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Air Pollution in New Delhi

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Anna Bickerton

Introduction

Air pollution is, according to the United Nations, the world's greatest environmental health threat https://unece.org/air-pollution-and-health: it is responsible for seven million excess deaths per year as a result of diseases with proven links to air pollution, and places health care systems under extreme pressure.

In few places is this more evident than New Delhi, which is consistently ranked one of the most air-polluted cities on the planet and where air pollution killed an estimated 54,000 people in 2020 alone.[1]

This report first examines air pollution's effect on the health of New Delhi's population and the resilience of its healthcare systems, and explains its key causes, such as stubble burning and vehicle emissions. Having reviewed existing responses to air pollution and found them inadequate and inequitable, we set out what reforms should be prioritised.

Our policy recommendations seek to tackle both the cause and the symptoms of the problem. We call on the government to adopt a less punitive approach to limiting activities causing air pollution and instead provide support for businesses and individuals to adopt alternatives. We also recommend reforms to enable citizens to better protect themselves from air pollution by enhancing building standards to avoid pollution "leakage" indoors. Finally, acknowledging that air pollution has already permanently harmed the health of many, propose long-term solutions to the under-staffing of New Delhi hospitals to ensure those affected by pollution receive adequate care.

Air pollution challenges are not unique to New Delhi; approximately 99% of the global population breathes air that exceeds WHO limits.[2] We hope that the recommendations of this briefing, although designed specifically for New Delhi, will be applicable elsewhere, in order that the pernicious health effects of air pollution can be mitigated worldwide.

[1] Arora, N., 2021, Air pollution led to around 54,000 premature deaths in New Delhi in 2020

[2] WHO, n.d., Air pollution

Briefing

Nature of air pollution in New Delhi:

New Delhi is one of the most polluted cities on Earth.

- New Delhi consistently ranks as one of the worst-affected cities by air pollution. It is the 9th most polluted city in the World in 2022, when measured by concentration of fine particulate matter (PM2.5).[3]
- Much of New Delhi's pollution can be attributed to causes outside of the city border. For example, one primary cause of New Delhi's air pollution is crop residue or stubble-burning in the surrounding territory of Delhi-NCT as well as the neighbouring states of Haryana, Punjab and Western Uttar Pradesh.[4]
- This is not the sole cause however; other contributors include motor vehicle emissions, coal-fired power plants and industrial activity.[5]

The capital sees significant seasonal variances in pollution levels with the poorest air quality observed in November and December.

- WHO guidelines for safe quantities of fine particulate matter are exceeded by over 10 times for 9 of 12 months a year.[6]
- Nevertheless, pollution remains a year-round health threat; 2022 air quality monitoring indicates that WHO limits were exceeded by a minimum of five times in all 12 months of the year.[7]
- Stubble-burning practices, which can be linked to 38% of air pollution in New Delhi, generally peak in late October and early November.[8] This has had grave consequences, resulting in episodic shutdowns of the city's schools, roads and

[3] IQAir, 2022, World's Most Polluted Cities in 2022 - PM2.5 Ranking

[4] Nirwan, N., 2024, Determining hotspots of gaseous criteria air pollutants in Delhi airshed and its association with stubble burning

[5] Rizwan, SA., Nongkynrih, B., and Gupta, S. K., 2013, Air pollution in Delhi: Its Magnitude and Effects on Health

[6] IQAir, 2022, World's Most Polluted Cities in 2022 - PM2.5 Ranking

[7] IQAir, 2022, World's Most Polluted Cities in 2022 - PM2.5 Ranking

[8] Dayal, S., 2023, Explainer: Why is South Asia the global hotspot of pollution?

non-essential construction. This includes what was labelled the 'Great Smog' month in November 2017.[9]

- In November 2023, Delhi's air quality index spiked to 500, which is the highest level the index can reach.[10]
- The bursting of firecrackers and burning of effigies involved in the celebration of religious festivals, most notably Diwali and Vijayadashami, also have additive effects to pollution levels in October and November.[11]

Low-income areas generally have higher inhalable particulate matter concentrations and thus are more vulnerable to pollution-related health conditions.

- A 2011 study found that concentrations of inhalable particulate matter ("PM10") were generally higher in Delhi's less affluent neighbourhoods despite lower rates of car ownership.[12]
- The disproportionality of the health effects of pollution is furthered by inequalities in work. Those at the bottom of the income scale spend more time outside which studies link to poorer respiratory health in New Delhi.[13]
- Access to air conditioning is limited in low-income areas of the capital,[14] allowing pollutants to build up and worsening air quality.[15]
- Concentrations of air pollutants on arterial roads are particularly high as a result of auto-rickshaw commutes. One 2011 study found that in-vehicle concentrations of hazardous ultrafine particulate matter exceeded simultaneously measured ambient levels by 8.4 times as well as a 3.6 times higher value seen in in-vehicle measurements of similarly dangerous black carbon concentration.[16]

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[9] Garg, A., 2020, The Great Smog Month and Spatial and Monthly Variation in Air Quality in Ambient Air in Delhi, India

[10] Ellis-Petersen, H., 2023, Delhi air pollution spikes to 100 times WHO health limit

[11] Ghei, D., 2018, Estimates of air pollution in Delhi from the burning of firecrackers during the festival of Diwali

[12] Garg, A., 2011, Pro-equity Effects of Ancillary Benefits of Climate Change Policies: A Case Study of Human Health Impacts of Outdoor Air Pollution in New Delhi

[13] Foster, A. and Kumar, N, 2011, Health Effects of Air Quality Regulations in Delhi, India

[14] Boyce, K. J. and Shrivastava, A., 2016, Delhi's air pollution is a classic case of environmental injustice

[15] Ferguson, L., et al., 2020, Exposure to indoor air pollution across socio-economic groups in high-income countries

[16] Apte, J., S., et al., 2011, Concentrations of fine, ultrafine, and black carbon particles in auto-rickshaws in New Delhi, India

- Centrally located air quality monitors may even understate the severity of air pollution in New Delhi.[17] It also places those that live and work on the streets of New Delhi at an acute risk of harmful pollution-related health effects.[18]

[17] Apte, J., S., et al., 2011, Concentrations of fine, ultrafine, and black carbon particles in auto-rickshaws in New Delhi, India

[18] Boyce, K. J. and Shrivastava, A., 2016, Delhi's air pollution is a classic case of environmental injustice

Health effects of air pollution:

Air pollution damages the respiratory and cardiovascular system, directly increasing the risk of non-transmissible diseases in these systems.

