Wednesday, Apr 27

Simpson's Paradox

Example: The following data are from an observational study that compared open surgical methods with percutaneous nephrolithotomy with respect to success of removing a kidney stone.[1]

	Outcome		
Treatment	success	failure	Total
open surgical method	273 (0.78)	77 (0.22)	350
percutaneous nephrolithotomy	289 (0.83)	61 (0.17)	350

Now consider the same data but now also considering the *size* of the kidney stone.

		Outcome		
Size	Treatment	success	failure	Total
large	open surgical method	192 (0.73)	71 (0.27)	263
large	percutaneous nephrolithotomy	55 (0.69)	25 (0.31)	80
small	open surgical method	81 (0.93)	6 (0.07)	87
small	percutaneous nephrolithotomy	234 (0.87)	36 (0.13)	270

Why?

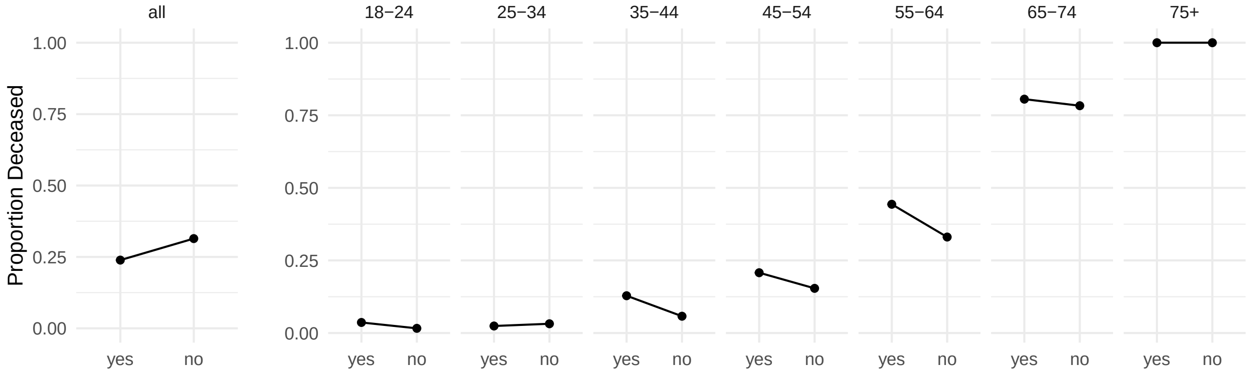
Simpson's Paradox: A situation when the relationship between two variables "reverses" when conditioning upon a third confounding variable.

Example: The data shown below are from an investigation of the relationship between the defendant's race and whether or not the death penalty was given in murder trials.

	Death Penalty		
Defendant	yes	no	Total
white	53 (0.11)	430 (0.89)	483
black	15 (0.08)	176 (0.92)	191
White Victim			
white	53 (0.11)	414 (0.89)	467
black	11 (0.23)	37 (0.77)	48
Black Victim			
white	0 (0)	16 (1)	16
black	4 (0.03)	139 (0.97)	143

Example: Consider data from a survey of women and an investigation of the relationship between smoking and mortality.

[1] Charig, C. R., Webb, D. R., Payne, S. R., & Wickham, J. E. A. (1986). Comparison of treatment of renal calculi by open surgery, percutaneous nephrolithotomy, and extracorporeal shockwave lithotripsy. *British Medical Journal*, *292*, 879–882.



Berkson's Paradox

Berkson's paradox is when an association between two variables is due (in part) to *selection bias* (i.e., that some units have a higher probability of being sampled than others).

Example: Suppose that an observational study of people from the general population does not reveal any relationship between diabetes and cholecystitis (an inflammation of the gallbladder).

	Cholecystitis		
Diabetes	yes	no	Total
yes	100 (0.1)	900 (0.9)	1000
no	1900 (0.1)	17100 (0.9)	19000
Total	2000	2000	20000

But if this study was based on *hospital records* then many people *without* diabetes *or* cholecystitis would not be sampled. This causes an apparent association between diabetes and cholecystitis, and appears to show that people with diabetes are *less likely* to have cholecystitis.

	Cholecystitis		
Diabetes	yes	no	Total
yes	100 (0.1)	900 (0.9)	1000
no	1900 (0.48)	2100 (0.52)	4000
Total	2000	2000	5000

Example: A study published in the *Journal of Internal Medicine* of individuals aged 19 years or younger who received emergency medical care in Ontario, Canada, following an off-road vehicle crash showed that those that were wearing a helmet were associated with a *greater* injury severity and necessity for more medical care than those not wearing a helmet.

	Hospitalized		
Helmet	yes	no	Total
yes	945 (0.1)	8917 (0.9)	9862
no	1652 (0.07)	23688 (0.93)	25340
Total	2597	2597	35202

But individuals who *did not* receive emergency medical care (either because they were fine or because they died at the scene) are not included. What happens if we include them?

Suppose that there were 10000 cases where an individual was wearing a helmet but did not require emergency medical care, and 50 cases where an individual was not wearing a helmet but did not require emergency medical care.

	Hospitalized		
Helmet	yes	no	Total
yes	945 (0.05)	18917 (0.95)	19862
no	1652 (0.07)	23738 (0.93)	25390
Total	2597	2597	45252

Ecological Fallacy

The **ecological fallacy** is the misconception that an association at the *group* level implies a similar association at the *individual* level.

Example: Research in Europe in the 19th century showed that suicide was more common in *regions* that were predominantly Protestant in comparison to areas that were predominantly Catholic. Would we conclude that within any given area the suicide rate is higher among Protestant *people* than Catholic *people*?

