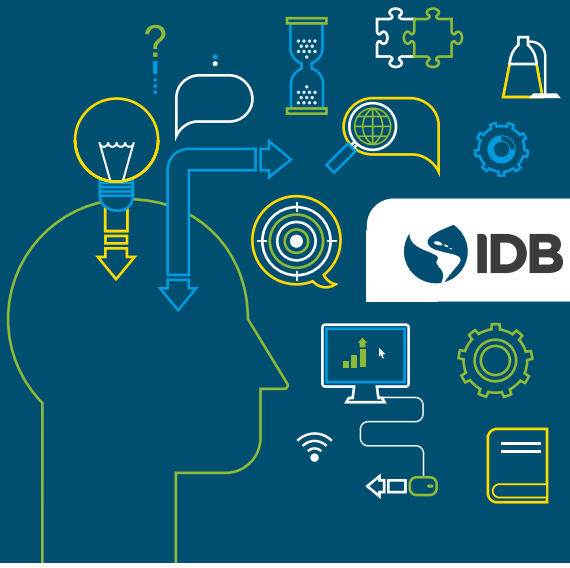
RESEARCH INSIGHTS

# How Is Air Pollution Monitoring and Exposure Distributed Across Socioeconomic Groups in Major Latin American Cities?



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**Authors:** Patricio Domínguez, Bridget Hoffmann, and María Paula Medina.

- **In Bogotá, Mexico City, and São Paulo, air pollution monitors are more likely to be located in higher-income, better-educated neighborhoods.**
- **Across all four cities studied (Bogotá, Mexico City, Santiago, and São Paulo), individuals in lower education and income quintiles experience significantly more hours of extreme particulate matter pollution, despite small disparities in mean annual pollution levels.**
- **The unequal distribution of pollution peaks likely exacerbates existing social inequalities due to the non-linear negative impacts of air pollution on health and well-being.**

## CONTEXT

**Latin America remains one of the most unequal regions globally.** While overall air pollution levels have declined since the 1990s, localized disparities in pollution exposure may reinforce or exacerbate broader socioeconomic inequalities. Air pollution affects not only physical health but also education, labor outcomes, and cognitive function—key drivers of social mobility. Despite the crucial role of monitoring infrastructure, its distribution and implications for inequality have not been systematically studied. This research addresses that gap by combining 2023 particulate matter data with census information across four major Latin American cities to analyze disparities in monitoring and exposure.

## PROJECT

**This paper analyzes how socioeconomic status correlates with both the presence of air pollution monitoring infrastructure and levels of exposure to particulate matter (PM10 and PM2.5) in Bogotá, Mexico City, Gran Santiago, and São Paulo.** By linking high-frequency air quality data from government-operated monitors with recent census data on education and income, the study investigates how monitoring coverage and pollution levels vary across income and education quintiles. The research assesses both chronic (annual average) and acute (extreme peak) pollution exposure.

## RESULTS

**The study finds systematic inequality in the distribution of air pollution monitoring infrastructure and in exposure to air pollution extremes.** In Bogotá, Mexico City, and São Paulo, monitors are disproportionately located in areas with higher levels of education and income. These areas not only have shorter distances to the nearest monitor but are also more likely to have multiple monitors within a 3 km radius. This spatial distribution implies better monitoring coverage in high-income areas. This disparity could lead to more policy responsiveness in higher-income areas.

Key Concept

### PARTICULATE MATTER (PM10 AND PM2.5)

Microscopic particles suspended in the air that can be inhaled, affecting respiratory and cardiovascular health. PM2.5 refers to finer, more harmful particles.

In terms of pollution exposure, while differences in annual mean concentrations of PM10 and PM2.5 are relatively small across socioeconomic groups, disparities in peak exposure are stark. In particular, lower education and income quintiles are exposed to significantly more hours above critical WHO air quality thresholds (i.e., peaks in air pollution concentrations) than high education and income quintiles. These disparities in exposure are present in all four cities.

These findings are important because short-term peaks in particulate matter pollution have strong non-linear negative effects on outcomes such as labor supply, potentially amplifying existing inequalities. Moreover, if local pollution-reduction policies are informed by data from better-monitored areas that are also more privileged, disadvantaged neighborhoods may be overlooked.

## POLICY IMPLICATIONS

**This research highlights two central policy lessons.** First, the design of air quality monitoring systems should consider socioeconomic inequalities. Decisions on where to place monitors should not rely solely on factors like population density or centrality, as these may inadvertently prioritize wealthier neighborhoods. A more equitable siting strategy that includes low-income areas can ensure that pollution exposure is measured across all communities and that policy interventions reach those who need them most. Better monitoring in neighborhoods with lower socioeconomic residents could also allow more tailored policy interventions.

