Randomized experiments

PSCI 2301: Quantitative Political Science II

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Recap

Last week — the potential outcomes model

1. Causal effects as differences in potential outcomes, $\tau_i = Y_{1i} - Y_{0i}$
2. Observed difference in means $\neq$ avg treatment effect (usually)
    - Treatment group not representative of full population
    - … except under the independence condition: No covariance between potential outcomes and treatment assignment
3. How can we meet the independence condition?
    a. Experimentally manipulate treatment assignment
    b. Condition on confounding variables
    c. Look for natural experiments with "as-if random" assignment

Today's agenda

Randomized experiments: Most reliable path to causal inference

... but also the most difficult to pull off in practice

1. Motivating question: How does social pressure affect voting?
2. Basic experimental design
3. Why randomization ensures the independence condition holds

Motivating question: Social pressure and voting

Voting: the cost-benefit calculus

Voting is costly

- Registration
- Remembering when the election is held
- Learning about the candidates
- Standing in line on Election Day, or figuring out how to vote early

...and yet the direct political benefits are infinitesimal

Chances are, your vote will never decide an election

The probability of being pivotal

Imagine there are only 500 other voters

Close election: Each other voter 50% to vote R, 50% to vote D

What's the probability your vote will decide the election?

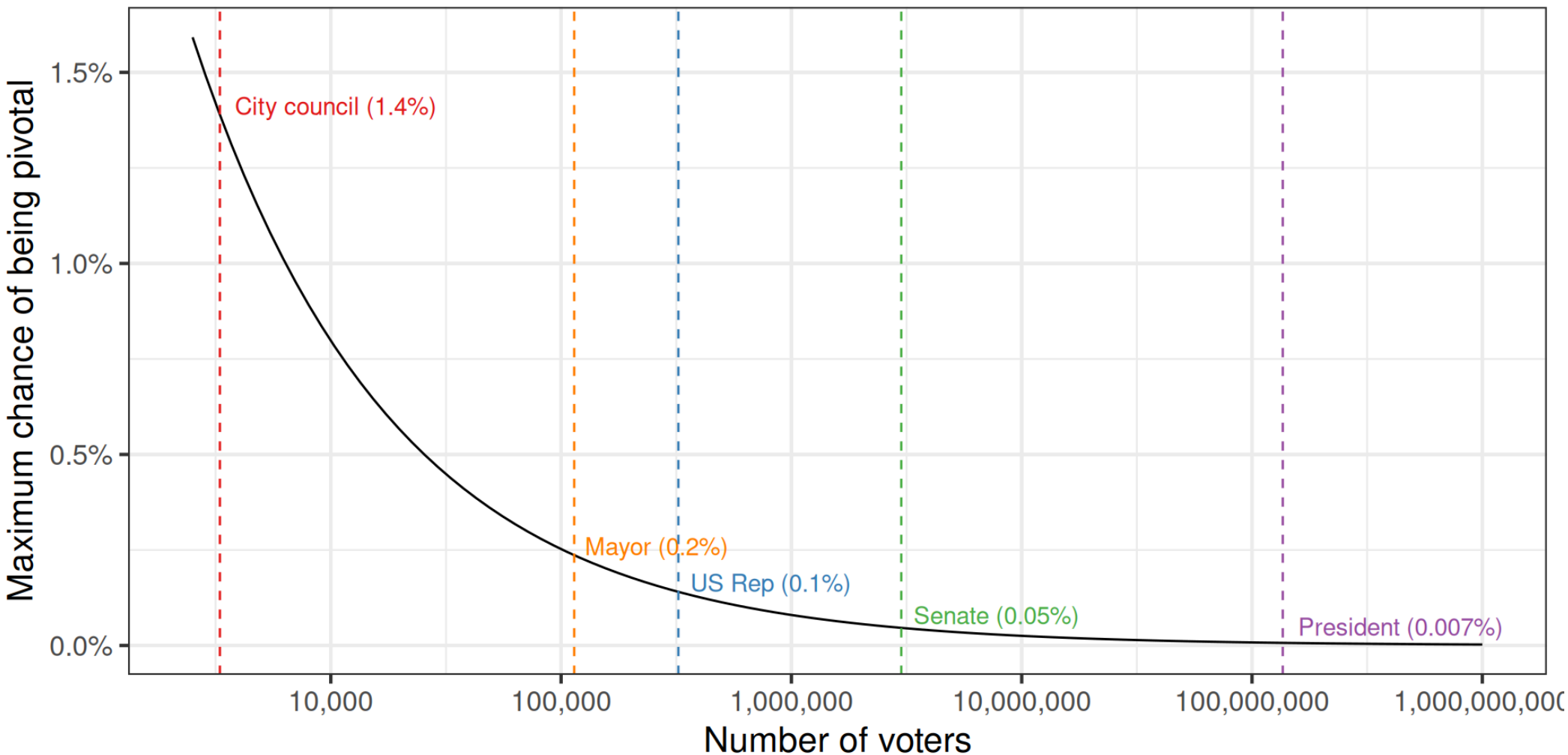
```
dbinom(250, 500, 0.5)
```

```
[1] 0.03566465
```

