

What role for meta-analysis in plant health risk assessment?

David Makowski

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Meta-analysis

« The analysis of analyses »

« The statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings »

« Systematic review + statistical analysis »

Dictionary of epidemiology, 2001; Chalmers et al., 2002; Glass, 1976; Koricheva et al., 2013

Karl Pearson, 1904, about the effect of a vaccine against typhoid

Inoculation Against Enteric Fever

Correlation Between Immunity and Inoculation

I.	Hospital staffs	+0.373	± 0.021
II.	Ladysmith garrison	+0.445	± 0.017
III.	Methuen's column	+0.191	± 0.026
IV.	Single regiments	+0.021	± 0.033
V.	Army in India	+0.100	± 0.013
	Mean value	+0.226	

Correlation Between Mortality and Inoculation

VI.	Hospital staffs	+0.307	± 0.128
VII.	Ladysmith garrison	-0.010	± 0.081
VIII.	Methuen's column	+0.300	± 0.093
IX.	Single regiments	+0.119	± 0.022
X.	Various military hospitals	+0.194	± 0.022
XI.	Army in India	+0.248	± 0.050
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Why Most Published Research Findings Are False

John P. A. Ioannidis

PLoS Medicine, 2005

However, there are several approaches to improve the post-study probability.

Better powered evidence, e.g., large studies or low-bias meta-analyses, may help, as it comes closer to the

« We gather and summarize the best evidence from research to help you make informed choices about treatment. »

Most popular Cochrane evidence:

- 1 Gabapentin for chronic neuropathic pain and fibromyalgia in adults
- 2 Prescribing roles for health professionals other than doctors New
- 3 Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases
- 4 Early skin-to-skin contact for mothers and their healthy newborn infants Updated
- 5 Amitriptyline for neuropathic pain in adults
- 6 Vaccines to prevent influenza in healthy adults
- 7 Vitamin E supplementation in pregnancy
- 8 T-tube drainage versus no T-tube drainage after open common bile duct exploration
- 9 Corticosteroids for bacterial meningitis
- 10 Weaning from mechanical ventilation using pressure support or a T-tube for a spontaneous breathing trial

Effect of longer-term modest salt reduction on blood pressure

[New search](#) [Conclusions changed](#) [Review](#) [Intervention](#)

Feng J He , Jiafu Li, Graham A MacGregor

Thirty-four trials (3230 participants) were included.

Authors' conclusions:

« A modest reduction in salt intake for 4 or more weeks causes significant [...] falls in blood pressure. »



The Cochrane Collaboration is an enterprise that rivals the Human Genome Project in its potential implications for modern medicine."

- The Lancet

Benefits for risk analysis

- Lower bias
- Higher accuracy
- Higher statistical power

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... but high cost.

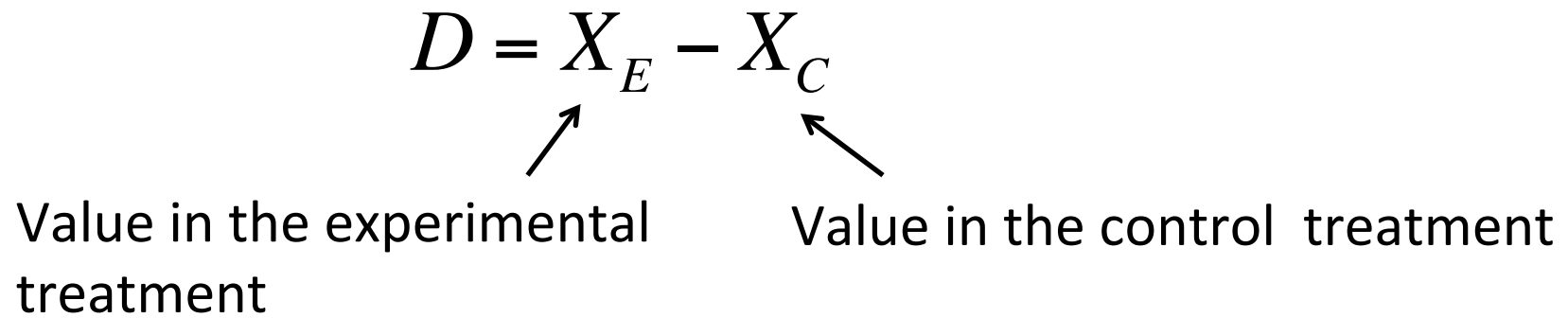
Main steps of a meta-analysis

- Definition of the objective
- Systematic review
- Data selection and extraction
- Statistical analysis
- Assessment of risk of publication bias and sensitivity analysis
- Presentation of results and of associated uncertainties

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Effect size

$$D = X_E - X_C$$
The diagram shows the formula $D = X_E - X_C$ centered on the page. Below the formula, there are two lines of text. The first line, "Value in the experimental treatment", has an arrow pointing from it to the X_E term in the formula. The second line, "Value in the control treatment", has an arrow pointing from it to the X_C term in the formula.

Value in the experimental
treatment

Value in the control treatment

Effect size

$$R = \frac{X_E}{X_C}$$

Value in the experimental treatment

Value in the control treatment

The diagram illustrates the formula for effect size R . It consists of the equation $R = \frac{X_E}{X_C}$ centered on the page. To the right of the equation, there are two text labels with arrows pointing to the variables in the formula. The label 'Value in the experimental treatment' has an arrow pointing to the numerator X_E . The label 'Value in the control treatment' has an arrow pointing to the denominator X_C .

A Meta-Analysis of the Impact of Anaerobic Soil Disinfestation on Pest Suppression and Yield of Horticultural Crops

*Utsala Shrestha, Robert M. Augé and David M. Butler**

Effect size

$$R = \frac{X_E}{X_C}$$

The diagram illustrates the components of the effect size formula $R = \frac{X_E}{X_C}$. An arrow points from the text "Yield after anaerobic soil disinfestation" to the numerator X_E . Another arrow points from the text "Yield in the control (no disinfestation)" to the denominator X_C .

Yield after anaerobic soil disinfestation

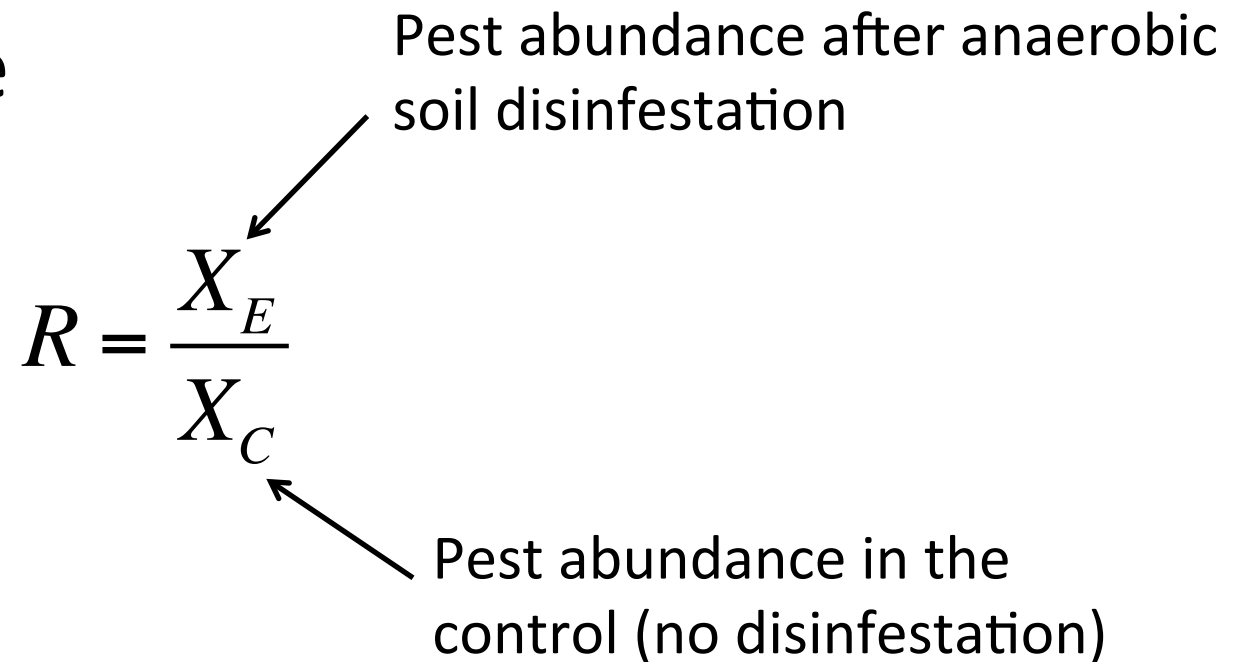
Yield in the control (no disinfestation)

