

Example 16
T-test (paired)
Comparing paired samples
Setup

A virus produces lesions on tobacco leaves. This costs tobacco farmers millions of dollars a year in lost sales. Two different substances have been suggested as being effective in suppressing the viral lesions. Do the two substances differ in their ability to suppress lesions?

Pair number	Preparation 1 X_1	Preparation 2 X_2
1	31	18
2	20	17
3	18	14
4	17	11
5	9	10
6	8	7
7	10	5
8	7	6

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Solution

1. State your question: Do the two preparations differ in their ability to suppress virus lesions in tobacco plants?
 - a. Is it a good scientific question? Definable, measurable, and controllable.
 - b. Identify your population: Viral lesions on tobacco plants
 - c. Identify your dependent variable: Number of lesions
 - d. Identify your independent variable: Preparations
2. State your hypothesis set
 - a. Verbal hypothesis: The two preparations differ in their ability to suppress viral lesions.
 - b. Statistical hypothesis (H_0 , H_A)
 - $H_0: \mu_d = 0$, The two preparations do not differ in the ability to suppress virus lesions
 - $H_A: \mu_d \neq 0$, The two preparations do not suppress virus lesions to the same degree
 - c. Is your hypothesis set exhaustive? Yes
 - d. Is your hypothesis set exclusive? Yes
3. State your significance level: $\alpha = 0.05$
4. Select the appropriate test.
 - a. Variable scales:
 - i. Dependent variable: Ratio
 - o Converted: Ratio \rightarrow Interval
 - ii. Independent variable: Nominal
 - o Converted or transformed? No
 - b. What information is given or available?
 - i. Sample data
 - c. Number of samples: 2
 - d. Are the data paired or unpaired? Paired
 - e. What aspect of the variable do you want to compare?
 - i. Central tendency – means
 - f. State the test to be used: t-test – paired
 - i. Are the assumptions of the test met? Yes
 - o Random sample – Assumed
 - o The differences in the means are normally distributed. – tested

Shapiro-Wilk normality test

data: Difference

$W = 0.8988$, $p\text{-value} = 0.2817$

5. Conduct your sampling

We use a total of eight leaves (one from each of 8 plants). On each leaf, one-half was rubbed with one virus preparation and the other half was rubbed with the other preparation. The leaf constitutes the pair -- one-half was given one treatment, the other half was given another treatment

6. Graph the data

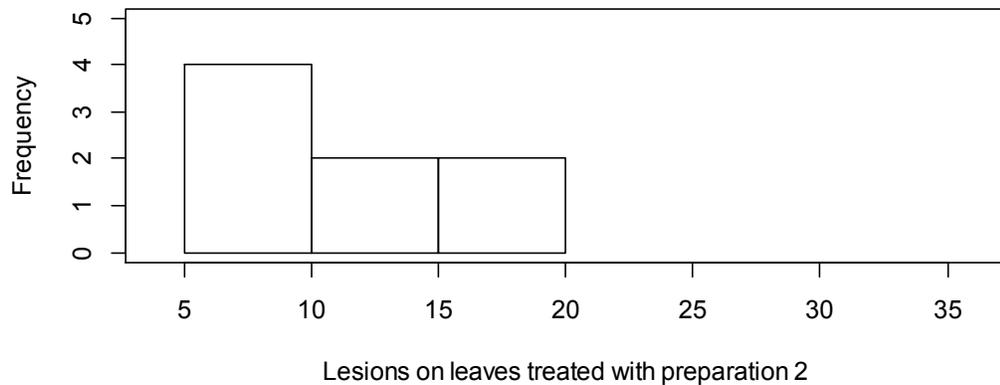
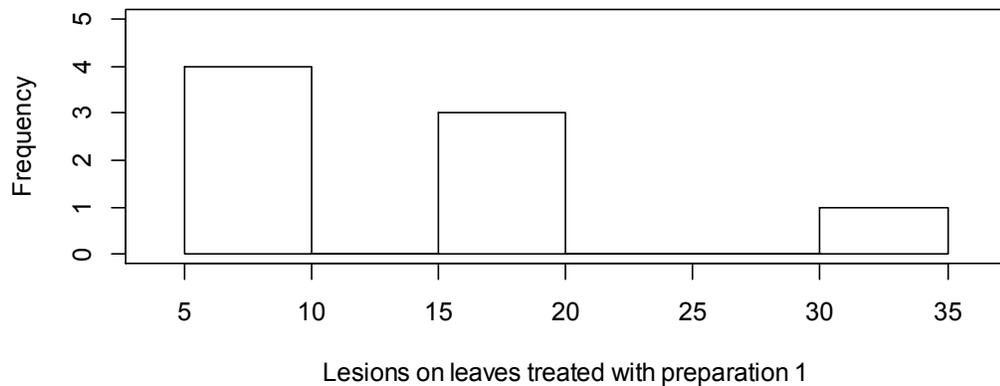


Figure 1. Viral lesions on tobacco leaves treated with preparation 1 and preparation 2.

7. Summarize the data.
n=8 (number of pairs)
d=4 lesions
s=4.31 lesions

8. Calculate your test statistic.

Paired t-test

data: Leaves\$Lesions1 and Leaves\$Lesions2

t = 2.6253, df = 7, p-value = 0.03414

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

0.3972029 7.6027971

sample estimates:

mean of the differences

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9. Retain or reject your null hypothesis based on your test statistic.
The calculated p-value (0.034) is less than the significance level (0.05), therefore we would reject our null hypothesis and retain our alternate hypothesis.
10. Interpret the results in biological terms.
The two preparations differ in their ability to suppress viral lesions (t=2.63, df= 7, p=0.034).