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Statistics Literacy For Decision Makers

Chapter 3: Measurements

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www.StatLit.org/pdf/2019-Schild-USCOTS-Slides3.pdf

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Measurements: Chapter 3 Outline

- Distributions
- Measures of center
- Two-group comparisons of Means & Medians
- Two-variable co-variation
- Spread
- Slope and simple regression

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Stat Literacy: Study Statistics as Evidence in Arguments

The Point or the Target

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

Statistic As Evidence

"All Statistics are Socially Constructed"
So, "Take CARE"!!

Statistics may be influenced by:

C	A	R	E
Context	Assembly	Randomness	Error

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Measures of Center

Figure 3D6

In an asymmetric distribution, mean, median and mode typically align alphabetically with mean most sensitive to extremes. Why?

Figure 3D7

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Mean, median, mode: Alphabetically. Why?

Suppose that house prices in your town have a positive near-symmetric distribution

Suppose Bill and Melinda Gates move to your town. They built two Mac-Mansions.

How does that change the mode, median and mean of the original distribution?

Mode? Median? Mean?

Most relevant in the short run? In the long-run?

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Issues:

1. Mean is more sensitive to outliers.
Yet statisticians prefer the mean. Why?
2. Omit measure: *City1 income more than City2.*
3. Omit characteristic: *Midtown is a median city.*
4. Assume the mean exists. *1.8 kids per family.*
5. Ambiguity in specifying the group

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Controlling Confounding: Control Of

CONTROL OF CONFOUNDERS

Physical Control (Grade = Quality)

Experiment	Observational Study
A+ Scientific	C Longitudinal
A- Random Assign	D Cross-sectional
B Quasi-Exper	F Anecdotal story

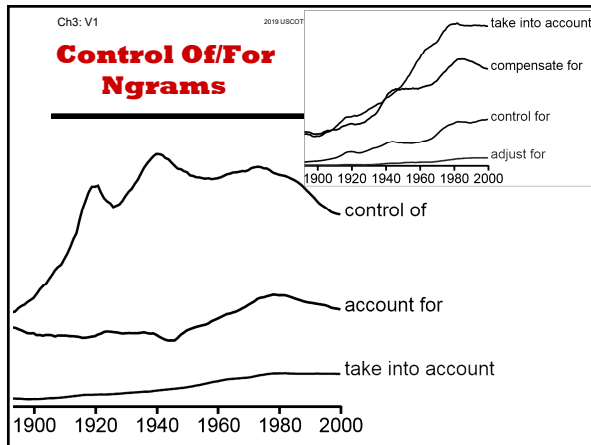
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Controlling Confounding: Control For

CONTROLLING FOR CONFOUNDERS

Take into account (mental)

<i>Can do by hand</i>	<i>Calculator/Computer</i>
1 Select/Stratify	4 Linear Regression
2 Form Ratios	5 Logistic Regression
3 Standardize	6 Multivariate Regress



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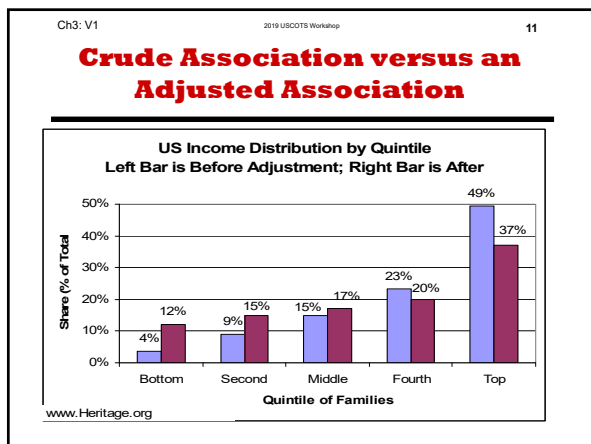
Crude Associations

A **crude association** is an association in which nothing else has been taken into account.

Less likely to get pregnant:

- Short young adults than tall.
- Adults that shave daily than those that don't
- Adults with long hair than those with short.

What one takes into account is an assumption. Teachers should say, "Check your assumptions."



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Prison Expense: Crude vs Adjusted Associations

State	Total	# Inmates	Per Inmate	Total	Per Inmate
CA	\$2.9B	136K	\$21,385	50% more ↑	25% less ↓
NY	\$1.9B	69K	\$28,426		

State	Total	# Inmates	Per Inmate	Total	Per Inmate
MD	\$481M	21,623	\$22,245	3 times.. ↑	Same
KS	\$159M	7,148	\$22,245		

State	Total	# Inmates	Per Inmate	Total	Per Inmate
MN	\$184M	4,865	\$37,825	260% more ↑	12% more ↑
ME	\$48M	1,424	\$33,711		

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Crude Ratio Associations It's the Mix!!!

Ratio associations can be still be confounded.
Averages are ratios.

