

Inequality in Air Pollution Monitoring and Exposure: Evidence from Four Latin American Cities

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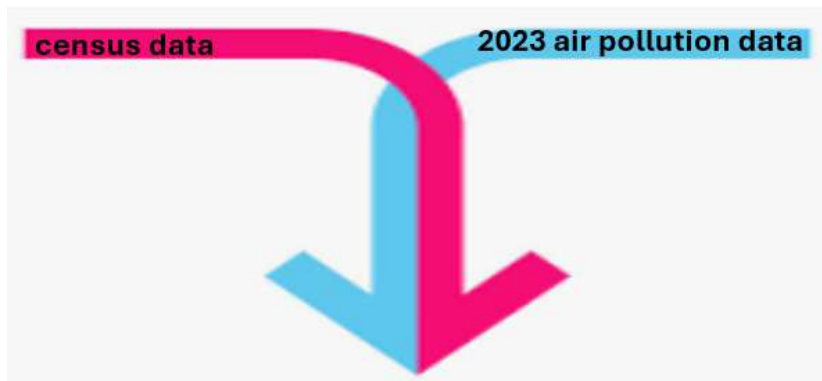
Inequality in air pollution exposure can have long-term implications for economic inequality and social mobility.



We study inequality in monitoring and exposure to particulate matter in four metropolitan areas of Latin America.



We merge recent census data and 2023 air pollution data.



Census data with disaggregated geographic identifiers.

City	Year	Total population	Census geographic level	Number of census geographic units	Average population per census geographic unit
Bogota	2005	7,902,707	Locality/Municipality	42	188,160
Mexico	2020	21,717,324	Municipality	76	285,754
Gran Santiago	2017	5,984,604	Census tract	384	15,585
Sao Paulo	2010	19,683,975	Weighting area	633	31,096

Hourly air pollution data for 2023 from ground monitoring stations.

City	PM_{10}	$PM_{2.5}$
Santiago	10	10
Bogotá	19	19
Mexico City	23	19
São Paulo	29	25

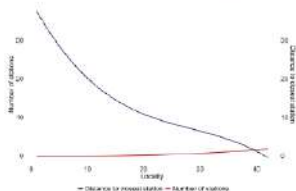
Particulate matter concentrations in these cities exceed WHO air quality guidelines.



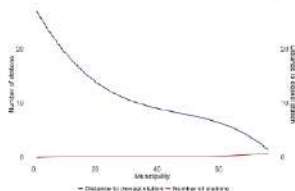
Is there inequality in air pollution monitoring?

In Bogota, Mexico City, and Sao Paulo, high education neighborhoods are closer to monitoring stations.

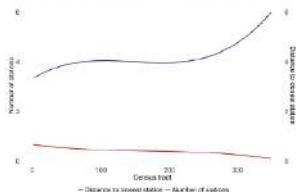
Metropolitan Area of Bogotá



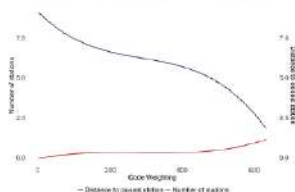
Metropolitan Area of Mexico City



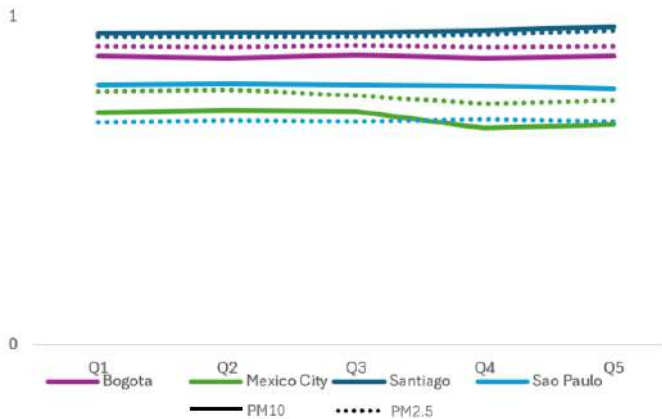
Metropolitan Area of Gran Santiago



Metropolitan Area of São Paulo



Conditional on being near a monitoring station, no difference in monitoring quality.



Is there inequality in air pollution exposure?

