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Hypothesis Testing for the Population Proportion p: Overview

Learning Objective: In a given context, specify the null and alternative hypotheses for the population proportion and mean.

Overview

Now that we understand the process we go through in hypothesis testing and the logic behind it, we are ready to start learning about specific statistical tests (also known as significance tests).

The first test we are going to learn is the test about the population proportion (p). This test is widely known as the **z-test for the population proportion (p)**. (We will understand later where the "z-test" part comes from.)

When we conduct a test about a population proportion, we are working with a categorical variable. Later in the course, after we have learned a variety of hypothesis tests, we will need to be able to identify which test is appropriate for which situation. Identifying the variable as categorical or quantitative is an important component of choosing an appropriate hypothesis test.

Learn By Doing

1/1 point (graded)

For the following scenario, identify the variable as either quantitative or categorical.

A poll of students at your college asks each student to give an estimate of the number of military casualties that have occurred since the United States invaded Iraq in March of 2003.

☒ quantitative ✓☐ categorical**Answer**

Correct:

The variable is the estimate of the number of military casualties. It is quantitative. So this type of scenario will be analyzed using means, not proportions.

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Learn By Doing

1/1 point (graded)

For the following scenario, identify the variable as either quantitative or categorical.

A poll of students at your college shows that 2 out of 3 do not support continuing military intervention in Iraq.

☐ quantitative☒ categorical ✓**Answer**

Correct:

The variable is support (or not) for continuing military intervention. It is categorical. So this type of scenario will be analyzed using proportions.

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Learn By Doing

1/1 point (graded)

For the following scenario, identify the variable as either quantitative or categorical.

A local newspaper claims that 67% of the county's residents support a bond measure. We conduct a phone survey and find that 85 out of the 150 people contacted support the measure.

☐ quantitative

☒ categorical ✓

Answer

Correct:

The variable is support (or not) for a bond measure. It is categorical. So this type of scenario will be analyzed using proportions.

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Learn By Doing

1/1 point (graded)

For the following scenario, identify the variable as either quantitative or categorical.

A local newspaper claims that the county's residents commute an average of 18 miles each way to work. We conduct a phone survey in which we ask the number of miles the respondent drives each way to work.

☒ quantitative ✓

☐ categorical

Answer

Correct:

The variable is number of miles commuted each way to work. It is quantitative. So this type of scenario will be analyzed using means, not proportions.

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Our discussion of hypothesis testing for the population proportion p follows the four steps of hypotheses testing that we introduced in our general discussion on hypothesis testing, but this time we go into more details. More specifically, we learn how the test statistic and p-value are calculated and interpreted.

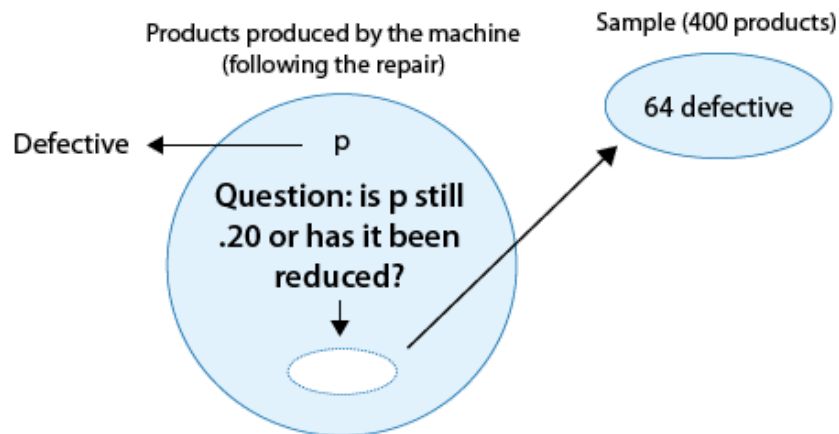
Once we learn how to carry out the test for the population proportion p , we discuss some general topics that are related to hypotheses testing. More specifically, we see what role the sample size plays and understand how hypothesis testing and interval estimation (confidence intervals) are related.

