

# Learn How to Interpret T-Test Results in R: A Comprehensive Guide

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November 4, 2025

## RECOMMENDED CITATION

Mohammed loot (2025). *Learn How to Interpret T-Test Results in R: A Comprehensive Guide*. PSYCHOLOGICAL STATISTICS. Retrieved from <https://statistics.arabpsychology.com/?p=9869>

The [t-test](#) is an indispensable inferential statistical method utilized across virtually all scientific and analytical disciplines. Its primary function is to rigorously determine whether the population [means](#) of two distinct, independent groups are statistically different from one another, providing a foundation for evidence-based conclusions.

This expert guide is designed to provide a comprehensive walkthrough on not only executing a two-sample t-test but, more importantly, mastering the interpretation of its technical output when using the powerful statistical programming language, [R](#). We will navigate this process using a straightforward, practical example to ensure complete clarity regarding every metric generated.

## Preparing Your Data Vectors in R

To properly illustrate the mechanics of the two-sample t-test, we will use a hypothetical scenario involving two different species of plants. Our core analytical objective is to test the fundamental assumption that the true population [means](#) of their heights are statistically equivalent. This comparison forms the basis of our statistical hypothesis test.

For this experiment, we have gathered a [simple random sample](#), collecting 12 independent height measurements for each of the two species. Before we can perform the analysis, these raw measurements must be organized into separate, named numeric vectors within the [R](#) environment, preparing the data structure for the statistical function call.

```
#create vector of plant heights from group 1  
group1 <- c(8, 8, 9, 9, 9, 11, 12, 13, 13, 14, 15, 19)
```

```
#create vector of plant heights from group 2  
group2 <- c(11, 12, 13, 13, 14, 14, 14, 15, 16, 18, 18, 19)
```

## Executing the Welch Two Sample t-test

Once the sample data is correctly loaded into the vectors, the analysis is executed using R's powerful built-in function: **t.test()**. It is important to note that when critical arguments, specifically `var.equal = TRUE`, are omitted, R automatically defaults to performing the [Welch Two Sample t-test](#).

The [Welch t-test](#) is generally considered the safer and more robust choice for comparing two independent groups, as it does not require the restrictive assumption that the population variances of the two groups are equal. This flexibility ensures that the results are reliable even when the spread of data differs substantially between the samples.

The following command initiates the statistical test and displays the complete output directly within

the [R](#) console, which we will analyze in the next section:

```
#perform two sample t-test
```

```
t.test(group1, group2)
```

```
Welch Two Sample t-test
```

```
data: group1 and group2
```

```
t = -2.5505, df = 20.488, p-value = 0.01884
```

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

```
95 percent confidence interval:
```

```
-5.6012568 -0.5654098
```

```
sample estimates:
```

```
mean of x mean of y
```

```
11.66667 14.75000
```

## Deconstructing the R Output Metrics

Interpreting the output generated by the `t.test()` function is paramount to drawing statistically sound conclusions. Each line of the result provides a specific metric essential for evaluating the relationship between the two samples. Understanding these components is a core skill in statistical analysis.

Below is a detailed breakdown of the key metrics yielded by the [R](#) function call:

**data:** This line serves as confirmation, explicitly stating which data vectors (group1 and group2) were used in the analysis, ensuring the correct variables were processed.

**t (Test Statistic):** The calculated t-statistic, which quantifies the magnitude of the difference between the sample [means](#) relative to the standard error of that difference. In our example, the value is **-2.5505**. A larger absolute value typically suggests a greater difference between the groups.

**df (Degrees of Freedom):** The [degrees of freedom](#) associated with the t-statistic is **20.488**. Because we utilized the [Welch t-test](#) (which assumes unequal variances), the calculation employs the Satterthwaite approximation, resulting in a non-integer value.

**p-value:** The resulting [p-value](#) is **0.01884**. This is the probability of observing our data (or data more extreme) if the [null hypothesis](#) were true. This value is the central metric for making a decision regarding the hypotheses.

