

Two-Sample Hypothesis Testing and Confidence Intervals for the Difference in Population Means

OVERVIEW

In this lab, you will work with descriptive statistics, two-sample hypothesis testing, and two-sample confidence intervals.

OBJECTIVES

By the end of this laboratory, you will be able to

- Perform and interpret two-sample hypothesis testing using *Minitab*.
- Use Minitab to calculate a two-sample confidence interval and interpret the meaning.

EQUIPMENT

- PC with *Minitab*
- Computer diskette to save files

BACKGROUND MATERIAL

Statistical Terms and Topics

- Null hypothesis
- Alternative/research hypothesis
- One-tailed test, upper tail
- One-tailed test, lower tail
- Observed significance level
- (p -value)
- Confidence interval
- Confidence level
- Two-tailed test
- Alpha (α)
- Test statistic
- “t” test statistic
- “z” test statistic

Scenario

A sample of 51 students from two undergraduate math classes filled out a questionnaire. The students were asked their height. For each class, the data for the height of each student is given in inches.



Exercise

INSTRUCTIONS

1. How do you believe that the data from the two groups should relate? *Hint: Do you have any reason to believe that the data from one group is specifically larger or smaller than the data from the other? Write out your hypothesis below.

2. Now form the hypothesis using statistical notation.
 The null hypothesis is denoted H_0 .
 The alternative / research hypothesis is denoted H_a .
 D_0 is the hypothesized difference between the two means or μ 's.
 (*Hint: if you want to test whether or not the two populations are equal, D_0 should equal zero.

$$H_0: \mu_1 - \mu_2 = \text{_____} (D_0)$$

$$H_a: \mu_1 - \mu_2 \text{ ______ } (D_0) \text{ (*Hint: go back and look at one-tailed and two tailed tests)}$$

Class 1

72.0	67.0	70.0	70.0
71.0	64.0	66.5	68.0
71.0	69.0	66.0	64.0
70.0	70.0	67.0	63.0
69.0	77.0	65.0	63.0
70.0	69.0	69.0	
70.0	73.0	69.0	
72.5	66.0	69.0	

Class 2

66.0	67.0	74.0	67.0
66.0	68.0	59.0	74.0
64.0	64.0	61.0	68.0
63.0	71.0	71.0	71.0
66.0	68.0	68.0	
67.0	67.0	68.0	



Computer Exercise

- Enter the data from the **first class** into column 1 (**C1**). Name column 1 (**C1**) "**Class1**."
- Enter the data from the **second class** into column 2 (**C2**). Name column 2 (**C2**) "**Class2**."
- Run **descriptive statistics** on Class1 and Class 2.
- Is there a difference in the means of the two classes? _____ Do you expect the difference to be significant? _____. Specify the chosen significance level for this test. $\alpha =$ _____.
- Since you have less than 30 students in each group and you don't know sigma, you will be performing a two-sample t-test.
- Talk about assumptions. Draw a histogram for each of the classes. The steps are below if needed.
 - Go to **GRAPH > HISTOGRAM**.
 - Select **Class1** to put in line 1 of Graph variables.
 - Select **Class2** to put in line 2 of Graph variables.
 - Click **OK**.
- Make a rough sketch of Class 1 histogram _____. Does the data from Class1 look approximately normal? _____
- Make a rough sketch of Class 2 histogram _____. Does Class 2 appear to be approximately normal in distribution? _____
- Choose a maximum value of α that you are willing to tolerate. $\alpha =$ _____
- Perform the 2 Sample t test for means.
 - Go to **STAT > BASIC STATISTICS > 2 SAMPLE T**.
 - Mark **Samples in different columns**.

- Select **Class1** for **First**.
- Select **Class2** for **Second**.
- Click **OK**.

t-test statistics = _____ p -value = _____ df = _____

Why was the t-test the correct test? _____

Recall: The pooled standard deviation is used if the standard deviations for the two populations are approximately equal. Should you have marked the "Assume equal variances" box when you ran the 2-sample T test? _____ If so, re run the test and compare the answers. Use the "best" answer for your interpretation below.

12. Interpret the t test.

If the observed significance level (p -value) of the t test is less than the chosen value of α (See step 6.), reject the null hypothesis. Otherwise, do not reject the null hypothesis.

*Note that you only reject or do not reject – you **never** “accept the null” Based on the p -value and α , what do you conclude about the test?

13. Look back at the analysis for the two-sample t-test. On the output, find the confidence intervals.

Perform a two-sample C.I. with a 95% and 99% confidence level.

95% C.I. _____ 99% C.I. _____

14. Compare the two confidence intervals you just performed.

Which is the confidence interval with the largest range _____% C.I.?

Which is the confidence interval with the smallest range _____% C.I.?

15. Interpreting the confidence interval. Pick one of the above confidence intervals and fill out the following:

We can be _____% confident that the difference between $\mu_1 - \mu_2$ lies between (lower bound of interval) _____ and (upper bound of interval) _____.

*Note: This statement reflects our confidence in the estimation process rather than in the particular interval that is calculated from the sample data.

16. Now write out the statement above for the other confidence intervals.



Application to Psychology

Two-sample hypothesis testing tells us if there is a significant difference between the averages of two separate groups. Two-sample hypothesis testing is used frequently in psychological research because it can compare two levels of a treatment. Also, if there is a difference between two groups, the hypothesis testing and the confidence interval can indicate which group is higher.

A two sample hypothesis testing could be used in an experiment to test the effectiveness of a specific type of counseling on bulimic eating patterns. Suppose that you have an experimental group of women with bulimia who have received counseling and a control group of women with bulimia who have not had counseling. Each person's score is determined by how many times they have binged and purged in the past week.

What assumptions would have to be met about the data before you could perform a two-sample t-test?

Please write out your hypothesis below. Use Step #2 as a model.

If you were a clinical psychologist reviewing the results of this study, what level of alpha would the data need to be significant at for you to make recommendations about this type of counseling?

If the data were significant at this level, would you be able to say accurately that this type of counseling cures bulimia? Why?

Ethics Application

Go back and read over the scenario in the Application to Psychology section. Comment on any ethics situations that may be a problem. Then list at least four actions that must be taken to ensure that the experiment is ethical. Write your response in the space below and be prepared to share it with the class.