

# Observational studies and experiments

An **observational study** is a study based on observations or measurements

# Observational studies and experiments

An **observational study** is a study based on observations or measurements

An **experiment** is a study in which the effects of a treatment are measured.

# Examples of experiments:

**Agricultural Study:** A farmer tests a new type of fertilizer by applying it to half of their crops while using traditional fertilizer on the other half. The new fertilizer is the treatment.

**Environmental Science Experiment:** A researcher tests the effect of a new water filtration system on river water quality by installing it at one site and comparing it to an unfiltered site. The filtration system is the treatment.

**Mental Health Intervention:** A therapist tests the effectiveness of a new meditation technique by introducing it to a group of patients and comparing their stress levels to a group that does not use the technique. The meditation technique is the treatment.

# Question

Determine whether the following scenario describes an observational study or an experiment:

Blood pressure levels are recorded for 50 people at rest and after walking up a flight of stairs.

# Question

Determine whether the following scenario describes an observational study or an experiment:

Blood pressure levels are recorded for 50 people at rest and after walking up a flight of stairs.

**Experiment**

# Question

Determine whether the following scenario describes an observational study or an experiment:

Blood pressure levels are recorded for 50 people at rest and after walking up a flight of stairs.

**Experiment**

# Question

Determine whether the following scenario describes an observational study or an experiment:

A researcher records the dietary habits of 100 individuals and tracks their health outcomes over five years.

# Question

Determine whether the following scenario describes an observational study or an experiment:

A researcher records the dietary habits of 100 individuals and tracks their health outcomes over five years.

**Observational study**



# Question

Determine whether the following scenario describes an observational study or an experiment:

Two groups of athletes are randomly assigned to different training programs, and their performance is measured after six months.

# Question

Determine whether the following scenario describes an observational study or an experiment:

Two groups of athletes are randomly assigned to different training programs, and their performance is measured after six months.

**Experiment**

# Question

Determine whether the following scenario describes an observational study or an experiment:

Researchers survey 1,000 adults about their sleep habits and analyze the relationship between sleep duration and reported mental health.

# Question

Determine whether the following scenario describes an observational study or an experiment:

Researchers survey 1,000 adults about their sleep habits and analyze the relationship between sleep duration and reported mental health.

**Experiment**

A city wants to reduce traffic accidents at a dangerous intersection. To test a new traffic signal system, they install it at the intersection and compare accident rates before and after the change. After six months, the number of accidents decreases significantly.

However, at the same time, the city also began a public safety campaign about driving cautiously, and the signs were changed in the area. It's unclear whether the drop in accidents is due to the new traffic signal, the increased police presence, or the public safety campaign.

A city wants to reduce traffic accidents at a dangerous intersection. To test a new traffic signal system, they install it at the intersection and compare accident rates before and after the change. After six months, the number of accidents decreases significantly.

However, at the same time, the city also began a public safety campaign about driving cautiously, and the police increased patrols in the area. It's unclear whether the drop in accidents is due to the new traffic signal, the increased police presence, or the public safety campaign.

This is called **confounding** – when it is not clear which factor or factors caused the observed effect. Confounding is the downfall of many experiments, though sometimes it is hidden.

# Confounding

**Confounding** occurs when there are two potential variables that could have caused the outcome and it is not possible to determine which actually caused the result.

## Example

A marine biologist tests a new type of fish food to see if it enhances the growth rate of juvenile fish. They feed one group of fish the new food and another group the standard food. Over a few months, the fish fed the new food show faster growth.

However, during this period, the biologist also installs new water filtration systems and increases the frequency of water changes. It's unclear whether the improved growth is due to the new fish food, the upgraded filtration system, or the more frequent water changes. These additional changes introduce confounding variables, making it difficult to determine the specific cause of the enhanced growth.



## Example

A chemist tests a new method for purifying water by using a novel filtration material. They apply the method to one batch of contaminated water and compare its purity to another batch treated with the traditional filtration method.

At the same time, the chemist also changes the flow rate of the water through the filter and adjusts the temperature of the water. It's unclear whether the improvement in water purity is due to the new filtration material, the altered flow rate, or the temperature adjustments. These additional changes introduce confounding variables, making it difficult to determine which factor most significantly affected the water purity.

## Question

To evaluate the effectiveness of a new sleep aid on improving sleep quality, a researcher conducts the following experiment: 80 participants (50 men and 30 women) who report having trouble sleeping are recruited. Their sleep quality is measured using a sleep diary and wearable devices. The researcher gives the men a new sleep aid pill and the women a placebo pill, but only the researcher is aware of this distinction.

