PARTICULATE AIR POLLUTION AND SURVIVAL: PROPORTIONALITY ASSUMPTION, TIMING OF DOSE, AND DOSE-RESPONSE RELATIONSHIP IN THE HARVARD SIX CITIES STUDY

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Background and Aims: The association of fine particulate air pollution ($PM_{2.5}$) with mortality is well established, however questions have been raised about the sensitivity of results to model specification, including whether covariates are proportional and whether the dose-response is linear. We addressed these issues using an extended follow-up of the Harvard Six Cities Study through 2006, incorporating more recent lower exposures.
Methods: 8111 white adults were included. Personal characteristics were collected at enrollment (1974). Vital status has been updated using the National Death Index. Annual $PM_{2.5}$ was measured by study or US EPA monitors. We replicated the original results for $PM_{2.5}$ and all-cause mortality using a Cox regression and repeated with a Poisson survival analysis with separate hazard rates for each year of follow-up. To relax the proportionality assumption, we included interactions between year of follow-up and smoking, sex, and education. We examined the shape of the dose response relationship using penalized splines and the fit of models with different lags.
Results: Poisson and Cox models produced similar results, which did not change with time-varying covariate effects. Akaike's information criterion was lower for models using current year's $PM_{2.5}$ than for the models including earlier years. Each 10µg/m^3 increase in $PM_{2.5}$ exposure in the year of death was associated with an adjusted RR=1.13 (95% CI, 1.06-1.20). The penalized spline model chose one degree of freedom, indicating a linear dose-response relationship. The results did not show any rationale for threshold in the association, and the effects of $PM_{2.5}$ did not change by time period.
Conclusions: Including more recent observations with exposures below the US standard (15µg/m^3), we found a strong linear association without any threshold between $PM_{2.5}$ and all-cause mortality. Results showed that current year was the best exposure window and that the toxicity of $PM_{2.5}$ has not changed over time.
References:

Laden F, Schwartz J, Speizer FE, and Dockery DW. Reduction in Fine Particulate Air Pollution and Mortality, Am J Respir Crit Care Med 2006;173:667-672.

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