

Perform a Wilcoxon Signed Rank Test in SAS

Authored by
Mohammed loot

November 1, 2025

RECOMMENDED CITATION

Mohammed loot (2025). *Perform a Wilcoxon Signed Rank Test in SAS*. PSYCHOLOGICAL STATISTICS. Retrieved from <https://statistics.arabpsychology.com/?p=7675>

The Wilcoxon Signed-Rank Test: A Robust Alternative to the Paired T-Test

The [Wilcoxon Signed-Rank Test](#) stands as a cornerstone procedure within the methodology of [non-parametric statistics](#). It is specifically designed to analyze dependent samples, effectively serving as the direct non-parametric analog to the traditional [paired t-test](#). This test is essential for researchers investigating scenarios where two related measurements are collected--such as evaluating the performance of subjects before and after an intervention, or comparing matched pairs in a clinical setting. Its primary strength lies in its ability to proceed with analysis even when the stringent assumptions of parametric methods cannot be met, providing a reliable and powerful statistical tool.

When applying this method, the goal is to ascertain whether a statistically significant difference exists between the two conditions or measurements. Crucially, unlike the paired t-test, which focuses on comparing the means of the differences, the Wilcoxon Signed-Rank Test evaluates the distribution of the differences to determine if it is symmetrically centered around zero. This distinction allows the test to bypass the critical requirement of normality for the distribution of difference scores, making it invaluable when data exhibits strong skewness, has extreme outliers, or when dealing with ordinal data.

The underlying mechanism of the test involves transforming the raw difference scores into ranks based on their absolute magnitude. These ranks are then signed according to the direction of the original differences (positive or negative). By analyzing these signed ranks rather than the original magnitudes, the test becomes highly robust against violations of distribution assumptions. Consequently, it offers a statistically sound conclusion regarding whether the intervention or treatment caused a shift in the central tendency of the paired measurements.

Criteria for Utilizing This Non-Parametric Procedure

The decision to employ the Wilcoxon Signed-Rank Test is typically guided by a careful assessment of the data characteristics and the viability of parametric assumptions. In any study involving repeated measures or matched data, the first analytical step is the calculation of the difference scores between the paired observations. These difference scores become the focus of the subsequent statistical analysis, regardless of whether a parametric or non-parametric test is ultimately chosen.

If preliminary checks, such as the [Shapiro-Wilk](#) or Kolmogorov-Smirnov tests, indicate that these difference scores deviate significantly from a normal distribution, or if the sample size is prohibitively small (making it difficult to reliably assess normality), the assumptions underpinning the paired t-test are violated. In these precise scenarios, the Wilcoxon Signed-Rank Test provides the most powerful and appropriate alternative. It handles situations where the data might arise from unknown distributions or those known to be non-normal, thereby protecting the integrity of the

inferential conclusions.

It is paramount to recall that [non-parametric statistics](#) generally focus on testing the [median](#) of the distribution, rather than the mean. Consequently, when we reject the [null hypothesis](#) using the Wilcoxon Signed-Rank Test, the appropriate interpretation is that the median difference between the paired observations is significantly different from zero. This conclusion strongly suggests that the treatment or factor under investigation has indeed produced a measurable effect on the population from which the sample was drawn.

Case Study: Evaluating Fuel Treatment Efficacy

To illustrate the practical application of this test, consider a detailed case study involving an automotive engineering team. Their objective is to rigorously evaluate a newly formulated fuel treatment designed specifically to enhance vehicle efficiency, measured in miles per gallon (MPG). The central question is whether this treatment yields a statistically meaningful change in the average MPG of a standardized car model. For the experimental design, the engineers selected 12 identical vehicles and recorded the MPG for each car first without the treatment, and then again after the treatment had been applied.

Because the same 12 vehicles serve as their own controls--meaning each car generates a pair of observations (pre-treatment and post-treatment)--the data gathered are inherently paired and dependent. This structure immediately makes the dataset suitable for either a [paired t-test](#) or the Wilcoxon Signed-Rank Test. Given the inherent variability in fuel efficiency measurements and the conservative nature required for new product validation, the team decides against assuming normality of the MPG differences. They therefore opt for the robust, non-parametric approach to ensure the validity of their findings.

The tabulated results derived from this controlled experiment, which detail the MPG measurements for all 12 cars under both experimental conditions, provide the necessary foundation for the SAS analysis. These raw data points are visually summarized below, showing the individual observations that will be used to calculate the critical difference variable:

With Treatment	Without Treatment
20	24
23	25
21	21
25	22
18	23
17	18
18	17
24	28
20	24
24	27
23	21
19	23

Preparing the Data for Analysis in SAS

Before any statistical test can be executed within the [SAS](#) environment, the raw data must be meticulously imported and properly structured. The Wilcoxon Signed-Rank Test specifically operates on a single variable that represents the difference between the two paired measurements. This necessary transformation is accomplished efficiently through the use of SAS data steps, which are essential for cleaning and manipulating the input data.

