

# Comments on Uncertainty in Air- Pollution Epidemiology

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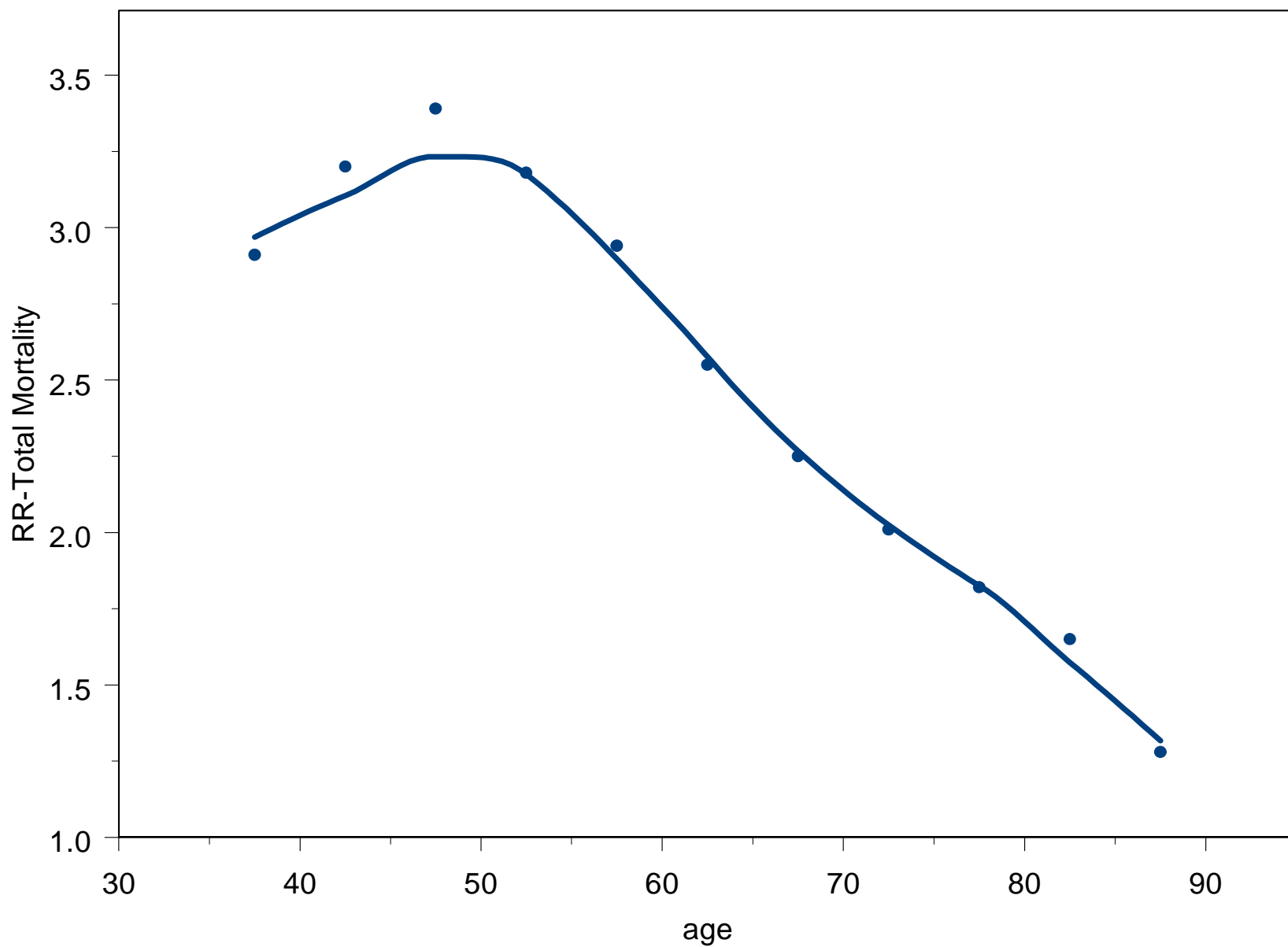
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# Sources of Uncertainty

- We have only a meager understanding of factors that affect health in human populations – in particular, role of SES poorly understood. See, e.g., Steenland et al. 2004.
- Inadequacy of currently used statistical models and methods – assumptions of the ubiquitously used Cox proportional model are simply not satisfied by the many confounders that must be considered.
- Results are highly model-dependent.
- Estimates of personal exposure not available in epidemiologic studies.
- Range of reported risks is huge. Recently reported risks (Miller et al. NEJM, 2007; Ostro et al. EHP, 2009) are so large as to be totally implausible biologically.

