

Invited Perspective: Moving from Characterizing to Addressing Racial/Ethnic Disparities in Air Pollution Exposure

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The issue of racial/ethnic disparities in air pollution exposure in the United States has received increasing attention in recent years, with studies often examining the extent of disparities and how ambient concentration patterns have changed over time as air pollution levels have decreased. For example, publications have demonstrated that relative disparities in concentrations of ambient fine particulate matter (PM \leq 2.5 μ m in aerodynamic diameter) (Colmer et al. 2020) and nitrogen dioxide (Clark et al. 2017) persist even as overall concentrations have declined over time. The growth in this literature has been facilitated by the increasing availability of national-scale air pollution concentration estimates at high geographic resolution that can be coupled with national-scale census data on sociodemographic patterns.

Liu et al. (2021) built on this literature in a few important ways. They included all criteria air pollutants in a single analysis and looked at multiple years (1990, 2000, and 2010) across the entire contiguous United States. The authors also explicitly differentiated between absolute and relative differences in concentrations, calculated multiple metrics of inequality, and looked at patterns across the country, as well as by urbanicity and within individual states. Another important element was the simultaneous examination of race/ethnicity and income, which demonstrated not only that income differences did not explain racial/ethnic disparities but also that there were important interactions between race/ethnicity and income.

Given the comprehensive geographic, temporal, and multi-pollutant scale of this investigation, with numerous sensitivity analyses and comparisons, the obvious question is whether any additional research is needed. Perhaps the most substantial gap is the lack of specific and actionable insight; racial/ethnic exposure disparities have been extensively documented, but what should be done about these disparities? Answering this question requires studies that go beyond characterizing exposure patterns and start identifying root causes of those patterns. Furthermore, these studies need to have expansive definitions of root causes. Although exposure science often defines root causes narrowly (i.e., which emission sources most contribute to disparities), racial/ethnic disparities cannot be addressed without going further upstream (i.e., which racist policies most contribute to the distribution of those emission sources or the underlying patterns of residential segregation).

Another gap in the literature is the fact that race/ethnicity is often examined as a covariate without consideration of the causal interpretation, which is complex, multifaceted, and differential across context, space, and time (Williams et al. 2010). The importance of this tendency is exemplified in a study by Woo et al. (2019) that showed that exposure disparities for multiple air pollutants were greater for Black, Latinx, and Asian populations who lived in areas with high residential segregation, relative to areas with low residential segregation. However, there are many factors beyond residential segregation that can influence the interpretation of a race/ethnicity covariate. More studies are needed that include local nuance and acknowledge that race is a social construct, not a biological one.

In addition, as articulated by Liu et al. (2021), air pollution disparities analyses are generally dependent on publicly available census data, which creates limitations in moving beyond general racial/ethnic categories (e.g., the Hispanic category, which encompasses numerous countries of origin, racial identities, and nativity statuses). Census data also limit the ability to conduct truly intersectional analyses or to incorporate attributes, such as sexual orientation or gender identity, that are underrepresented in the environmental justice literature (Collins et al. 2017). Studies using more granular data on identity may not be practical at a national scale, but cohort studies or more geographically resolved studies may be able to examine exposures across more dimensions of identity simultaneously.

A final challenge involves the need to pivot from modeling disparities in ambient concentrations to investigating personal exposure, or at a minimum, the residential indoor environment. There is strong evidence of disparities by income or race/ethnicity in housing attributes (Adamkiewicz et al. 2011; Swope and Hernández 2019), and a modeling study demonstrated that disparities in pollutant infiltration can exacerbate disparities in ambient air pollution concentrations (Rosofsky et al. 2019). There are also pronounced disparities in indoor source contributions (Adamkiewicz et al. 2011), and understanding the combined influence of indoor sources and outdoor pollutant infiltration is crucial to accurately characterize personal exposure disparities. Racial/ethnic differences in commuting patterns and occupational exposures would also be important to comprehensively characterize personal exposure disparities. As with sociodemographic data, this is challenging to do at a national scale given data limitations, which may imply the need for more geographically targeted case studies.

Liu et al. (2021) should be commended for their comprehensive, rigorous, and informative analyses. Now it is time to move beyond describing disparities and to start addressing them.

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