

# Ecologic Studies

Madhukar Pai, MD, PhD  
McGill University  
[madhukar.pai@mcgill.ca](mailto:madhukar.pai@mcgill.ca)

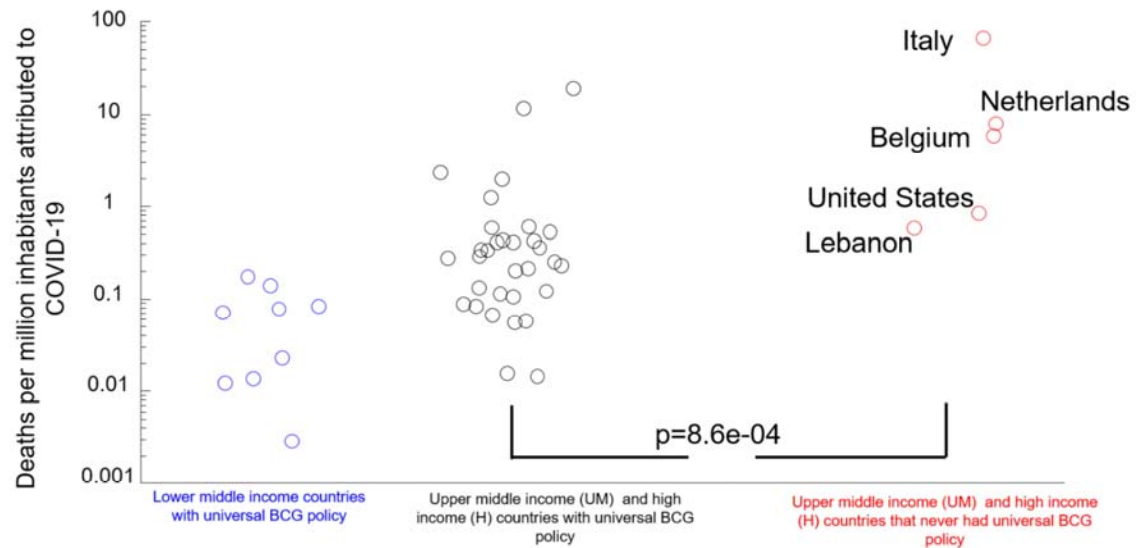


Comments (145)

## Correlation between universal BCG vaccination policy and reduced morbidity and mortality for COVID-19: an epidemiological study

Aaron Miller, Mac Josh Reandelar, Kimberly Fasciglione, Violeta Roumenova, Yan Li, Gonzalo H Otazu


doi: <https://doi.org/10.1101/2020.03.24.20042937>



**Figure 1:** Higher death rates were presented in countries that never implemented a universal BCG vaccination policy.

A community from nature research

MENU MICROBIOLOGY Search Nature Research Microbiology Commu Q



CONTRIBUTOR

JOURNAL CLUB CORONAVIRUSES: PAST, PRESENT AND FUTURE

## Universal BCG vaccination and protection against COVID-19: critique of an ecological study

This post was written by Lena Faust, Sophie Huddart, Emily MacLean and Anita Svadzian. The authors are PhD students in Epidemiology at the McGill International TB Centre, Montreal, Canada.

**Emily MacLean**  
PhD candidate, McGill University

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## BCG Against Coronavirus: Less Hype And More Evidence, Please



**Madhukar Pai** Contributor

Healthcare

*I write about global health, infectious diseases, and equity*



Close up of reaction of Bacillus Calmette Guerin or BCG vaccination infants. GETTY

## A Skeptic's Guide To Ecologic Studies During A Pandemic



**Madhukar Pai** Contributor

Healthcare

*I write about global health, infectious diseases, and equity*



24 January 2020, Bavaria, Munich: A face mask and protective goggles are displayed in front of a map ... [+] DPA/PICTURE ALLIANCE VIA GETTY IMAGES

