------------|----------|------------------------|-----------|
| “Exposure to traffic emissions throughout life and risk of breast cancer: the Western New York Exposures and Breast Cancer (WEB) study” | This work examined the possibility of breast cancer in reference to life-long exposure to air pollution from transport sector emissions. | Early-life proximity has an effect on breast cancer occurrence and shows a significant influence of traffic pollution in its potential risk. | Traffic emissions | Nie et al., 2007 [21] |
| “Exposure to traffic-related air pollution and the risk of developing breast cancer” | The research examines the correlation between historical NO2 exposure metrics | This work finds that air pollution from traffic emissions could be associated with susceptibility to air pollution through traffic | | Hystad et al., 2015 [22] |
| Study Title | Summary | Key Findings |
|-------------|---------|--------------|
| Cancer among women in eight Canadian provinces: A case-control study | and incidences of breast cancer development, with greater correlations among premenopausal females. |  |
| Breast Cancer Risk and Exposure in Early Life to Polycyclic Aromatic Hydrocarbons using Total Suspended Particulates as a Proxy Measure | This work conducted a study of exposure to polycyclic aromatic hydrocarbons (PAHs) in early life with respect to breast cancer risk. | The findings suggest that exposure to PAHs in formative years might increase the possibility of postmenopausal breast cancer. |
| Postmenopausal Breast Cancer Is Associated with Exposure to Traffic-Related Air Pollution in Montreal, Canada: A Case-Control Study | This study assesses how well the occurrence of postmenopausal breast cancer is correlated with air pollution susceptibility in big urban sprawls. | This study shows that the occurrence of postmenopausal breast cancer is linked to exposure to nitrogen dioxide. |
| Hazardous air Pollutants and breast cancer risk in California teachers: a cohort study | This research investigated the association between the emergence of breast cancer cases and air pollutants which are identified as mammary gland carcinogens (considering the modeled levels of air pollutants). | This work reported significant correlations between elevated chances of breast cancer with respect to housing in locations where vinyl chloride and propylene levels are higher. |
| Air Pollution and Breast Cancer: a Review | The purpose of this work is to examine epidemiological information concerning the involvement of air pollution with the | The study reveals the possible relationship between air pollution in breast cancer emergence. |
prevalence of breast cancer. while considering NO2 as a marker for air contamination from the transportation sector.

“Association between ambient air pollution and breast cancer risk: The multiethnic cohort study”

The research investigated the likelihood of breast cancer in Southern California Multiethnic Cohort by exposure to air contaminants over longer periods of time. Women living near major roads were at a higher likelihood of breast cancer as they were more susceptible to air pollution.

Ambient air pollution Cheng et al., 2020 [26]

“Residential Exposure to Estrogen Disrupting Hazardous Air Pollutants and Breast Cancer Risk: the California Teachers Study”

The link between the threat of breast cancer and the susceptibility of housing to ambient estrogen disruptors is investigated in this work. There is a possibility of breast cancer with minimal dose exposure to inorganic arsenic or ambient cadmium for a longer duration.

Estrogen Disrupting Hazardous Air Pollutants Liu et al.; 2015 [18]

“Metallic Air Pollutants and Breast Cancer Risk in a Nationwide Cohort Study”

The study assessed the breast cancer risk in a large U.S.-wide cohort with respect to proximity to toxic metallic pollutants in the air. Elevated levels of certain airborne metals, namely Pb, Cd, and Hg are linked to an increased threat of postmenopausal breast cancer.

Metallic Air Pollutants White et al., 2019 [19]

“PAHs and PM2.5 emissions and female breast cancer incidence in metro Atlanta and rural Georgia”

In this research, emission levels of PM2.5 and polycyclic aromatic hydrocarbons have been examined in reference to breast cancer emergence. This study concluded that air pollution, especially PM2.5 and PAHs, may significantly affect the likelihood of suffering from breast cancer.

ambient air pollution, especially PAHs and PM2.5 Parikh et al., 2016 [27]
in rural Georgia and Atlanta metro.

