

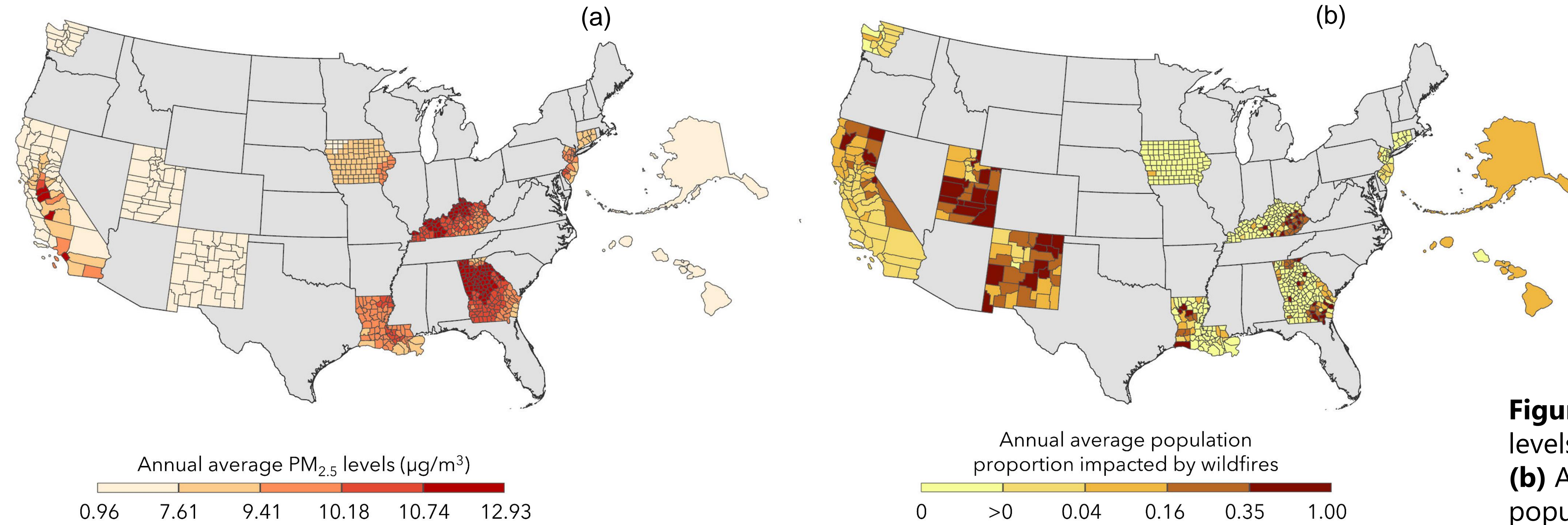
# Ambient PM<sub>2.5</sub> air pollution exposure and colorectal cancer incidence in wildfire-impacted areas in the United States

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## BACKGROUND

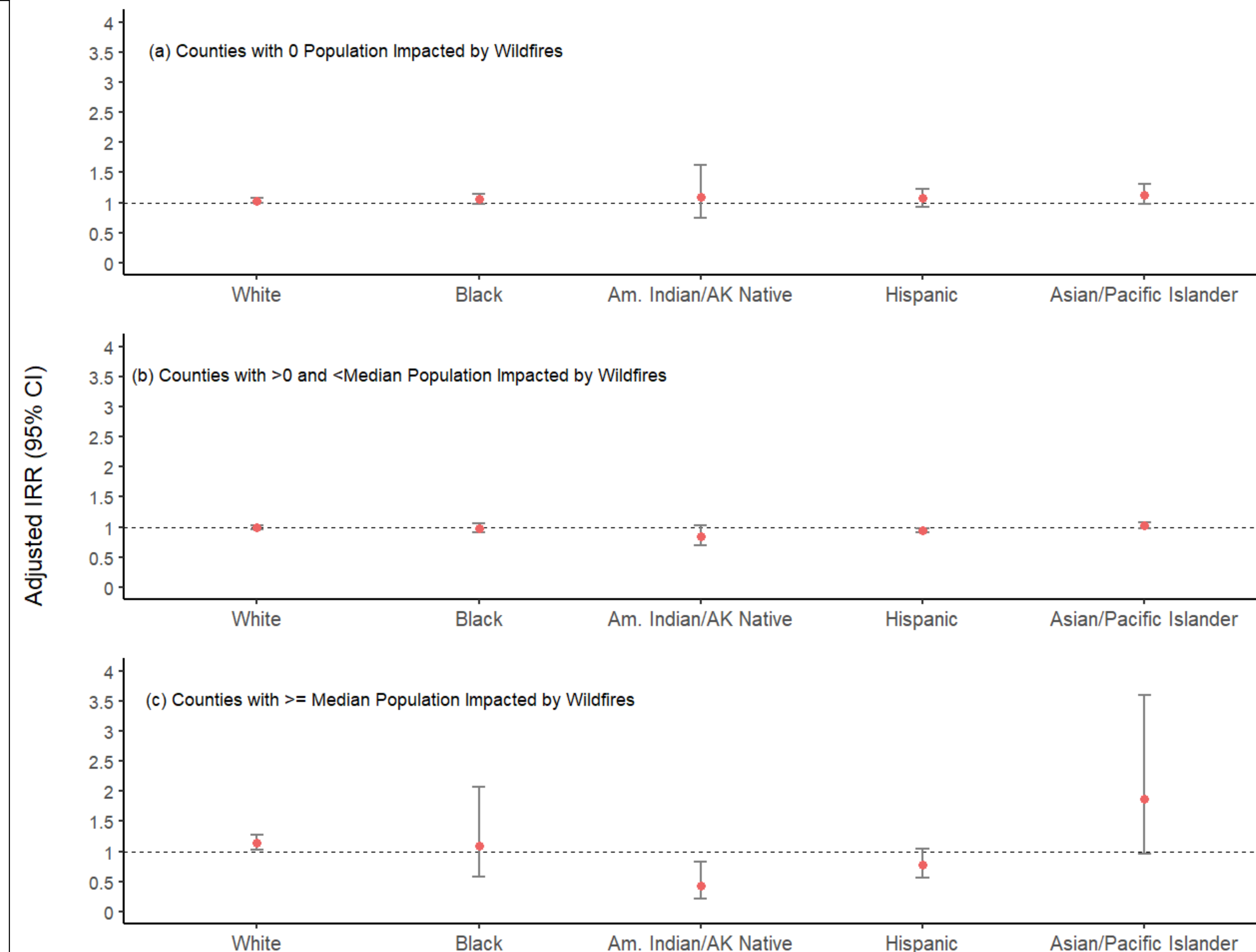
- Extreme weather events, including wildfires, have grown more frequent and severe due to climate change.
- Wildfires are a major source of particulate matter (PM), which is classified as an International Agency for Research on Cancer (IARC) Group 1 human carcinogen.
- The role of PM <2.5 microns in diameter (PM<sub>2.5</sub>) on colorectal cancer (CRC) risk, especially from wildfires, has not been well explored.
- Our objective was to examine the associations between PM<sub>2.5</sub> exposure, wildfires, and CRC risk.