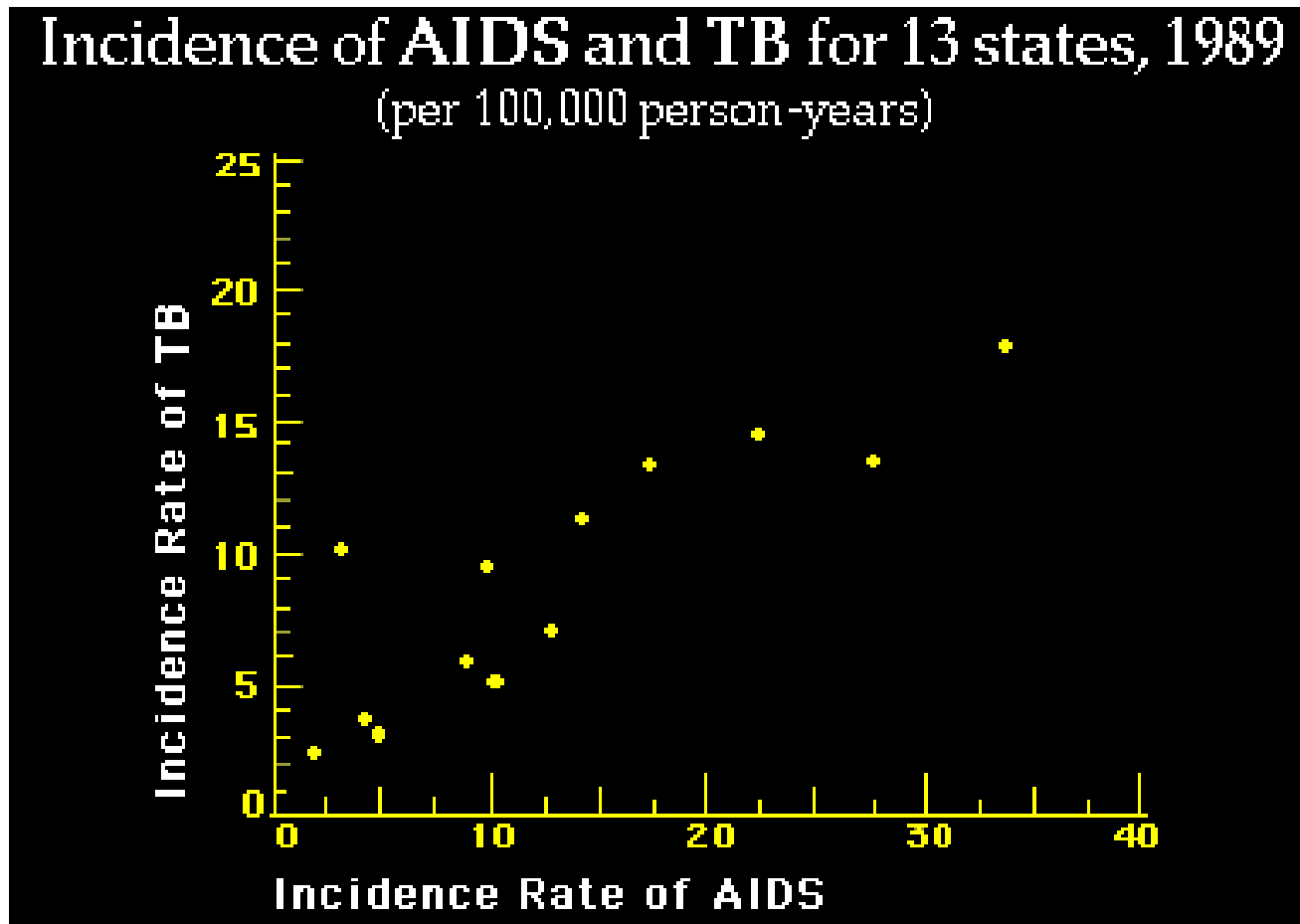
# Critique

- Ecologic correlations do not have to be true at the individual level
- Low testing rates in many low-income countries
- Epidemic is not on the same time scale across countries
- Confounding by age structure
- Confounding by indication – why is BCG still being given?
- Countries that give BCG also give many other vaccines or have other issues (e.g. malaria endemic)
- Inconsistencies: India, Brazil, Peru, Russia, Iran, Pakistan, Mexico, Chile – all give BCG & have huge Covid-19 epidemics
- Why should BCG at birth protect adults? Biology?

