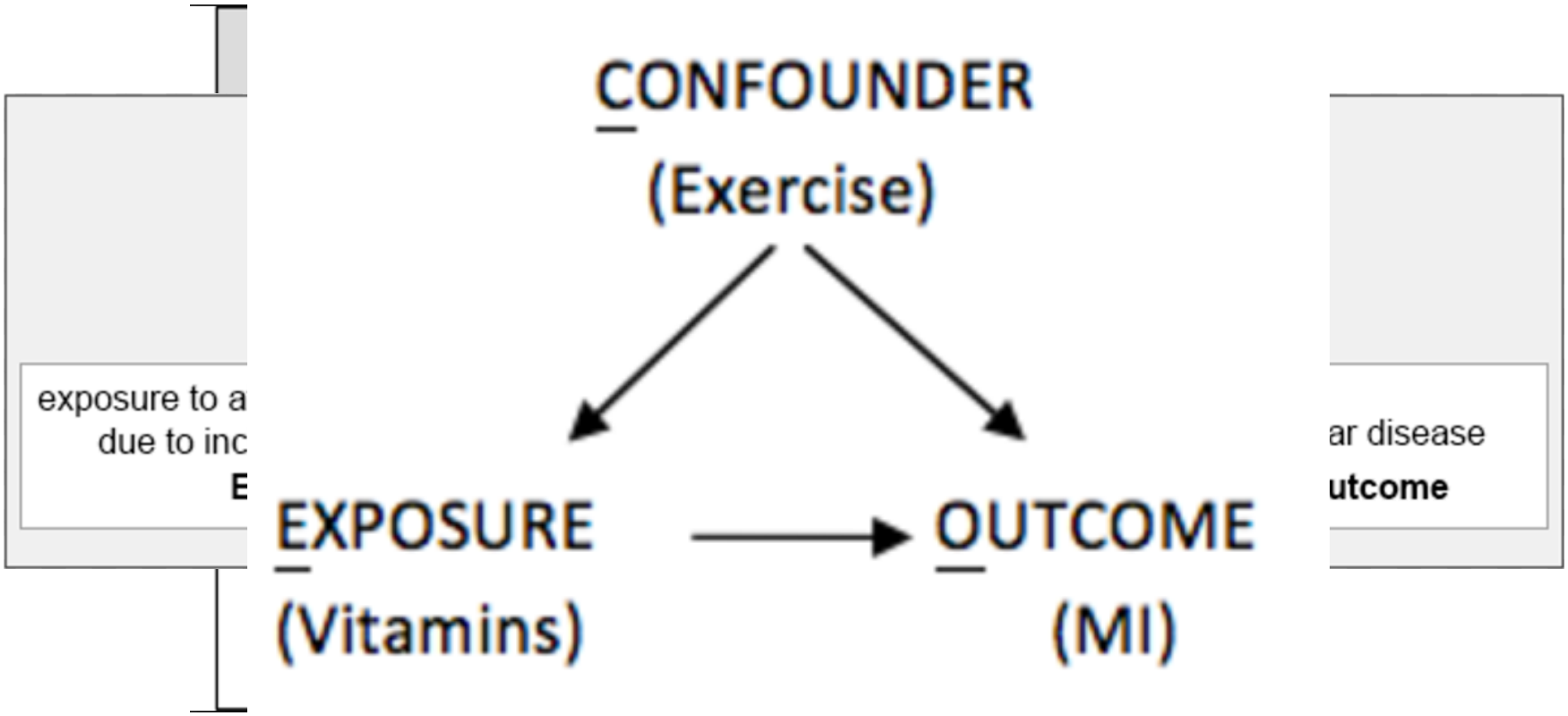
Confounding

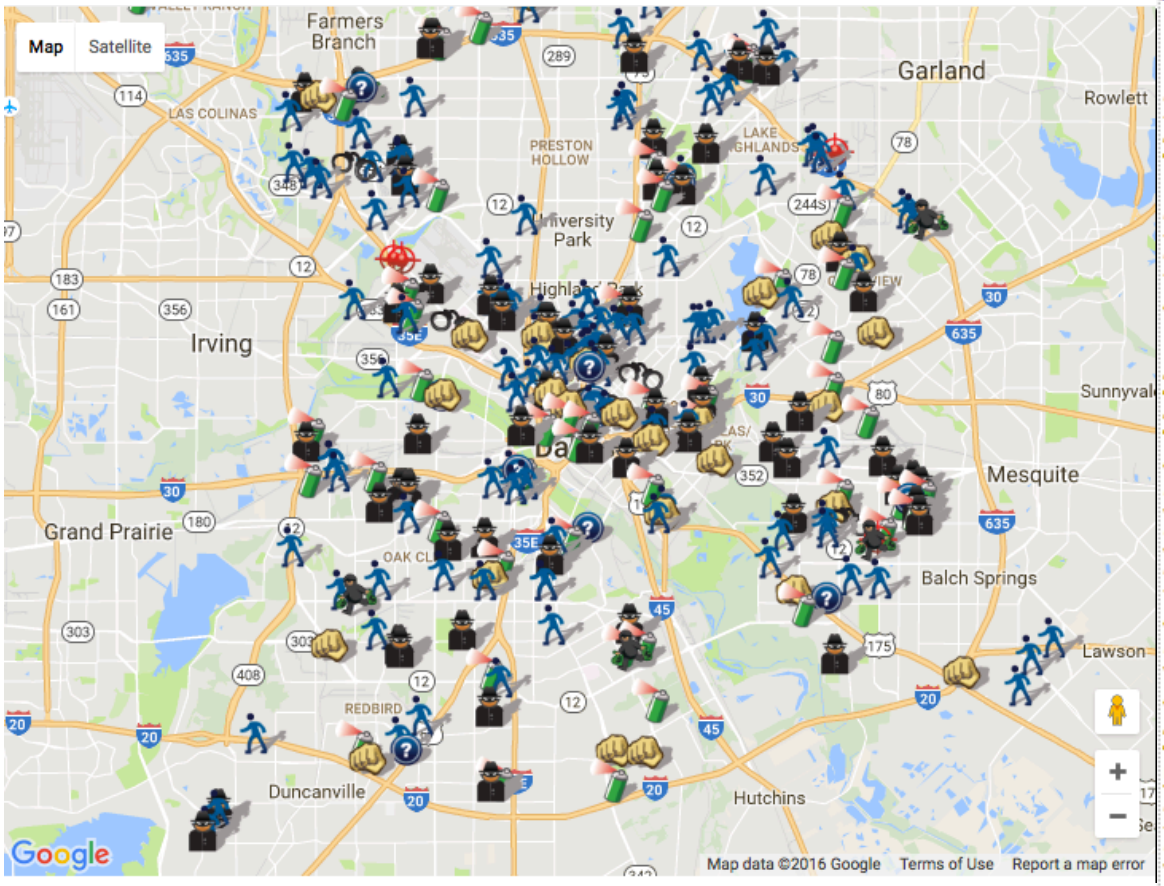
ALTERNATIVE ASSOCIATION BETWEEN THE TREATMENT AND OUTCOME