Let's start by introducing the three examples, which will be the leading examples in our discussion. Each example is followed by a figure illustrating the information provided, as well as the question of interest.

Example: 1

A machine is known to produce 20% defective products, and is therefore sent for repair. After the machine is repaired, 400 products produced by the machine are chosen at random and 64 of them are found to be defective. Do the data provide enough evidence that the proportion of defective products produced by the machine (p) has been **reduced** as a result of the repair?

The following figure displays the information, as well as the question of interest:



The question of interest helps us formulate the null and alternative hypotheses in terms of p , the proportion of defective products produced by the machine following the repair:

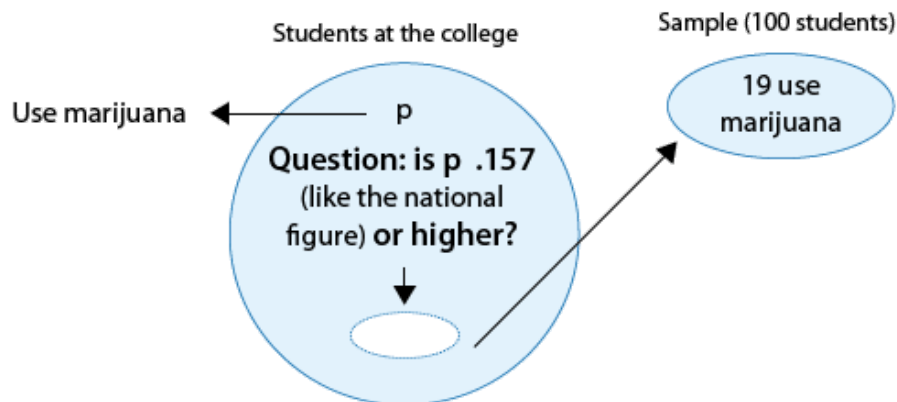
$H_0: p = 0.20$ (No change; the repair did not help).

$H_a: p < 0.20$ (The repair was effective).

Example: 2

There are rumors that students at a certain liberal arts college are more inclined to use drugs than U.S. college students in general. Suppose that in a simple random sample of 100 students from the college, 19 admitted to marijuana use. Do the data provide enough evidence to conclude that the proportion of marijuana users among the students in the college (p) is **higher** than the national proportion, which is 0.157? (This number is reported by the Harvard School of Public Health.)

Again, the following figure displays the information as well as the question of interest:



As before, we can formulate the null and alternative hypotheses in terms of p , the proportion of students in the college who use marijuana:

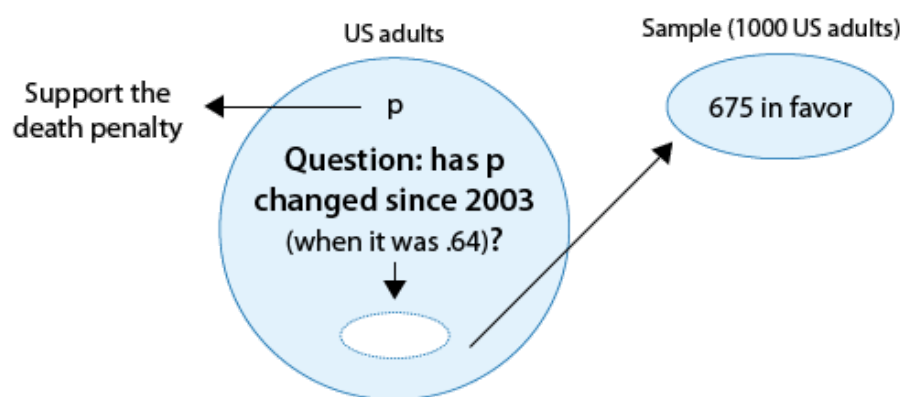
$H_0: p = 0.157$ (same as among all college students in the country).

$H_a: p > 0.157$ (higher than the national figure).

