Testing Hypotheses Using Statistics

Biol 1012, Little & Shannon

Scenario: Say that you are a coach that wants to know whether the supplement creatine will improve the performance of your team. You **randomly** assign individuals to two different groups, and conduct a **double-blind** experiment. One group will get creatine, but the other gets a **placebo** (control group). The groups will be treated similarly in all other ways (training, diet, etc…). At the end of your experiment, you get the following results:

With Creatine		**With Placebo**	
Individual #	Inc. in Strength (kg)	Individual #	Inc. in Strength (kg)
1	11	9	10
2	8	10	8
3	9	11	8
4	12	12	9
5	15	13	10
6	11	14	12
7	10	15	8
8	9	16	8
Mean	10.6		9.1
95% CI	1.5		1.0

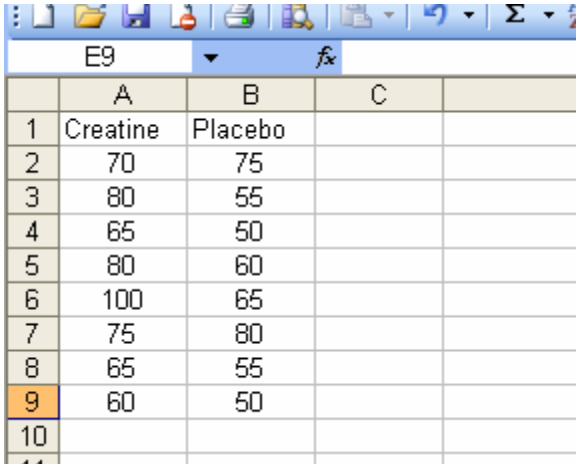
Statistical significance

In order to determine whether there is a meaningful difference between the means of the two treatments we will be using a procedure called a t-test. This test, originally developed by a statistician working for the Guinness Brewery, compares the difference between the two means to the difference in their standard deviations. This procedure involves two steps: 1) computing a t value, and 2) computing the probability (p) that the difference between the means is due to chance alone. Most of the time, scientists will say that a difference between means is **statistically significant if there is less than a 5% probability that the difference is due to chance alone**.

Calculating p-values in Excel

You can calculate statistical significance using the t-test procedure built into Excel. Listed below are the steps to use:

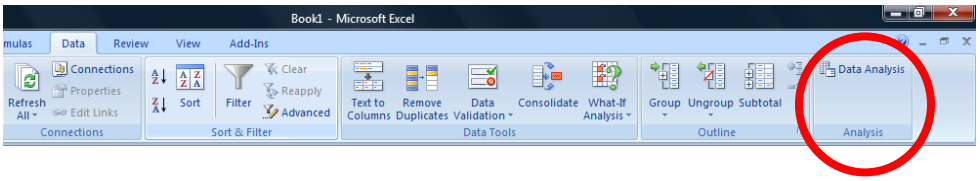
A. Enter the data into Excel in two columns. Include column headings, but do not include the mean and standard deviation rows. Your data should look something like this (NOTE: DO NOT USE THE DATA HERE, USE THE ORIGINAL DATA FROM THE FIRST PAGE):



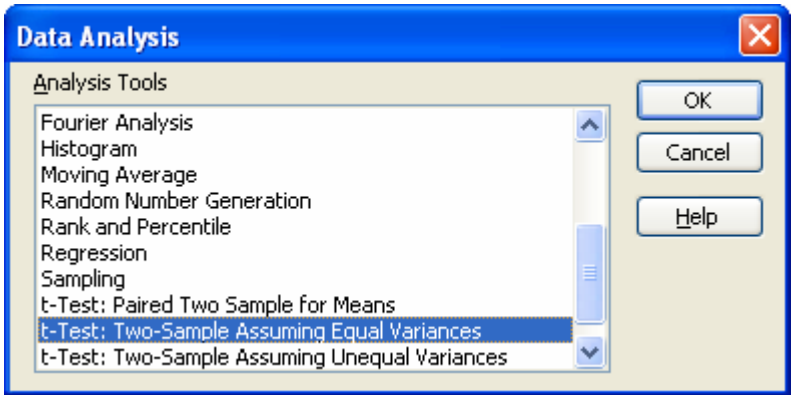
E9

	A	B	C
1	Creatine	Placebo	
2	70	75	
3	80	55	
4	65	50	
5	80	60	
6	100	65	
7	75	80	
8	65	55	
9	60	50	
10			

B. Click the data tab at the top of the Excel worksheet and then select **Data Analysis** at the right end of the menu bar