Confounding

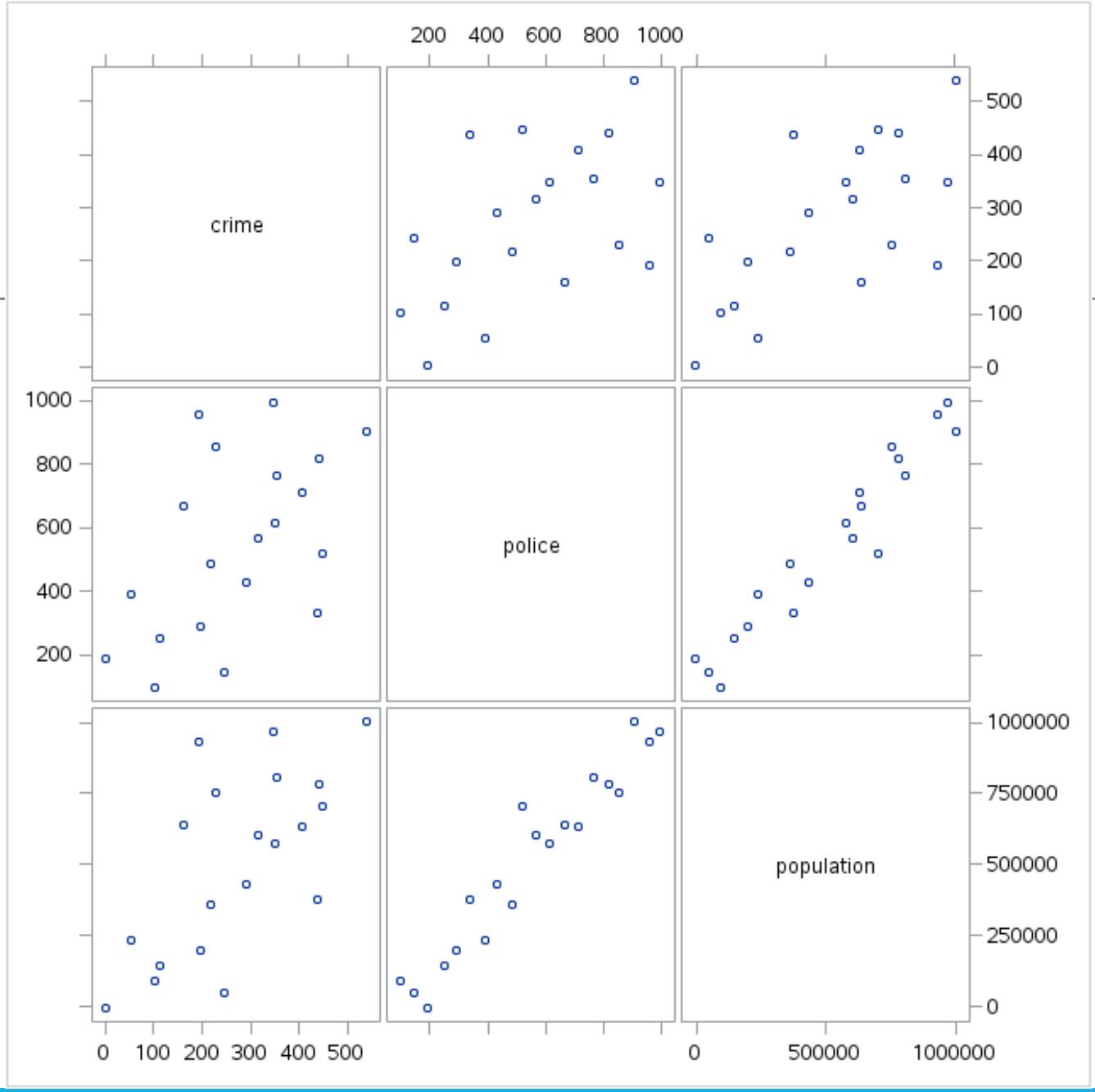
A **CONFOUNDER** is an unaccounted for variable associate with both the treatment and response



Sociology Study:
Effect of Policing on Crime



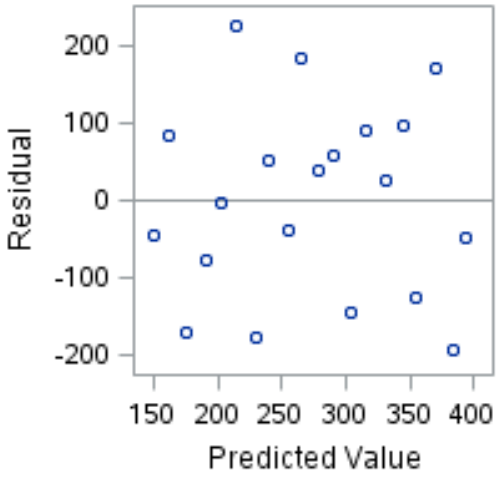

```
DATA population;
    INPUT crime police population;
    DATALINES;
102.19982  97.53736   92363.074
244.28284 145.76616   47964.911
  1.87773 189.30260   -5702.095
114.02854 250.38397  146179.128
197.95982 289.62971  200410.452
438.68450 335.29042  375002.756
 53.35986 391.29857  235925.734
291.72441 430.65358  430912.671
215.75286 486.80421  358192.930
447.69143 520.90118  703331.781
315.92210 569.13462  602519.765
348.82063 615.91598  574949.847
160.84569 668.72415  638570.170
407.32849 711.67700  632351.588
355.52645 763.26775  806768.200
441.34309 818.99970  783857.024
229.64802 854.90956  751340.937
539.96992 905.89926 1003749.961
192.05458 957.37726  930355.415
347.03579 995.38679  968160.031
;
```