- Inhaling contaminants causes damaging inflammation and oxidative stress to the cells in the airways and lungs.[19]
- According to the World Health Organisation, in India, every year an extra 108 people in every 100,000 die due to respiratory and cardiovascular diseases related to air pollution. This is eight times the global average.[20]
- In Delhi in 2020, air pollution caused 54,000 excess deaths.
- The specific non-communicable diseases most strongly linked to air pollution include stroke, heart disease, chronic obstructive pulmonary disease, and pneumonia.[21]
- Air pollution is a particularly significant cause of lung cancer - second only to smoking.
  It is classed as a “group 1” carcinogen for lung cancer - as a cause of lung cancer, it is second only to smoking.[22]
- Although it is not included in WHO estimates of excess deaths due to air pollution, asthma is exacerbated by polluted air due to its irritating effect on airways. In 2010, air pollution caused an additional 6 million asthma attacks across New Delhi and its satellite cities.[23]

There is evidence for the effect of air pollution on the rest of the body.

- Some types of air pollutant, such as very fine particulate matter (known as "PM<2.5") can penetrate the lungs and circulate in the bloodstream, thus affecting the entire body.[24]

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[19] World Health Organisation, n.d., Air quality and health

[20] World Health Organisation, 2022, Mortality attributed to household and ambient air pollution

[21] World Health Organisation, n.d., Air quality and health

[22] Turner, M. et al., 2020, Outdoor air pollution and cancer: An overview of the current evidence and public health recommendations

[23] Guttikunda, S.K. and Goel, R. 2013. Health impacts of particulate pollution in a megacity—Delhi, India

[24] World Health Organisation, n.d., Air quality and health

- There is tentative evidence for the effect of air pollution on other kinds of cancer, including breast cancer, and brain tumours. However, these results have not been consistently replicated.[25]
- A systematic review of 52 studies found association between exposure to particulate matter (PM) during pregnancy and low birth weight,[26] which in turn is correlated with increased childhood mortality and heart disease in adulthood.[27]
- Air pollution appears to increase the risk of neurological disorders in older adults including Parkinson's disease and dementia.[28]

Air pollution has indirect effects on health too, by increasing vulnerability to transmissible diseases.

- During the 2002 SARS outbreak in East Asia, air pollution was associated with increased death rates: patients from regions with a "high" air pollution index were twice as likely to die than those from "low"-index regions.[29]
- In particular, air pollution was likely to have exacerbated the effects of Covid-19: it increases the presence of an enzyme which is a Covid-19 "receptor" on surfaces of the respiratory tract.[30]
- This effect is evidenced by observational studies: although findings are somewhat mixed, a review of studies found half of studies found increased air pollution to be associated with increased risk of death from Covid-19 - just 8% of studies found the reverse.[31]
- Admittedly, it should be noted that studies so far have identified a correlational, rather than a causal effect. That is, other factors which increase the risk of these

[25] Turner, M. et al., 2020, Outdoor air pollution and cancer: An overview of the current evidence and public health recommendations

[26] Bai, W. et al., 2014, Association between ambient air pollution and pregnancy complications: A systematic review and meta-analysis of cohort studies

[27] Šrám, R.J., et al., 2005, Ambient Air Pollution and Pregnancy Outcomes: A Review of the Literature | Environmental Health Perspectives

[28] National Institute of Environmental Health Sciences, n.d., Air Pollution and Your Health

[29] Cui, Y. et al., 2003, Air pollution and case fatality of SARS in the People's Republic of China: an ecologic study

[30] Maleki, M. et al., 2021, An updated systematic review on the association between atmospheric particulate matter pollution and prevalence of SARS-CoV-2

[31] Ibid.

airborne diseases and are associated with high air pollution, such as high population density, may not have been adequately controlled for.[32]

[32] Ali, N. and Islam, F., 2020, The Effects of Air Pollution on COVID-19 Infection and Mortality—A Review on Recent Evidence


Every year, an extra
108
people in every 100,000
die due to respiratory & cardiovascular diseases related to air pollution

Effects of air pollution on healthcare infrastructure:

The cost of healthcare is rising exponentially for the general public.

- India is experiencing a 15% medical inflation rate, which has resulted in a significant rise in the average size of insurance claims from Rs 60,000 to Rs 80,000–85,000.[33]
- Air pollution contributes 11.5% of the disease burden, or an estimated $11.9 billion (£9.36 billion) in healthcare costs, which represents the financial burden on the public due to pollution-induced diseases and deaths, accounting for medical expenses and lost wages. In 2019, India's total healthcare cost was $103.7 billion (£81.6 billion).[34]

Air pollution is placing an increased burden on hospitals, leading to overcrowding.

- An increase in emergency room (ER) visits has been associated with rising pollution levels; AIIMS (All India Institute of Medical Science) Delhi had 69,400, of which 2,669 were due to acute respiratory symptoms.[35] ER visits between June 2017 and February 2019 - which is an average increase of about 20%,[36] was shown in a study published in the International Journal of Tuberculosis and Lung Disease.[37]
- One set of emergency rooms recorded a 20% increase in visits between June 2017 and February 2019, demonstrating that this problem is growing.[38]

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[33] Chadha, S. 2023, Delhi air: 50% surge in health insurance inquiries, most pick Rs 1 cr cover

[34] Prakash, S., 2021, $12bn: Burden of pollution on India's healthcare bill

[35] Yadav, R., et al, 2023, Short-term exposure to air pollution and emergency room visits for acute respiratory symptoms among adults - PMC

[36] Dutt, A., 2023, Why this polluting gas, NO2, is what you should worry about: It may land you in ER, says AIIMS study | Health and Wellness News - The Indian Express

[37] Jha, D. N., 2023, Air Pollution: Delhi, neighbours put on alert for health emergency | Delhi News - Times of India

[38] Jha, D. N., 2023, Air Pollution: Delhi, neighbours put on alert for health emergency | Delhi News - Times of India

- In the years between 2017 and 2019, more than 100,000 children at Delhi's AIIMS requested emergency care; of them, 25% had respiratory difficulties. Over 70,000 adults sought care, of which 10% had respiratory issues.[39]
- The number of Delhi-National Capital Region (NCR) families seeking medical attention for ailments related to pollution doubled within a week in 2021, from 22% to 44%.[40]

Indoor pollution raises the risk of infections and respiratory problems for patients and healthcare workers.

- Since the average person spends 90% of their time indoors, elevated indoor pollutant levels—which frequently exceed outdoor levels by five to 100 times—raise serious concerns.[41]
- Poor indoor air quality is often blamed for symptoms that healthcare professionals face, such as headaches and fatigue. It can exacerbate pre-existing conditions in vulnerable patients. Serious risks, such as the possibility of work-related respiratory illnesses and hospital-acquired infections, are associated with improper control of indoor air quality in hospitals.[42]
- According to USEPA (United States Environmental Protection Agency) data, indoor air quality can be two to five times worse than outdoor air quality. This highlights the significance of controlling indoor pollutants, since worldwide reports show that air pollution causes over 7 million deaths annually, of which 4.3 million are related to indoor exposure.[43]

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[39] Healthworld, Economic Times, 2023, Delhi hospitals witness spike in emergency patients as air pollution increases: AIIMS, ET HealthWorld

[40] Chakraborty, A., 2021, Delhi pollution impact | 100% jump in patients in a week: Study

[41] Ibrahim, F., et al. 2022, Hospital indoor air quality and its relationships with building design, building operation, and occupant-related factors: A mini-review - PMC

[42] Fussell, J. and Gião, S. 2023, Importance of indoor air quality in healthcare settings | HSJ Partners | Health Service Journal.

