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Centre for Air Pollution & Environmental Health · Pahle India Foundation

Realizing NCAP's Health Promise:

Evidence and Recommendations for National Clean Air Programme Reform

How India's own research and data systems can strengthen the next phase of NCAP 's health impact

Global evidence has firmly established that $PM_{2.5}$ exposure drives cardiovascular disease, respiratory illness, metabolic disorders, and premature mortality. What is less widely recognized is that India's own institutions have been independently generating this evidence for Indian populations for two decades - in Indian cities, cohorts, and clinical settings.

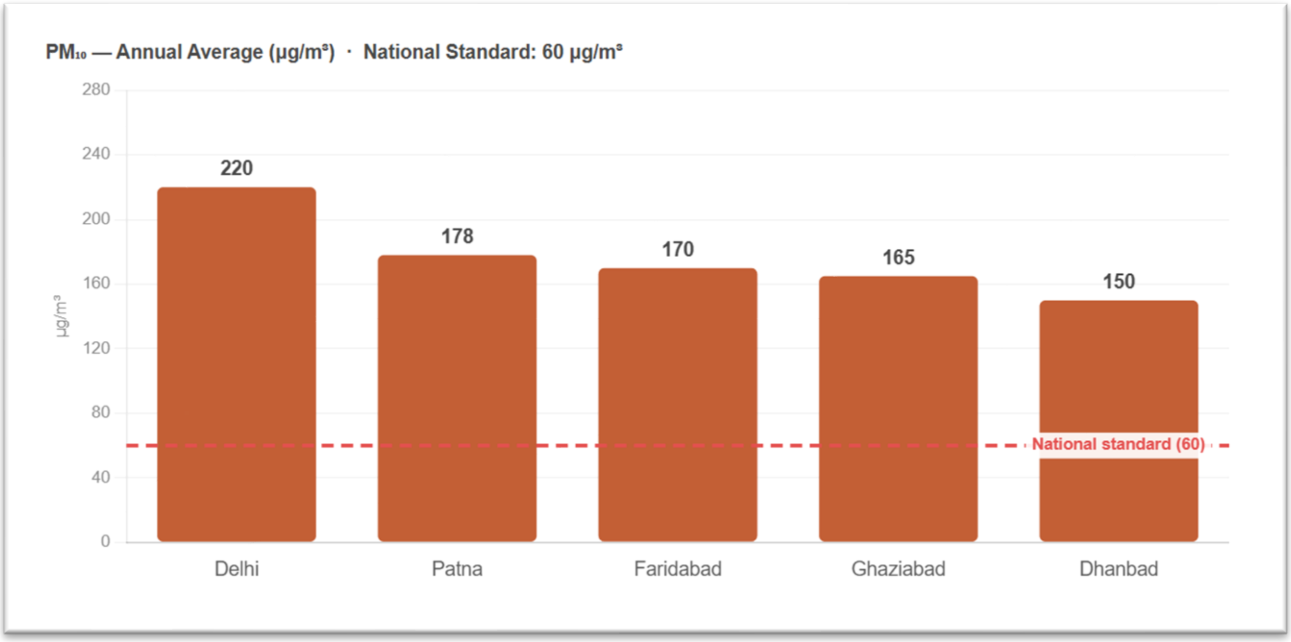
This brief was developed in response to a request from government for a synthesis of that Indian evidence and its implications for the next phase of NCAP. The findings presented here are Indian in origin. The recommendations are grounded in what India's own data systems can already measure, track, and act on.