**alternative hypothesis:** This confirms the directionality of the test performed. Here, the test was a two-sided test, meaning we are testing whether the true difference in means is simply "not equal to zero."

**95 percent confidence interval:** This interval, ranging from **-5.601** to **-0.5654**, is the range of plausible values for the true difference in population [means](#). Crucially, because this 95% [confidence interval](#) does not encompass the value zero, it provides strong evidence for a statistically significant difference.

**sample estimates:** These are the descriptive statistics calculated directly from the samples: **11.667** for group 1 (x) and **14.75** for group 2 (y).

## Hypothesis Testing: Rejecting or Failing to Reject H0

All statistical testing is predicated upon comparing two competing statements about the population parameters: the [null hypothesis](#) (H0) and the alternative hypothesis (HA). These hypotheses define the scope of the statistical question being addressed by the [t-test](#).

For our two-sided test concerning the plant heights (where  $\mu$  represents the population mean height), the formal hypotheses are defined precisely as follows:

**H0:**  $\mu_1 = \mu_2$  (The true population means are equal, implying the difference is zero.)

**HA:**  $\mu_1 \neq \mu_2$  (The true population means are not equal, implying a non-zero difference exists.)

To make a definitive statistical decision, we must compare the calculated [p-value](#) (which is 0.01884) against the predetermined [significance level](#) (alpha, or  $\alpha$ ). Conventionally,  $\alpha$  is set at 0.05. Since our calculated [p-value](#) (0.01884) is significantly less than the threshold of 0.05, we have robust statistical evidence leading us to reject the [null hypothesis](#) (H0). This conclusion is reinforced by the 95% [confidence interval](#), which excludes zero, further confirming that a statistically significant difference exists in the mean heights between the two investigated plant species.

## Mastering the t.test() Function Syntax (Reference)

The `t.test()` function in [R](#) is incredibly flexible, allowing users to tailor the statistical test to fit various investigative requirements, including one-sided tests, paired samples, or tests based on the assumption of equal variance. Its comprehensive standard syntax is structured to incorporate these options:

```
t.test(x, y, alternative = "two.sided", mu = 0, paired = FALSE, var.equal = FALSE, conf.level = 0.95)
```

A detailed explanation of the key parameters available within the function call is provided below, highlighting how each argument modifies the nature of the statistical test performed:

**x, y:** These are the mandatory inputs, representing the names of the two numeric vectors containing the sample data to be compared.

**alternative:** This argument specifies the format of the alternative hypothesis (HA). Options include the default "two.sided", "less" (for HA:  $\mu_x < \mu_y$ ), or "greater" (for HA:  $\mu_x > \mu_y$ ).

**mu:** Defines the hypothesized value for the true difference in population means under the [null hypothesis](#). The default setting is 0.

**paired:** A logical switch (TRUE/FALSE) used to select between an independent samples t-test (default is FALSE) and a [paired t-test](#), which is necessary when samples are dependent (e.g., before-and-after measurements).

**var.equal:** A logical value (TRUE/FALSE) determining whether to assume equal population variances. Setting it to TRUE performs the standard Student's t-test; keeping the default FALSE performs the robust [Welch t-test](#).

**conf.level:** This parameter specifies the desired [confidence level](#) for the interval calculation, with the standard default being 0.95 (representing a 95% interval).

In the plant height example demonstrated throughout this guide, we consciously relied on the default settings of the **t.test()** function, which included:

A two-sided alternative hypothesis.

Testing whether the true difference in means was equal to zero ( $\mu = 0$ ).

Executing an independent two-sample t-test (paired = FALSE).

Assuming unequal variances, thereby executing the [Welch t-test](#) (var.equal = FALSE).

Using a 95% [confidence level](#).

When conducting your own statistical investigations, ensure you adjust these arguments appropriately to match the specific characteristics and assumptions required by your data and research question.

## Additional Resources