PAVANA · POLICY BRIEF

Centre for Air Pollution & Environmental Health · Pahle India Foundation

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

ICMR has the research mandate. What is needed is the commission to direct it at air pollution.

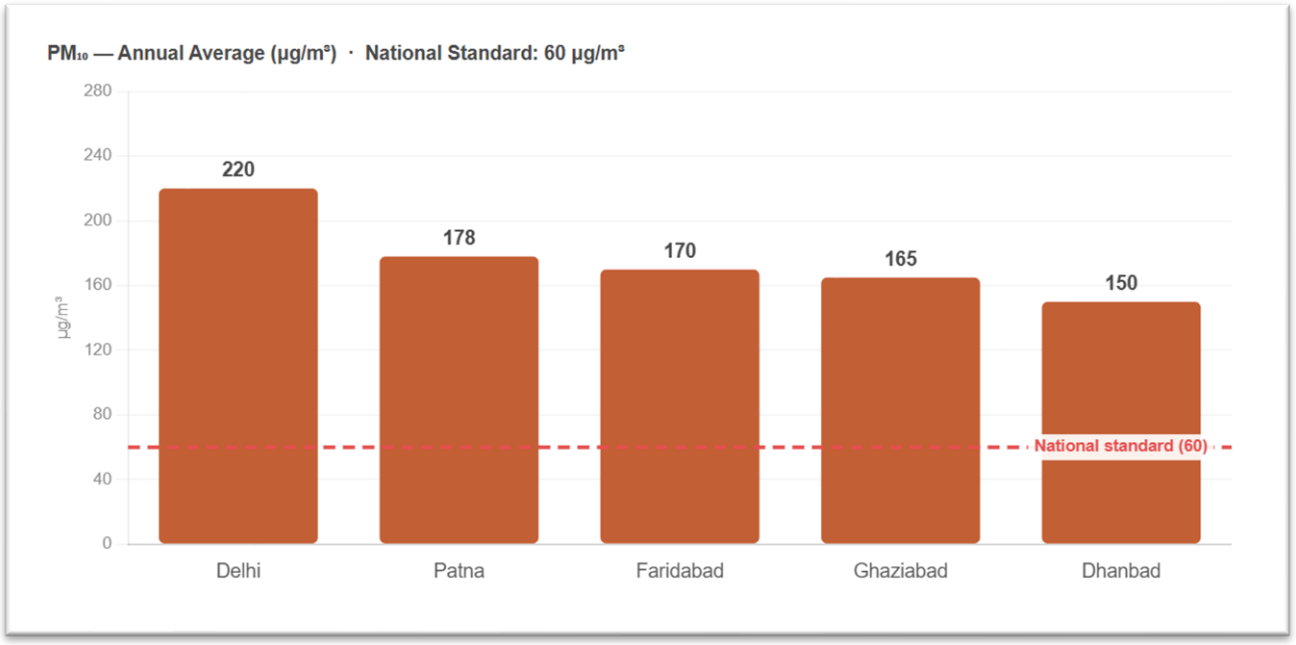
This policy brief responds to a felt and recognized gap in India's clean air policy discourse: the absence of a synthesis of India's own evidence on the health consequences of air pollution. Every study, dataset, and institutional source cited in this brief is India-generated - drawn from Indian cohorts, 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 mandate requiring $PM_{2.5}$ reduction to be tracked against health outcomes.