Binomial distribution in R

`dbinom(x, n, p)` = probability of exactly `x` successes in `n` independent trials, each with probability `p` of success.

The probability of being pivotal



The “duty” logic of voting

If your vote is very unlikely to swing the race, why is turnout so high?

Two explanations:

1. People are idiots who don’t realize they won’t swing the election
2. Something other than pivotality probability motivates voting

Political scientists generally think it’s #2 — civic duty

But this bundles multiple things together

- Intrinsic motivation: I vote because I personally find it important
- Extrinsic motivation: I vote because of social norms/pressure to do so

Correlational evidence for extrinsic motivation

TABLE 4: 1990 Social Sanctions Survey: Duty, Social Sanctions, and Turnout (dependent variable: turnout)

	Parameter Estimates (t Ratios)	
Variable	*Model 1*	*Model 2*
Intercept	–3.741	–5.253
	(–1.22)	(–1.45)
Graduate or professional degree	0.793	0.665
	(1.91)	(1.37)
Age	0.030	0.020
	(2.23)	(1.40)
Homeowner	–0.155	0.352
	(–0.37)	(0.73)
Log income	0.328	0.351
	(1.12)	(1.02)
Newcomer	–0.632	–1.168
	(–1.44)	(–2.20)
Knows < 3 neighbors	–0.930	–0.701
	(–2.12)	(–1.36)
Regular churchgoer	0.544	0.181
	(1.49)	(0.43)
Weak extended family ties	–0.535	–0.672
	(–1.01)	(–1.16)
Duty		2.215
		(5.29)
Social sanctions		1.156
		(2.65)
n	236	229
Likelihood ratio index	.138	.310

Knack 1992, "Civic Norms, Social Sanctions, and Voter Turnout"

→ "Do you have any friends, neighbors, or relatives who would be disappointed or angry with you if they knew you had not voted in this year's elections?"

→ Positive, statistically significant predictor of voting

Other studies: People whose close social ties vote are themselves more likely to vote

From correlation to causation

Treatment D_i: Feel pressure to vote from close peers

Outcome Y_i: Turning out to vote

- Y_{1i}: vote if feel pressure?
- Y_{0i}: vote if feel no pressure?

Exercise:

1. Identify a confounding variable in this relationship
2. Explain in words why it's a confounding variable
3. Explain precisely why we'd expect the independence condition to fail

Basic experimental design

Motivation for experimentation

We want to know — How does social pressure affect turnout?

