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Centre for Air Pollution & Environmental Health · Pahle India Foundation

Realizing NCAP's Health Promise: Indian Evidence and Recommendations for National Clean Air Programme Reform

SPCBs have the monitoring infrastructure. What is needed is the formal connection to health outcome data.

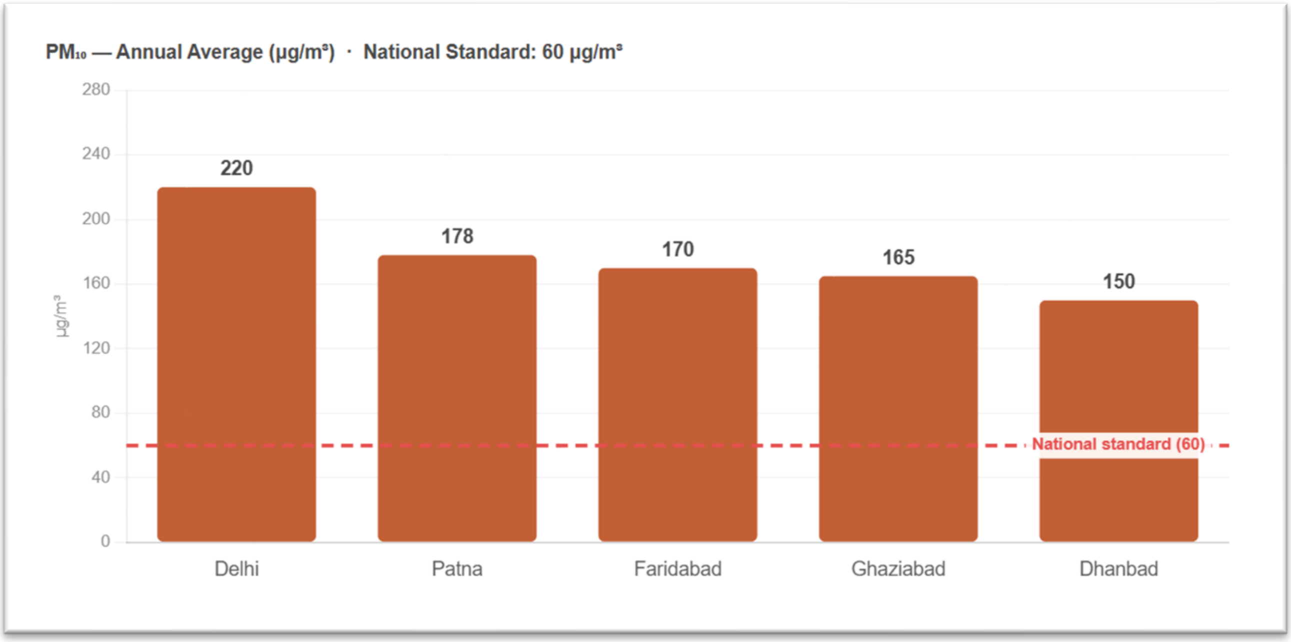
This policy brief responds to a felt and recognized gap in India's clean air policy discourse: the absence of a synthesis of India's own evidence on the health consequences of air pollution. Every study, dataset, and institutional source cited in this brief is India-generated - drawn from Indian cohorts, Indian registries, Indian surveillance systems, and Indian research institutions. India has produced substantial primary evidence on air pollution and health; what has been missing is a formal connection between SPCB monitoring data and state health outcome datasets.