# Ecologic Studies

- “A study in which units of analysis are populations or groups of people than individuals.” — Dictionary [Porta 2008]

## Example: Correlation between TB and AIDS

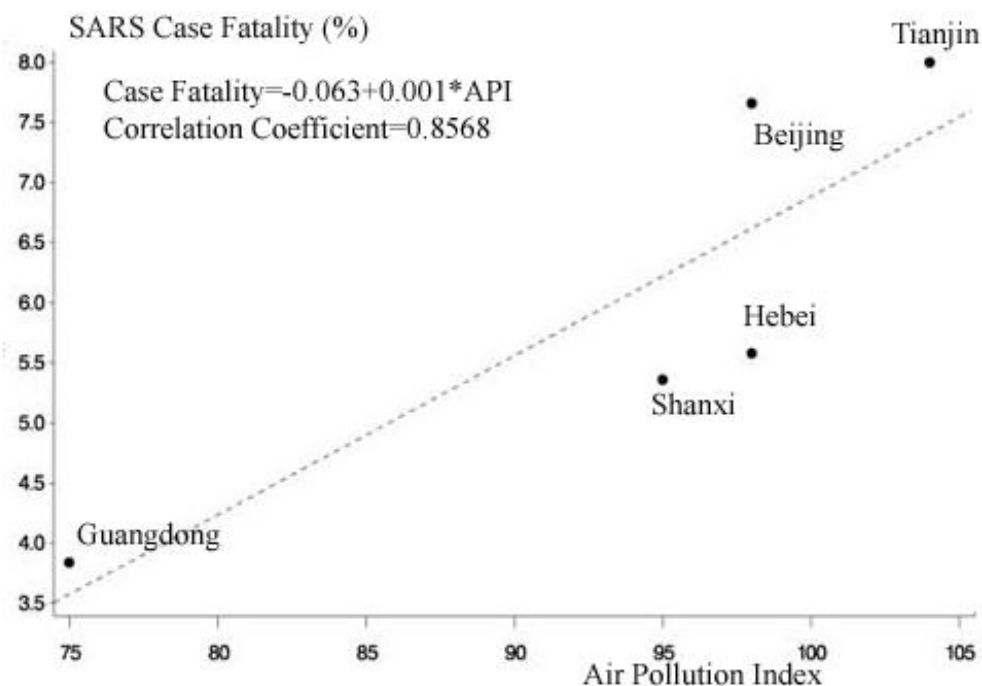


Research

**Open Access**

## **Air pollution and case fatality of SARS in the People's Republic of China: an ecologic study**

Yan Cui<sup>1</sup>, Zuo-Feng Zhang<sup>\*1</sup>, John Froines<sup>2</sup>, Jinkou Zhao<sup>3</sup>, Hua Wang<sup>3</sup>, Shun-Zhang Yu<sup>4</sup> and Roger Detels<sup>1</sup>



The Correlation and Association between Short-term Exposure to Ambient Air Pollution and Case Fatality of SARS in People's Republic of China.



## The role of vitamin D in the prevention of coronavirus disease 2019 infection and mortality

Petre Cristian Ilie<sup>1</sup> · Simina Stefanescu<sup>2</sup> · Lee Smith<sup>3</sup>