Effect size

$$R = \frac{X_E}{X_C}$$

Pest abundance after anaerobic
soil disinfestation

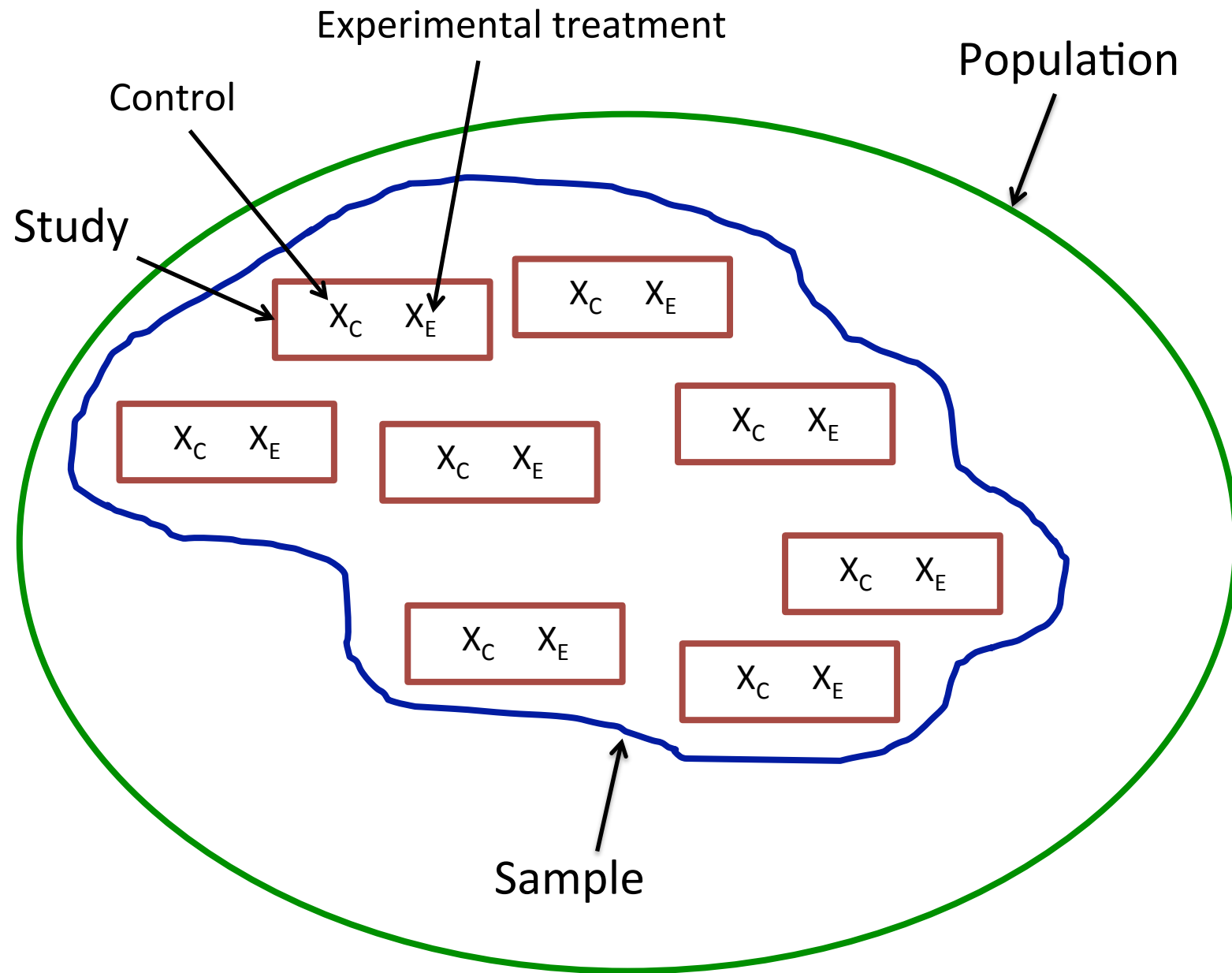
Pest abundance in the
control (no disinfestation)



- Pathogens (bacteria, fungi, oomycetes)
- Nematodes
- Weeds

Main steps of a meta-analysis

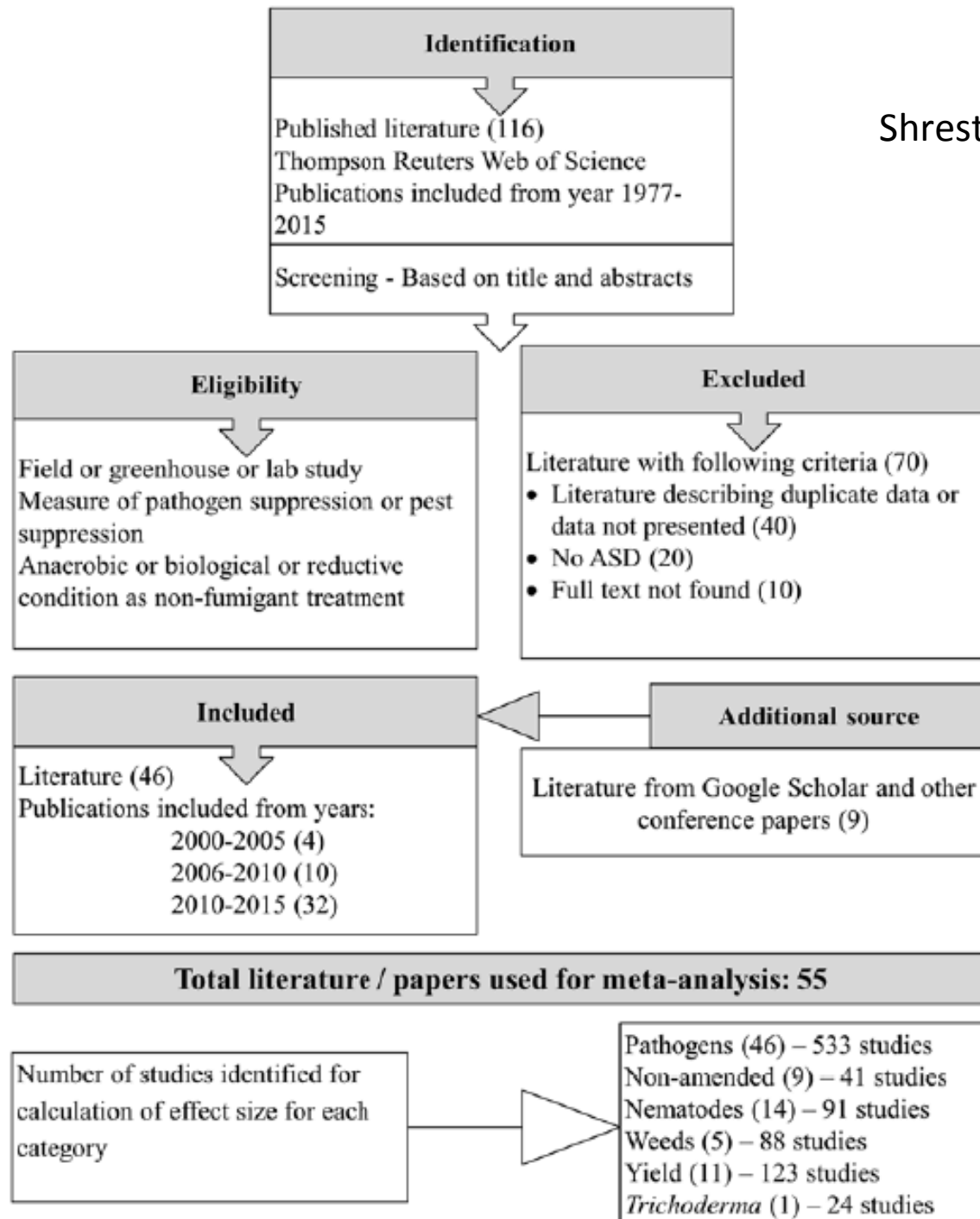
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Shrestha et al. (2016)

116 papers

46 papers



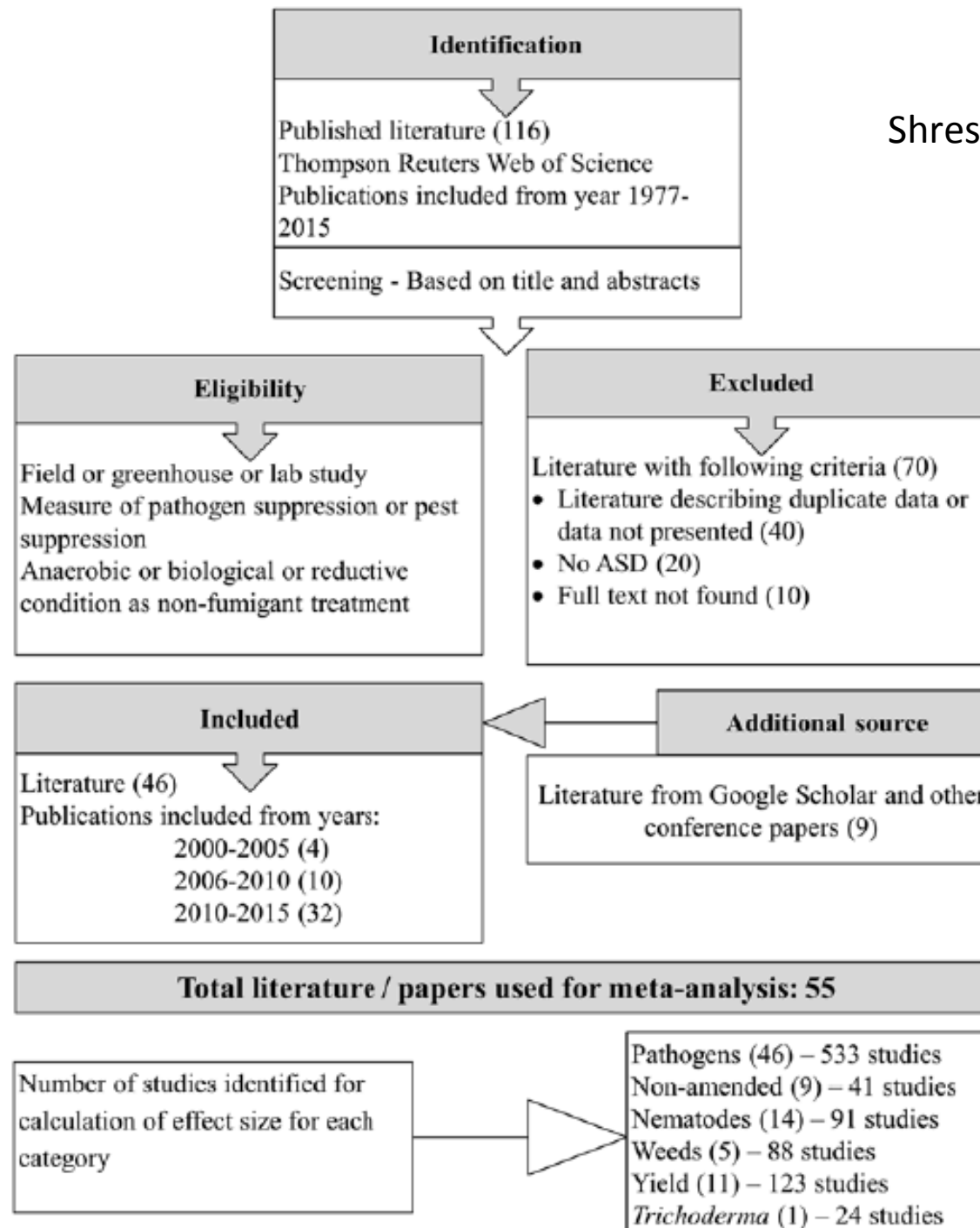
Shrestha et al. (2016)