Total Mortality Rate Ratio for 40+ Cigs/day, CPS-I



## Statistical models are inadequate for unbiased detection of risks

- If the Cox model assumption (proportionality of hazards) were satisfied for smoking, a potentially strong confounder, the RRs would fall approximately on a horizontal line. Clearly not true. Same holds for other possible confounders.
- Just because a covariate is entered into the regression does not mean it has been adequately controlled.
- Pack-years is a poor measure for control of cigarette smoking. Risk depends independently on both intensity and duration of smoking.

## Results depend on model choice

- Long-term studies – Re-analysis of CPS II (Krewski et al., 2000, table 37).

### Single pollutant analyses:

- **Fine PM: RR = 1.20 (1.11, 1.29)**
- SO<sub>2</sub>: RR = 1.49 (1.36, 1.64)

### Two-pollutant analyses:

- Fine PM: RR = 1.03 (0.95, 1.03)**
- SO<sub>2</sub>: RR = 1.46 (1.32, 1.63)

# Inconsistent Results

- Krewski et al. (2000) find much lower fine PM-mortality effect in California than in the northeastern U.S.
- However, spatial analysis in Krewski et al (2009) reports no effects in N.Y. city but a positive effect in L.A.
- First stage NMMAPS analyses finds a significant effect in N.Y. city but not in L.A.

# Biologically implausible results

- Pope et al. Circulation, 2004 reports *significant protective* effect of fine PM on respiratory mortality:

## Table 4:

Diseases of resp. system: RR=0.92 (0.86, 0.98)

COPD and allied conditions: RR=0.84 (0.77, 0.93)

Pneumonia & Influenza: RR=1.07 (0.95, 1.20)

All other resp. diseases: RR=0.86 (0.73, 1.02)

When scaled linearly risks are implausibly large for air-pollution effects – could be picking up residual SES effects

- Miller et al. NEJM, 2007, reported fine PM associated risks for cardiovascular mortality among women that were much higher than reported in earlier papers.
- A simple calculation shows that their results imply that a woman moving from the least polluted (Honolulu) to the most polluted city (Riverside) would increase her risk of cardiovascular mortality more than if she smoked 40 cigarettes per day. Defies biological plausibility.



When scaled linearly risks are implausibly large for air-pollution effects – could be picking up residual SES effects

- The most egregious example – Ostro et al. Environmental Health Perspectives, 2009. The reported risks for fine PM are as large as, or larger than, the risks reported in Miller et al. Those for sulfates are preposterously large.
- RRs (95% CI) associated with incremental exposure (10 micrograms/m<sup>3</sup> scaled up from an inter-quartile range of 1.3 micrograms/m<sup>3</sup>) to sulfates, a component of fine PM:
  - All-cause mortality, RR = 21.5 (7.5, 62.0)
  - Cardiopulmonary mortality, RR = 27.7 (6.7, 113.5)
  - Ischemic heart disease, RR = 100.1 (9.0, 1151.0)
- The risks associated with inter-quartile ranges for fine PM and sulfates are approximately equal. Could these risks and those in Miller et al. be picking up residual SES effects?

# Conclusions

- Miller et al. and Ostro et al. results could be explained by residual confounding by SES – the attempt to better characterize exposure may actually lead to estimation of an SES effect.
- Regulation is a policy decision in the face of considerable uncertainty. Attempting to justify specific regulation on the basis of ‘causality’ leads to distortion of the science.
- Data that are used for regulation should be available to all stakeholders.