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## Statistical Literacy: Confounding

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Slides at [www.StatLit.org/pdf/2010SchieldUST6up.pdf](http://www.StatLit.org/pdf/2010SchieldUST6up.pdf)

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## Statistical Literacy

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Statistical literacy is **the ability to read and interpret summary statistics in everyday life.**

Statistical Literacy studies

- (1) the relation between statistical associations and causation, and
- (2) the full-range of influences on a statistic or on a statistical association. [Take CARE]

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## Take CARE: Context

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The influence of factors **taken into account** by

- data broken out by subgroups in tables and graphs
- averages, ratios and comparisons of averages and ratios
- epidemiological models (cf., deaths attributed to obesity)
- regression models and
- the study design (cf., longitudinal vs. cross-sectional; experiment vs. observational study).

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The influence of related factors (confounders) **not taken into account** in the study and **not blocked** by the study design.

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## Controlling for a confounder can DECREASE an association

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MN has 3.8 times as much prison expense as ME

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

MN has 3.4 times as many inmates as ME

MN has 25% more prison expense *per inmate* than ME

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## Controlling for a confounder can NULLIFY an association

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MD has 3 times as much prison expense as KS

State	Total	# Inmates	Per Inmate
MD	\$481M	21,623	\$22,250
KS	\$159M	7,148	\$22,250

MD has three times as many inmates as KS

MD has the same prison expense *per inmate* as KS

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## Controlling for a confounder can REVERSE an association

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CA has 50% more prison expense than NY

State	Total	# Inmates	Per Inmate
CA	\$2.9B	136K	\$21,385
NY	\$1.9B	69K	\$28,426

CA has almost twice as many inmates as NY

CA has 25% less prison expense *per inmate* than NY

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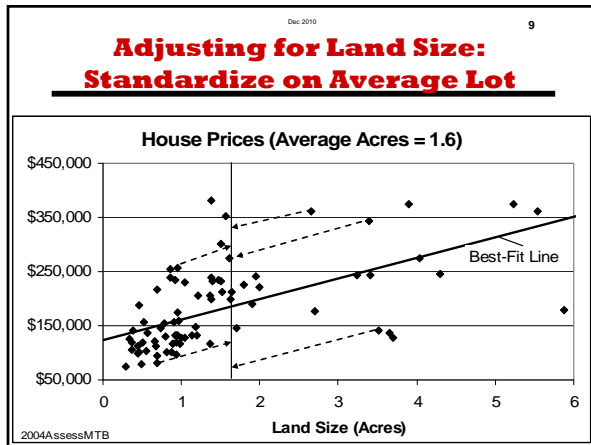
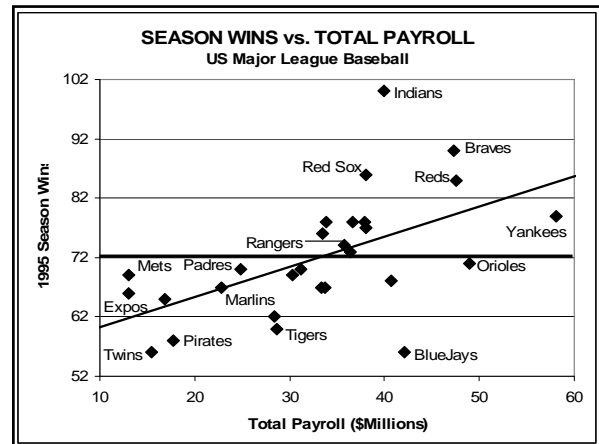
**Controlling for a confounder can INCREASE an association**

MN has 27% more prison expense than IA

State	Total	# Inmates	Per Inmate
MN	\$184M	4,865	\$37,825
IA	\$144M	5,929	\$24,286

MN has 18% fewer inmates than IA

MN has 56% more prison expense *per inmate* than IA



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**SAT VERBAL SCORES: FLAT**

GROUP	1981	2002	CHANGE
White			
Black			
Asian			
Mexican			
Puerto Rican			
American Indian			
<b>ALL Test takers</b>	<b>504 (100%)</b>	<b>504 (100%)</b>	<b>ZERO</b>

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**Multivariate Analysis can be Complex**

To simplify, consider cases with

- a binary outcome,
- a binary predictor and
- a binary confounder.

What are the necessary conditions for nullification or a reversal?