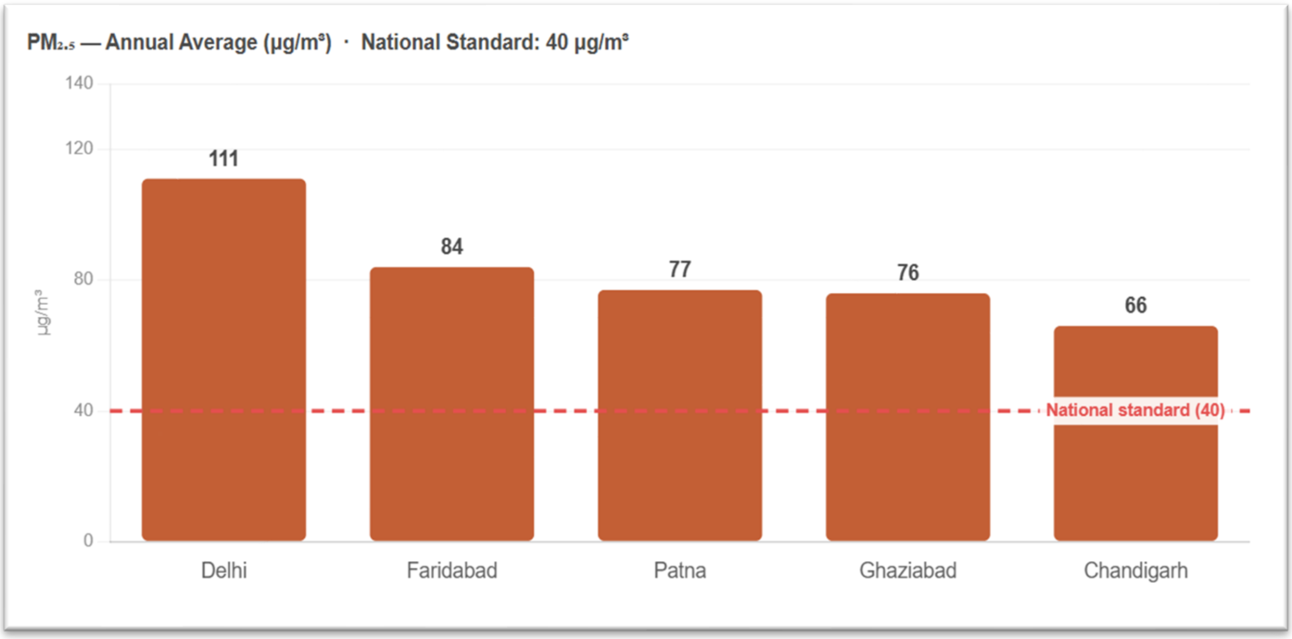
1 India's Clean Air Progress - and the Health Opportunity Ahead

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 utilised by 82 MoEFCC-funded cities (₹831 cr of ₹1,616 cr released) - a utilisation 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 National Clean Air Programmes (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 the next phase of NCAP is not whether air pollution harms health. India's own institutions have answered that. The question is whether India's policy framework is designed to measure, track, and reduce that harm or to measure the pollution burden itself.

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 $\mu g/m^3$ 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 Lockdown experiment	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)[23]

The studies presented here are drawn from a broader peer-reviewed evidence base. Please note that the studies vary in design; they are indicative of the breadth of Indian literature and do not constitute an exhaustive list. Health Effects Institute's global burden of disease evidence portal list 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.

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.*** Under NCAP, Ministry of Environment, Forest and Climate Change (MoEFCC) has established the National Knowledge Network (NKN) on Air Pollution Management coordinated through IITs and other premier institutions as the technical advisory and capacity-building framework for NCAP implementation, with dedicated technical personnel deployed across NCAP cities. The government has built the infrastructure. What is needed is the connection to health outcome measurement.

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. Increasingly, 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, there is very limited evidence from North-Eastern states on the growing pollution levels in the region.

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 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	Zero
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	Formal mechanisms currently linking CPCB ambient data to MoHFW hospital admissions at the district level

This is not a data shortage. It is the absence of linkage and integration. India's Air Quality Index (AQI), is useful for public communication, but not designed to capture health responses. It collapses multiple pollutants into a single score, obscuring the $PM_{2.5}$ levels that actually drive disease burden. the next phase of NCAP needs metrics that measure harm, not just air quality categories.

4 Proposed Health Metrics for the next phase of NCAP

Measuring pollution is not enough. the next phase of NCAP must measure harm. The following four asks - **structural, exposure, outcome, and accountability -** use existing Indian data infrastructure alone. These do not require legislation or foreign technical dependence.

4.1 - Structural Ask: Mandate $PM_{2.5}$ as the Primary NCAP Performance Metric

Indicator: Annual mean $PM_{2.5}$ concentration (μg/m³) per city, measured through CAAQMS replacing PM_{10} as the primary performance and fund disbursement metric under the next phase of NCAP. All CAAQMS stations across NCAP cities already monitor $PM_{2.5}$ in real time. This can be operationalized from data that is already collected.