2.2 Influence of lockdown imposed during COVID-19 on air quality

The COVID-19 pandemic, which emerged in Wuhan, China, has been recognized by the World Health Organization as a public health emergency at a worldwide scale. Consequently, several countries-imposed restrictions on flights to China [28]. With the abrupt onset of the novel coronavirus (COVID-19), lockdown measures have been adopted in various countries across the world [29]. In India, a countrywide twenty-one days lockdown was implemented from March 25, 2020, to April 14, 2020, to limit the transmission of the coronavirus pandemic. Consequently, all educational establishments, offices, transport facilities, and factories are to be closed during the lockdown period excluding essential services [13]. The countrywide temporary suspension of major industrial units and public transport systems has contributed to a reduction in the emissions of gases from the transportation and energy sector [12] which resulted in improved air quality. Table 2 presents a review of the literature showing COVID-19 lockdown’s influence on air quality.

Table 2. Literature review showing the effect of COVID-19 lockdown on the quality of air.

| TITLE OF PAPER                                                                 | DESCRIPTION                                                                 | FINDINGS                                                                 | REFERENCES                           |
|--------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------|
| “A Study on Air Quality Index (AQI) of Bengaluru, Karnataka during Lockdown Period to Combat Coronavirus Disease (Covid-19): Air Quality Turns ‘Better’ from ‘Hazardous’” | The focus of this research is to examine the trend in AQI during the lockdown time in Bengaluru. | Bengaluru’s AQI turned ‘better’ from ‘hazardous’ within twenty-four hours after the lockdown was imposed. | Kambalagere et al., 2020 [13] |
| “COVID-19, City Lockdown, and Air Pollution: Evidence from China”              | Using a comprehensive and timely dataset, the study examined the influence of city lockdown on China's air quality. | The PM2.5 concentrations and the Air Quality Index dropped significantly by 25 percent within weeks. | He et al., 2020 [30] |
| “Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic” | This work attempts to demonstrate shifts in air pollution rates in the city of Barcelona (NE Spain) during lockdown measures. | Urban air pollution declined considerably after fourteen days of lockdown however with considerable variations between pollutants. | Tobías et al., [31] |
| “The dramatic impact of Coronavirus outbreak on air quality: Has it saved as much as it has killed so far?” | This work presents the first case study that compares the pre and post-crisis air quality. | The study concluded that through COVID-19 lockdown measures a greater number of people might have been saved by | Isaifan (2020) [32] |


| Topic                                                                 | Description                                                                                                                                                                                                 | Reference       |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Abrupt declines in tropospheric nitrogen dioxide over China after the outbreak of COVID-19 | This study provides observations into the unforeseen economic and environmental implications of reduced economic activities.                                                                                      | Liu et al., 2020 |
| COVID-19 lockdowns cause global air pollution declines with 2 implications for public health risk | The study tested that lockdown has reduced ground-level and tropospheric air pollution levels using a network of more than ten thousand air quality stations and satellite data. | Venter et al., 2020 |
| Good in The Worst: COVID-19 Restrictions and Ease in Global Air Pollution | This document analyzes and outlines valuable data that appeared in newspapers and media covering information on air pollution mitigation in major cities that were severely affected by COVID-19. | Anjum et at., 2020 |
| Lockdown caused by COVID-19 pandemic reduces air pollution in cities worldwide | The study examines the variations in levels of six air pollutants namely NO2, O3, CO, PM2.5, SO2, PM10 between February, March 2019, and 2020, in forty cities. | Shrestha et al., 2020 |

Following the lockdown, several air quality studies found a considerable drop in pollution levels. Pratima and Dogra compared the levels of particulate matter 2.5 and 10 as well as ground-level ozone, SO2, and NO2 before and after lockdown. As per the findings, the levels of SO2, NO2, PM2.5, and PM10 in Delhi were reduced by 19 percent, 60 percent, 49 percent, and 55 percent, respectively, in the post-lockdown phase [45]. Another study compared the AQI before and after lockdown considering seven air pollutants. During the lockdown, PM2.5, PM10, and CO levels in Delhi fell by 52 percent, 39 percent, and 13 percent, respectively. In the post-lockdown period, these pollutants showed the same decreasing pattern, with 4 percent, 4 percent, and 12 percent for Delhi [46].
3. Material and methods

This section discusses the study area and methods adopted during the air quality analysis in Delhi.

3.1 Study Area

The current work is conducted on Delhi, India's capital city, located on the western side of the Yamuna River, and captures a range of 1,490 square kilometers [38]. Delhi is among the large cities worldwide that are grappling with fast urban sprawl and enormous rates of emissions from household, transport, and industrial activities [39]. It has undergone a rapid pace of urbanization noticeable from the growing population. The sharply growing population has changed considerably the pattern of land utilization [40].

