V2D   2022 Schield CCT   **1**

Statistical Literacy:
Critical Thinking about Statistics

Milo Schield
University of New Mexico
Statistical Literacy Coordinator
Fellow, American Statistical Association

July 26, 2022
2022 Conference on Critical Thinking
www.StatLit.org/pdf/2022-Schield-CCT-Slides.pdf
www.StatLit.org/pdf/2022-Schield-CCT.pdf

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Statistical Literacy:
Social Statistics vs. Numbers

Statistics are numbers in context (in reality)
Statistics can be influenced by reality:
  • In arithmetic, 1 plus 1 is always 2.

Bunny math: $1 + 1 >= 2$

$1 + 1 <= 2$ Ice cube math

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"Statistics are Socially Constructed"

Joel Best, author of "*Lies, Damned Lies and Statistics*" identified this fact as *the most important, the most fundamental,* aspect of *all* reality-based statistics.

Statistics, just like words, are created by people: people with motives, values and goals.

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Statistics can Be Influenced

Q. Best advice when dealing with statistics?
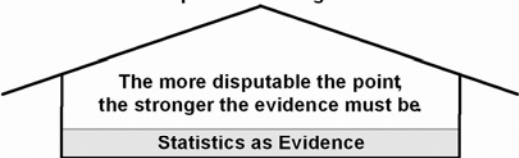A. "Take CARE". Statistics can be influenced.

All influences are grouped into four categories:
 C: Confounding: Confused by related factors
 A: Assembly: how things are defined, counted, etc.
 R: Randomness
 E: Error (including bias)

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Statistics in Arguments:
"Take CARE"

The point of the argument

The more disputable the point, the stronger the evidence must be.

Statistics as Evidence

"All Statistics are Socially Constructed"
So, "Take CARE"!!
Statistics may be influenced by:

C	A	R	E
Confounding	Assembly	Randomness	Error

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Admonition:
"Take CARE"

Students like "CARE". It gives them a structure.

When asked to rank what idea they considered the most valuable, students chose "Take CARE".

Confounding

Association: *People who read home and fashion magazines are more likely to get pregnant than people who read car and sport magazines.*

We know that pregnancy isn't caused by magazines. We know that only women can get pregnant.

We quickly recognize that women are more likely to read home and fashion magazines than men.

QED. This association is confounded by gender.

Statistics can be Confounded: Down Syndrome

Down Syndrome: Cases per 10,000 Births
By Child's Birth Order

Birth Order	Cases
1st	5.6
2nd	6.8
3rd	8.3
4th	11.5
5th (One chance in 600)	16.7

Fifth child is three times as likely to have Down syndrome as first

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Down Syndrome: Cases per 10,000 Births
By Mom's Age

Mom's Age	Cases
15-19	4.3
20-24	4.3
25-29	5.2
30-34	8.8
35-39	26.4
40-50 (One chance in 116)	86.4

A mom 40-50 is 20 times as likely to have a Down syndrome child as a mom 15-24.

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Today's Students are Interested in Arguments

Many stories in the everyday media involve *controversial claims*.

Most give reasons – they involve *arguments*.

Many of these arguments involve **statistics**.

Most of these statistics are **Social statistics**: statistics about people.

Today's student need to study Statistics

Disparities in
- Education, suspensions and graduation
- Policing, crime, sentencing and prison
- Wages, income, assets, loans and wealth
- Health, health care, homicides and deaths

Disparities by
gender, race, ethnicity, religion, politics, age, etc.

All of these rely on statistics: social statistics.

Where is the Math? Covid Deaths

Covid vaccinated cases are MORE likely to die than unvaccinated cases.

Covid Death Rates Per Case

	Crude Rate	# Cases
Unvaccinated	0.17%	151,052
Vaccinated	0.41%	117,114

41/17 = 2.4   UK NHS 2021

This result is unexpected. Doesn't make sense.