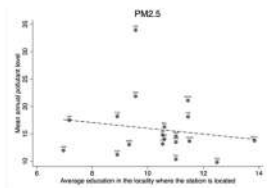
We measure inequality in exposure in multiple ways.

- **Monitoring station level:** no aggregation of AQ data.
- **Individual-level:** inverse distance weighting within 3 km.
- **Longer-Term:** Average 2023 concentration
- **Short-Term/Acute:** Hours above WHO Thresholds

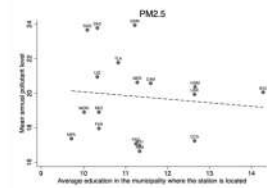


Negative correlation between annual average PM 10 and education across stations.

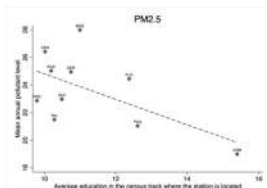
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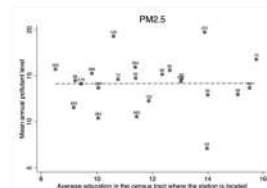
Metropolitan Area of Mexico City



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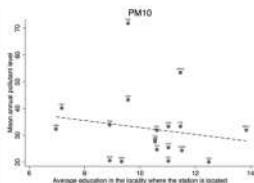


Metropolitan Area of São Paulo

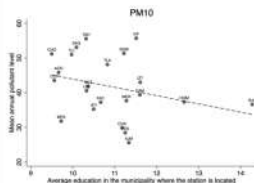


Negative correlation between annual average PM 2.5 and education across stations.

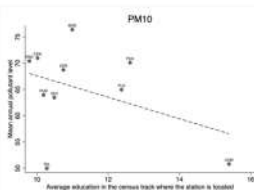
Metropolitan Area of Bogotá



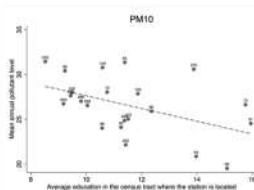
Metropolitan Area of Mexico City



Metropolitan Area of Gran Santiago

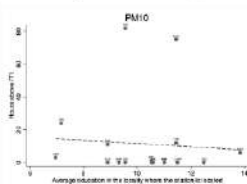


Metropolitan Area of São Paulo

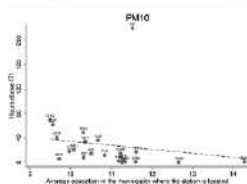


Stations located in areas with higher education have fewer peak hours of PM10.

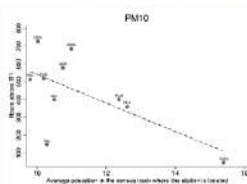
Metropolitan Area of Bogotá



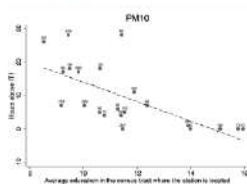
Metropolitan Area of Mexico City



Metropolitan Area of Gran Santiago

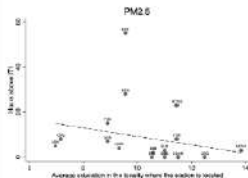


Metropolitan Area of São Paulo

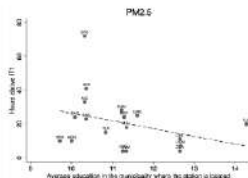


Stations located in areas with higher education have fewer peak hours of PM2.5.