The inferential problem — Lots of confounders

- People who feel more social pressure may be unlike others
- Observed correlation unlikely to represent true causal effect

Gerber, Green, Larimer solution: Randomize exposure to social pressure

The experimental ideals

Ex ante, every unit in sample has same probability of getting treated

- Don't be thoughtful and tailor who gets what treatment
- Doesn't need to be 50% chance for everyone, just same for everyone
- Administer treatment appropriately if spillovers are likely
  - → e.g., GGL mailers go to households instead of individuals

⇝ No systematic differences between treatment and comparison groups

Modes of experiment

Lab experiment: Recruit subjects, observe outcomes in lab

- Easier to monitor compliance
- Easier to prevent spillovers
- More detailed outcome measures
- Lower sample sizes (usually)
- More external validity concerns
- Fewer ethical concerns (usually)

Field experiment: Randomize treatment “in the wild”

- Harder to monitor compliance
- Harder to prevent spillovers
- Coarser outcome measures
- Higher sample sizes (usually)
- Better “real world” takeaways
- …but also more ethical peril

How randomization ensures independence

Randomization and the independence condition

Independence: The mathematical condition

No correlation between potential outcomes and treatment assignment:

$$\mathbb{C}[Y_{1i}, D_i] = 0$$
$$\mathbb{C}[Y_{0i}, D_i] = 0$$

Random assignment with prob. $p \Leftrightarrow$ for all possible y_1 and y_0,

$$\Pr[D_i = 1 \mid Y_{1i} = y_1, Y_{0i} = y_0] = p$$

$\rightsquigarrow \mathbb{E}[Y_{1i} \mid D_i = 1] = \mathbb{E}[Y_{1i} \mid D_i = 0]$ (and same for Y_{0i})

$\rightsquigarrow$ Independence condition holds

Randomization and independence in samples

In any given sample, treatment group might not be fully representative

→ "randomization failure"

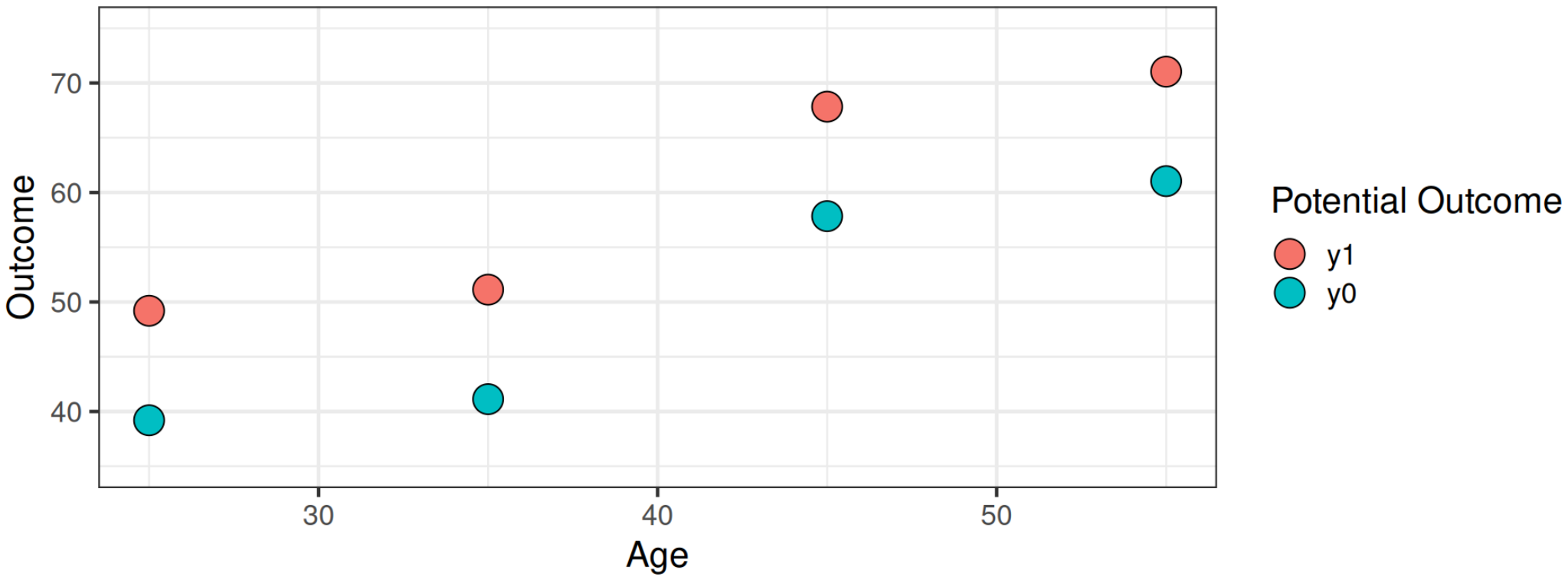
→ e.g., possible — but unlikely — for everyone under 40 to end up in treatment and everyone 40+ to end up in comparison