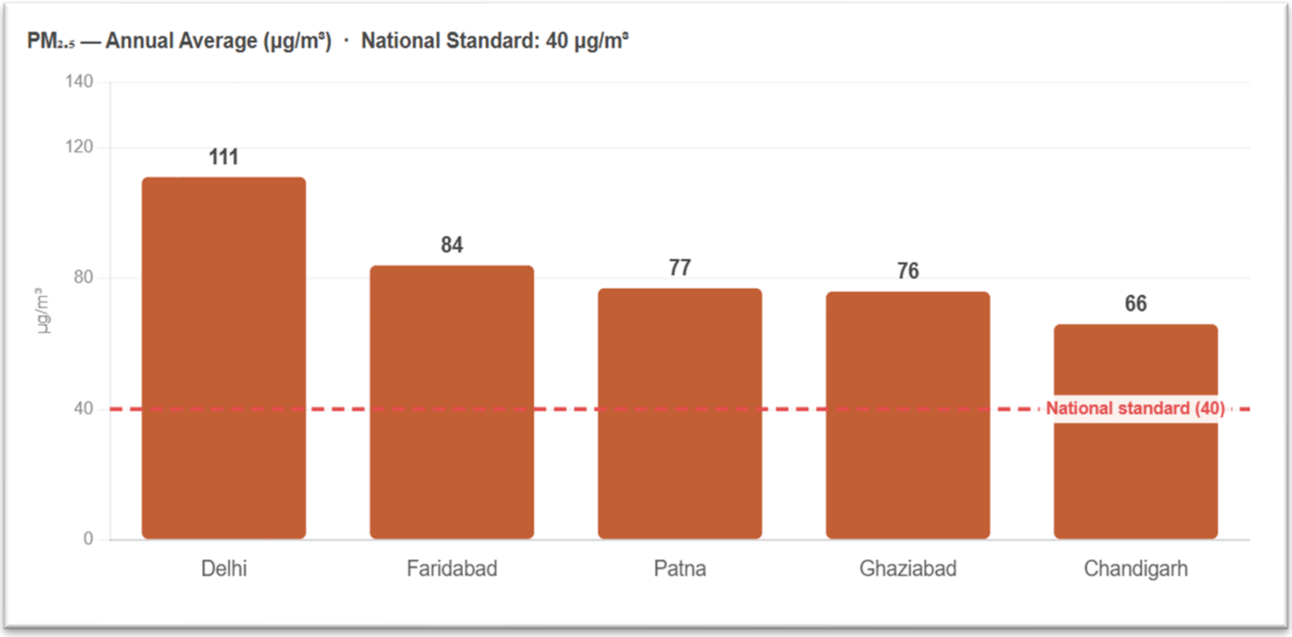
1 India's Clean Air Progress - and the Health Opportunity Ahead

India is home to some of the most polluted cities on earth. Many cities in the Indo-Gangetic Plain including Delhi, Siwan, Greater Noida, Patna, and Lucknow rank among the world's most polluted[1]. Yet the air pollution challenge is not confined to large cities alone. Annual $PM_{2.5}$ concentrations across Indian cities consistently exceed India's own Central Pollution Control Board (CPCB) standard (40 µg/m³) [2]. In 2024, annual average concentrations of PM_{10} and $PM_{2.5}$ exceeded national ambient air quality standards (NAAQS), among cities with continuous CPCB monitoring stations, in 43 and 23 cities respectively[3]. A programme designed to protect Indian lives should also include places where most of those lives, and most of that burden, is actually located. It is against this backdrop that India's own research institutions have spent two decades documenting what this pollution does to Indian bodies and that evidence now demands a policy response.

108 of 130	**51%**
NCAP cities fall short of India's NAAQS PM_{10} standard in FY 2024-25 after six years and ₹13,000+ crore of the programme	of released NCAP funds utilized by 82 MoEFCC-funded cities (₹831 cr of ₹1,616 cr released) -- a utilization challenge alongside the health challenge
MoEFCC, Lok Sabha, December 2025[4]	CSE, An Agenda for Reform, July 2024[5]

Top 5 polluted cities in India by PM_{10} & $PM_{2.5}$ concentration (2024)





Source: Central Pollution Control Board (CPCB), Annual Report 2024-25, MoEFCC, Government of India[3]

Within this broader challenge, NCAP's own performance data tells a partial but important story. In FY 2024-25, 103 of 130 NCAP cities showed improvement in PM_{10} concentrations compared to the 2017-18 baseline, yet only 22 cities actually conform to India's own NAAQS[4]. While the trend is improving, 108 cities still do not meet India's own standard. More critically, NCAP targets remain pegged to PM_{10}, not $PM_{2.5}$, the finer particulate that penetrates deeper into lung tissue and carries stronger dose-response links to cardiovascular mortality. $PM_{2.5}$ penetrates the blood-brain barrier, and has documented impacts on neurological health as well. **A programme benchmarked against the less health-relevant pollutant, and scoped only to cities, is misaligned with the burden it was actually designed to address. The health consequences of this pollution are not confined to the lungs. Evidence generated through Government of India surveillance and research systems consistently demonstrates that air pollution**

affects multiple organ systems and disease categories across the life course.

