Racial-Ethnic Disparities in Exposure to $PM_{2.5}$ from California's On-Road Mobile Sources Remain After Decades of Emissions Controls*

Libby Koolik

University of California, Berkeley, California, USA

Background. California has made significant progress reducing emissions from on-road mobile sources over the past two decades. California's mobile source strategy has principally focused on the overall impact of emissions on health and climate. However, longstanding racial/ethnic disparities in exposure to fine particulate matter ($PM_{2.5}$) cause an unequal burden of disease in communities of color.

Objective. Evaluate whether reductions in mobile source emissions in California have contributed to a reduction in $PM_{2.5}$ exposure disparities for communities of color.

Methods. Using the Intervention Model for Air Pollution Source-Receptor Matrix, which models primary and secondary $PM_{2.5}$concentrations, we estimated concentrations resulting from on-road mobile source emissions across California from 2000 to 2019. Gridded exposure concentrations (variable sized; down to 1 km in cities; up to 36 km in rural areas) were combined with tract-level population estimates from the 2010 Census. We estimated absolute and relative disparities in exposures among racial-ethnic groups disaggregated by air basin and on-road mobile source category: light-duty vehicles (LDVs), heavy-duty vehicles (HDVs), medium-duty vehicles, buses, motorcycles, and motorhomes.

Results. While population-weighted mean $PM_{2.5}$ concentrations attributable to mobile sources decreased over the past two decades across all population groups, disparities by race/ethnicity have remained. Statewide, the population-weighted mean exposure to $PM_{2.5}$ from mobile sources has decreased by approximately 62%. However, the relative disparity between the population-weighted mean exposures for the most disparately exposed group (Hispanic Californians) and the statewide population has increased from 12% to 15%. For the most disparately exposed group, LDVs contributed between 60-70% of the exposure and absolute disparity; the contribution from HDVs decreased from 24% to 16% over the study period. The contribution of each vehicle type on the overall mobile source exposure concentration did not meaningfully differ compared to the contribution to the absolute disparity. Repeating the analysis on sub-geographies shows that while HDVs are more important in some disparately impacted communities compared to statewide, LDVs remain the most significant contributors to exposure disparities for disparately exposed groups.

Conclusions. Our analysis indicates that two decades of aggressive mobile source emissions control policy in California was effective at reducing average exposures, but not at reducing the relative inequality in mobile-source $PM_{2.5}$exposure by communities of color. While LDVs contribute the most to exposure and disparity, the consistency between a vehicle group's contribution to exposure and disparity suggest that disparities cannot be ameliorated by focusing on a single fleet type. An overarching implication of this work is that a continued trend of mobile emissions reductions will not necessarily reduce the disparate exposures faced by historically disadvantaged racial-ethnic groups in California without greater attention to the underlying factors that lead to this relative disparity and without actively working to address those disparities.

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