# MATH110: Sampling Design

Introduction to Statistics · C-ID MATH110 · numberbender.com

Name: _____ Date: _____ Score: / 30

**Learning Objectives**

- Distinguish a population from a sample
- Compute the standard error of the sample mean
- Connect sample size to the Central Limit Theorem

*Simplify each expression completely. Show all steps and circle your final answer.*

## Central Limit Theorem

**1.** A population has mean mu=131 and standard deviation sigma=8. Samples of size n=25 are drawn. Find the mean and standard error of the sampling distribution of x-bar.

$$\mu = 131, \quad \sigma = 8, \quad n = 25$$

Answer: _____

**2.** A population has mean mu=84 and standard deviation sigma=6. Samples of size n=100 are drawn. Find the mean and standard error of the sampling distribution of x-bar.

$$\mu = 84, \quad \sigma = 6, \quad n = 100$$

Answer: _____

**3.** A population has mean mu=123 and standard deviation sigma=10. Samples of size n=25 are drawn. Find the mean and standard error of the sampling distribution of x-bar.

$$\mu = 123, \quad \sigma = 10, \quad n = 25$$

Answer: _____

## Lurking and Confounding Variables

**4.** A study finds that students who eat breakfast score higher on tests. However, students from higher-income families are more likely to eat breakfast AND more likely to have tutoring resources. Identify the confounding variable.

Answer: _____

**5.** Researchers notice that cities with more ice cream sales have higher drowning rates. They suspect a hidden variable is responsible. Identify the lurking variable.

Answer: _____

**6.** A study finds that students who eat breakfast score higher on tests. However, students from higher-income families are more likely to eat breakfast AND more likely to have tutoring resources. Identify the confounding variable.

Answer: _____

**7.** Researchers notice that cities with more ice cream sales have higher drowning rates. They suspect a hidden variable is responsible. Identify the lurking variable.

Answer: _____

**8.** A study finds that students who eat breakfast score higher on tests. However, students from higher-income families are more likely to eat breakfast AND more likely to have tutoring resources. Identify the confounding variable.

Answer: _____

**9.** Researchers notice that cities with more ice cream sales have higher drowning rates. They suspect a hidden variable is responsible. Identify the lurking variable.

Answer: _____

## Population vs. Sample

**10.** A city has 80,000 registered voters. A polling company surveys 500 of them about a ballot measure. Identify the population and the sample.

Answer: _____

**11.** A college wants to know the average GPA of all its 12,000 students. A dean randomly selects 200 student records to review. Identify the population and the sample.

Answer: _____

**12.** A nutritionist studies the eating habits of all patients at a clinic by interviewing every patient who visited last Tuesday (38 patients total). Identify the population and the sample.

Answer: _____

**13.** A city has 80,000 registered voters. A polling company surveys 500 of them about a ballot measure. Identify the population and the sample.

Answer: _____

**14.** A college wants to know the average GPA of all its 12,000 students. A dean randomly selects 200 student records to review. Identify the population and the sample.

Answer: _____

**15.** A nutritionist studies the eating habits of all patients at a clinic by interviewing every patient who visited last Tuesday (38 patients total). Identify the population and the sample.

Answer: _____

**16.** A city has 80,000 registered voters. A polling company surveys 500 of them about a ballot measure. Identify the population and the sample.

Answer: _____

**17.** A college wants to know the average GPA of all its 12,000 students. A dean randomly selects 200 student records to review. Identify the population and the sample.

Answer: _____

**18.** A nutritionist studies the eating habits of all patients at a clinic by interviewing every patient who visited last Tuesday (38 patients total). Identify the population and the sample.

Answer: _____

## Sampling Techniques

**19.** A researcher assigns each of 1,000 employees a number from 1 to 1,000, then uses a random number generator to select 50 employees to survey. Identify the sampling technique.

Answer: _____

**20.** A school divides its 800 students into four grade levels and randomly selects 25 students from each grade level. Identify the sampling technique.

