

How to Perform a Wilcoxon Signed Rank Test in SPSS: A Step-by-Step Guide

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Understanding the Fundamentals of the Wilcoxon Signed Rank Test

The **Wilcoxon Signed Rank Test** is a sophisticated **non-parametric statistical test** designed to evaluate differences between two related groups, matched samples, or repeated measurements on a single sample. In the realm of quantitative analysis, this test serves as the primary alternative to the **paired samples t-test**. While the t-test relies on the assumption that the differences between pairs follow a **normal distribution**, the Wilcoxon variant does not require such stringent parameters, making it incredibly robust for analyzing **ordinal data** or continuous data that exhibit significant skewness or outliers.

When researchers encounter data sets where the distribution of differences is non-normal or when the sample size is too small to accurately assess normality, the **IBM SPSS Statistics** software provides the Wilcoxon Signed Rank Test as a reliable solution. This test operates by ranking the absolute differences between pairs and then restoring the signs (positive or negative) to those ranks. By focusing on the magnitude of the ranks rather than the raw values themselves, the test effectively mitigates the influence of extreme values that might otherwise distort the results of a standard **arithmetic mean** comparison. This makes it an essential tool for behavioral sciences, clinical research, and any field where data often violates parametric assumptions.

The primary objective of this tutorial is to guide you through the execution and interpretation of this test within the **SPSS** environment. We will explore a practical scenario involving automotive engineering to demonstrate how the test determines whether a specific intervention--in this case, a fuel treatment--produces a **statistically significant** change in performance. By the conclusion of this guide, you will be equipped to handle related-sample comparisons with confidence, ensuring your **data analysis** is both mathematically sound and professionally reported.

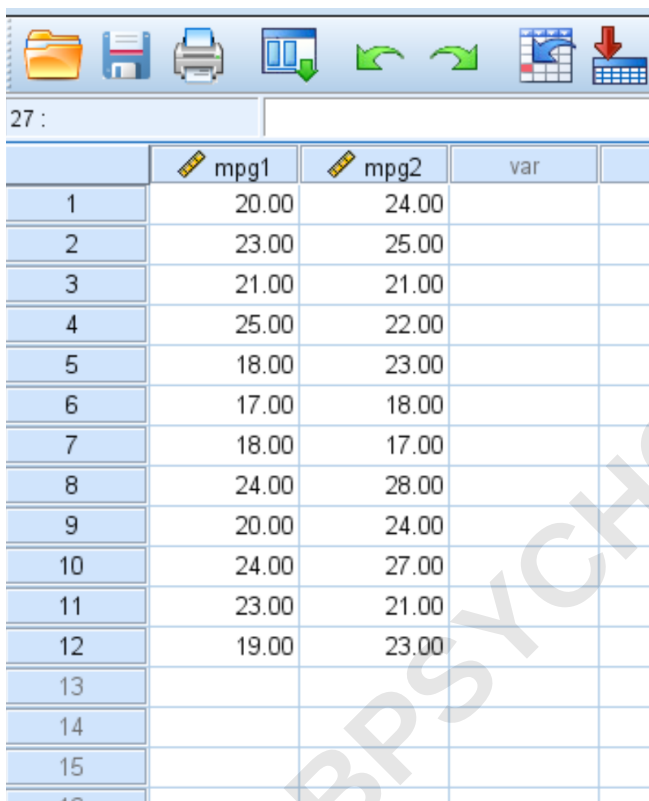
Identifying the Research Scenario and Data Requirements

To illustrate the application of the test, consider a study conducted by automotive researchers seeking to verify the efficacy of a new fuel additive. The core research question asks whether this treatment leads to a measurable change in the average miles per gallon (mpg) of a specific vehicle model. To address this, the researchers utilized a **repeated measures design**, measuring the fuel efficiency of 12 distinct cars under two different conditions: once using standard fuel and once using fuel enhanced with the treatment. This "before-and-after" approach creates the "related samples" necessary for the Wilcoxon analysis.