4.2 - Exposure Ask: Population-Weighted Exposure to $PM_{2.5}$ (PWE-$PM_{2.5}$)

TIER 1 · PRIMARY INDICATOR · Implementable with existing Indian data

Population-Weighted Annual Mean $PM_{2.5}$ Exposure (PWE-$PM_{2.5}$)

$$\text{PWE-}PM_{2.5} = \Sigma\,(\text{Population\_ward\_i} \times \text{Annual mean } PM_{2.5}\text{\_i}) \div \text{Total city population}$$

What it measures	The pollution load experienced by the average resident not the average pollution recorded at a monitor. Weights ambient $PM_{2.5}$ by where people actually live.
Why health-relevant	Answers the key policy question: is pollution falling where people actually live? Reducing PWE-$PM_{2.5}$ directly reduces the pollution dose received by the population. There is an important difference between concentration: what a monitor records; and exposure: what people actually breathe. PWE-$PM_{2.5}$ measures exposure, not just concentration, making it a more meaningful health metric. To ease adoption, it should be reported alongside AQI in CPCB's public reporting /national dashboards. This will build exposure into India's regulatory vocabulary without replacing tools that policymakers and the public already understand.
Data sources (Indian)	CPCB CAAQMS (primary); Census ward-level population. Satellite gap-filling: ISRO INSAT-3D aerosol optical depth data, cross-validated against CPCB ground stations.
Anti-gaming property	Cannot be improved by optimizing a single monitoring station. Requires city-wide residential pollution reduction. Cross-verified by ISRO satellite data that cities cannot influence and further vetted by low-cost sensors as complementary ground level validation effort.

4.3 - Outcome Ask: $PM_{2.5}$-Attributable Cardiorespiratory Admission Rate

Indicator: City-level hospital admissions for respiratory (ICD-10 J-codes) and cardiovascular (ICD-10 I-codes) conditions per 100,000 population, tracked against annual mean $PM_{2.5}$ using PM-JAY / Ayushman Bharat HMIS data linked to CPCB CAAQMS data. Both data streams exist and are Indian government systems; what is missing is the formal linkage protocol between MoEFCC and MoHFW. This single inter-ministerial mechanism would create India's own primary evidence pipeline at national scale.

The importance of strengthening active health surveillance is illustrated by recent findings from Maharashtra. During a state-led cancer screening campaign, the Maharashtra Public Health Department identified 1,677 cancer patients, including a substantial proportion diagnosed with lung cancer. Reporting to the Maharashtra Legislative Assembly on 24 February 2026, Health Minister Prakash Abitkar noted concerns regarding the possible contribution of rising pollution levels in Mumbai[21]. A single active campaign surfaced what passive HMIS tracking had missed. ***This points to a practical starting point by mandating disease-specific reporting, beginning with lung cancer as a pilot for $PM_{2.5}$ data linkage.***

4.4 - Accountability Ask: Performance-Linked Disbursement

Fund utilization under NCAP has been chronically suboptimal. CSE's 2024 assessment found that the 82 cities funded directly by MoEFCC had utilized only ₹831 crore of ₹1,616 crore released - 51% since the programme's launch[5]. According to the Press Information Bureau release of 24 July 2025, MoEFCC reported that ₹13,036.52 crore had been allocated to 130 cities under NCAP, of which ₹9,209.44 crore - about 71% - had been utilized by July 2025[22]. A critical caveat: source apportionment remains methodologically contested in many Indian city contexts. Strengthening source apportionment methodology must be a foundational investment under the next phase of NCAP. This includes not only improving measurement-based studies but also better connecting emission sources to population exposure outcomes so that interventions can be prioritized based on where the greatest health burden reduction is achievable.