Difference of means only approximates average treatment effect in sample

Greater sample size ⇒ closer approximation

Randomization and independence in samples

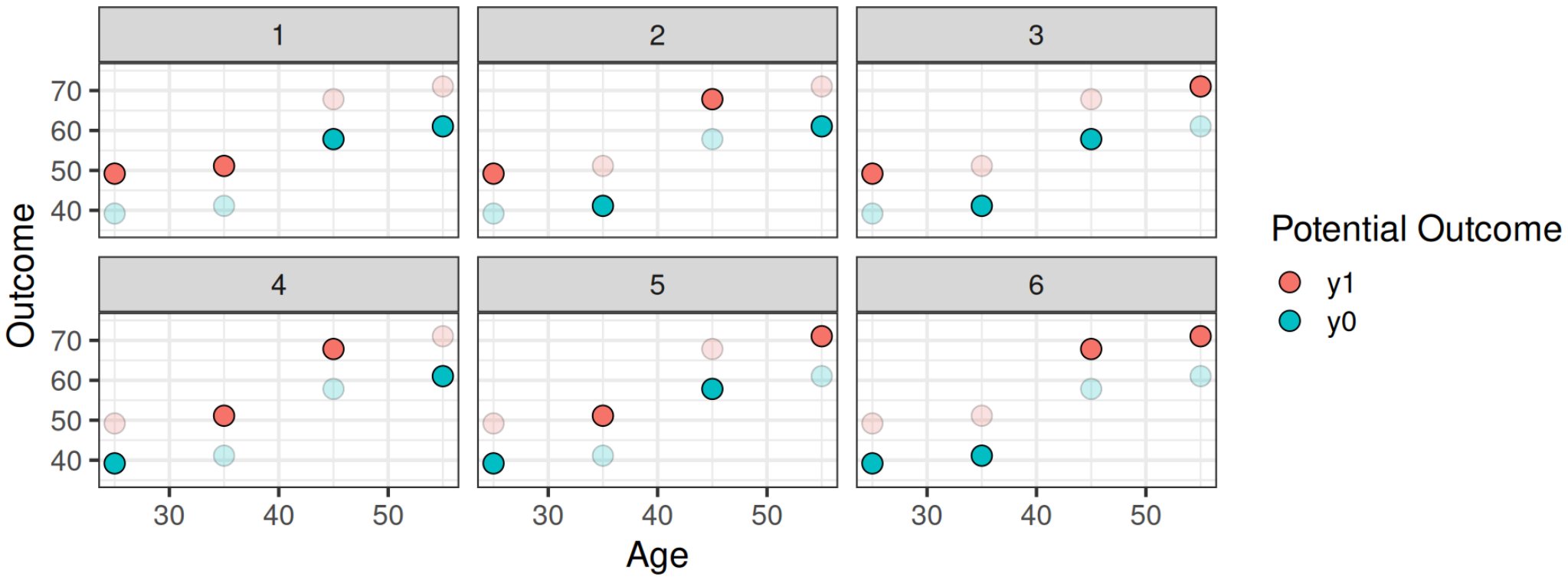
Small sample $\longrightarrow$ randomization failure easy



4 observations $\rightsquigarrow$ 33% chance treatment and control separated by age

