



# Lecture 1

---

Cause & Effect

# Announcements

- Lab 1 released Monday, due Sunday
- HW 1 released today! Also due Sunday!
- Reading too.
- iClickers, Piazza & tutor hours.

**(demo)**

# A Link

## Coffee

### Three coffees a day linked to a range of health benefits

Research based on 200 previous studies worldwide says frequent drinkers less likely to get diabetes, heart disease, dementia and some cancers



< 34

6

Staff and agencies

Wednesday 22 November  
2017 19:54 EST



 The findings supported other studies showing the health benefits of drinking coffee. Photograph: Wu Hong/EPA

Guardian UK

# A Stronger Link?

---

eating and health

## Chocolate, Chocolate, It's Good For Your Heart, Study Finds

JUNE 19, 2015 5:03 AM ET



ALLISON AUBREY



[npr.org](http://npr.org) (report on a study in [heart.bmj.com](http://heart.bmj.com))

---

# Observation

---

- **individuals**, study subjects, participants, units
    - *European adults*
  - **treatment**
    - *chocolate consumption*
  - **outcome**
    - *heart disease*
-

# The first question

---

Is there **any relation** between chocolate consumption and heart disease?

- **association**
    - any relation
    - link
-

# An answer

---

## Some data:

“Among those in the top tier of chocolate consumption, 12 percent developed or died of cardiovascular disease during the study, compared to 17.4 percent of those who didn’t eat chocolate.”

-Howard LeWine of Harvard Health Blog, reported by [npr.org](https://www.npr.org)

- Yes, this points to an association  
(in my opinion)
-



# The next question

---

Does chocolate consumption **lead to** a reduction in heart disease?

- **causality**

This question is often harder to answer.

“[The study] doesn’t prove a cause-and-effect relationship between chocolate and reduced risk of heart disease and stroke.”

– JoAnn Manson, chief of Preventive Medicine at Brigham and Women’s Hospital, Boston

---

# Association

# London, early 1850's

---



A COURT FOR KING CHOLERA.

Illustration from *Punch*  
(1852).