Slide 13 — V2D · 2022 Schield CCT

Covid Death Rates by Age

Covid Death Rates Per Case			Death Rates by Age	
	Crude Rate	# Cases	<50	50+
Unvaccinated	**0.17%**	151,052	0.03%	5.96%
Vaccinated	**0.41%**	117,114	0.02%	1.68%
41/17 = 2.4		UK NHS 2021		

Who are LESS likely to die?
Under 50: Vaccinated.   50+? Vaccinated

Vaccinated win '1st and 2nd half'; lose game

Slide 14 — V2D · 2022 Schield CCT

Covid Death Rates Simpson's Paradox

Paradox: Two group comparison has opposite direction from that in each of the sub-groups.
Impossible with counts. Possible with ratios.

Simpson's paradox: the elephant in the room for the social sciences.
What causes it?   It's the "mix"!
A crude comparison: a "mixed fruit" compare!
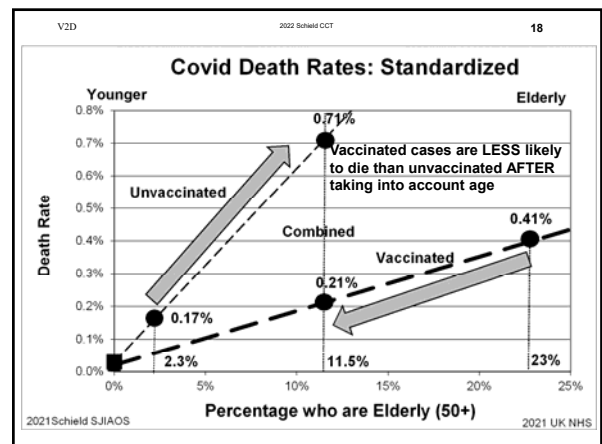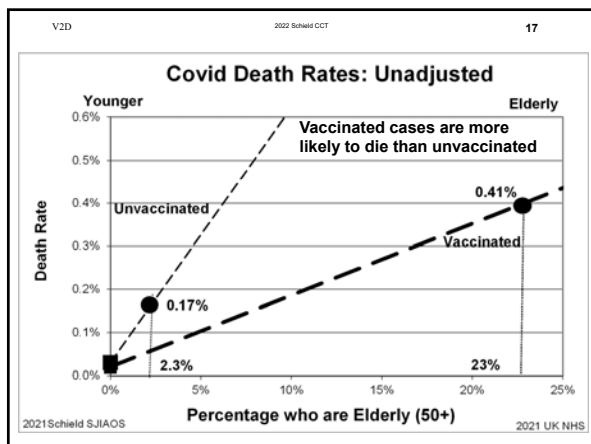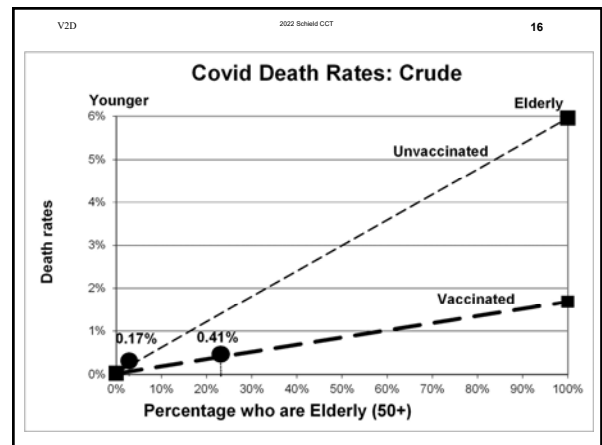

Slide 15 — V2D · 2022 Schield CCT

Covid Death Rates by Age

Show paradox arithmetically or graphically.
Both start with this data:

Covid Death Rates Per Case			Death Rates by Age	
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41/17 = 2.4		UK NHS 2021		

Elderly are:

    23% of vaccinated
    2.3% of unvaccinated

Slide 16 — V2D · 2022 Schield CCT

Covid Death Rates: Crude

Slide 17 — V2D · 2022 Schield CCT

Covid Death Rates: Unadjusted

Slide 18 — V2D · 2022 Schield CCT

Covid Death Rates: Standardized

Confounding: Taking into Account

"Taking into account" the influence of a related factor means converting a mixed-fruit comparison (apples and oranges) into a same fruit comparison (apples and apples).

