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Sampling Distributions and Sampling Variance, Part 1

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Lecture Overview

- **What** is a **sampling distribution**?
- **What** is **sampling variance**?
- **Why** is **sampling variance so important** for making population inferences based on probability samples?

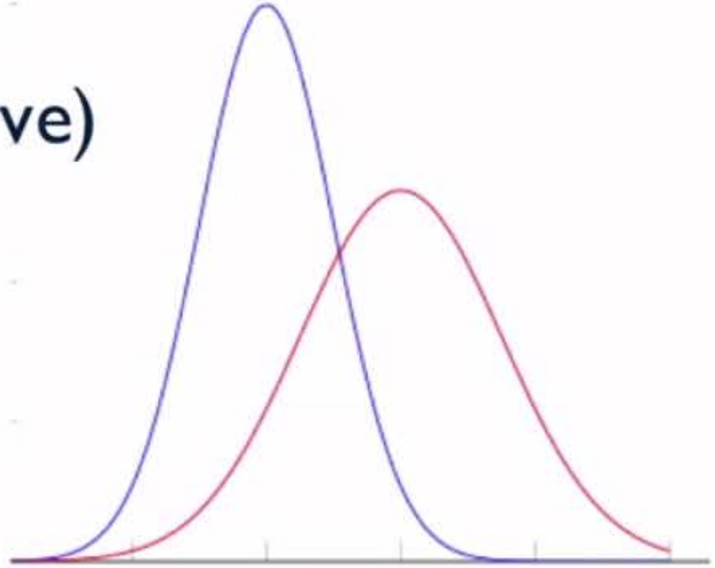
Third, we're going to talk about why sampling variance is so important

What is a Sampling Distribution?

- **Recall: Distribution of values on a variable of interest**

  Example: **Normal distribution** (bell curve)

- **Assume** values on variable of interest would follow certain distribution *if we could measure entire population*



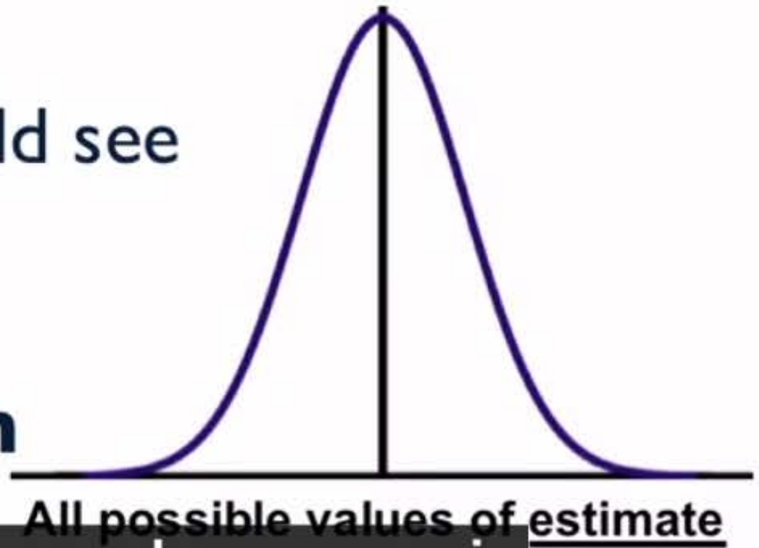
All possible values of variable of interest

Bell curve by Jake CC-BY 2.0

Okay, so we make assumptions about the distribution of values on a variable of interest.

What is a Sampling Distribution?

- **Recall:** When we select probability samples to make inferential statements about larger populations
  → we refer to a **sampling distribution**
- **Sampling distribution** =
  distribution of **survey estimates** we would see
  if we selected many random samples
  using **same sampling design**,
  and **computed an estimate from each**



the same probability sampling design over and over again

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What is a Sampling Distribution?

- **Key properties** of sampling distributions:
  - **Hypothetical!** What would happen if we had luxury of drawing thousands of probability samples and measuring each of them?
  - Generally very **different in appearance from distribution of values on a single variable of interest…**
  - With **large enough probability sample size**, sampling distribution of estimates will look like a **normal distribution**, *regardless* of what estimates are being computed! **Central Limit Theorem: CLT**

the more that sampling distribution is going to look like a normal distribution.

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What is Sampling Variance?

- **Sampling variance** = variability in the estimates described by the sampling distribution
- Because we select a **sample** (do not measure everyone in a **population**), a survey estimate based on a **single sample** **will not** be exactly equal to population quantity of interest (cases are randomly selected!)

Sampling Error

This is what's called sampling error.

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What is Sampling Variance?

- Across hypothetical repeated samples, **these sampling errors will randomly vary** (some positive, some negative…)
- **Variability of these sampling errors** describes the variance of the sampling distribution
- **If every sample estimate was equal to population quantity of interest** (e.g., in the case of a Census), there would be **no** sampling error, and **no** sampling variance!

would be exactly equal to the population value.