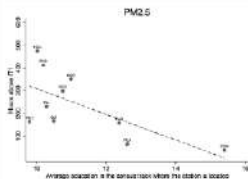
Metropolitan Area of Bogotá



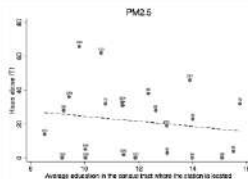
Metropolitan Area of Mexico City



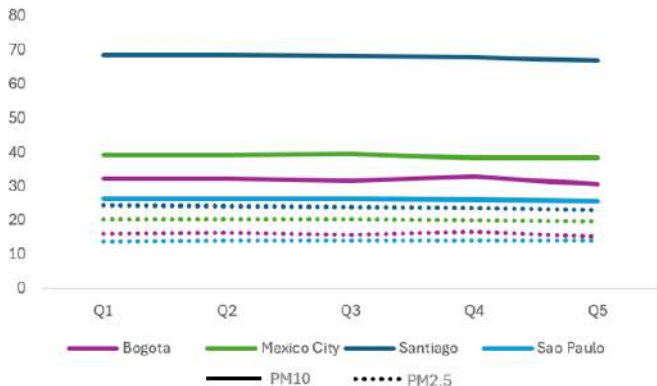
Metropolitan Area of Gran Santiago



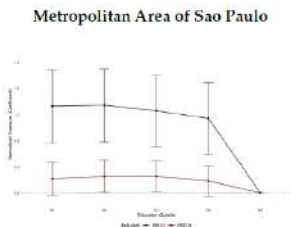
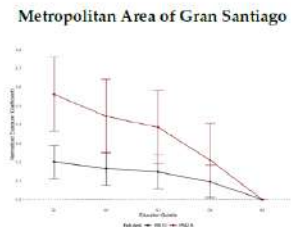
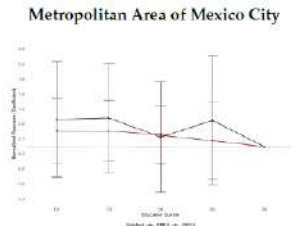
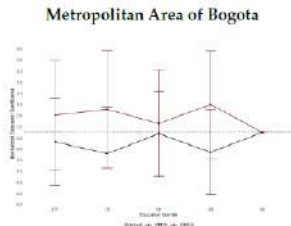
Metropolitan Area of São Paulo



Small, mostly insignificant differences in annual means.

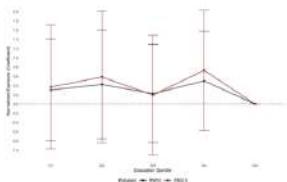


Disparities in extreme peaks (IT1) largest in Santiago and Sao Paulo.

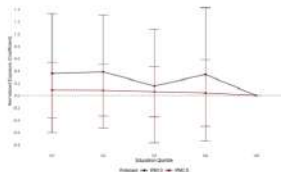


Disparities in peaks (IT2) largest in Santiago and Sao Paulo.

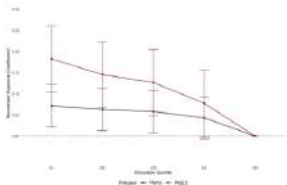
Metropolitan Area of Bogota



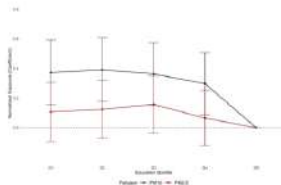
Metropolitan Area of Mexico City



Metropolitan Area of Gran Santiago

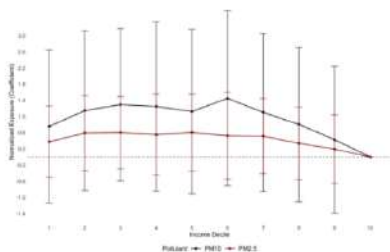


Metropolitan Area of Sao Paulo

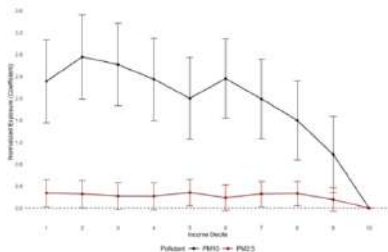


Disparities in extreme peaks (IT1) by income show similar patterns.

Metropolitan Area of Mexico City



Metropolitan Area of Sao Paulo



The findings have two key policy implications.

- 1 The design of air quality monitoring systems should consider economic inequality and the spatial distribution of lower-income residents.

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 - Spatially targeting interventions to areas with high measured concentrations of air pollution could exacerbate disparities.
- 2 Because disparities in exposure are driven by peaks in air pollution, focusing on reducing peaks is likely to lead to a greater reduction in inequality in air pollution exposure.

The findings have two key policy implications.

- ① The design of air quality monitoring systems should consider economic inequality and the spatial distribution of lower-income residents.
 - Spatially targeting interventions to areas with high measured concentrations of air pollution could exacerbate disparities.
- ② Because disparities in exposure are driven by peaks in air pollution, focusing on reducing peaks is likely to lead to a greater reduction in inequality in air pollution exposure.
 - Non-linearities in the impacts of air pollution implies reducing exposure to peaks could go a long way in reducing the unequal impacts of air pollution.