> The question before State Pollution Control Boards is not whether they have the monitoring capacity. India's SPCBs have already built much of the infrastructure. The question is whether SPCBs will use the data they already collect to connect air quality improvement to health outcomes at the state level where it ultimately matters most.

2 The Evidence: What Indian Research Has Established

A substantial and growing body of primary research, generated by the very institutions that underpin India's tobacco control policy, non-communicable disease (NCD) burden estimates, and maternal health guidelines, documents the health consequences of air pollution across multiple outcomes and populations. The stakes extend beyond domestic health policy. Meeting Sustainable Development Goals (SDG) is not achievable in India without substantially reducing the health burden of air pollution[6]. Air pollution is not a parallel agenda to NCDs; it is one of its primary drivers.

> The Government of India routinely relies on evidence in public health generated by institutions such as All India Institute of Medical Sciences, Indian Council of Medical Research, Public Health Foundation of India, the Indian Institutes of Technology, and Sri Ramachandra Institute of Higher Education and Research. These same institutions generate evidence on air pollution and health; hence its integration into clean air policy would be consistent with established evidence-based governance processes.

Evidence by Health Outcome and Intervention Response

Health Outcome	Key Indian Findings and Institution	Study / Source
Cardiovascular-Hypertension	$PM_{2.5}$ exposure associated with elevated systolic blood pressure and significantly higher incidence of hypertension in urban Delhi adults. Prospective cohort design; 5,342 participants. *PHFI / AIIMS-CARRS Cohort, Delhi*	Prabhakaran D et al. (2020)[7]
Metabolic- Type 2 Diabetes	22% higher incidence of type 2 diabetes per 10 μg/m³ increase in annual average $PM_{2.5}$ (HR 1.22; 95% CI 1.09-1.36) among 12,064 participants in Delhi and Chennai. Among the first prospective cohort evidence on $PM_{2.5}$ and diabetes from Indian urban populations. *PHFI - CARRS Cohort, Delhi & Chennai*	Mandal S et al. (2023)[8]
Respiratory- Children	Indoor $PM_{2.5}$ and NO_2 significantly elevated in homes of children with respiratory illness in an industrial area of Delhi. Lung function impairment documented in Ashok Vihar children; exposure- response relationship demonstrated. *Delhi-based research group*	Kumar R et al. (2007, 2008)[9,10]

Health Outcome	Key Indian Findings and Institution	Study / Source
Respiratory- Urban Slums	Indoor PM and Respirable Suspended Particulate Matter (RSPM) levels in Nizamuddin slum households in Delhi significantly elevated above reference levels; associated respiratory health effects documented among residents in poorly ventilated housing. *IIT Delhi / Delhi University*	Kulshreshtha P et al. (2008)[11]
Respiratory- Rural Women	Both obstructive and restrictive lung defects documented in women and children exposed to biomass cookstove emissions in rural Tamil Nadu. $PM_{2.5}$ identified as the primary driver. *Multi-institutional, rural Tamil Nadu*	Patel et al. (2018)[12]
Cancer- Lung	ICMR-NCDIR documents higher lung cancer incidence in India's most polluted metro cities. Lung cancer incidence has shown a significant upward trend in Indian metro cities. *National Cancer Registry Programme, Bengaluru*	Nath et al. (2022)[13]
Systemic- Vitamin D	Children aged 9-24 months in high-pollution locality in Delhi had mean serum vitamin D of 12.4 ng/ml less than half of the requirement from low-pollution area. ($p<0.001$). This demonstrates pollution's reach beyond respiratory and cardiovascular systems. *St. Stephen's Hospital, Delhi*	Agarwal KS et al. (2002)[14]
Intervention - BP & Oxidative Stress	Portable HEPA air filtration in an all-female old-age home in Rohtak, Haryana (29 participants) showed statistically significant improvement in systolic blood pressure ($p<0.001$) during active vs. sham filtration, with CRP and oxidative DNA damage as secondary outcomes. *PGIMS, Rohtak, Haryana*	Ahuja A et al. (2025)[15]
Intervention evidence Natural Experiment - Lockdown	COVID-19 lockdown (2020) caused approximately 50% $PM_{2.5}$ reductions across Delhi, Mumbai, and Kolkata documented by CPCB monitoring data and peer-reviewed analysis. This demonstrated that targeted emission controls can achieve rapid, measurable air quality improvements, providing India-specific empirical evidence that policy-driven source reduction works. *Multiple Indian universities*	Dhaka SK et al. (2020) and Mandal J et al. (2021)[16,17]