**Figure 1 (a)** Annual average PM<sub>2.5</sub> levels (µg/m<sup>3</sup>) from 1998-2021  
**(b)** Annual average proportion of population impacted by wildfires

## METHODS

- **Study population:** Incident, confirmed CRC cases from Surveillance, Epidemiology, and End Results (SEER) cancer registries spanning 609 counties in the United States and the state of Alaska.
- **Exposure assessment:** Ambient PM<sub>2.5</sub> exposure was assessed using estimates from a convolutional neural network that combined aerosol optical depth retrievals from satellite instruments with a chemical transport model calibrated to ground observations, generated by the Atmospheric Composition Analysis Group.
  - Time-varying cumulative average exposure measures were calculated for each county using the earliest available year of exposure data until and inclusive of the year of diagnosis.
  - Exposure levels were assigned based on county of residence at diagnosis.
  - The Burned Area Boundaries Dataset was used to calculate three measures of wildfire exposure: number of wildfires, percent area intersecting a wildfire, and population located in census tracts within a county intersecting a wildfire.
- **Statistical analysis:** Incidence rate ratios (IRRs) and 95% confidence intervals (CIs) for the association between cumulative average PM<sub>2.5</sub> exposure per interquartile range increase (IQR; 3.61 µg/m<sup>3</sup> overall), wildfires, and CRC risk were estimated using Poisson regression models with robust variance estimation.
  - Models were adjusted for individual-level age, sex, race, and ethnicity, marital status, year of diagnosis, and SEER registry, and county-level data on health conditions, lifestyle factors, and socioeconomic status.
  - We examined two-way interactions between PM<sub>2.5</sub> and wildfires and 3-way interactions with race and ethnicity using likelihood ratio tests.
  - PM<sub>2.5</sub> and wildfires were each modeled separately as exposures for CRC risk and together to assess interaction.
  - We conducted sensitivity analyses by assessing associations using each wildfire exposure measure and under different categorizations. We also used per 10 µg/m<sup>3</sup> as the unit of increase for PM<sub>2.5</sub> exposure.



**Figure 2** Associations between PM<sub>2.5</sub> (per IQR increase) exposure and CRC risk by race in counties with **(a)** 0 population impacted by wildfires, **(b)** population impacted by wildfires >0 and < median population impacted by wildfires, and **(c)** population impacted by wildfires ≥ to median value.

Models are adjusted for SEER registry, age, sex, marital status, year of diagnosis, and county-level median household income, diabetes prevalence, obesity prevalence, physical activity prevalence, smoking prevalence, county alcohol consumption prevalence, and urbanicity.

## RESULTS

- 770,348 CRC cases diagnosed between 2000 and 2021 were included in this study.
- No significant association was found between PM<sub>2.5</sub> (adjusted IRR per IQR increase: 1.00, 95% CI 0.99 – 1.02) or wildfire-impacted areas (adjusted IRR for above median of population exposed to wildfires compared to counties not impacted by wildfires: 0.99, 95% CI 0.97 – 1.01) and CRC risk.
- We observed evidence of an interaction between PM<sub>2.5</sub> and wildfire-impacted areas on CRC risk (adjusted IRR per IQR increase in counties with above median of population exposed to wildfires [9%]: 1.09, 95% CI 0.99 – 1.20; vs. counties not impacted by wildfires: 1.03, 95% CI 1.00 – 1.06; p interaction <0.001).
- There was a statistically significant three-way interaction between PM<sub>2.5</sub>, wildfire-impacted areas, and race and ethnicity (p interaction < 0.001). The association between PM<sub>2.5</sub> and CRC risk by wildfire-impacted areas was stronger among non-Hispanic White persons (n = 517,461 cases; adjusted IRR in counties above median of population exposed to wildfires: 1.14, 95% CI 1.03 – 1.27; vs. counties not impacted by wildfires: 1.03, 95% CI 0.99 – 1.07).

## CONCLUSIONS

- The association between PM<sub>2.5</sub> exposure and CRC risk differed according to wildfire-impacted areas and race and ethnicity. Future research should utilize high-resolution address locations and individual-level data on confounders.

## ACKNOWLEDGEMENTS

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