The process begins with the creation of the initial dataset, conventionally named `my_data`, which precisely mirrors the structure of the experimental results. This dataset contains the MPG scores for each car, categorized by the two conditions: `with_fuel` (treated) and `without_fuel` (untreated). Following this input step, a secondary dataset, `my_data2`, is generated. Within this crucial step, we define and calculate the difference variable, labeled `diff`, by subtracting the initial MPG measurement from the post-treatment MPG measurement ($\text{diff} = \text{with_fuel} - \text{without_fuel}$). It is critical to note that a positive difference signifies an improvement in MPG following the treatment, while a negative difference indicates a decrease in fuel efficiency.

The complete [SAS](#) code block required to perform both the initial data creation and the subsequent calculation of the difference variable is provided below. This code establishes the required input format and prepares the specific variable necessary for the final statistical computation:

```
/*create dataset*/  
data my_data;
```

```
input car with_fuel without_fuel;
datalines;
1 20 24
2 23 25
3 21 21
4 25 22
5 18 23
6 17 18
7 18 17
8 24 28
9 20 24
10 24 27
11 23 21
12 19 23
;
run;

/*create new dataset with difference between two fuel treatments*/
data my_data2;
set my_data;
diff=with_fuel-without_fuel;
run;

/*perform Wilcoxon Signed Rank Test*/
proc univariate data=my_data2;
var diff;
run;
```

Executing the Analysis using PROC UNIVARIATE

In the [SAS](#) statistical programming language, the conventional and most reliable method for performing the Wilcoxon Signed-Rank Test is through the utilization of the `PROC UNIVARIATE` procedure. While this procedure is most commonly associated with generating detailed descriptive statistics and thoroughly exploring the distribution of a single variable, its application to a difference variable automatically triggers the calculation and reporting of appropriate non-parametric tests, including the required Wilcoxon statistic.

The procedural syntax is intentionally concise and highly functional: the `PROC UNIVARIATE` statement is initiated by specifying the dataset containing the difference scores (`data=my_data2`). Subsequently, the `VAR` statement is used to clearly designate the variable of primary interest, which

is the calculated difference variable, `diff`. Once this code is executed, SAS efficiently processes the designated variable and produces a comprehensive analytical output. This output encompasses various summary statistics, robust tests for location, and detailed quantile information, all essential for a complete statistical assessment.

The generated output from the execution of `PROC UNIVARIATE` furnishes all the necessary numerical evidence required for formal hypothesis testing. This allows the engineering team to formally and objectively assess the true impact--positive, negative, or negligible--of the new fuel treatment on the vehicles' fuel efficiency.

Interpreting the Results and Formulating Conclusions

Following the successful execution of the SAS code, the resulting output log provides several tables containing the analytical results. The most critical information required for the Wilcoxon Signed-Rank Test is located within the section clearly labeled **Tests for Location**, which presents the calculated test statistic and the associated probability value. The specific output generated by the procedure is visually represented in the image below:

The UNIVARIATE Procedure
Variable: diff

Moments			
N	12	Sum Weights	12
Mean	-1.75	Sum Observations	-21
Std Deviation	2.70100991	Variance	7.29545455
Skewness	0.57922226	Kurtosis	-1.101612
Uncorrected SS	117	Corrected SS	80.25
Coeff Variation	-154.34342	Std Error Mean	0.7797144

Basic Statistical Measures			
Location		Variability	
Mean	-1.75000	Std Deviation	2.70101
Median	-2.50000	Variance	7.29545
Mode	-4.00000	Range	8.00000
		Interquartile Range	4.50000

Tests for Location: Mu0=0				
Test		Statistic		p Value
Student's t	t	-2.24441	Pr > t 	0.0463
Sign	M	-2.5	Pr >= M 	0.2266
Signed Rank	S	-22.5	Pr >= S 	0.0469

Examining the initial summary statistics provided in the output, we first note that the arithmetic mean difference in MPG between the treated and untreated cars is calculated to be **-1.75**. This preliminary descriptive finding suggests an average decrease in MPG following the application of the fuel treatment. However, sound statistical practice dictates that we must rely on the formal inferential hypothesis test to determine if this observed difference is statistically significant and not merely due to random chance. The key statistics extracted from the **Tests for Location** table for the Wilcoxon Signed-Rank Test are:

The calculated Wilcoxon Signed-Rank Test statistic (S) is: **-22.5**.

The corresponding two-sided [p-value](#) (Prob > |S|) is: **0.0469**.

To finalize the analysis and draw a scientifically supported conclusion, we must formally relate these numerical findings back to the predefined statistical hypotheses. The study operates under the following framework:

The decision rule is based on comparing the calculated [p-value](#) to the predetermined significance level, typically set at **alpha = 0.05**. Since the p-value of 0.0469 is found to be less than the standard threshold of 0.05, we possess sufficient statistical evidence to reject the [null hypothesis](#) (H₀). This rejection signifies that the median MPG difference between the two conditions is statistically different from zero. Based on the negative mean difference observed and the statistically significant result, the definitive conclusion is that the new fuel treatment has a statistically significant, and unfortunately negative, impact on the average miles per gallon achieved by the tested car model.