116 papers



46 papers

55 papers



+9 papers

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WebPlotDigitizer

Web based tool to extract data from plots, images, and maps

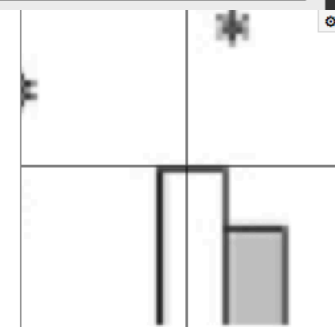
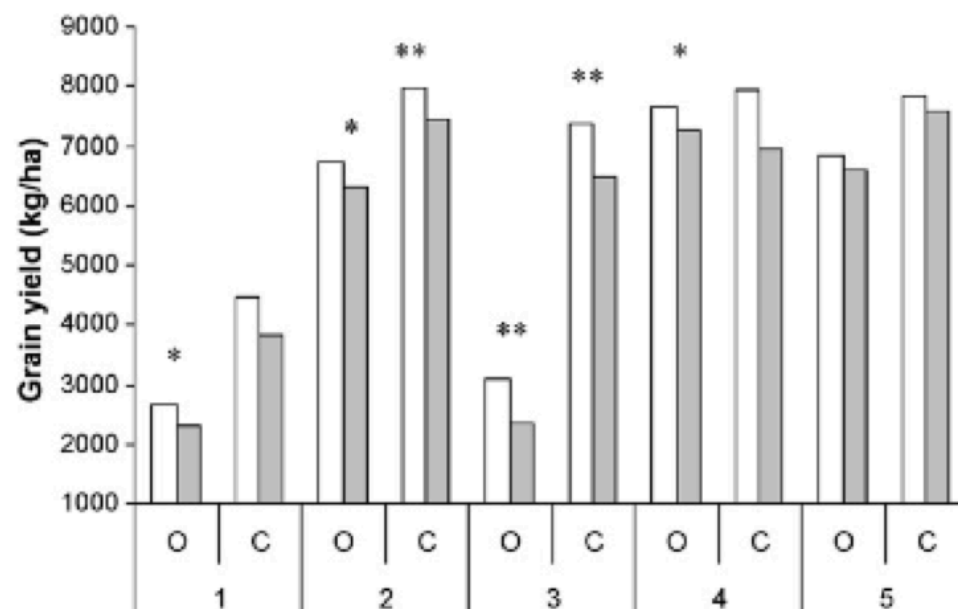
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File Axes Data Analyze Help

+ - 100% Fit



[294.71, 43.12]

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Web based tool to extract data from plots, images, and maps

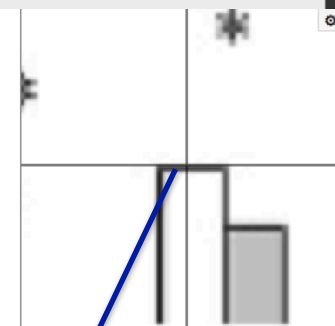
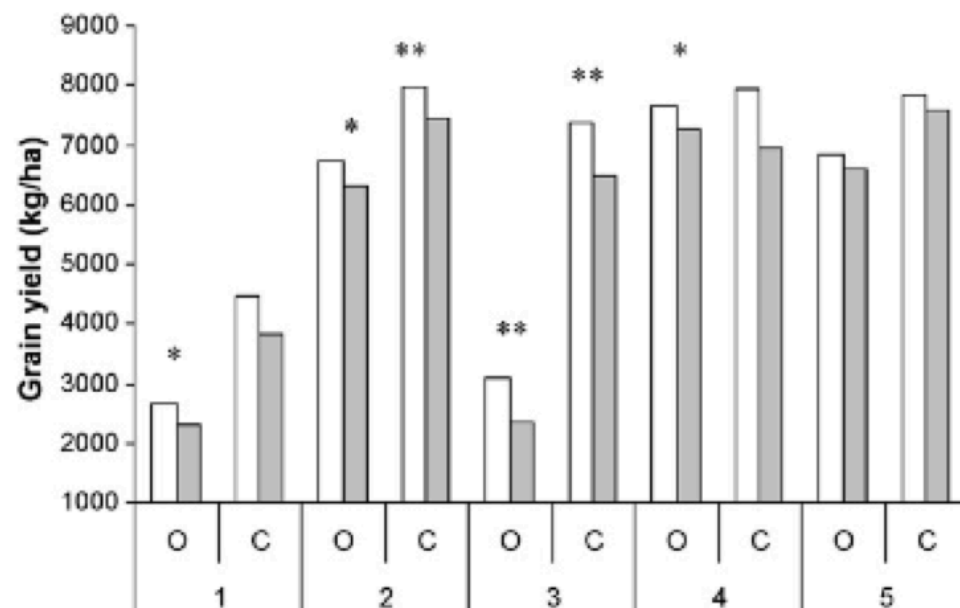
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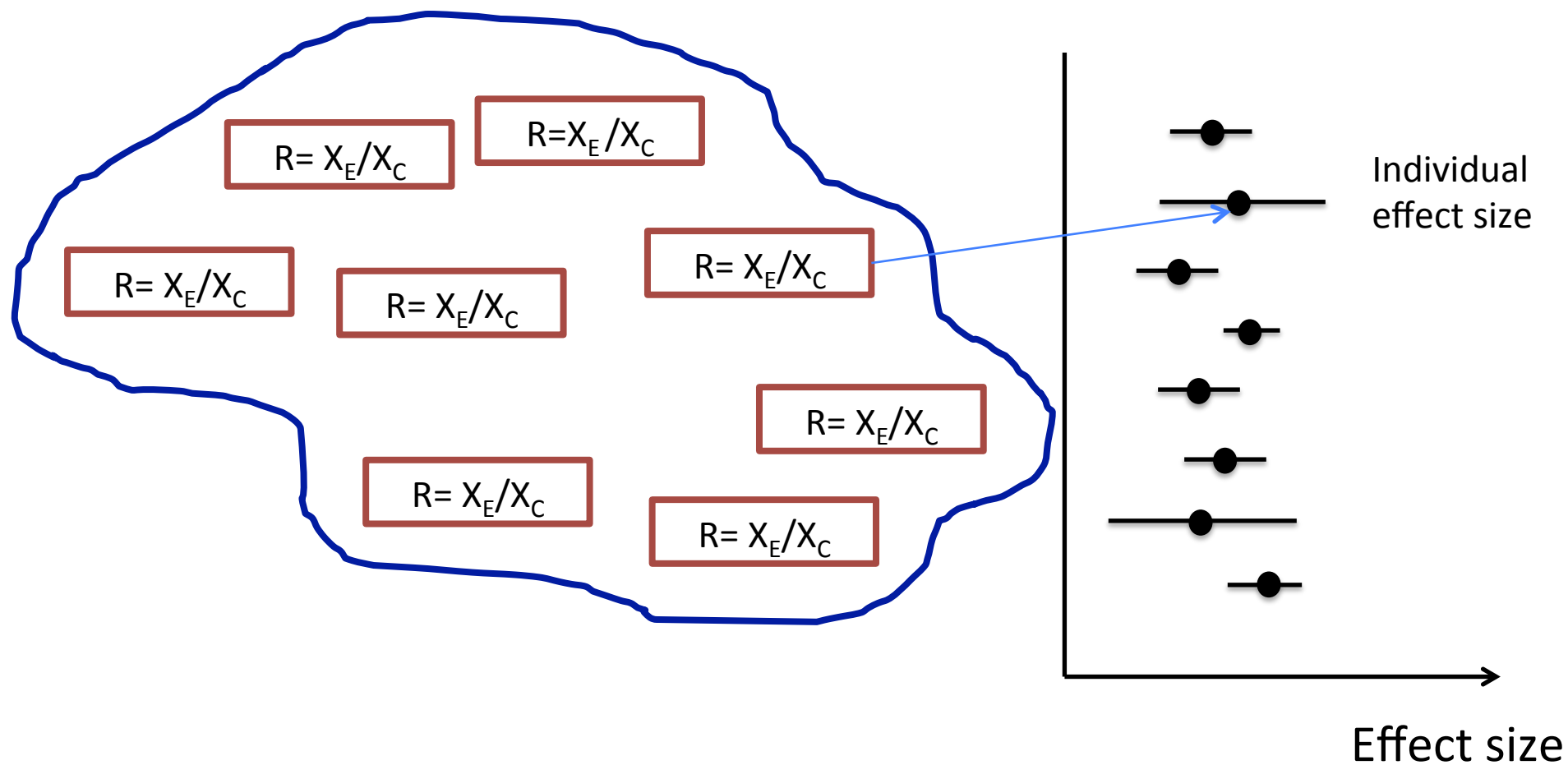
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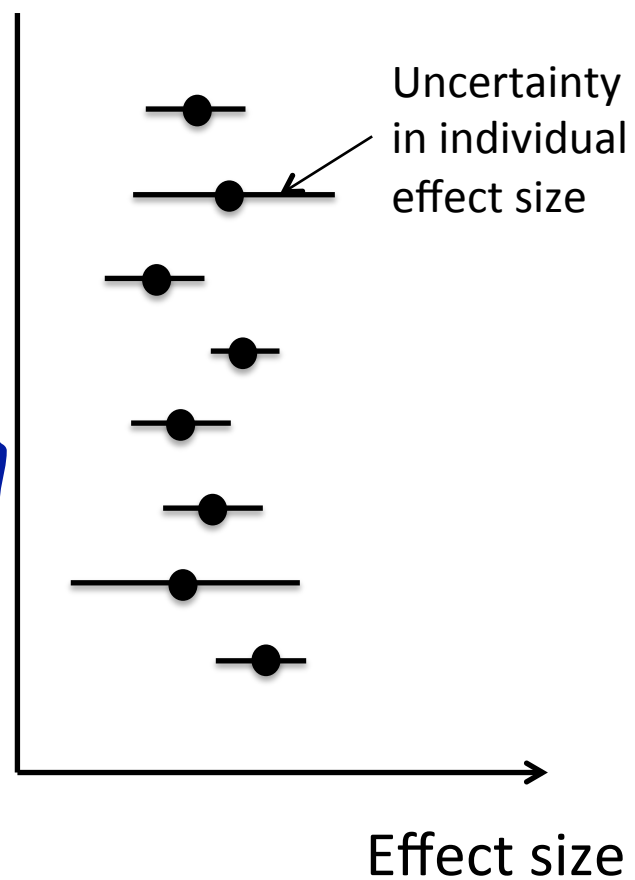
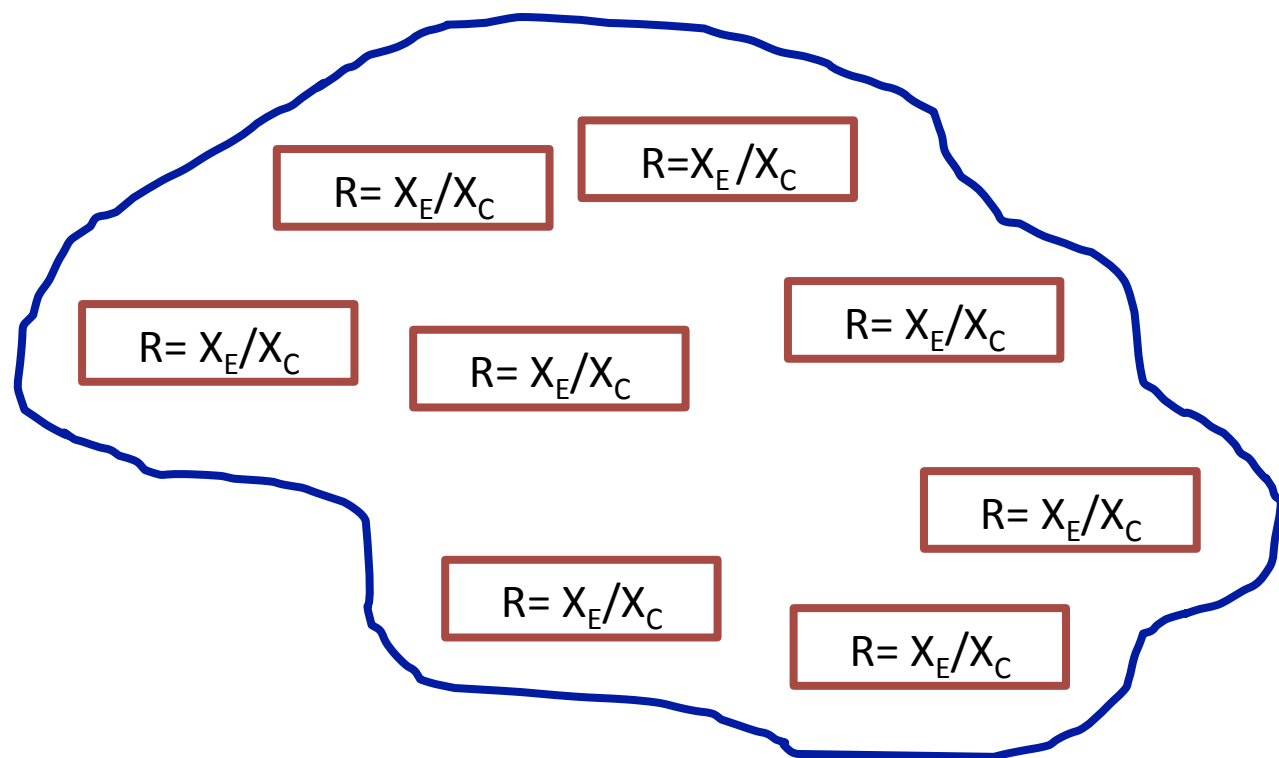
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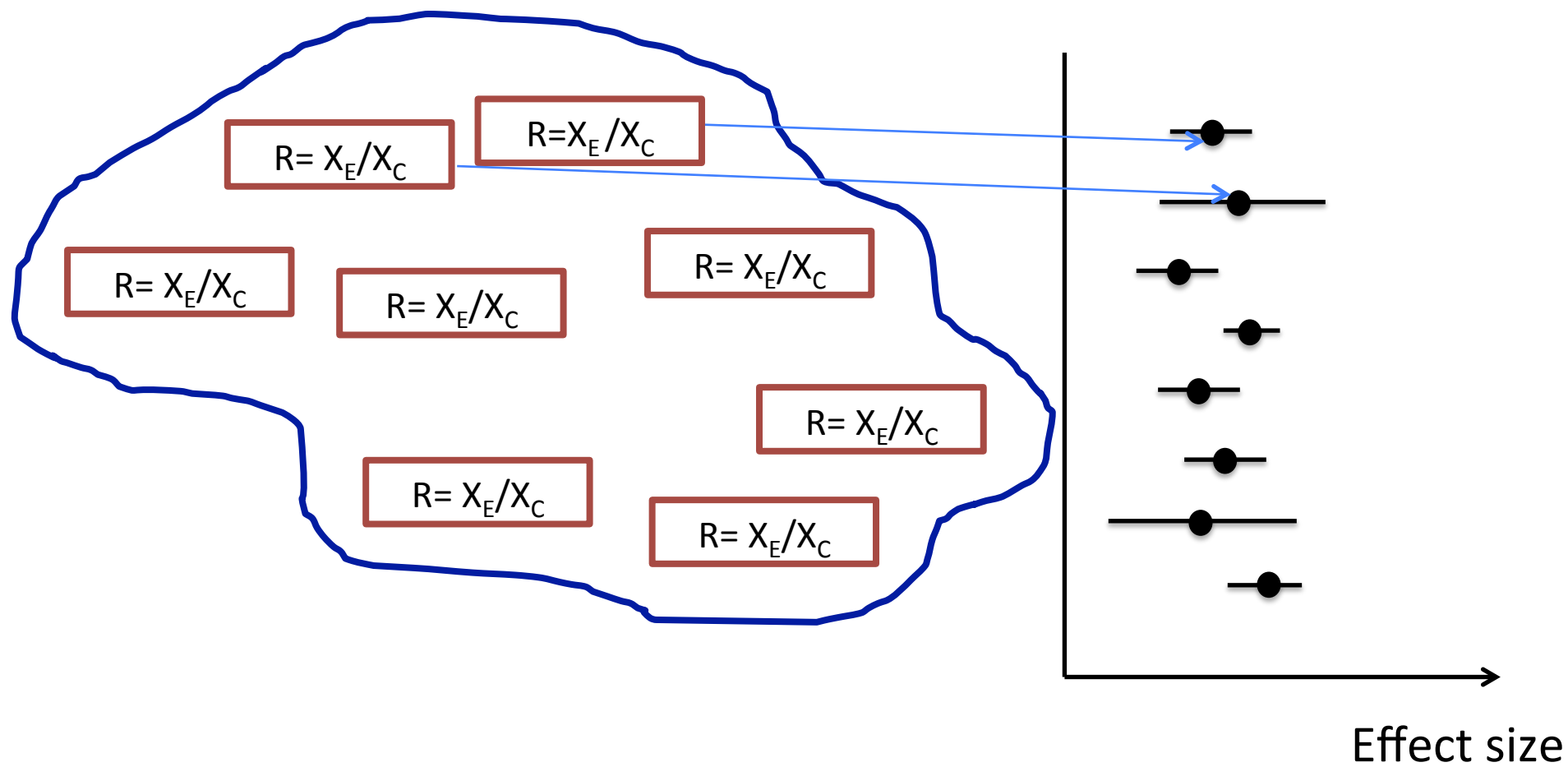