The results of the experiment are likely to be invalid mostly because:

## Question

To evaluate the effectiveness of a new sleep aid on improving sleep quality, a researcher conducts the following experiment: 80 participants (50 men and 30 women) who report having trouble sleeping are recruited. Their sleep quality is measured using a sleep diary and wearable devices. The researcher gives the men a new sleep aid pill and the women a placebo pill, but only the researcher is aware of this distinction.

The results of the experiment are likely to be invalid mostly because:

- A: The subjects did not know if they were receiving the real treatment.
- B: The treatment group and control group were not the same size.
- C: The subjects were volunteers.
- D: The gender of the participant is a confounding variable in this experiment.
- E: None of the above

## Question

To evaluate the effectiveness of a new sleep aid on improving sleep quality, a researcher conducts the following experiment: 80 participants (50 men and 30 women) who report having trouble sleeping are recruited. Their sleep quality is measured using a sleep diary and wearable devices. The researcher gives the men a new sleep aid pill and the women a placebo pill, but only the researcher is aware of this distinction.

The results of the experiment are likely to be invalid mostly because:

- A: The subjects did not know if they were receiving the real treatment.
- B: The treatment group and control group were not the same size.
- C: The subjects were volunteers.
- D: The gender of the participant is a confounding variable in this experiment.
- E: None of the above

There are a number of measures that can be introduced to help reduce the likelihood of confounding.

The primary measure is to use a **control group**.

# Control Group

When using a control group, the participants are divided into two or more groups, typically a **control group** and a **treatment group**.

The treatment group receives the treatment being tested; the control group does not receive the treatment.

# Example

A pharmaceutical company tests a new drug by administering it to one group of patients while another group receives the standard treatment. Both groups are monitored in the same clinic with similar conditions and protocols. The health outcomes are compared to control for differences in clinical environment and care.

# Example

A pharmaceutical company tests a new drug by administering it to one group of patients while another group receives the standard treatment. Both groups are monitored in the same clinic with similar conditions and protocols. The health outcomes are compared to control for differences in clinical environment and care.



# Example

An environmental scientist tests a new method of cleaning oil spills by applying it to one section of a contaminated beach and using a standard method on another section. Both sections are exposed to similar environmental conditions. The effectiveness of the new cleaning method is compared to assess its impact on oil removal and beach recovery.

Sometimes not giving the control group anything does not completely control for confounding variables. For example, suppose a medicine study is testing a new headache pill by giving the treatment group the pill and the control group nothing. If the treatment group showed improvement, we would not know whether it was due to the medicine in the pill, or a response to have taken any pill. This is called a **placebo effect**.

# Placebo effect

The **placebo effect** is when the effectiveness of a treatment is influenced by the patient's perception of how effective they think the treatment will be, so a result might be seen even if the treatment is ineffectual.

A 2013 study from the U.K. found that 97% of physicians acknowledged in a survey having used some form of placebo during their career. This might be as simple as expressing a strong belief in the likelihood that a patient will feel better from whatever treatment the doctor prescribes, even if the treatment itself is not chemically powerful.

Howick, Jeremy, Felicity L. Bishop, Carl J. Heneghan, Jane L Wolstenholme, Sarah L Stevens, FD Richard Hobbs and George Lewith. "Placebo Use in the United Kingdom: Results from a National Survey of Primary Care Practitioners." PLoS ONE 8 (2013): n. pag.

To control for the placebo effect, a placebo, or *dummy treatment*, is often given to the control group. This way, both groups are truly identical except for the specific treatment given.

# Placebo and Placebo controlled experiments

A **placebo** is a dummy treatment given to control for the placebo effect.

An experiment that gives the control group a placebo is called a **placebo controlled experiment**.

# Example

In a clinical trial testing a new anti-nausea medication, participants in the control group receive a pill that looks identical to the medication but contains only a harmless substance. This allows researchers to determine whether the new medication is more effective than the placebo at reducing nausea.

# Example

In a trial for a new antihistamine, one group of participants receives the actual drug while another group gets a placebo tablet made of an inert substance. Both groups are asked to track their allergy symptoms, allowing researchers to see if the new antihistamine provides better relief compared to the placebo.



In some cases, it is more appropriate to compare to a conventional treatment than a placebo. For example, in a cancer research study, it would not be ethical to deny any treatment to the control group or to give a placebo treatment. In this case, the currently acceptable medicine would be given to the second group, called a comparison group in this case.

When using a placebo, it would defeat the purpose if the participant knew they were receiving the placebo.

# Blind studies

A **blind study** is one in which the participant does not know whether or not they are receiving the treatment or a placebo.