Taking into account can reverse the direction of a comparison: Simpson's paradox.

Confounding is the elephant in observational statistics

Teachers know it.

Not in intro. statistics or research methods.

It should be taught in an introductory course.

There isn't time in traditional statistics.

University of New Mexico is offering a new course!

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Statistical Literacy   UNIVERSITY CATALOG

MATH 1300 (3)
Participants will study the social statistics encountered by consumers. Investigate the story behind the statistics. Study the influences on social statistics. Study the techniques used to control these influences. Strong focus on confounding.

Meets New Mexico General Education Curriculum Area 2: Mathematics and Statistics.

Math1300: Statistical Literacy

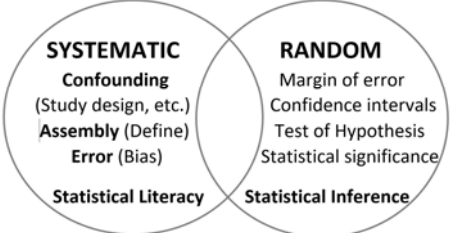**Less than 30% overlap with traditional statistics**

Statistics as a Discipline

STATISTICS STUDIES VARIATION
Two kinds of variation

SYSTEMATIC
Confounding
(Study design, etc.)
Assembly (Define)
Error (Bias)
Statistical Literacy

RANDOM
Margin of error
Confidence intervals
Test of Hypothesis
Statistical significance
Statistical Inference

Math1300: Confounder-Based Statistical Literacy

Traditional statistics is designed for the *producers of statistics*: students in STEM majors

Statistical literacy is designed for the *consumers of statistics*: students in non-quantitative majors like journalism and political science.

Q. Who or what determines the content?
A. The statistics in the everyday media

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Hypothetical Thinking: Plausible Confounders

What else might influence pregnancy than choice of magazine.

What else might influence a mom having a Down syndrome child besides birth order?

Why might vaccinated cases have a higher Covid death rate than those who are vaccinated.

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More Confounding

Association is not … causation.
- *People who shave their face are taller than those who shave their legs.*

Disparity is not … discrimination.
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New Course; New Textbook

Field tested:
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Statistical Literacy
Seeing the story behind the statistics

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Students Find Statistical Literacy Valuable

How valuable is this course in helping you read and interpret everyday statistics?
Negative (1%), Neutral (4%), Some value (12%),
            Fair value (38%), Highly valuable (45%).

How helpful was this course in developing your critical thinking skills?
Not helpful (0), Neutral (5%), Somewhat (21%),
            Very (42%), Extremely (32%)

76 students, Fall 2021 UNM Math 1300

V2D   2022 Schield CCT   **29**

Conclusion

Students need to be able to read and interpret social statistics in order to evaluate today's arguments.

Faculty in the humanities need
to persuade their math-stat colleagues
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V2D   2022 Schield CCT   **30**

References

Schield (2022). Seven Simple Questions for Policymakers. Copy at: www.StatLit.org/pdf/2022-Schield-SJIAOS.pdf