[43] Thermal Control Business Update (TCBU) Editorial, 2019, Air quality management in Indian healthcare | Thermal Control Business Update | HVAC-R Industry

Air pollution is placing an increased burden on hospitals

Healthcare Insight overview

In this insight, we justify the need for government intervention and investment to address air pollution. Firstly, New Delhi's healthcare system is not robust enough to guarantee that individuals negatively affected by air pollution will receive adequate care. Secondly, economic inequality means it is unfair and unrealistic to expect individuals to take responsibility to avoid the negative effects of air pollution with expensive air purifiers or the like. Ultimately, air pollution must be prevented from reaching dangerous levels in the first place.

We then scrutinise the policies adopted to address the causes of air pollution, and conclude that these, too, are unrealistic and unfair. New Delhi's government has relied thus far upon excessively punitive measures to prevent polluting activities which, without support for citizens to find alternatives, are likely to simply be circumvented.

New Delhi's air pollution and its effects on health cannot be fairly or effectively mitigated at the individual level.

It is inevitable that citizens will seek to take individual measures to protect themselves from the effects of air pollution: namely, staying indoors and employing masks or air purifiers. However, this insight argues that these personal measures are inequitable and inadequate responses to the pollutant crisis making community-level government action sorely needed.

One individual response to air pollution has been to stay indoors. Although data is not available for New Delhi, 43% of citizens in neighbouring city Chandigarh report reducing outdoor activity as a response to air pollution. However, this option is not available to the thousands of New Delhi citizens, largely daily wage workers, who work outside. Although the government often issues advisories to remain indoors,[44, 45] it provides no financial support to compensate for missed pay, and so those citizens who can neither work from home nor survive a period of lost income are left with little alternative but to continue their exposure to outdoor pollution. In the words of one auto driver, "what choice do I have?"[46]

Even indoors, outdoor air pollution can penetrate through gaps under doors, in walls, and windows such that one study found air pollution levels indoors in New Delhi to be still over 20 times World Health Organisation standards.[47]

A solution, growing in popularity, is to employ indoor air purifiers - either portable air cleaners or filters mounted in air-conditioning systems. High efficiency purifiers may be capable of reducing PM2.5 air pollution by at least 20% and up to 70%[48]. This is proven to lead to improved health outcomes (as measured by indicators such as blood pressure and cellular inflammation).[49]

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[44] Business Standard, 2017, Delhi residents asked to stay indoors, avoid morning walks

[45] Kambiri, K., 2023, AQI woes: Is staying indoors possible? Delhi says not always

[46] Saadi, Y., 2023, Delhi Air Pollution: Working Class Stays Outdoors Despite Health Issues, Sees a Cut in Pay

[47] Greenstone et al., 2021, Indoor Air Quality, Information, and Socio-Economic Status: Evidence from Delhi

[48] Laumbach, R.J. and Cromar, K.R., Personal Interventions to Reduce Exposure to Outdoor Air Pollution

[49] Allen, R.W. and Barn, P., 2020, Individual- and Household-Level Interventions to Reduce Air Pollution Exposures and Health Risks: a Review of the Recent Literature

However, there is a correlation between a purifiers' efficacy and its cost: the best filters may be prohibitively expensive, but there is a risk that cheaper products are ineffective. The founder of one air purifier company expressed concern about substandard products flooding the market. Regardless, even the cheapest purifier recommended by the Times of India[50] cost 8886 rupees (£84) - over half of the minimum monthly wage for unskilled labourers.[51] Hence high-income households in New Delhi are 13 times more likely to own air purifiers than low-income households.[52] While New Delhi's government has made full use of air purifiers, with six ministries spending a total of five million rupees (£47,000) on purifiers in 2018-19, it is not clear that reliance on air purifiers can legitimately be pursued as an equitable solution.

A final individual-level response to the effects of air pollution on health is the use of facemasks. While this solution is somewhat more equitable given masks' lower cost (at least per purchase, though it must be noted that masks must be replaced more frequently than air purifiers), it is still by no means adequate to address New Delhi's pollution-related health problems.

On the one hand, masks can be effective at reducing pollutant exposure. "N95" masks are designed to filter 95% of even the smallest (PM<0.3) particles,[53] and their use, like high-efficiency air purifiers, have been associated with reduced inflammation and blood pressure.[54] Hence, New Delhi's government has seized upon masks as a response to the pollution crisis, distributing annually thousands of N95 masks to vulnerable groups and municipal workers and, in 2019, millions to schoolchildren.[55]

On the other hand, while the most effective masks, when worn properly to ensure a tight fit around the face, may prove useful in reducing pollutant exposure, most mask usage does not meet this ideal. Improper usage of even N95 masks, including wearing them

[50] Joy, S.., 2024, Air Purifier Price: Best Picks In Every Budget So You Breathe Cleaner Air In Your Home

[51] Times of India, 2023, People in Delhi made to work for less than minimum wages: BJP

[52] Greenstone et al., 2021, Indoor Air Quality, Information, and Socio-Economic Status: Evidence from Delhi

[53] Laumbach, R.J. and Cromar, K.R., Personal Interventions to Reduce Exposure to Outdoor Air Pollution

[54] Allen, R.W. and Barn, P., 2020, Individual- and Household-Level Interventions to Reduce Air Pollution Exposures and Health Risks: a Review of the Recent Literature

[55] BBC, 2019, Millions of masks distributed to students in 'gas chamber' Delhi

over a beard, can break the mask's seal and thus undermine its effectiveness. Consequently, although masks may be cheaper than air purifiers, their use is still associated with equity issues, given certain religions, including Sikhism and some Islamic schools of thought, emphasise the wearing of beards for men as a spiritual obligation. 83% of Sikh men and 64% of Muslim men in India wear beards.[56]

In conclusion, New Delhi's citizens have not suffered the pollution crisis passively, altering their behaviour to mitigate their own exposure to pollution. While individual-level action is understandable and to some extent effective, this insight criticises New Delhi's government's apparent reliance on such individual-level solutions. By encouraging individual-level response to pollution, the government abdicates its own responsibility for managing the crisis. This can be interpreted as reflecting a neoliberal paradigm which turns a public health crisis into an economic issue. The phrase "pay-to-breathe" accurately summarises the commodification of a good - clean air - which should be a human right. Moreover, the individualisation of the problem means that those individuals who cannot afford to stay indoors, pay for purifiers, or purchase masks are left entirely vulnerable to the health effects of air pollution, exacerbating inequities in exposure to air pollution.[57] Ultimately, individual-level action to reduce one's own exposure to pollution merely treats the symptom and not the cause of air pollution. At best, it is an incomplete solution; at worst, it is inequitable.