Choose the response that correctly fills in the four blanks in the statement about sampling distributions below:

A sampling distribution is the distribution of all possible _____ that would arise from _____, and larger sample sizes (closer to the size of the population) will result in a sampling distribution with _____ variance, meaning that estimates are _____ precise.

- Values of a variable, a single sample, less, more
- Values of a variable, hypothetical repeated sampling, more, less
- Estimates, a single sample, less, less
- Estimates, hypothetical repeated sampling, less, more

Correct

A sampling distribution is the distribution of all possible estimates that would arise from hypothetical repeated sampling, and larger sample sizes will result in a sampling distribution with less variance, meaning that estimates are more precise.

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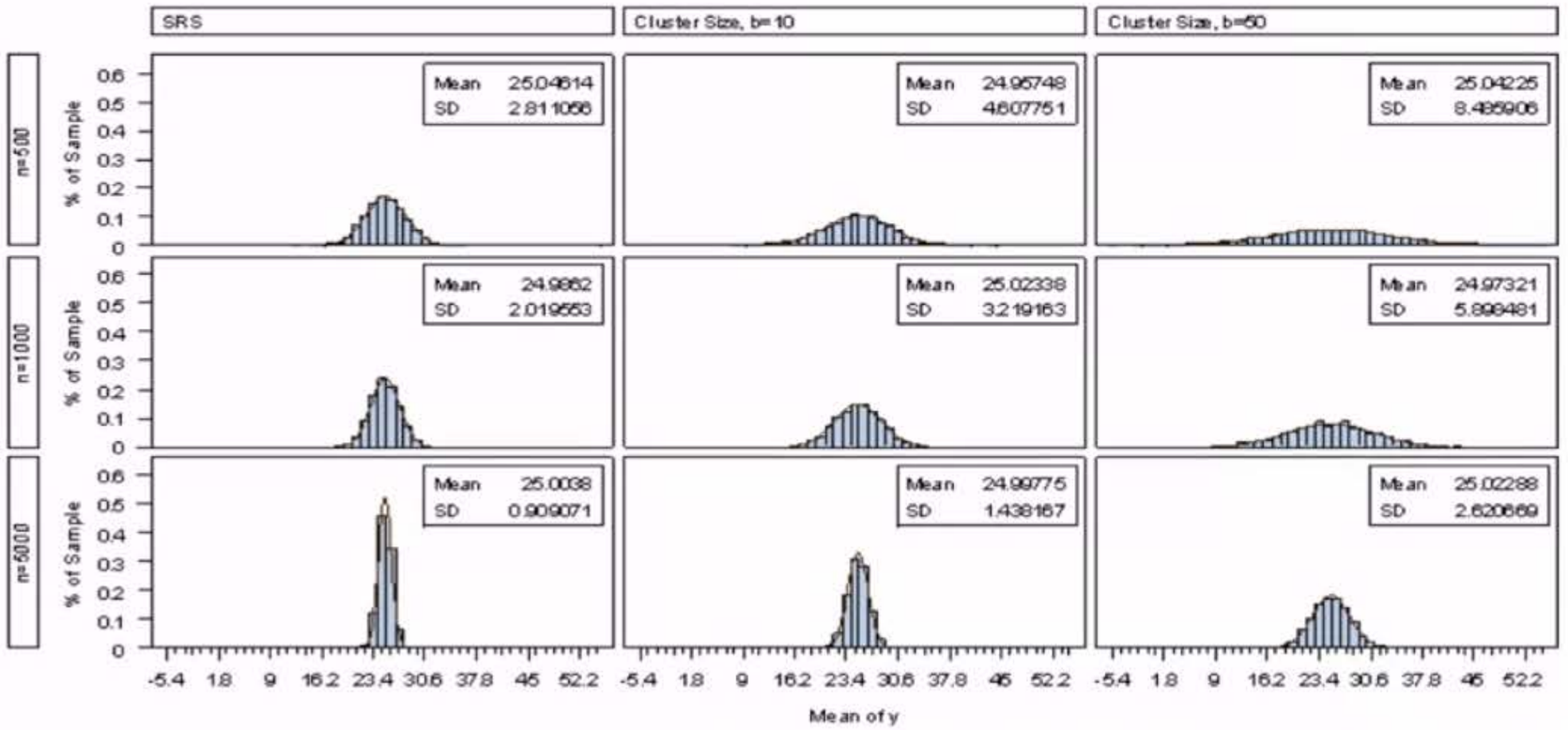
What is Sampling Variance?

- With a **larger probability sample size**, sampling more from a given population → in theory there will be less sampling error, and sampling errors will be less variable
- **Larger samples → Less sampling variance!**
  More precise estimates, **more confidence** in inferential statements (***but*** more costly!)
- **Spread** of sampling distribution becomes **smaller as sample size** become **larger**

There's less sampling variance.

Simulated Sampling Distributions



As sample size increases (across rows), sampling distributions shrink (**less variance**)

With cluster sampling, (2nd and 3rd columns) distributions spread out (**more variance**)

Credit: Heeringa et al. (2017), Applied Survey Data Analysis, Second Edition