



Department of Epidemiology

Variation in the Effect of Air Pollution

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What are the sources of variability in estimates?

- Chance, i.e., random variability
- Methodological approaches
- Publication Bias
- True variation
 - Differences in pollutant toxicity
 - Differences in population susceptibility

Why is variation important?

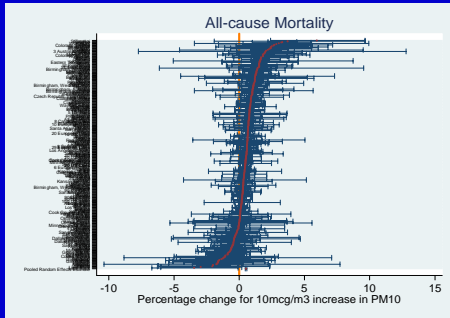
- Insights into potential determinants of toxicity—variation in both pollutant effect and population susceptibility
- Policy relevance of local estimates
- Transportability of external estimates

What is transportability?

- The idea that risks of air pollution observed in one or more populations can be extended to other populations.
- AKA: generalizability or external validity
- Corollary: Are local data needed as the basis for policy?

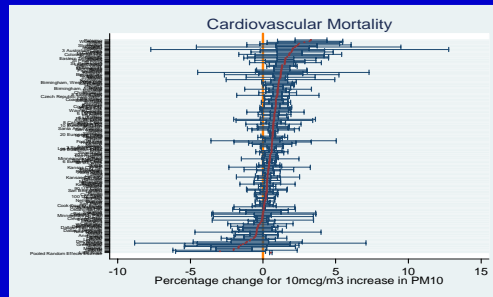
St. George's data base

**Time-series estimates to 2006
Daily all-cause mortality and PM₁₀ (n=314)**



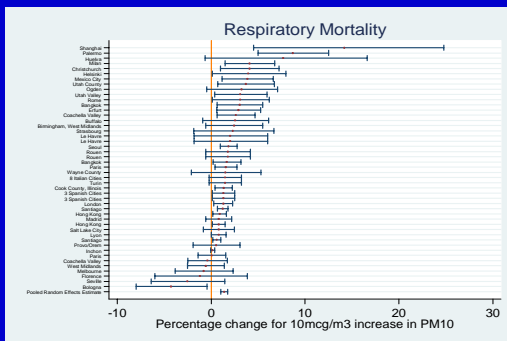
St. George's data base, 10/06

**Time-series estimates to 2006
Daily cardiovascular mortality and PM₁₀ (n=177)**



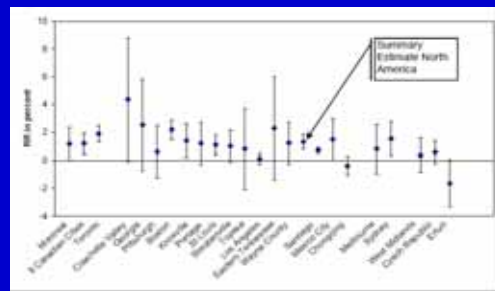
St. George's data base, 10/06

**Time-series estimates to 2006
Respiratory mortality and PM₁₀ (n=47)**



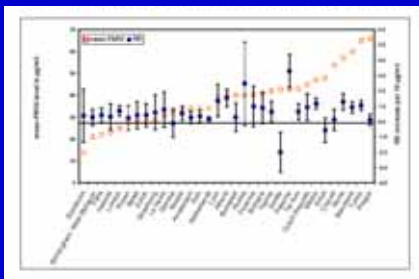
St. George's data base, 10/06

All-cause mortality: % change in number of deaths associated with 10 µg/m³ increase in daily PM_{2.5}



Source: Anderson HR et al. WHO 2004

Ranking of PM₁₀ estimates for all-cause mortality by annual average levels of PM₁₀*



*left y-axis: mean PM₁₀ levels in µg/m³;

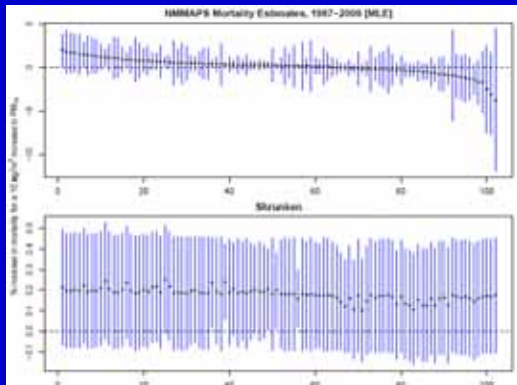
right y-axis: RR in total mortality of a 10 µg/m³ increase of PM₁₀.

Source: Anderson HR et al. WHO 2004

What about random variation?

- Results will vary by chance
 - How do we know if an estimate is truly higher or lower?
 - How do we quantify the role of chance?