Randomization and independence in samples

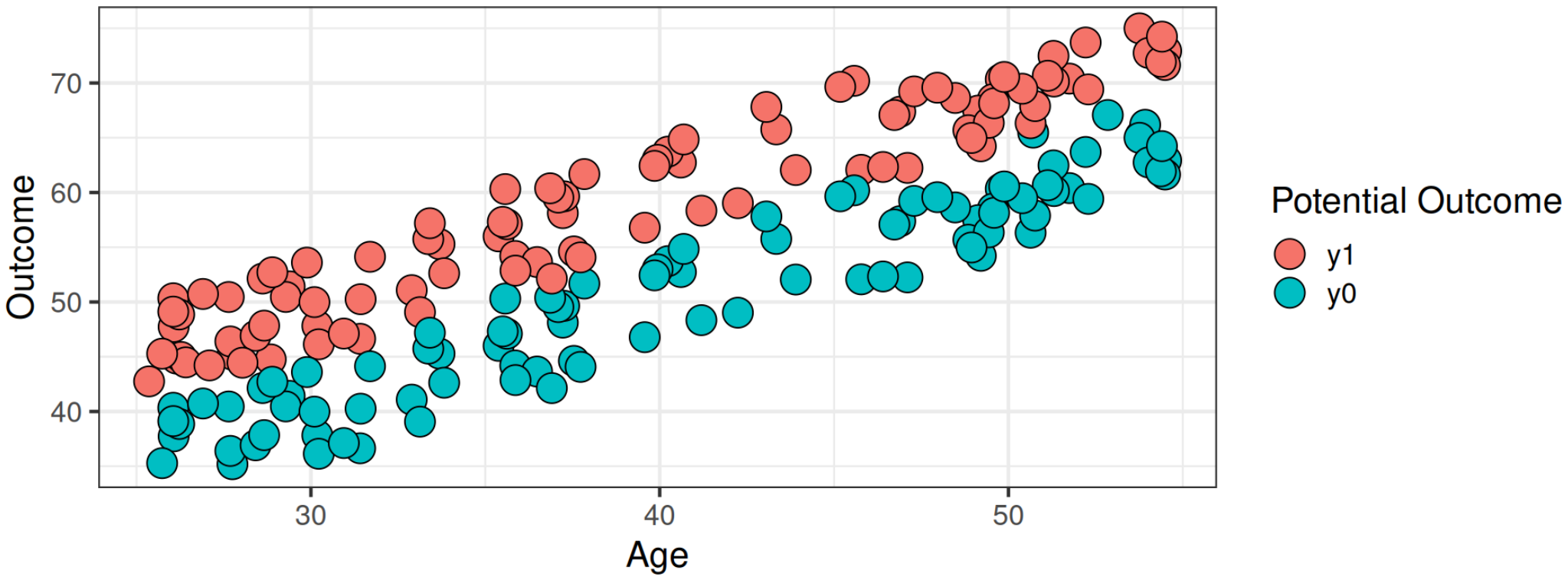
Small sample $\longrightarrow$ randomization failure easy



4 observations $\rightsquigarrow$ 33% chance treatment and control separated by age

Randomization and independence in samples

Large sample $\longrightarrow$ randomization failure much harder



100 observations $\rightsquigarrow$ 0.00000000000000000000000002% chance treatment and control separated by age