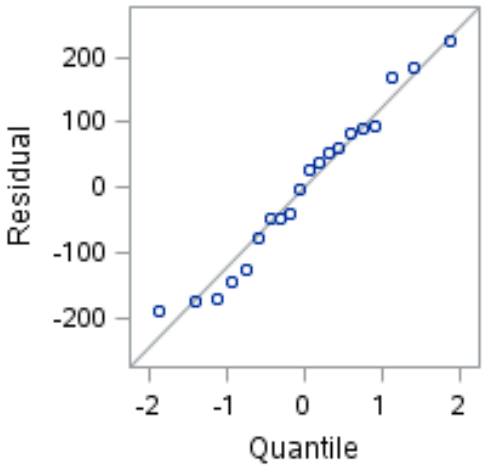

crime
police
population
200 400 600 800 1000
0 100 200 300 400 500
200 400 600 800 1000
0 500000 1000000
0 100 200 300 400 500
0 250000 500000 750000 1000000

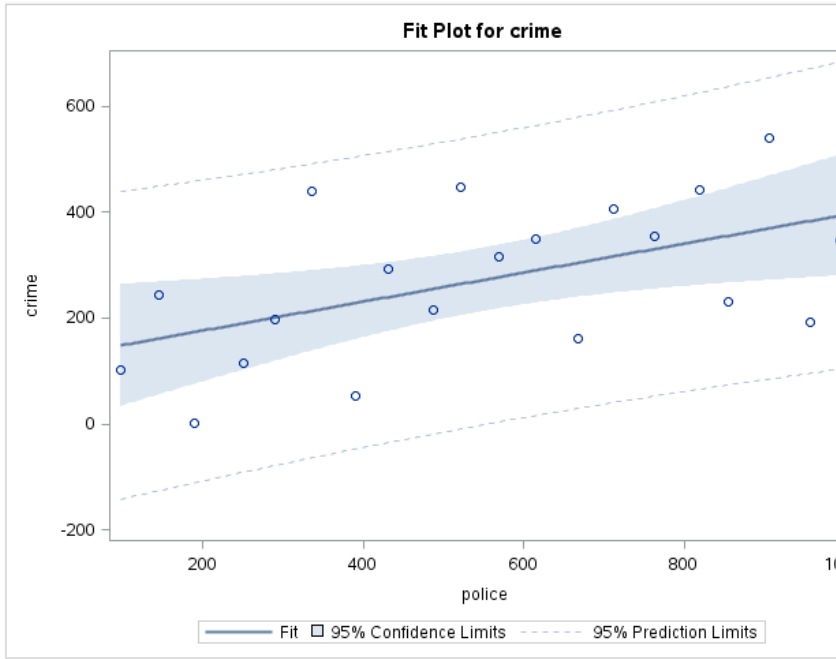
Simple Linear Regression: Crime and Policing

```
PROC GLM DATA = population PLOTS = ALL;
    MODEL crime = police / SOLUTION;
RUN;
```

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	121.8850878	63.91254453	1.91	0.0726
police	0.2735152	0.10408009	2.63	0.0171







