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Impact of Ambient Air Quality on Respiratory Morbidity: A Retrospective Trend Analysis of The Cases Reported In The Regions of Delhi, India

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ABSTRACT

Air pollution remains a major public health challenge in Delhi, for past decade in India with elevated AQI, PM2.5, and PM10 levels closely associated with respiratory morbidities evident through the number of admissions in the emergency departments of the health facilities across regions of Delhi, India. This study analyses five years of data (from years 2018–2022) to examine persistence of linkage between air quality and respiratory morbidity, including cases requiring nebulization and ventilator support. Respiratory cases peaked at 983,339 during periods of severe pollution in the year 2018, declined in 2020 following lockdown measures, and rose again to over 192,000 after restrictions were lifted and normal activities resumed. The study recommends a balanced mainstreaming of systemic policies with strategic approaches to implement laws and rules as well as regulatory standards and public guidelines, specifically targeting vulnerable populations in the form of regulatory to control the air pollution generating sources and practicing community–driven desirable behaviours adhering to the governmental advisories to prevent alarming levels of air pollution and related respiratory morbidities leading to pre-mature mortalities.

Keywords: Air pollution, Air quality Index (AQI), PM2.5, PM10, respiratory illness cases

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INTRODUCTION

Delhi, the capital city of India, has been consistently ranked among the most polluted cities in the world for past decade, threatening the public health of 33 million citizens (Chen.Y 2024). Evidently, the ambient air quality of Delhi which indicates the levels of outdoor air pollution and the deviating concentration of pollutants show seasonal variation with persistently exceeding the safe limits of concentration (WHO 2022). Globally, the poor air quality has been proven to be associated with 7 million pre-mature deaths (WHO 2021) and affecting the morbidity levels due to high risk of heart, renal, liver and respiratory diseases (IHME, 2024). Evidently, the quest led to explore the linkage of Prevalence of AQI and pollutant concentrates affecting respiratory illness cases reported to the emergency departments of the health facilities over five years in the regions of Delhi. The study has been undertaken to analyse the secondary sources of the system and highlight the impact of persistent poor ambient air quality on the burden of respiratory diseases in the health facilities or hospitals in the regions across Delhi.

Concept and operational Definitions

The Ambient Air Quality of the region or country is the condition or purity of the air in the outdoor environment that refers to the out door's air cleanliness, specifically in the spaces where people work, live, breathe and engage in activities. It indicates the overall concentration of the pollutants, including particulate matter, gases and other undesirable substances present in the atmosphere (CPCB, 2013).

Particulate matters are the undesirable substances, which are settled in the atmosphere derived from various sources. According to the CPCB (2013) and IHME (2024), "There are two key local air pollutants that can have adverse health impacts: ozone and particulate matter. The particulate matters are the tiny solid or liquid particles released from the vehicles, industries and dust known in the forms of PM2.5 and PM10, pose higher death risks than ozone on the Earth's atmosphere, as they enter the respiratory pathways and settle in the respiratory systems (Ghorani et al. 2016) detrimental effect of these pollutants have been reported especially on female health (Afzal et al., 2024). The other pollutants are found in the form of gases as Nitrogen Dioxide released from vehicles and power plants, Sulphur Dioxide from burning fossil fuels, Carbon Monoxide from vehicle emissions and Lead from the heavy metals."

Air Pollution is the contamination of indoor or outdoor environments or both by the prevalence of the range of higher levels of the particulate matters and undesirable gases in the outdoor environment, caused either naturally or human activities often not visible by the naked eyes

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due to tiny size of pollutant particles and effect the ambient air quality of the regions or nations (MOHFW, NCDC 2025)

Air Quality Index (AQI) is a tool based on ambient concentration values of air pollutants and is categorized as Good, Satisfactory, Moderately Poor, Very Poor, and Severe pollution levels. Quality Index especially in the range of 'poor to severe' in a region may result in increased respiratory morbidity and mortality among the exposed people (MOHFW, NCDC 2025). Regular and frequent monitoring of the air quality is essential to determine the level of air pollution, environmental risks and its potential impact on human health. Regulatory standards and guidelines have been established by the World Health Organisation, Ministry of Health and Family Welfare, India, National Pollution Control Board of India and National Centre for disease control of to ensure that ambient air quality meets specific health and environmental criteria, safeguarding the well-being of communities and the natural surroundings.