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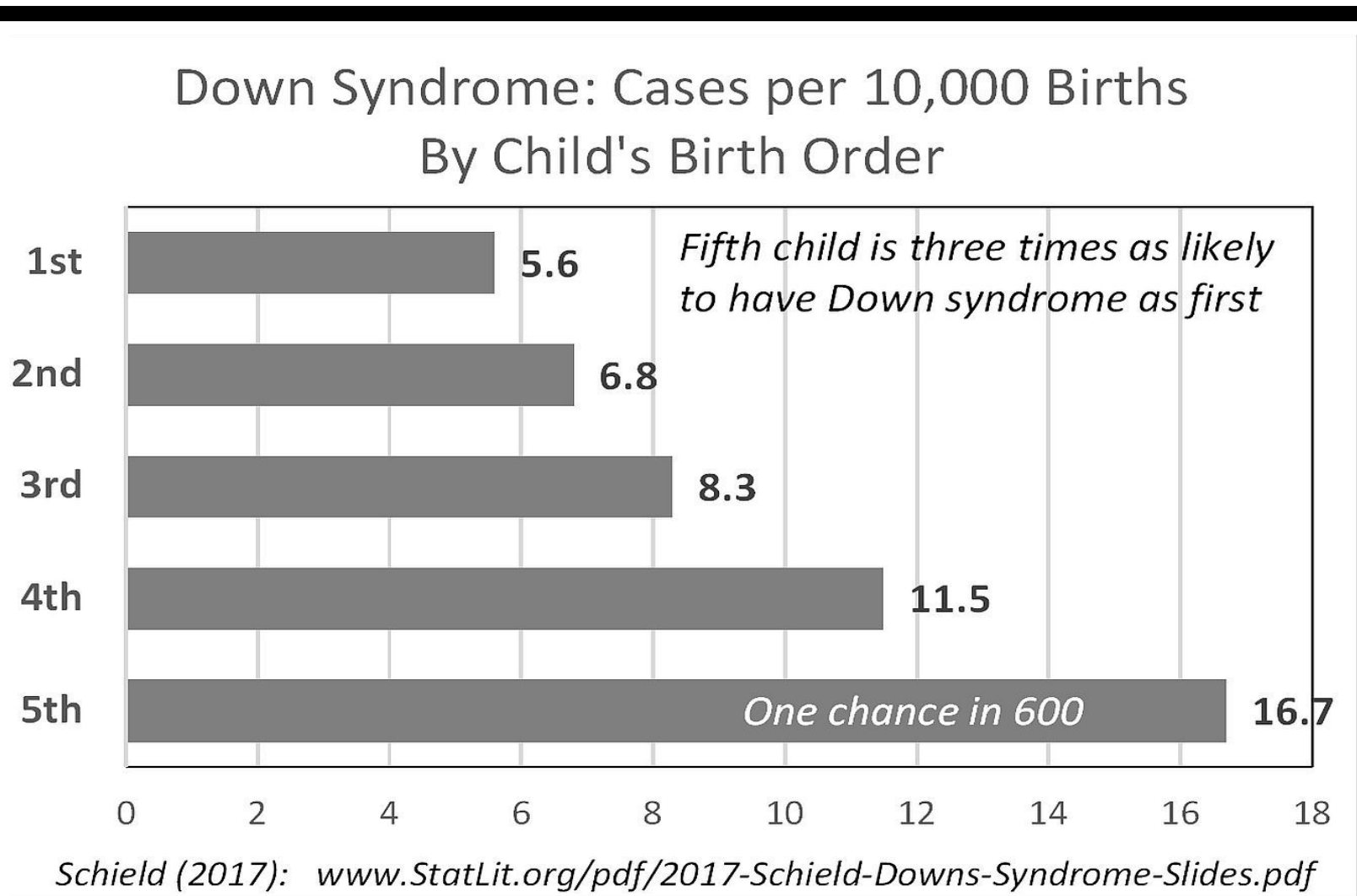
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