Multiple Linear Regression: Crime and Policing/Population

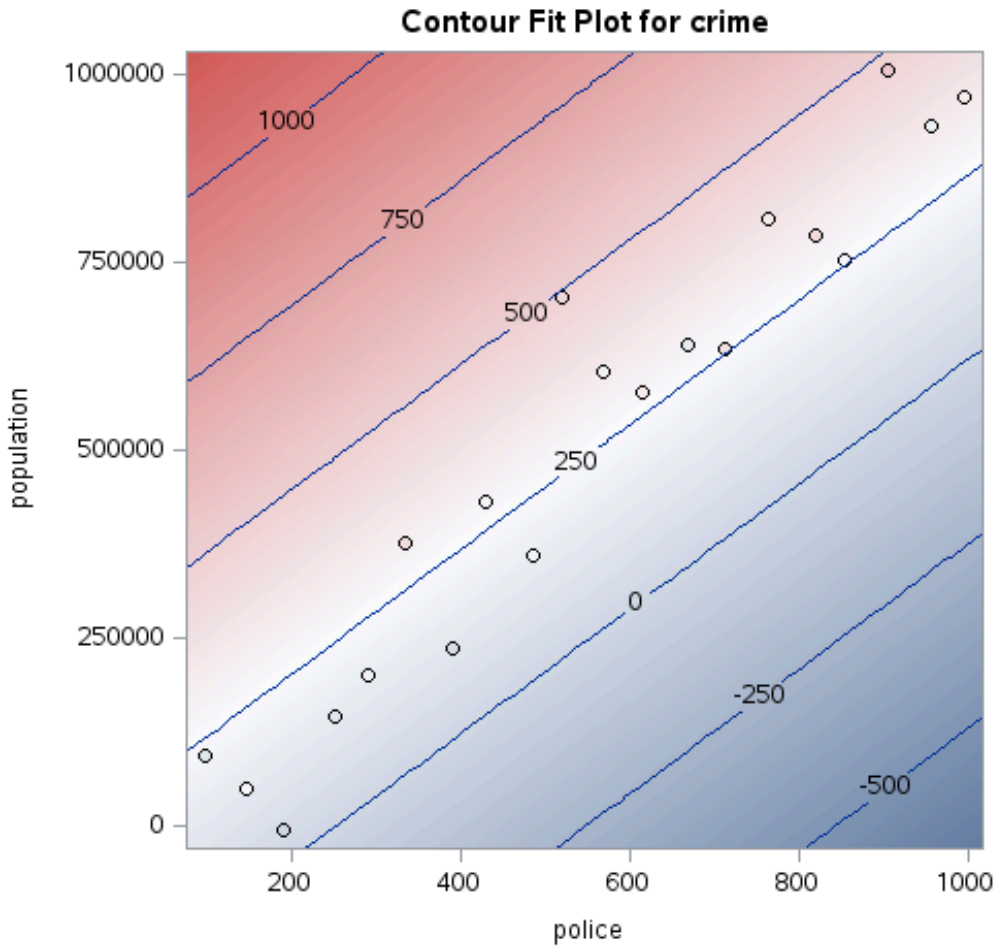
```
PROC GLM DATA = population PLOTS = ALL;
    MODEL crime = police / SOLUTION;
RUN;
```

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	121.8850878	63.91254453	1.91	0.0726
police	0.2735152	0.10408009	2.63	0.0171

```
PROC GLM DATA = population PLOTS = ALL;
    MODEL crime = police population / SOLUTION;
RUN;
```

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	213.5840719	52.54467999	4.06	0.0008
police	-0.8427494	0.29009519	-2.91	0.0099
population	0.0010162	0.00025463	3.99	0.0009

Contour Plot



Chocolate Study

Important:

- We can say that chocolate consumption is **predictive** of Nobel prizes
- We cannot say that changing chocolate consumption will **change** the number of Nobel prizes