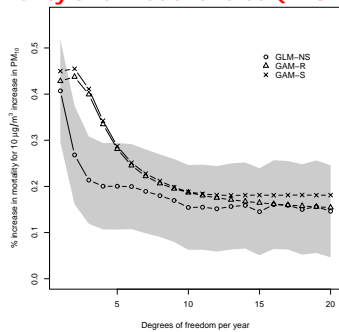
NMMAPS: "Raw" and Shrunken Estimates



What about methodological issues?

- Related to the data:
 - Exposure variables
 - Outcome measures
 - Confounding/modifying variables
- Related to the analysis
 - Model used
 - Specification of model
 - Confounder control strategy

Sensitivity of the national average estimates of the PM₁₀ - mortality association to adjustment for seasonality and model choice (1987-2000)



Peng, Dominici, Louis JRSS (2006)

Sensitivity of national average estimates to model selection methods

- National average estimates of the % increase in mortality for a 10 µg/m³ increase in PM₁₀

	AIC	PACF	GCV-PM ₁₀
GLM-NS (natural splines)	0.20 _(0.11, 0.29)	0.25 _(0.14, 0.36)	0.20 _(0.10, 0.29)
GAM-R (penalized splines)	0.25 _(0.16, 0.34)	0.35 _(0.24, 0.46)	0.26 _(0.16, 0.35)
GAM-S (smoothing splines)	0.27 _(0.18, 0.37)	0.35 _(0.24, 0.46)	0.26 _(0.16, 0.37)

- Previously reported results appear robust to choice of model selection method

Overview of APHENA

Air Pollution and Health: a Combined European and North American Approach (APHENA)

The APHENA Group

Europe: Touloumi G, Samoli E, Pipikou M, Atkinson R, Le Tertre A, Anderson R, Katsouyanni K

US: Dominici F, Peng R, Schwartz J, Zanobetti A, Samet J

Canada: Ramsay T, Burnett R, Krewski D.

Supported by the Health Effects Institute

What is publication bias?

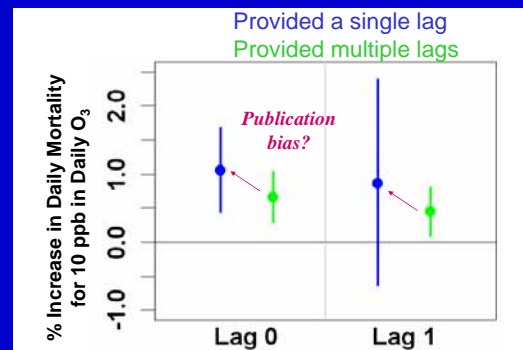
- A tendency for the publication process to differentially lead to publication of papers reporting statistically significant findings.
 - May influence data analysis and selection of findings for publication
- Can it be identified?
 - Graphical approaches
 - Analytic approaches

Ozone for example: a meta-analysis

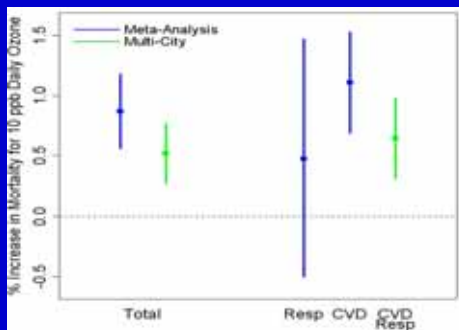
- 144 effect estimates from 39 time-series studies
- Strong statistically significant association identified between ozone and mortality for total deaths and cardiovascular disease
- Implied relationship between ozone and respiratory disease mortality
- Large heterogeneity in individual study estimates
- Some indication of publication bias

Bell et al., 2005

Ozone effect estimates and lags: publication bias?

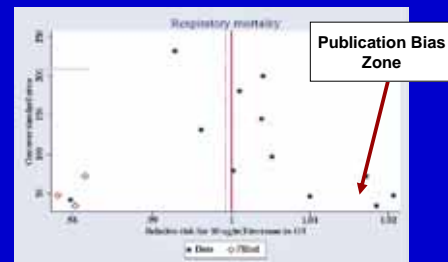


Comparison of ozone meta-analysis and multi-city results



Bell et al. 2005

Funnel plot for estimates for respiratory mortality and ozone



Source: Anderson HR et al. WHO 2004

Why transport risk estimates?

- Local evidence not available as basis for policy formulation.
- Use external evidence as framework to strengthen interpretation of locally derived evidence.
- To estimate burden of disease globally

Some solutions to unwanted variation

- Maintained data base and periodic meta-analysis
- Multi-city analyses
- Periodic global analyses
- Also needed:
 - Unbiased publication processes
 - Transparent analytic approaches
 - Bayesian methods for handling local data

Looking Ahead

- Need for tracking development of risk estimates through systematic data bases
- Empiric evaluation of impact of local research estimates is needed
- Methods development needed for use of local risk estimates in context of regional and global estimates
- Continuation of APHENA-like approaches? Nationally? Globally?