# Blind studies

A **blind study** is one in which the participant does not know whether or not they are receiving the treatment or a placebo.

A **double-blind study** is one in which those interacting with the participants don't know who is in the treatment group and who is in the control group.

# Example

In a study about anti-depression medicine, you would not want the psychological evaluator to know whether the patient is in the treatment or control group either, as it might influence their evaluation, so the experiment should be conducted as a double-blind study.

It should be noted that not every experiment needs a control group.

An example of an experiment without a control group is if a researcher is interested in the effect of a new medication on blood pressure, they could measure blood pressure in the same group of participants both before and after taking the medication.

## Question

To evaluate a new dietary supplement, researchers divide participants into two groups: one group receives the supplement, and the other group receives a placebo that looks identical to the supplement. The researchers administering the supplement do not know which participants are receiving the real supplement and which are receiving the placebo.

Does this experiment have a control group?

Is it blind, double-blind, or neither?

## Question

To evaluate a new dietary supplement, researchers divide participants into two groups: one group receives the supplement, and the other group receives a placebo that looks identical to the supplement. The researchers administering the supplement do not know which participants are receiving the real supplement and which are receiving the placebo.

Does this experiment have a control group?

Yes, the experiment has a control group. The control group is the group receiving the placebo, which is used to compare against the experimental group receiving the actual dietary supplement.

Is it blind, double-blind, or neither?

The experiment is double-blind because neither the participants nor the researchers administering the supplement know which group the participants are in.

## Question

A study is conducted to evaluate the effectiveness of a new cognitive training program designed to improve memory. Participants are randomly assigned to either the new training program or a traditional training program. The evaluators who assess the participants' memory improvement do not know which program each participant underwent.

Does this experiment have a control group?

Is it blind, double-blind, or neither?



## Question

A study is conducted to evaluate the effectiveness of a new cognitive training program designed to improve memory. Participants are randomly assigned to either the new training program or a traditional training program. The evaluators who assess the participants' memory improvement do not know which program each participant underwent.

Does this experiment have a control group?

Yes, the experiment has a control group. The control group is the one receiving the traditional training program, which serves as a baseline to compare the effects of the new cognitive training program.

Is it blind, double-blind, or neither?

The experiment is single-blind because the evaluators assessing the memory improvement do not know which training program each participant received. However, the participants are aware of which training program they are undergoing, so it is not double-blind.

## Question

A research team wants to assess the impact of a new classroom teaching method on students' math test scores. They conduct a study with 500 students from several schools. The students are randomly assigned to one of two groups. The first group of 250 students is taught using the new teaching method, while the second group of 250 students is taught using the standard teaching method. The students' math test scores are compared at the end of the school year. All students know which teaching method they are receiving.

## Question

A research team wants to assess the impact of a new classroom teaching method on students' math test scores. They conduct a study with 500 students from several schools. The students are randomly assigned to one of two groups. The first group of 250 students is taught using the new teaching method, while the second group of 250 students is taught using the standard teaching method. The students' math test scores are compared at the end of the school year. All students know which teaching method they are receiving.

In this study, which is the control group?

- A: The group of 250 students using the new teaching method
- B: The 500 students in total
- C: The group of 250 students using the standard teaching method
- D: There is no control group.

## Question

A research team wants to assess the impact of a new classroom teaching method on students' math test scores. They conduct a study with 500 students from several schools. The students are randomly assigned to one of two groups. The first group of 250 students is taught using the new teaching method, while the second group of 250 students is taught using the standard teaching method. The students' math test scores are compared at the end of the school year. All students know which teaching method they are receiving.

In this study, which is the control group?

A: The group of 250 students using the new teaching method

B: The 500 students in total

C: The group of 250 students using the standard teaching method

D: There is no control group.

## Question

A research team wants to assess the impact of a new classroom teaching method on students' math test scores. They conduct a study with 500 students from several schools. The students are randomly assigned to one of two groups. The first group of 250 students is taught using the new teaching method, while the second group of 250 students is taught using the standard teaching method. The students' math test scores are compared at the end of the school year. All students know which teaching method they are receiving.

This study is:

- A: Not an experiment
- B: Not blind.
- C: Double-blind
- D: Blind, but not double-blind
- E: None of the above

## Question

A research team wants to assess the impact of a new classroom teaching method on students' math test scores. They conduct a study with 500 students from several schools. The students are randomly assigned to one of two groups. The first group of 250 students is taught using the new teaching method, while the second group of 250 students is taught using the standard teaching method. The students' math test scores are compared at the end of the school year. All students know which teaching method they are receiving.

This study is:

A: Not an experiment

B: Not blind.