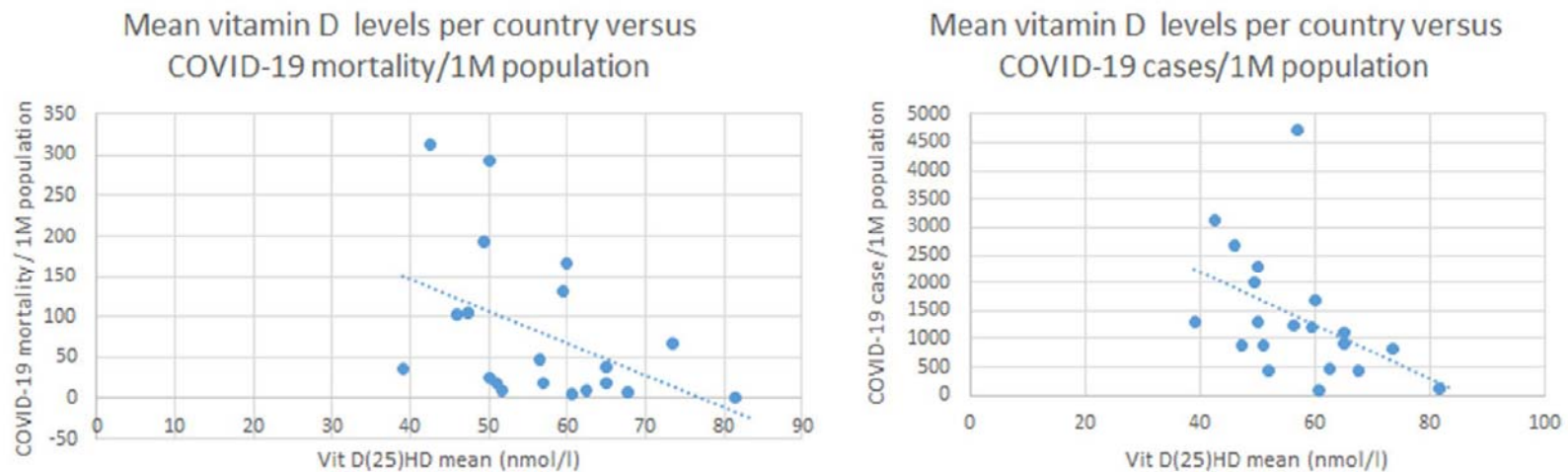


Fig. 1 Mean vitamin D levels per country versus COVID-19 cases and mortality/1M population



# Why do ecologic studies?

- Low cost and convenience
- Some measurements cannot be made on individuals
- Ecologic effects are the main interest (at the population level)
- Simplicity of analyses and presentation
- Often helpful for generating new hypotheses for further research

# Levels of measurement

- Aggregate measures:
  - Means or proportions in groups, derived from individuals in groups (e.g. % smokers in a country)
- Environmental measures:
  - E.g. air pollution level in a country
  - Environmental measure has an analog at the individual level, but not easy to measure
- Global measures:
  - Attributes for groups or places for which there is no individual analog
  - E.g. population density, type of healthcare system, political system in the country

# Units of analysis

- Individual-level analysis:
  - Measurements are available for each individual in the study
- Completely ecologic analysis:
  - All variables (exposure, outcome, covariates) are ecologic, so unit of analysis is the group
- Partially ecologic analysis
- Multi-level analysis
  - Combines data collected at two or more levels

# Limitations of Ecological Studies

- Usually Hypothesis Generating
- Lack of adequate data and missing data
  - May not be recorded a group level
- Confounding is hard to adjust for
- Collinearity
- Temporal Ambiguity
- Ecological Fallacy