Mortality	Every 25 µg/m³ increase in $PM_{2.5}$ associated with 0.8% increase in daily non-accidental mortality in Delhi; 1.5% increase among adults aged 60 and above. Short-term exposure time-series analysis; 700,512 deaths recorded June 2010–December 2016. *PHFI / Centre for Policy Research, Delhi*	Krishna B et al. (2021)[21]

The studies presented are drawn from a broader peer-reviewed evidence base. Health Effects Institute global burden of disease evidence portal lists 647 Indian studies, and approximately 200 peer-reviewed studies document direct human health outcome evidence from air pollution exposure in India, spanning respiratory, cardiovascular, metabolic, maternal, and child health outcomes. Please note that studies mentioned above vary in design; table is indicative of the breadth of Indian literature and is not an exhaustive list.

India's Emerging Primary Evidence Infrastructure

Two ongoing prospective cohort studies led by researchers across AIIMS Delhi, IIT Delhi, IIT Bombay, and St John Research Institute will fill the gap with gold-standard primary evidence:

APiPED - Air Pollution Impact on Pregnancy & Early Childhood Development[18]	**APEAL - Longitudinal Effects of Air Pollution on Adolescent Lungs[19]**
Enrolling 2,500 pregnant women from urban and rural Delhi NCR; following children to age 2. Directly measures $PM_{2.5}$ and PM_{10} using personal portable monitors for a sub-sample. Will generate India's first primary clinical evidence linking measured ambient $PM_{2.5}$ to maternal outcomes and early child development - birthweight, inflammation biomarkers, and neurodevelopment.	4,000 adolescents across Delhi, Mumbai, Bengaluru, and Mysuru; categorized by $PM_{2.5}$ exposure level. Uses spirometry and forced oscillation technique alongside blood biomarkers. Will produce India's first age- appropriate lung function reference values in polluted urban settings and establish trajectory of lung development under chronic $PM_{2.5}$ exposure.

Both studies are at the protocol-stage - results are several years away, but this indicates that India's research institutions are now generating the gold-standard prospective cohort evidence that current policy gaps demand. ***The next phase of NCAP should be designed to receive and act on these findings as they emerge.***

Where the Evidence Is Strongest - and Where It Thins

Well-Studied: Regions	**Under-Studied: Regions**
Delhi NCR mainly dominates the primary evidence based followed by Tamil Nadu reflecting the concentration of research infrastructure - AIIMS, PHFI, IIT Delhi, SRIHER in cities where institutional capacity is strongest. Moreover, evidence is also emerging from cities such as Mumbai, Bengaluru and Mysuru.	The Indo-Gangetic Plain cities with the worst pollution burden i.e., Patna, Kanpur, Lucknow, Ghaziabad have the least primary research coverage. This is the most critical geographic gap for policy purposes. Additionally, North-Eastern states have no or little evidence on the growing pollution level.

Critical Disease Gaps

India has no prospective cohort study linking ambient $PM_{2.5}$ to COPD incidence. For ischemic heart disease, the Million Death Study - using nationally representative SRS mortality data found a null-to-weak association[20] These gaps are significant and must not become a reason for inaction.