Checking for randomization failure

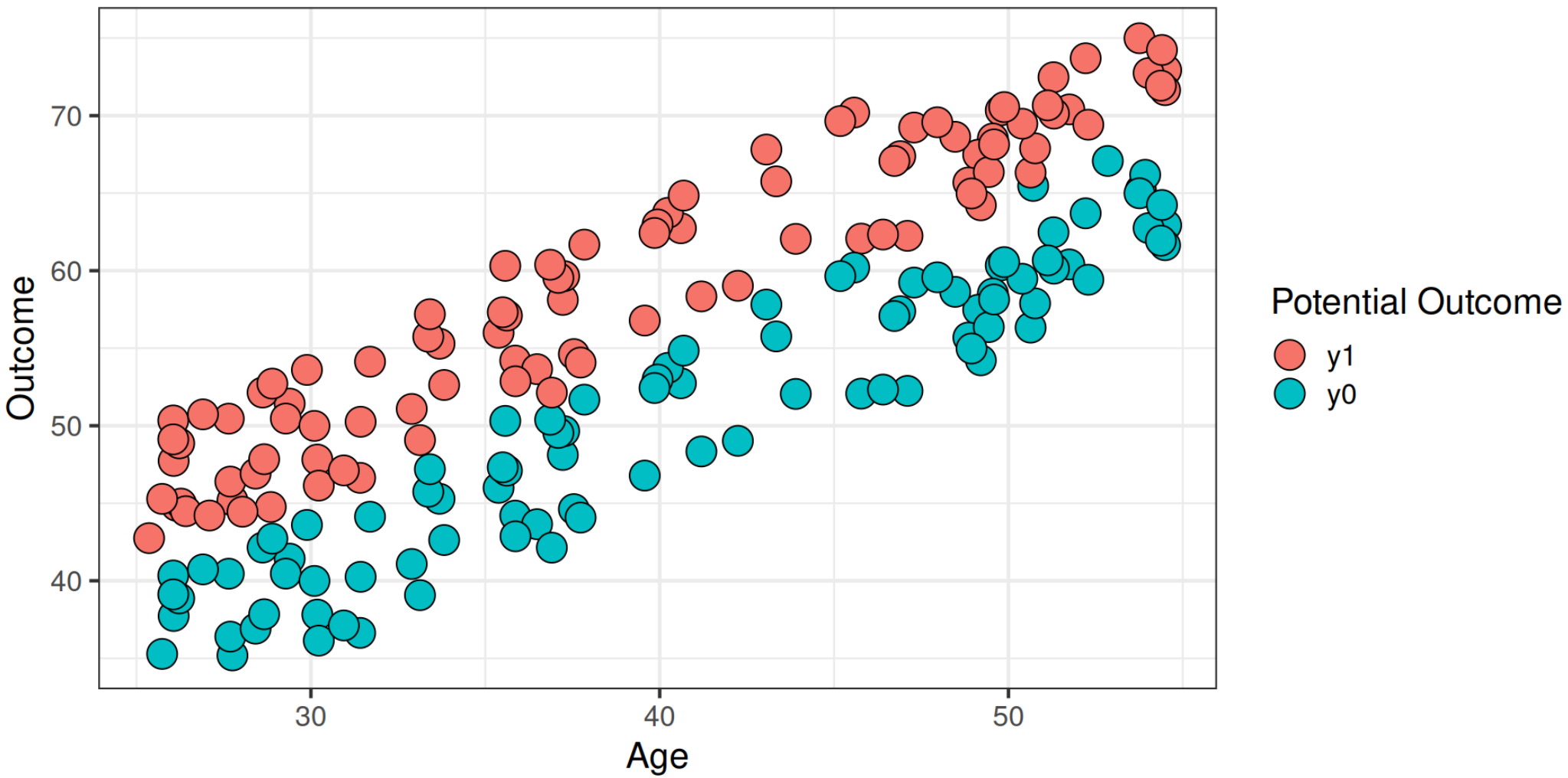
Can't directly check whether independence condition holds