Example: 3

Polls on certain topics are conducted routinely in order to monitor changes in the public's opinions over time. One such topic is the death penalty. In 2003 a poll estimated that 64% of U.S. adults support the death penalty for a person convicted of murder. In a more recent poll, 675 out of 1,000 U.S. adults chosen at random were in favor of the death penalty for convicted murderers. Do the results of this poll provide evidence that the proportion of U.S. adults who support the death penalty for convicted murderers (p) **changed** between 2003 and the later poll?

Here is a figure that displays the information, as well as the question of interest:



Again, we can formulate the null and alternative hypotheses in term of p , the proportion of U.S. adults who support the death penalty for convicted murderers.

$H_0: p = 0.64$ (No change from 2003).

$H_a: p \neq 0.64$ (Some change since 2003).

Scenario: Federal Grants for Community College Students

According to the American Association of Community Colleges, 23% of community college students receive federal grants. The California Community College Chancellor's Office anticipates that the percentage is smaller for California community college students. They collect a sample of 1,000 community college students in California and find that 210 received federal grants.

Learn By Doing

1/1 point (graded)

For which group are we making a hypothesis?

- ☐ The population of community college students
- ☒ The population of community college students in California ✓
- ☐ A sample of community college students in California

Answer

Correct: We are trying to answer a question about California community college students.

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Learn By Doing

1/1 point (graded)

What is p for California?

- ☐ 23
- ☒ 0.23 ✓
- ☐ 210
- ☐ 0.210

Answer

Correct: We want to know if the proportion for California is the same as the national proportion.

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Learn By Doing

1/1 point (graded)

How does the California Chancellor's Office think California students will compare to the 23% receiving federal grants nationwide?

☐ California proportion will be larger than the national proportion

☐ California proportion will not be equal to the national proportion

☒ California proportion will be smaller than the national proportion ✓

Answer

Correct:

The California Community College Chancellor's Office anticipates that the percentage receiving federal grant is **smaller** for California community college students.

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Learn By Doing

1/1 point (graded)

Which are the correct hypotheses for this scenario?

☐ $H_0: p = 0.23, H_a: p < 0.210$

☒ $H_0: p = 0.23, H_a: p < 0.23$ ✓

☐ $H_0: p = 0.210, H_a: p > 0.210$

☐ $H_a: p = 0.23, H_a: p \neq 0.23$

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Learn By Doing

1/1 point (graded)

What does p represent in the hypotheses?

- ☐ The proportion of community college students who received federal grants
- ☒ The proportion of California community college students who received federal grants ✓
- ☐ The proportion of 1,000 community college students who received federal grants
- ☐ The number of federal grant recipients attending community colleges in California

Answer

Correct:

In the hypotheses, p is the proportion of California community college students who received federal grants.

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Scenario: Number of Community College Students in the U.S.

Using data from 2008, the American Association of Community Colleges (AACC) reports that community college students constitute 46% of all U.S. undergraduates. Given the downturn in the U.S. economy, the AACC anticipates an increase in this percentage for 2010. A poll of 500 randomly chosen undergraduates taken in 2010 indicates that 52% are attending a community college.

Did I Get This

1/1 point (graded)

Which are the correct hypotheses for this scenario?

- ☐ $H_0: p = 0.46, H_a: p \neq 0.46$
- ☒ $H_0: p = 0.46, H_a: p > 0.46$ ✓
- ☐ $H_0: p = 0.52, H_a: p > 0.52$

☐ $H_a: p = 0.52, H_a: p > 0.46$

Answer

Correct: These are the correct hypotheses about the population proportion.

Submit

Did I Get This

1/1 point (graded)

What does p represent in the hypothesis?

☐ Of all U.S. undergraduates, the proportion attending community college

☐ Of all U.S. undergraduates, the proportion attending community college in 2008

☒ Of all U.S. undergraduates, the proportion attending community college in 2010 ✓

☐ Of 500 U.S. undergraduates, the proportion attending community college in 2010

Answer

Correct:

We are making a hypothesis about the proportion of U.S. undergrads who are attending community college in 2010.

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