See Schield (1999) and Schield and Burnham (2003)

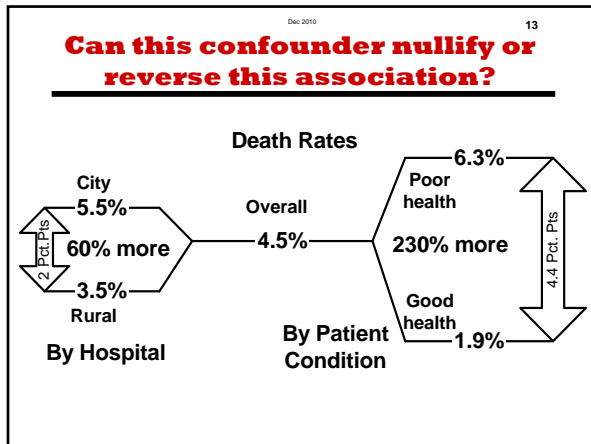
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**City Hospital: Hospital of Death??**

Hospital	Total	Died	Death Rate
City	1,000	55	5.50%
Rural	1,000	35	3.50%
Both	2,000	90	4.50%

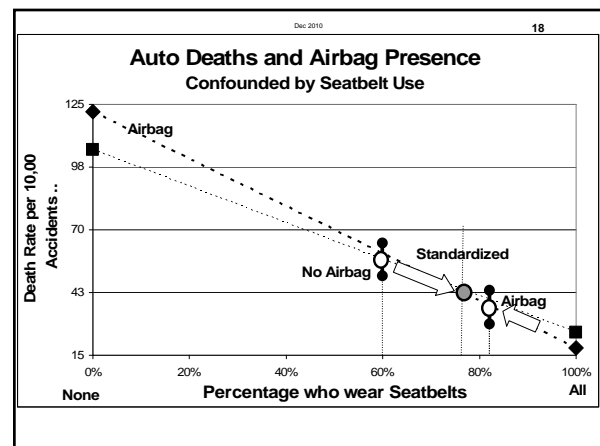
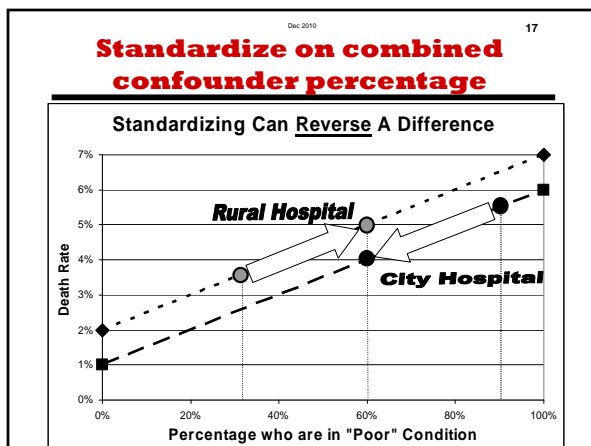
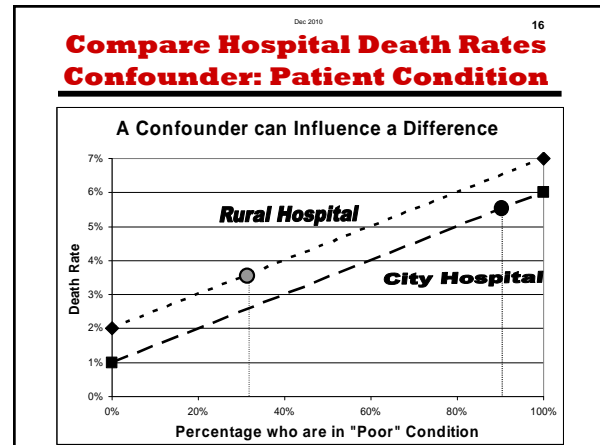
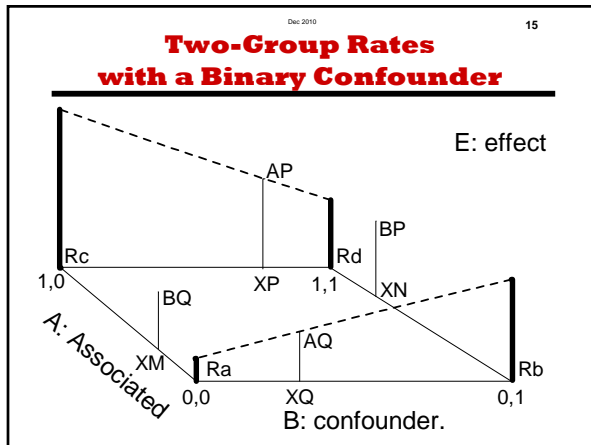
  

