Name: _____ SID: _____

Week 6 Problem Set

Hypothesis tests for the differences of means and proportions

PHW142

Part A. Two independent sample tests for comparing means

Ink Toxicity

1. (11 points) The National Toxicology Program evaluates the toxicity of chemicals found in manufacturing, in consumer products, or in the environment after disposal. Toxicity is assessed through a battery of tests. Here are some results from a study of the toxicity of black newsprint ink in 7-week-old female rats. The rats' fur was locally clipped twice a week for 13 weeks. One group of rats received a dermal application of ink right after each clipping, and a control group of rats was left untreated. The table in Baldi and Moore contains the body weights (in grams) of the rats at the beginning of the study and at the end of the 13 weeks.

   Note: I am assuming that 20 rats of the same strain, reared in the same way, were available for the study and that 10 were randomly assigned to the ink treatment and the other 10 to be controls.

   The Excel data set is toxic_ink.xlsx.

   There are 3 variables:

`group`	coded "C" or "T"
`week0`	rat's weight at beginning of the study
`week13`	rat's weight at at end of the study

   The variable group is coded C for control and T for treatment. Baldi and Moore ask students to do two complete analyses.

   a. Verify that the two experimental groups are not significantly different at the beginning of the study. [That is, that the randomization "worked."] I will include part (a) in the key.

You only need to do part (b).

b. Is there good evidence that ink application impairs the growth in female rats between 7 and 20 weeks of age? [Use P < .05 as the criterion for "good evidence."]

Estimate the difference between the two population mean weight gains. (Use 95 % confidence.)

Part (b) is a "difference in differences" analysis.

The R Markdown files I used for the Reader and Lecture examples for the GMO transgenic and control chicks and the piano lessons preschoolers with a control group are in bCourses. Use them as models for the R functions you need to use for this analysis.

part (b): comparing the changes in weights over the 13 weeks for the experimental and the control group.

For part (b), you will need to compute the differences in weights for week 13 and week 0 . Subtract the week 0 values from the week 13 values, and call it `weight_gain`.

The differences in weight from `week0` to `week13` are the basic data for comparing the control and treatment groups.

See the R Markdown files for the GMO chicks example and the piano lessons and control group for spatio-temporal reasoning for examples of how to get the side-by-side box plots and the normal quantile plots and Shapiro-Wilk tests for each group separately by subsetting the data.

(i) Paste your side-by-side box plot of the weight gains here:

(ii) Paste your normal quantile plot for the weight gains in the **control** here:

(iii) Paste your Shapiro-Wilk test for the weight gains in the **control** here:

(iv) Paste your normal quantile plot for the weight gains in the **toxic ink group** here:

(v) Paste your Shapiro-Wilk test for the weight gains in the **toxic ink group** here:

1 and 2. Use the side-by-side box plot, the normal quantile plots, and the Shapiro-Wilk tests to explain why methods using the t distribution can be used to analyze these data.

(vi) (1 point) Detailed discussion of box plots.

(vii) (1 point) Detailed discussion of normal quantile plots

(viii) (1 point) Detailed discussion of Shapiro-Wilk test results

(ix) (1 point) Overall comments on normal curve assumptions for the weight gains and the sampling distribution $\bar{x}_{\text{control}} - \bar{x}_{\text{toxic ink}}$ Be sure to point out that the design is balanced and explain the limitations.

(x) (1 point) State the investigators' alternative and null hypotheses.

(xi) (2 points) Calculate the standard error of the difference $\bar{x}_{\text{control}} - \bar{x}_{\text{toxic ink}}$ and then calculate the test statistic. [1 point standard error; 1 point test statistic]

(xii) Paste your `t-test` function command and results here:

(xiii) (1 point) For the hypotheses you set up in question 3, quote the P value from the `t.test` output and use it to answer the investigators' research question.

(xiv) (2 points) Find a 95% confidence interval for the difference of the population mean weight gains. Write a summary sentence interpreting the confidence interval.

(xv) (1 point) Write a sentence explaining clearly what ”95% confidence” means.

Part B. Two independent sample proportion problems

adapted from Baldi and Moore, exercises 20.39 and 20.40, 3rd edition and 20.27, 4th edition

Post-Surgery Staph Infection

2. (13 points) Researchers recruited 917 patients preparing for surgery who tested positive for Staphylococcus aureus and randomly assigned them to receive a nasal ointment that contained either a staph-killing solution or a placebo. The patients were monitored and assessed for postsurgery infections with S. aureus.

   The researchers question is: Do staph-positive patients treated with staph-killing ointment before surgery have a lower proportion of postsurgical staph infection compared to those not treated?

   Here's the data.

	post-surgery staph infection		
	Yes	No	total
placebo	32	381	413
staph-killing ointment	17	487	504

   (i) (2 points) Verify that the procedure based on the normal approximation can be used to find a confidence interval for the difference in the population proportions of those who develop postsurgery staph infection with the placebo and the staph-killing ointment

To get any points for questions c-h, you must give details and show your work.

(ii) (2 points) Calculate the 95% confidence interval for the difference of the population proportions.

(iii) (1 point) State the investigator's null and alternative hypotheses.

Phrase the hypotheses in terms of the population propotions of patients with post-surgery staph infections.

(iv) (3 points) Verify that the procedure based on the normal approximation can be used to carry out the test.

(v) (1 point) Calculate the standard error to use for the denominator in the hypothesis test. State the formula and carry out the calculations.

(vi) (1 point) Calculate the test statistic

(vii) (1 point) Sketch the normal curve, mark and label the value of the test statistic on the horizontal axis, and shade the area that represents the P value.

(viii) (1 point) What is the P value for the investigator's test?

(ix) (1 point) For the hypotheses you set up in question 3, quote the P value from the `t.test` output and use it to answer the investigators' research question.

(x) (1 point) Based on the P value, and using $P < .05$ as the criterion for statistical significance, write a summary sentence that clearly communicates the test conclusion to the researchers. (50 words or fewer.)