Delhi has been consistently listed among the world’s severely polluted cities in recent years. Particulate Matter 2.5 pollution over Delhi poses a challenge to India's capital. The concentration of Particulate Matter 2.5 in Delhi surpasses the national air quality level by over 300 percent [41]. In addition, there are around 4.8 million registered vehicles, 125,000 industrial units (medium and small-sized), and 3 coal-fired thermal power stations in Delhi. The key pollution sources in Delhi include vehicular emissions, power plants, domestic cooking, and small-scale industries [42].

Delhi, once renowned for its diverse historical architectural attractions, is now a smog-smothered place which often compromises the attractiveness of these historical structures due to reduced visibility [43]. Delhi is undergoing health implications from various contaminants, notably respirable particulate matter. The findings in the year 2010 revealed that lung cancer has caused 223,000 fatalities worldwide attributable to air pollution. The IARC, which is a WHO specialized agency has categorized outdoor air pollution in Group-2 carcinogenic to mankind in October 2013 [44]. Based on all the PBCRs, Delhi held top place with AAR 41.0 (per 100,000). Delhi registry had a minimal mortality/incidence ratio of 8.0 without being affected by elevated incidence (28.6%) [4].

3.2 Sampling Stations

Various air quality stations have been established in various parts of Delhi with the goal of determining air quality trends so that suitable steps can be taken if necessary. Table 3 lists the various monitoring stations run by the CPCB in Delhi.

Table 3. Ambient Air Quality Monitoring Stations, Delhi

| Ambient Air Quality Monitoring Stations, Delhi |
|-----------------------------------------------|
| “Ambient Air Quality Monitoring Station 1” Alipur, Delhi- DPCC |
| Ambient Air Quality Monitoring Station 2 Anand Vihar, Delhi - DPCC |
| Ambient Air Quality Monitoring Station 3 Ashok Vihar, Delhi - DPCC |
| Ambient Air Quality Monitoring Station 4 Aya Nagar, Delhi - IMD |
| Ambient Air Quality Monitoring Station 5 Bawana, Delhi - DPCC |
| Ambient Air Quality Monitoring Station 6 Burari Crossing, Delhi - IMD |
| Ambient Air Quality Monitoring Station 7 CRRI Mathura Road, Delhi - IMD |
| Ambient Air Quality Monitoring Station 8 DTU, Delhi - CPCB |
| Ambient Air Quality Monitoring Station 9 Dr. Karni Singh Shooting Range, Delhi - DPCC |
| Ambient Air Quality Monitoring Station 10 Dwarka-Sector 8, Delhi - DPCC |
| Ambient Air Quality Monitoring Station 11 IGI Airport (T3), Delhi - IMD |
| Ambient Air Quality Monitoring Station 12 IHBAS, Dilshad Garden, Delhi - CPCB |
| Ambient Air Quality Monitoring Station 13 ITO, Delhi - CPCB |
| Ambient Air Quality Monitoring Station 14 Jahangirpuri, Delhi - DPCC |
| Ambient Air Quality Monitoring Station 15 Jawaharlal Nehru Stadium, Delhi - DPCC |
4. Result and discussion

This section discusses the air quality in Delhi using the air quality index.

4.1 National Air Quality Index

The National Air Quality Index (NAQI), a measure initiated by the government of India as an effort to track air quality on a daily basis under the 'Swachh Bharat Programme' as 'One Number - One Colour - One Definition' for the layman to understand air quality [13].

The National Air Monitoring Program (NAMP), which includes 240 cities across the country, is administered by the Central Pollution Control Board in coordination with State Pollution Control Boards. In addition, in a few cities, continuous monitoring systems are also installed which provide data on a near-real-time basis. Air Quality Index (AQI) is a tool adopted to effectively portray information to people on air quality [35]. AQI can be measured by employing a formula based on a comprehensive evaluation of air pollutant levels, which can be utilized by government authorities to describe the air quality status at a specific location [36]. There are 6 categories of AQIs: Severe, Very Poor, Poor, Moderately Polluted, Satisfactory, and Good. The proposed Air Quality Index would include eight pollutants (NO2, PM10, CO, PM2.5, Pb, SO2, NH3, and O3) of which National Ambient Air Quality Levels are specified for an average duration of up to twenty-four hours [35].

