

# **Correlation vs Causation: Why the Media gets it wrong**

**Rebecca Barter**  
**Department of Statistics**

# Human causal reasoning



# What are correlation and causation?

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  - For example, these two events tend to happen at the same time.

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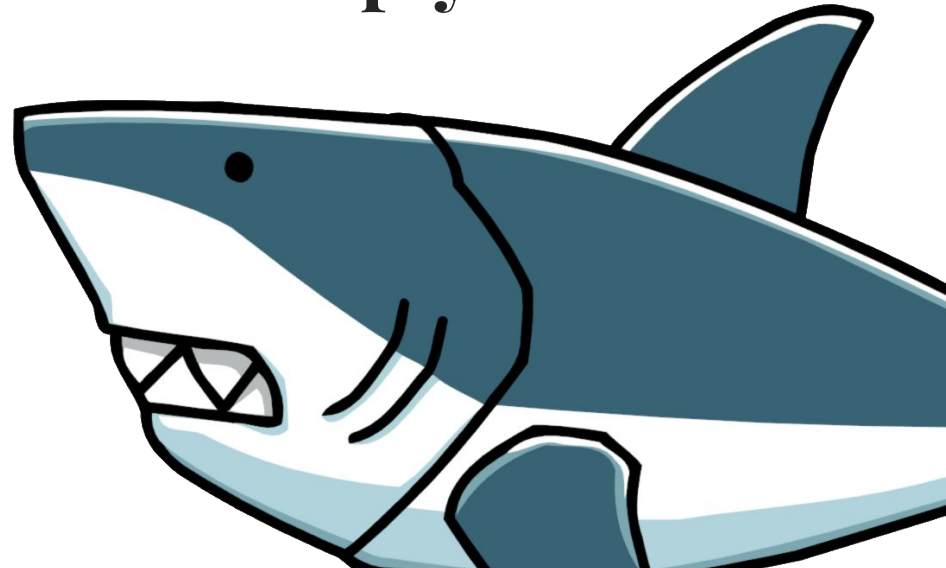
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**Correlation does not imply causation!**

## Correlation or causation?



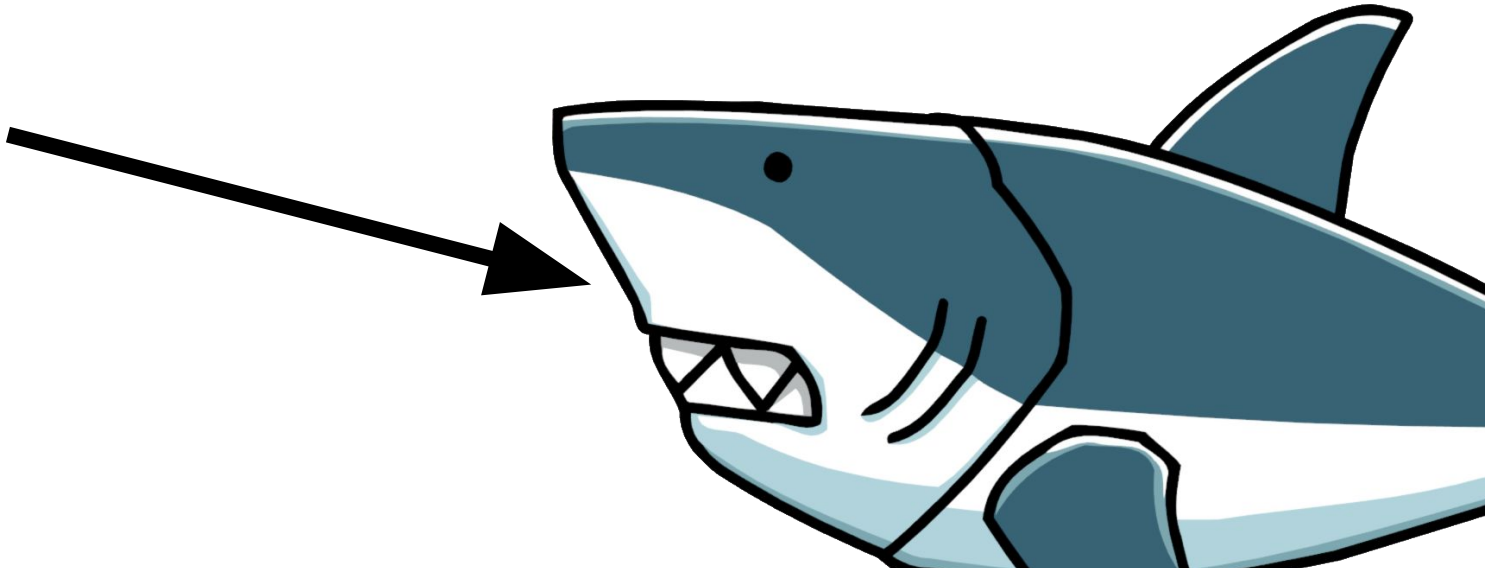
**As ice cream sales increase, the rate of shark attacks sharply increases.**



Correlation or causation?