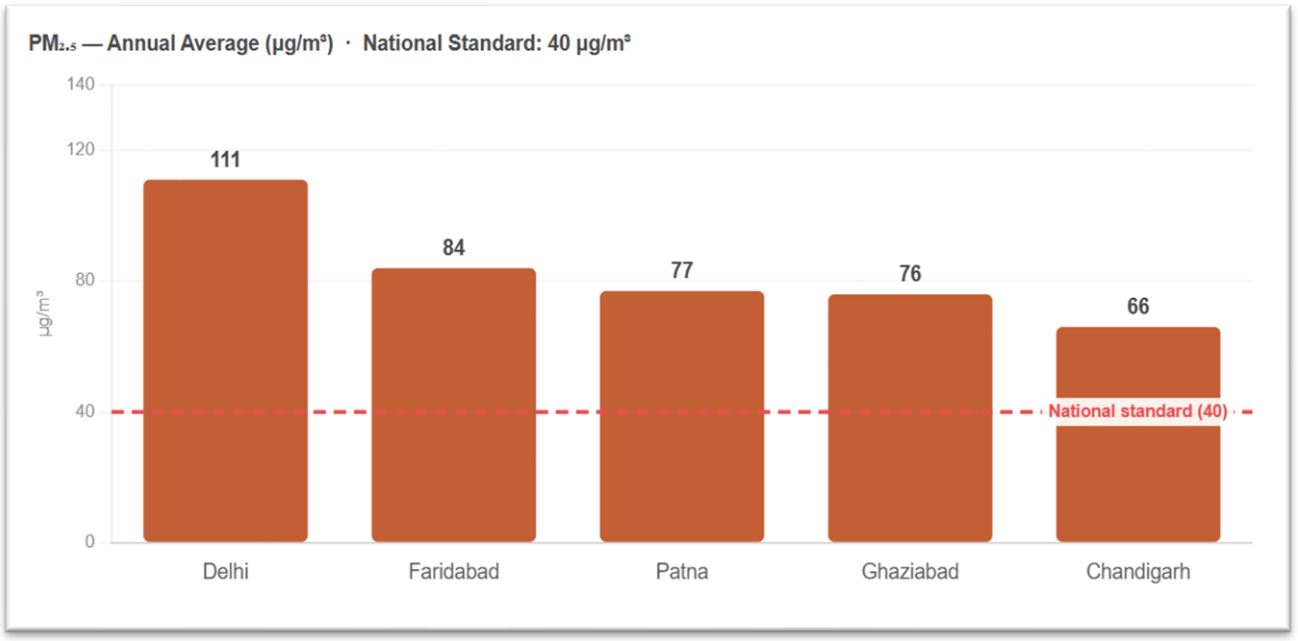
1 India's Clean Air Progress - and the Health Opportunity Ahead

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 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 MoEFCC, Lok Sabha, December 2025[4]	**51%** of released NCAP funds utilized by 82 MoEFCC-funded cities (₹831 cr of ₹1,616 cr released) - a utilization challenge alongside the health challenge 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 ICMR is not whether India has the health evidence. Its own institutions have generated it. The question is whether ICMR will commission the research that makes India's $PM_{2.5}$ burden measurable - and use that evidence to make the next phase of NCAP accountable for health outcomes, not just pollution concentrations.

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's 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] 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.	**APEAL - Longitudinal Effects of Air Pollution on Adolescent Lungs[19]** 4,000 adolescents across Delhi, Mumbai, Bengaluru, and Mysuru; categorised 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 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.	**Under-Studied: Regions** 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 ICMR's Mandate - The Research Infrastructure India Needs to Lead on Health-Linked NCAP Reform

ICMR is India's apex biomedical research body, operating under the Department of Health Research, Ministry of Health and Family Welfare. Through its network of constituent institutes, regional medical colleges, and research programmes, ICMR funds, coordinates, and sets standards for health research that informs national policy - from NFHS methodology to the National Cancer Registry Programme. Two of the most important studies cited in this brief are directly ICMR-linked: the ICMR-NCDIR National Cancer Registry Programme, which documents higher lung cancer incidence in India's most polluted metro cities; and the CARRS cohort studies - conducted in partnership with PHFI under ICMR's NCD research agenda - which provide the first prospective Indian evidence linking $PM_{2.5}$ to hypertension and type 2 diabetes in urban populations.

ICMR has the institutional capacity, inter-institutional network, and research commissioning mandate to lead India's health burden evidence agenda on air pollution. No other institution in India combines the methodological authority to set national research standards, the inter-institutional reach to coordinate multi-site studies across AIIMS, SRIHER, and regional medical colleges, and the mandate to commission primary evidence at national scale. ICMR's current NCD research portfolio addresses cardiovascular disease, diabetes, cancer, and respiratory illness - the four health outcome categories most directly linked to $PM_{2.5}$ exposure in India's own peer-reviewed literature.

ICMR does not need new authority to act. It needs to direct its existing research commissioning capacity at air pollution as a national health priority - generating the India-specific health burden estimates and exposure-response coefficients that the next phase of NCAP needs if it is to measure harm, not just pollution.

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.

CPCB	PM-JAY	NPCCHH ARI Sentinel Surveillance
Real-time $PM_{2.5}$ from CPCB's nationwide CAAQMS network across NCAP cities- Data collected, published, available	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.

