



# AIR QUALITY INDEX

## UNDERSTANDING THE AIR QUALITY INDEX (AQI) AND ITS ADVERSE EFFECTS ON HUMAN HEALTH

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Delhi's air has, over the years, transformed from a seasonal inconvenience into a persistent public health emergency. Every winter, the capital enters a familiar yet deeply unsettling cycle: a thick grey haze begins to settle over the city, visibility drops, the smell of burning biomass lingers in the air, and residents brace themselves for weeks of respiratory discomfort. This crisis has become so normalized that many forget its severity. Yet, doctors routinely advise families with young children, elderly members, or those with respiratory conditions to consider temporarily relocating during peak pollution periods. The deteriorating air quality is no longer just an environmental concern it has become a threat to the basic right to breathe.

Despite the heavy attention that air pollution receives in public discourse, many people only understand the crisis through one number: the Air Quality Index, or AQI. This numerical indicator flashes across news screens, weather apps, and digital billboards, informing citizens whether the air is "good," "poor," or "severe." But beyond this number lies a complex blend of

pollutants and atmospheric conditions that most people are not familiar with. Understanding what the AQI truly represents, how it is calculated, and how it connects to human health is essential for a more informed and engaged response to Delhi's pollution crisis.

The AQI is essentially a simplified communication tool, designed to make complex air pollution data understandable for the general public. The atmosphere contains a wide variety of pollutants, each with different sources, chemical properties, and health impacts. Scientific instruments measure the concentration of these pollutants in micrograms per cubic meter or in parts per billion, resulting in a huge amount of detailed information. The AQI condenses this information into a single value ranging from 0 to 500. A low number indicates cleaner air, while a higher number signals more dangerous pollution levels. In India, the Central Pollution Control Board calculates the AQI based on the concentration of eight pollutants: PM2.5, PM10, nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone,

ammonia, and lead. These pollutants are chosen because they are both prevalent in Indian urban environments and have well-established health impacts. Among these pollutants, particulate matter specifically PM<sub>2.5</sub> and PM<sub>10</sub> poses the greatest risk to public health. PM<sub>10</sub> refers to particulate matter with a diameter of less than 10 micrometers. These particles include dust, pollen, ash, and smoke. While PM<sub>10</sub> can irritate the respiratory system, the human body is somewhat capable of filtering out larger particles through the nasal passages and upper airways. PM<sub>2.5</sub>, on the other hand, consists of extremely fine particles with diameters less than 2.5 micrometers. These particles are so small that they evade the body's natural defenses, penetrate deep into the lungs, and enter the bloodstream. Once inside the circulatory system, PM<sub>2.5</sub> particles can travel to various organs, causing widespread inflammation and oxidative stress. These particles often originate from diesel exhaust, burning biomass, industrial emissions, and chemical reactions between atmospheric gases. Delhi's climatic conditions during winter, including temperature inversion and low wind speeds, trap these particles close to the ground, amplifying their concentration.

The health impacts of breathing polluted air are far more severe and far-reaching than most people realize. The most immediate and visible effects include irritation of the eyes, nose, and throat, along with coughing, wheezing, and breathlessness. However, the long-term implications are much more dangerous. Continuous exposure to high levels of air pollution weakens the respiratory system and increases the risk of chronic respiratory diseases such as asthma, bronchitis, and chronic obstructive pulmonary disease. Children are especially vulnerable because their lungs are still developing, and they breathe more air relative to their body weight compared to adults. Numerous studies have shown that prolonged exposure to PM<sub>2.5</sub> can impede lung development in children, leading to lasting respiratory impairment.

Air pollution also plays a significant role in

cardiovascular diseases. Fine particulate matter has been scientifically linked to hypertension, plaque buildup in arteries, arrhythmias, heart attacks, and strokes. When PM<sub>2.5</sub> enters the bloodstream, it affects the endothelial lining of blood vessels, promotes clot formation, and increases systemic inflammation. Over time, this increases the likelihood of cardiovascular events, even in individuals who do not have a prior history of heart disease. The World Health Organization now considers air pollution as harmful to the heart as tobacco smoking. Recent research also shows that pollution affects the brain, with studies indicating that long-term exposure to PM<sub>2.5</sub> is associated with reduced cognitive performance in children, accelerated cognitive decline in older adults, and an increased risk of neurodegenerative diseases such as Alzheimer's and Parkinson's. This damage occurs because ultra-fine particles can cross the blood-brain barrier or indirectly harm neural tissues through chronic inflammation.

Pregnant women exposed to polluted air face higher risks of miscarriages, preterm births, low birth weight infants, and developmental issues in newborns. Polluted air reduces the oxygen supply reaching the fetus by impairing the mother's cardiovascular functioning and affecting the placenta. This means that unborn children are exposed to the harmful effects of pollution even before they take their first breath. Beyond individual health problems, pollution contributes to systemic issues such as diabetes, hormonal imbalances, compromised immunity, and reduced kidney function. According to the WHO, air pollution is responsible for seven million premature deaths globally each year, making it one of the leading causes of mortality worldwide.

Delhi's pollution problem is rooted not only in its human-generated emissions but also in its geographic and meteorological characteristics. The city is landlocked, surrounded by the plains of Haryana and Uttar Pradesh, which creates a natural bowl-like effect that hinders the dispersion of pollutants. In winter, cold air settles near the ground while warmer air forms a

layer above it. This phenomenon, known as temperature inversion, traps pollutants close to the surface, resulting in dangerously high concentrations. At the same time, emissions from millions of vehicles, construction activities, industries, and the seasonal burning of crop residues in Punjab and Haryana overwhelm the city's already stressed air quality. Policies aimed at curbing pollution often exist on paper, but inconsistent enforcement and lack of long-term planning weaken their impact.

Living in such an environment demands a proactive approach to personal health. While systemic solutions require government action, citizens can take steps to reduce their exposure. Many families in Delhi now rely on N95 or N99 masks during peak pollution days, especially when stepping outdoors. Indoors, HEPA-based air purifiers help reduce particulate matter, although their effectiveness varies depending on room size, purifier quality, and maintenance. It is advisable to avoid outdoor exercise when the AQI is in the "poor," "very poor," or "severe" categories, since heavy breathing during exertion increases the amount of pollutant-laden air entering the lungs. Keeping windows closed during peak pollution hours and ventilating the home during relatively cleaner periods can help maintain indoor air quality. While indoor plants do not significantly remove airborne pollutants, they contribute to psychological well-being and help maintain comfortable humidity levels.

Ultimately, Delhi's air pollution crisis is not just an environmental issue but a profound challenge to public health, urban planning, and social responsibility.

The Air Quality Index is more than a daily statistic; it represents a clear and urgent warning about the air people breathe and the risks they face. A deeper understanding of the AQI, the pollutants that influence it, and the consequences of long-term exposure is essential for encouraging informed decision-making and demanding stronger, more consistent action from authorities.

Cleaning Delhi's air will require a collective effort involving technological innovation, policy enforcement, community engagement, and

sustained political will. Only through such coordinated action can Delhi hope to move toward a future where its citizens can breathe freely and live without the constant fear of invisible poisons in the air.

The journey toward cleaner air will not be easy, but it is absolutely necessary. Every delayed intervention compounds future harm, and every improvement no matter how small brings the city a step closer to reclaiming its skies. As conversations about AQI and pollution become more mainstream, they must evolve into a movement that insists on accountability and long-term vision. The health of millions, especially children who bear the greatest burden, depends on the choices made today. And if Delhi can confront this crisis with urgency and unity, it can become a model for other polluted cities struggling with similar challenges.