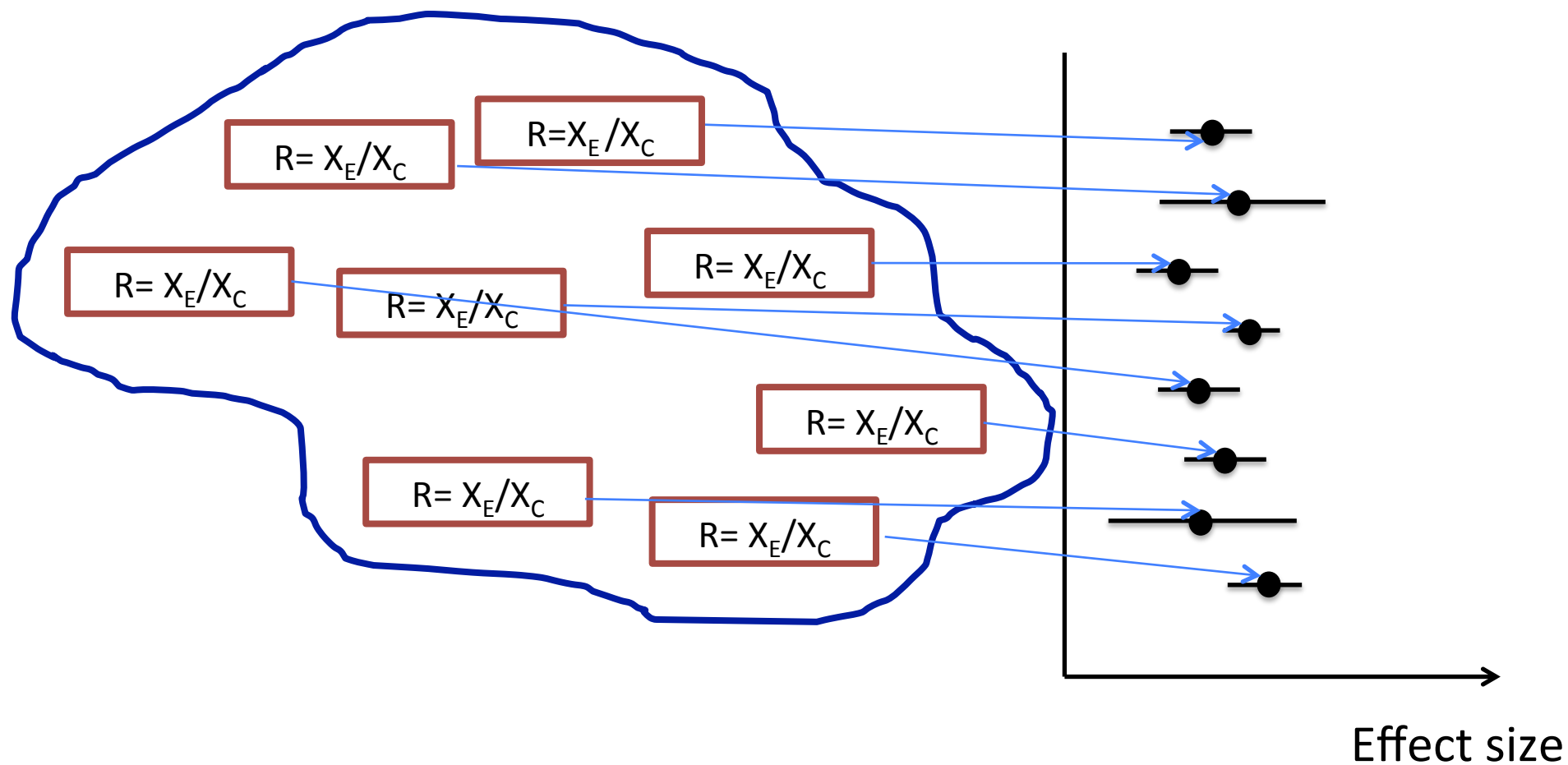
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DATASET