The Air Quality Index reports daily for air quality. It informs on whether the air is polluted or clean, and what could be the possible health concerns. This emphasizes health consequences that might be encountered in about a very few hours/ days upon inhaling toxic air [37]. The AQI ranges from 0-500. A higher AQI value reflects an elevated degree of air pollution, suggesting a greater health concern. An Air Quality Index value of a hundred usually refers to the standard of air quality set at the national level regarding the pollutants and is also the threshold decided by Environment Protection Agency for health protection in India. Its values below a hundred are deemed satisfactory. As the values increase, it becomes dangerous initially for a sensitive group of individuals and gradually for all [37].
In reference to the measured ambient values along with their potential health impacts, a sub-index for all pollutants is calculated. Associated potential health implications for different pollutants and AQI categories have been indicated, with critical inputs from medical experts. The Air Quality Index values and respective ambient levels (health breakpoints) along with the associated potential health consequences for the eight pollutants are shown in Figure 3 and Table 4 [35].

![AQI Category, Pollutants and Health Breakpoints](image)

Table 4. Air quality index categories and precautionary health advice [35].

| AQI Category (Range) | PM$_{10}$ 24-hr | PM$_{2.5}$ 24-hr | NO$_2$ 24-hr | O$_3$ 8-hr | CO 8-hr (mg/m$^3$) | SO$_2$ 24-hr | NH$_3$ 24-hr | Pb 24-hr |
|----------------------|-----------------|-----------------|-------------|-------------|---------------------|-------------|------------|---------|
| Good (0-50)          | 0-50            | 0-30            | 0-40        | 0-50        | 0-1.0               | 0-40        | 0-200      | 0-0.5   |
| Satisfactory (51-100)| 51-100          | 31-60           | 41-80       | 51-100      | 1.1-2.0             | 41-80       | 201-400    | 0.5-1.0 |
| Moderately polluted (101-200) | 101-250         | 61-90           | 81-180      | 101-168     | 2.1-10              | 81-380      | 401-800    | 1.1-2.0 |
| Poor (201-300)       | 251-350         | 91-120          | 181-280     | 169-208     | 10-17               | 381-800     | 801-1200   | 2.1-3.0 |
| Very poor (301-400)  | 351-430         | 121-250         | 281-400     | 299-748*    | 17-34               | 801-1600    | 1200-1800  | 3.1-3.5 |
| Severe (401-500)     | 430+            | 250+            | 400+        | 748+*       | 34+                 | 1600+       | 1800+      | 3.5+    |

**Figure 3.** AQI Category, Pollutants and Health Breakpoints [35].

**Table 4.** Air quality index categories and precautionary health advice [35].

| AQI | Remark   | Color Code | Possible Health Impacts                             |
|-----|----------|------------|-----------------------------------------------------|
| 0 to 50 | Good      | Green      | Minimal Impacts                                     |
| 51 to 100 | Satisfactory | Yellow    | Mild respiratory distress to sensitive individuals   |
| 101 to 200 | Moderate   | Orange     | Breathing difficulty for individuals suffering from asthma, heart, and lungs diseases |
| 201 to 300 | Poor       | Red        | Breathing distress to most individuals on long exposure |
| 301 to 400 | Very Poor  | Red        | Breathing distress following prolonged exposure      |
| 401-500 | Severe     | Red        | Influences healthy individuals and has significant implications for those with existing illness |

4.2 Air Quality Trends in Delhi

This study describes the pattern of the AQI during lockdown time in Delhi. With the COVID-19 outbreak, a lockdown of twenty-one days was imposed across the entire country including Delhi to curb the transmission of coronavirus. With no factories functioning and limited vehicles on the roads, Delhi’s air quality has greatly improved amid the lockdown. This study has compiled the data from the Central Pollution Control Board website without modifications.
4.2.1. Air quality Analysis Oct 2019 to March 2020. Air pollution is of concern to health and the environment, especially in urban areas [35]. For several years, CPCB has been measuring the air quality of different regions across Delhi. Monitoring sites have been categorized based on the land utilization patterns i.e., traffic intersections, and residential and industrial areas [37]. In this work, the everyday data from all the air sampling sites in Delhi put by CPCB is procured. Six months are taken into account for examining the variability of the AQI values as follows: October, November, December, January and February, and March (including the nationwide lockout period beginning on March 25). The month-wise average of the Air Quality Index of these stations was then computed as shown in Figure 4. The highest AQI value is observed in December as per the analysis done, and the lowest value is observed in March, which includes the lockdown period. Delhi showed much lower levels of harmful contaminants emitted by power plants and vehicles during the lockdown.

