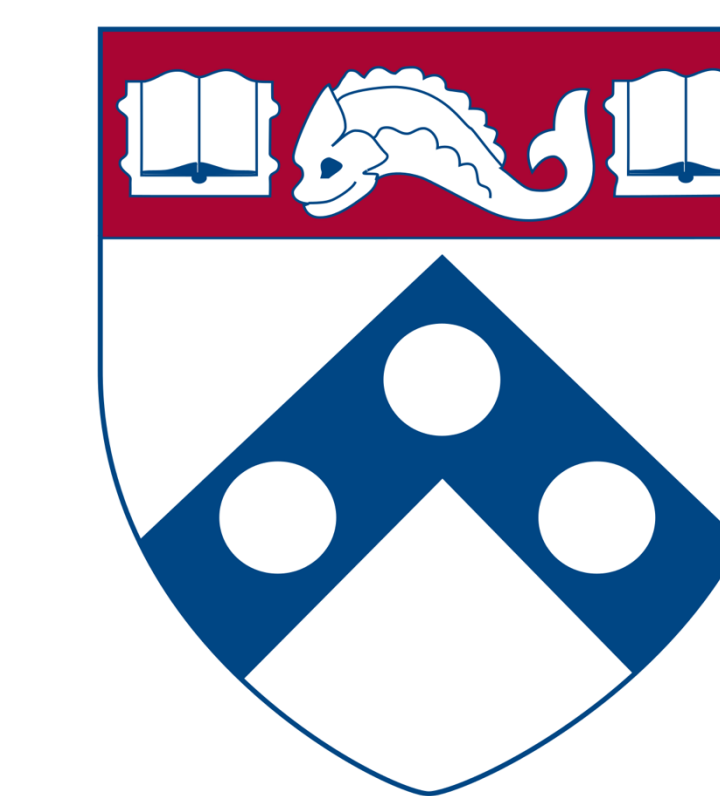


Dementia risk associated with long-term exposure to wildfire and non-wildfire PM_{2.5} A follow-up analysis from 2008–2023

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BACKGROUND

- Long-term exposure to ambient air pollution—including fine particulate matter <2.5µm in diameter (PM_{2.5})—is associated with incident dementia.
- While prior analysis suggested a strong association between long-term exposure to wildfire-derived PM_{2.5} and dementia between 2009–2019, results were imprecise due to relatively infrequent wildfire events.
- Here, we extend follow-up to 2009–2023, including recent years of wildfire intensification in the Western U.S.

METHODS

- Open cohort study using 2008–2023 electronic health record data from Kaiser Permanente Southern California (KPSC), which serves 4.7 million people in 10 counties.
- From 1.65 million eligible KPSC members aged ≥60, we included 1.23 million after excluding those not meeting enrollment criteria, with a dementia diagnosis before cohort entry, or missing address information.
- Exposure:** Three-year rolling mean wildfire and non-wildfire PM_{2.5}, updated quarterly, in participant census tracts from 2006–2023, estimated via monitoring and remote sensing data and statistical techniques.
- Outcome:** Incident all-cause dementia diagnoses identified using diagnostic codes from ICD-9 and ICD-10.
- Statistical Analysis:** We estimated the odds of dementia diagnoses associated with three-year average wildfire and non-wildfire PM_{2.5} exposure using a discrete-time approach with pooled logistic regression. All models were adjusted for EHR-derived patient characteristics, including age, sex, race and ethnicity (a social construct), marital status, smoking status. We additionally adjusted for calendar year and census tract-level poverty and population density derived from the 2010 US Census.
- Odds ratios correspond to a one µg/m³ increase in three-year average wildfire and non-wildfire PM_{2.5}
- As a secondary analysis, we assessed potential effect measure modification by age at cohort entry (and sex).

Table. Characteristics of KPSC beneficiaries, 2008–2023.