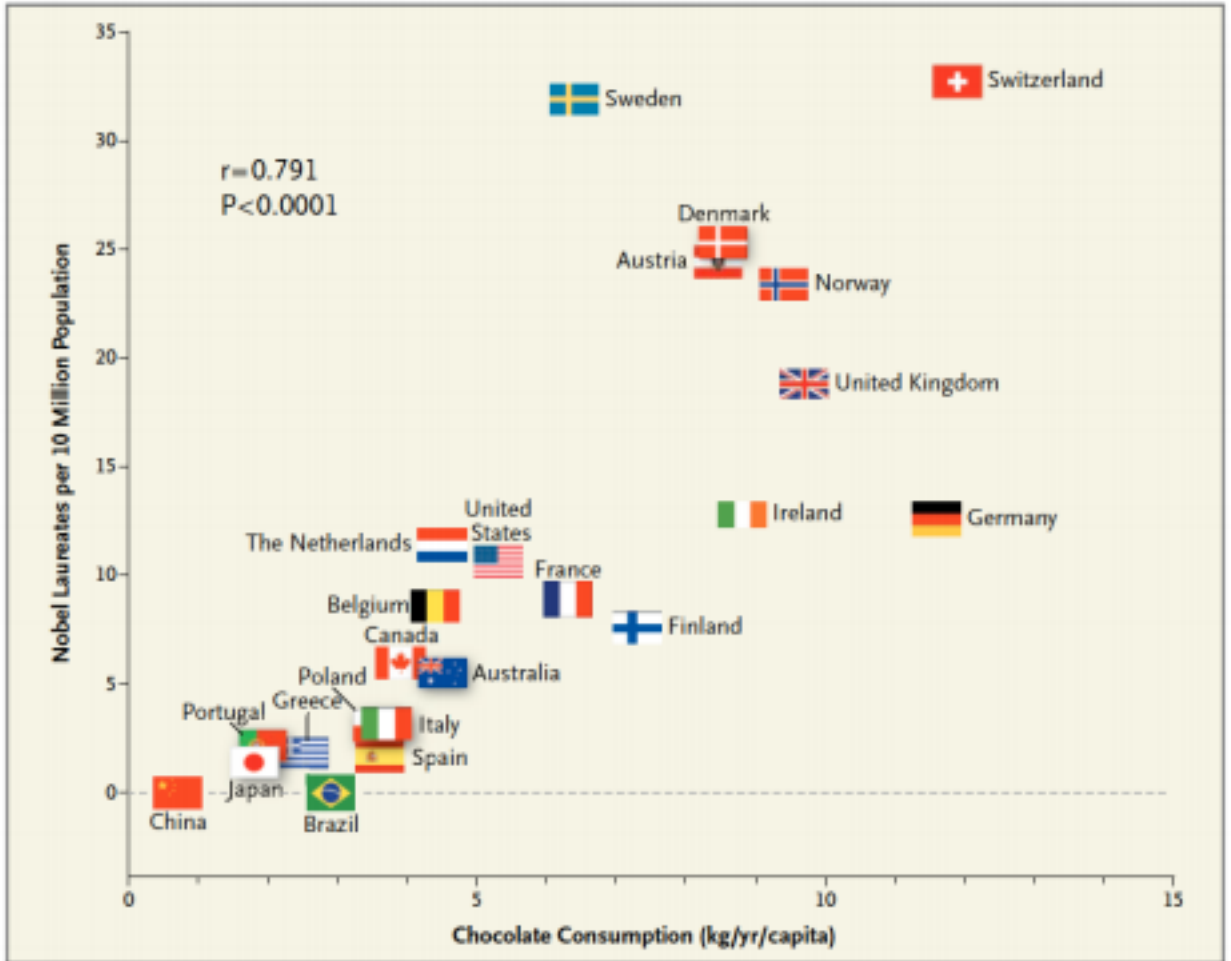


Figure 1. **Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.**

Messerli (2012), New England Journal of Medicine

Chocolate Study

Important:
Prediction: Predict Y after **observing** X
Causation: Predict Y after **setting** X

(note that randomization breaks any confounding relationships and hence allows for causal inference)