# Temporal sequence is not clear

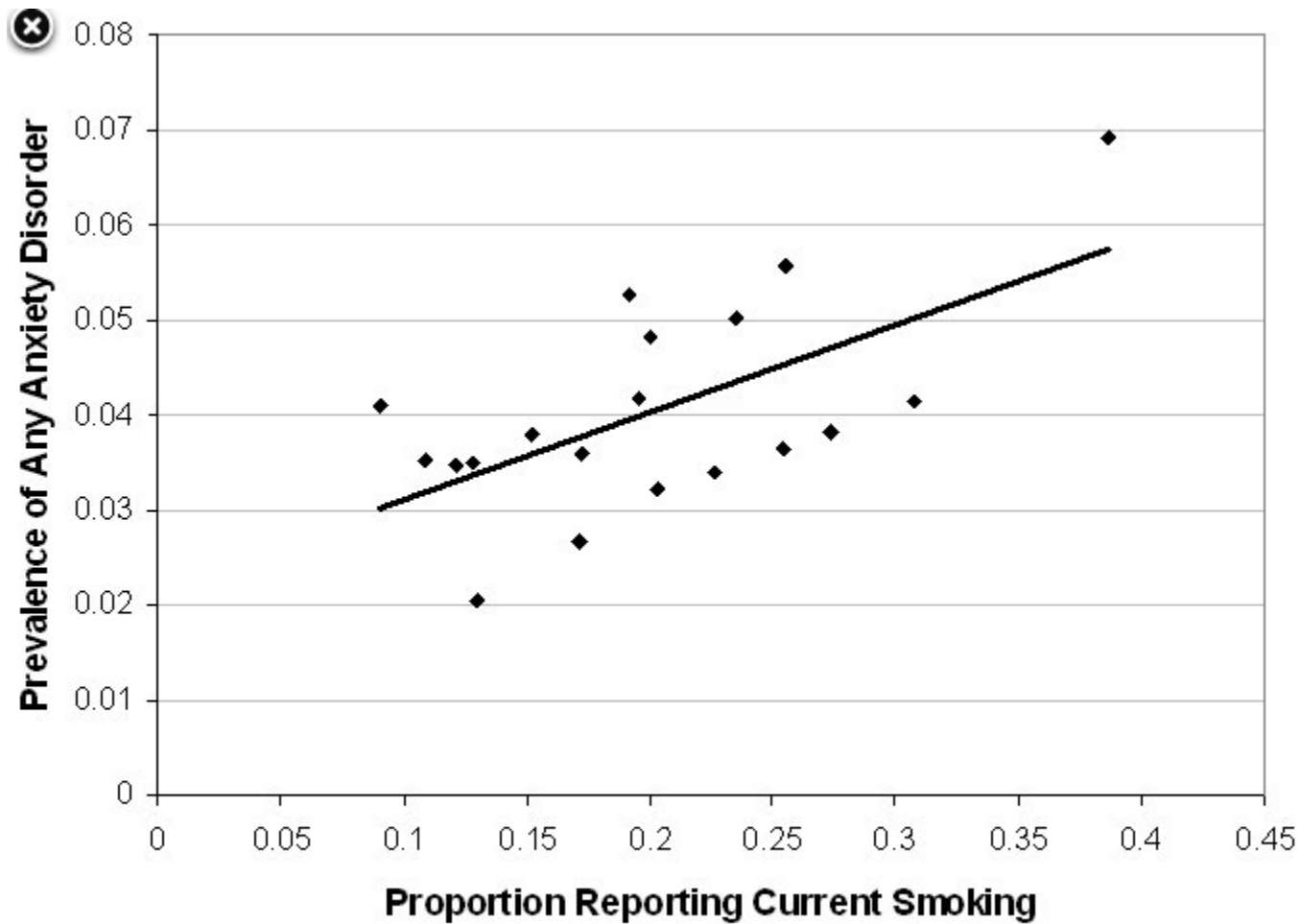


Figure 4: Ecological Analysis: Current Smoking and Anxiety Disorder Prevalence

# Ecologic fallacy: Durkheim's study of suicide in Bavaria

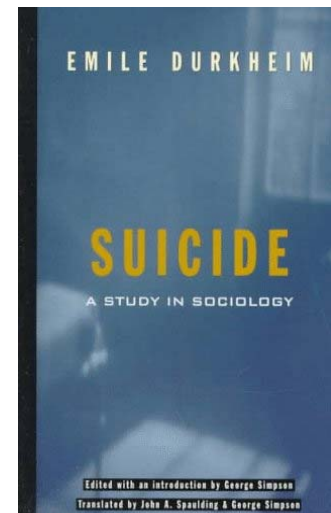
## T H E **B** F I L E S

**Case studies of bias in real life epidemiologic studies**

**Bias File 3. Émile Durkheim and the ecological fallacy**

# Émile Durkheim

- Émile Durkheim (1858 –1917) was a famous French sociologist and pioneer in the development of modern sociology and anthropology.
- In a groundbreaking book published in 1897, entitled *Le Suicide*, Durkheim explored the differing suicide rates among Protestants and Catholics.
- In 19th century Europe, suicide rates were higher in countries that were more heavily Protestant. Durkheim found that suicide rates were highest in provinces that were heavily Protestant.
- He concluded that stronger social control among Catholics resulted in lower suicide rates.
- However, Durkheim's study of suicide was criticized as an example of the logical error termed the "ecological fallacy."



