A defense of ecological analysis

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What is an ecological analysis?

• Correlation of aggregate data
  – Time trend analyses (how do disease rates change after introduction of a vaccine?)
  – Spatial analyses (association of ZIP code-level incidence of lung cancer with ZIP code level smoking rates)
Why is ecological analysis essential?

- Some phenomena act at the population level or can only be measured at the population level, so individual-level analysis cannot capture it:

  Vaccines provide direct protection to individual and disrupt transmission, providing an additional community benefit.

COVID-19 Pandemic had both individual-level and societal impact that affected health:

- Infection
- Overwhelmed healthcare
- Other social/environmental determinants

Weinberger et al. JAMA Internal Medicine 2020
Why do people hate ecological analyses?

• Often not done in a rigorous way
  – Insufficient adjustment for confounding (or inability to adjust for relevant confounders);
  – Association of hot chocolate sales with influenza rates

Percent of the population in poverty

Flu vaccine rates

COVID rates
Why do people hate ecological analyses?

• “The ecological fallacy”: inferring individual level effects from aggregate associations
  – Provinces with higher % Protestant had higher suicide rates in Europe in 19th century than predominantly Catholic provinces ≠ Protestants more likely to commit suicide

• Simpson’s Paradox: relationships at individual level flip when viewed in aggregate

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Causation from ecological data

Regression: \[ E(\text{pneumonia cases}_t) = b0 + b1 \times \text{Perfect_control}_t \]

Identify confounders at the same level of measurement

Hernan and Robbins
General approaches to improve the rigor of ecological studies

• Control variables
  – E.g., ‘synthetic controls’ approach: use other causes of death to adjust for trends unrelated to a vaccine

• Negative control outcomes
  – outcomes that shouldn’t be affected by the change
  – Evaluate changes that happen just before intervention

• Incorporate time series data from multiple spatial units

• Combine ecological + individual level analyses

Jackie Kleynhans, Cheryl Cohen, PLOS Medicine
The flip side.

- “individualistic fallacy” in which the major population determinants of health are ignored and undue attention is focused on individual characteristics.

https://jech.bmj.com/content/54/5/326
Combining ecologic and individual-level analyses in DCNP

• There are many ecologic variables of relevance for DCNP (measures of hospital capacity and disruption, community transmission rates)

• Also relevant individual-level variables (e.g., loss of control of chronic conditions)
Example: Pandemic-related increases were more pronounced for women in the VA (now: why?)