Answer: _____

**21.** A pollster divides a city into 50 neighborhoods and randomly selects 5 neighborhoods, then surveys every household in those 5 neighborhoods. Identify the sampling technique.

Answer: _____

**22.** A researcher assigns each of 1,000 employees a number from 1 to 1,000, then uses a random number generator to select 50 employees to survey. Identify the sampling technique.

Answer: _____

**23.** A school divides its 800 students into four grade levels and randomly selects 25 students from each grade level. Identify the sampling technique.

Answer: _____

**24.** A pollster divides a city into 50 neighborhoods and randomly selects 5 neighborhoods, then surveys every household in those 5 neighborhoods. Identify the sampling technique.

Answer: _____

**25.** A researcher assigns each of 1,000 employees a number from 1 to 1,000, then uses a random number generator to select 50 employees to survey. Identify the sampling technique.

Answer: _____

**26.** A school divides its 800 students into four grade levels and randomly selects 25 students from each grade level. Identify the sampling technique.

Answer: _____

**27.** A pollster divides a city into 50 neighborhoods and randomly selects 5 neighborhoods, then surveys every household in those 5 neighborhoods. Identify the sampling technique.

Answer: _____

## Standard error of the sample mean

**28.** A population has standard deviation sigma = 12. For random samples of size n = 25, find the standard error of the sample mean (the standard deviation of the sampling distribution).

$$\sigma = 12, \quad n = 25$$

Answer: _____

**29.** A population has standard deviation sigma = 20. For random samples of size n = 25, find the standard error of the sample mean (the standard deviation of the sampling distribution).

$$\sigma = 20, \quad n = 25$$

Answer: _____

**30.** A population has standard deviation sigma = 15. For random samples of size n = 16, find the standard error of the sample mean (the standard deviation of the sampling distribution).

$$\sigma = 15, \quad n = 16$$

Answer: _____

# MATH110: Sampling Design

Introduction to Statistics · C-ID MATH110 · numberbender.com

ANSWER KEY & SOLUTIONS

*Topics: Sampling Techniques, Population vs. Sample, Standard error of the sample mean, Lurking and Confounding Variables, Central Limit Theorem. All answers verified by independent computation.*

## Solutions

## Central Limit Theorem

**1.** A population has mean mu=131 and standard deviation sigma=8. Samples of size n=25 are drawn. Find the mean and standard error of the sampling distribution of x-bar.

$$\mu = 131, \quad \sigma = 8, \quad n = 25$$

→ *By the Central Limit Theorem, the sampling distribution of x-bar has mean equal to the population mean.*
→ *Mean of x-bar = mu = 131.*
→ *Standard error: SE = sigma / sqrt(n) = 8 / sqrt(25) = 8 / 5 = 1.6.*

**Answer:** $\mu_{\bar{x}} = 131, \quad SE = \frac{8}{5} = 1.6$

**2.** A population has mean mu=84 and standard deviation sigma=6. Samples of size n=100 are drawn. Find the mean and standard error of the sampling distribution of x-bar.

$$\mu = 84, \quad \sigma = 6, \quad n = 100$$

→ *By the Central Limit Theorem, the sampling distribution of x-bar has mean equal to the population mean.*
→ *Mean of x-bar = mu = 84.*
→ *Standard error: SE = sigma / sqrt(n) = 6 / sqrt(100) = 6 / 10 = 0.6.*

**Answer:** $\mu_{\bar{x}} = 84, \quad SE = \frac{6}{10} = 0.6$

**3.** A population has mean mu=123 and standard deviation sigma=10. Samples of size n=25 are drawn. Find the mean and standard error of the sampling distribution of x-bar.

$$\mu = 123, \quad \sigma = 10, \quad n = 25$$

→ *By the Central Limit Theorem, the sampling distribution of x-bar has mean equal to the population mean.*
→ *Mean of x-bar = mu = 123.*
→ *Standard error: SE = sigma / sqrt(n) = 10 / sqrt(25) = 10 / 5 = 2.0.*

**Answer:** $\mu_{\bar{x}} = 123, \quad SE = \frac{10}{5} = 2.0$

## Lurking and Confounding Variables

**4.** A study finds that students who eat breakfast score higher on tests. However, students from higher-income families are more likely to eat breakfast AND more likely to have tutoring resources. Identify the confounding variable.

