Sampling, margin of error and causal claims

Original skill preparation; versioned source scope

Sampling, Margin of Error and Causal Claims

- Decide whether a sample's result can be applied to a population, using whether it was a **random sample** 随机样本.
- Interpret an estimate and its **margin of error** 误差范围.
- Recognise **sampling bias** 抽样偏差.
- Decide whether a study supports a causal claim, using whether it used **random assignment** 随机分组.

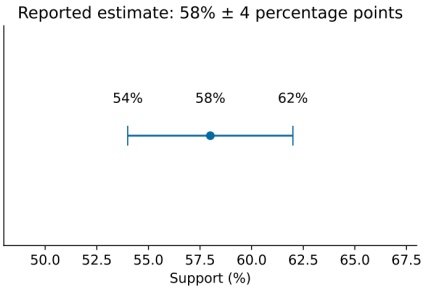
Samples and populations

- The population is the whole group the question is about; the sample is the part actually measured.
- Results from a random sample can be generalised to the population it was drawn from, and only to that population.
- A sample of volunteers, or of people easy to reach, may differ from the population in a systematic way.

Margin of error

- An estimate of 58% with a margin of error of 4 percentage points gives the plausible interval 54% to 62%.
- A larger random sample gives a smaller margin of error: roughly, four times the sample size halves it.
- The margin covers random sampling variation only. It does not correct bias.

Figure: Margin of error



- An estimate of 58% with an interval running from 54% to 62%
- Match each part of the diagram to the text.

Observational studies and experiments

- An observational study records what people already do. It can show an association, but other factors may explain it.
- An experiment assigns treatments. With random assignment, groups are alike on average, so a difference can be put down to the treatment.
- Random sampling allows generalisation; random assignment allows cause. A study may have one, both or neither.

Judging claims

- Check three things: the population, the method of selection, and whether treatments were randomly assigned.
- The right answer usually limits the claim to the group studied.
- Watch for "proves", "all" and "every": they are usually too strong.

Worked example: a library survey

- Plausible interval: 58% to 66% of registered members.
- The population is registered members, so the result says nothing reliable about town residents who are not members.
- It is plausible that a majority of members support the change, since the whole interval is above 50%.

Worked example: an experiment with volunteers

- Random assignment supports the causal claim that the new instructions made these participants faster.
- The participants were volunteers, not a random sample, so the result may not apply to all users.
- A reasonable conclusion: "For people like these volunteers, the new instructions probably cause faster completion."

Common errors

- Generalising beyond the population that was sampled.
- Believing a very large sample cannot be biased.
- Claiming cause from an observational study.

Common errors (2)

- Treating the margin of error as covering all possible errors.
- Confusing random sampling with random assignment.

Key terms

- **random sample**: A sample in which every member of the population has a known, fair chance of being chosen.
- **margin of error**: The amount added to and subtracted from an estimate to allow for random sampling variation.
- **sampling bias**: A systematic difference between the sample and the population caused by how the sample was chosen.
- **random assignment**: Using chance to decide which treatment each participant receives.

Check yourself

- An estimate is 45% with a margin of error of 3 points. What is the interval?
- A town surveys gym members about how often residents exercise. What is the problem?
- An observational study finds coffee drinkers live longer. Does coffee cause longer life?