Factors affecting Ambient Air Quality levels in perspective of possible health consequences in India and Delhi

According to **MOHFW, NCDC and CPCB (2025)**, "Air quality in India, particularly in Delhi, affects population health depending on pollution levels, duration of exposure, individual vulnerability, demographic characteristics, seasonal variations, and pre-existing health conditions. Short-term exposure to high pollution levels causes acute effects such as eye, nose, and throat irritation, coughing, wheezing, chest discomfort, and upper respiratory infections. Vulnerable groups—including young children, pregnant and lactating women, individuals with cardiovascular or respiratory diseases, and socio-economically marginalised populations—experience more severe outcomes. Long-term exposure increases the risk of chronic respiratory and cardiovascular diseases, lung cancer and premature mortality. Seasonal factors significantly influence pollution patterns, with winter trapping particulate matter suspending particles for long time on the ground and causes smog, summer increasing ozone formation, and monsoon rainfall improving air quality. In Delhi, smog problem is on the rise, especially during winter months, causing poor air quality and increasing respiratory health risks for residents by combining smoke and fog "

Situational Analysis

Air pollution is one of the world's most significant global health and environmental challenges. The Global Burden of Disease study by the Institute for Health Metrics and Evaluation (IHME, 2025) estimates that air pollution accounts for approximately 8 million deaths globally and

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annually, contributing to nearly one in ten deaths worldwide. In India, the proportion of deaths attributable to air pollution increased from 18.5% in 1990 to 23% in 2021. High population density, widespread vulnerability and emissions from vehicles, biomass and solid fuel use, industrial and agricultural activities as well as soil dust contribute to severe particulate pollution. The World Air Quality Report 2024 ranked India as the fifth most polluted country in the world and Delhi has been identified as the world's most polluted capital with a Particulate matter PM2.5 concentration of 91.6 µg/m³ (micrograms per cubic metre). Northern India faced extreme pollution levels with crop stubble-burning contributing to 60% of PM2.5 levels.

Deriving health risks from the AQI levels and public health behaviours advised in India

According to the Health adaptation plan for diseases due to air pollution released by the Ministry of Health and Family Welfare, India in the year 2021, "The AQI levels are distributed in seven levels as shown in the box below:

Air quality index (AQI) /Air Pollution level	**Possible health risks and consequences due to AQI**	**Public health advice and actions**
0-50: good	Low risk	No precautions
51-100: Satisfactory	Minor breathing discomfort in vulnerable populations	Reduce outdoor strenuous exercises
101-200: Moderate	Breathing discomfort in vulnerable populations or other health discomfort	Avoid outdoor strenuous exercises
201- 300: poor	Breathing discomfort in healthy population on long exposure and breathing discomfort in vulnerable populations on short exposure	Avoid outdoor physical exertions
301-400: Very poor	Respiratory illness in healthy people on prolonged exposure and pronounced respiratory and other illness in vulnerable populations on short exposure	Avoid outdoor physical activities during morning and evening hours and remain indoor with low activities
401-500: Severe	Respiratory illness in healthy people on prolonged exposure and serious respiratory and other illness in vulnerable populations on short exposure	remain indoor with low activities and seek admission in ED on shortness of breath and serious coughing
More than 500: dangerous/hazardous	Respiratory illness in healthy people and vulnerable populations on short exposure	

The populations under AQI levels above 100 are all under poor and dangerously at risk of receiving respiratory morbidities."

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REVIEW OF LITERATURE

Kumar et al. (2020) found that poor AQI in Delhi was linked with higher respiratory admissions. Balakrishnan et al. (2019) highlighted that air pollution is one of the biggest contributors to disease burden in India. It is noteworthy to mention that COVID-19 brought many challenges in northern India (Afzal et al., 2020). However, Sharma et al.(2021) reported that during the COVID-19 lockdown, Delhi's air quality improved significantly, leading to fewer respiratory illness cases. Pollutants in air causes many health problems especially in women related to reproductive health, and in many instance the awareness is very low especially in poor households (Afzal et al., 2024; Afzal 2024). The WHO reports and studies in Lancet Planetary Health (Balakrishnan et al., 2019), showed PM2.5 as the most harmful pollutant for human health. Researcher have reported that many manufacturing industries that do not comply with quality standards, that contribute to the emission of particulate matter (Afzal and Zaini, 2015). Studies in India have confirmed that higher AQI and PM2.5 levels are associated with more hospital visits and increased mortality (HEI 2019) For example, Balakrishnan et al. (2019) showed that exposure to air pollution contributes significantly to disease burden in India. Global studies confirm these findings as Ghorani-Azam et al. (2016) found that exposure to air pollutants is linked with asthma attacks, hospital admissions, and higher healthcare costs.