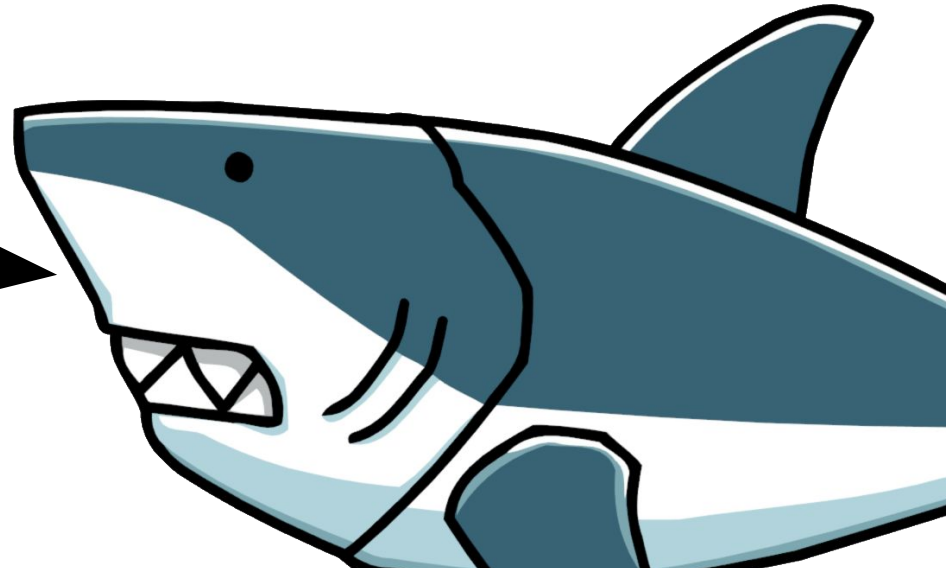
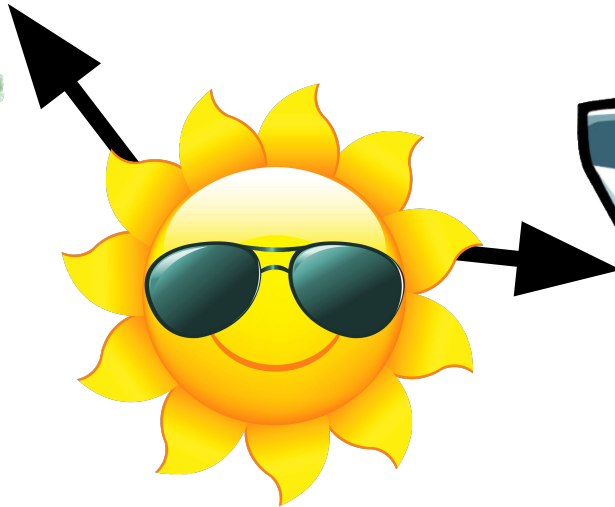


Ice cream **causes** shark attacks!!



## Correlation or causation?

On hot days, people eat more ice cream  
and spend more time in the ocean.






**Most examples are not so  
obvious...**

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Check out this media report

## Want to live longer, even if you're poor? Then move to a big city in California.

*Updated by Ezra Klein on April 13, 2016, 1:30 p.m. ET*  [@ezraklein](#)

 TWEET

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# The original JAMA research paper



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Special Communication | April 10, 2016

## The **Association** Between Income and Life Expectancy in the United States, 2001-2014 **FREE**

**ONLINE FIRST**

Raj Chetty, PhD<sup>1</sup>; Michael Stepner, BA<sup>2</sup>; Sarah Abraham, BA<sup>2</sup>; Shelby Lin, MPhil<sup>3</sup>; Benjamin Scuderi, BA<sup>4</sup>; Nicholas Turner, PhD<sup>5</sup>; Augustin Bergeron, MA<sup>4</sup>; David Cutler, PhD<sup>4</sup>

[\[+\] Author Affiliations](#)

JAMA. Published online April 10, 2016. doi:10.1001/jama.2016.4226

Text Size: [A](#) [A](#) [A](#)

# The original JAMA research paper



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“Although the **correlational analysis in this study cannot establish causal mechanisms**, it is a step toward determining which theories for disparities in longevity deserve further consideration.”

# Here's another example...

SECTIONS

HOME SEARCH

The New York Times



Chip, Implanted in Brain,  
Helps Paralyzed Man  
Regain Control of Hand



WELL  
A Decades-Old Study,  
Rediscovered, Challenges  
Advice on Saturated Fat



PHYS ED  
An Easy Way to Prevent  
Blisters? Try Tape



Aid Groups Aim to Put  
Mental Health on World  
Agenda

## RESEARCH

# Fan in Room Seems to Cut Infants' Risk of Crib Death

By TARA PARKER-POPE OCT. 6, 2008



Sleeping in a room with a fan lowers a baby's risk of [sudden infant death syndrome](#) by 72 percent, a new study has found.

The finding, published Monday in The Archives of Pediatrics and Adolescent Medicine, is the latest evidence to suggest that a baby's sleep environment is a critical factor in the risk of [SIDS](#), which is diagnosed when an infant's sudden death cannot be explained by other factors.

# Here's another example... the original research paper

Arch Pediatr Adolesc Med. 2008 Oct;162(10):963-8. doi: 10.1001/archpedi.162.10.963.

## **Use of a fan during sleep and the risk of sudden infant death syndrome.**

Coleman-Phox K<sup>1</sup>, Odouli R, Li DK.

### **Author information**

### **Abstract**

**OBJECTIVE:** To examine the relation between room ventilation during sleep and risk of sudden infant death syndrome (SIDS).

**DESIGN:** Population-based case-control study.

**SETTING:** Eleven California counties.

**PARTICIPANTS:** Mothers of 185 infants with a confirmed SIDS diagnosis and 312 randomly selected infants matched on county of residence, maternal race/ethnicity, and age. Intervention Fan use and open window during sleep. Main Outcome Measure Risk of SIDS.

**RESULTS:** Fan use during sleep was associated with a 72% reduction in SIDS risk (adjusted odds ratio [AOR], 0.28; 95% confidence interval [CI], 0.10-0.77). The reduction in SIDS risk seemed more

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I could go on for days...



REUTERS

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Life | Tue Sep 18, 2007 2:26pm EDT

# Tooth loss in elderly linked to mental impairment

NEW YORK | BY ANNE HARDING



(Reuters Health) - Older people who have lost their teeth are at more than three-fold greater risk of memory problems and dementia, UK researchers report.

"This study essentially raises questions rather than answering them," Dr. Robert Stewart of Kings College London, the study's lead author, told Reuters Health. "The measurements were taken at the same time, so we are not able to say what caused what."

