# Quantifying the Health Impacts of Air Pollution

## Day 2: Estimating the Risks Associated with Air Pollution

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# Outline

# What is a Meta Analysis?

# META-ANALYSIS

- A meta-analysis is a statistical analysis of a collection of studies, often collected together through a systematic review.
- A systematic review provides a summary appraisal of the evidence in the systematically collected studies in a narrative form.
- Statistical techniques in a meta-analysis enable a quantitative review to be undertaken by combining together the results from all the individual published studies to estimate an overall summary, or average, finding across studies.

# META-ANALYSIS

- A meta-analysis often conducted as a result of
  - limited study size
  - biases
  - differing definitions
  - quality of, exposure, disease and potential confounding data
  - as well as other study limitations.

# META-ANALYSIS

- Making sense of an inconsistent body of evidence by contrasting and combining results from different studies with the aim of identifying consistent patterns.
- Including more people than any single constituent study, and produce a more reliable and precise estimate of effect.
- Identifying differences (heterogeneity) between individual published studies.
- Exploring whether, for the question under investigation, studies with positive findings are more likely to have been published than studies with negative findings (publication bias).
- Providing an evidence base for clinical decisions.

# Performing Meta Analyses

# Steps in a Meta-analysis

- Extracting
  - main results from each of the studies, for example, Relative Risks, Odds Ratios
  - estimates of whether the result may have occurred by chance, for example, Standard Errors, Confidence Intervals.
- Checking
  - whether it is appropriate to calculate a pooled summary/average result across the studies
  - appropriateness depends on just how different the individual studies are that you are trying to combine.
- Calculation
  - by summarising results as a weighted average across the studies using a specified model.

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# Fitting Models

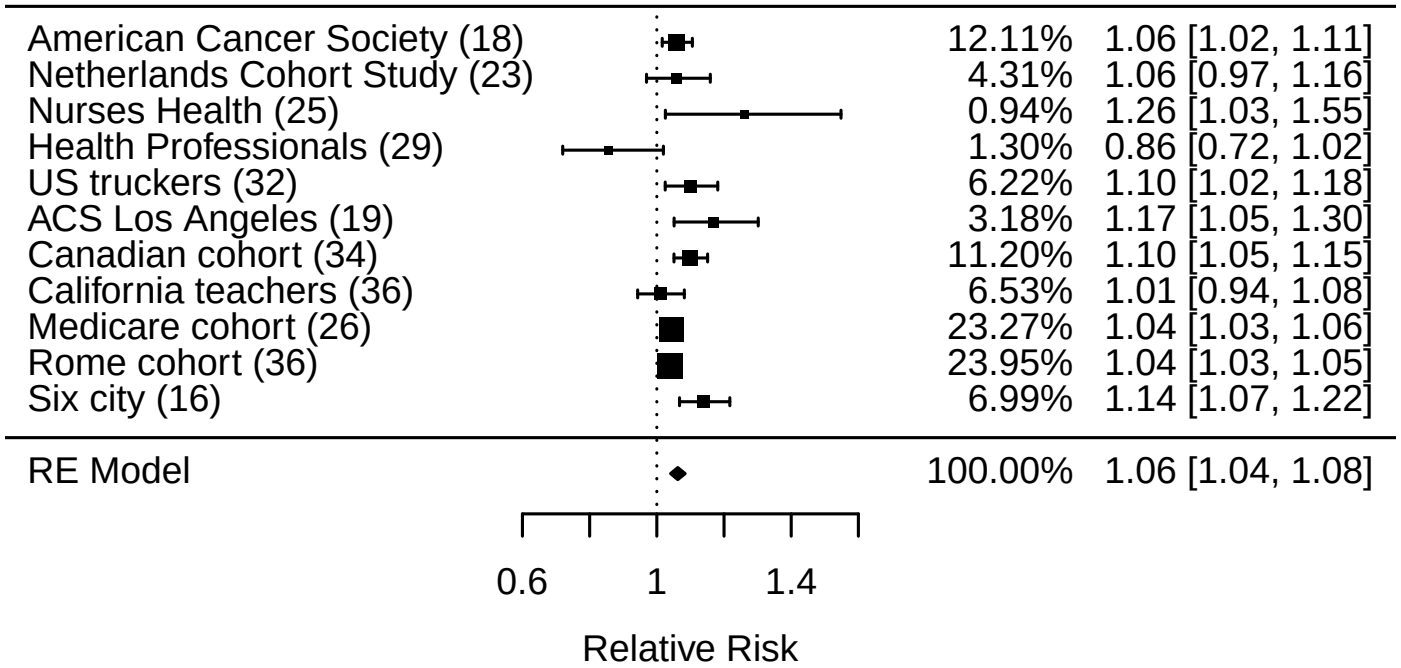
- Once the results have been extracted and verified, a model will need to be fit to find an over all result.
- This can be done by fitting fixed or random effects to the studies.
- Fixed Effects
  - assumes all of the studies examined are considered to have been conducted under similar conditions with similar subjects
  - assumes the only difference between studies is their power to detect the outcome of interest
  - assumes there is no single effect to estimate but a distribution of effects due to between-study variation
  - assumes there is a single âĂŹtrueâĂŹ or âĂŹfixedâĂŹ underlying effect
  - can be used where there is no evidence of heterogeneity.

# Fitting Models

- Random Effects
  - assumes that the true treatment/exposure effects in the individual studies may be different from each other
  - allows the study outcomes to vary in a normal distribution between studies
  - assumes there is no single effect to estimate but a distribution of effects due to between-study variation
  - will tend to give more conservative results than fixed effects as it includes an extra source of variation (between study).

# Forest Plots

- A forest plot is a good graphic representation of estimated results from other studies addressing the same question, along with the overall results.



# Measuring Heterogeneity

- Cochran's $Q$
  - calculated as the weighted sum of squared differences between individual study effects and the pooled effect across studies.
- An $I^2$ statistic
  - describes the percentage of variation across studies that is due to heterogeneity rather than chance
  - unlike Q it does not inherently depend upon the number of studies considered
  - a value of 0% indicates no heterogeneity, 25% indicates low heterogeneity, 50% indicates moderate heterogeneity, and 75% indicates high heterogeneity
  - can never reach 100% and values above 90% are very rare.

# Funnel Plots

- A funnel plot is designed to check the existence of publication bias.
- It assumes that the largest studies will be near the average, and small studies will be spread on both sides of the average.
- Variation from this assumption can indicate publication bias.