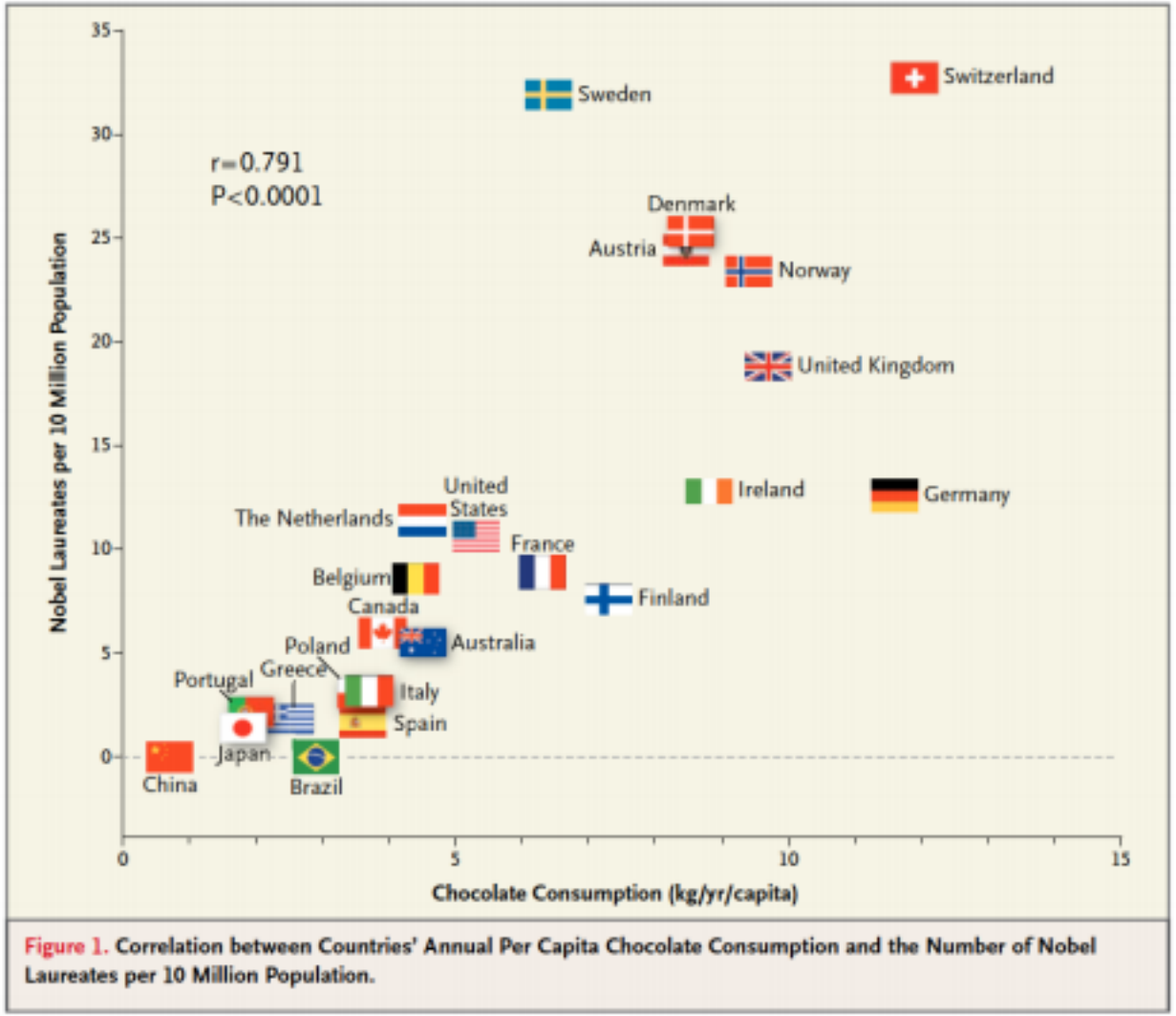