[56] Pew Research Centre, 2021, Religious clothing and personal appearance in India

[57] Garg, A., 2011, Pro-equity Effects of Ancillary Benefits of Climate Change Policies: A Case Study of Human Health Impacts of Outdoor Air Pollution in New Delhi

Existing government initiatives have, thus far, been insufficient in meaningfully tackling the causes of air pollution in New Delhi.

Whilst it should be acknowledged that governments have made some efforts, existing initiatives have been insufficient in adequately mitigating the negative health effects linked to New Delhi's poor air quality. Not only have national, state and municipal governments failed to develop a practical long-term strategy to reduce harmful particulate matter concentrations, but emergency measures implemented during the height of the capital's 'smog season' also do not compensate individuals and firms enough for the negative financial implications to encourage compliance.

Existing emergency protocols particularly falter in regards to the protection of low-income populations of New Delhi. As noted in the briefing, higher concentrations of inhalable particulate matter ("PM 10") are observed in less affluent areas of the capital year-round[58], compounded by poor access to air conditioning.[59]

Furthermore, farmers in neighbouring states of Haryana and Punjab, where emissions from stubble-burning contribute significantly to New Delhi's pollution crisis, have cited a lack of affordable alternatives to clearing crop residue.[60] Just renting an appropriate machine can be 10,000 rupees (£110) a day, whilst the cost of stubble-burning comes in at a mere tenth of the price; approximately 1000 rupees a day.[61] Subsequently, for the vast majority of farmers, abiding by the existing legal restrictions on crop-burning just is not possible as costs exceed the realm of financial viability. It is therefore wholly unreasonable to expect farming communities in Haryana and Punjab to adopt more sustainable practices without some form of government assistance.

It is an issue that has ultimately come with a huge social cost as pollution-related diseases strain the country's healthcare infrastructure and farmers feel "demonised" for engaging in what, in their view, is the only affordable option. India's Environment Agency reports that almost 50% of Delhi's pollution can be attributed to stubble burning[62] as smoke from

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[58] Garg, A., 2011, Pro-equity Effects of Ancillary Benefits of Climate Change Policies: A Case Study of Human Health Impacts of Outdoor Air Pollution in New Delhi

[59] Boyce, J. K., and Shrivastava, A., 2016 Delhi's air pollution is a classic case of environment injustice.

[60] Ellis-Petersen, H., 2019, Delhi's smog blamed on crop fires – but farmers say they have little choice

[61] Ibid.

[62] Nirwan, N. 2024, Determining hotspots of gaseous criteria air pollutants in Delhi airshed and its association with stubble burning

35 million tons of crop stubble enters the air in the week before the further inflaming Diwali celebrations in the city.[63]

Religious and cultural factors have also limited the success of government policies in reducing pollution. Although Delhi's government prohibited the bursting of firecrackers in 2017, it has repeatedly been ignored during religious celebrations and labelled "an attack on Hindu festivals" by right-wing groups.[64] There is some anecdotal evidence from Delhi residents that 2023 saw a fewer number of firecrackers in comparison to previous year, which does perhaps suggest some progress, albeit limited. Despite that, in November 2023, "tens of thousands" of firecrackers were reportedly sold illegally around the capital leading up to and during Diwali.[65] Minimal prosecution rates[66] indicate the ban has been largely ineffectual.

High-ranking officials in India's governing BJP party, which is strongly affiliated with Hindu nationalism, tend to affirm and prioritise the importance of traditional Hindu rituals. This may explain the absence of action on firecrackers and indeed, it is pragmatic that cultural and religious sensitivities are taken into account.[67] However, this is no excuse for inaction; current celebrations, as described by environmentalist Bhavreen Khandari, mean "allowing… children to choke in the name of celebration".[68]

Whilst stubble burning is undeniably a huge contributor, the absence of long-term infrastructure investment in the capital territory itself may also be attributed to the persistence of air pollution in New Delhi. For instance, an apparent neglect to the development of a rapid rail system that could pave the way for congestion reduction, was described by India's Supreme Court as a "gross breach of assurances".[69]

Between stubble-burning outside of the Delhi's state boundaries, religious tensions and auto-rickshaw commutes that leave those travelling on the city's arterial roads particularly

[63] Wilkins, J., 2019, What if... New Delhi's air pollution is here to stay?
[64] Rai, A., 2023, How Diwali fireworks have become a political issue during Delhi's annual air pollution crisis
[65] Wilkins, J., 2019, What if... New Delhi's air pollution is here to stay?.
[66] Arora, N., 2023, Smoky skies in Indian capital on Diwali as revellers defy firecracker ban
[67] Mahajan, S., 2023, Cracker ban violation sparks AAP-BJP war of words
[68] The Hindu, 2023, Ban on firecrackers flouted in Delhi despite Supreme Court order
[69] Poddar, U., 2023, Delhi pollution: Indian Supreme Court's 40-year quest to clean foul air

exposed,[70] a progress-stagnating culture of blame between India's northern states has arisen. Officials in BJP-governed stubble-burning states of Haryana and Uttar Pradesh seek to blame the industrial, congested, AAP-governed Delhi national capital territory for the severity of New Delhi's air quality challenges and vice versa.[71]

To summarise, Anumita Roychowdhury, air pollution expert and executive director of Delhi-based Centre for Science and Environment, estimates PM2.5 levels in Delhi need to fall by over 60% to meet clean air standards.[72] It is of paramount importance that, in order to meet this target, state governments in particular must work collaboratively to lessen particulate matter concentrations and make the sorely needed investments in both rural agricultural methods and urban infrastructure to do so.

In addition, it is evident that legal conditions alone are insufficient to enable farmers, firms and workers in Northern India to adequately protect themselves from the detrimental impacts of air pollution. Legislating against polluting practices without accompanying fiscal support drastically limits the efficacy of emission reduction policy. Any future government initiative must fully consider feasibility for enforcement and additional funding that may be necessary to facilitate effective mitigation of the harmful health effects of air pollution in New Delhi.

[70] Apte, J., S., et al., 2011, Concentrations of fine, ultrafine, and black carbon particles in auto-rickshaws in New Delhi, India

[71] Rai, A., 2023, How Diwali fireworks have become a political issue during Delhi's annual air pollution crisis

[72] Biswas, S., 2023, Delhi AQI: Why Indian capital lags behind Beijing in battle to breathe

The hospital sector in New Delhi faces regular challenges when addressing the harmful health effects of extreme pollution.