ICMR has already built the institutional framework for multi-site health research in India - from coordinating NFHS rounds to leading the National Cancer Registry Programme across multiple cities. Its constituent institutes and research partners hold the health outcome data that the next phase of NCAP needs. What is missing is the formal commissioning directive that connects ICMR's research capacity to CPCB's ambient $PM_{2.5}$ data - generating the India-specific disease burden estimates that health-linked NCAP governance requires.

5 Specific Asks for ICMR

01 Lead India's First City-Level $PM_{2.5}$-Attributed Disease Burden Study

ICMR - in partnership with SRIHER and AIIMS Delhi - to commission and lead India's first city-level, primary-data-based estimate of $PM_{2.5}$-associated disease burden. Prioritize cities in the Indo-Gangetic Plain where pollution burden is highest but primary evidence is thinnest: Patna, Kanpur, Lucknow, and Varanasi. The study design should link CPCB CAAQMS ambient $PM_{2.5}$ data with PM-JAY HMIS cardiorespiratory admissions and ICMR-NCDIR National Cancer Registry data - producing India's own health burden estimates that are independent of foreign modelling assumptions and defensible in inter-ministerial policy settings.

Short term · ICMR / SRIHER / AIIMS Delhi

02 Develop India-Specific $PM_{2.5}$ Exposure-Response Coefficients

Estimates of $PM_{2.5}$-associated mortality and disease burden in India currently rely on coefficients derived from studies in high-income countries or global modelling frameworks. ICMR to commission development of India-specific $PM_{2.5}$ exposure-response coefficients - drawing on the Indian prospective cohort evidence in this brief (CARRS hypertension and diabetes cohorts, ICMR-NCDIR cancer registry data, and APiPED and APEAL cohort data as they mature). India-specific coefficients would: (i) make the next phase of NCAP health impact calculations independent of foreign modelling; (ii) allow CPCB to compute India-specific health burden estimates in its annual reporting; (iii) provide the scientific basis for performance-linked disbursement tied to health outcomes.

Short–Medium term · ICMR / PHFI / AIIMS Delhi

03 Formally Partner with APiPED and APEAL - Receive and Translate Findings into Policy

APiPED (enrolling 2,500 pregnant women in Delhi NCR) and APEAL (following 4,000 adolescents across four Indian cities) are generating exactly the gold-standard prospective cohort evidence that ICMR's research standards require. Both studies are at protocol stage - ICMR to formally: (i) recognise APiPED and APEAL as ICMR-endorsed research platforms and embed their findings into ICMR's annual health research agenda; (ii) co-commission data collection at IGP non-attainment cities not currently in their geographic scope; (iii) establish a formal mechanism to receive findings as they emerge and translate them

04 Direct ICMR-NCDIR to Track Lung Cancer Incidence Against $PM_{2.5}$ in NCAP Cities

ICMR-NCDIR's National Cancer Registry Programme already documents lung cancer incidence across India's major cities, including the most polluted metro centres. ICMR to direct ICMR-NCDIR to: (i) formally cross-reference NCRP lung cancer incidence data with CPCB district-level $PM_{2.5}$ from NCAP cities - producing India's first registry-based evidence linking ambient $PM_{2.5}$ to cancer incidence at city level; (ii) include a $PM_{2.5}$ exposure section in NCRP annual reports for NCAP cities; (iii) share disaggregated city-level lung cancer data with MoEFCC and CPCB for inclusion in NCAP city performance assessments. No new data collection is required - the registry data and the ambient $PM_{2.5}$ data already exist.

into ICMR recommendations to MoHFW and MoEFCC. This ensures that when gold-standard Indian evidence arrives, it enters national policy through ICMR's institutional channel. Immediate · ICMR/APiPED–APEAL research teams	Immediate · ICMR / ICMR-NCDIR / CPCB

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 ICMR is not whether it has the capacity. It commissioned the NFHS. It leads the National Cancer Registry Programme. It coordinates India's largest multi-site research programmes. The question is whether ICMR will direct that capacity at air pollution - generating the India-specific health burden estimates, exposure-response coefficients, and cohort evidence that the next phase of NCAP needs to measure, track, and reduce harm.

PAVANA offers technical support to ICMR: (1) Providing an evidence synthesis framework drawing on APiPED, APEAL, and existing Indian cohort studies to inform ICMR's city-level disease burden study design; (2) Designing the protocol for linking ICMR-NCDIR National Cancer Registry data with CPCB ambient $PM_{2.5}$ data; (3) Developing the analytical methodology for India-specific $PM_{2.5}$ exposure-response coefficient studies. All three are offered at no cost and are executable within ICMR's existing research and commissioning mandate.

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.