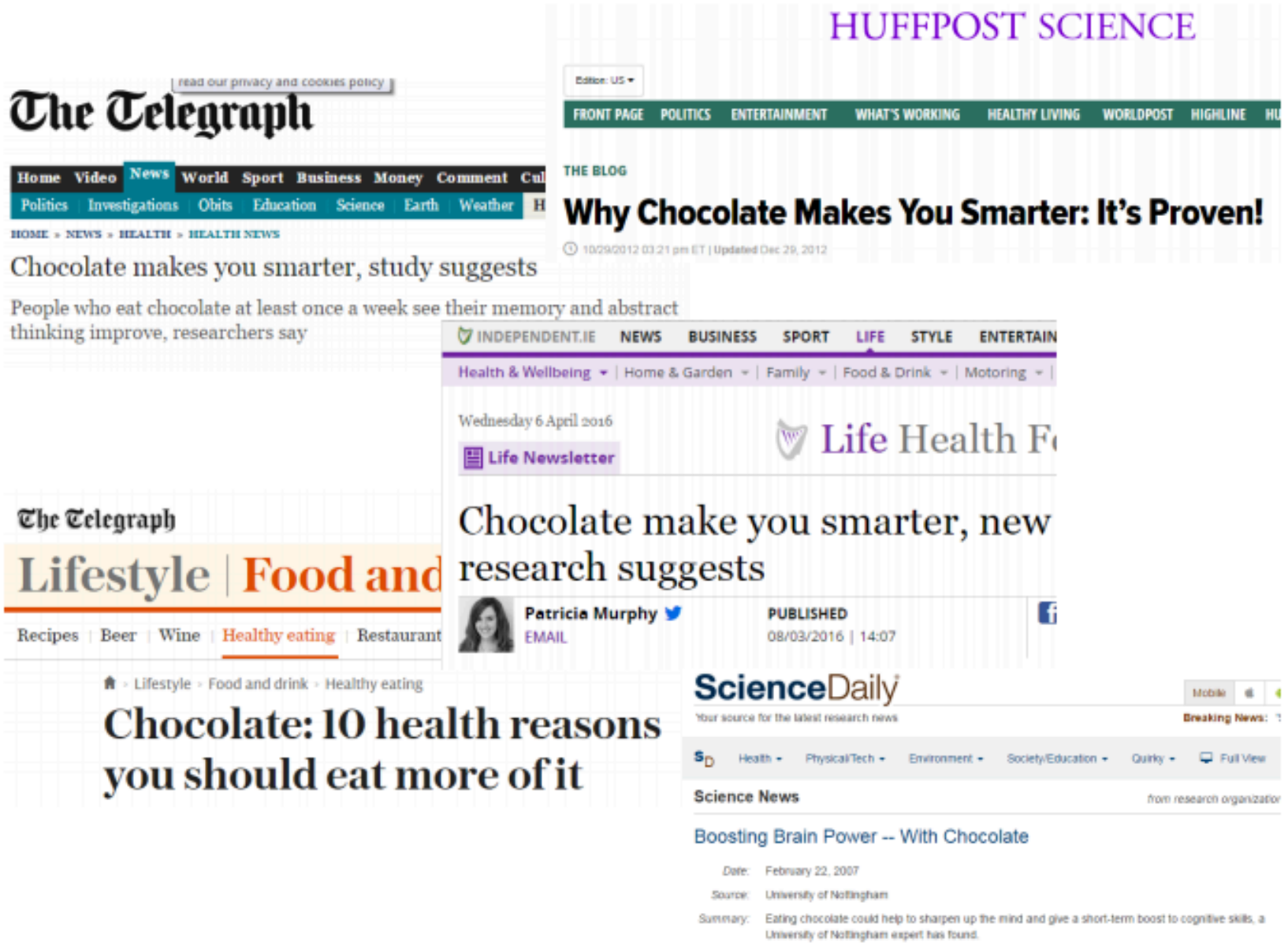