# Miasmas, miasmatism, miasmatists

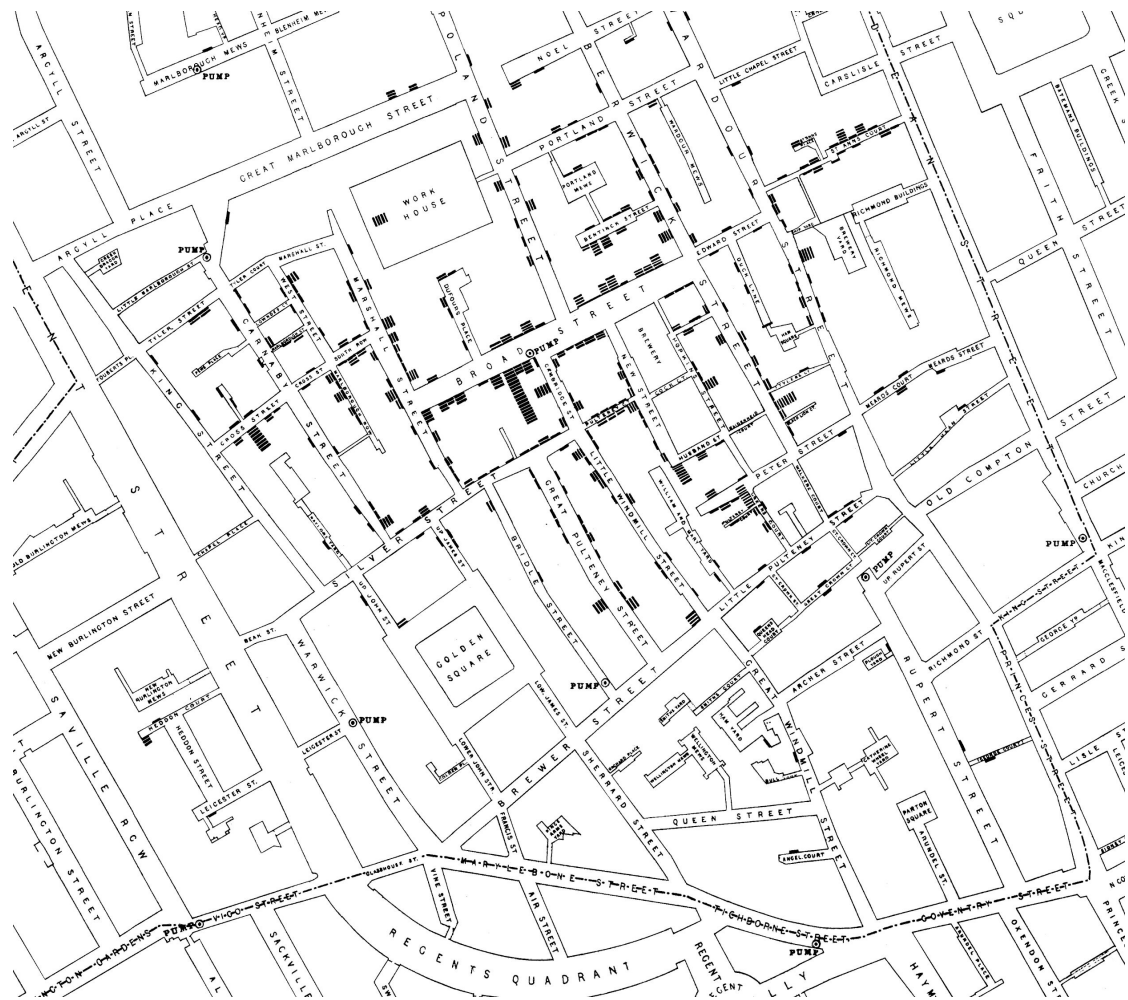
---

- **Bad smells** given off by waste and rotting matter
  - **Believed to be the main source of disease**
  - Suggested remedies:
    - “fly to clene air”
    - “a pocket full o’posies”
    - “fire off barrels of gunpowder”
  - **Staunch believers:**
  - Florence Nightingale
  - Edwin Chadwick, Commissioner of the General Board of Health
-