→ *The explanatory variable is breakfast eating; the response variable is test scores.*
→ *Family income is related to both breakfast eating and test scores.*
→ *Because it is associated with both variables and was not controlled, it is a confounding variable.*
→ *Answer: Family income is a confounding variable..*

**Answer:** $Familyincomeisaconfoundingvariable.$

**5.** Researchers notice that cities with more ice cream sales have higher drowning rates. They suspect a hidden variable is responsible. Identify the lurking variable.

→ *Ice cream sales and drowning rates are both higher in hot weather.*
→ *Hot weather drives both variables independently.*
→ *This is a classic lurking variable — not a causal relationship.*
→ *Answer: Hot weather (temperature) is a lurking variable causing both increased ice cream sales and more swimming, which leads to more drownings..*

**Answer:** $Hotweather(temperature)isalurkingvariablecausingbothincreasedicecreamsalesandmoreswimming,whichleadstomoredrownings.$

**6.** A study finds that students who eat breakfast score higher on tests. However, students from higher-income families are more likely to eat breakfast AND more likely to have tutoring resources. Identify the confounding variable.

→ *The explanatory variable is breakfast eating; the response variable is test scores.*
→ *Family income is related to both breakfast eating and test scores.*
→ *Because it is associated with both variables and was not controlled, it is a confounding variable.*
→ *Answer: Family income is a confounding variable..*

**Answer:** $Familyincomeisaconfoundingvariable.$

**7.** Researchers notice that cities with more ice cream sales have higher drowning rates. They suspect a hidden variable is responsible. Identify the lurking variable.

→ *Ice cream sales and drowning rates are both higher in hot weather.*
→ *Hot weather drives both variables independently.*
→ *This is a classic lurking variable — not a causal relationship.*
→ *Answer: Hot weather (temperature) is a lurking variable causing both increased ice cream sales and more swimming, which leads to more drownings..*

**Answer:** $Hotweather(temperature)isalurkingvariablecausingbothincreasedicecreamsalesandmoreswimming,whichleadstomoredrownings.$

**8.** A study finds that students who eat breakfast score higher on tests. However, students from higher-income families are more likely to eat breakfast AND more likely to have tutoring resources. Identify the confounding variable.

→ *The explanatory variable is breakfast eating; the response variable is test scores.*
→ *Family income is related to both breakfast eating and test scores.*
→ *Because it is associated with both variables and was not controlled, it is a confounding variable.*
→ *Answer: Family income is a confounding variable..*

**Answer:** $Familyincomeisaconfoundingvariable.$

**9.** Researchers notice that cities with more ice cream sales have higher drowning rates. They suspect a hidden variable is responsible. Identify the lurking variable.

→ *Ice cream sales and drowning rates are both higher in hot weather.*

→ *Hot weather drives both variables independently.*

→ *This is a classic lurking variable — not a causal relationship.*

→ *Answer: Hot weather (temperature) is a lurking variable causing both increased ice cream sales and more swimming, which leads to more drownings..*

**Answer:** *Hotweather(temperature)isalurkingvariablecausingbothincreasedicecreamsalesandmoreswimming, whichleadstomoredrownings.*

## Population vs. Sample

**10.** A city has 80,000 registered voters. A polling company surveys 500 of them about a ballot measure. Identify the population and the sample.

→ *The group of interest (all registered voters in the city) is the population.*
→ *The 500 surveyed voters are a subset chosen for study -> this is the sample.*
→ *Answer: Sample: the 500 surveyed voters. Population: all 80,000 registered voters..*

**Answer:** $Sample: the 500 surveyed voters. Population: all 80,000 registered voters.$

**11.** A college wants to know the average GPA of all its 12,000 students. A dean randomly selects 200 student records to review. Identify the population and the sample.