In this experimental context, the **null hypothesis** (H_0) posits that there is no significant difference in the median fuel efficiency between the two conditions. Conversely, the **alternative hypothesis** (H_1) suggests that a significant difference does exist, implying that the fuel treatment has a tangible effect. Because the sample size is relatively small ($n=12$), the researchers cannot safely

assume that the differences in mpg follow a bell curve, which necessitates the use of a **non-parametric** approach rather than a parametric t-test.

The following screenshot illustrates the data entry format within the **SPSS** Data Editor. Each row represents a single subject (a car), and the two columns represent the paired observations: "mpg1" for the initial measurement and "mpg2" for the measurement following the fuel treatment. Maintaining this structure is critical, as **SPSS** requires paired variables to be in separate columns within the same row to calculate the differences required for ranking.



	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			
16			

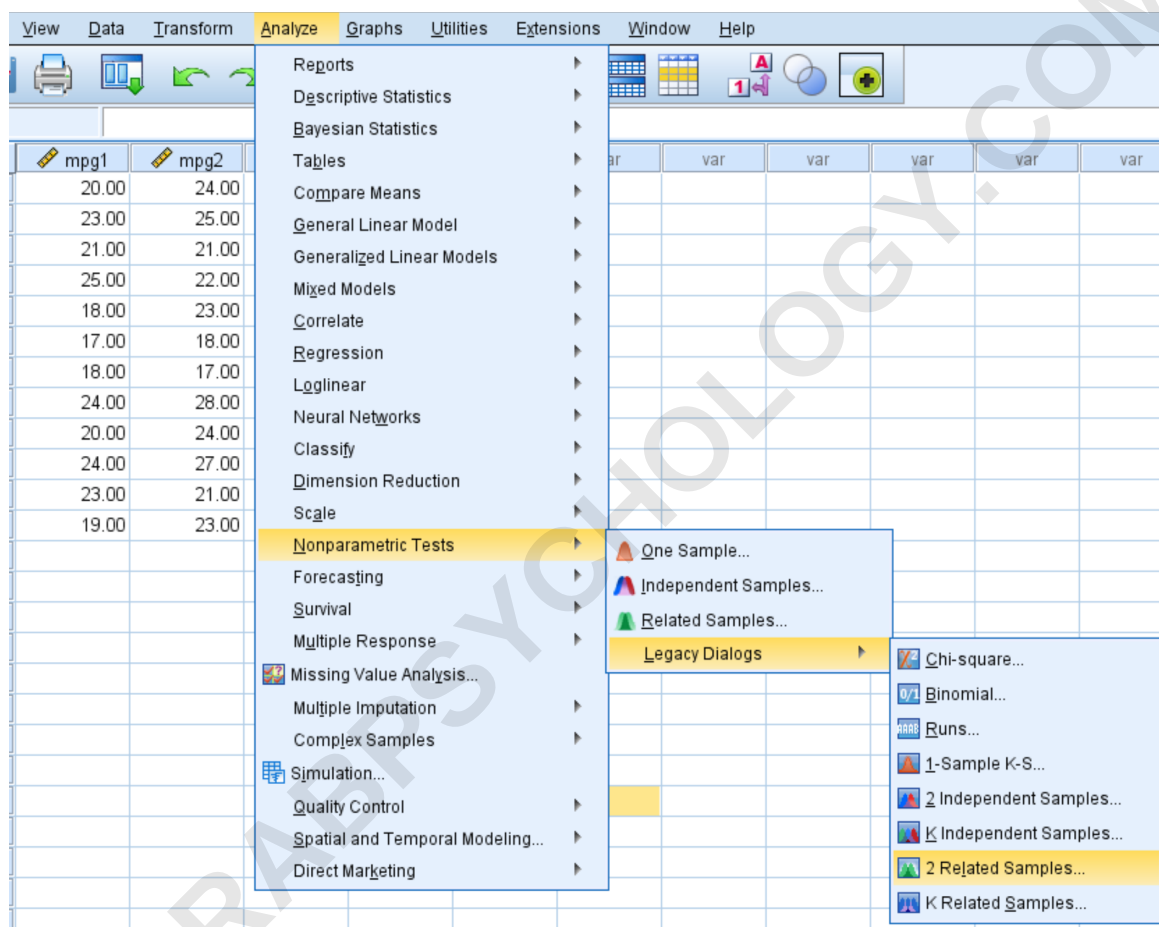
Navigating the SPSS Menu System for Non-parametric Analysis

