

Hypothesis Test Notes

Finding the Null and Alternative Hypothesis

Null Hypothesis : H_0

Alternative Hypothesis : H_A or H_1

These are competing ideas about the population.

Note: The sample data is never part of the null or alternative hypotheses. Only population statements.

Hypothesis Test: Procedure for deciding between two opposing views about the population.

Claim: What the person now thinks is true about the population. The claim can also be what they are asking you to prove, or a question that someone needs to figure out.

Steps for finding the Null and Alternative Hypothesis

- 1. Write down the two competing views about the population in symbolic language. Make sure to determine if it is one or two-population and the correct letter (parameter) to use.*
- 2. Write the word "claim" next to what the person thinks is true or what they are asking you to prove.*
- 3. The statement that has = or \geq or \leq is the null hypothesis. Put an H_0 next to it. This is usually a statement about no change, no effect, or not related. That is why the null hypothesis is often given with "=".*
- 4. The statement that has \neq or $<$ or $>$ is the alternative hypothesis. Put an H_A next to it. This is usually a statement about something changing or being related.*

Symbols for population parameters:

μ (population mean)

π or p (population proportion/percentage)

σ (population standard deviation)

Important Notes

- *Never use a sample statistic (\bar{x}, \hat{p}, s). Remember a null and alternative hypothesis are statements about the population parameters (μ, π, σ).*
- *For one-population, always write the letter on the left side and the number on the right side. $\mu < 50$ (never as $50 > \mu$)*
- *For two-population, always put population 1 on the left side and population 2 on the right side. $\pi_1 > \pi_2$ (never as $\pi_2 < \pi_1$)*

Example 1: Auto Magazine Article:

“The population mean average weight of car transmissions used to be about 300 pounds. With more and more small car options, we think the population mean average car transmission weight has decreased.”

The population views are about one population mean.

So what letter should we use?

Population mean: μ

Now write down the two opposing views about the population mean in symbolic language. Identify the claim.

$\mu = 300$

$\mu < 300$ (Claim)

The statement that has “=” or “≥” or “≤” is the null hypothesis. Put an “ H_0 ” next to it.

The statement that has “≠” or “<” or “>” is the alternative hypothesis. Put an “ H_A ” next to it.

$$H_0: \mu = 300$$

$$H_A: \mu < 300 \text{ (Claim)}$$

Example 2: The FDA says that about 2.5% of people that take this medicine will have serious side effects.

The population views are about the population percentage. So what letter should we use?

Population proportion: π or p

Write down the claim (what person said) in symbolic language. Write the word “claim” next to it.

$$\pi = 0.025 \text{ (Claim) (Note } 2.5\% = 0.025)$$

Since we are not given the opposing view, write down the opposite of the claim as the opposing view in symbolic language. Note the opposite of “=” is “≠”.

$$\pi = 0.025 \text{ (Claim)}$$

$$\pi \neq 0.025$$

The statement that has “=” or “≥” or “≤” is the null hypothesis. Put an “ H_0 ” next to it.

The statement that has “≠” or “<” or “>” is the alternative hypothesis. Put an “ H_A ” next to it.

$$H_0: \pi = 0.025 \text{ (Claim)}$$

$$H_A: \pi \neq 0.025$$

Note: Some computer programs also use “p” for population percentage/proportion.

$$H_0: p = 0.025 \text{ (Claim)}$$

$$H_A: p \neq 0.025$$

Example 3: The school board claims that the average SAT score for female high school students is greater than the average SAT score for male high school students. If gender is not related to SAT scores, then the SAT scores should be the same.

Since this is a two population mean average problem we will need to decide what is population 1 and what is population 2 and the correct letter to use.

μ_1 : Female

μ_2 : Male

Write down the two opposing views in symbolic language.

$$\mu_1 > \mu_2 \text{ (Claim)}$$

$$\mu_1 = \mu_2$$

The statement that has “=” or “≥” or “≤” is the null hypothesis. Put an “ H_0 ” next to it.

The statement that has “≠” or “<” or “>” is the alternative hypothesis. Put an “ H_A ” next to it.

$$H_A: \mu_1 > \mu_2 \text{ (Claim)}$$

$$H_0: \mu_1 = \mu_2$$

Three Types of Hypothesis Tests

- Hypothesis Tests are designated as one of three types. It is important to know what type of test you are doing.
- Note that the alternative hypothesis H_A decides the type of test. *(A hypothesis test attempts to reject the null hypothesis. We would reject the null hypothesis if the alternative was correct. So the alternative hypothesis H_A decides the test.)*

Right Tailed Test (H_A is " $>$ ". Notice greater than points to the right)

Left Tailed Test (H_A is " $<$ ". Notice less than points to the left)

Two Tailed Test (H_A is " \neq ". There are two ways for not-equal to happen.)

Look at the three previous examples. What type of test is being used?

Example 1

$$H_0: \mu = 300$$

$$H_A: \mu < 300 \text{ (Claim)}$$

Type of Test? Left-Tailed Test (*Notice H_A is " $<$ " which points to the left*)

Example 2

$$H_0: \pi = 0.025 \text{ (Claim)}$$

$$H_A: \pi \neq 0.025$$

Type of Test? Two-Tailed Test (*Notice H_A is " \neq "*)

Example 3

$$H_A: \mu_1 > \mu_2 \text{ (Claim)}$$

$$H_0: \mu_1 = \mu_2$$

Type of Test? Right-Tailed Test (*Notice H_A is ">" which points to the right*)

Null Hypothesis Confusion

Some students get confused over the sign in the null hypothesis.

It is important to pay attention to the language. Look at the following two examples.

"The population standard deviation (σ) used to be 2 inches but now we think it has increased."

Since we have two opposing views, we can write them both and then chose the null and alternative hypothesis by the sign.

$$H_0: \sigma = 2$$

$$H_A: \sigma > 2 \text{ (Claim)}$$

"We think that the population standard deviation is more than 2 inches."

This time, we do not have the opposing view, so we use opposites. The opposite of ">" is " \leq ".

$$H_0: \sigma \leq 2$$

$$H_A: \sigma > 2 \text{ (Claim)}$$

These two examples illustrate a point of confusion. Sometimes you may see the null hypothesis of the same hypothesis test written as "=" and sometimes it may be written with " \leq " or " \geq ".

$$H_0: \sigma = 2$$

$$H_A: \sigma > 2 \text{ (Claim)}$$

OR

$$H_0: \sigma \leq 2$$

$$H_A: \sigma > 2 \text{ (Claim)}$$

???????

Either answer is ok. Notice the parameter is still 2 inches and they are both right-tailed tests. In all practicality, they are the same test.

Many scientists prefer to write the null almost always as “=”. Remember the null in an experiment is usually “no change” or “no effect”. Change of any kind is usually denoted by the alternative hypothesis.