$PM_{2.5}$ AND MORTALITY RISK: MODIFICATION BY DIABETES AND THE NEUROLOGICAL IMPAIRMENT, A NATIONAL ANALYSIS

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INTRODUCTION

- There is mounting evidence that long- and short-term exposures to ambient air pollution are associated with both acute and chronic mortality risk
- Diabetes, cognitive decline, Parkinson's disease, dementia, and Alzheimer's disease are also a growing burden
- The biological responses thought to effect cardiovascular disease through air pollution-mediated systemic oxidative stress and inflammation could also be relevant for diabetes and neurodegenerative diseases.
- Goal of the study: estimate the mortality risks associated with short-term exposures to the two days average $PM_{2.5}$ across all Medicare deaths, and whether the mortality risks associated with short- term $PM_{2.5}$ among elderly is modified by neurological disorders or diabetes.

STUDY POPULATION: THE COHORT

- We defined 115 cities (175 counties) with the criterion that at least 265 days of data in at least one year was available.
- We used the Medicare beneficiary denominator file to select 8 million deaths among all Medicare enrollees from 1999-2008 in the 115 cities
- We traced previous cause of specific hospital admissions, based on primary and secondary cause of admissions for:

  Diabetes (ICD-9: 250)
  Alzheimer's disease (ICD-9: 331.0)
  Parkinson's disease (ICD-9: 332)
  Multiple sclerosis (ICD-9: 340)
- Medicare discharge records also contain information for each subject on: date of death, age, gender, race

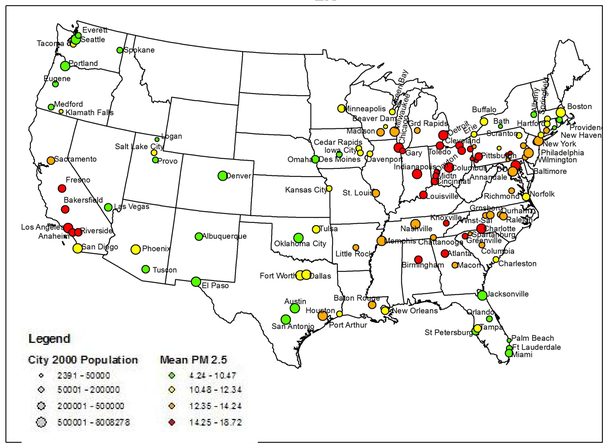
ENVIRONMENTAL DATA

- Air Pollution data: We obtained daily air pollution PM2.5 from the U.S. Environmental Protection Agency's Air Quality System Technology Transfer Network
- Meteorological data: from the National Oceanic and Atmospheric Administration (NOAA). Weather data included: daily temperature (mean, min, max), daily dew point.

Table 1: Number of deaths and of hospitalizations across the 115 cities

	Events by 1000			
	Minimum	Maximum	Total	%
Deaths	3	447	8057	
Hospitalization for:				
Diabetes	0.298	56	829	10.29
Dementia	0.073	16	150	1.86
Alzheimer's disease	0.071	16	275	3.42
Parkinson's disease	0.031	8	105	1.31
Multiple sclerosis	0.003	1	7	0.08

Figure 1: Map of the US with the location of the 115 cities; the symbol size represent the population in each city, while the color represent the average $PM_{2.5}$ in the city.



METHODS

- We conducted a city specific time-stratified case-crossover design
- We defined: the case as the day of death
- Control days as every third day in the same month and year as the case.
- Conditional logistic regression controlling for:
  - Day of the week
  - Same and previous day temperature
- We then examined effect modification by specific cause of prior admission by including an interaction term between $PM_{2.5}$ and indicator variables for each medical condition in the same model.
- We combined results across cities using a random effect meta-analysis.
- Spatial clusters were developed by Austin et al. (2012) by grouping sites across the United States according to their $PM_{2.5}$ composition profiles.
- In the second stage of the analysis the city-specific coefficients of the $PM_{2.5}$ mortality association were used in a meta-regression to examine whether the health effects estimates were modified by cluster.