When it comes to treating the detrimental health effects of excessive pollution, the healthcare sector in New Delhi faces many obstacles, especially in the winter and during religious holidays like Vijayadashami and Diwali. India's poor healthcare infrastructure, which is exemplified by the lack of hospital beds and healthcare facilities,[73] makes these problems worse. Hospitals treat a greater number of patients seeking treatment for health issues related to pollution when pollution levels rise, which puts a tremendous burden on healthcare resources and exacerbates gaps in healthcare delivery and access.[74]

According to the Global Healthcare Report, India lacks 2 billion square feet of additional space for healthcare, making it more difficult to provide for the needs of its 1.42 billion-person population. India's inadequate healthcare infrastructure is highlighted by the World Health Organization's recommendation of 3 beds per 1000 people: India is currently 2.4 million beds short of the standard.[75]

Diwali celebrations and the winter weather raise pollution levels, which increases the public's risk of respiratory and allergic diseases. Particularly in October and November, there is a noticeable increase in air pollution due to firecrackers during Vijayadashami and Diwali.[76] Pollution causes allergic symptoms like runny nose, watery eyes, and coughing, which makes more people seek medical attention. ENT specialists note shifts in healthcare demand during this period as patients are presenting with allergy symptoms caused by pollution at a markedly higher rate. The strain on healthcare facilities during winter and Diwali becomes apparent, as health complaints related to pollution account for a large portion of hospital visits. [77]

The increase in emergency room (ER) visits has been associated with rising pollution levels. A study published in the International Journal of Tuberculosis and Lung Disease showed AIIMS (All India Institute of Medical Science) Delhi received 69,400 visits, of

[73] Chelani, D., 2023, India grapples with critical healthcare real estate deficit of 2 bn sq ft, reveals report

[74] Press Trust of India, 2022, Patients surge at hospital OPDs as Delhi air quality remains 'severe'

[75] Chelani, D., 2023, India grapples with critical healthcare real estate deficit of 2 bn sq ft, reveals report

[76] Ghei, D., 2018, Estimates of air pollution in Delhi from the burning of firecrackers during the festival of Diwali

[77] Press Trust of India, 2022, Patients surge at hospital OPDs as Delhi air quality remains 'severe'

which 2,669 were due to acute respiratory symptoms[78] between June 2017 and February 2019, an average increase of about 20%.[79, 80]

The sharp disparity in the quantity of public and private hospitals in India is indicative of the Indian healthcare system' fragmented character. India has roughly twice as many private hospitals as public ones according to data from 2019[81] - and this difference is more prominent in cities such as New Delhi.

The public healthcare system in India bears a disproportionate amount of the burden compared to the private healthcare sector, resulting in a notable disparity in healthcare delivery. Government hospitals provide free medical care, but they are typically understaffed, ill-equipped, and mostly located in cities. On the other hand, despite their greater number, private hospitals serve the wealthy and thus create gaps in healthcare access and quality.[82]

The healthcare sector in New Delhi is confronted with significant challenges in reducing the detrimental impact of excessive pollution on health, which are further compounded by insufficient healthcare facilities and inequalities in healthcare provisions. The spike in health complaints related to pollution during religious festivals and the winter months highlights the critical need for all-encompassing measures to improve healthcare resilience and lessen the harmful effects of pollution on human health. To address these issues and protect the public's health in New Delhi and elsewhere, coordinated efforts must be made to improve healthcare delivery and access, invest in healthcare infrastructure, and put in place efficient pollution control measures.

[78] Yadav, R., et al, 2023, Short-term exposure to air pollution and emergency room visits for acute respiratory symptoms among adults - PMC

[79] Dutt, A., 2023, Why this polluting gas, NO2, is what you should worry about: It may land you in ER, says AIIMS study | Health and Wellness News - The Indian Express

[80] Jha, D. N., 2023, Air Pollution: Delhi, neighbours put on alert for health emergency | Delhi News - Times of India

[81] Statista, 2023, Estimated number of public and private hospitals in India 2019

[82] Sharan, U., 2021, India's Fragmented Healthcare System: Filling The Cracks

Insight Conclusion:

In conclusion, this insight has found that it is crucial that New Delhi's government tackle the causes as well as the symptoms of air pollution. The health effects of air pollution cannot be adequately or equitably mitigated at individual-level, particularly given the weaknesses of the region's overburdened healthcare system.

So far, however, regulatory attempts to tackle air pollution's causes (such as stubble burning) have proved ineffectual: with neither adequate enforcement of prohibitions on polluting activities, nor incentives to switch to less polluting alternatives, regulations have merely been circumvented. A key focus of our policy recommendations, therefore, is on incentives to render less polluting alternatives more appealing.

Policy Recommendations

Overview

Our policy recommendations focus on incentivising activities which are less polluting: we offer solutions to encourage commuters to switch from vehicle travel to public transport, and to encourage farmers to switch from crop-burning to mechanical agricultural techniques. However, we also acknowledge that it may not be possible to reduce pollution levels immediately, or completely. Therefore we also recommend policies to better protect citizens from air pollution (by introducing building standards to reduce the "leakage" of outdoor pollution indoors), and to render the region's healthcare system more resilient to the demands of air pollution-induced ailments.

Action 1: Expand the healthcare workforce to increase resilience to air pollution-related healthcare demand.

Our briefing and insight noted that the health-related effects of air pollution in New Delhi place profound strain on the region's healthcare infrastructure. While air pollution must be tackled and prevented at its source, in the interim strategies to prevent pollution-related ailments from overwhelming the healthcare system, particularly during winter when weather conditions and crop-burning exacerbate the effects of pollution.[83]

This briefing recommends that, to improve its capacity to respond to pollution-related ailments, New Delhi should prioritise expanding its healthcare workforce, since one of the greatest obstacles to adequate healthcare provision in New Delhi, like much of India, is understaffing. India has just 11.0 practising doctors and nurses per 10,000 population, far below the WHO's recommended health worker density of 34.5-44.5 per 10,000.[84]

This briefing proposes a two-pronged approach to resolving staffing crises: first, reduce the emigration and attrition of the healthcare workforce to maximise the "active" workforce. Second, increase the supply of healthcare workers by expanding and improving medical education.