Aim of the study

Based on the contextual evidence presented in the introduction, situation analysis and existing literature, this study employed secondary data analysis to examine the association between elevated AQI levels and the burden of respiratory morbidity leading to increased emergency department admissions for clinical management in health facilities across Delhi. The analysis focuses on periods when average daily AQI consistently exceeded 200—and frequently surpassed 300 during winter months—corresponding to very poor to severe air quality levels.

METHODOLOGY

Data Collection and Study Settings

The descriptive study was undertaken using the secondary sources to know and understand the technical facts, concepts of the ambient air quality and its outcome in the form of air pollution and pollutants through technical documents, journals and reports found in the global and national literature.

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In consonance, the investigation is based on a retrospective observational study of the secondary data collected from the Central Pollution Control Board (CPCB), National Centre for Disease Control (NCDC) newsletters and Lok Sabha parliamentary documents from the years 2018 to 2022.

The data of the cases of respiratory illness admitted and treatments administered in the health facilities covering the regions of Delhi was obtained from official periodic records submitted periodically to the CPCB and the Lok Sabha Parliamentary documents, by the health facilities across Delhi. Delhi is bordered by states, Haryana on three sides and by Uttar Pradesh in the east. It is located at North Latitude from 28.24 – 28.53 degrees and East Longitude from 76.50 - 77.20 degrees. Delhi covers an area of 1483 Km2, of which 369.35 sq. Km. is designated as rural and 1113.65 Km2 as urban, which makes it the largest city in terms of area in the country. It has a length of 51.9 km and breadth of 48.48 Km. Delhi has 11 districts with 88 % literacy.

With due permissions taken from the concerned authorities, the two research scholars of Department of Healthcare and Pharmaceutical Management, SMBS, Jamia Hamdard, New Delhi, collected, sorted and segregated data for secondary analysis from the year 2018 to the year 2022. Although these sources contain wider data, but continuous periodic data were available with AQI levels, PM2.5 and PM10 along with number of cases admitted in various health facilities and treatments administered were found appropriate for the years 2018–2022. As per the data available before the year 2018 and after the year 2022, the average daily AQI were recorded only for few months with no value of PM2.5 and PM10 and records of admissions were not available periodically. Therefore, the data available from the year 2018 to the year 2022 were considered for further analysis

Secondary data analysis

The trends of the data for the cases of respiratory morbidities were analysed year-wise in relation with the levels of Average daily Air quality levels as per AQI, PM2.5 and PM 10. The data were categorised for the regions in Delhi:

- Average daily AQI per year, PM2.5 per year and PM 10 per year as calculated by the CPCB for the regions of Delhi
- The number of cases recorded for admissions with respiratory illnesses per year from 2018-2022 and treatments administered in the Emergency department of health facilities.

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The year-wise (years 2018-2022) figures of the numbers of respiratory morbidities were reported as the dependent variables as per the aim of the study, specifically linking to independent variables of the levels of daily average air quality composing PM2.5 and PM10 concentration levels and the kind of treatments administered were entered in the Microsoft excel sheets. The relationship for the linkages were studied through tabulations and graphical representations using Microsoft excel and the trends were analysed for the change in the number of respiratory illnesses reported for change in the prevalent levels of daily average air quality, PM2.5 and PM 10 per year.

RESULTS AND DISCUSSIONS

The analysis revealed the year-wise deviations of the ambient air quality from the year 2018-2022 in the regions of Delhi

The undesirable trends of average daily ambient air quality prevailed consistently for five years (years 2018-2022) in the regions of Delhi

The analysis of the distribution of the average daily AQI as per the records of CPCB for the regions of Delhi, revealed consistently, "very poor" trends as shown in the figure 1 below.

***The AQI*:** In the year 2018, the average daily AQI was 225, which was the highest in the series. The value slightly decreased in the year 2019 but stayed well above the safe range. A drop was observed in the year 2020 (185), mainly due to effects of pandemic COVID-19 lockdown, but the levels again increased in the years 2021 and 2022.