PICTURES OF THE DAY





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## Politics

# Diet of fish 'can prevent' teen violence

New study reveals that the root cause of crime may be biological, not social

Gaby Hinsliff,  
chief political  
correspondent

Sunday 14 September  
2003 04.22 EDT



This article is 12 years  
old

Shares

1

Feeding children a diet rich in fish could prevent violent and anti-social behaviour in their teens, according to research to be announced this week which suggests the root causes of crime may be biological rather than social.

The study raises major questions over the extent to which criminals exercise free will, as well as fuelling fresh debate over whether simple childhood interventions might be more use in preventing crime than blaming parents or organising draconian crackdowns on crime.

Professor Adrian Raine, a leading psychologist at the University of California, will outline a growing body of evidence showing that violent offenders have physical defects in a part of the brain linked to decision-making and self-control - which

## Most popular in US



Letting them die:  
parents refuse medical  
help for children in the  
name of Christ



Trump supporters sent  
Colorado GOP chair  
'thousands' of death  
threats - live

So how *can* we infer  
causation?

---

A case study

# Smoking causes lung cancer?

You can smoke fewer cigarettes by smoking longer ones.

"It's wacky, but it works."

A woman with blonde hair is smiling broadly. A hand from a man in a patterned shirt is holding a lit cigarette near her face, as if about to light it. The background is a solid blue color.

According to repeated nationwide surveys,

## More Doctors Smoke **CAMELS** than any other cigarette!

Doctors in every branch of medicine were asked, "What cigarette do you smoke?" The brand named most was Camel!

You'll enjoy Camels for the same reasons so many doctors enjoy them. Camels have cool, cool *mildness*, pack after pack, and a *flavor* unmatched by any other cigarette.

Make this sensible test: Smoke only Camels for 30 days and see how well Camels please your taste, how well they suit your throat as your steady smoke. You'll see how enjoyable a cigarette can be!

THE DOCTORS' CHOICE IS AMERICA'S CHOICE!



MAUREEN O'HARA says: "I pick Camels. They agree with my throat and taste wonderful!"



DICK HAYMES says: "I get more pleasure from Camels than from any other brand!"



RALPH BELLAMY reports: "Camels suit my taste and throat. I've smoked 'em for years!"



For 30 days, test Camels in your "T-Zone" (T for Throat, T for Taste).

# The first solid epidemiological evidence, 1950s

## BRITISH MEDICAL JOURNAL

LONDON SATURDAY NOVEMBER 10 1956

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### LUNG CANCER AND OTHER CAUSES OF DEATH IN RELATION TO SMOKING

A SECOND REPORT ON THE MORTALITY OF BRITISH DOCTORS

BY

**RICHARD DOLL, M.D., M.R.C.P.**

*Member of the Statistical Research Unit of the Medical Research Council*

AND

**A. BRADFORD HILL, C.B.E., F.R.S.**

*Professor of Medical Statistics, London School of Hygiene and Tropical Medicine; Honorary Director of  
the Statistical Research Unit of the Medical Research Council*

On October 31, 1951, we sent a simple questionnaire to all members of the medical profession in the United Kingdom. In addition to giving their name, address, and age, they were asked to classify themselves into one of three groups—namely, (a) whether they were, at that time, smokers of tobacco; (b) whether they had smoked but had given up; or (c) whether they had never smoked regularly (which we defined as having never smoked as much as one cigarette a day, or its equivalent in pipe tobacco or cigars, for as long as one year). All smokers

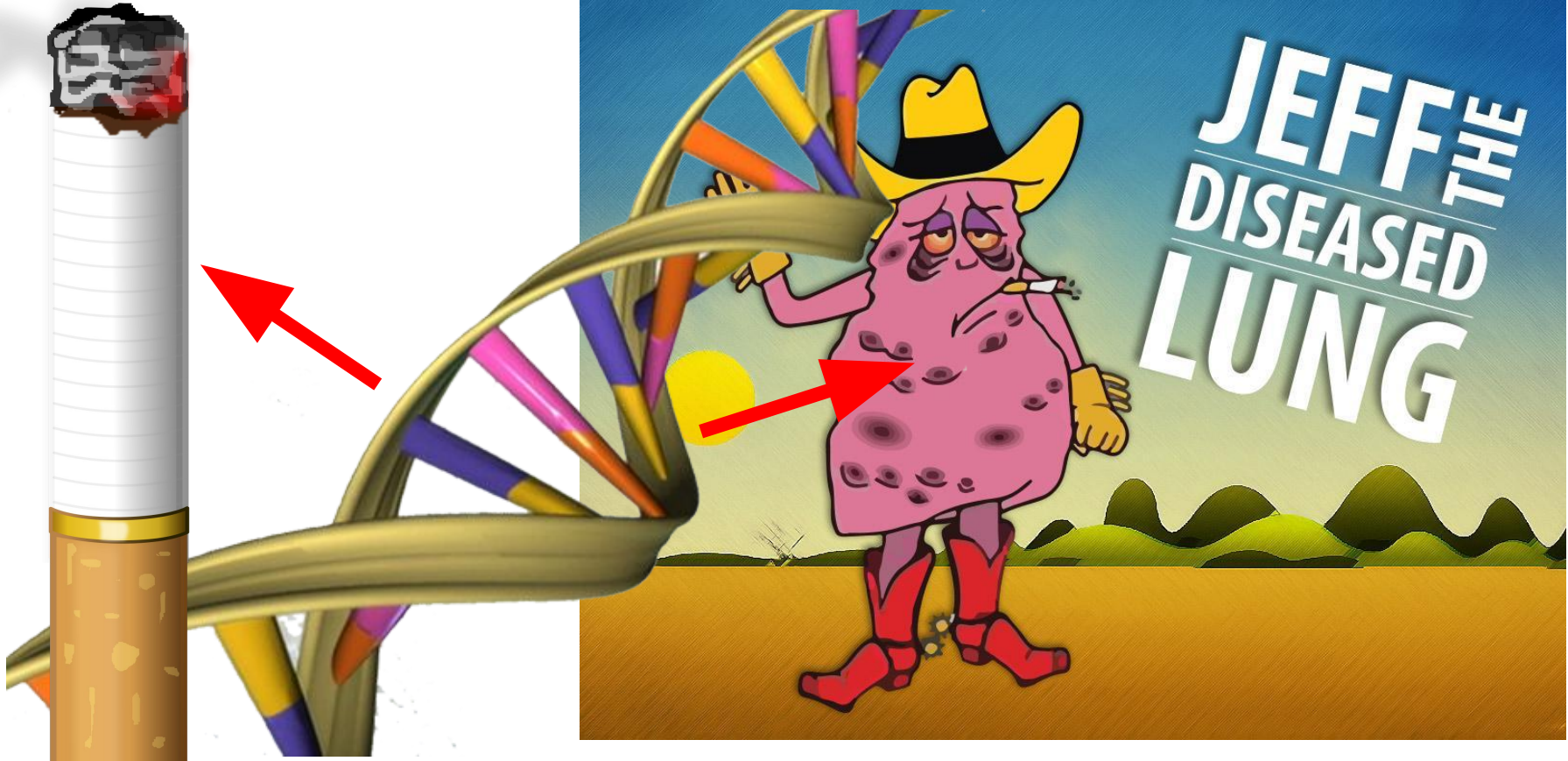
previously have been a light smoker or may since then have given up smoking altogether; we shall have continued to count him, or her, as a heavy smoker. If there is a differential death rate with smoking, we must by such errors tend to inflate the mortality among the light smokers and to reduce the mortality among the heavy smokers. In other words, the gradients we present in this paper may be understatements but (apart from sampling errors due to the play of chance) cannot be overstatements.