India experiences remarkably high rates of healthcare workforce attrition to migration. 6.6% of doctors and 3% of nurses trained in India now work in just four countries: UK, USA, Canada and Australia. This can in part be explained by salary disparities: US nursing and physician salaries are 80% and 57% higher than respective Indian salaries (at purchasing power parity). Resolving these "pull" factors attracting Indian medical staff to work abroad will require significantly more investment than existing policies, which focus largely on punitive regulation, which make it more difficult to obtain emigration visas. However, this investment must be balanced with the "brain drain" of wasted investment in these professional's education from which only other countries benefit.[85]

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[83] Chakraborty, A., 2021, Delhi pollution impact I 100% jump in patients in a week: Study

[84] Saxeena, S. and Godfrey, T., 2023, India's Opportunity to Address Human Resource Challenges in Healthcare

[85] Walton-Roberts, M. and Rajan, I., 2020., Global Demand for Medical Professionals Drives Indians Abroad Despite Acute Domestic Health-Care Worker Shortages

WHO studies have estimated that, across India, if all qualified healthcare professionals were active, the shortfall of doctors to meet WHO standards by 2030 would be 1.47 million less, and the shortfall of nurses 1.33 million less. That said, even if the workforce operated at maximum activity, there would still exist a shortfall of 0.16 million doctors and 1.63 million nurses. Therefore, it is clearly also crucial to increase the supply of new healthcare practitioners.[86]

One obvious solution is to expand the number and size of medical colleges. Significant progress has been made in this area, with annual undergraduate intake to medical colleges more than doubling since 2005.[87]

However, existing colleges could also be rendered more efficient at meeting demand if student pass-out rates were improved: figures are unavailable for Delhi specifically but in Maharashtra the average first-year pass rate across the city's five medical colleges was just 74%.[88] Medical colleges are under-staffed: trends in teacher hiring have not matched the expanded student intake.[89] We advise the New Delhi government to invest in medical school staffing: since staff can educate multiple students, a multiplier effect will maximise the benefit of this investment.

Finally, curricula should incorporate more emphasis on non-communicable diseases such as heart disease. The prevalence of such diseases has increased drastically since curricula were first designed in the last century.[90] This reform is particularly relevant to New Delhi given the effect of air pollution on rates of non-communicable diseases.[91]

This briefing has focussed on policies to improve the supply and retention of healthcare staff in New Delhi in order to improve hospital capacity to respond to the additional burden imposed by air pollution-related ailments. However, we acknowledge that this policy recommendation, while necessary in the short-term, addresses the symptoms not the

[86] WHO, 2022, Health workforce in India

[87] George, A., 2023, Addressing India's Healthcare Worker Shortage: Evaluating Strategies to Improve Medical Education and Retention

[88] Mishtra, L., 2022, Lockout knock-out: 24 percent 1st year MBBS students flunk in Maharashtra

[89] The Hindu Bureau, 2023, Need for protecting and promoting teaching profession in medical colleges stressed.

[90] George, A., 2023, Addressing India's Healthcare Worker Shortage: Evaluating Strategies to Improve Medical Education and Retention

[91] World Health Organisation, 2022, Mortality attributed to household and ambient air pollution

cause of the health effects of air pollution. Therefore we also advocate for solutions to tackle air pollution at its source.

Action 2: Expand and integrate New Delhi's public transport system to reduce vehicle emissions.

Vehicle emissions are a key source of air pollution in New Delhi. Emissions from vehicles within New Delhi contribute around half of all PM2.5 emissions produced within the New Delhi locality. Vehicles are the largest single source of PM2.5 emissions, exceeding emissions even from crop burning in the surrounding regions.[92]

The government periodically attempts to restrict vehicular emissions by limiting vehicle travel. For example, it has repeatedly required cars to operate only on alternate days, based on their number plate. However, without robust alternative modes of transport, such "knee-jerk" schemes to reduce vehicle travel will prevent travel altogether, scuppering the city's economic activity.[93]

Therefore we recommend that the Government of Delhi invest in Delhi's public transport system to increase its attractiveness as a mode of transportation. Encouraging citizens to switch from private vehicles to public transport will require a number of reforms to make public transport more accessible and useful.

A top priority should be to improve the integration of New Delhi's various transport systems to enable seamless and cheaper travel. At present, commuters may struggle to access Metro stations. If they do take buses to their nearest station, they are charged for two separate journeys, significantly increasing commuting costs: when bus fares are included, Metro commuters spend around 14% of their income on transport costs.[94]

Therefore this briefing calls for greater collaboration between the metro system, two bus systems and multiple rail systems, all of which are at present operated as independent services with little communication between operators.[95] Bus routes should be designed

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[92] Roychowdhury, A. et al., 2022, Fact sheet: Source contribution to particulate pollution in Delhi and impact of traffic congestion on local pollution

[93] Energy Policy Institute, 2023, Odd-even scheme makes a comeback as Delhi chokes on pollution, experts question efficacy

[94] Centre for Science and Environment, 2018, CSE responds to comments on its recent analysis of affordability of urban transport and commuting

[95] Agarwal, A.P., 2019, To Clean Delhi's Air, Reform Its Transport System

to maximise access to the metro. One model of the effect of a network of "feeder" buses operating in a 6km radius around each metro station found that improving access thus could decrease the frequency of private vehicle trips by 6.2%.[96] Collaboration could also entail the integration of metro and bus fares to ensure that travellers are not penalised for taking "mixed-mode" journeys. New Delhi's 20-year "Master Plan" for 2041 acknowledged the need for "network integration", proposing for example "multi modal integration" at major metro and rail stations - that is, ensuring that citizens can easily access buses at each station.[97] It is crucial that political commitment to this reform is sustained.

Another starting point for reform is the transport system's range. Transport infrastructure must be expanded to improve connectivity into the city of New Delhi from cities in the surrounding region, since much of New Delhi's vehicle emissions is attributable to inter-city, rather than intra-city travel: the number of personal vehicles which enter the city daily is equivalent to the number of vehicles registered within the city throughout the whole of 2014.[98]

In sum, encouraging citizens to reduce their reliance on private transport will reduce the number of private vehicles on their roads, hence reducing emissions. A 2016 study predicted that overhaul and expansion of the metro and bus systems could, between 2007 and 2021, reduce passenger vehicle PM10 emissions by 24 percentage points more than expected under "business as usual".[99]

The reforms to public transport recommended here would therefore not only reap economic benefits by improving mobility within the region, but also provide an attractive alternative to private vehicle transport, hence reducing vehicle emissions and their pernicious health effects.

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[96] Chalumuri, R.S. et al., 2017, Development and evaluation of an integrated transportation system: A case study of Delhi

[97] Delhi Development Authority, 2021, About MPD-2041

[98] Roychowdhury, A., 2016, More cars enter Delhi every day than are registered in a year: CSE study

[99] Jain, S. et al., 2016, Vehicular exhaust emissions under current and alternative future policy measures for megacity Delhi, India

Action 3: Work with rural neighbouring states to offer financial incentives for stubble-burning alternatives and promote a shift towards more sustainable agricultural methods.

As discussed in the insight, 38% of air pollution in New Delhi can be attributed to stubble burning practices[100] from the nearby states of Haryana and Punjab brought over to the city by winds.

