Learn How to Perform a Wilcoxon Signed-Rank Test in SPSS

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The **Wilcoxon Signed Rank Test** is a crucial statistical tool, serving as the non-parametric equivalent of the widely used **paired t-test**. This test is specifically designed for situations involving repeated measures or matched pairs when the foundational assumption of the parametric test--that the distribution of the differences between the two samples is **normal**--cannot be met. It effectively assesses whether there is a statistically significant difference in the central tendency (typically the median) between two related populations.

In practical research, the Wilcoxon test is highly valuable when dealing with ordinal data or when sample sizes are small, preventing robust assessment of normality. This comprehensive tutorial provides a detailed, step-by-step guide on how to successfully conduct and interpret a Wilcoxon Signed Rank Test using the powerful statistical software, **SPSS** (Statistical Package for the Social Sciences).

Understanding the Wilcoxon Signed Rank Test

Before diving into the mechanics of **SPSS**, it is essential to understand the underlying principles of the Wilcoxon Signed Rank Test. Unlike the paired t-test, which compares mean scores based on the raw differences, the Wilcoxon test converts these differences into **ranks**. It then compares the sum of the ranks for positive differences (where the score increased) against the sum of the ranks for negative differences (where the score decreased). This method relies on the magnitude and direction of the differences, making it robust against violations of the normality assumption.

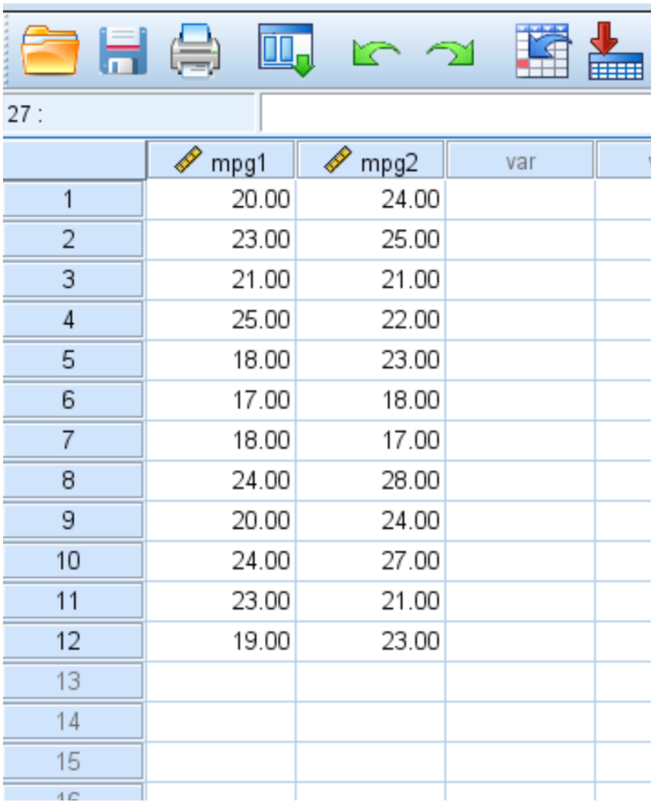
The primary purpose of this test is to determine if the median difference between the paired observations is zero. If the sums of the positive and negative ranks are significantly different, it suggests that the intervention or condition change had a statistically significant effect. Choosing this non-parametric approach ensures the validity of your conclusions, particularly when dealing with data that exhibits severe skewness or contains outliers that would distort the results of a parametric analysis.

Setting Up the Research Scenario in SPSS

To illustrate the application of this test, consider a common scenario in automotive research. A team of researchers is investigating the efficacy of a new fuel treatment designed to improve vehicle efficiency. Their objective is to ascertain if this treatment results in a measurable change in the average miles per gallon (mpg) of a specific model of car. To maintain experimental control, they adopt a repeated measures design, testing the same 12 cars both before and after applying the fuel treatment.

