



RESEARCH HIGHLIGHTS

Indoor Air Quality, Information, and Socio-Economic Status: Evidence from Delhi

by Prof. Michael Greenstone, Kenneth Lee, and Harshil Sahai

In a study of Delhi households across varying socioeconomic strata, researchers observe high levels of indoor air pollution and yet low demand for clear air or adoption of defensive behaviors.

Context

Delhi is one of the most polluted cities across the globe. During recent years, with the air quality routinely reaching hazardous levels during the winter season¹, there has been increased focus and demand for action regarding ambient air quality. This has created momentum among government agencies to form policies and design interventions to address the issue. However, indoor air quality (IAQ) has not received any such attention.

Information is a key determinant in the demand for clean air, which in turn, can drive the introduction and implementation of public policies that can address air pollution. Indoor air quality monitors (IAQMs), which measure and communicate real-time levels of indoor $PM_{2.5}$ and other pollutants—can potentially address any market failures related to awareness and information.

In this study, researchers first look at the comparison between indoor and outdoor quality, establishing the need for awareness. Next, they look at behavioral changes and participants' demand for clean air after being exposed to air quality information of the household.

Methods

To understand the indoor-outdoor air quality researchers look at two sections of populations in the city, divided based on their socio-economic status (SES), and compare the indoor $PM_{2.5}$ levels with the corresponding ambient levels. The study takes into account ~ 300 low SES households mostly consisted of poor, non-migrant individuals living in Delhi². 1248 medium and high SES households were sampled from 90 neighborhood clusters across the city.

Additionally, researchers also assessed the effect of information on high SES households and the subsequent demand for clean air through investments in defensive mechanisms over the month.

A small section of high SES households was also provided wifi-enabled IAQ monitoring devices, which allowed the researchers to collect minute-wise IAQ information for the treatment period (4 weeks). Using geotagged locations, researchers matched these data points with the corresponding ambient air quality collected via the nearest government-installed monitor.

By combining data collected using both air quality monitors with survey data collected at the beginning and end of the study period, researchers investigated the effect of different levels of air quality information on participants' knowledge of air quality, changes in their behavior, demand for clean air³ and the eventual change in their indoor air quality.

Key Findings

- Researchers find that on average, indoor $PM_{2.5}$ is substantially worse than the values reported by the government monitors and that this pattern holds in both low and high SES households (mean differences of $+114.4\mu g/m^3$ and $+122.3\mu g/m^3$, respectively).
- 24% (24.1%) of high SES households and only 2% (1.8%) of low SES households own an air purifier, but despite this difference, the indoor $PM_{2.5}$ concentration is only 10 % less in high SES households as compared to low SES households.

- Relative to the ambient air, indoor $PM_{2.5}$ rise more quickly in the morning and evening hours, at periods where the household is likely to be cooking.
- There is a substantial degree of spatial variation in $PM_{2.5}$, evidenced by the wide variation in $PM_{2.5}$ levels captured by Delhi's government monitors at any given point in time.
- The user trial did not result in higher investments in defensive mechanisms against indoor air pollution (like the purchase of air purifiers, door seal gaps, etc.)
- However, there was a significant increase in the air pollution awareness index⁴, suggesting that the information video and real-time information on $PM_{2.5}$ levels increase awareness.
- Among high SES households, the study also spots a decline of 8.6% of $PM_{2.5}$ levels in households that had real-time information for the same during the treatment period.
- Findings also indicate an increase in ventilation habits⁵ among these households, which might be linked to the decline noted above.

CLOSING TAKE-AWAY

In this study, researchers found that indoor air pollution levels are 20 times higher than WHO standards, regardless of socio-economic strata. Despite these levels, the study observes relatively low ownership of air purifiers (4.9 percent in the medium and high SES household sample), suggesting that the demand for defensive technologies may be modest. The experiment results suggest that a month-long experience with an indoor air quality monitor may not lead to investments in air purifiers. The findings suggest that the high-frequency IAP information provided by an IAQM does not fully address the information gaps about air pollution that may exist in this setting. Providing households with more substantial information about the health impacts of air pollution, for instance, may lead to different outcomes and is an area that deserves further study.

¹November - February

²We first consulted the administrative list of Jhuggie Jhopri Squatter Settlements/Clusters (or J.J. Clusters") provided by the Delhi Urban Shelter Improvement Board). Using this list, we randomly selected hundreds of sampling points (i.e., locations where enumerators could begin administering in-person surveys) located around the center of each J.J. Cluster, assigning the number of points for each cluster based on its estimated population size.

³To establish demand, the researchers considered participants' take up on subsidised air purifier rentals or other monetary investment in defensive mechanisms.

⁴Respondents answered a brief quiz on air pollution-related knowledge

⁵Opening doors and windows to improve circulation