Protecting schoolchildren from air pollution in Delhi: Evidence from a two-year randomised controlled trial in KV schools

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- This policy brief summarises findings from a two-year cluster-randomised controlled trial conducted across 180 classes and approximately 9,000 students across Delhi's Kendriya Vidyalaya (KV) schools. It finds that air pollution education increased awareness, encouraged protective behaviours, and improved some health and cognitive outcomes, particularly in the first year.
- The educational intervention generated positive peer spillovers, with information spreading beyond directly treated students and increasing awareness across the wider school community.
- HEPA air purifiers successfully reduced classroom PM2.5 concentrations, but evidence suggests some students reduced protective behaviours outside school, partially offsetting potential health benefits.
- The findings support integrating air pollution education into the school curriculum and pairing purifier deployment with stronger behavioural messaging to improve student health while informing future policy on school operations during severe pollution events.

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The problem

Delhi consistently ranks among the most polluted cities in the world. Annual average PM2.5 concentrations far exceed India's national standard, and during winter months, the air quality reaches levels associated with serious respiratory illness and cognitive impairment. Children are disproportionately vulnerable: they breathe faster than adults, have less developed immune and respiratory systems, and face cumulative cognitive harm from sustained exposure. Air pollution in Delhi is estimated to reduce life expectancy by nearly twelve years on average.

Source-level pollution control—cleaner industry, reduced vehicle emissions, an end to stubble burning—remains the only permanent solution, but progress has been slow and meaningful reductions are not imminent. In the interim, children are largely unprotected, and the question of what can practically be done to reduce their exposure and its consequences is urgent.

The study

This policy brief summarises findings from a two-year cluster-randomised controlled trial conducted across 180 classes and approximately 9,000 students in Delhi's Kendriya Vidyalaya (KV)—the central government school network—during the winters of 2024-25 and 2025-26. KV schools follow a standardised national curriculum and represent a realistic vehicle for scaled policy implementation across northern India.

Classrooms were randomly assigned to one of three groups:

- Behavioural arm: An educational campaign teaching students about air pollution risks, the Air Quality Index, and ten personal protective strategies, including avoiding traffic, closing windows, stopping the use of firecrackers, and wearing masks on high-AQI days.
- Behavioural + Purifier arm: The same educational campaign, plus a high-capacity HEPA air purifier running during school hours, capable of filtering 99.99% of particles down to 0.1 microns.
- Control group: No intervention.

Two of the ten participating schools were designated as pure control schools—receiving no treatment—to enable detection of within-school informational spillovers. Indoor air pollution monitors were deployed in all classrooms to track PM2.5 concentrations. Outcomes measured include awareness and knowledge, adoption of protective behaviours, self-reported health, spirometry (lung function), working memory (Corsi test), and perceptions of air quality.

Key findings

The behavioural education campaign raises awareness and changes behaviour, particularly in year one.

In the first year, students in the Behavioural arm were significantly more likely to close windows on high-pollution days, avoid traffic on the school commute, and stop bursting firecrackers. Both treatment arms significantly increased students' knowledge of mitigation strategies. The Behavioural arm also produced a significant reduction in self-reported breathing difficulty and a marginally significant improvement in working memory scores.

The behavioural effects attenuate in year two, partly due to the control group catching up through peer spillovers.

Second-year behavioural effects are smaller. For the Behavioural arm only, these behavioural effects are concentrated in closing windows, stopping firecrackers, and avoiding traffic. Awareness effects weaken substantially as control group mean values rise, reflecting the spread of information through peer networks that the study was designed to detect.

Educational content spreads through peer networks within treatment schools.

By year two, untreated students in control classrooms within treatment schools significantly outperformed students in pure control schools on awareness of air pollution and mitigation strategies. This secondary diffusion—information transmitted peer-to-peer among students—is an underappreciated benefit of school-based interventions. It implies that the true population-level impact of the educational campaign is larger than treatment-arm estimates alone suggest.

HEPA purifiers reduce indoor PM2.5 as intended, but produce a moral hazard response that partially offsets health gains.

Indoor air quality monitoring confirms that purifiers significantly reduce classroom PM2.5 concentrations, with the combined intervention producing larger and longer-lasting reductions than the educational campaign alone. However, the Behavioural plus Purifier arm consistently underperforms the Behavioural arm on objective health and cognitive outcomes across both years. In year one, students in the Behavioural arm significantly outperformed students in the Purifier arm on working memory. In year two, the Purifier arm is associated with a significant reduction in spirometry scores. Behavioural adoption in the Purifier arm is systematically lower than in the Behavioural-only arm in year two, particularly for outdoor and home-based behaviours.