The resulting data set includes two variables for each of the 12 participants: **mpg1**, representing the baseline mpg measured without the fuel treatment, and **mpg2**, representing the mpg measured after the treatment was administered. Since they cannot assume that the distribution of the difference scores (mpg2 - mpg1) is perfectly normal, the **Wilcoxon Signed Rank Test** is the most appropriate statistical procedure to test their hypothesis.

The following screenshot displays the layout of the data within the **SPSS** Data View, clearly showing the paired measurements for each of the 12 observed vehicles:



27 :

	mpg1	mpg2	var
1	20.00	24.00	
2	23.00	25.00	
3	21.00	21.00	
4	25.00	22.00	
5	18.00	23.00	
6	17.00	18.00	
7	18.00	17.00	
8	24.00	28.00	
9	20.00	24.00	
10	24.00	27.00	
11	23.00	21.00	
12	19.00	23.00	
13			
14			
15			

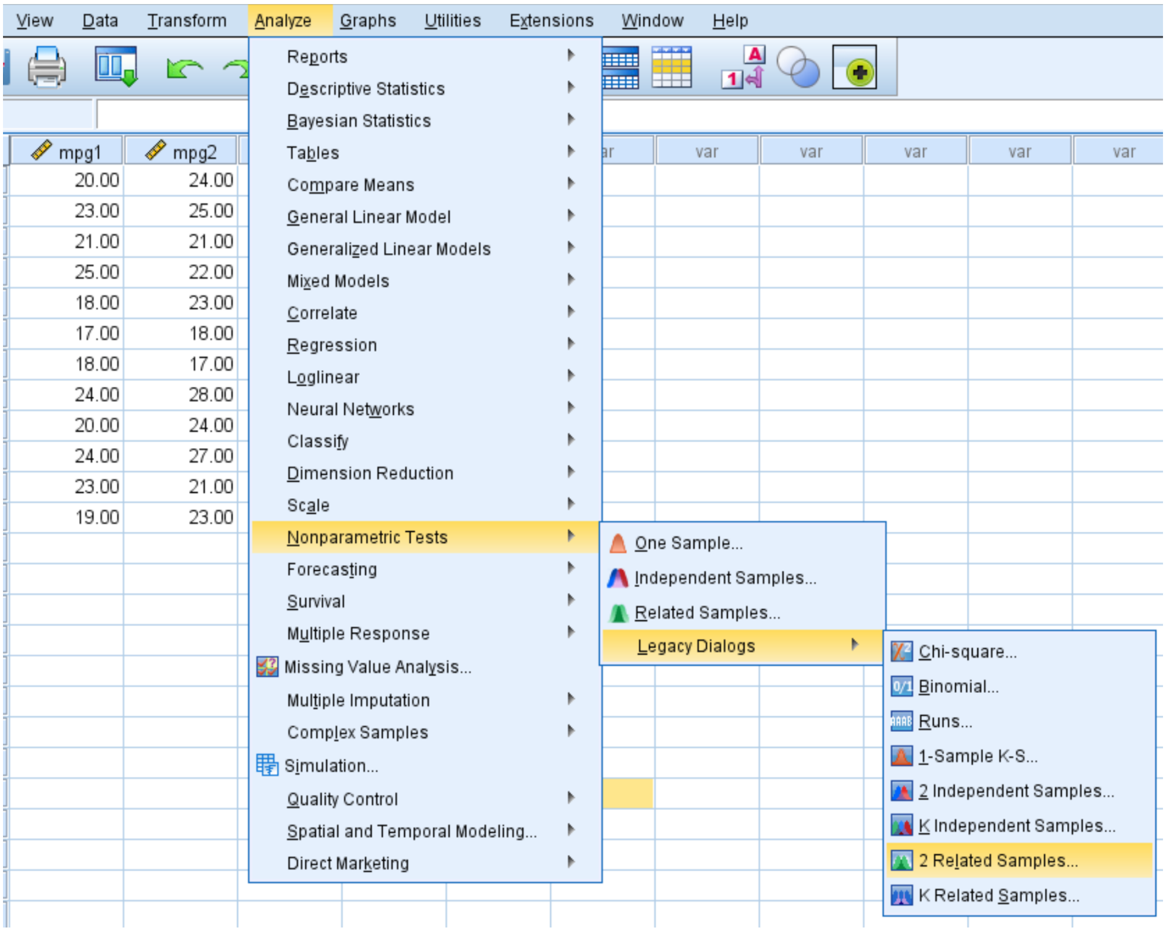
Our goal is to execute the test to rigorously determine if the fuel treatment induced a genuine, statistically significant difference in the mean mpg between the two measured conditions.