PWE-$PM_{2.5}$ Reduction from Baseline	Tranche Released	Condition	Notes
≥ 20% reduction	100% + 5% performance incentive	Monitor coverage ≥ 70% of residential wards	Full disbursement + incentive; publicly recognized
15-19% reduction	100% of tranche	Monitor coverage ≥ 60% of residential wards	Full disbursement; trajectory on track
10-14% reduction	75% of tranche	Source apportionment study required within 6 months	Partial; balance on action plan submission
5-9% reduction	50% of tranche	Mandatory CPCB technical assistance; revised CAP required	Enhanced monitoring; TA support
< 5% or increase	Withheld	Independent CPCB audit; revised city action plan required	Withheld; redirected to TA pool

Baseline: 3-year average 2019-2021 (2020 lockdown months to be corrected or excluded per CPCB technical guidance). Thresholds are proposed starting points for MoEFCC calibration; differentiation by baseline pollution level may be warranted.

5 Recommended Actions for the next phase of NCAP

01 Shift NCAP Primary Metric from PM_{10} to $PM_{2.5}$ The next phase of NCAP performance and disbursement framework to use annual mean $PM_{2.5}$ as the primary metric. All CAAQMS stations already collect $PM_{2.5}$ in real time. No new monitoring infrastructure required - a policy amendment only. Immediate · MoEFCC	**02 Adopt PWE-$PM_{2.5}$ as the next phase of NCAP Disbursement Indicator** CPCB to compute population-weighted $PM_{2.5}$ exposure baselines (2019-2021) for all 130 NCAP cities using CAAQMS data and Census ward-level population. Amend disbursement guidelines per Section 4.4 framework. Immediate · MoEFCC / CPCB
03 Formally Request MoHFW to Commission ICMR: A City-Level $PM_{2.5}$-Health Burden Study MoEFCC to formally request MoHFW — as the ministry responsible for ICMR — to task ICMR, in partnership with SRIHER and AIIMS Delhi, - with producing India's first city-level, primary-data-based estimate of $PM_{2.5}$-associated disease burden for NCAP cities, using CPCB CAAQMS + PM-JAY + NCRP data. Short term · MoEFCC / MoHFW / ICMR / SRIHER / AIIMS	**04 Establish MoEFCC–MoHFW Data-Linkage Protocol** Issue a joint order enabling routine linkage of CPCB district-level ambient data with HMIS ICD-coded admissions. One inter-ministerial order creates India's own primary evidence pipeline at national scale. Short term · MoEFCC + MoHFW

05 Mandate Ward-Level Monitoring + Annual PWE-$PM_{2.5}$ City Rankings

Require all 130 NCAP cities to achieve minimum CAAQMS density within 3 years as a disbursement pre-condition (≥1 station per 50 km² in residential zones). CPCB to publish annual PWE-$PM_{2.5}$ rankings for all NCAP cities within its existing annual air quality report - making the health-relevant exposure metric publicly visible and accountable.

Short-medium term · CPCB

06 Extend NCAP Accountability Beyond Cities

MoEFCC to initiate a roadmap for expanding NCAP's air quality management framework beyond designated cities- establishing baseline $PM_{2.5}$ monitoring and health outcome tracking in high-burden rural districts, beginning with IGP. Monitoring data alone cannot drive optimal interventions; city action plans should be supported by tools that connect emission sources to population exposure outcomes, enabling health-impact-based prioritization.

Medium term · MoEFCC / 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. National Family Health Survey 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.***

India's own evidence base is equally honest about its limits: COPD incidence and ischemic heart disease lack India-internal prospective cohort validation. the next phase of NCAP must therefore be designed not only to act on what is established, but to systematically invest in closing the evidence gaps that remain.

What is missing is not evidence - it is a mechanism to make that evidence consequential. The six actions in this brief are achievable within existing data infrastructure, without new legislation, and without foreign technical dependence. The question before MoEFCC is not whether to act. It is whether the next phase of NCAP will be designed to measure, track, and reduce harm - or only to measure pollution.

> PAVANA offers three specific forms of technical support to MoEFCC: (1) Computing PWE-$PM_{2.5}$ baselines for NCAP cities using CPCB and Census data- with projections to be updated once the 2027 Census data become available; (2) Drafting the terms of reference for an ICMR-led city-level burden of disease study; (3) Facilitating the inter-ministerial working group on CPCB-HMIS data linkage. All three are executable within the the next phase of NCAP architecture.

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