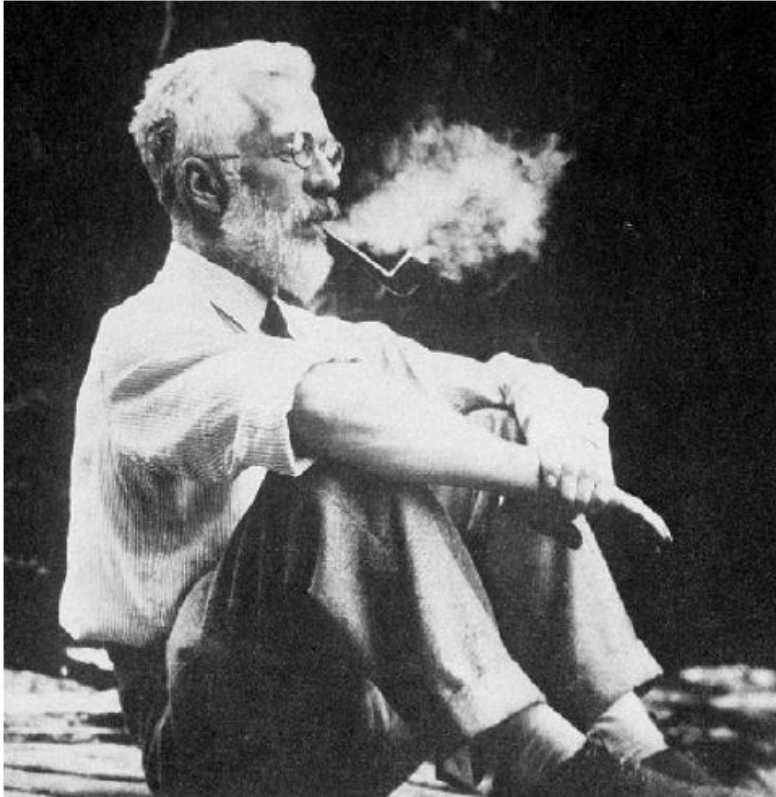
**Cigarettes cause lung cancer!**



# Genetics as the cause of both smoking and lung cancer?



**R. A. Fisher strongly believed in a common genetic cause!**



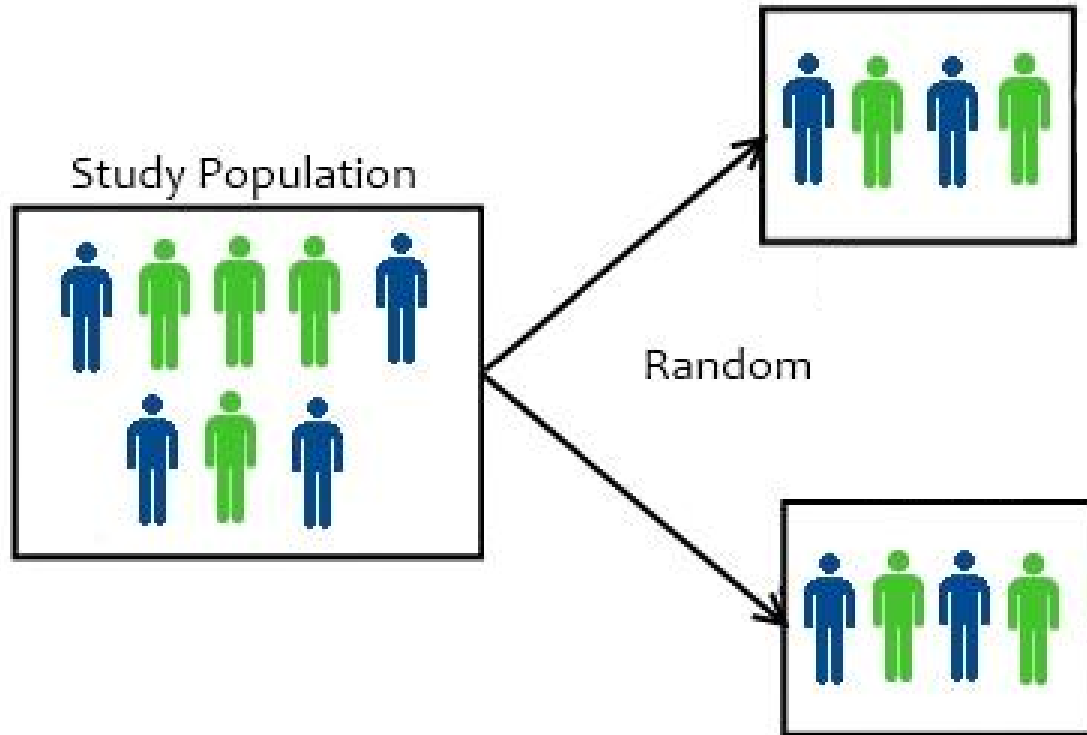