Executing the Test: Navigating the SPSS Interface

Performing the Wilcoxon Signed Rank Test in **SPSS** is a straightforward, three-step process once the data is correctly entered into the variables **mpg1** and **mpg2**.

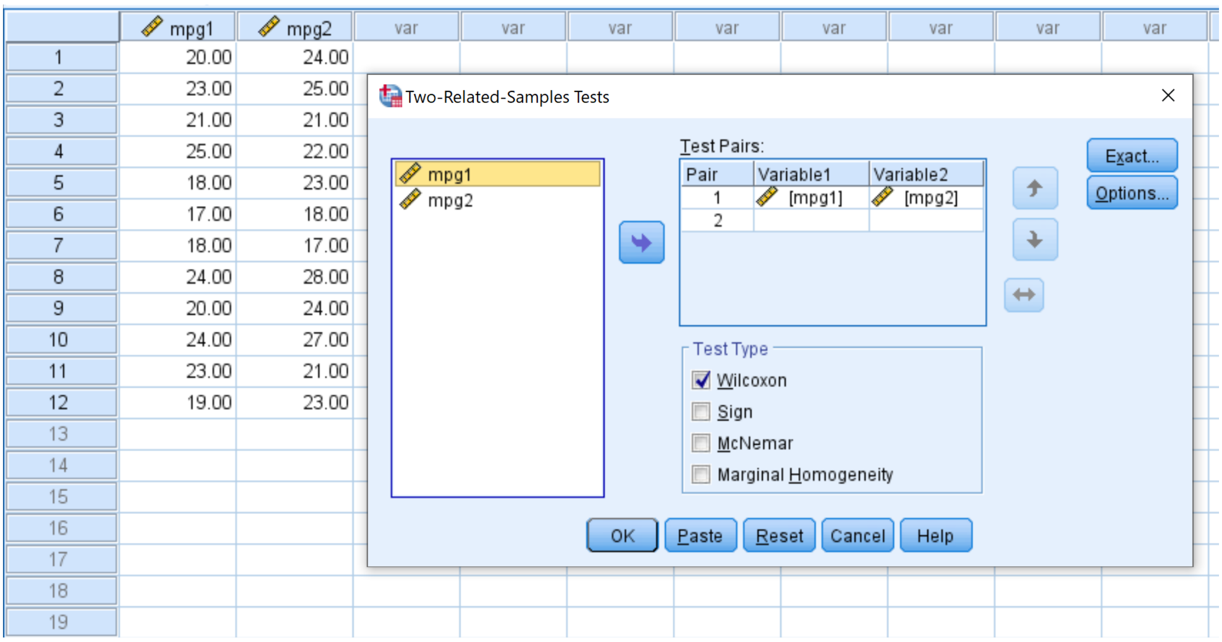
Step 1: Choose the 2 Related Samples option.

Begin by navigating the menu system. Click the **Analyze** tab located at the top of the **SPSS** window. Hover over **Nonparametric Tests**, then select **Legacy Dialogs**, and finally click on **2 Related Samples**. This path directs **SPSS** to compare two measurements taken from the same group of subjects.



Step 2: Fill in the necessary values to perform the test.