# John Snow, 1813-1858

---

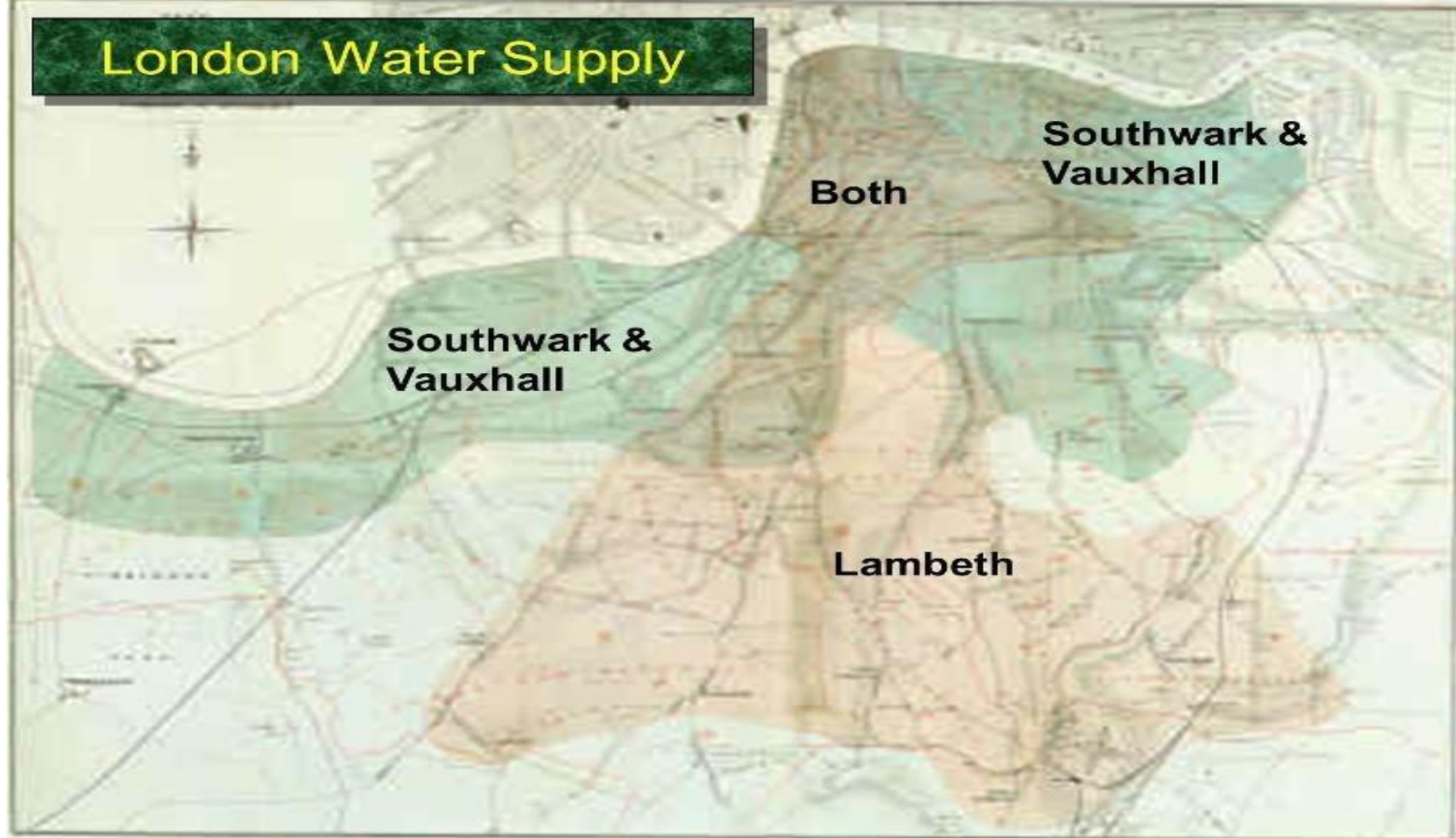




# Causation



# London Water Supply





# Comparison

---

- **treatment group**
- **control group**
  - does not receive the treatment

# Snow's “Grand Experiment”

---

“... there is no difference whatever in the houses or the people receiving the supply of the two Water Companies, or in any of the physical conditions with which they are surrounded ...”

- The two groups were *similar except for the treatment*.
-

# Snow's table

---

Supply Area	Number of houses	Cholera deaths	Deaths per 10,000 houses
S&V	40,046	1,263	315
Lambeth	26,107	98	37
Rest of London	256,423	1,422	59

---

# Key to establishing causality

---

If the treatment and control groups are *similar apart from the treatment*, then differences between the outcomes in the two groups can be ascribed to the treatment.

---

# Confounding

# Trouble

---

If the treatment and control groups have **systematic differences other than the treatment**, then it might be difficult to identify causality.

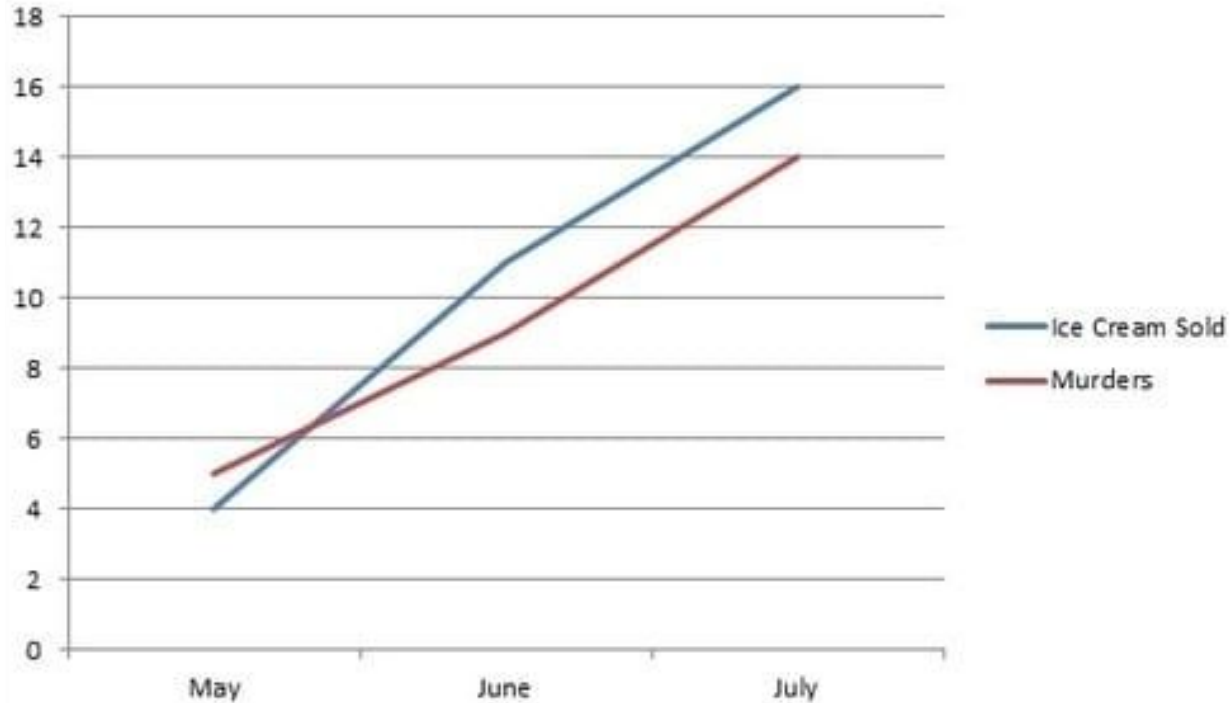
Such differences are often present in **observational studies**.