C: Double-blind

D: Blind, but not double-blind

E: None of the above

## Question

A researcher tests whether a new type of energy bar improves athletic performance. The study involves 100 participants who are divided into two groups. The first group of 50 participants eats the new energy bar before exercising, while the second group of 50 participants eats a regular energy bar. The participants' exercise performance is measured and compared. All participants know which type of energy bar they are consuming.

## Question

A researcher tests whether a new type of energy bar improves athletic performance. The study involves 100 participants who are divided into two groups. The first group of 50 participants eats the new energy bar before exercising, while the second group of 50 participants eats a regular energy bar. The participants' exercise performance is measured and compared. All participants know which type of energy bar they are consuming.

In this study, which is the control group?

- A The group of 50 participants eating the new energy bar
- B The 100 participants in total
- C The group of 50 participants eating the regular energy bar
- D There is no control group.



## Question

A researcher tests whether a new type of energy bar improves athletic performance. The study involves 100 participants who are divided into two groups. The first group of 50 participants eats the new energy bar before exercising, while the second group of 50 participants eats a regular energy bar. The participants' exercise performance is measured and compared. All participants know which type of energy bar they are consuming.

In this study, which is the control group?

- A The group of 50 participants eating the new energy bar
- B The 100 participants in total
- C The group of 50 participants eating the regular energy bar
- D There is no control group.

## Question

A researcher tests whether a new type of energy bar improves athletic performance. The study involves 100 participants who are divided into two groups. The first group of 50 participants eats the new energy bar before exercising, while the second group of 50 participants eats a regular energy bar. The participants' exercise performance is measured and compared. All participants know which type of energy bar they are consuming.

This study is:

- A Not an experiment
- B Not blind.
- C Double-blind
- D Blind, but not double-blind
- E None of the above

## Question

A researcher tests whether a new type of energy bar improves athletic performance. The study involves 100 participants who are divided into two groups. The first group of 50 participants eats the new energy bar before exercising, while the second group of 50 participants eats a regular energy bar. The participants' exercise performance is measured and compared. All participants know which type of energy bar they are consuming.

This study is:

- A Not an experiment
- B Not blind.
- C Double-blind
- D Blind, but not double-blind
- E None of the above

## Question

A research study is conducted to test the effectiveness of a new anti-anxiety medication. Participants are randomly assigned to receive either the new medication or a placebo pill that looks identical but contains no active ingredients.

**Participants:** 100 participants are divided into two groups: one group receives the new medication, while the other group receives the placebo.  
**Healthcare Providers:** The therapists who interact with the participants and assess their anxiety levels do not know which treatment each participant is receiving.

## Question

A research study is conducted to test the effectiveness of a new anti-anxiety medication. Participants are randomly assigned to receive either the new medication or a placebo pill that looks identical but contains no active ingredients.

Participants: 100 participants are divided into two groups: one group receives the new medication, while the other group receives the placebo.  
Healthcare Providers: The therapists who interact with the participants and assess their anxiety levels do not know which treatment each participant is receiving.

Q: Which is the control group?

## Question

A research study is conducted to test the effectiveness of a new anti-anxiety medication. Participants are randomly assigned to receive either the new medication or a placebo pill that looks identical but contains no active ingredients.

**Participants:** 100 participants are divided into two groups: one group receives the new medication, while the other group receives the placebo.  
**Healthcare Providers:** The therapists who interact with the participants and assess their anxiety levels do not know which treatment each participant is receiving.

Q: Which is the control group?

**The group receiving the placebo pill.**

## Question

A research study is conducted to test the effectiveness of a new anti-anxiety medication. Participants are randomly assigned to receive either the new medication or a placebo pill that looks identical but contains no active ingredients.

**Participants:** 100 participants are divided into two groups: one group receives the new medication, while the other group receives the placebo.  
**Healthcare Providers:** The therapists who interact with the participants and assess their anxiety levels do not know which treatment each participant is receiving.

Q. What type of study is this?

## Question

A research study is conducted to test the effectiveness of a new anti-anxiety medication. Participants are randomly assigned to receive either the new medication or a placebo pill that looks identical but contains no active ingredients.

**Participants:** 100 participants are divided into two groups: one group receives the new medication, while the other group receives the placebo.  
**Healthcare Providers:** The therapists who interact with the participants and assess their anxiety levels do not know which treatment each participant is receiving.

Q. What type of study is this?

**Double-blind.** Both the participants and the healthcare providers assessing the participants' anxiety levels are unaware of which treatment is being administered. This design helps to minimize biases and ensures that the observed effects are due to the medication itself rather than expectations or prejudices.