# Ecological fallacy

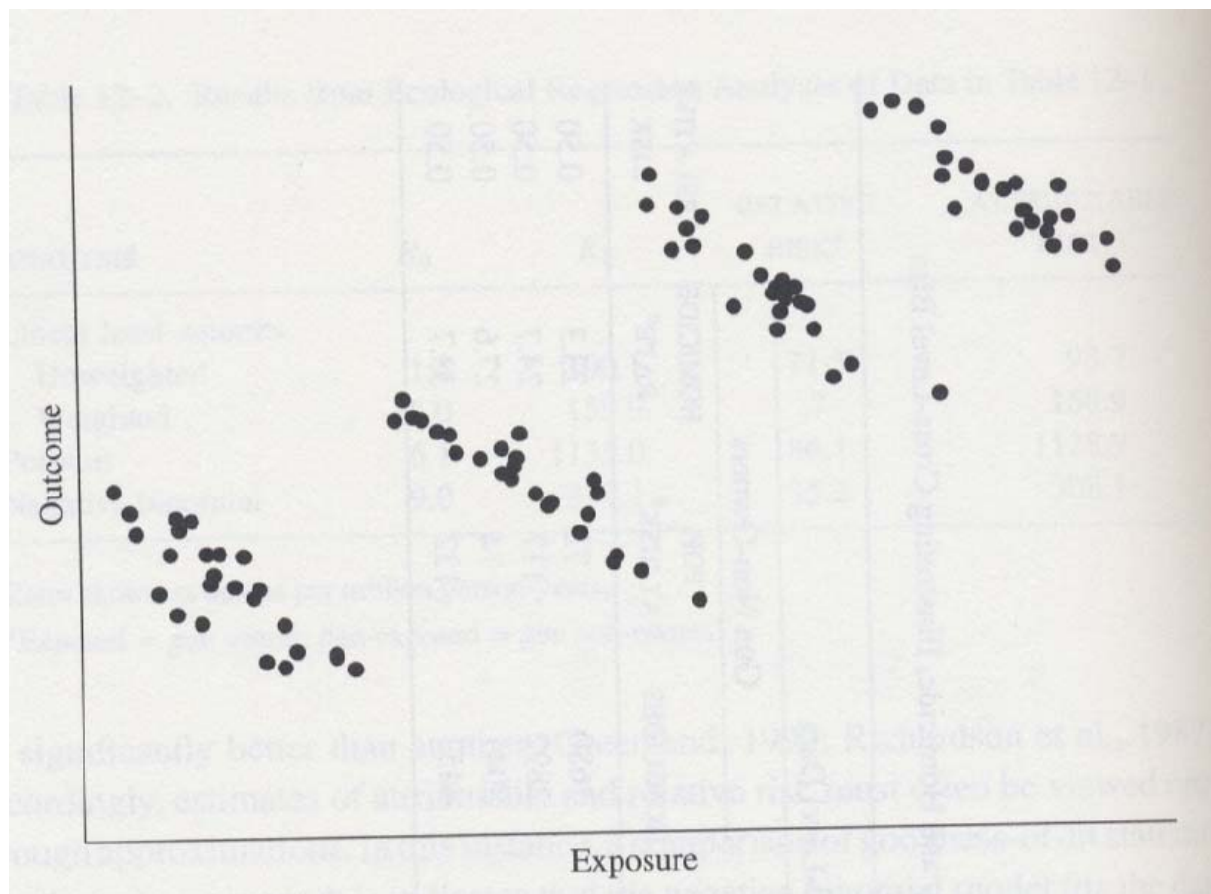
- Ecological fallacy arises from thinking that relationships observed for groups necessarily hold for individuals: if provinces with more Protestants tend to have higher suicide rates, then Protestants must be more likely to commit suicide; if countries with more fat in the diet have higher rates of breast cancer, then women who eat fatty foods must be more likely to get breast cancer.
- Such inferences made using group-level data may not always be correct at the individual level.
- For example, associations seen using country-level data may not correlate with associations that exist at the individual or neighborhood-level.



