

9.2: Null and Alternative Hypotheses

The actual test begins by considering two **hypotheses**. They are called the **null hypothesis** and the **alternative hypothesis**. These hypotheses contain opposing viewpoints.

H_0 : **The null hypothesis**: It is a statement of no difference between the variables-they are not related. This can often be considered the status quo and as a result if you cannot accept the null it requires some action.

H_2 : **The alternative hypothesis**: It is a claim about the population that is contradictory to H_0 and what we conclude when we cannot accept H_0 . This is usually what the researcher is trying to prove. The alternative hypothesis is the contender and must win with significant evidence to overthrow the status quo. This concept is sometimes referred to the tyranny of the status quo because as we will see later, to overthrow the null hypothesis takes usually 90 or greater confidence that this is the proper decision.

Since the null and alternative hypotheses are contradictory, you must examine evidence to decide if you have enough evidence to reject the null hypothesis or not. The evidence is in the form of sample data.

After you have determined which hypothesis the sample supports, you make a decision. There are two options for a **decision**. They are "cannot accept H_0 " if the sample information favors the alternative hypothesis or "do not reject H_0 " or "decline to reject H_0 " if the sample information is insufficient to reject the null hypothesis. These conclusions are all based upon a level of probability, a significance level, that is set by the analyst.

Table 9.2.1 presents the various hypotheses in the relevant pairs. For example, if the null hypothesis is equal to some value, the alternative has to be not equal to that value.

Table 9.2.1

H_0	H_a
equal (=)	not equal (\neq) or greater than ($>$) or less than ($<$)
greater than or equal to (\geq)	less than ($<$)
less than or equal to (\leq)	more than ($>$)

Note

As a mathematical convention H_0 always has a symbol with an equal in it. H_a never has a symbol with an equal in it. The choice of symbol depends on the wording of the hypothesis test.

? Exercise 9.2.1

State the null and alternative hypotheses for the proposition that no more than 30% of registered voters in Santa Clara County will vote in the primary election.

Answer

H_0 : No more than 30% of the registered voters in Santa Clara County voted in the primary election. $p \leq .30$

H_a : More than 30% of the registered voters in Santa Clara County voted in the primary election. $p > 30$

Try It 9.2.1

A medical trial is conducted to test whether or not a new medicine reduces cholesterol by 25%. State the null and alternative hypotheses.

? Exercise 9.2.2

We want to test whether the mean GPA of students in American colleges is different from 2.0 (out of 4.0). The null and alternative hypotheses are:

$$\begin{aligned}H_0 : \mu &= 2.0 \\H_a : \mu &\neq 2.0\end{aligned}\tag{9.2.1}$$

Try It 9.2.2

We want to test whether the mean height of eighth graders is 66 inches. State the null and alternative hypotheses. Fill in the correct symbol (=, \neq , \geq , $<$, \leq , $>$) for the null and alternative hypotheses.

- a. $H_0 : \mu$ 66
- b. $H_a : \mu$ 66

? Exercise 9.2.3

We want to test if college students take less than five years to graduate from college, on the average. The null and alternative hypotheses are:

Answer

$$\begin{aligned}H_0 : \mu &\geq 5 \\H_a : \mu &< 5\end{aligned}\tag{9.2.2}$$

Try It 9.2.3

We want to test if it takes fewer than 45 minutes to teach a lesson plan. State the null and alternative hypotheses. Fill in the correct symbol (=, \neq , \geq , $<$, \leq , $>$) for the null and alternative hypotheses.

- a. $H_0 : \mu$ 45
- b. $H_a : \mu$ 45

H_0 : No more than 30% of the registered voters in Santa Clara County voted in the primary election. $p \leq .30$

H_a : More than 30% of the registered voters in Santa Clara County voted in the primary election. $p > 30$

Try It 9.1

A medical trial is conducted to test whether or not a new medicine reduces cholesterol by 25%. State the null and alternative hypotheses.

Example 9.2

We want to test whether the mean GPA of students in American colleges is different from 2.0 (out of 4.0). The null and alternative hypotheses are:

$H_0: \mu = 2.0$

$H_a: \mu \neq 2.0$

Try It 9.2

We want to test whether the mean height of eighth graders is 66 inches. State the null and alternative hypotheses. Fill in the correct symbol (=, \neq , \geq , $<$, \leq , $>$) for the null and alternative hypotheses.

- a. $H_0: \mu$ ___ 66
- b. $H_a: \mu$ ___ 66

Example 9.3

We want to test if college students take less than five years to graduate from college, on the average. The null and alternative hypotheses are:

$$H_0: \mu \geq 5$$

$$H_a: \mu < 5$$

Try It 9.3

We want to test if it takes fewer than 45 minutes to teach a lesson plan. State the null and alternative hypotheses. Fill in the correct symbol ($=$, \neq , \geq , $<$, \leq , $>$) for the null and alternative hypotheses.

a. $H_0: \mu \underline{\hspace{0.5cm}} 45$

b. $H_a: \mu \underline{\hspace{0.5cm}} 45$

Example 9.4

In an issue of *U. S. News and World Report*, an article on school standards stated that about half of all students in France, Germany, and Israel take advanced placement exams and a third pass. The same article stated that 6.6% of U.S. students take advanced placement exams and 4.4% pass. Test if the percentage of U.S. students who take advanced placement exams is more than 6.6%. State the null and alternative hypotheses.

$$H_0: p \leq 0.066$$

$$H_a: p > 0.066$$

Try It 9.4

On a state driver's test, about 40% pass the test on the first try. We want to test if more than 40% pass on the first try. Fill in the correct symbol ($=$, \neq , \geq , $<$, \leq , $>$) for the null and alternative hypotheses.

a. $H_0: p \underline{\hspace{0.5cm}} 0.40$

b. $H_a: p \underline{\hspace{0.5cm}} 0.40$

Collaborative Exercise

Bring to class a newspaper, some news magazines, and some Internet articles. In groups, find articles from which your group can write null and alternative hypotheses. Discuss your hypotheses with the rest of the class.

This page titled [9.2: Null and Alternative Hypotheses](#) is shared under a [CC BY 4.0](#) license and was authored, remixed, and/or curated by [OpenStax](#) via [source content](#) that was edited to the style and standards of the LibreTexts platform.