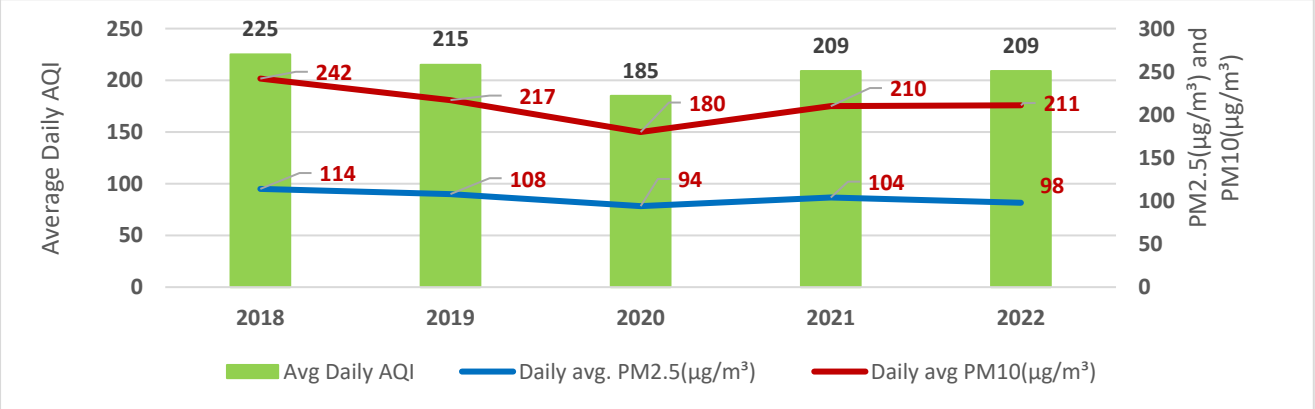

Figure 1: The distribution of the prevalence of levels of air quality composing PM2.5 (µg/m³) and PM10 (µg/m³) in the regions of Delhi from the years 2018-2022. **(Source: CPCB, 2022)**

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PM2.5*:* The trends as visible in Figure 1 reveal, the daily average PM2.5 concentration was always above 90 µg/m³ in the duration of 5 years, which is nearly 9 times of the WHO's safe **limit of 10 µg/m³ (WHO, 2021). The significant incremental trend of PM2.5 with increase in** AQI levels, is observed except in the year 2020, showing a temporary decline.

PM10*:* Similar to PM2.5, as per the trends shown in the figure 1, the year-wise levels of PM10 consistently remained above safe standards between 180–242 µg/m³ during the study period. It touched the level below 200 µg/m³ only during the pandemic COVID-19 lockdown period.

Acute respiratory illness cases in relation to the ambient air quality reported to the Emergency Departments (ED) of the health facilities in the regions of Delhi from the years 2018-2022

A strong linkage between acute respiratory morbidity (excluding COVID-19 morbidities) and poor ambient air quality is observed from the trends in cases reported to the emergency departments of health facilities in Delhi over the five-year period from 2018 to 2022, as presented in Table 1 below.

Table 1: *Distribution of the cases of Acute Respiratory Illness reported to ED in Relation to AQI in the regions of Delhi (Year 2018-2022).*

Year	Average Daily AQI	Average daily PM2.5 (µgm/m^3)	Average daily PM10 (µgm/ m^3)	Total number of cases of acute respiratory illness reported to Emergency departments of health facilities
2018	225	114	242	983339
2019	215	108	217	497557
2020	185	94	180	116450
2021	209	104	210	58598
2022	209	98	211	192354

(Sources: CPCB and NCDC, 2022)

Table 1 clearly demonstrates that the incidence of respiratory illnesses increases with higher average daily concentrations of PM2.5 and PM10, resulting in elevated average daily AQI levels. In 2018, when the average daily AQI reached its highest value of 225 across the five-year period, the number of reported respiratory illness cases was also the highest, with 983,339 cases (over nine lakh) recorded in the emergency departments of health facilities across Delhi.

Although there was a marked reduction in average daily AQI, PM2.5, and PM10 levels between the years 2019 and 2020, the number of reported respiratory illness cases also declined

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substantially to less than half of those reported in 2018, which can be largely attributed to the COVID-19 pandemic and the lockdowns imposed in phases during years 2019–2020.