Once your data is correctly imported and structured within the **SPSS** interface, the first technical step involves locating the appropriate analysis tool. SPSS organizes its functions into logical categories, and because the Wilcoxon test does not assume a specific distribution, it is categorized under the "Nonparametric Tests" menu. Specifically, for users familiar with the classic interface, the "Legacy Dialogs" path offers a straightforward and highly customizable way to run this procedure.

To begin the process, navigate to the top toolbar and click on the **Analyze** tab. From the resulting dropdown menu, hover over **Nonparametric Tests** to reveal further sub-options. From this secondary menu, select **Legacy Dialogs** and then click on **2 Related Samples**. This specific

selection is used when you have two measurements taken from the same group or two groups that are matched on specific criteria, perfectly fitting our fuel treatment study design.

Selecting this option will open the "Two-Related-Samples Tests" dialog box. This interface is designed to facilitate the comparison of paired variables efficiently. It is important to distinguish this from the "Independent Samples" option, which would be used if you were comparing two entirely different groups of cars (e.g., a group of SUVs versus a group of sedans). The following visual guide highlights the exact menu path required to initiate the test.

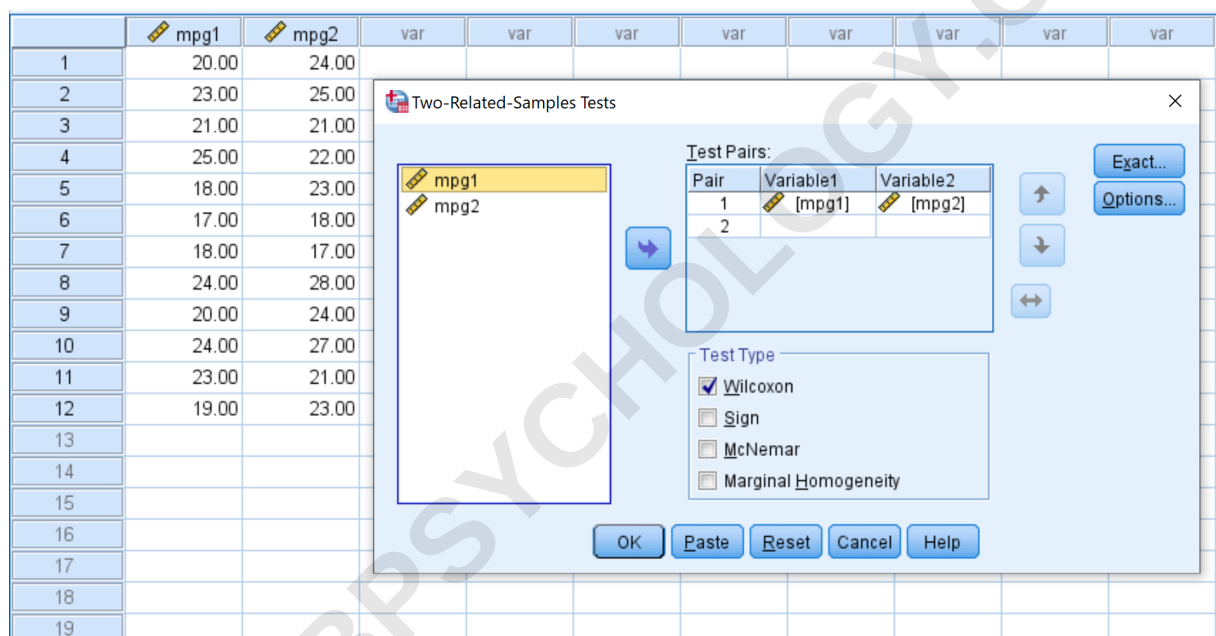


Configuring the Paired Variables and Test Settings

After the "Two-Related-Samples Tests" window appears, you must define which variables **SPSS** should compare. On the left side of the window, you will see a list of all variables currently in your dataset. Your goal is to move the relevant pair into the "Test Pairs" box. In our example, you would click on **mpg1** and then **mpg2**, using the arrow button to move them into the "Variable 1" and "Variable 2" columns respectively. This pairing tells the software to calculate the difference for each car individually before proceeding with the ranking logic.

While configuring the variables, it is essential to ensure that the correct **statistical test** is selected. Below the variable selection area, you will find a "Test Type" section containing several checkboxes. Ensure that the **Wilcoxon** box is checked. While other tests like the "Sign" test or "McNemar" test are available, the **Wilcoxon Signed Rank Test** is generally more powerful as it considers both the direction and the magnitude of the differences between the pairs.

Before executing the analysis, you may also choose to click the "Options" button to request **descriptive statistics** or **quartiles**. These additional outputs can provide context, such as the **median** mpg for each group, which helps in the final interpretation of the direction of the change. Once the variables are paired and the settings are confirmed, click **OK** to generate the results in the SPSS Output Viewer.



Interpreting the Ranks and Test Statistic Output

