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Confounders as Mathematical Objects

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Paper 2006SchieldBurnhamMAA.pdf

Slides 2006SchieldBurnhamMAA6up.pdf

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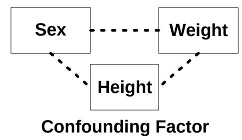
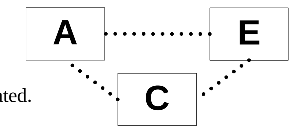
Confounding: Can Cause Variation

Observational studies: associations often *confounded*



E is Effect of interest
A is Associated predictor
C is confounder



Confounding not chance-related.

As sample size increases,

* margin of error (influence of chance) decreases,

* influence of confounder is unchanged.

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Confounder Resistance: Rules of Thumb

Sir Richard Doll: No single study is persuasive unless the lower limit of its 95% confidence level falls above a **threefold** increased risk.

“As a general rule of thumb,” says Angell of the New England Journal, “we are looking for a relative risk of **three or more”** before accepting a paper.

Robert Temple, FDA Director of Drug Evaluation, puts it bluntly: "My basic rule is if the relative risk isn't at least **three or four**, forget it."

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Problem of Confounding in Epidemiology

John Bailar, epidemiologist: “*There is no reliable way of identifying the dividing line*.”

Epidemiologists need an abstract description of confounding that can generate confounder significance and confounder intervals for Relative Risk. RP(E:C) = P(E|C) / RP(E|~C)

This description must handle binary data, be meaningful, useful and easy to understand.

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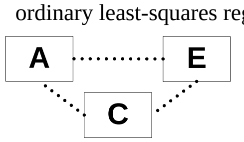
Modeling Spuriosity: *A* has “no effect” on *E*

Model relation between 3 binary variables using an ordinary least-squares regression model:



E is Effect of interest
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Non-Interactive model: E(A,C) = bo + b1*A + b2*C

Association between A and E is **spurious** if **b1 = 0.**

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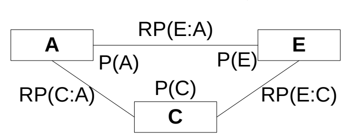
Simplifying: Defining an S Confounder

A, C and E are binary. Top three ratios are observed. Confounder is defined by the bottom three ratios.



$$RP(E:A) = \frac{P(E|A)}{P(E|\sim A)}$$

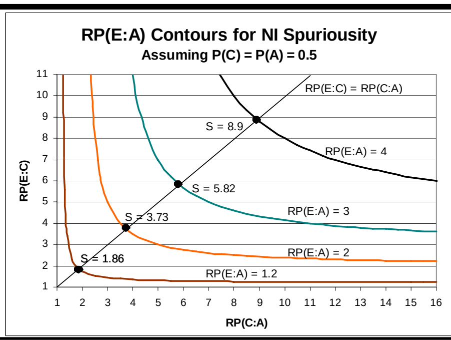
$$RP(E:C) = \frac{P(E|C)}{P(E|\sim C)}$$

$$RP(A:C) = \frac{P(A|C)}{P(A|\sim C)}$$

Definition: An “**S confounder**” is a binary confounder with P(C:A) = RP(E:C) = S. P(C) = P(A).

An association is “confounder resistant” to a size S confounder if it withstands nullification.

Spuriousity Contours



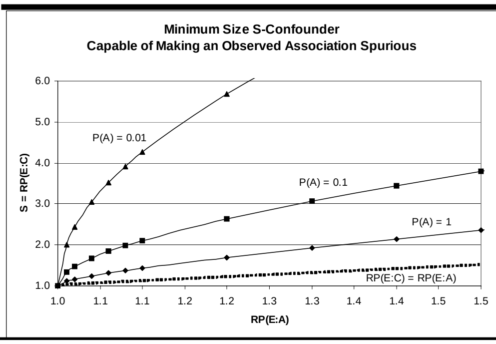
S Confounder Needed to Nullify Relative Risk

Given an observed association, RP(E:A), and a predictor prevalence, P(A), determine the size of the S confounder needed for nullification.

$$\frac{S-1}{[RP(E:A)-1]} = 1 + \sqrt{1 + \frac{1}{P(A)[RP(E:A)-1]}}$$

If P(A) = 0.5 and S = 5, then RP(E:A) = 2.6.
If P(A) = 0.4 and S = 6, then RP(E:A) = 3.1

S Confounder Needed to Nullify a Relative Risk



Confounder Intervals: Influence of S Confounder

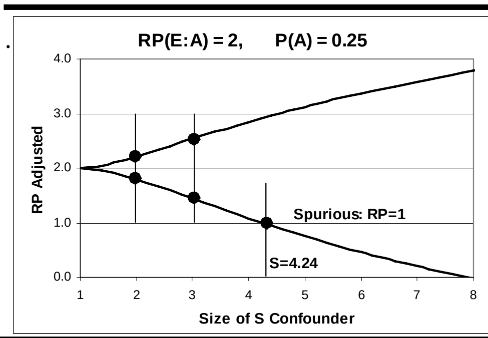
Lower limit: determined by removing the influence of a confounder where RP(C:A) = RP(E:C) = S.

Upper limit: determined by removing the influence of a confounder where RP(C:A) = 1/RP(E:C) = 1/S.

Given the size of an S confounder, the confounder influence can be determined algebraically and illustrated using a standardization diagram.

For a S confounder of size 2, the confounder interval for RP(E:A) = 2 with P(A) = 0.5 is [1.67, 3.0].

S Confounder Intervals



Recommendations

Review/critique Schield & Burnham (2006) MAA paper: *Confounders as Mathematical Objects.* Copy at www.StatLit.org/pdf/2006SchieldBurnhamMAA.pdf

This 26 page paper is dense: 150 equations with new concepts and new ratio-comparison notation.

In-depth reviews will be acknowledged in the final paper.

If published, this paper will help make confounding a mathematical object. This could open up an entirely new area for statistics and statistical education.