NAEP Math 8	Internet Access at Home		
	All	Yes	No
State			
Virginia (VA)	↑ 275	↓ 282	↓ 258
Texas (TX)	↓ 273	↓ 285	↓ 260

NAEP Math 8	Internet Access at home		
	All	Yes	No
State			
Virginia (VA)	↑ 275 (100%)	↓ 282 (69%)	↓ 258 (31%)
Texas (TX)	↓ 273 (100%)	↓ 285 (53%)	↓ 260 (47%)

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Simpson's Paradox: Time It's the Mix!!

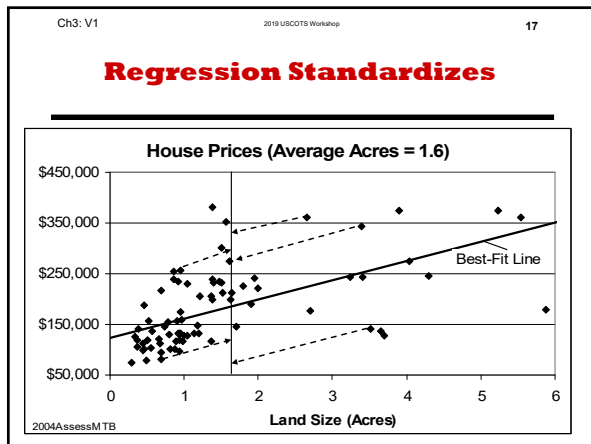
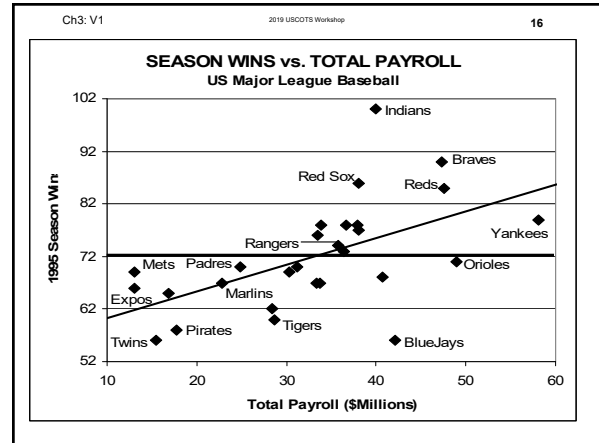
SAT Verbal flat, but every group improved.

SAT-Verbal	--- Scores ---			--- Distribution ---		
	1981	2002*	Chg	1981	2002*	Points
Group						
White	519	527	+8	85%	65%	-20
Black	412	431	+19	9%	11%	+2
Asian	474	501	+27	3%	10%	+7
Mexican	438	446	+8	2%	4%	+2
Puerto Rican	437	455	+18	1%	3%	+2
Amer. Indian	471	479	+8	0%	1%	+1
ALL	504	504	0			

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Will an Association Reverse? The Cornfield Conditions

After learning about Simpson's Paradox, one student said, "I'll never trust another statistic."
This is cynicism: not a good outcome.
Not all confounders can reverse an association.
Jerome Cornfield proved that a confounder association must be "bigger" than the observed.
Cornfield's conditions are one of the three biggest contributions of statistics to human knowledge.



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Regression Standardizes An Example:

The data shows that house prices increase by \$39,000 per bedroom. This is a crude association.
\$16,000 per bedroom if land is *controlled for*,
\$9,000 per bedroom after *accounting for* land and house size,
\$5,000 after *adjusting for* land, house size, and number of bathrooms.

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TV for toddlers interferes with brain growth, says study:

Children under two should not be allowed to watch television because it increases their chances of suffering attention problems later in life, says an American study.

A study of 1,345 children found that each hour spent in front of the set every day increased the risks of attention deficit disorders by 10%.

U.S. journal, *Pediatrics*

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Time to Double given Growth Rate

If a child’s risk of Attention Deficit Disorder increases by 10% for every extra hour of watching TV, how many hours do they have to watch to double their risk?

Rule of 72*: Time to double = 72 / Rate

72 divided by 10% per hour = 7.2 hours

* Assuming compounding

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How to Relate this to Math Colleagues

Don’t talk about confounding or effect size.
Talk about assumptions.

- What one controls for is an assumption.
- What one fails to control for is an assumption.

AAU&C Quantitative Literacy VALUE rubric:

Assumptions: Ability to make and evaluate important assumptions in estimation, modeling, and data analysis.

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AAC&U Quantitative Literacy VALUE Rubric

Interpretation, Representation, Calculation, Application, **Assumptions**, and Communication

Assumptions: Ability to **make and evaluate** important assumptions in estimation, modeling, and data analysis.

www.statlit.org/pdf/2009QuantitativeLiteracyRubricACU.pdf
www.aacu.org/peerreview/2014/summer/RealityCheck