Furthermore, the continuation of post–COVID-19 governmental and public health measures—such as social distancing, restricted vehicular movement, stringent traffic regulations, implementation of the Graded Response Action Plan (GRAP) and mandatory annual Pollution Under Control (PUC) certification of vehicles—contributed to a further reduction in respiratory morbidity. As a result, the number of reported cases declined to 58,698 in 2021, representing the lowest level observed during the study period from years 2018 to 2022.

By the year 2022, the trends presented in Table 1 indicate a renewed increase in respiratory morbidity, with 192,354 cases reported to the EDs of health facilities in Delhi, despite the average daily AQI remaining relatively constant and PM2.5 and PM10 levels being lower than in earlier years. The number of reported cases more than doubled within a single year compared to 2021. These trends suggest that the risk of respiratory illness remains high when ambient air quality persists at hazardous levels above safe thresholds over prolonged periods, which underscores the importance of sustained governmental public health interventions and responsible public behaviour to protect respiratory health during extended periods of poor ambient air quality.

Management and Treatment of reported cases of Acute Respiratory Morbidity in the Emergency Departments of the health facilities across the regions of Delhi

According to the records of NCDC and Lok Sabha Parliamentary documents, the patients were administered with three treatments in the emergency departments of the health facilities in Delhi Region: Nebulization, Non-Invasive Ventilation and Invasive ventilation.

According to Katiyar et.al (2022), Max Healthcare and Artemis Hospitals (2025), "***Nebulization*** is the process to treat and quickly deliver medication directly to the airways through nebulizer for making breathing easier interrupted due to clogged lungs by the air pollutants, which can trigger inflammation, swelling and spasm of the airway smooth muscles, along with increased mucus production.

Non-invasive ventilation is administered to treat persistent respiratory distress, hypoxemia (lack of oxygen levels in the human body) and clinical deterioration of the suffering patient. ***The invasive ventilation*** is introduced when the resulting respiratory distress is severe enough to cause acute respiratory failure (ARF), unresponsiveness to non-invasive ventilation or inability to protect the air pathways." The year-wise distribution of treatments administered to

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the cases suffered with acute respiratory illness due to poor AQI in the regions of Delhi is shown in Table 2 below.

Number of cases of respiratory illness nebulized

As seen in table 2, high number of cases suffering with the respiratory illnesses were nebulized in the years 2018-2019, which was a pre –pandemic period characterised by high average daily AQI, PM2.5 and PM10. The highest numbers were recorded, with over 64,000 cases. But in the year 2020, cases declined significantly to 21,995 and furthermore to 4509 cases, reflecting the improvement in air quality during pandemic COVID -19. However, the trend showed nebulization cases rose again to nearly 30,000, due to factors discussed above.

Table 2: *Distribution of the type of treatment administered to the cases of Acute Respiratory Illness reported to ED in relation to poor AQI in the regions of Delhi (Years 2018-2022)*

Year	Average Daily AQI	Average daily PM2.5 (µgm/m^3)	Average daily PM10 (µgm/ m^3)	Cases of Respiratory illnesses administered nebulization	Cases of Respiratory Illnesses administered Non-invasive ventilation	Cases of Respiratory illnesses administered invasive ventilation
2018	225	114	242	50075	6723	3466
2019	215	108	217	64495	5838	3048
2020	185	94	180	21995	2358	1197
2021	209	104	210	4509	943	362
2022	209	98	211	29903	2783	778

(Sources: CPCB and NCDC, 2022)

Number of cases of respiratory illness treated with non-invasive and invasive ventilation

The table 2 clearly shows the trends that the number of 6723 cases for non-invasive ventilation and 3466 cases were treated with invasive ventilation, were the highest in the year 2018. By the year 2021, the number of cases gradually and consistently declined to 943 for non- invasive treatment and only 342 cases treated with invasive ventilation. But post pandemic COVID-19, in the year 2022, the cases for non-invasive ventilation increased nearly four times of what reduced in the year 2021 and invasive ventilation cases also doubled within a span of one year from year 2021 to the year 2022.