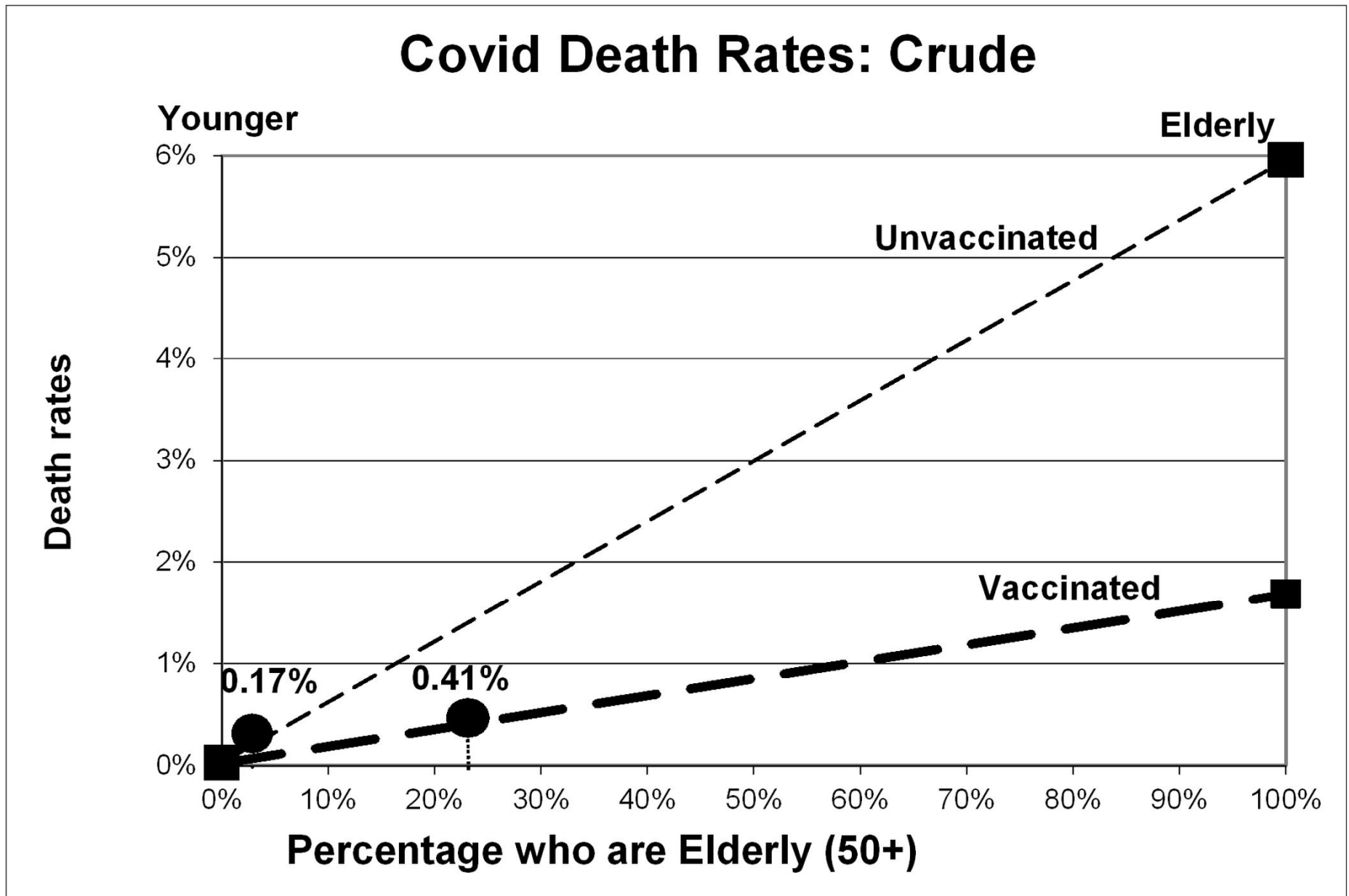
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