![AQI Trends in Delhi (Oct 2019 to March 2020)](image)

**Figure 4.** AQI Trends in Delhi (Oct 2019 to March 2020).

The patterns are compared on monthly basis for different monitoring stations in Delhi considering the observations for declining air quality standards from AQI Categories, which depict poor, moderate, and very poor categories. The Air Quality Index presented the following pattern in the declining order: December > November > January > February > October > March. Decreasing AQI order indicates that the air quality goes from the inferior to improved category e.g., this means that there is the worst air quality in December and the best in March. Delhi’s Air Quality Index (AQI) has shown a sharp change from earlier very poor and poor levels to 'Moderate' levels in March as shown in Table 5. Air quality gradually improved by the end of March.
Table 5. Air quality index categories and precautionary health advice in Delhi (Oct 2019 to March 2020).

| MONTH      | AQI (Average) in Delhi | AQI    | Remark | Color Code | Possible Health Impacts                                      |
|------------|------------------------|--------|--------|------------|-------------------------------------------------------------|
| OCTOBER    | 204.31                 | 201 to 300 | Poor   | Yellow | Breathing difficulty after long exposure to most individuals.|
| NOVEMBER   | 278.05                 | 201 to 300 | Poor   | Yellow | Breathing difficulty after long exposure to most individuals.|
| DECEMBER   | 302.11                 | 301 to 400 | Very Poor | Red | Respiratory illness on prolonged exposure.                  |
| JANUARY    | 250.04                 | 201 to 300 | Poor   | Yellow | Breathing difficulty after long exposure to most individuals.|
| FEBRUARY   | 218.56                 | 201 to 300 | Poor   | Yellow | Breathing difficulty after long exposure to most individuals.|
| MARCH      | 112.17                 | 101 to 200 | Moderate | Yellow | Breathing difficulty for individuals with asthma, heart, and lungs disease.|

4.2.2. Air quality Analysis 25th to 31st March 2018, 2019, 2020. In the study, the Average air quality of Delhi is computed for the year 2018-2020 from 25th to 31st March. Delhi's air quality index (AQI) showed a sharp fall to 'Satisfactory' levels amid the lockdown period in comparison to the last two years as shown in Table 6 and Figure 5. In the previous two years, AQI was Moderate and Poor during the same period with a possibility of causing breathing discomfort. The countrywide lockout adopted to fight Covid-19 positively affected the air quality. The air quality index procured from CPCB indicated relatively safer AQI levels. The analysis of the average AQI of the past two years (from 25th to 31st March) and its comparison with the 7 days of the lockdown period also showed a significant improvement in the air quality as shown in Figure 6.

Table 6. Air Quality Index of Delhi (25th to 31st March 2018, 2019, 2020).

| LOCKDOWN DAYS (March) | 2018 | 2019 | 2020 |
|-----------------------|------|------|------|
| 25                    | 193  | 138  | 59   |
| 26                    | 186  | 161  | 64   |
| 27                    | 229  | 173  | 60   |
| 28                    | 259  | 227  | 34   |
| 29                    | 214  | 232  | 40   |
| 30                    | 221  | 223  | 56   |
| 31                    | 256  | 183  | 68   |
| Average AQI           | 223  | 191  | 54   |
**Figure 5.** Average Air Quality Index of Delhi (25th to 31st March 2018, 2019, 2020).

**Figure 6.** AQI on the days of lockdown in comparison with the same days of the previous two years.
5. Conclusions

Breast cancer is caused by the uncontrolled division of breast cells. There are several causes that have been linked to breast cancer occurrence including environmental causes. Among various environmental causes, air pollution has become a matter of concern for the environment and has been acknowledged for its adverse effects on the human body. There has been a variety of health effects attributable to air pollution including respiratory illness, asthma, cancer, etc. Several findings support the involvement of ambient air pollution in breast cancer occurrence. The nationwide temporary suspension of large industrial units and transportation facilities amid the COVID-19 lockdown has led to obvious cutbacks in the emission of transport and energy-related gases. The countrywide lockdown in an attempt to prevent Covid-19 transmission has greatly improved the air quality of various Indian cities like Delhi. Delhi has a high incidence of breast cancer (28.6 percent), and with an unprecedented drop in rates of air pollution over Delhi, breast cancer occurrence may also decrease. The current study concludes that air pollution serves a significant part in breast cancer occurrence, but more work is required to determine the potential association between breast cancer and different air pollutants.

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