3 PCBs as India's Ground-Level Implementation Engine

State Pollution Control Boards are India's frontline environmental regulatory institutions - the bodies that operate monitoring stations, verify compliance with emission standards, assess city action plans, and report city performance to CPCB and MoEFCC. The outcomes of NCAP depend, in practice, on what SPCBs do on the ground.

The Indo-Gangetic Plain SPCBs (Uttar Pradesh, Bihar, Punjab, Haryana) oversee the cities where pollution and health burden is highest and primary evidence is thinnest. These are also the states where CAAQMS density is lowest and where the gap between monitored concentrations and actual population exposure is largest. SPCBs in these states have the most to gain from health-linked metrics: evidence of health outcomes would strengthen their case for enforcement, for central funding, and for inter-departmental collaboration with state health departments.

SPCBs do not set national policy. But they are the ground truth of whether national policy works. The asks in this brief are executable within existing SPCB mandates - and would meaningfully strengthen the evidence base that SPCBs need to do their job.

4 The Opportunity: Connecting India's Air Quality and Health Data

India does not have an evidence problem. It has an institutional design problem. India generates pollution data and health data in parallel and has no routine system to connect them.

SPCB	PM-JAY	NPCCHH ARI Sentinel Surveillance
Real-time $PM_{2.5}$ data is available, collected, and published	Hospital admissions with ICD-10 disease codes across Ayushman Bharat- Data collected, not linked to pollution	Operational since 2017 across selected sites across states but no public data reports released and no formal $PM_{2.5}$ linkage

These three systems operate in parallel. No formal mechanism connects them.

SPCBs have already built much of the monitoring infrastructure. CAAQMS stations operated by SPCBs across NCAP cities generate the ambient $PM_{2.5}$ data that makes health linkage possible. What is missing is the formal connection: SPCB monitoring data flows upward to CPCB and MoEFCC, but is never linked to the hospital admissions data held by state health departments. the next phase of NCAP is the moment to close that gap. Many SPCBs do not need to wait for a national protocol- a state SPCB can initiate the data linkage with its own state health department today.

5 Specific Asks for State Pollution Control Boards

01 Expand CAAQMS Network to Residential Zones Within NCAP Cities

SPCBs to plan and implement expansion of CAAQMS station coverage within their designated NCAP cities to achieve a minimum density of ≥1 station per 50 km^2 in residential zones within 3 years. Current monitoring in many IGP cities is concentrated at administrative or industrial locations, systematically underestimating residential $PM_{2.5}$ exposure. Residential zone coverage is the prerequisite for computing Population-Weighted Exposure to $PM_{2.5}$ — the metric the next phase of NCAP will use for performance-linked disbursement.

Short term · SPCBs

02 Compute and Report City-Level PWE-$PM_{2.5}$ to CPCB

SPCBs to ensure data quality and completeness of CAAQMS submissions to CPCB, actively supporting CPCB's computation of Population-Weighted Exposure to $PM_{2.5}$ (PWE-$PM_{2.5}$) baselines. SPCBs with ward-level monitoring data should compute and publish city-level PWE-$PM_{2.5}$ estimates independently using CPCB methodology, building institutional familiarity with the metric ahead of its adoption as the NCAP disbursement indicator. Cross-verify against ISRO INSAT-3D satellite AOD data where available.

Immediate · SPCBs + CPCB

03 Pilot State-Level $PM_{2.5}$-to-Cardiorespiratory Data Linkage

SPCBs in states with stronger institutional capacity — Maharashtra, Karnataka, Tamil Nadu — to pilot the linkage of SPCB ambient $PM_{2.5}$ data with state HMIS and National Health Mission cardiorespiratory admission data. A state-level pilot does not require the national MoEFCC–MoHFW protocol to be in place — it can be initiated through a bilateral agreement between the SPCB and the state health department. A working state pilot creates both the evidence and the template for national rollout.

Short term · SPCBs + State Health Departments

04 Commission Source Apportionment and Embed Health Outcomes in City Action Plans

IGP-state SPCBs — Uttar Pradesh, Bihar, Punjab, Haryana — to commission city-level source apportionment studies for their highest-burden NCAP cities where apportionment is absent or outdated. In parallel, SPCBs to embed a health outcome section in city action plans submitted under NCAP, tracking cardiorespiratory indicators at district level alongside $PM_{2.5}$ measurements. Plans that connect emission sources to population health outcomes will be better positioned for full disbursement under the next phase of NCAP's performance-linked framework.