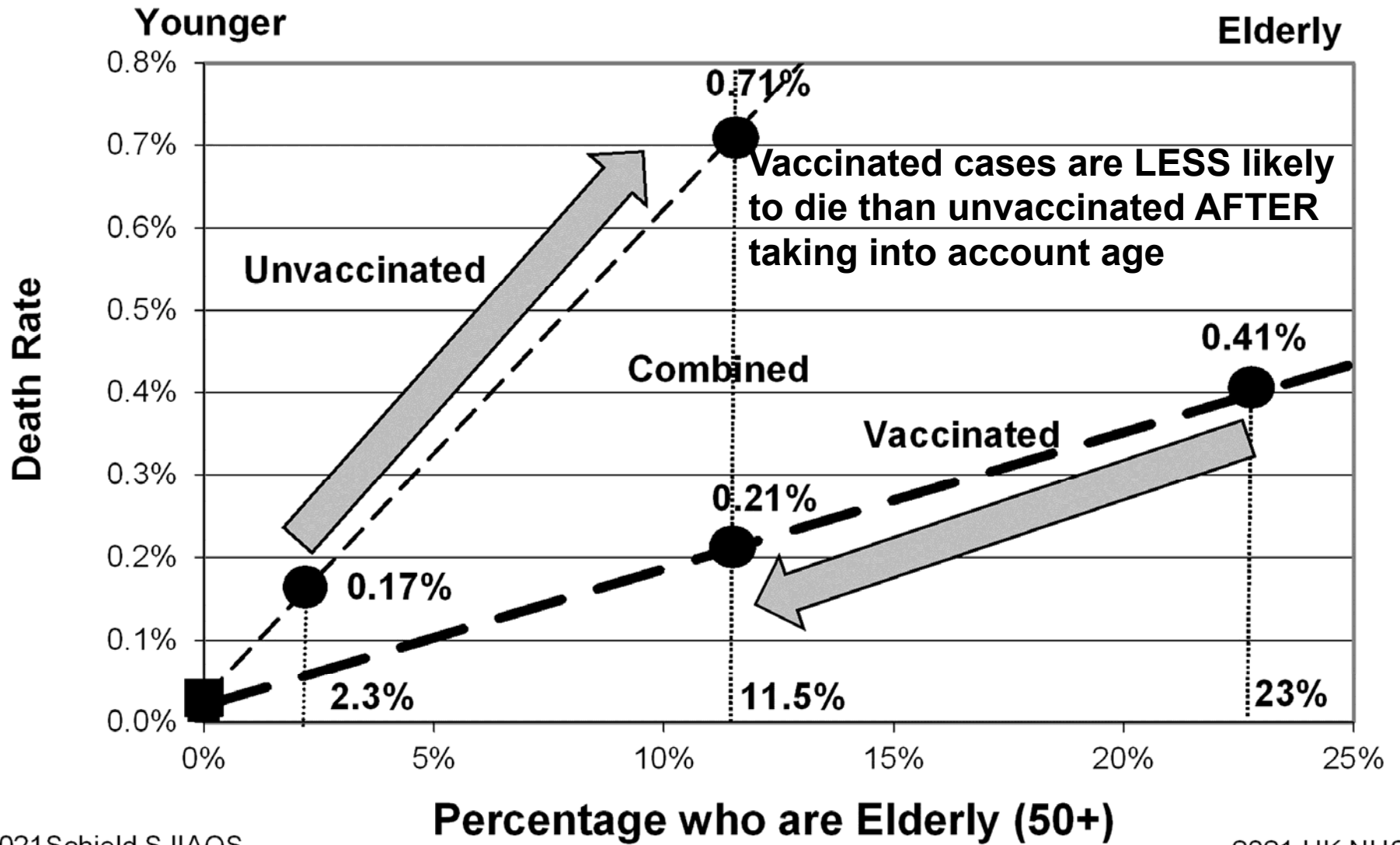
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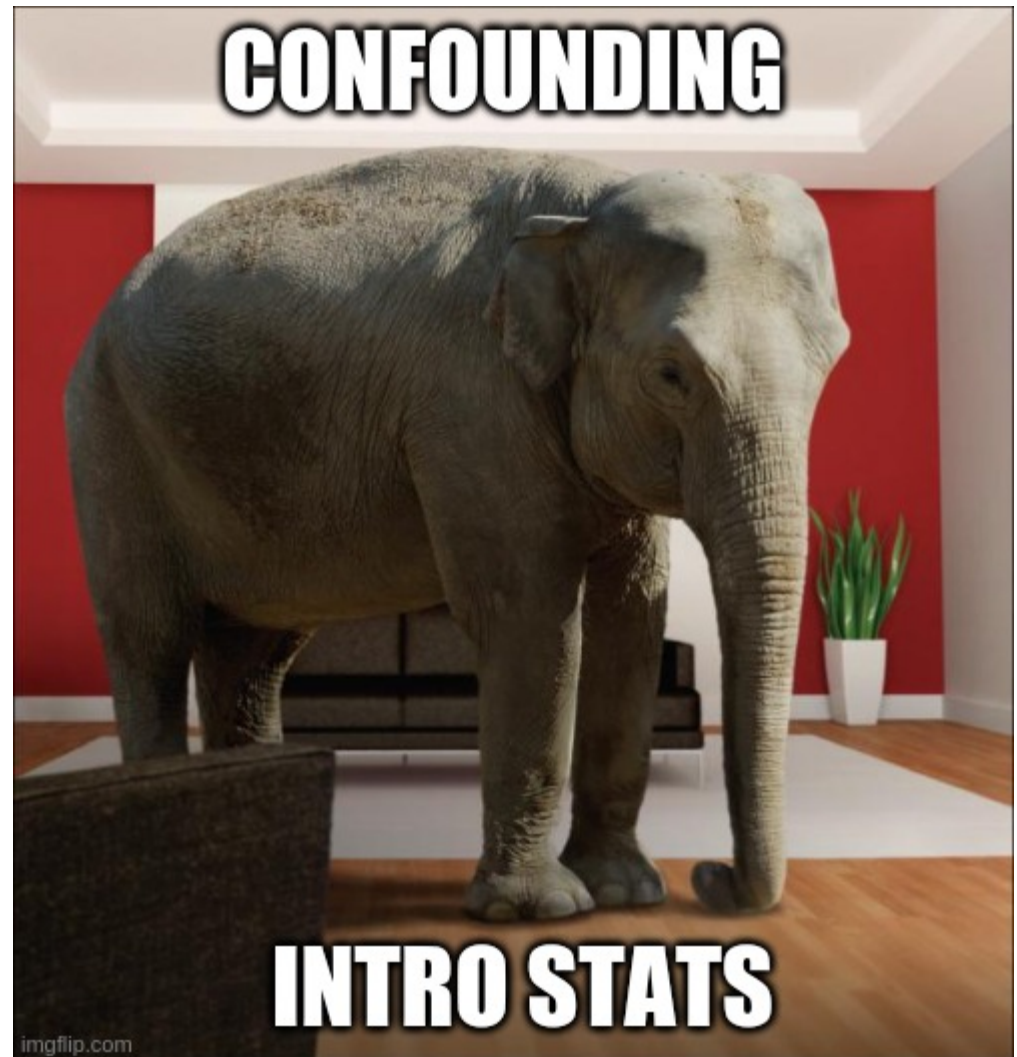