17 February 1890 –  
29 July 1962

# Gold Standard Evidence: Randomized Trial

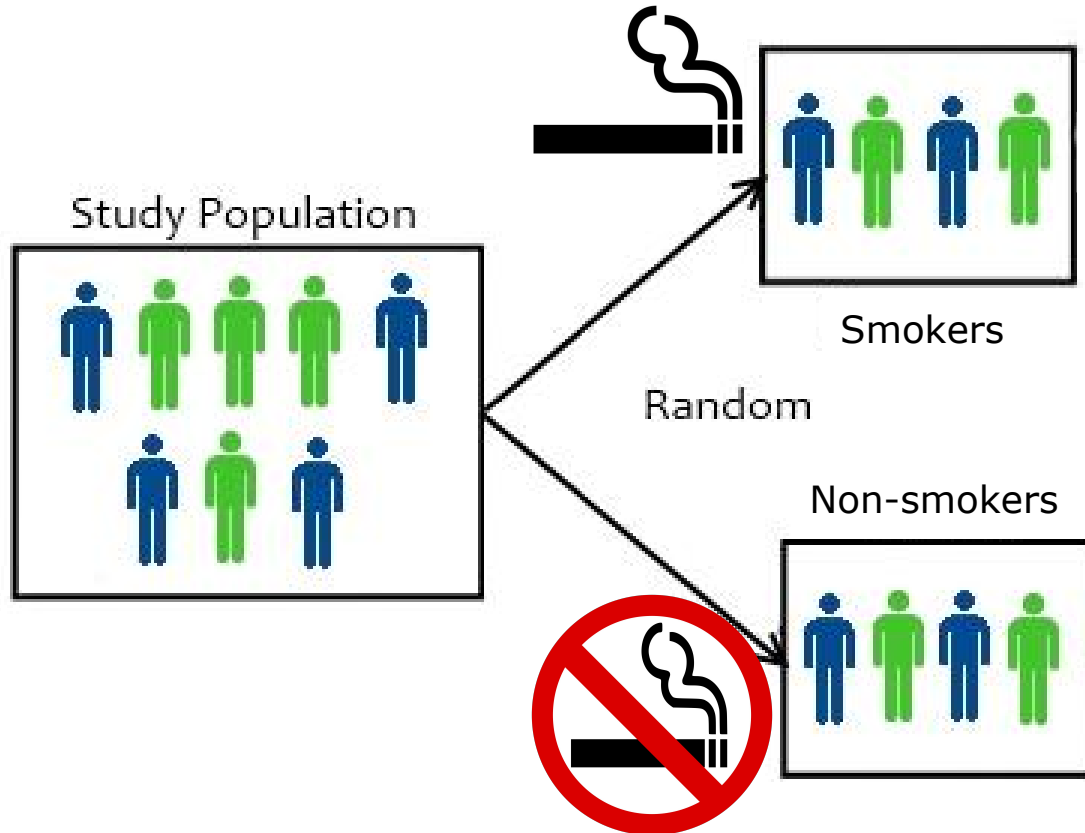
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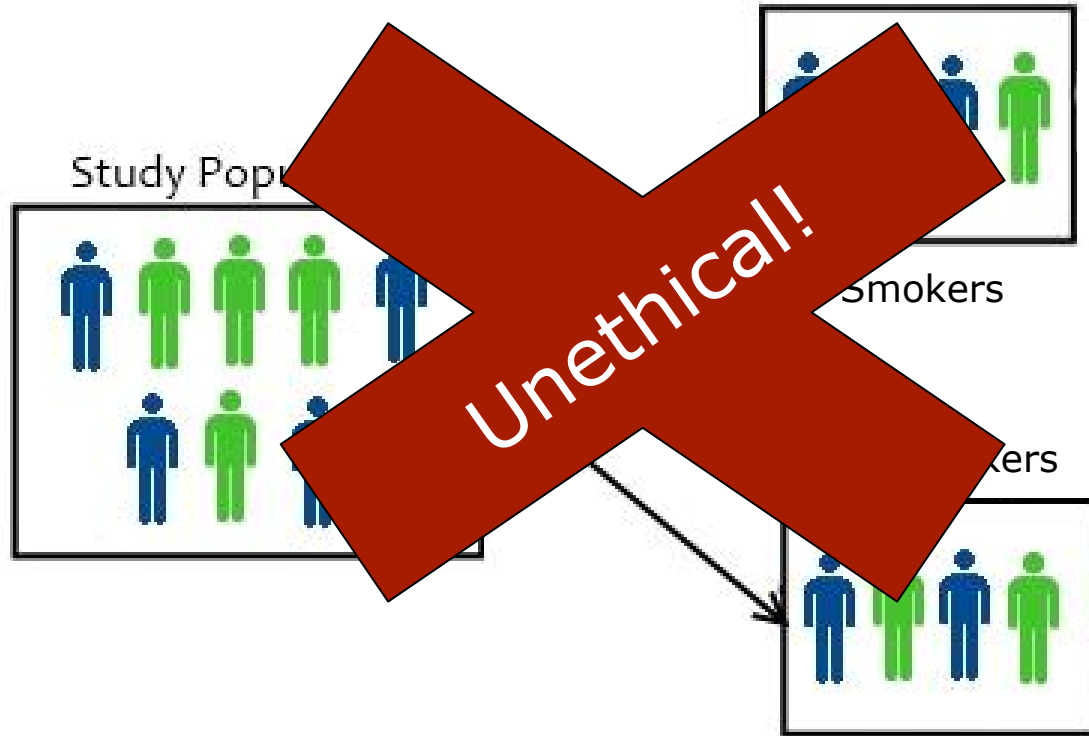
# Conduct a randomized study!