Not only does the agricultural sector in Haryana and Punjab play an important role in job creation and economic growth, it is crucial to India's food security. Often referred to as the nation's 'breadbasket', the two states account for over 70% of the country's wheat production.[101] This dependency, coupled with its major contribution to New Delhi's poor air quality renders it paramount that more sustainable alternatives to stubble burning, a method of crop residue removal, are developed and spread as soon as possible to mitigate the hazardous impacts on health.

Concern among farmers as to the financial viability of mechanical alternatives to stubble burning has generated resistance to switching. Many farmers in northern India alternate between planting rice in May and wheat in November, and thus must ensure fields are prepared for wheat-planting quickly. As a result, any potential solution should consider that land must often be ready just 15-20 days after harvest for farmers to make ends meet, ruling out manual time-consuming options with fewer pollutant emissions.[102]

Stubble-burning prohibition has historically been poorly enforced, as state governments seek to keep the influential voting bloc that is farmers onside in highly competitive elections in Punjab and Haryana.[103] However, more stringent enforcement measures, unless accompanied by support for farmers to find alternatives to stubble-burning, would be unjustly punitive.

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[100] Dayal, S., 2023, Explainer: Why is South Asia the global hotspot of pollution?

[101] Hussain, S. and Saini, S., 2022, Punjab, Haryana can hedge India against climate-induced food shortages.

[102] Arigela, A., 2023, Super Seeder - An alternate for Crop Residue Management

[103] Dolsak, N. and Prakash, A. 2019, Saving Delhi From The Toxic Smog: Regulations Have Failed But Financial Incentives Could Work

As discussed in the insight, renting an appropriate machine can be 10,000 rupees (£110) a day, whilst the cost of stubble-burning comes in at a mere tenth of the price; approximately 1000 rupees a day.[104] However, appropriate technologies, namely "Super Seeder" and "Happy Seeder" machines, are available and already in limited use in some parts of India. These appliances are capable of sowing wheat directly into crop residue, eliminating the need for stubble-burning.[105]

Furthermore, due to the negative effects of burning stubble on nutrient concentrations and thus soil fertility, the end to stubble burning practices would ultimately translate into greater profit opportunities for farmers. One study from the International Journal of Agricultural Sustainability estimated that the associated cost savings of using the "Happy Seeder" could result in increased revenues of $136 per hectare for farmers.[106] The study also refutes the common misconception amongst agricultural communities that the machine's usage entails a "yield penalty"[107] that could restrict wheat production. This is a fact that national and regional governments should aim to highlight in encouraging take-up of crop residue management (CRM) machinery, and may help to reduce the extent of the necessary subsidy to sufficiently reduce emissions.

Currently, under the national government's Crop Residue Management (CRM) Machinery scheme, farmers in the states of Delhi, Punjab, Haryana and Uttar Pradesh can purchase a "Happy Seeder" machine from the government at a 50% subsidy, at ₹75000 (£715).[108] However, as of October 2023, over 90% of "Happy Seeder" and "Super SMS" machines were not in use. Furthermore, although potentially due to the COVID-19 pandemic, only 7% of the state's machines have been distributed in the past three years[109], indicating a slowdown in the scheme.

Farmers cite a lack of support for high operating costs, particularly diesel costs, and lingering concerns about operational time for their reluctance.[110] Thus, in partnership with

[104] Ellis-Petersen, H., 2019, Delhi's smog blamed on crop fires – but farmers say they have little choice

[105] Keil, A., 2020, Changing agricultural stubble burning practices in the Indo-Gangetic plains: is the Happy Seeder a profitable alternative?

[106] Ibid.

[107] Ibid.

[108] Chaba, A. A., 2023, Stubble burning: Farms burn as Punjab farmers junk machines bought to manage crop residue

[109] Ibid.

[110] Chaba, A. A., 2023, Stubble burning: Farms burn as Punjab farmers junk machines bought to manage crop residue

a revamping of the subsidy scheme, we recommend a 12-month program of ongoing support payments after purchase be put in place to assure farmers of financial viability before harvest revenues come in.

We emphasise that the rewards of these changes and provisions available to farmers must also be strongly and widely publicised, since historical empty promises have resulted in a distrust of government programs amongst farmers. One farmer, who refrained from stubble burning in 2019, never received his pledged reward: “We waited a whole year but we got nothing, so I decided to burn the stubble this year”. By August, the Punjabi government had admitted they did not have the funds to pay farmers.[111] Whilst the short-term nature of this policy’s success may dismay some, it does offer validity to the view that Indian farmers are willing, and even eager to switch to other residue removal methods as long as it is accompanied by the necessary investment.

However, this still leaves issues for smaller farms where making outright purchases for mechanised farming would not be worth the investment. Of the 1.8 million farming families in the state of Punjab, 1 million of these own only 2-5 acres of land[112] and constitute approximately 80% of farmland[113] forming a significant but unfulfilled demand for machinery. Custom Hiring Centers (CHCs) serve this purpose; these facilities enable smaller farmers to use the expensive “Happy Seeders”, and other agricultural technology on more affordable short-term leases and therefore could play a vital role in preventing stubble burning. The current offer of an 80% subsidy on crop residue management (CRM) machinery for CHCs is crucial to keeping rents affordable and thus the accessibility of sustainable agricultural practices to small farmers.

To the detriment of emission reduction efforts, Custom Hiring Center provision in Haryana and Punjab lagged behind for years: only 29 centres existed across the two states in 2018.[114] Significant CHC expansion was seen in 2022[115] and the efforts of the Indian government here should be praised. There are still steps to be taken nonetheless, especially given the vast share of India’s agriculture the two states have. Coupled with the imperative further proliferation and publication of Custom Hiring Centers to farmers,

[111] BBC News, 2020, Stubble burning: Why it continues to smother north India

[112] Sarin, J., 2018, Govt moves to stop stubble burning go up in smoke in Punjab, Haryana

[113] Tamil Nadu Agricultural University, n.d., Agricultural Machinery Custom Hiring Centers (CHC) Model Scheme

[114] Sundaram, P. K. et al., 2019, Farm Mechanization for Small and Marginal Farmers

[115] Bethi, S. K., 2023, Custom Hiring Centers in Indian Agriculture: Evolution, Impact and Future Prospects

the government should also aim to promote an increased integration of Artificial Intelligence (AI) and Machine Learning (ML). Studies have demonstrated great potential for further cost reduction and productivity gains[116] from the use of AI and ML, further incentivising their usage, and the establishment of CHCs across the north of India.