Total – N (%)	1,564,087 (100.0%)
Age at Cohort Entry, Years – Median (IQR)	61 (60, 68)
Sex – N (%)	
Male	737,782 (47%)
Female	826,305 (53%)
Race and Ethnicity – N (%)	
Hispanic	439,839 (28%)
Non-Hispanic	
Asian	168,980 (11%)
Black	143,769 (9.2%)
Other ^a	83,015 (5.3%)
White	728,484 (47%)
Smoking Status – N (%)	
Never, passive, unknown	988,798 (63%)
Former smoker	497,727 (32%)
Current smoker	77,562 (5%)
Requires Interpreter – N (%)	186,554 (12%)
Percent Poverty^c – Median (IQR)	9 (5, 16)
Population Density^c – Median (IQR)	2,497 (1,258, 3,928)

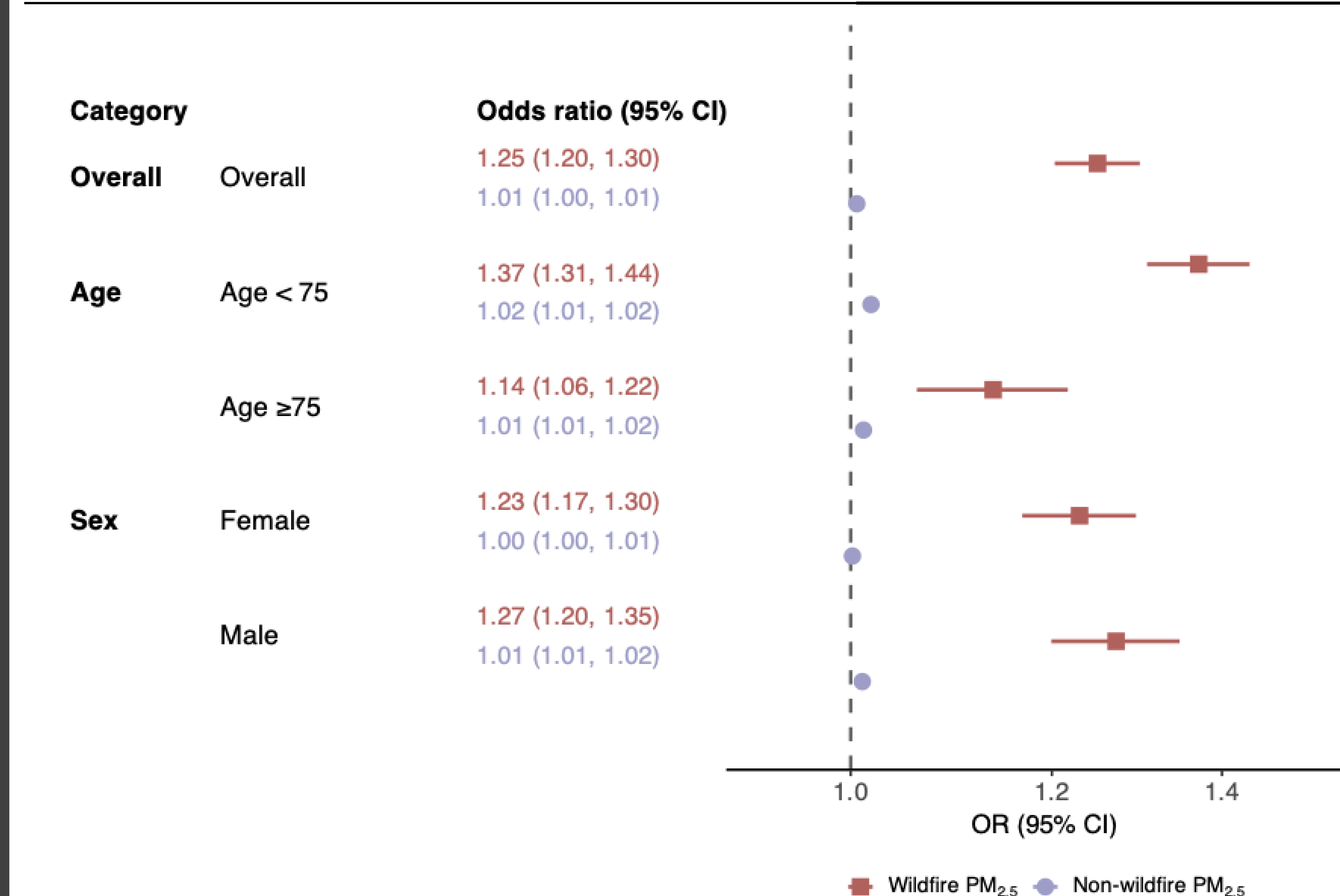


Figure. Association of wildfire and non-wildfire PM_{2.5} with incident dementia diagnoses in KPSC, 2008–2023. Estimated using pooled logistic regression, adjusting for calendar year, age, sex, race and ethnicity, marital status, smoking status, and census-tract characteristics.