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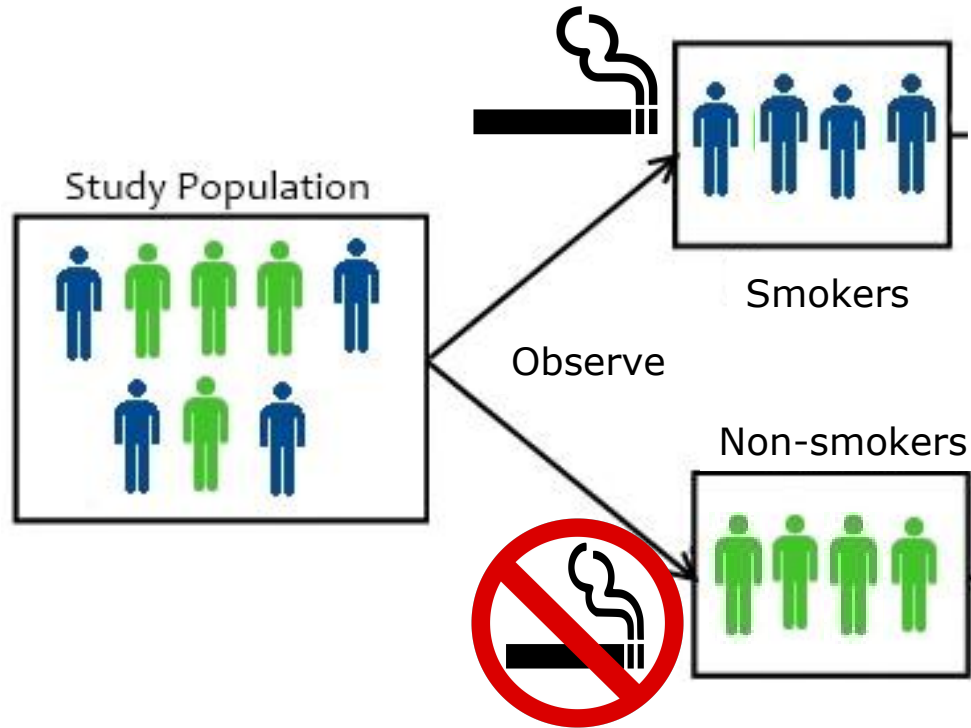
**Conduct a randomized study!**



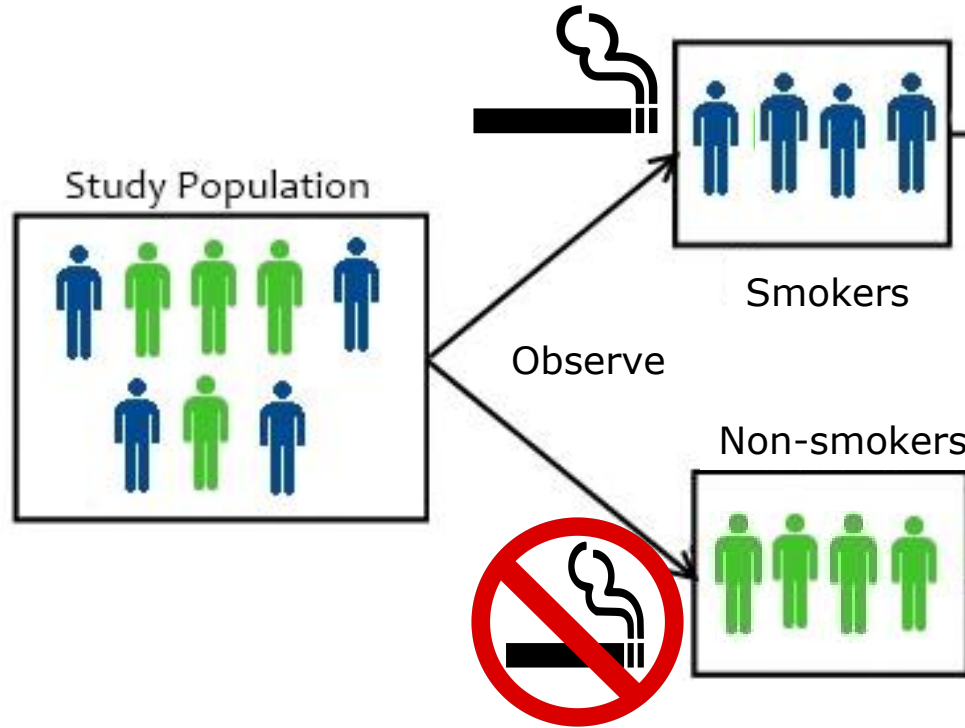
Next best thing:  
Observational study

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# Conduct an observational study!