RESULTS

- Figure 1 presents the map of the 115 US cities included in the study together with the city-specific average of PM2.5
- Table 1 shows characteristics of the study population
- Figure 2 shows the results of the analysis:
- We found a 0.68 % increase (95% CI: 0.48- 0.88) in mortality rate for each 10 $\mu g/m^3$ increase in the 2 days average of $PM_{2.5}$ among all Medicare enrollees.
- We found significantly higher effects in subjects with a previous admission for:
  - Multiple sclerosis (5.2 %, 95% CI: 0.89- 9.69)
  - Parkinson's Disease (1.54%, 95% CI: 0.48; 2.62)
  - Diabetes with a 1.02 % increase (95% CI: 0.53; 1.51)
- In preliminary results we found some significant clusters characterized by higher concentrations of Zn, Mn, V, and Pb.

Figure 2: Total mortality and effect modification by medical conditions : percent increase (95% CI) for 10 $\mu g/m^3$ increase in the 2 days average $PM_{2.5}$. Combined results across 115 cities.

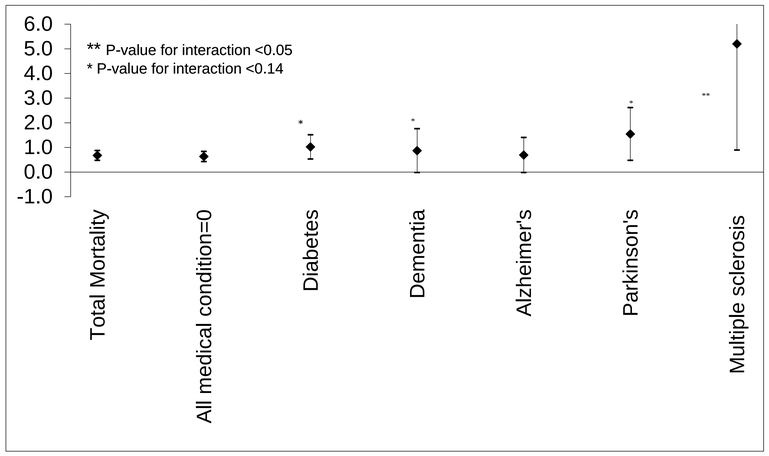
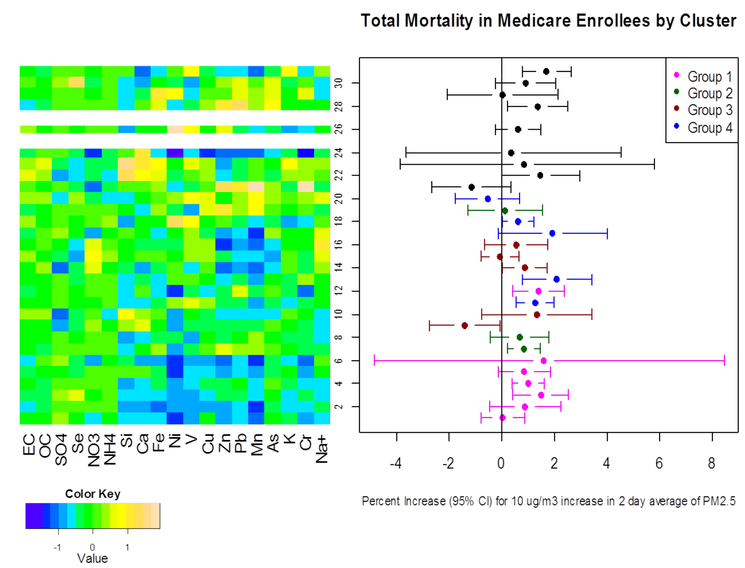


Figure 3: Percent increase in total mortality by 10 $\mu g/m^3$ increase in 2-days average $PM_{2.5}$ by cluster



CONCLUSION

- In this multi-city study we found particles increased the risk of mortality
- We identified diabetes, multiple sclerosis, dementia, Alzheimer's Disease, and Parkinson's Disease as susceptible subpopulations
- Biological mechanism are still unclear, but could be related to systemic inflammation, oxidative stress, vascular and autonomic dysfunction
- Preliminary investigation suggests that spatial clusters are informative about the composition of $PM_{2.5}$ and/or types of sources posing higher risks.

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