Short term · SPCBs

6 Conclusion

India's challenge in addressing air pollution is not a shortage of evidence, but rather one of institutional design and policy translation. NFHS data traces its footprint in child respiratory health. ICMR-NCDIR cancer registries show its signature in lung cancer incidence in India's most polluted cities. CPCB's own monitoring network confirms that virtually all 130 NCAP cities exceed the $PM_{2.5}$ NAAQS of 40 µg/m³ and 108 cities still fall short of even the less stringent PM_{10} standard. Primary studies from AIIMS, PHFI, IIT Delhi, and other institutes independently document what this exposure does to Indian lungs, hearts, and metabolic health. ***The science is Indian. The data is Indian. The conclusion is unambiguous.***

The window to embed health outcome metrics into the next phase of NCAP is open now - and it will not remain open indefinitely. Programme architecture, inter-ministerial data protocols, and surveillance mandates are set at the design stage. A programme that launches without formal $PM_{2.5}$ to health linkage will spend years trying to retrofit what could have been built in from the start. The four asks in this brief are executable within existing institutional mandates, require no new legislation, and carry no foreign technical dependence.

The question before State Pollution Control Boards is not whether they have the capacity. Many do. The question is whether SPCBs will use the monitoring data they already collect to measure, track, and report harm - connecting air quality improvement to health outcomes at the state level where it ultimately matters most.

PAVANA offers three specific forms of technical support to State Pollution Control Boards:
(1) Developing the methodology and tools for computing PWE-$PM_{2.5}$ at city level using CAAQMS and Census data;
(2) Designing the state-level $PM_{2.5}$-to-health data linkage pilot framework;
(3) Supporting preparation of city action plans that embed health outcome tracking alongside $PM_{2.5}$ reduction targets.
All three are executable within existing SPCB mandates.

