Confidence Intervals & Margin of Error

- Course: Biostatistics / Research Methods
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Learning Objectives

- By the end of this lecture, students will be able to:
- • Define a confidence interval (CI)
- • Explain margin of error
- • Understand the meaning of the confidence level
- • Calculate a CI for a population mean
- • Interpret confidence intervals correctly

What is a Confidence Interval?

- A confidence interval (CI) is:
- • A range of values
- • Constructed from sample data
- • Likely to contain the true population parameter
- Example: A 95% CI for the mean height is (160–170 cm).

Why Do We Use Confidence Intervals?

- Confidence intervals help to:
- • Quantify uncertainty
- • Provide more information than a point estimate
- • Support decisions in research & medicine
- • Understand population parameters using samples

Components of a CI

- A CI consists of:
- 1. Point Estimate (e.g., sample mean $\bar{x}$)
- 2. Margin of Error (ME)
- Formula: CI = Point Estimate ± ME

Margin of Error

- Margin of Error measures potential difference between sample estimate and true population value.
- Formula: $ME = Z \times (\sigma / \sqrt{n})$
- Z depends on confidence level.

Z-Scores for Common Confidence Levels

- Confidence Level → Z-score:
- • 90% → 1.645
- • 95% → 1.96
- • 99% → 2.576

Example Calculation

- Sample of 50 students:
- Mean = 70 kg, SD = 8 kg, 95% CI:
- ME = $1.96 \times (8/\sqrt{50}) \approx 2.2$
- CI = $70 \pm 2.2 \rightarrow (67.8 , 72.2)$
- Interpretation: True mean lies within this range.

Interpretation Mistakes

- Incorrect: “There is a 95% probability the mean is inside the interval.”
- Correct: “95% of intervals constructed this way will contain the true mean.”

What Affects CI Width?

- CI becomes wider with:
- • Higher confidence level
- • Higher standard deviation
- CI becomes narrower with:
- • Larger sample size

CI in Real Research

- Applications:
- • Medical trials
- • Public health surveys
- • Biology/ecology studies
- • Polling and statistics
- Example: Drug A improved symptoms by 15% (95% CI: 10–20%).

Summary

- • CI = estimate ± margin of error
- • ME depends on Z, SD, and sample size
- • Higher confidence → wider CI
- • CI shows uncertainty, not probability

Practice Questions

- 1. Mean = 120, SD = 20, n = 40 → compute 95% CI.
- 2. How does increasing sample size affect CI?
- 3. Why is the 99% CI wider than the 95%?

Thank You