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Analysis of Table 2 indicates that reductions in average daily AQI, PM2.5, and PM10 levels were linked with a decline in the number of patients requiring nebulization, non-invasive ventilation, and invasive ventilation. However, this reduction largely corresponds to the period of COVID-19 pandemic measures and lockdowns during 2019–2020, when population exposure to ambient air pollutants was substantially limited. In contrast, during the post–COVID-19 period, as populations reverted to pre-pandemic behaviours, exposure to ambient air pollution likely increased due to enhanced human mobility, relaxation of traffic controls, and the resumption of construction, industrial, transportation, public, and agricultural activities. This shift was accompanied by a marked rise in the number of cases requiring all three forms of respiratory treatment in the Delhi region. The severity of these cases indicates a heightened risk to patient health, suggesting that preventable exposures and prolonged contact with consistently high and hazardous average daily AQI levels contributed to the increased need for non-invasive and invasive respiratory interventions in emergency departments across Delhi. Despite advisories and mitigation measures issued by the National Pollution Control Board (NPCB), National Centre for Disease Control (NCDC) and the relevant ministries of environment, sanitation and health, the ambient air pollution levels in Delhi did not fall below safe thresholds. The persistently poor air quality combined with reduced adherence to preventive public health behaviours likely contributed to the observed rise in respiratory morbidities reported to EDs of health facilities across Delhi.

CONCLUSION

This secondary analysis of the descriptive study confirms a strong association between poor ambient air quality and acute respiratory morbidity in Delhi. Elevated AQI, PM2.5, and PM10 levels—particularly during smog episodes—were linked to increased emergency department visits and greater need for nebulization and ventilator support.

Analysis of five years of data (2018–2022) demonstrates that seasonal and annual pollution fluctuations directly influence emergency healthcare demand. The findings highlight the life-threatening risks of prolonged exposure to hazardous air quality and underscore the need for sustained public health interventions and community-level preventive behaviours, especially for vulnerable populations.

While this study establishes a strong association between elevated AQI and increased respiratory morbidity, it does not provide causal evidence for policy reform. Therefore, strict enforcement of existing air pollution control regulations and emission-reduction initiatives is

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essential to improve ambient air quality and reduce the burden on emergency health services (WHO Health and environmental score card 2025). Hospitals in Delhi should be equipped with real-time air quality–linked surveillance systems to anticipate seasonal spikes in the respiratory cases (Sahota R.2024). Integrating environmental data into hospital planning can enable timely mobilisation of resources such as nebulization and ventilator support during high-pollution periods, as demonstrated during improved air quality in 2020. The sustained social and behaviour change communication (SBCC) interventions are required to improve public awareness, promote self-care practices, and encourage adherence to government advisories during high-pollution episodes.

Conflict of interest

No conflict of interest

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REFERENCES

Afzal, F., Siddiqui, R., Khan, M. R., Afzal, M., & Usmani, N. (2020). COVID-19-a public health emergency: what do we know? A cross-sectional study on community awareness level towards COVID-19 in Uttar Pradesh, India. *Int J Commun Med Public Health, 7*(11), 4562-4569.

Afzal, F., Das, A., & Chatterjee, S. (2024). Drawing the linkage between women's reproductive health, climate change, natural disaster, and climate-driven migration: Focusing on low-and middle-income countries-a systematic overview. *Indian Journal of Community Medicine, 49*(1), 28-38. https://doi.org/10.4103/ijcm.ijcm_257_23

Balakrishnan, K., Dey, S., Gupta, P., Ramaswami, A., & Shankar, V. (2019). The impact of air pollution on health in India. *The Lancet Planetary Health, 3*(10), e450–e452. https://doi.org/10.1016/S2542-5196(19)30206-8

Afzal, F., & Zaini, S. H. (2015). Quality assurance in manufacturing industry-A study on Link Locks Private Limited, Aligarh. *Al-Barkaat Journal of Finance & Management, 7*(2), 92-102.

Afzal, F. (2024). A study on reproductive health behavior of left-behind wives of male outmigrants originating from Patna, Bihar. Available from: https://doi.org/10.13140/RG.2.2.32321.06243

CENTRAL POLLUTION CONTROL BOARD. " Guidelines for the Measurement of Ambient Air Pollutants Volume-II"., Ministry of Environment & Forests, 2012-13. Central Pollution Control Board. (n.d.). *National Air Quality Index Reports, Delhi*.