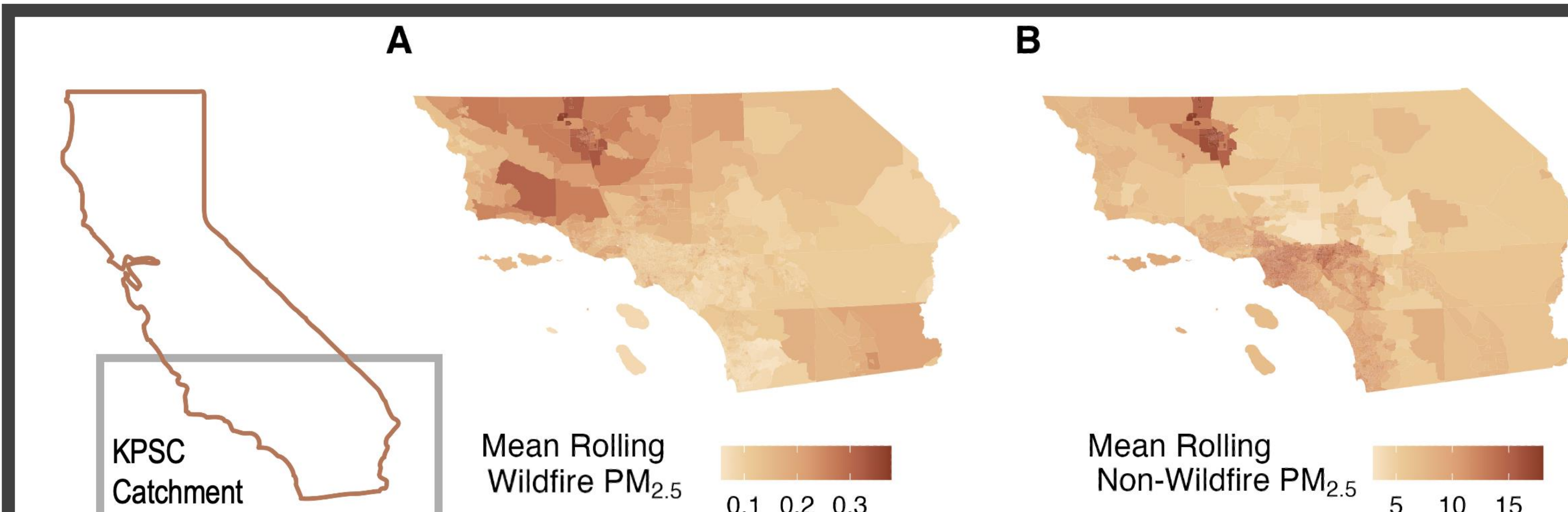


Figure 1. Mean census-tract level wildfire and non-wildfire PM_{2.5}

RESULTS

- Our analysis included 1,564,087 eligible KPSC beneficiaries with 107,844 (6.9%) dementia diagnoses during follow-up. The cohort was 53% female, with median baseline age of 61 years (IQR: 60–68).
- In adjusted models, odds of dementia diagnosis increased by 25% per 1 µg/m³ increase in three-year average wildfire PM_{2.5} (OR=1.25, 95%CI: 1.20, 1.30).
- For non-wildfire PM_{2.5}, the odds of dementia diagnosis increased by 1% per 1 µg/m³ increase in three-year average exposure (OR=1.01, 95%CI: 1.00, 1.01).
- For wildfire PM_{2.5}, the association was stronger among those age <75 years (OR=1.37, 95%CI: 1.31, 1.44) than among those age ≥75 years (OR=1.14, 95%CI: 1.06, 1.22); we did not observe a difference between age groups for non-wildfire PM_{2.5}.
- Results were similar within strata defined by sex for wildfire PM_{2.5}, but stronger for men for non-wildfire PM_{2.5} (p-for-heterogeneity = 0.01)

CONCLUSIONS

- With extended follow-up, we observed a robust association between long-term wildfire PM_{2.5} exposure and incident dementia, with a stronger association observed for wildfire versus non-wildfire PM_{2.5}.
- Wildfire smoke may thus represent a potentially important and increasingly common risk factor for dementia.