# Conduct an observational study!

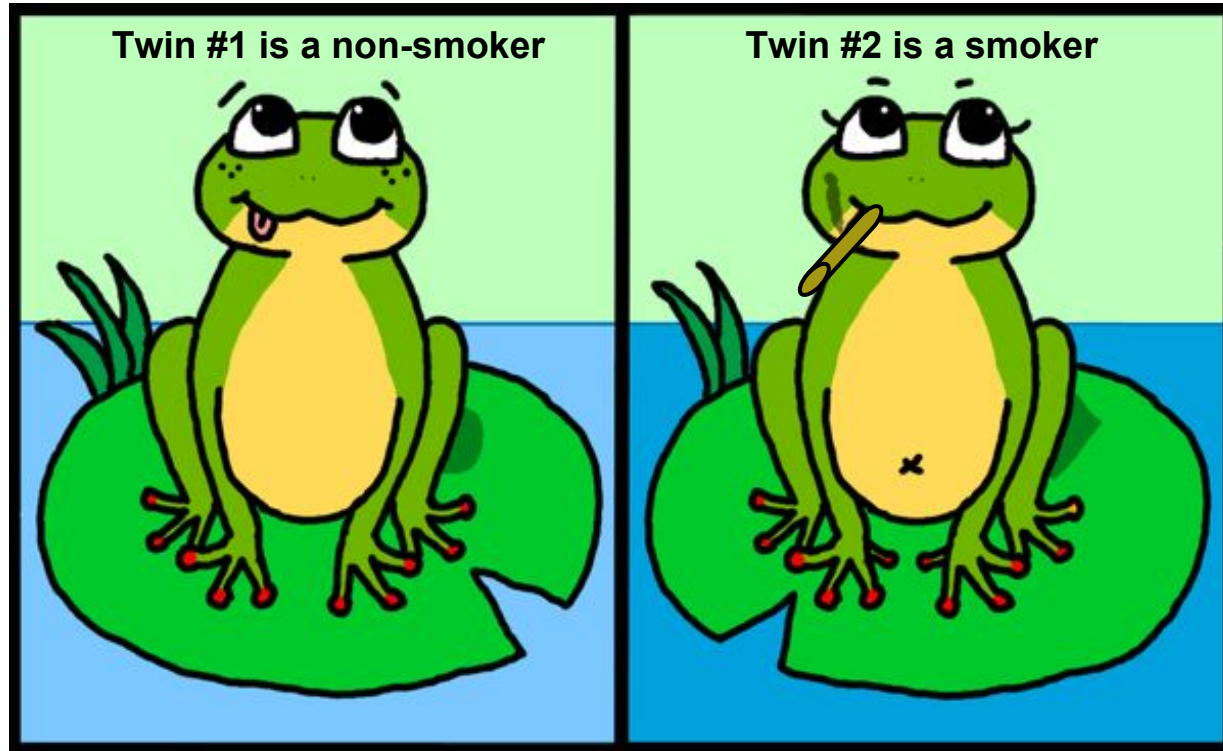


The smokers  
and  
non-smokers  
**differ in ways  
other than  
smoking status!**

Goal: Compare like-with-like

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# Control for genetic differences: **compare identical twins!**





The evidence kept piling in... Until finally in 1964

# SMOKING *and* HEALTH

REPORT OF THE ADVISORY COMMITTEE  
TO THE SURGEON GENERAL  
OF THE PUBLIC HEALTH SERVICE



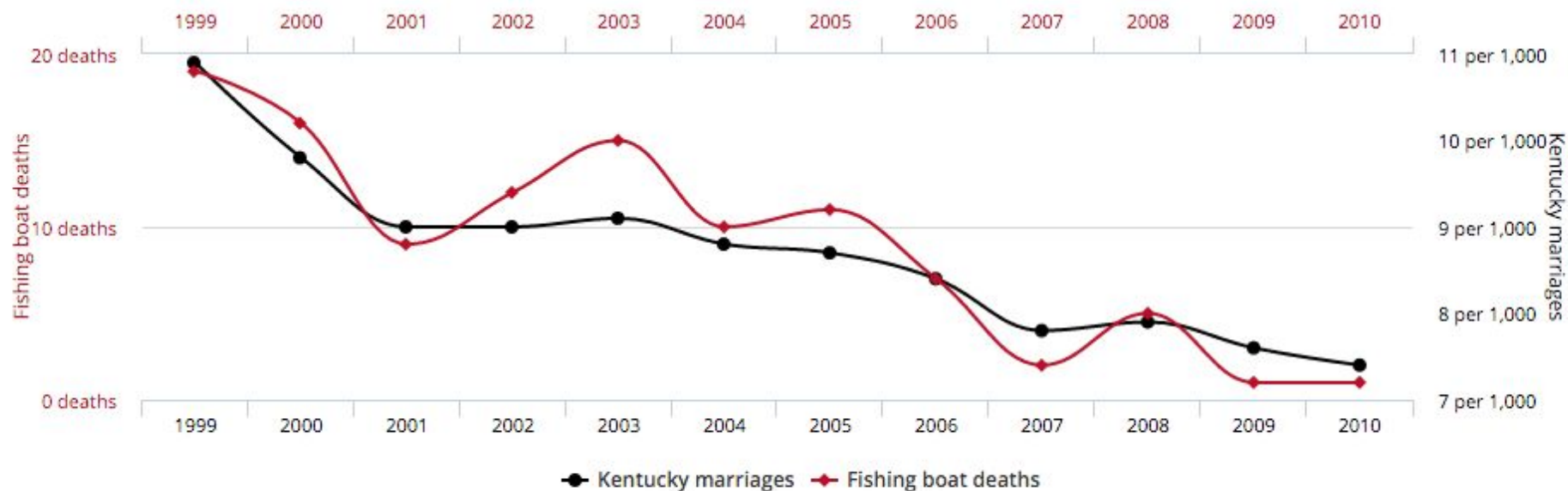
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE  
Public Health Service

**Just for fun... here are some  
spurious correlations!**

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# People who drowned after falling out of a fishing boat correlates with Marriage rate in Kentucky