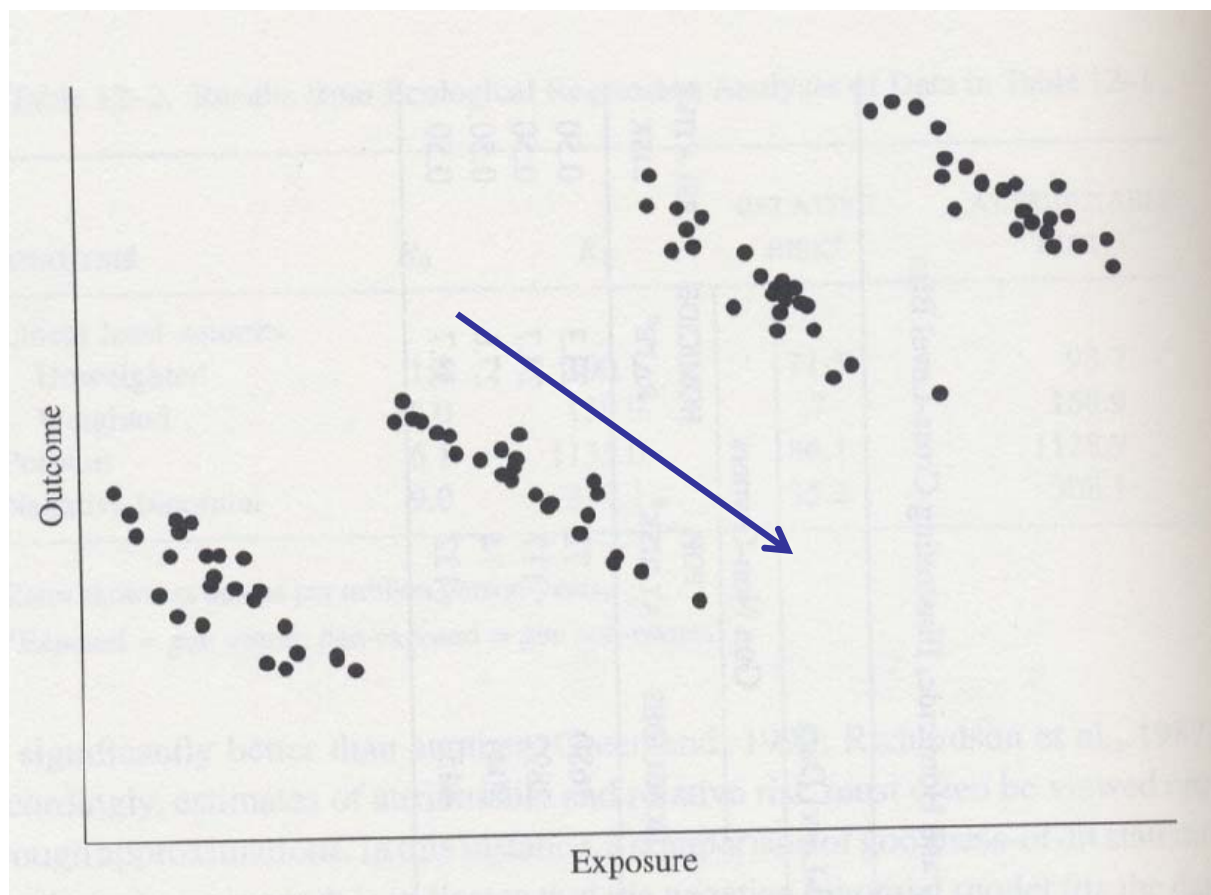
# Control of confounding

- Always a concern
  - E.g. BCG and Covid-19
    - Age structure across countries
    - Other vaccines given
    - Testing rate variability
- You don't often have data on confounders
- Even if we adjust for confounding at the group level, it can still be an issue at the individual level