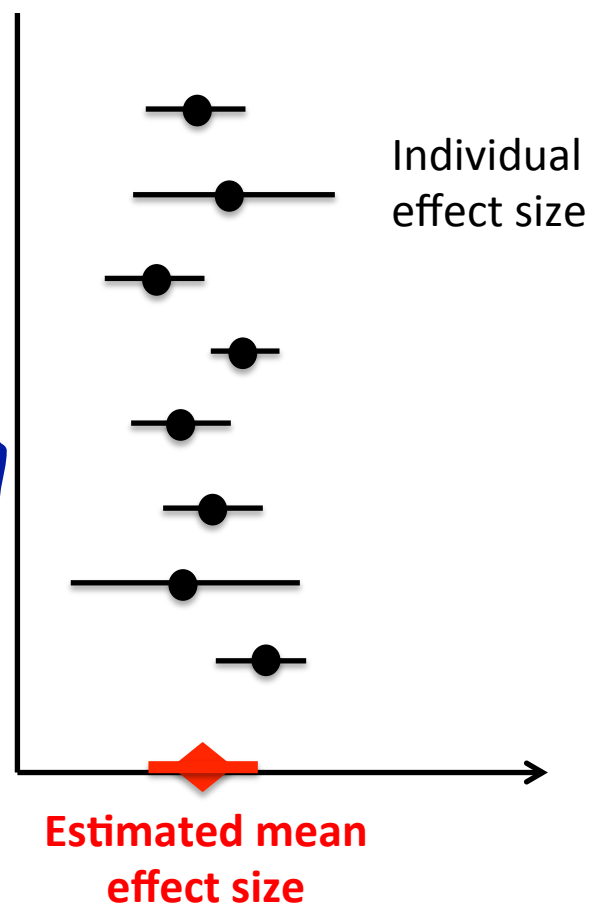
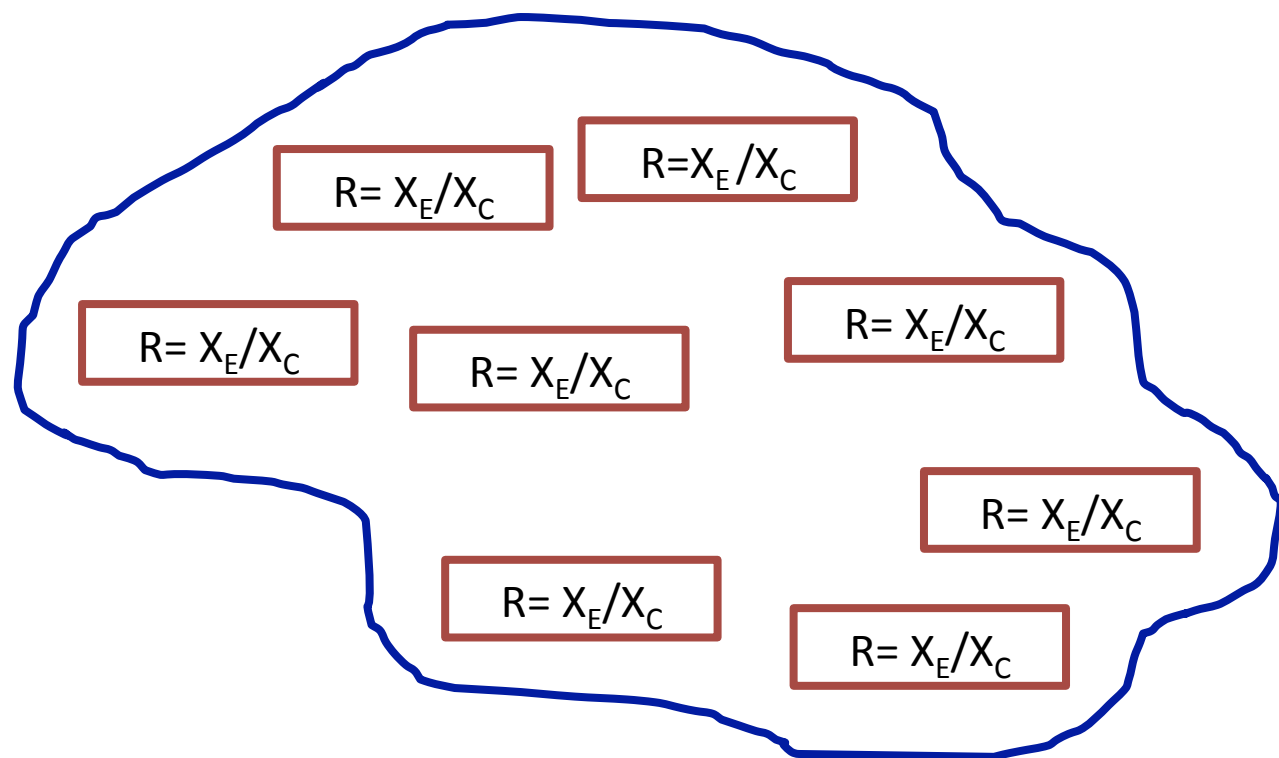






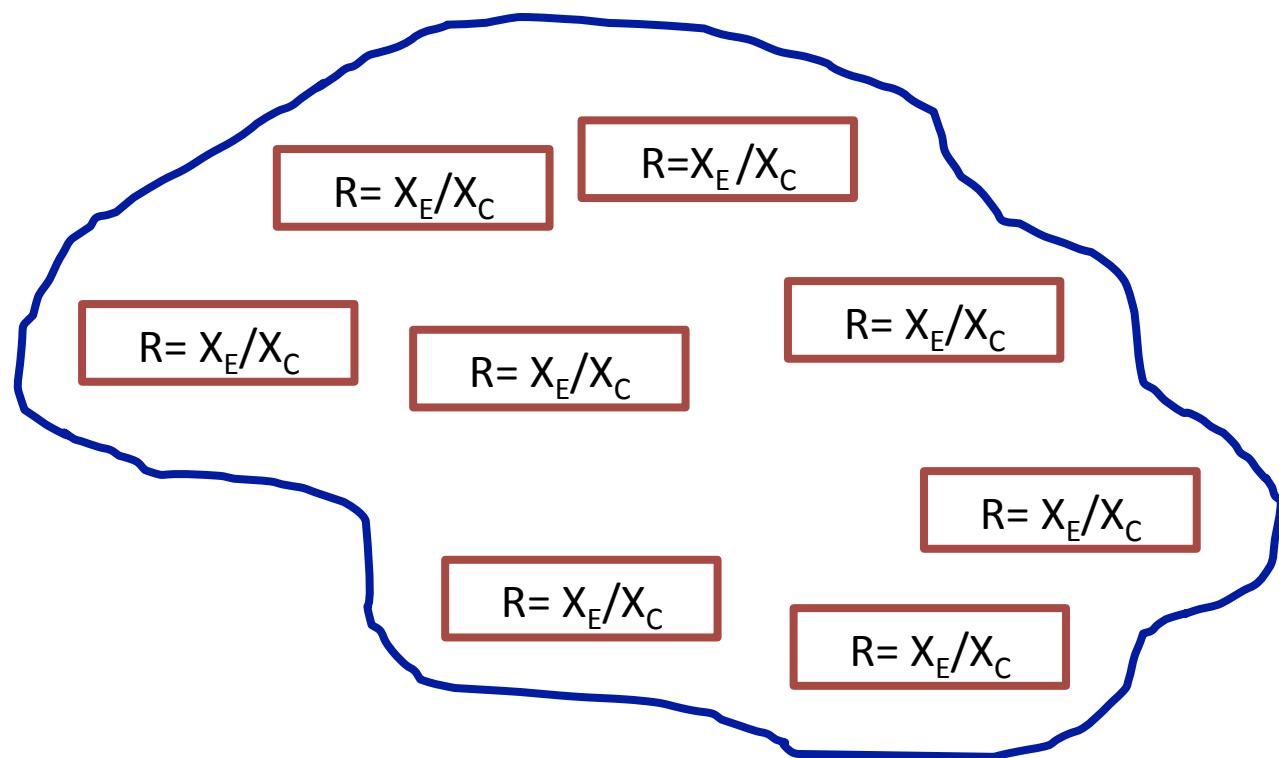
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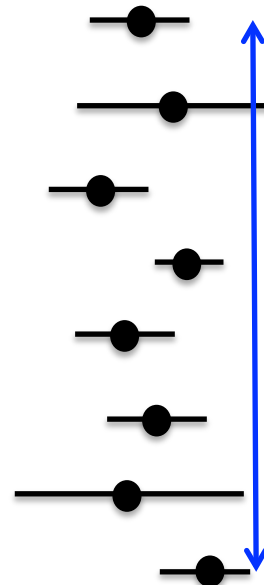