Example: Hobbit *villages* with higher pipe weed consumption also tend to have higher rates of foot lice. Would we conclude that within a given village that foot lice is more common among *individual* Hobbits that smoke in comparison to those who do not?

Suppressor Variables

A **suppressor variable** is a variable that, if not conditioned upon, will "suppress" (i.e., reduce in magnitude) the relationship between two variables.

Example: Consider a study of the relationship between participation in a Head Start program and academic success.

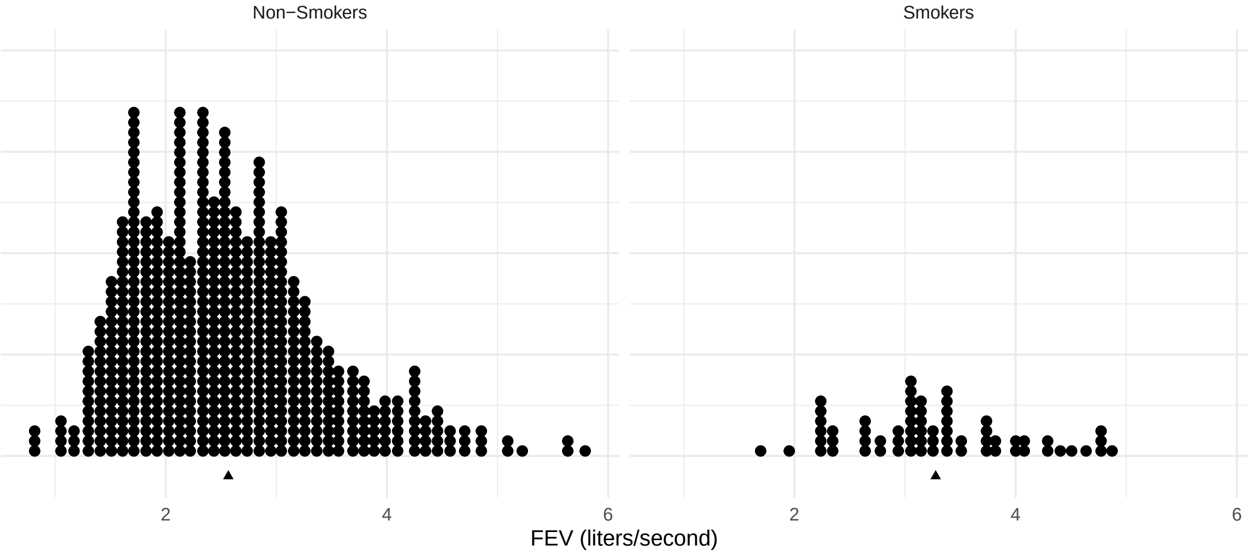
	Success		
Head Start	yes	no	Total
no	471 (0.47)	533 (0.53)	1004
yes	509 (0.51)	487 (0.49)	996

		Success		
SES	Head Start	yes	Total	total
high	no	426 (0.5)	422 (0.5)	848
high	yes	101 (0.78)	29 (0.22)	130
low	no	45 (0.29)	111 (0.71)	156
low	yes	408 (0.47)	458 (0.53)	866

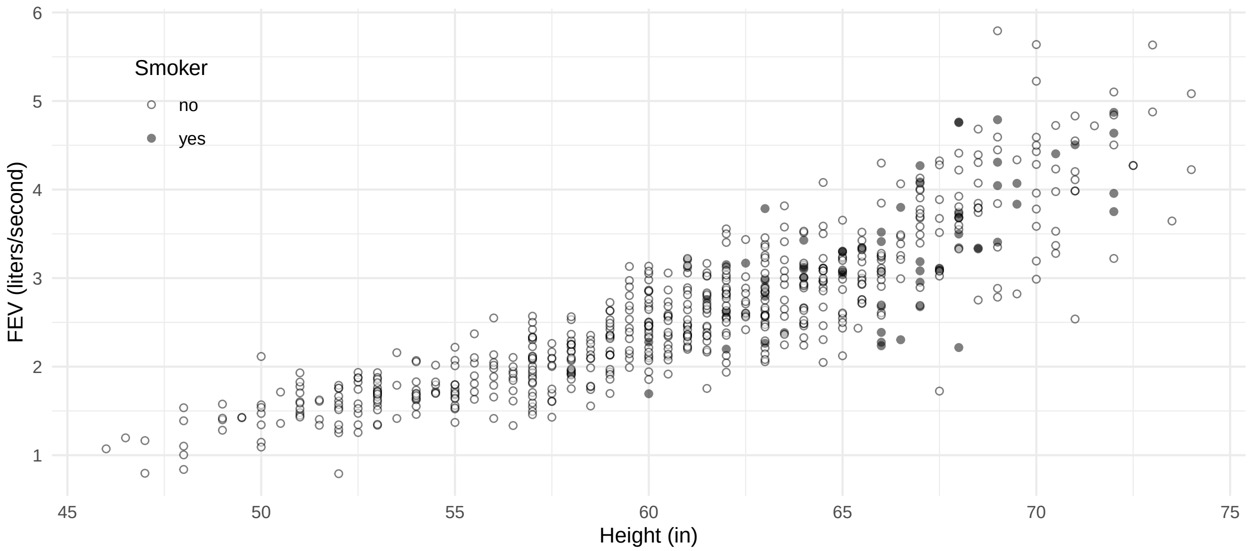
Spurious Relationships

A **spurious relationship** is when the apparent association between two variables disappears when conditioning on a third variable.

Example: Consider data from an observational study of the relationship between smoking and forced expiratory volume (FEV) and children and adolescents.



Now suppose we examine the data but take into consideration *height*.


Smoker
○ no
● yes
FEV (liters/second)
Height (in)