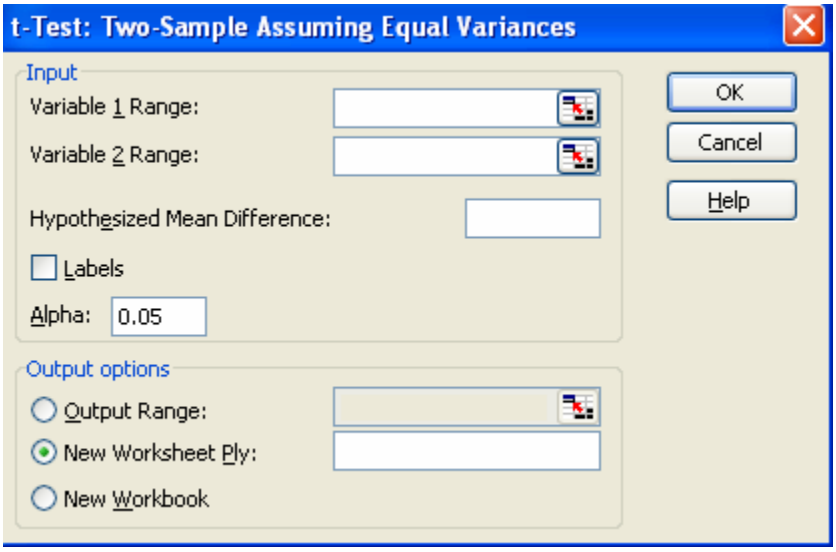
A menu will open that looks like this:



If you do not have the Data analysis option on your computer, you may have to add it in. To do this, select Add-ins… on the Tools menu, check the Analysis Toolpak option,

and hit OK. Now the Data analysis option should be available on the Tools menu. You may need the Excel installation CD to access this add-in.

Scroll down to select **t-Test: Two-Sample Assuming Equal Variances** from the menu. Another dialog box will open that looks like this:



C. Click the little red arrow box by the **Variable 1 Range.** This lets you highlight your data column for variable 1, the creatine sample. Highlight this data, along with the column heading (label). After highlighting, click the red arrow box again to return to the t-Test dialog.

D. Repeat this procedure for **Variable 2 Range**, except highlight the placebo data this time.

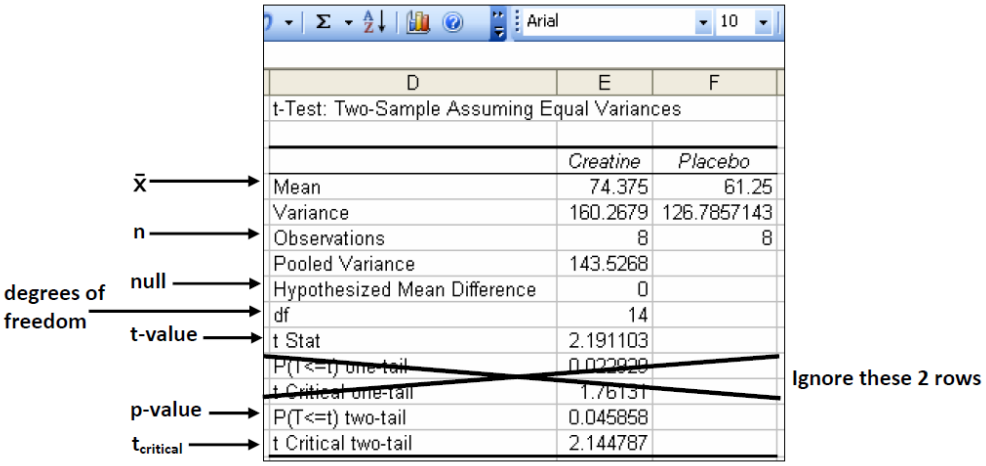
E. The **Hypothesized Mean Difference** is for your null hypothesis. What should you enter here?

F. Check the **Labels** box, because you included the column headings in your highlighting.

G. **Alpha** is the p-value (probability) that you would like to test for. The p-value is a measure of how much confidence we have in stating whether our data support our null hypothesis. A p-value of .05 means that there is only a 5% probability that that the differences observed between the treatment means could occur by chance alone. Since we would like to see if p is ≤ 0.05, we will leave it alpha at 0.05.

H. In **Output options**, click the button beside **Output Range**. Again, click the red arrow box, and highlight the cell in which you would like the output table to appear. Click the arrow box again to return to the dialog.

I. Finally, click **OK.**
On your spreadsheet, you should get an output like this (NOTE: THE NUMBERS HERE ARE DIFFERENT FROM THOSE THAT YOU WILL GET USING THE ORIGINAL DATA FROM PAGE 1):



In this case, t = 2.19 (round it to 2 decimal places). (Note that you should use the **absolute value of the t-value** – i.e. if it has a negative sign, ignore it). This exceeds the reference t value ($t_{critical}$) which is the t-value at which there would be no difference in the means. (The computation of $t_{critical}$ is beyond the scope of this exercise, but it is computed using the standard deviations and sample sizes in the experiment). The table above shows that the p value is <.05 (.04), so there is less than a 5% probability that this difference is due to chance. So we conclude that the difference is statistically significant.

In a lab report, you should state your findings and reference your statistics like this:

"On average, athletes taking creatine were able to lift significantly more weight (74.3kg) than athletes taking a placebo (61.2kg) ($p \leq 0.05$, two-sample t-test, $t = 2.19$)."

Notice that we include the p-value, test type, and the test statistic (t-value).

6. Note that the analysis shown above is for illustration only and was NOT applied to the data at the beginning of this handout.

What t-value did you calculate using Excel?

What was your p value?

What conclusions can you draw from this experiment?