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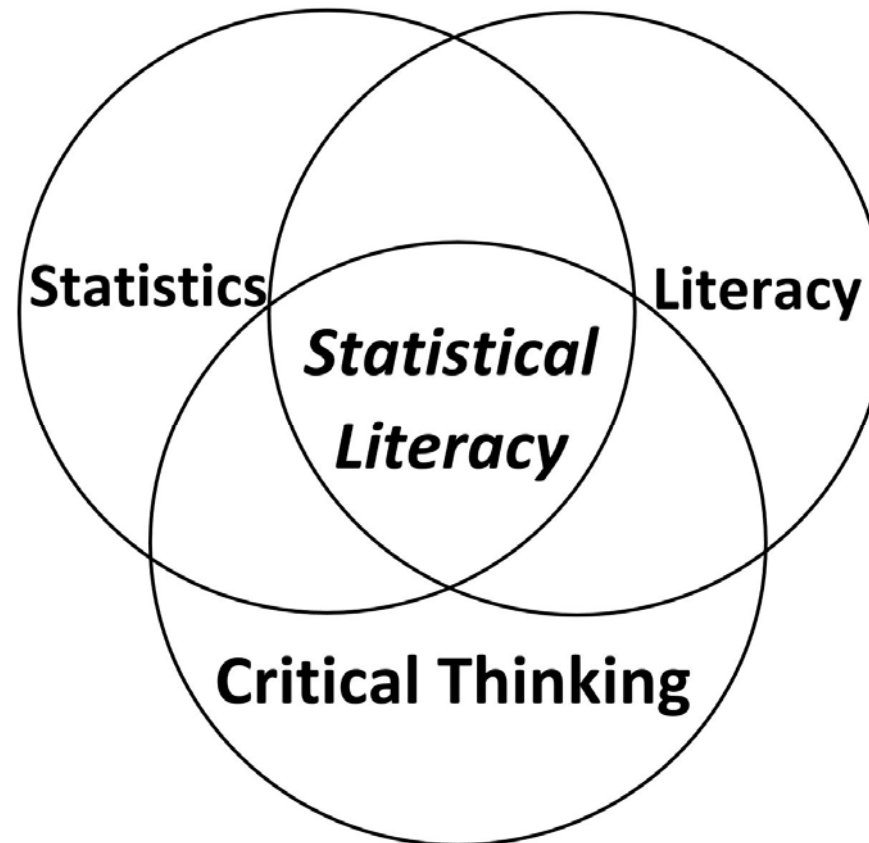