Several methods

- Fixed-effect models
- Random-effect models
- Bayesian methods



Within-study variability

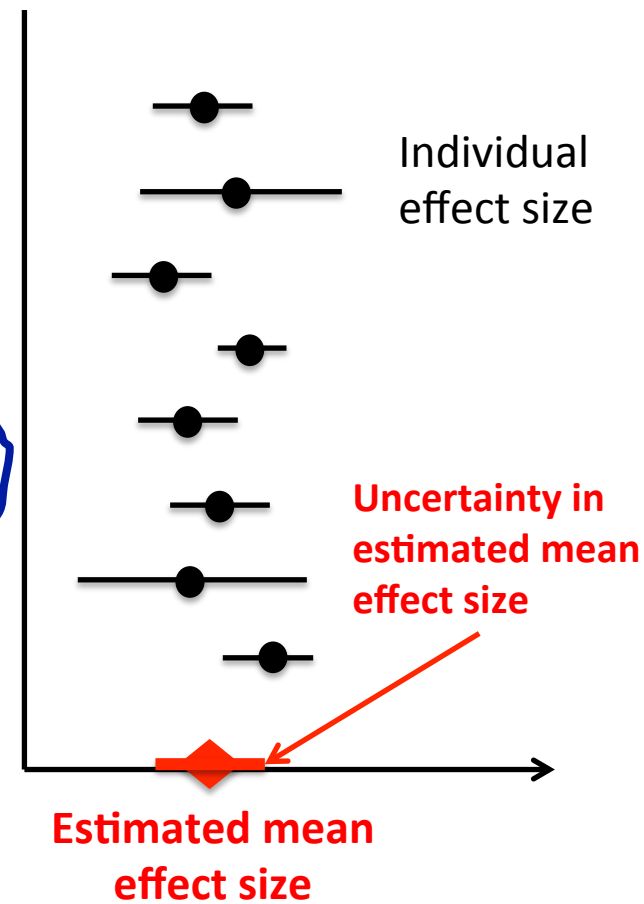
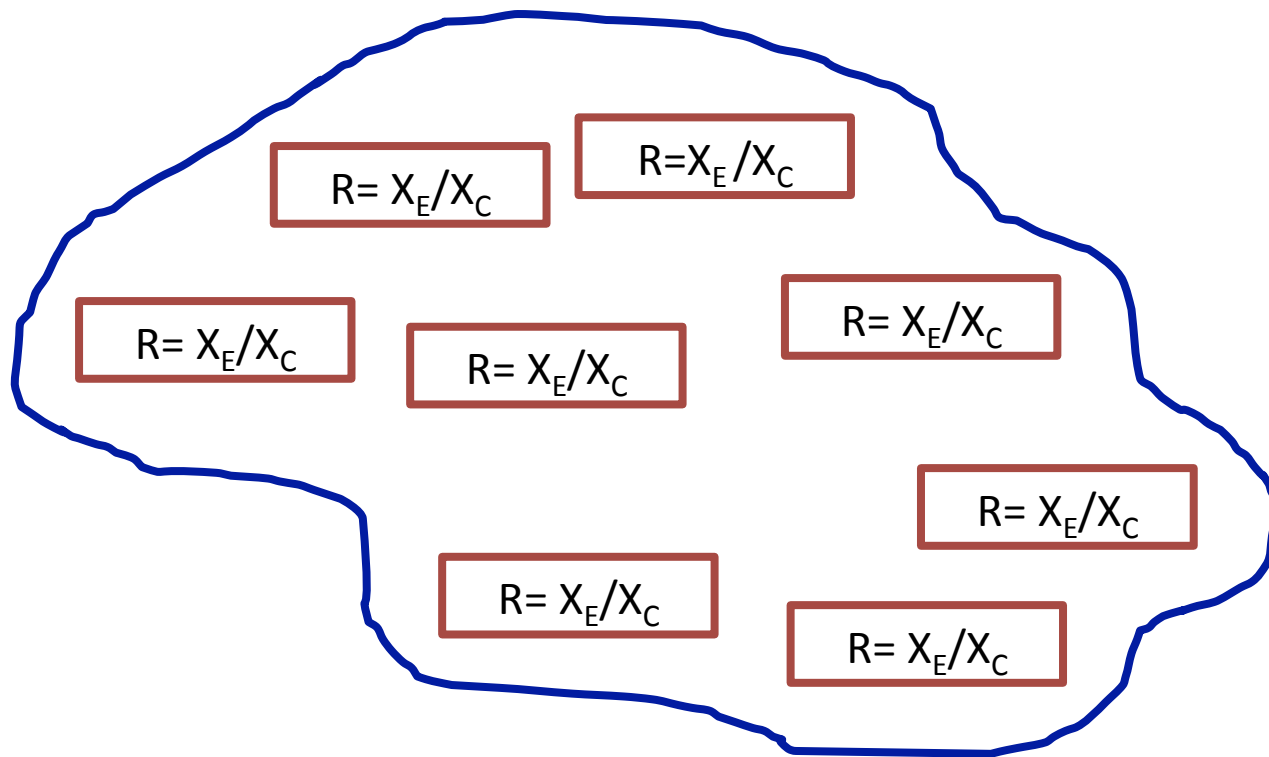