But can check for **balance** on observable characteristics

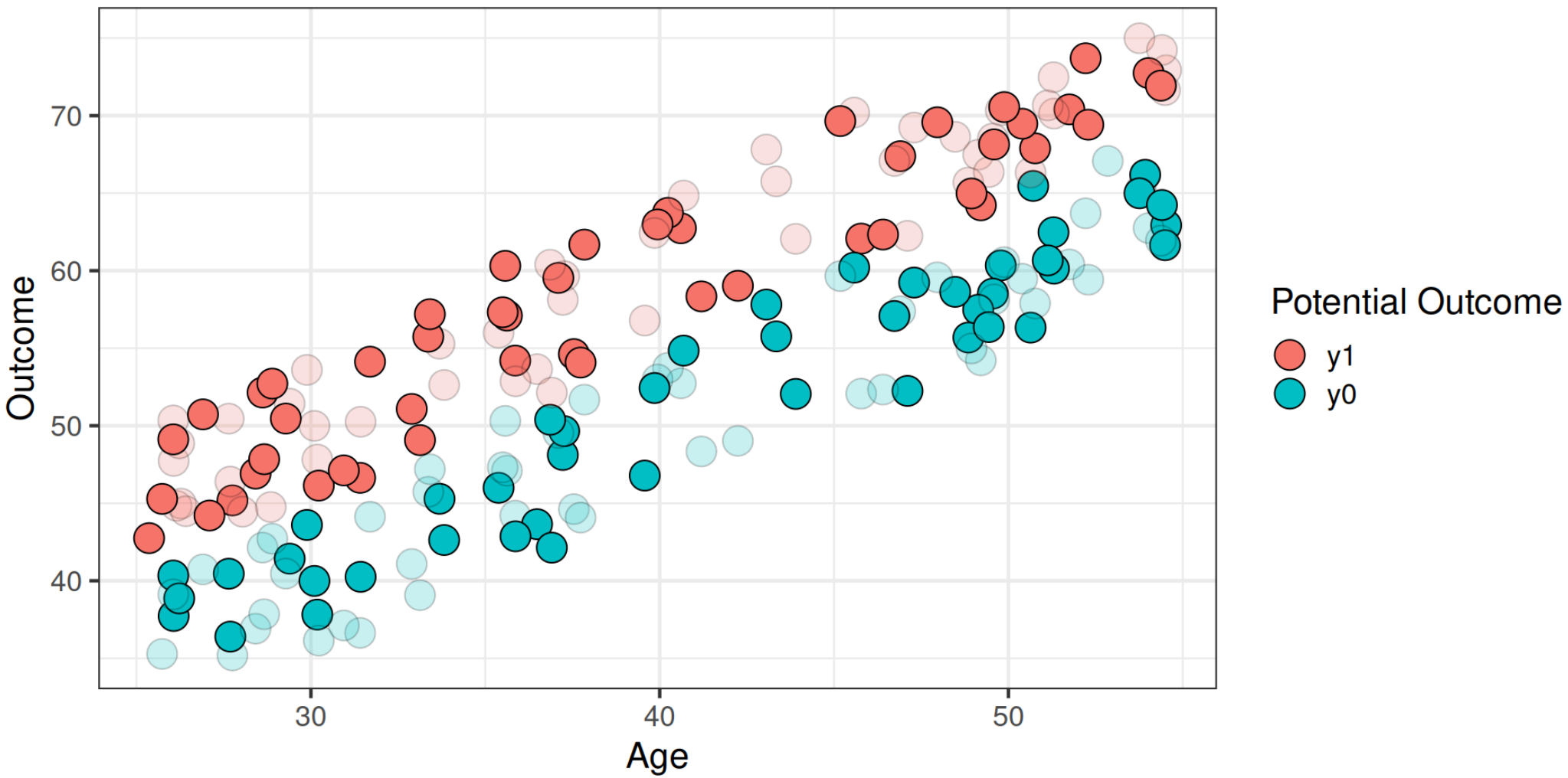
→ Should be measured before treatment administered