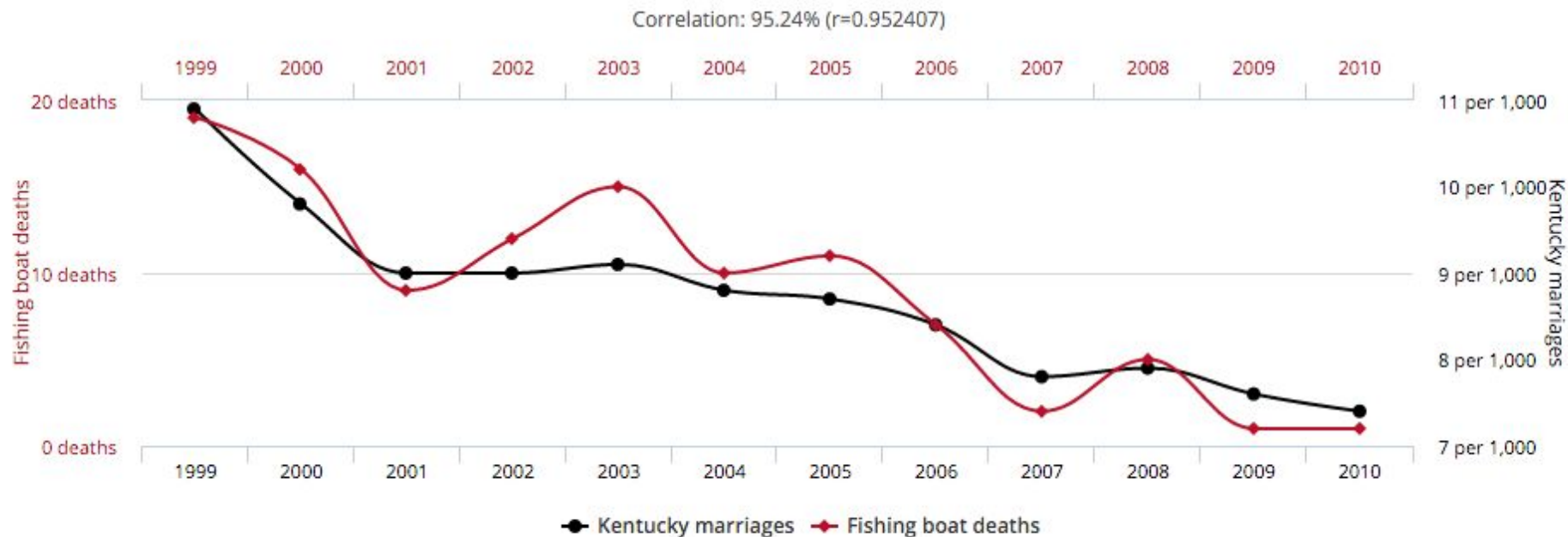
Correlation: 95.24% ( $r=0.952407$ )



Data sources: Centers for Disease Control & Prevention and National Vital Statistics Reports

tylervigen.com

# Marriage causes drowning...



tylervigen.com

Data sources: Centers for Disease Control & Prevention and National Vital Statistics Reports

# Per capita consumption of mozzarella cheese correlates with Civil engineering doctorates awarded

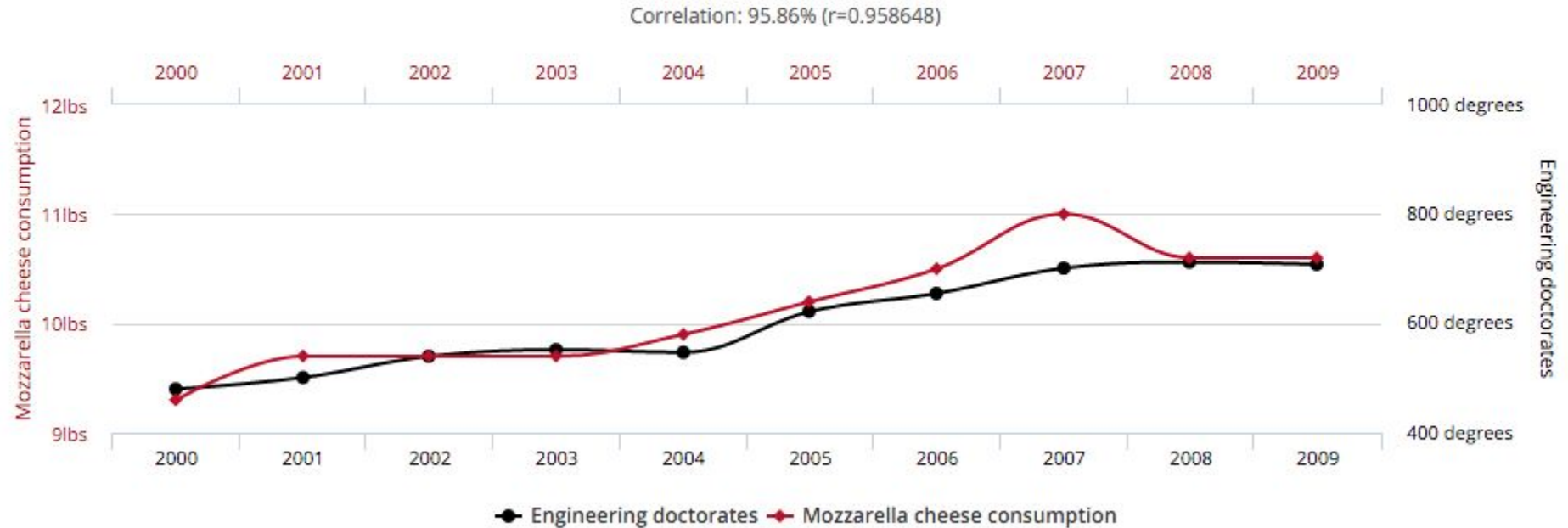
Correlation: 95.86% ( $r=0.958648$ )



tylervigen.com

Data sources: U.S. Department of Agriculture and National Science Foundation

# Eating a lot of cheese will get you a civil engineering PhD



tylervigen.com

Data sources: U.S. Department of Agriculture and National Science Foundation

**Thanks!**

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