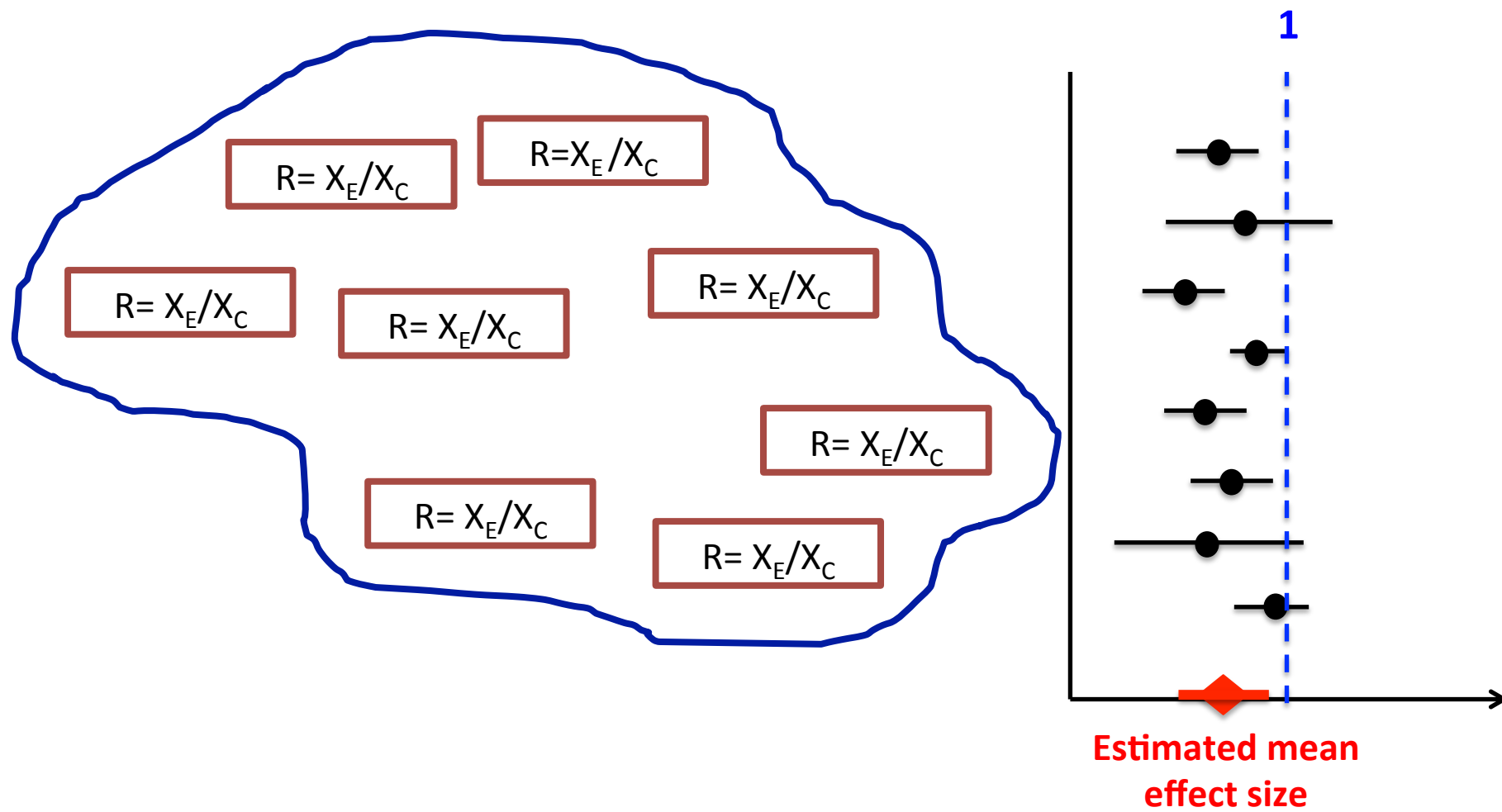
Between-study variability

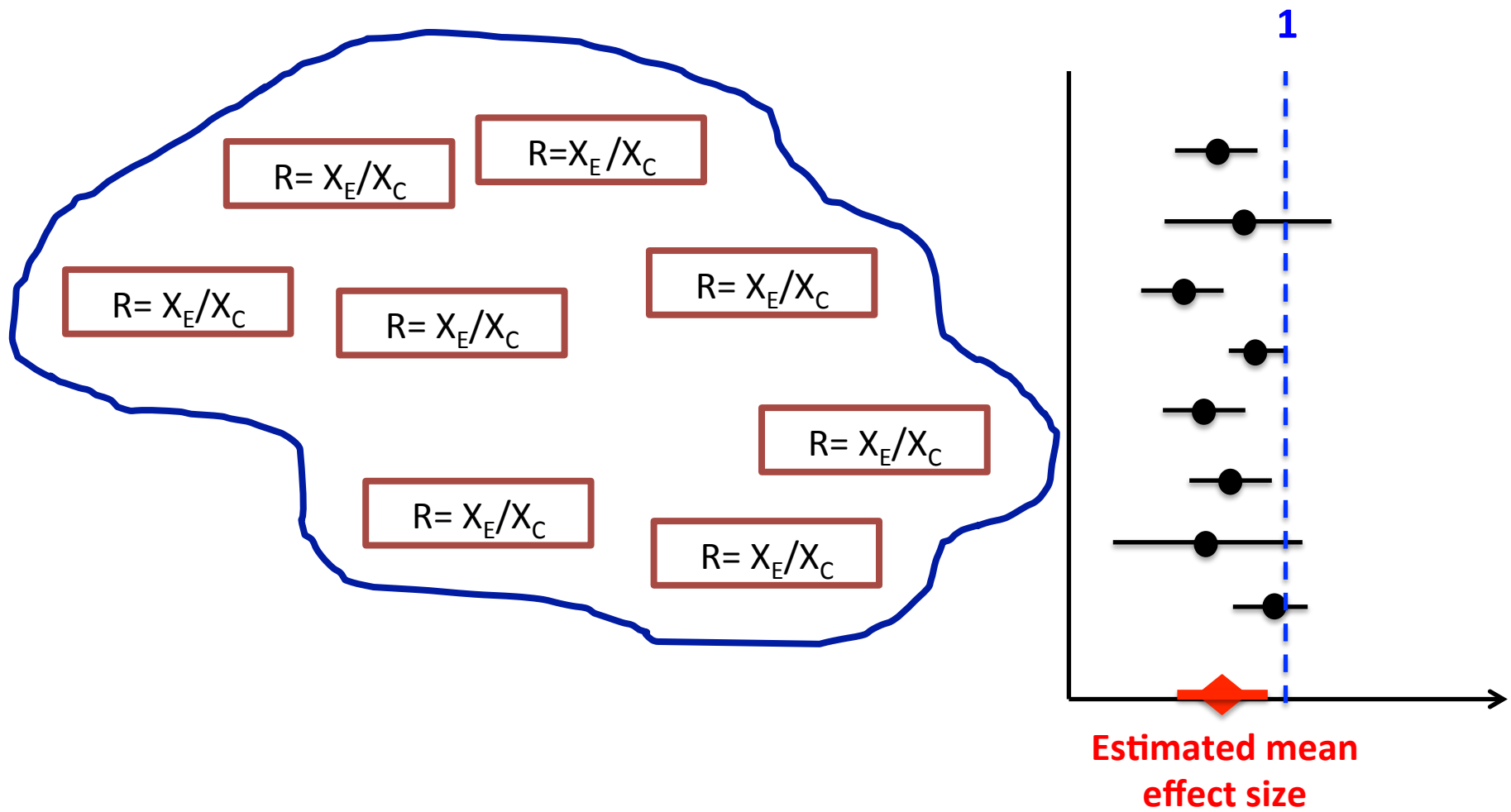


Estimated mean
effect size

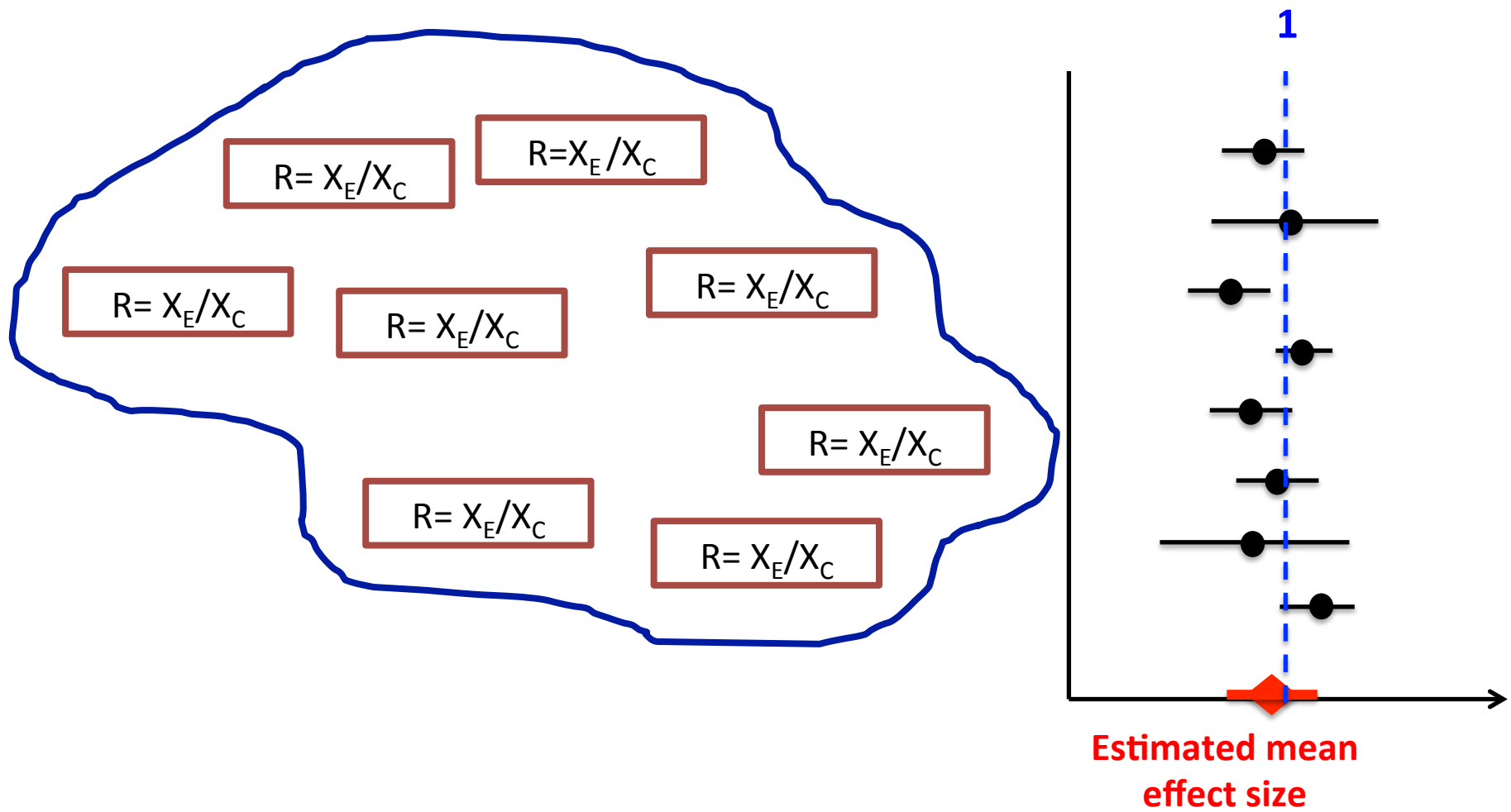








Evidence of effectiveness



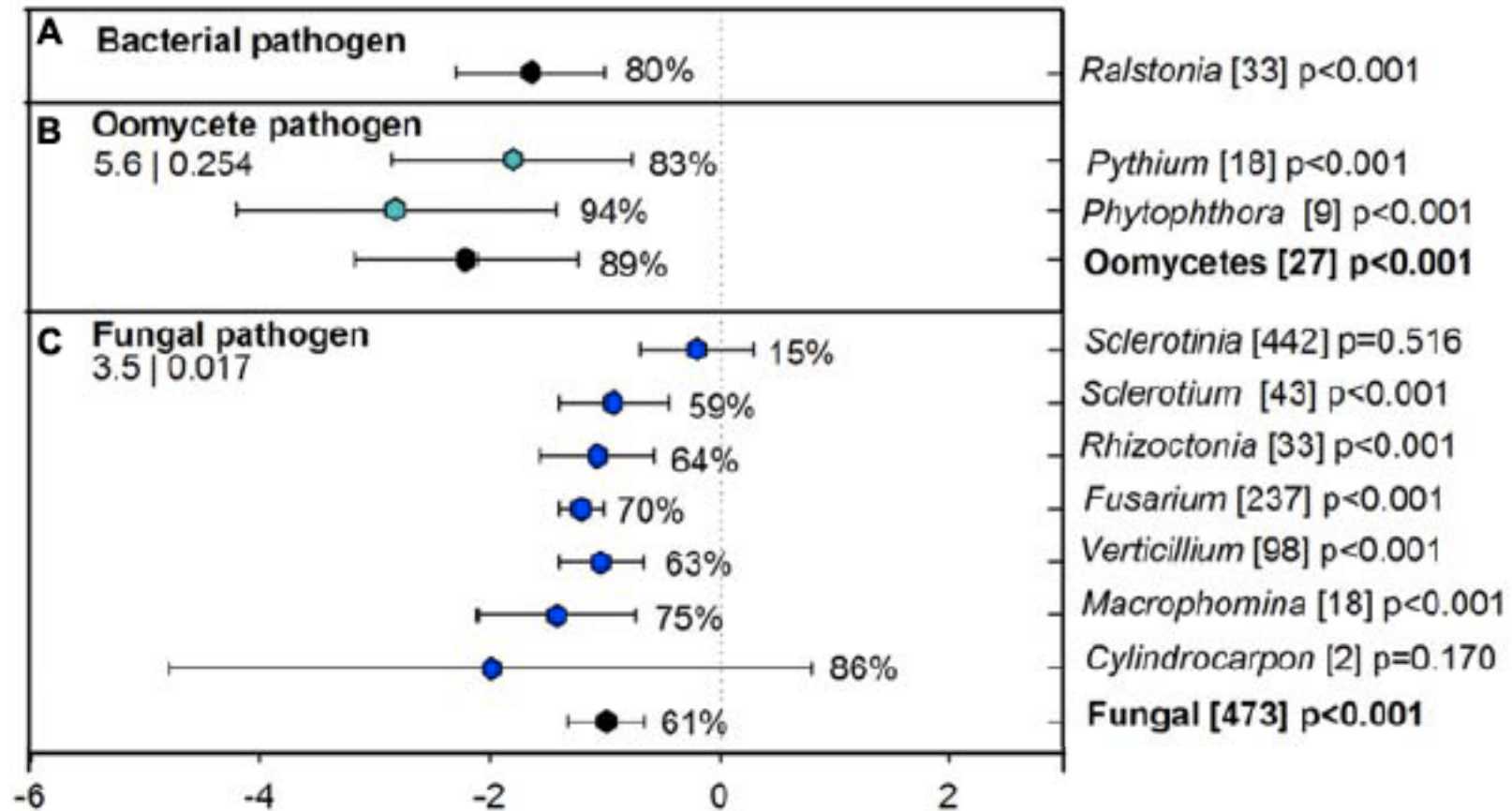
No evidence of effectiveness

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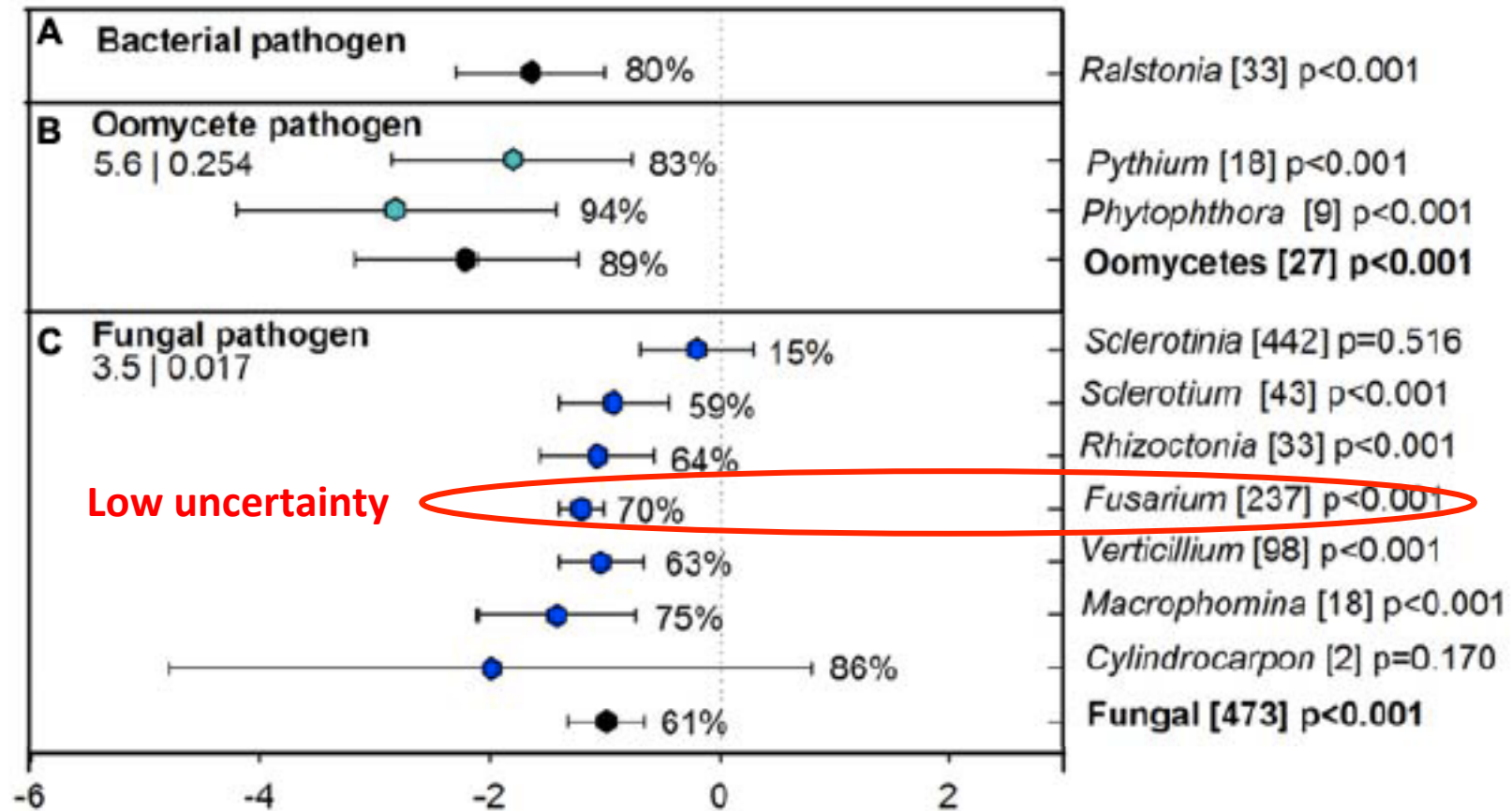
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Log of ratio of pest abundance

$$\log\left(\frac{X_E}{X_C}\right)$$

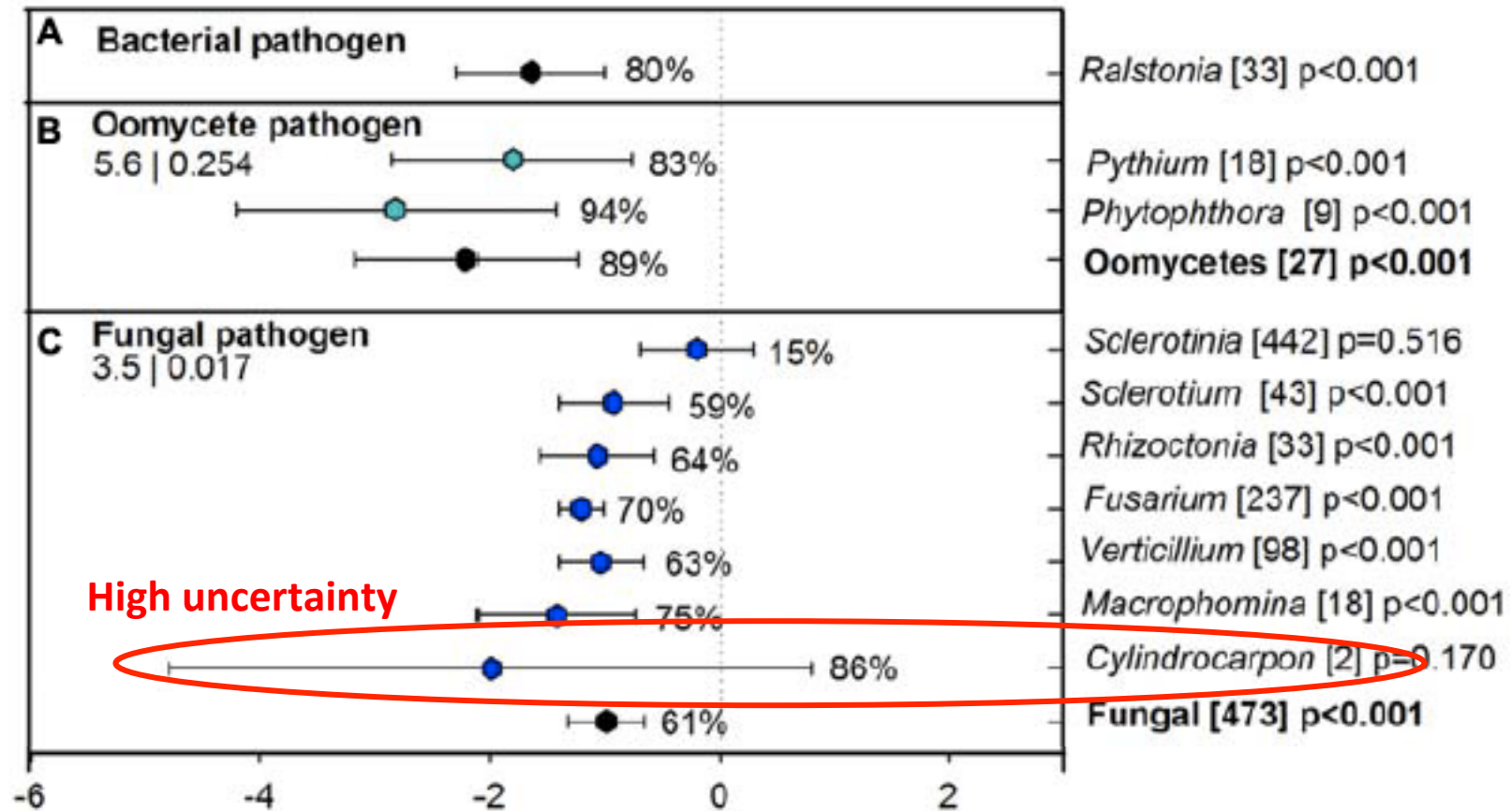
Shrestha et al. (2016)



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Shrestha et al. (2016)

Meta-analysis, an emerging approach in plant health



Methyl bromide alternatives for strawberry and tomato pre-plant uses: A meta-analysis



Anna Belova^{a,*}, Tulika Narayan^b, Ingram Olkin^c

Meta-Analysis of the Relationship Between Crop Yield and Soybean Rust Severity

Felipe Dalla Lana, Patricia K. Ziegelmann, Aline de H. N. Maia, Cláudia V. Godoy, and Emerson M. Del Ponte

Meta-analysis, an emerging approach in plant health

Phytopathology SYMPOSIUM

Meta-Analysis for Evidence Synthesis in Plant Disease Epidemiology and Management
Presented at the Annual Meeting of The American Phytopathological Society August 4, 2009, Portland, OR

Meta-Analysis for Evidence Synthesis in Plant Pathology: An Overview