Ideal: Similar distribution between treatment and comparison

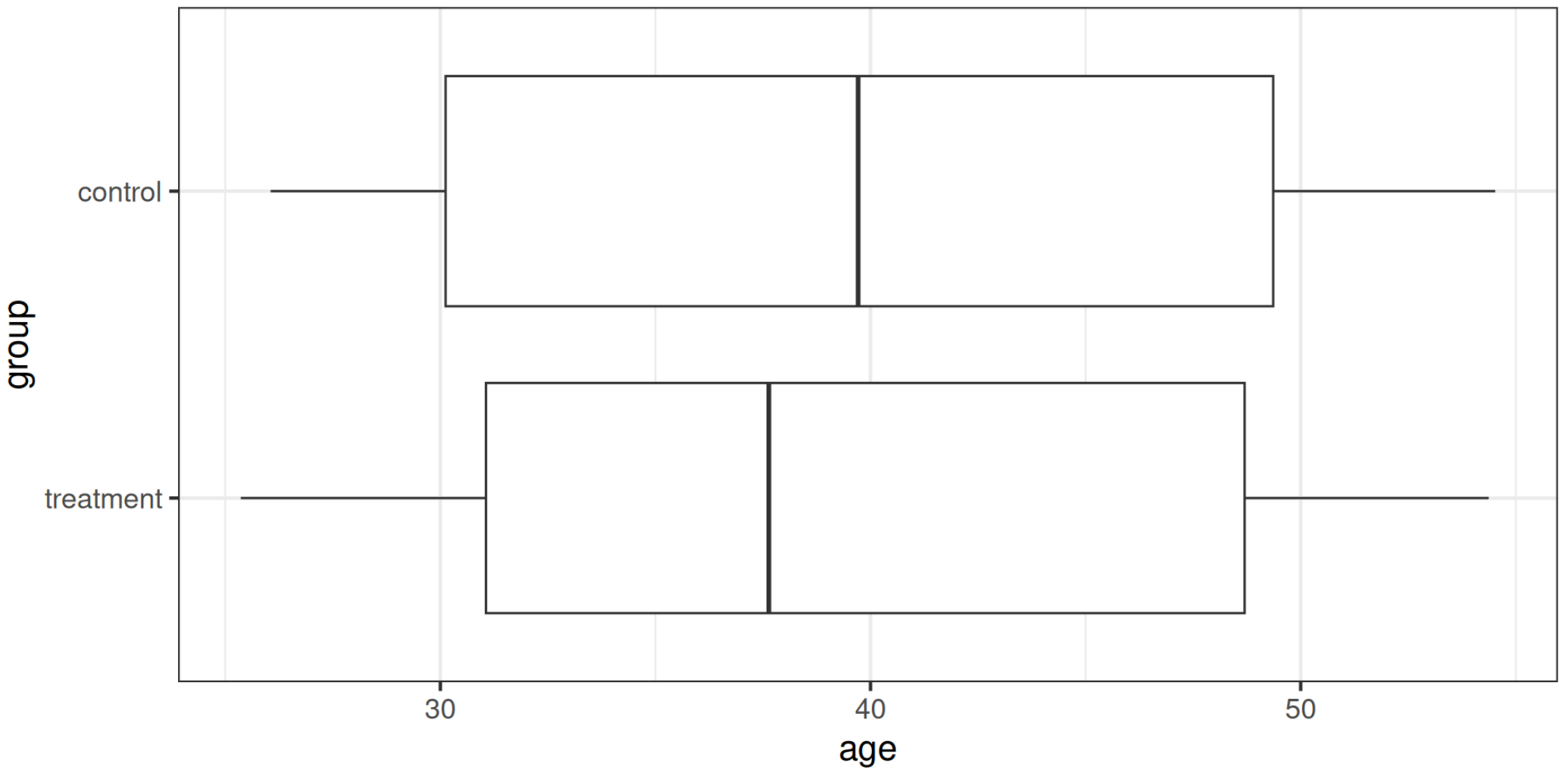
Checking for randomization failure



Checking for randomization failure



Checking for randomization failure



Wrapping up

What we did today

1. Asked how social pressure affects voting
    - Those who report more pressure also vote more...
    - but lots of reasons to suspect that correlation isn't causal
2. Reviewed very basics of experimental design
    - Prob of treatment should be same for all units
    - Ideal is for treatment and control to be representative of full sample
3. Showed how randomization implies independence condition
    - Equal assignment probability $\rightsquigarrow$ no correlation of potential outcomes and treatment assignment in population
    - Randomization failure possible in any given sample, but unlikely in large sample

Next time

1. Gerber, Green, Larimer's design and results
2. Potential pitfalls of randomized experiments