When they lead researchers astray, they are called **confounding factors**.

---

# Example of Confounding

---



# Randomize!

---

- If you assign individuals to treatment and control **at random**, then the two groups are likely to be similar apart from the treatment.
  - You can account – mathematically – for variability in the assignment.
  - **Randomized Controlled Experiment**
-



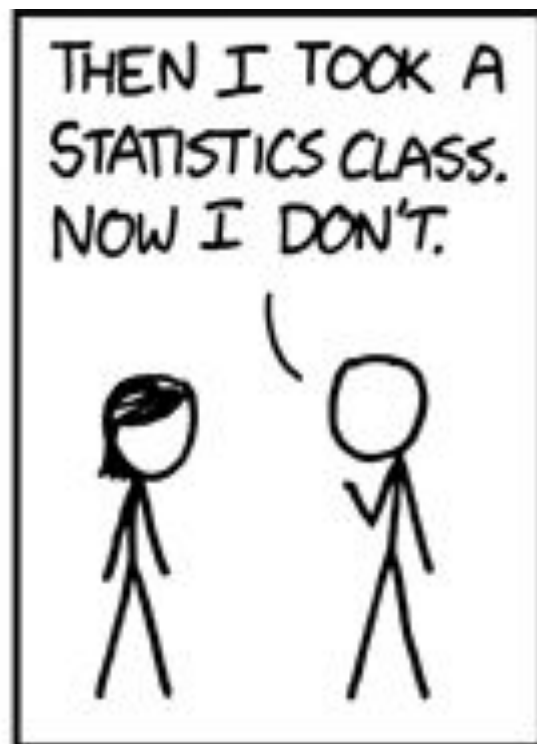
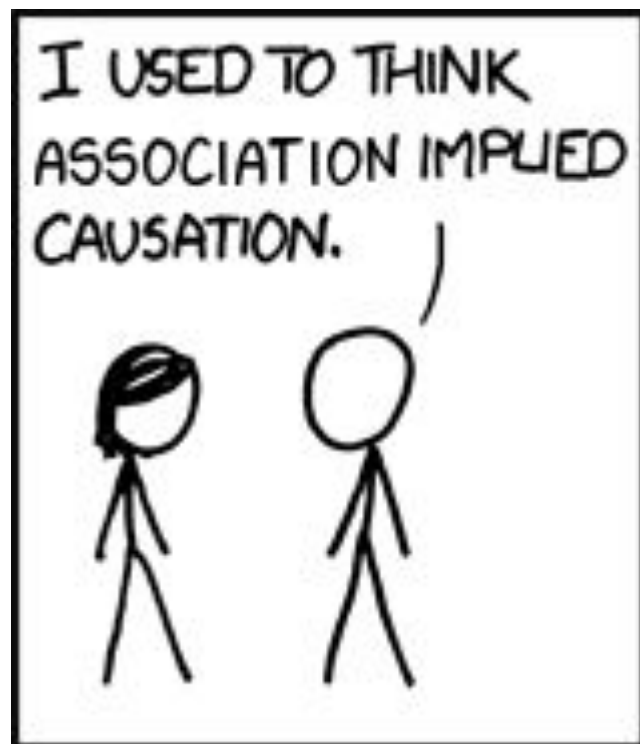
# Careful ...

---

Regardless of what the dictionary says,  
in probability theory

**Random  $\neq$  Haphazard**

---



Credit: xkcd