Not only could the proliferation and streamlining of machinery leases in farming benefit the environment, the associated productivity enhancements also promise economic gains for small and marginal farming communities. Surveys also indicate positive attitudes towards CHCs from farmers.[117]

We also stress the importance of cross-state collaboration in reducing emissions and improving air quality in New Delhi and the wider region of north India. All too often, attempts to combat air pollution in New Delhi have descended into a political blame game between AAP-governed states of Delhi and Punjab and BJP states of Haryana and Uttar Pradesh[118]. Thus, we recommend that the Government of Delhi establishes a cross-state committee across north India, with representation from the urban Delhi-NCT, and more rural states of Haryana, Punjab, and Uttar Pradesh. This committee should meet quarterly at the very least and involve annual target-setting practices that clearly set out the states' collective responsibility in resolving New Delhi's hazardous air quality.

In sum, given the severity of New Delhi's air pollution crisis and its severe strain on existing healthcare infrastructure, we call on India's national government as well as the state governments of Haryana, and Uttar Pradesh to reprioritise climate action urgently. The existing availability of suitable agricultural technology as a substitute for stubble burning offers ample opportunity for the cessation of the highly polluting practice with adequate funding. It is an investment that the associated fertility gains and reduction in the burden of pollution-related disease will more than return to national and state governments.

[116] Bethi, S. K., 2023, Custom Hiring Centers in Indian Agriculture: Evolution, Impact and Future Prospects
[117] Ibid.
[118] Prakash, A., and Dolsak, N., 2023, Is Politics Causing Delhi Air Pollution And Climate Policy Slowdown?

Action 4: Introduce mandatory regulations on building designs to minimise indoor pollution.

Our briefing and insight highlighted the difficulties of escaping pollution even indoors, an issue exacerbated by “leaky” building design. The danger that indoor pollution presents to public health is greater than that of outdoor pollution[119] and therefore building plans that prioritise pollution resilience are desperately needed. This section proposes policy suggestions for putting pollution-resilient building plans into action in New Delhi, drawing upon the ideas that Singapore successfully implemented with sustainable growth in mind.

To control indoor air quality and protect citizens from outdoor air pollution, Singapore has implemented strict building standards and regulations. The Building and Construction Authority (BCA) developed the Green Mark Certification program to promote the use of green building practices, such as actions to enhance indoor air quality and lower pollution infiltration.[120] The plan contributes to the creation of healthier indoor environments that are less vulnerable to pollution infiltration by giving priority to factors like ventilation, air filtration, and material selection. This is especially important in New Delhi, where indoor air pollution levels are constantly above safety thresholds (exceeding outdoor levels by five to 100 times[121]) and have an adverse effect on building occupants' health and wellbeing. By incorporating pollution-resistant architectural elements, developers can lessen the negative impact of outdoor air pollution on building occupants' health.

Moreover, architects, engineers, builders, and other industry stakeholders should be the focus of capacity building and training programs designed to support the implementation of pollution-resilient building plans. The main goals of these initiatives should be to increase industry professionals' cooperation, educate the public about the value of indoor air quality, and offer technical advice on pollution-resilient design principles.[122] Through the provision of appropriate knowledge and skills to stakeholders, New Delhi can guarantee the effective execution of building plans that are resilient to pollution.

It is imperative that New Delhi update and reinforce its building codes to guarantee adherence to standards for pollution-resistant design. This means pushing for the use of

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[119] Ibrahim, F., et al. 2022, Hospital indoor air quality and its relationships with building design, building operation, and occupant-related factors: A mini-review - PMC

[120] Joannides, C., 2023, The Green Mark Certification Scheme explained

[121] Ibrahim, F., et al. 2022, Hospital indoor air quality and its relationships with building design, building operation, and occupant-related factors: A mini-review - PMC

[122] Utilities One, 2023, Educating the Next Generation about Carbon-Neutral Construction

ecologically friendly building materials, imposing stringent ventilation rate regulations, and requiring the installation of air quality monitoring systems. Standards for ventilation should guarantee sufficient air exchange to reduce indoor pollutants. Particulate matter and volatile organic compounds (VOC) levels should be continuously monitored by air quality monitoring systems.[123] Off-gassing is decreased by requiring the use of environmentally friendly products, such as low-VOC paints. Strict inspection procedures that check for compliance with rules and impose fines for noncompliance are necessary to guarantee accountability. Industry compliance is fostered by enforcement actions that are transparent. These actions encourage healthier living conditions, reduce indoor pollution, and give priority to sustainability in building.

The city ought also to create a thorough inspection framework carried out by certified inspectors trained in sustainable building techniques, building on the rules and guidelines already in place that have been established by agencies such as the Bureau of Indian Standards (BIS). To discourage non-compliance, there should be fines and penalties for violations, along with transparent enforcement procedures and clear guidelines. Enforcement actions should be supervised by designated government organisations, such as the Delhi Development Authority (DDA) and the Municipal Corporation of Delhi (MCD) - which have struggles due to unauthorised construction, code violation and poor urban planning[124] - working in tandem with environmental protection and law enforcement agencies, to not only come up with better standards, but also work to address issues like illegal constructions. In addition to encouraging compliance and accountability, public reporting systems and awareness campaigns can also foster healthier indoor environments and lessen the negative effects of pollution on public health.

To sum up, New Delhi needs to fight indoor pollution immediately by putting pollution-resilient building plans into action. Getting proper and sustainable ventilation, air filtration, and environmentally friendly materials should be a top priority for agencies and builders. This was successfully demonstrated by Singapore's Green Mark Certification program, where updating building code and design for stakeholders was necessary for compliance. Additionally, addressing issues like illegal building and inadequate urban planning requires cooperation between public and government entities for public health and sustainability to coexist in safer and healthier indoor environments in New Delhi.

[123] Presaac, 2024, What are Volatile Organic Compounds (VOCs) and why should you be monitoring them?
[124] Balasubramanian, H., 2024, Delhi HC directs DDA, MCD to put structural reforms in place

Conclusion

Air pollution is the greatest environmental threat to health in the world. The problem is particularly acute in New Delhi, where high pollution levels from multiple sources, the expense of individual-level solutions such as air purifiers, and the fragility of an already overburdened healthcare system combine to result in an estimated excess 54,000 deaths per year from air pollution.

Our policy recommendations seek to address the problem at every level - both cause and symptom. We encourage less punitive policies to address polluting vehicle travel and crop-burning, with a focus instead on providing appealing alternatives to these activities such as better public transport and subsidised agricultural machinery. However, we also suggest ways to reduce the effects of air pollution where it exists, including improving building standards to reduce the leakage of ambient air pollution indoors, and strengthening the healthcare workforce to ensure citizens can receive the care they need for air pollution ailments.

We acknowledge that our solutions will require at least some level of investment of public funds. However, our insight demonstrates that, thus far, efforts to redress air pollution without investment, such as encouraging citizens to take personal precautions or enforcing bans on crop-burning without offering feasible alternatives, have been ineffective and inequitable. Further, we believe that the New Delhi government should see any expenditure to tackle the scourge of air pollution, given that at present it threatens economic productivity, deters tourism, burdens the healthcare system and ultimately threatens lives, as a worthwhile investment.

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