

Practice Assignment: Null and Alternative Hypotheses

Questions 1–7: The American Community Survey (ACS) is a survey of around 3.5 million homes in the United States and Puerto Rico conducted annually by the U.S. Census Bureau. Aggregate data from the ACS are released every five years. The overall ACS poverty rate, or the proportion of people living in poverty, from 2015 to 2019 was reported to be 13.4%.¹ Suppose that some new economic reforms were made in the years after 2019, and you want to use a hypothesis test to determine whether the poverty rate has decreased.

1) What is the null hypothesis for this test?

- a) $H_0: p = 0.134$
- b) $H_0: p > 0.134$
- c) $H_0: p \neq 0.134$
- d) $H_0: p < 0.34$

2) What is the alternative hypothesis for this test?

- a) $H_A: p = 0.134$
- b) $H_A: p > 0.134$
- c) $H_A: p \neq 0.134$
- d) $H_A: p < 0.134$

3) Suppose you draw a simple random sample of American households and record the proportion of people living in poverty. Which of the following would constitute more evidence in support of the alternative hypothesis?

- a) A higher sample proportion of people living in poverty
- b) About 13.4% of people in the sample living in poverty
- c) A lower sample proportion of people living in poverty

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¹ U.S. Census Bureau. (2020, December 10). *Census Bureau releases new American community survey 5-year estimates*. <https://www.census.gov/newsroom/press-releases/2020/acs-5-year.html>

- 4) What does it mean to say that the null hypothesis is true in this context?
- a) The poverty rate has decreased.
 - b) The poverty rate remains at about 13.4%.
 - c) The poverty rate has increased.
- 5) Which of the following probabilities do we want to consider to see how strong our evidence is in favor of the alternative hypothesis?
- a) The probability of obtaining a sample proportion as large or larger if there really has been no change in the poverty rate
 - b) The probability of obtaining a sample proportion as small or smaller if there really has been no change in the poverty rate
 - c) The probability of obtaining a sample proportion as large or larger if the poverty rate has actually decreased
 - d) The probability of obtaining a sample proportion as small or smaller if the poverty rate has actually decreased
- 6) Which of the following would cause us to reject the null hypothesis?
- a) A sample proportion where the probability of obtaining a sample proportion that small or smaller is very low
 - b) A sample proportion where the probability of obtaining a sample proportion that small or smaller is very high
 - c) A sample proportion where the probability of obtaining a sample proportion that large or larger is very low
 - d) A sample proportion where the probability of obtaining a sample proportion that large or larger is very high
- 7) Which of the following are possible conclusions to our hypothesis test? Select all that apply. There will be more than one correct answer.
- Hint: Recall from the preview assignment and in-class activity that we never accept the null hypothesis. We either obtain enough evidence to reject the null hypothesis or we do not, so the only possible conclusions are to reject the null hypothesis or to fail to reject the null hypothesis.

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- a) We do not have a sample proportion low enough to be very unlikely, so we do not have enough evidence to support the idea that the poverty rate has decreased. We therefore fail to reject the null hypothesis.
- b) We do not have a sample proportion low enough to be very unlikely, so we have sufficient evidence to support the idea that the poverty rate has decreased. We therefore reject the null hypothesis.
- c) We do not have a sample proportion low enough to be very unlikely, so we do not have enough evidence to support the idea that the poverty rate has decreased. We therefore accept the null hypothesis.
- d) We have a sample proportion so low that it is very unlikely, so we have sufficient evidence to support the idea that the poverty rate has decreased. We therefore reject the null hypothesis.
- e) We have a sample proportion so low that it is very unlikely, so we have sufficient evidence to support the idea that the poverty rate has decreased. We therefore fail to reject the null hypothesis.
- f) We have a sample proportion so low that it is very unlikely, so we have sufficient evidence to support the idea that the poverty rate has decreased. We therefore accept the null hypothesis.

Recall: We have now seen a few examples of the uses of null and alternative hypotheses for testing a proportion. Hypothesis testing can also be done for other population parameters, such as means.

Recall that the null hypothesis is a statement of no change or no difference from the previously accepted value, while the alternative hypothesis describes how the parameter is guessed to differ from the null value (i.e., do we suspect the actual parameter to be greater than, less than, or just different from the null value?). Here is a summary of the notations used for hypotheses when testing means or proportions:

	Null Hypothesis Forms	Alternative Hypothesis Possible Forms
Proportions	$H_0: p = \text{some value}$	$H_A: p > \text{null value}, H_A: p < \text{null value},$ $H_A: p \neq \text{null value}$
Means	$H_0: \mu = \text{some value}$	$H_A: \mu > \text{null value}, H_A: \mu < \text{null value},$ $H_A: \mu \neq \text{null value}$

Questions 8–14: The Pew Research Center is a non-partisan fact tank that conducts

social science research. Periodically, they conduct a Core Trends Survey, which measures many different variables for a sample of American adults including demographic information and information about use of technology. According to the Core Trends Survey from January 8, 2019 to February 7, 2019, the mean number of social media sites used by American adults was 3.11, where the possible social media sites considered were *Facebook, Instagram, LinkedIn, Pinterest, Reddit, Snapchat, Twitter, WhatsApp, and YouTube*.²

Suppose you want to know whether the mean number of these social media sites used by teenagers aged 13–17 is different from the mean number used by adults.

8) What is the parameter of interest in this situation?

9) You decide to conduct a hypothesis test in order to test your conjecture. What is the null hypothesis?

a) $H_0: p = 3.11$

b) $H_0: \mu = 3.11$

c) $H_0: \mu > 3.11$

d) $H_0: \mu < 3.11$

e) $H_0: \mu \neq 3.11$

10) What is the alternative hypothesis for your hypothesis test?

Hint: This alternative hypothesis is a bit different from the ones we've seen before. Notice that the question we're asking in this case is, "Is the mean number of social media sites used by teenagers different from the mean number used by adults?" (We're not asking whether the mean is larger or smaller but just whether it's different.)

a) $H_A: \mu \neq 3.11$

b) $H_A: \mu = 3.11$

c) $H_A: \mu > 3.11$

d) $H_A: \mu < 3.11$

² Pew Research Center. (2019). *Core trends survey - Survey conducted Jan. 8 to Feb. 7, 2019*.
<https://www.pewresearch.org/internet/dataset/core-trends-survey>

- 11) Once you have your hypotheses, you draw a random sample of American teenagers aged 13–17 and ask them how many of the nine social media websites they use. What sample statistic are you interested in?
- 12) What does it mean to say the null hypothesis is true in this context?
- a) The mean number of social media sites used by teenagers aged 13–17 is different from the mean number of social media sites used by adults.
 - b) The mean number of social media sites used by teenagers aged 13–17 is about the same as the mean number of social media sites used by adults.
- 13) Which of the following would constitute more evidence in favor of the alternative hypothesis?
- a) A mean number of social media sites used by teenagers in the sample that is closer to 3.11
 - b) A mean number of social media sites used by teenagers in the sample that is farther from 3.11
- 14) Which of the following would cause us to reject the null hypothesis?
- a) A sample mean where the probability of obtaining a sample mean that far from 3.11 is very low
 - b) A sample mean where the probability of obtaining a sample mean that far from 3.11 is very high
 - c) A sample mean where the probability of obtaining a sample mean that close to 3.11 is very low
 - d) A sample mean where the probability of obtaining a sample mean that close to 3.11 is very high