Fine Particulate Air Pollution and Life Expectancy in the United States

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Summary of estimates in increased mortality risk from cohort studies of long-term exposure
Survival curves based on projected U.S. life tables and alternative excess risk assumptions

- Baseline survival curve, life expect.=76.4
- 1.25 RR from Pollut, ages < 45 unaffected; life expect.=73.9
- 1.25 RR from Pollut., infants unaffected; life expect.=73.5
- 1.25 RR from Pollut., infants affected; life expect. = 73.4
- 2.00 RR from Smoking from age 20; life expect.=67.9

Note: 1.15 RR from Polut., infants unaffected; life expect=74.6 (curve not shown)

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OCCUPATIONAL AND ENVIRONMENTAL MEDICINE
Brunekreef 1997

EPH ENVIRONMENTAL HEALTH PERSPECTIVES
Pope 2000
Fine-Particulate Air Pollution and Life Expectancy in the United States

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Matching PM$_{2.5}$ data for 1979-1983 and 1999-2000 in 51 Metro Areas

Life Expectancy data for 1978-1982 and 1997-2001 in 211 counties in 51 Metro areas

Evaluate changes in Life Expectancy with changes in PM$_{2.5}$ for the 2-decade period of approximately 1980-2000.
Life Expectancy vs PM$_{2.5}$
1978-82

Slope
-1.2 yr/10 μg/m$^3$

EPA NAAQS

Topeka

Seattle

Boston

Steubenville
Life Expectancy vs PM$_{2.5}$
1997-2001

Slope
-2.1 yr/10 μg/m$^3$

EPA NAAQS

Topeka
Boston
Seattle
Steubenville
Δ Life Expectancy vs Δ PM$_{2.5}$
1980-2000

Slope +.61 yr/10 μg/m$^3$

Seattle

Boston

Steubenville

Topeka
Regression analysis

- Regression models were used to control for various socio-economic, demographic, and smoking variables.
- Cross-sectional regression models estimated for both time periods.
- First-difference regression models were estimated.
- Sensitivity analysis included:
  1. With and without different combinations of socio-economic, demographic, and smoking variables.
  2. Restricting to only counties with >100,000 population.
  3. Restricting to only 51 largest counties in each metro area.
  5. Stratifying according to beginning pollution levels.
Clustered standard errors (clustered by the 51 metro areas) were estimated for all models except for analysis that included only the 51 largest counties in each metro area.
Covariates included in the regression models

Changes in socio-economic and demographic variables (from U.S. Census Data):
- Per capita income
- Population
- 5-yr in-migration
- High-school graduates
- Urban population
- Black proportion of population
- Hispanic proportion of population

Proxy cigarette smoking variables—available for all 211 counties
- COPD mortality rates
- Lung Cancer mortality rates

Survey-based metro-area estimates of smoking prevalence
- National Health Interview Survey (1978-1980)
- Matching data available for only 24 of 51 metro areas
A $10 \mu g/m^3$ decrease in PM$_{2.5}$ is associated with approximately $0.61 (\pm 0.20)$ years increase in life expectancy. Not highly sensitive to controlling for socioeconomic, demographic, or smoking variables.
Conclusions

- The results of this analysis are generally good news.
- Multiple factors clearly affect life expectancy, but . . .
- These findings provide evidence that improvements in air quality contribute to measurable improvements in life expectancy in the U.S.
- This evidence is consistent with indirect estimates based on pollution-related elevated mortality risks from the cohort and related studies.