→ *The group of interest (all 12,000 students) is the population.*
→ *The 200 randomly selected students are the sample.*
→ *Answer: Sample: the 200 selected students. Population: all 12,000 students at the college..*

**Answer:** $Sample: the 200 selected students. Population: all 12,000 students at the college.$

**12.** A nutritionist studies the eating habits of all patients at a clinic by interviewing every patient who visited last Tuesday (38 patients total). Identify the population and the sample.

→ *The population is all patients at the clinic.*
→ *Only those who visited last Tuesday were studied -> this is the sample.*
→ *Answer: Sample: the 38 patients seen last Tuesday. Population: all patients at the clinic..*

**Answer:** $Sample: the 38 patients seen last Tuesday. Population: all patients at the clinic.$

**13.** A city has 80,000 registered voters. A polling company surveys 500 of them about a ballot measure. Identify the population and the sample.

→ *The group of interest (all registered voters in the city) is the population.*
→ *The 500 surveyed voters are a subset chosen for study -> this is the sample.*
→ *Answer: Sample: the 500 surveyed voters. Population: all 80,000 registered voters..*

**Answer:** $Sample: the 500 surveyed voters. Population: all 80,000 registered voters.$

**14.** A college wants to know the average GPA of all its 12,000 students. A dean randomly selects 200 student records to review. Identify the population and the sample.

→ *The group of interest (all 12,000 students) is the population.*
→ *The 200 randomly selected students are the sample.*
→ *Answer: Sample: the 200 selected students. Population: all 12,000 students at the college..*

**Answer:** $Sample: the 200 selected students. Population: all 12,000 students at the college.$

**15.** A nutritionist studies the eating habits of all patients at a clinic by interviewing every patient who visited last Tuesday (38 patients total). Identify the population and the sample.

→ *The population is all patients at the clinic.*
→ *Only those who visited last Tuesday were studied -> this is the sample.*
→ *Answer: Sample: the 38 patients seen last Tuesday. Population: all patients at the clinic..*

**Answer:** $Sample: the 38 patients seen last Tuesday. Population: all patients at the clinic.$

**16.** A city has 80,000 registered voters. A polling company surveys 500 of them about a ballot measure. Identify the population and the sample.

→ *The group of interest (all registered voters in the city) is the population.*

→ *The 500 surveyed voters are a subset chosen for study -> this is the sample.*

→ *Answer: Sample: the 500 surveyed voters. Population: all 80,000 registered voters..*

**Answer:** $Sample: the 500 surveyed voters. Population: all 80,000 registered voters.$

**17.** A college wants to know the average GPA of all its 12,000 students. A dean randomly selects 200 student records to review. Identify the population and the sample.

→ *The group of interest (all 12,000 students) is the population.*

→ *The 200 randomly selected students are the sample.*

→ *Answer: Sample: the 200 selected students. Population: all 12,000 students at the college..*

**Answer:** $Sample: the 200 selected students. Population: all 12,000 students at the college.$

**18.** A nutritionist studies the eating habits of all patients at a clinic by interviewing every patient who visited last Tuesday (38 patients total). Identify the population and the sample.

→ *The population is all patients at the clinic.*

→ *Only those who visited last Tuesday were studied -> this is the sample.*

→ *Answer: Sample: the 38 patients seen last Tuesday. Population: all patients at the clinic..*

**Answer:** $Sample: the 38 patients seen last Tuesday. Population: all patients at the clinic.$

## Sampling Techniques

**19.** A researcher assigns each of 1,000 employees a number from 1 to 1,000, then uses a random number generator to select 50 employees to survey. Identify the sampling technique.

→ *Every individual is numbered and selected by a random process.*
→ *Each possible sample of size 50 has an equal chance of being chosen.*
→ *This is a Simple Random Sample (SRS).*

**Answer:** *SimpleRandomSample(SRS)*

**20.** A school divides its 800 students into four grade levels and randomly selects 25 students from each grade level. Identify the sampling technique.