The most coherent account is a moral hazard mechanism: students in Purifier arm classrooms reduce their protective behaviour outside school, partially cancelling the device's benefit inside it.

Spillover effects bias the main treatment estimates in opposite directions across years.

Year one behavioural effects in the main regressions are likely overstated because untreated students in treatment schools underperformed pure controls on some behavioural outcomes (a displacement effect), pulling the pooled control group mean down. Year two awareness effects are likely understated because spillover recipients outperformed pure controls, therefore pulling the control mean up. These biases reinforce the finding that behavioural education has real and meaningful effects, and suggest the headline estimates in year one are conservative lower bounds for the program's true impact on awareness.

Policy recommendations

Recommended changes

Integrate air pollution education into the KV curriculum.

The behavioural campaign is low-cost, scalable within the KV system's standardised structure, and demonstrably effective at raising awareness and inducing protective behaviour. A small addition to the existing science or health curriculum—covering the Air Quality Index, the health effects of PM2.5, and specific protective strategies relevant to the Indian context—could reach millions of students across northern India at minimal marginal cost. The peer spillover effects observed in year two suggest that curriculum-embedded education would reach beyond the directly taught students into the broader school community.

Deploy HEPA purifiers in classrooms, but redesign the accompanying messaging.

The purifier technology works at cleaning classroom air. The problem is the behavioural signal it sends: students treat it as a substitute for personal protection rather than a complement. The educational content accompanying purifier deployment should explicitly address this—emphasising that the purifier reduces risk at school but that behaviours at home, on the commute, and during high-pollution events remain equally important. Framing the purifier as one layer of a multi-layered personal protection strategy, rather than as a solution in itself, is a low-cost messaging change that could substantially improve health outcomes from purifier programs.

Use purifier deployment as an opportunity to reinforce, not replace, behavioural content.

The two interventions should be positioned as complements in both design and communication. A student who has a purifier in the classroom and understands that it only covers part of their daily exposure has every reason to maintain protective behaviours elsewhere. A student who understands only that "the school has taken care of it" does not. The educational campaign's framing—which was designed to empower students to "fight against" air pollution themselves—should be retained and strengthened in purifier-equipped classrooms, not assumed to be redundant.

Evaluate Stage IV GRAP school closures against the purifier alternative.

Current policy under Delhi's Graded Response Action Plan closes schools during the worst pollution episodes, at significant cost to learning. If HEPA purifiers in classrooms can demonstrably reduce indoor PM2.5 during these episodes—as our monitoring data suggest—a policy of keeping schools open with purifiers running may provide better health and educational outcomes than closure. This requires a direct policy evaluation comparing the two regimes, which this study's infrastructure is well positioned to support.

Conduct longer-run tracking to assess persistence and design a third-year evaluation.

The two-year evidence base raises questions that require longer observation. Does behavioural change persist beyond the active intervention period, or do students revert when the educational stimulus is removed? Does the moral hazard response to the purifier weaken as students accumulate more years of behavioural training alongside the device? A third year of data collection—ideally tracking cohorts beyond the active intervention—would directly answer these questions and inform whether annual re-intervention is necessary or whether a one-time curriculum change produces durable effects.

Scalability

The KV school system spans the whole of India, with particular density in the northern plains region where PM2.5 concentrations are among the highest in the world. A curriculum change adopted nationally by the KV system would reach hundreds of schools and hundreds of thousands of students at effectively zero marginal cost per student beyond the cost of curriculum development. The standardisation of the KV system—the same syllabus, the same school structure across states—is an asset for implementation: what works in Delhi's KV schools can be replicated without adaptation in schools in Lucknow, Patna, or Chandigarh, all of which face comparable air pollution challenges.

Study limitations

The study measures outcomes over a single pollution season (November to April) in each of two years. Longer-run health effects—including effects on lung development, chronic respiratory disease, and long-term cognitive trajectories—cannot be assessed in this timeframe. The sample is limited to KV schools, which serve a specific population of government-employed families and may not generalise to all Delhi schools or to rural settings. Indoor air pollution monitoring and spirometry were conducted in subsamples, limiting statistical power for health outcomes in year one. The IV analysis instrumenting health with treatment assignment—pre-registered as the primary test of H3—has not yet been completed and remains a priority for the next phase of analysis.

This brief summarizes findings from “Technology or Behaviour? Reducing School Children’s Exposure to Air Pollution in Delhi: a randomized controlled trial conducted in Delhi’s Kendriya Vidyalaya schools”. The study received feedback from referees and the editor of the Journal of Development Economics, and benefitted from discussions with researchers at LSE, UC San Diego, Duke University, and ISI Delhi.