On the first quiz we examined whether wearing wetsuits influences swimming velocity. Twelve competitive swimmers swam 1500 meters at maximum speed twice each; once wearing a wetsuit and once wearing a regular bathing suit. The order of the trials was randomized. Each time, the maximum velocity in meters/sec of the swimmer was recorded.

*Research Question*: Did the average maximum velocity for competitive swimmers differ when wearing wetsuits vs. not wearing wetsuits?

1. What would be the null and alternative hypothesis statements that would be used to answer the research question? Write out the hypothesis statements in both words and symbols.

H0:

Ha:

1. What would be an appropriate statistical test to perform? Select one of the tests below

|  |  |
| --- | --- |
| Test for a single proportion | Test for a difference in proportions |
| Test for a single mean | Test for a difference in means |

Below are graphical and numerical summaries of the data.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Wetsuit | No Wetsuit | Total |
| Sample Size | 12 | 12 | 24 |
| Mean | 1.507 | 1.429 | 1.468 |
| Std. Deviation | 0.136 | 0.141 | 0.141 |
| Minimum | 1.220 | 1.120 | 1.120 |
| Maximum | 1.750 | 1.640 | 1.750 |



1. Do we meet the necessary conditions to perform an independent samples t-test? Explain.
2. Calculate the test statistic.
3. Calculate the p-value using *StatKey,* select the appropriate Theoretical Distribution and find the p-value, using your test statistic from Question 4.
4. Interpret the p-value.
5. Answer your research question based off of your statistical test.

**The Problem with Paired Data**

There is a problem with the statistical test you just performed. We ignored the **paired** nature of the data! The test we just performed assumed these two samples were independent, but a swimmer swam in both conditions. Surely this isn’t independent. **This can have consequences.**

1. Using the table below, what percent of time was the wetsuit condition faster than the no wetsuit condition? The larger number indicates a faster maximum swimming velocity.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Swimmer | | | | | | | | | | | |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Wetsuit | 1.57 | 1.47 | 1.42 | 1.35 | 1.22 | 1.75 | 1.64 | 1.57 | 1.56 | 1.53 | 1.49 | 1.51 |
| No Wetsuit | 1.49 | 1.37 | 1.35 | 1.27 | 1.12 | 1.64 | 1.59 | 1.52 | 1.50 | 1.45 | 1.44 | 1.41 |

The dot plot on the page 1 is a visual depiction of these numbers, where the individual swimmers are indicated by the same colored dot in both panes of the graph. For example, the purple dot is the same swimmer in both conditions.

1. Based on your answer to Question 8 and looking at the dot plot, would you expect there to be a wetsuit effect? Explain.

Instead of doing a difference in means test between the two samples, we should do a test for a single mean on the differences between the two condition because the data are **paired**.

Below are graphical and numerical summaries of the *difference* data

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Swimmer | | | | | | | | | | | |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Wetsuit | 1.57 | 1.47 | 1.42 | 1.35 | 1.22 | 1.75 | 1.64 | 1.57 | 1.56 | 1.53 | 1.49 | 1.51 |
| No Wetsuit | 1.49 | 1.37 | 1.35 | 1.27 | 1.12 | 1.64 | 1.59 | 1.52 | 1.50 | 1.45 | 1.44 | 1.41 |
| *Difference* | 0.08 | 0.10 | 0.07 | 0.08 | 0.10 | 0.11 | 0.05 | 0.05 | 0.06 | 0.08 | 0.05 | 0.10 |

|  | | Difference | |
| --- | --- | --- | --- |
| Sample Size |  | 12 |  |
| Mean |  | 0.077 |  |
| Std. Deviation |  | 0.022 |  |
| Minimum |  | 0.050 |  |
| Maximum |  | 0.110 |  |
|  | | | |



1. We will use a one-sample t-test. Do we meet the necessary conditions to perform this test using the *difference* variable? Explain.

We can re-write the null and alternative hypotheses that you wrote in Question 1 as

H0:

Ha:

Where *d* is our *difference* variable.

1. Calculate the t-statistic using the *difference* variable.
2. Calculate the p-value using *StatKey,* select the appropriate Theoretical Distribution and find the p-value, using your test statistic from Question 11.
3. Interpret the p-value.
4. Answer the research question based off of your statistical test.
5. Do your answers to Question 7 and 14 agree? Explain.
6. Calculate a *range of plausible values* for the average difference between the two conditions with 95% confidence and interpret it.
7. Knowing that the second test you performed was the correct one, write at most a 280-character tweet about the impact of wetsuits on swimming speed. If you can tweet about **causation**, make sure to do so!