7 References

1. MoEFCC Annual Report (2024-25) and subsequent NCAP updates. CPCB's National Ambient Air Quality Status Reports.
2. Central Pollution Control Board. National Ambient Air Quality Status and Trends in India, 2021-2022. New Delhi: CPCB, Ministry of Environment, Forest and Climate Change, Government of India; 2024. Available from: cpcb.nic.in
3. Central Pollution Control Board. Annual Report 2024-25. 2025.
4. Ministry of Environment, Forest and Climate Change. Lok Sabha Unstarred Question No. 49, answered 1 December 2025. 18th Lok Sabha, Winter Session 2025.
5. Roy Chowdhary A, Kumari J. National Clean Air Programme- An Agenda for Reform. New Delhi; 2024.
6. World Health Organization. Sustainable Development Goal Indicator 3.9.1: Mortality Attributed to Air Pollution. WHO, 2024. World Health Organization. Environmental risk factors and NCDs. Geneva: WHO; 2024. Available from: https://www.who.int/teams/noncommunicable-diseases/integrated-support/environmental-risk-factors-and-ncds
7. Prabhakaran D, Mandal S, Krishna B, Magsumbol M, Singh K, Tandon N, et al. Exposure to Particulate Matter Is Associated With Elevated Blood Pressure and Incident Hypertension in Urban India. Hypertension. 2020 Oct 1;76(4):1289–98. doi:10.1161/HYPERTENSIONAHA.120.15373 PubMed PMID: 32816598.
8. Mandal S, Jaganathan S, Kondal D, Schwartz JD, Tandon N, Mohan V, et al. PM 2.5 exposure, glycemic markers and incidence of type 2 diabetes in two large Indian cities. BMJ Open Diabetes Res Care. 2023 Oct 5;11(5). doi:10.1136/bmjdrc-2023-003333 PubMed PMID: 37797962.
9. Kumar R, Nagar JK, Kumar H, Kushwah AS, Meena M, Kumar P, et al. Association of indoor and outdoor air pollutant level with respiratory problems among children in an industrial area of Delhi, India. Arch Environ Occup Health. 2007;62(2):75–80. doi:10.3200/AEOH.62.2.75-80 PubMed PMID: 18316264.
10. Kumar R, Nagar JK, Kumar H, Kushwah AS, Meena M, Kumar P, et al. Indoor air pollution and respiratory function of children in Ashok Vihar, Delhi: an exposure-response study. Asia-Pacific journal of public health
11. Kulshreshtha P, Khare M, Seetharaman P. Indoor air quality assessment in and around urban slums of Delhi city, India. Indoor Air. 2008;18(6):488–98. doi:10.1111/j.1600-0668.2008.00550.x
12. Patel S, Leavey A, Sheshadri A, Kumar P, Kandikuppa S, Tarsi J, et al. Associations between household air pollution and reduced lung function in women and children in rural Southern India. Journal of Applied Toxicology. 2018 Nov 1;38(11):1405–15. doi:10.1002/jat.3659 PubMed PMID: 30047157.
13. Nath A, Sathishkumar K, Das P, Sudarshan KL, Mathur P. A clinic-epidemiological profile of lung cancers in India — Results from the National Cancer Registry Programme. Indian Journal of Medical Research. 2022 Feb 1;155(2):264–72. doi:10.4103/ijmr.ijmr_1364_21. PubMed PMID: 35946203.
14. Agarwal KS, Mughal MZ, Upadhyay P, Berry JL, Mawer EB, Puliyel JM. The impact of atmospheric pollution on vitamin D status of infants and toddlers in Delhi, India. Arch Dis Child. 2002;87(2):111–3. doi:10.1136/adc.87.2.111. PMID: 12138058.
15. Ahuja A, Kumar A, Rulia R, Bhardwaj R, Arya G, Surapaneni V, et al. Effect of portable air filtration systems among female residents of old age home in northern India with hazardous air quality. Physiol Rep. 2025 Aug 1;13(15). doi:10.14814/phy2.70475
16. Dhaka SK, Chetna, Kumar V, Panwar V, Dimri AP, Singh N, et al. PM2.5 diminution and haze events over Delhi during the COVID-19 lockdown period: an interplay between the baseline pollution and meteorology. Sci Rep. 2020 Dec 1;10(1). doi:10.1038/s41598-020-70179-8 PubMed PMID: 32778673.
17. Mandal J, Samanta S, Chanda A, Halder S. Effects of COVID-19 pandemic on the air quality of three megacities in India. Atmos Res. 2021 Sep 1;259. doi:10.1016/j.atmosres.2021.105659
18. Salve HR, Dey S, Arora Y, Kapoor S, Ghosh S, Kumar R, et al. Air Pollution Impact on Pregnancy and Early Childhood Development (APiPED) in India: Protocol for a Cohort Study. JMIR Res Protoc. 2025 Nov 11;14:e72683. doi:10.2196/72683
19. Agrawal T, Phuleria HC, Mohan A, D'Souza G, Thimmulappa R, Jayaraj BS, et al. Rationale and methodology of a multicentric prospective cohort study on ' Longitudinal Effects of Air Pollution Exposure on Adolescent Lungs (APEAL)' in urban India: APEAL protocol. BMJ Open. 2025 Aug 12;15(8). doi:10.1136/bmjopen-2025-106329 PubMed PMID: 40803718.
20. Brown PE, Izawa Y, Balakrishnan K, Fu SH, Chakma J, Menon G, et al. Mortality Associated with Ambient PM2.5 Exposure in India: Results from the Million Death Study. Environ Health Perspect. 2022 Sep

1;130(9):097004-1-097004–14. doi:10.1289/EHP9538 PubMed PMID: 36102642.

21. Krishna B, Mandal S, Madhipatla K, Reddy KS, Prabhakaran D, Schwartz JD. Daily nonaccidental mortality associated with short-term PM2.5 exposures in Delhi, India. Environ Epidemiol. 2021 Aug 6;5(4):e167. doi:10.1097/EE9.0000000000000167. eCollection 2021 Aug. PubMed PMID: 34414349.

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