L. V. Madden and P. A. Paul

New Applications of Statistical Tools in Plant Pathology

Meta-Analysis in Plant Pathology: Synthesizing Research Results

M. S. Rosenberg, K. A. Garrett, Z. Su, and R. L. Bowden

Meta-analysis, an emerging approach in plant health



EFSA Journal 2014;12(2):3557

SCIENTIFIC OPINION

Scientific Opinion on the risk of *Phyllosticta citricarpa* (*Guignardia citricarpa*) for the EU territory with identification and evaluation of risk reduction options¹

EFSA Panel on Plant Health (PLH)^{2,3}

Eur J Plant Pathol (2014) 139:79–94
DOI 10.1007/s10658-013-0365-6

**Comparison of statistical models in a meta-analysis
of fungicide treatments for the control of citrus black spot
caused by *Phyllosticta citricarpa***

**D. Makowski • A. Vicent • M. Pautasso •
G. Stancanelli • T. Rafoss**

Potential benefits for pest risk analysis

- Assess quantitatively the effectiveness of risk reduction options
- Estimate quantitatively the impact of pest on crop production
- Analysis of uncertainty
- Estimations could be included in pathway models
- Results help identifying knowledge gaps
- Ensure a high level of transparency
- Stimulate the development of databases on key topics

Limits

- No applicable on emerging issues
- Study selection and data extraction can be very tedious
- Time consuming