Figure 1. Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.

Messerli (2012), New England Journal of Medicine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Chocolate makes you smarter, study suggests
People who eat chocolate at least once a week see their memory and abstract thinking improve, researchers say
HUFFPOST SCIENCE
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THE BLOG
Why Chocolate Makes You Smarter: It's Proven!
INDEPENDENT.IE NEWS BUSINESS SPORT LIFE STYLE ENTERTAIN
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Wednesday 6 April 2016
Life Newsletter
Chocolate make you smarter, new research suggests
Patricia Murphy
EMAIL
PUBLISHED
08/03/2016 | 14:07
The Telegraph
Lifestyle | Food and
Recipes Beer Wine Healthy eating Restaurant
Lifestyle › Food and drink › Healthy eating
Chocolate: 10 health reasons you should eat more of it
ScienceDaily
Your source for the latest research news
Health Physical/Tech Environment Society/Education Quirky Full View
Science News
Boosting Brain Power -- With Chocolate
Date: February 22, 2007
Source: University of Nottingham
Summary: Eating chocolate could help to sharpen up the mind and give a short-term boost to cognitive skills, a University of Nottingham expert has found.

There are Many Examples of Confounding

	1995		1996		1997		Combined	
Derek Jeter	12/48	.250	183/582	.314	190/654	.291	385/1284	**.300**
David Justice	104/411	**.253**	45/140	**.321**	163/495	**.329**	312/1046	.298

Batting averages in Major League Baseball

Kidney stone treatments
(This is why blinding is crucial in clinical trials)

	Treatment A	Treatment B
Small stones	*Group 1* **93% (81/87)**	*Group 2* 87% (234/270)
Large stones	*Group 3* **73% (192/263)**	*Group 4* 69% (55/80)
Both	78% (273/350)	**83% (289/350)**

Berkeley Admissions

Gender	Admitted	Denied	%
Male	1198	1493	44.52%
Female	557	1278	30.35%

Is there evidence of discrimination?

Berkeley Admissions

Selectivity	Gender	Admitted	Total
High	Male	Yes	333 (25.5%)
High	Male	No	973
High	Female	Yes	451 (26.5%)
High	Female	No	1251
Moderate	Male	Yes	865 (62.5%)
Moderate	Male	No	520
Moderate	Female	Yes	106 (79.7%)
Moderate	Female	No	27