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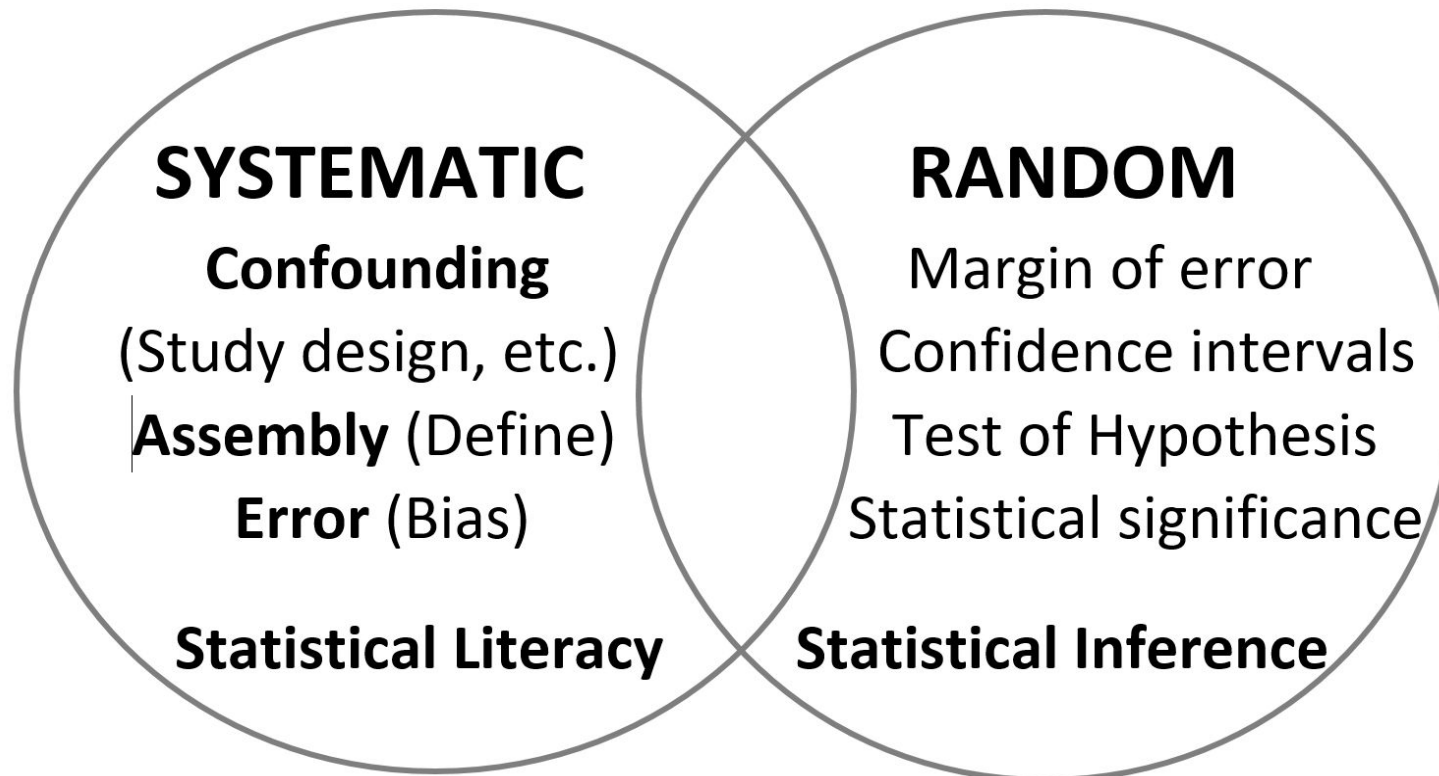
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