

1. Which of the following is an observational study?

- A. Students are randomly assigned to use one of two revision methods.
- B. Researchers record the number of hours students study and their test scores.
- C. Patients are randomly assigned to receive a new medication or a placebo.
- D. Farmers apply different fertilizers to randomly selected plots.



2. A researcher wants to determine whether drinking coffee improves reaction time. What is the explanatory variable?

- A. Reaction time
- B. Coffee consumption
- C. The participants
- D. Random assignment



Population	总体
Sample	样本
Observational Study	观察性研究
Experiment	实验
Explanatory Variable	解释变量（自变量）
Response Variable	响应变量（因变量）
Treatment	处理
Random Assignment	随机分配
Control Group	对照组
Confounding Variable	混杂变量

- In **AP Statistics**, planning a study begins with clearly defining the **population and variables of interest**.
- A well-designed study uses **random sampling or random assignment** to reduce bias.
- Researchers must choose an appropriate method, such as an **observational study or an experiment**.
- Control of variables and clear procedures help ensure valid results.
- Good study design allows conclusions to be made reliably **within the limits of the data collected**.

- **Population** – 总体
- **Sample** – 样本
- **Bias** – 偏差
- **Random sampling** – 随机抽样
- **Control group** – 对照组

Question:

A researcher is interested in studying the effect of a new medication on reducing blood pressure. The study is designed as follows:

- A random sample of 200 adults with high blood pressure is selected.
- 100 participants are randomly assigned to receive the medication, and 100 participants are assigned to receive a placebo.
- The blood pressure of all participants is measured after 3 months.

(a) Identify the **population** and **sample** in this study.

(b) Describe the **control group** in this experiment.

(c) How does **random sampling** help ensure the validity of this study?

(d) What is a potential **source of bias** in this study?

(a) Population and Sample:

- **Population (总体):** All adults with high blood pressure.
- **Sample (样本):** The 200 adults selected for the study.

(b) Control group:

- The **control group (对照组)** consists of the 100 participants who receive the placebo, allowing for comparison with the group that receives the medication.

(c) How random sampling helps ensure validity:

- **Random sampling (随机抽样)** ensures that every adult with high blood pressure has an equal chance of being selected, reducing the likelihood of bias and making the sample representative of the population.

(d) Potential source of bias:

- **Selection bias (选择偏差)** could occur if the 200 adults were not selected randomly or if certain groups (e.g., those with more severe blood pressure issues) were overrepresented or underrepresented



These questions require students to **justify their reasoning**, identify flaws in study design, and distinguish between **association and causation**.

1. Observational Study or Experiment?

A researcher wants to investigate whether students who exercise regularly have higher mathematics grades. She surveys 500 students and records their weekly exercise hours and mathematics grades.

- a) Is this an observational study or an experiment?
 - b) Identify the explanatory and response variables.
 - c) Can the researcher conclude that exercise causes higher mathematics grades? Explain.
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2. Designing an Experiment

A company claims that its new energy drink improves concentration.

Design an experiment to test this claim. Your design should include:

- The **experimental units**
- The **treatments**
- A **control group**
- **Random assignment**
- A **response variable**
- How you would reduce **bias**

3. Identify the Confounding Variable

Researchers find that students who spend more time studying generally achieve higher exam scores.

A student argues:

"Studying more definitely causes higher exam scores."

Give **one possible confounding variable** that could explain this association and explain how it could affect the results.

4. Spot the Problem

A researcher wants to compare two revision methods. She gives Method A to the 20 students who volunteer first and Method B to the remaining 20 students.

- a) Identify a problem with this design.
- b) Explain why the results might be biased.
- c) Describe how random assignment could improve the experiment.

1. **Observational study**; explanatory = exercise, response = grades; **no causation**.
2. Randomly assign students → **energy drink/placebo** → measure concentration → compare results.
3. Possible confounder: **motivation** or prior academic ability.
4. **Selection bias**; students are not randomly assigned. Random assignment creates comparable groups.

Sampling Methods

Population	总体
Sample	样本
Census	普查
Simple Random Sample	简单随机抽样
Stratified Sample	分层抽样
Cluster Sample	整群抽样
Systematic Sample	系统抽样
Convenience Sample	便利抽样
Voluntary Response Sample	自愿回应抽样
Bias	偏差

1. **Population & Sample** – Understand the difference between the entire population and the sample studied.
2. **Sampling Methods** – Use appropriate methods to obtain a representative sample and reduce bias.
3. **Observational Studies vs. Experiments** – Observational studies measure variables; experiments impose treatments.
4. **Randomization & Control** – Random assignment, control groups, and replication help produce reliable results.
5. **Causation & Confounding** – Experiments can establish cause and effect, while confounding variables can make conclusions difficult.

A school wants to determine how many hours students spend studying each week. The school has **1,200 students** in Grades 9–12.

The principal wants to survey **120 students**.

- (a) Explain how the principal could select a **simple random sample (SRS)** of 120 students.
- (b) The principal divides students into four grade levels and randomly selects 30 students from each grade. Identify the sampling method and explain why it is appropriate.
- (c) Another teacher surveys the first 120 students who enter the cafeteria at lunchtime. Identify the sampling method and explain one potential problem with it.
- (d) The principal randomly selects three homerooms and surveys **every student** in those homerooms. Identify the sampling method.
- (e) Explain the difference between **stratified sampling** and **cluster sampling**.
- (f) The survey is sent to 120 randomly selected students, but only 72 students respond. Identify a possible source of bias and explain how it could affect the results.

- (a) Number all 1,200 students and use a random number generator to select 120 different students.
- (b) **Stratified random sample** — students are divided into grade-level strata and randomly selected from each.
- (c) **Convenience sample** — easy to collect but may not represent the entire school.
- (d) **Cluster sample** — entire randomly selected groups (homerooms) are surveyed.
- (e) **Stratified**: some individuals are selected from **every group**.
Cluster: all individuals are selected from **some groups**.
- (f) **Nonresponse bias** — students who respond may differ systematically from those who do not respond.

True or False

- A stratified sample selects some individuals from every subgroup.

True or False

- Selecting every 10th person after a random starting point is systematic sampling.