

1. A study was conducted in the United Kingdom on the effectiveness of a four-day work week with the following hypotheses:
 H_0 : A four-day work week does not increase productivity.
 H_a : A four-day work week increases productivity.
 - a. Describe a Type I error in context.
 - b. Give one possible consequence of making a Type I error.
 - c. Describe a Type II error in context.
 - d. Give one possible consequence of making a Type II error.

2. A group of biologists is studying the effects of particular type of pesticide on bees. To test this, one group of bees is randomly assigned to be exposed to the pesticide, while the other group, a control group, is not exposed. After one week, the researchers calculate the proportion of bees in each group that survived. The null and alternative hypotheses for the test are:

$$H_0 : p_1 - p_2 = 0$$

$$H_a : p_1 - p_2 < 0$$

Where $p_1 - p_2 =$ the true difference in proportions of bees that survive for one week (pesticide – control).

- a. Write the null and alternative hypothesis in words.

- b. The researchers obtain a p -value of 0.03. Interpret this p -value in context.

- c. What conclusion will the researchers make at a significance level of $\alpha = 0.05$?

- d. Based on your answer to part (c), what type of error, if any, could have been made? Explain.

3. A marketing manager is evaluating whether a new online advertisement increases the click-through rate (CTR = clicks/views) for their company's website. The historical CTR for advertisements on this website is 0.04. After running the new advertisement for one month, the manager collects data on the number of views and clicks and performs a hypothesis test to determine if there is convincing statistical evidence that the advertisement's CTR is greater than the historical rate.
- State the null and alternative hypotheses in both symbols and words. Let p represent the true CTR for the new advertisement.
 - If the hypothesis test yields a p -value greater than $\alpha = 0.05$, what conclusion would the company make?
 - Based on your conclusion in part (b), what practical decision should the company make about implementing the new advertisement?
 - Based on your answers to parts (b) and (c), identify what type of error could have been made? Explain one consequence to the company of making this error.

4. A new diagnostic test is developed for a rare but serious disease. The diagnostic test is designed to quickly identify patients who are infected, allowing for rapid treatment intervention. At the $\alpha = 0.01$ level, medical researchers perform a hypothesis test of the following hypotheses to determine if a patient has the disease:

H_0 : The patient does not have the disease.

H_a : The patient has the disease.

- a. Describe a Type I and Type II error in context.
- b. Which would be more serious in this context, a Type I error or a Type II error? Explain.
- c. What is the probability the researchers will make a Type I error?

5. Looking for ways to become more profitable, a large corporation is considering increasing its prices. Concerned that higher prices may reduce sales, the corporation implements the price increases only in randomly selected stores across the country. To test whether there is a statistically significant decrease in sales after the price increases, they perform a hypothesis test of the following hypotheses:

H_0 : Sales remain the same after the price increases.

H_a : Sales decrease after the price increases.

- a. Describe a Type I error and Type II error in this setting.

- b. Which error is more serious from the perspective of the corporation?

- c. Which error is more serious from the perspective of the corporation's customers?

6. A food blogger with a large following wants to know if email subscribers would be willing to pay \$3 per month for additional recipes, videos, and behind-the-scenes footage of recipe development. The blogger plans to survey a random sample of followers to determine if there is convincing statistical evidence that a majority of followers would purchase additional content. If there is convincing evidence, the blogger will offer additional content to email subscribers. Which of the following describes the consequence of a Type II error in this setting?
- A) The food blogger decides to offer additional content to email subscribers when the actual percentage who would purchase additional content is greater than 50%.
 - B) The food blogger decides to offer additional content to email subscribers when the actual percentage who would purchase additional content is less than 50%.
 - C) The food blogger decides not to offer additional content to email subscribers when the actual percentage who would purchase additional content is less than 50%.
 - D) The food blogger decides not to offer additional content to email subscribers when the actual percentage who would purchase additional content is greater than 50%.

7. Medical researchers are testing a new drug designed to help adults with joint pain with the following null and alternative hypotheses:

H_0 : The new drug does not help adults with joint pain.

H_a : The new drug helps adults with joint pain.

For the medical researchers, the more consequential error would be determining that the new drug helps adults with joint pain, when it actually does not help. Which of the following should the researchers do to reduce the probability of making the more consequential error?

- A) Increase the α level to decrease the probability of a Type II error.
- B) Decrease the α level to increase the probability of a Type I error.
- C) Decrease the α level to decrease the probability of a Type I error.
- D) Increase the α level to decrease the probability of a Type I error.