Second, policies focused solely on reducing average pollution levels may not sufficiently address inequality. While mean particulate matter concentrations vary little by socioeconomic group, disparities in exposure to peaks in pollution are substantial. These peaks are linked to acute health events and other immediate negative outcomes. Thus, targeted efforts to reduce pollution spikes—such as limiting emissions during high-pollution periods or investing in cleaner transit in heavily impacted neighborhoods—may more effectively reduce environmental inequality.

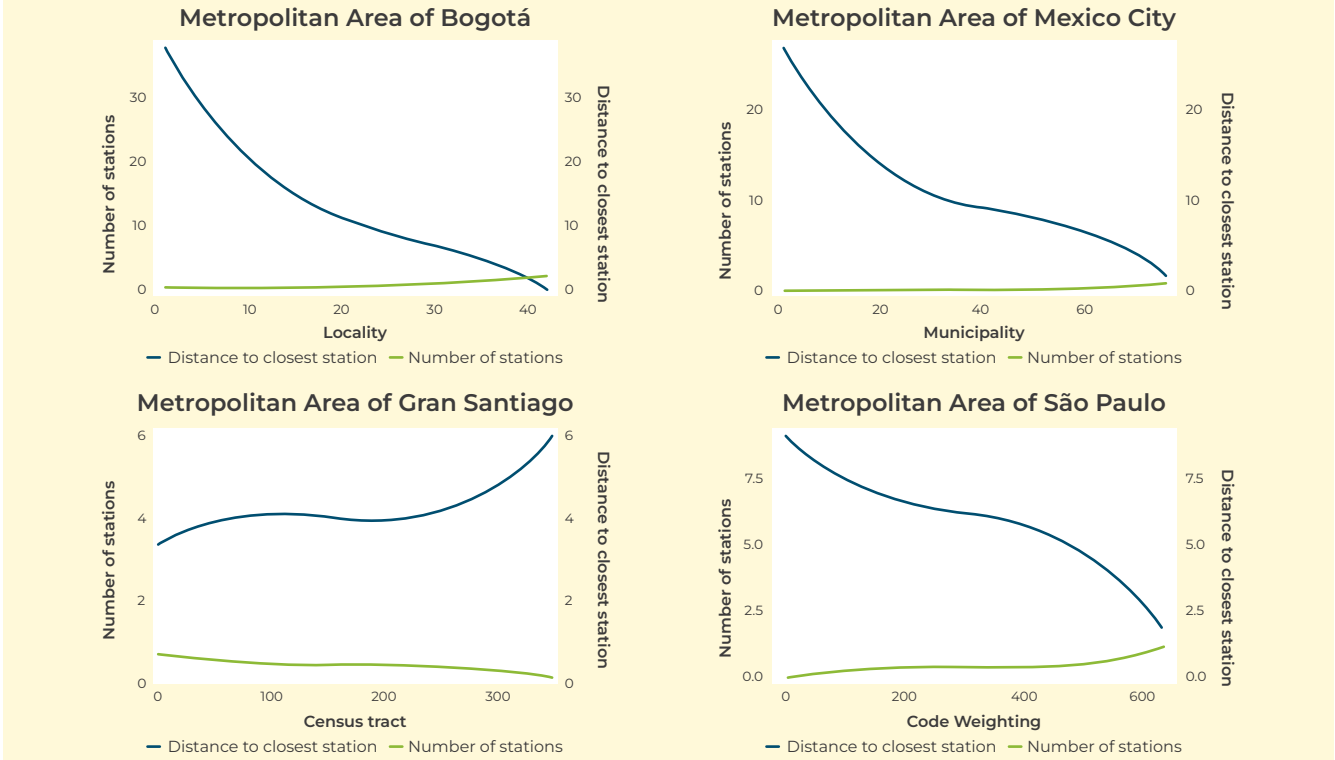
Key Concept

### AIR QUALITY MONITORING

The systematic measurement of air pollutants using ground-based instruments. These systems help governments assess pollution levels and design environmental health policies.

Without addressing these disparities, improvements in air quality may bypass vulnerable groups, allowing environmental health gaps to persist or worsen. **Ensuring equitable monitoring and targeted mitigation policies is critical for inclusive urban development in Latin America.**

## FIGURE 1. Number of Stations within a 3 km Radius and Distance to Nearest Station




*Note:* The figure illustrates the number of monitoring stations within a 3 km radius and the distance to the nearest station for each metropolitan area. The data were processed by importing a distance matrix between geographic units and air quality monitoring stations that report PM10 levels, converting distances to kilometers, and identifying geographic unit centroids with stations within 3 km. To analyze trends, geographic units were sorted from lowest to highest status based on their mean years of schooling. The plots depict these trends using smooth lines fitted with a third-degree polynomial regression. Distance to the nearest station is displayed on the secondary y-axis.