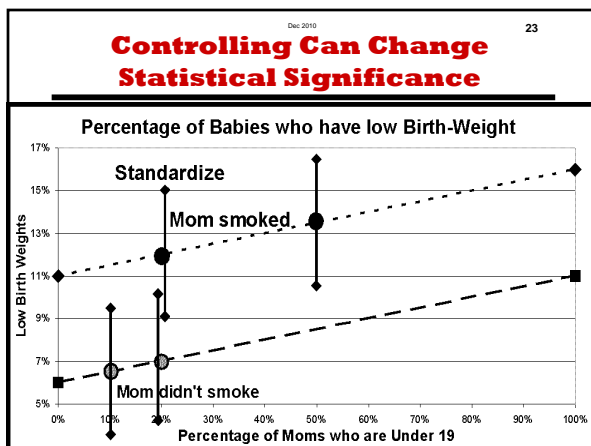
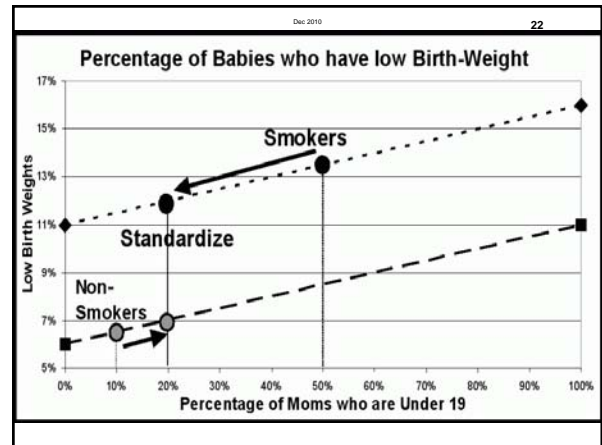
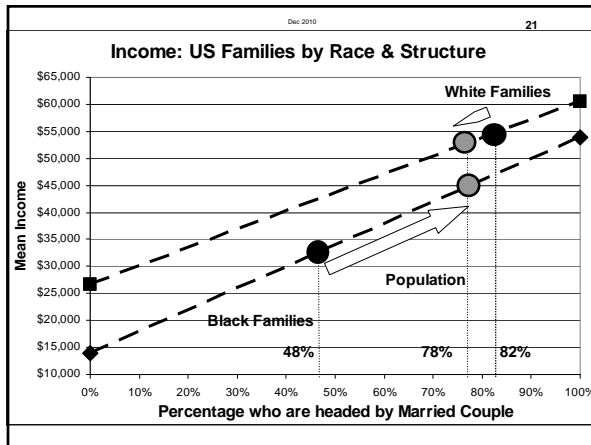
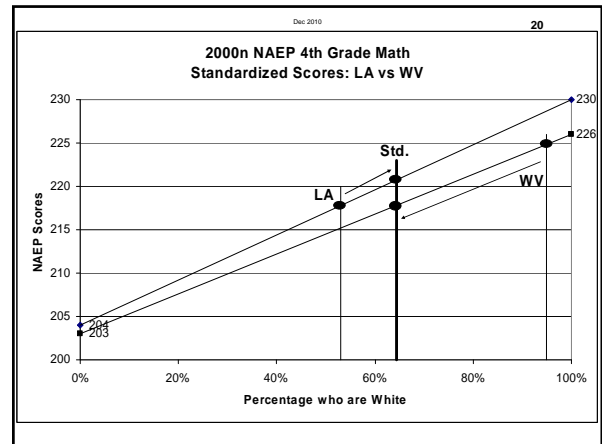
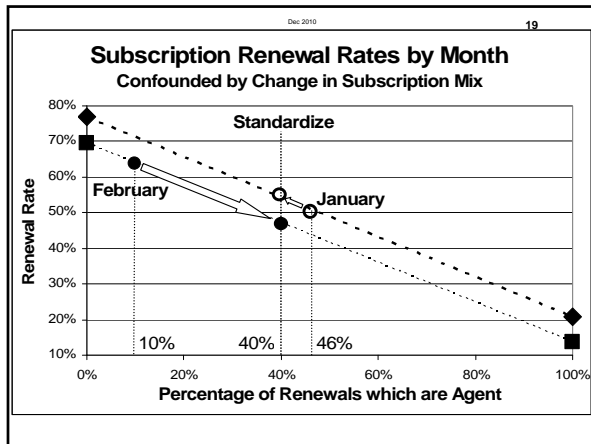
Condition	Total	Died	Death Rate
Good	800	15	1.90%
Poor	1,200	75	6.30%



### Confounder Reverses; City Hospital is Better

Condition	Hospital	Total	Died	Death Rate
Good	City	100	1	1.00%
	Rural	700	14	2.00%
	Total	800	15	1.90%
Poor	City	900	54	6.00%
	Rural	300	21	7.00%
	Total	1,200	75	6.30%





**Conclusion**

Statistical educators must show students how confounders can influence associations and change statistical significance. Their failure to do this may be seen as “*statistical negligence.*”

Schild (1999). Simpson's Paradox and Cornfield's Conditions. See [www.StatLit.org/pdf/1999SchildASA.pdf](http://www.StatLit.org/pdf/1999SchildASA.pdf).  
 Schild and Burnham (2003): Confounder-Induced Spuriousity and Reversal: Algebraic Conditions for Binary Data. Copy at: [www.StatLit.org/pdf/2003SchildBurnhamASA.pdf](http://www.StatLit.org/pdf/2003SchildBurnhamASA.pdf)  
 Schild, Milo (2006). Presenting Confounding and Standardization Graphically. *STATS Magazine*, ASA, Fall 2006, pp. 14-18. Draft at [www.StatLit.org/pdf/2006SchildSTATS.pdf](http://www.StatLit.org/pdf/2006SchildSTATS.pdf).