In the "Two-Related-Samples Tests" dialog box that appears, you must specify the paired variables. Drag the variable **mpg1** (baseline measurement) into the box designated as Variable 1, and drag the variable **mpg2** (post-treatment measurement) into the box labeled Variable 2. Crucially, ensure that the checkbox next to **Wilcoxon** is selected under the "Test Type" section. While **SPSS** often defaults to the Wilcoxon test for related samples, always verify this selection to ensure the correct non-parametric procedure is executed. Once the variables are correctly assigned and the test is selected, click **OK** to run the analysis.



Interpreting the Output Tables

After clicking **OK**, **SPSS** generates the output, which typically includes two main tables: the Ranks table and the Test Statistics table. Understanding both tables is fundamental for a complete interpretation of the results.

The first table, the Ranks table, provides an overview of how the differences were calculated and ranked. It categorizes the pairs based on the sign of the difference (mpg2 - mpg1): "Negative Ranks" indicate cases where mpg decreased after treatment, "Positive Ranks" indicate cases where mpg increased, and "Ties" are cases where the mpg remained exactly the same. The sum of the ranks for the positive and negative groups forms the basis of the test statistic calculation. A significant finding occurs when the sums of these ranks are drastically unequal, suggesting a systematic shift in one direction.

NPar Tests

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
mpg2 - mpg1	Negative Ranks	3[a]	3.50	10.50
	Positive Ranks	8[b]	6.94	55.50
	Ties	1[c]		
	Total	12		

a. mpg2 < mpg1
b. mpg2 > mpg1
c. mpg2 = mpg1

Test Statistics[a]

	mpg2 - mpg1
Z	-2.013[b]
Asymp. Sig. (2-tailed)	.044

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

The second, and most critical, table is the Test Statistics table. This table provides the numerical output necessary to make a definitive decision regarding the null hypothesis. The null hypothesis in this context posits that there is no difference in the median mpg between the pre-treatment and post-treatment conditions.

The key figures extracted from the Test Statistics table are:

Z test statistic: -2.013. This value represents the standardized test statistic calculated by the Wilcoxon procedure, analogous to the t-value in a parametric test.
Two-tailed p-value: .044. This is the Asymptotic Significance value, which quantifies the probability of observing our data (or data more extreme) if the null hypothesis were true.

Drawing Conclusions and Reporting Findings

Step 3: Interpret the results.

The decision rule in hypothesis testing relies on comparing the calculated **p-value** to the predetermined significance level (alpha, typically set at 0.05). If the **p-value** is less than alpha ($p < 0.05$), we reject the null hypothesis, concluding that the observed effect is statistically significant.

Conversely, if $p > 0.05$, we fail to reject the null hypothesis.

In this specific analysis, the two-tailed **p-value** is 0.044. Since 0.044 is less than the standard alpha level of 0.05, we possess sufficient statistical evidence to **reject the null hypothesis**. This leads to the conclusion that the fuel treatment did, in fact, have a statistically significant effect on the mpg of the cars included in the experiment. The data supports the alternative hypothesis that there is a difference in the median mpg between the two groups.

Step 4: Report the results.

The final step in any statistical analysis is to formally report the findings in a clear, standardized format, usually adhering to APA guidelines. A proper report includes the type of test conducted, the sample size, the test statistics (Z value), and the precise **p-value**. Here is an exemplary model for reporting the results of the **Wilcoxon Signed Rank Test**:

A Wilcoxon Signed Rank Test was performed to determine if there was a statistically significant difference in the median miles per gallon (mpg) measured before and after the application of a novel fuel treatment. A total of 12 matched cars were used in this repeated measures analysis.

The test revealed a statistically significant difference in mean mpg between the two groups. The calculated **Z test statistic** was -2.013, and the two-tailed **p-value** was 0.044.

These results strongly indicate that the fuel treatment had a significant, positive effect on the mpg achieved by the tested vehicles ($Z = -2.013$, $p = 0.044$).