**Key Concept**

### SOCIOECONOMIC INEQUALITY

Disparities in income, wealth, education, and other determinants of economic and social standing across different groups of a population.

### IDB RESEARCH ON AIR POLLUTION

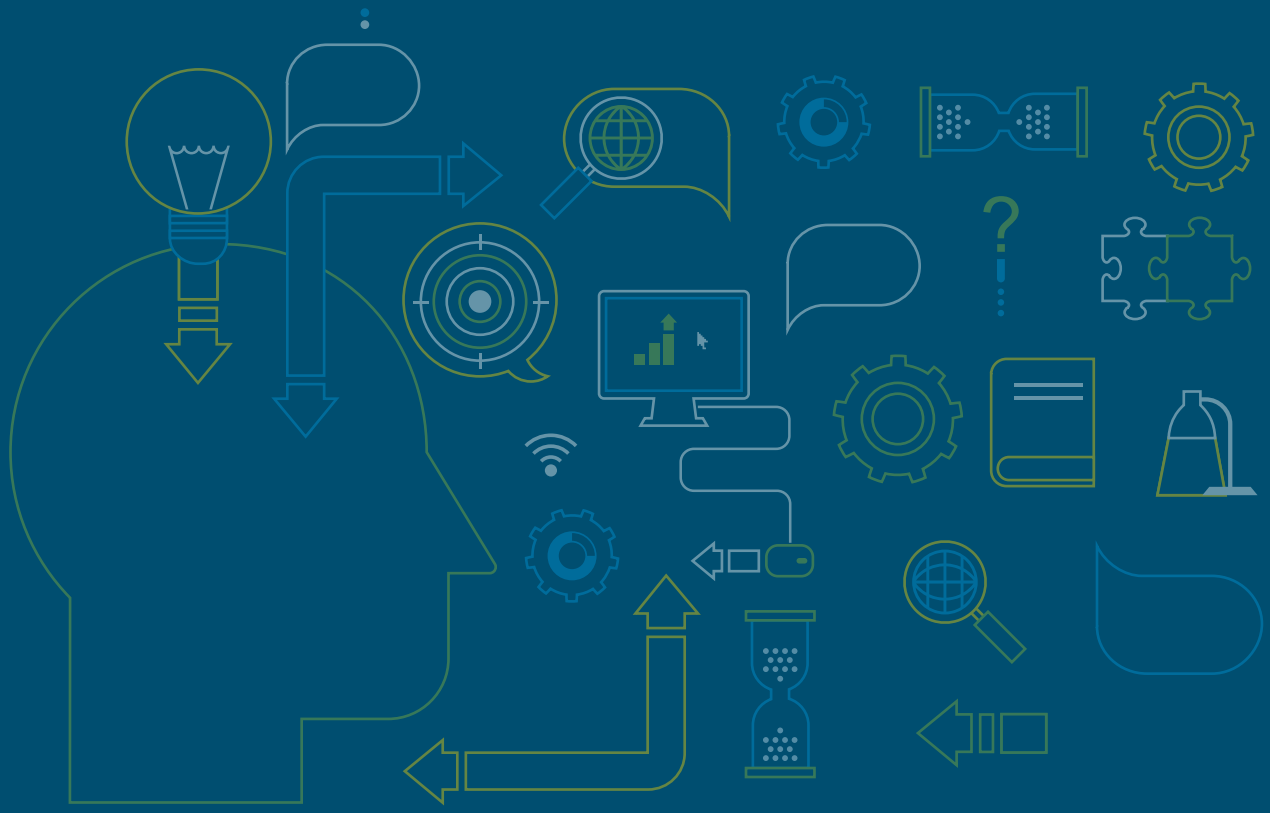
This research was funded by the Clean Air Fund through TC RG-T4014 of the Climate Change and Sustainable Development Sector. It aligns with ongoing work across IDB groups to promote an inclusive environmental policy and improve urban resilience, supporting data-driven strategies to address climate inequality and public health risks in Latin American cities.

### FULL STUDY

**Domínguez, Patricio, Bridget Hoffmann, and María Paula Medina. 2025. "Inequality in Air Pollution Monitoring and Exposure: Evidence from Four Latin American Cities." IDB Discussion Paper No. 1087. Washington, DC: Inter-American Development Bank. https://doi.org/10.18235/0013465.**

## Department of Research and Chief Economist

The Department of Research and Chief Economist generates new ideas to enrich the knowledge base that supports the policy agenda of the Inter-American Development Bank (IDB) and its member countries for achieving sustainable and equitable development in the region. To maximize the impact of its research, the Research Department carries out activities that serve as inputs to other IDB departments, governments, the academic community and public opinion in the region.



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