→ *The population is divided into subgroups (strata) by grade level.*
→ *A random sample is drawn from each stratum.*
→ *This is a Stratified Random Sample.*

**Answer:** *StratifiedRandomSample*

**21.** A pollster divides a city into 50 neighborhoods and randomly selects 5 neighborhoods, then surveys every household in those 5 neighborhoods. Identify the sampling technique.

→ *The population is divided into groups (clusters) — here, neighborhoods.*
→ *Entire clusters are randomly selected and all members within are surveyed.*
→ *This is a Cluster Sample.*

**Answer:** *ClusterSample*

**22.** A researcher assigns each of 1,000 employees a number from 1 to 1,000, then uses a random number generator to select 50 employees to survey. Identify the sampling technique.

→ *Every individual is numbered and selected by a random process.*
→ *Each possible sample of size 50 has an equal chance of being chosen.*
→ *This is a Simple Random Sample (SRS).*

**Answer:** *SimpleRandomSample(SRS)*

**23.** A school divides its 800 students into four grade levels and randomly selects 25 students from each grade level. Identify the sampling technique.

→ *The population is divided into subgroups (strata) by grade level.*
→ *A random sample is drawn from each stratum.*
→ *This is a Stratified Random Sample.*

**Answer:** *StratifiedRandomSample*

**24.** A pollster divides a city into 50 neighborhoods and randomly selects 5 neighborhoods, then surveys every household in those 5 neighborhoods. Identify the sampling technique.

→ *The population is divided into groups (clusters) — here, neighborhoods.*
→ *Entire clusters are randomly selected and all members within are surveyed.*
→ *This is a Cluster Sample.*

**Answer:** *ClusterSample*

**25.** A researcher assigns each of 1,000 employees a number from 1 to 1,000, then uses a random number generator to select 50 employees to survey. Identify the sampling technique.

→ *Every individual is numbered and selected by a random process.*
→ *Each possible sample of size 50 has an equal chance of being chosen.*
→ *This is a Simple Random Sample (SRS).*

**Answer:** $SimpleRandomSample(SRS)$

---

**26.** A school divides its 800 students into four grade levels and randomly selects 25 students from each grade level. Identify the sampling technique.

→ *The population is divided into subgroups (strata) by grade level.*
→ *A random sample is drawn from each stratum.*
→ *This is a Stratified Random Sample.*

**Answer:** $StratifiedRandomSample$

---

**27.** A pollster divides a city into 50 neighborhoods and randomly selects 5 neighborhoods, then surveys every household in those 5 neighborhoods. Identify the sampling technique.

→ *The population is divided into groups (clusters) — here, neighborhoods.*
→ *Entire clusters are randomly selected and all members within are surveyed.*
→ *This is a Cluster Sample.*

**Answer:** $ClusterSample$

---

## Standard error of the sample mean

**28.** A population has standard deviation sigma = 12. For random samples of size n = 25, find the standard error of the sample mean (the standard deviation of the sampling distribution).

$\sigma = 12, \quad n = 25$

→ *Standard error of the mean = sigma / sqrt(n).*
→ *= 12/sqrt(25) = 12/5 = 2.4.*

**Answer:** $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{12}{5} = 2.4$

**29.** A population has standard deviation sigma = 20. For random samples of size n = 25, find the standard error of the sample mean (the standard deviation of the sampling distribution).

$\sigma = 20, \quad n = 25$

→ *Standard error of the mean = sigma / sqrt(n).*
→ *= 20/sqrt(25) = 20/5 = 4.0.*

**Answer:** $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{20}{5} = 4.0$

**30.** A population has standard deviation sigma = 15. For random samples of size n = 16, find the standard error of the sample mean (the standard deviation of the sampling distribution).

$\sigma = 15, \quad n = 16$

→ *Standard error of the mean = sigma / sqrt(n).*
→ *= 15/sqrt(16) = 15/4 = 3.75.*

**Answer:** $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{15}{4} = 3.75$