Chen, Y. Air pollution in New Delhi is more severe than observed due to hygroscopicity-induced bias in aerosol sampling. *npj Clean Air* **1**, 1 (2025). https://doi.org/10.1038/s44407-024-000016

Choudhary, A., Kumar, R., & Singh, A. (2019). Impact of PM2.5 on respiratory health in India. *Lung India, 36*(5), 415-420. https://doi.org/10.4103/lungindia.lungindia_611_18

Croft, D. P., Kumar, R., & Singh, A. (2019). Associations between PM2.5 and hospital admissions for respiratory diseases. *Chest, 155*(3), 548-556. https://doi.org/10.1016/j.chest.2018.10.057

Dey, S., Kumar, R., Gupta, P., & Sharma, S. (2017). Air quality and health in India: State of evidence. *Environmental International,107*, 187-196. https://doi.org/10.1016/j.envint.2017.07.011

Dockery, D. W., Speizer, F. E., Stram, T. H., Fay, P. H., Ware, J. H., & Ferris, B. G., Jr. (1993). An association between air pollution and mortality in six U.S. cities. *The New England Journal of Medicine, 329*(24), 1753-1759. https://doi.org/10.1056/nejm199312093292401

Ghorani-Azam, A., Riahi-Zanjani, B., & Balali-Mood, M. (2016). Effects of air pollution on human health. *Environmental Science and Pollution Research, 24*, 1-13. https://doi.org/10.1007/s11356-016-7888-9

Gupta, P., Kumar, R., Sharma, S., & Singh, A. (2019). Exposure to air pollution and health effects in Indian cities. *International Journal of Environmental Research and Public Health, 16*(10), 1805. https://doi.org/10.3390/ijerph16101805

DOI: 10.48165/sajssh.2026.7103

Health Effects Institute. (2019). *State of Global Air 2019*.

IHME, Global Burden of Disease (2024) – with minor processing by Our World in Data. "High blood pressure" [dataset]. IHME, Global Burden of Disease, "Global Burden of Disease - Risk Factors" [original data].

Jain, S., & Sharma, T. (2020). Social and environmental factors affecting air pollution in Delhi. *Urban Climate, 32*, Article 100612. https://doi.org/10.1016/j.uclim.2020.100612

Kumar, R., Gupta, P., Sharma, S., & Singh, A. (2020). Air pollution and respiratory health in Delhi: A review. *Indian Journal of Public Health, 64*(4), 312-321. https://doi.org/10.4103/ijph.IJPH_21_20

Katiyar SK et al., Indian Guidelines on Nebulization Therapy, Indian Journal of Tuberculosis, https://doi.org/ 10.1016/j.ijtb.2022.06.004

Li, T., Kumar, R., & Singh, A. (2017). Air pollution and hospital admissions: A global study. *The BMJ, 357*, Article j1234. https://doi.org/10.1136/bmj.j1234

Lok Sabha Secretariat. (2022). *Annexure to Unstarred Question No. 178, AQI and health impacts*.

National Centre for Disease Control. (2023). *Newsletter* (Vol. 12, Issue 1).

Pope, C. A., Thun, M. J., Namboodiri, M. M., Dockery, D. W., Evans, J. S., Speizer, F. E., & Heath, C. W., Jr. (2002). Lung cancer and cardiopulmonary mortality associated with long-term exposure to air pollution. *JAMA, 287*(9), 1132-1141. https://doi.org/10.1001/jama.287.9.1132

Sahota, R., Das, A., & Afzal, F. (2024). Determinants of data use for programmatic evidence-based decision making at peripheral public health care centres in Haryana, India. *Clinical Epidemiology and Global Health, 29*, Article 101713. https://doi.org/10.1016/j.cegh.2024.101713

Samoli, E., Kumar, R., & Singh, A. (2008). Acute effects of air pollution on health: A European study. *Environmental Health Perspectives, 116*(12), 1680-1686. https://doi.org/10.1289/ehp.11210

Sharma, S., Gupta, P., Kumar, R., & Jain, S. (2021). Effect of lockdown on air quality in Delhi during COVID-19. *Current Science, 120*(8), 1309-1314. https://doi.org/10.18520/cs/v120/i8/1309-1314

Websites

https://ncdc.mohfw.gov.in/wp-content/uploads/2024/05/1-ADVISORY-ON-AIR-POLLUTION-AND-HEALTH.pdf

https://www.artemishospitals.com/blog/effects-of-air-pollution-on-asthma-and-bronchitis

https://www.maxhealthcare.in/blogs/protect-lungs-during-winter-pollution-in-delhi

World Health Organization. (2019). *Air pollution and health: WHO report*.

World Health Organization. (2021). *WHO global air quality guidelines*.

World Health Organization. (2022). *Ambient (outdoor) air pollution*.

DOI: 10.48165/sajssh.2026.7103