# Aggregation Bias

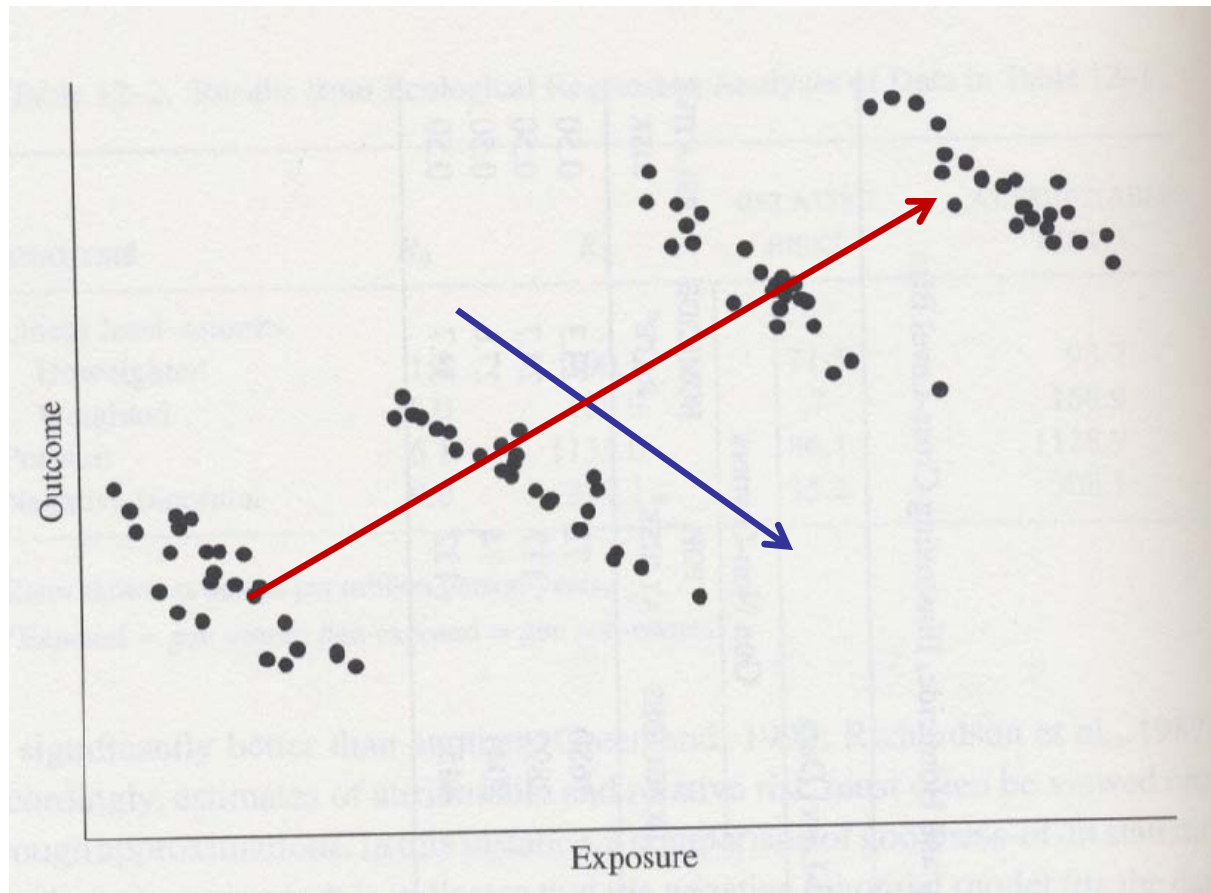


# Aggregation Bias



Correlation **negative** at individual level

# Aggregation Bias



Correlation **negative** at individual level but **positive** at group level

Koepsell and Weiss Epidemiologic Methods 2003

# Key issues with ecologic Studies

- Explores correlations between aggregate (group level) exposure and outcomes
- Unit of analysis: usually not individual, but clusters (e.g. countries, counties, schools)
- Useful for generating hypothesis
- Prone to “ecological fallacy”
- Cannot adjust well for confounding due to lack of comparability (due to lack of data on all potential covariates)
- Missing data is another concern