The **SPSS** output for a Wilcoxon Signed Rank Test typically consists of two primary tables: the "Ranks" table and the "Test Statistics" table. The Ranks table is vital for understanding the underlying mechanics of the test. It displays the number of negative ranks (where mpg2 was lower than mpg1), positive ranks (where mpg2 was higher than mpg1), and ties (where there was no change). By examining the "Mean Rank" and "Sum of Ranks," you can get an immediate sense of which direction the data is leaning before looking at the **p-value**.

The "Test Statistics" table provides the formal mathematical results of the analysis. The two most critical values here are the **Z-statistic** and the **Asymptotic Significance (2-tailed)**, often referred to as the **p-value**. The Z-score represents how many standard deviations the observed sum of

ranks is from the **expected value** under the null hypothesis. A larger absolute Z-value suggests a more significant departure from the null hypothesis, indicating a stronger effect of the treatment.

In our specific fuel treatment experiment, the output reveals a **Z-statistic** of -2.013. The negative sign simply indicates the direction of the difference based on how the variables were ordered. More importantly, the **Two-tailed p-value** is calculated as .044. Understanding these numbers is the key to drawing a valid conclusion about your research. The following image displays the exact tables you will see in your **SPSS** output window.

➔ 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.

Determining Statistical Significance and Hypothesis Conclusions

To determine if the results are **statistically significant**, we compare the generated **p-value** against a pre-determined **alpha level**, which is commonly set at .05 in social and physical sciences. The p-value represents the probability of observing a result as extreme as the one obtained, assuming that the **null hypothesis** is true. If this probability is low (less than the alpha level), we conclude that the observed difference is unlikely to have occurred by random chance alone.

In the case of our fuel treatment study, the p-value of .044 is strictly less than the alpha threshold of .05. Consequently, we have sufficient evidence to **reject the null hypothesis**. This allows us to conclude that there is a statistically significant difference in the mean mpg of the cars before and after the fuel treatment. If the p-value had been greater than .05, we would have failed to reject the null hypothesis, suggesting that any observed changes in mpg could likely be attributed to sampling error or random variation.

It is important to note that statistical significance does not always equate to practical significance. While the **Wilcoxon Signed Rank Test** tells us that a change occurred, researchers should also consider the **effect size** to understand the magnitude of that change in a real-world context. In professional reporting, providing the median values alongside the test statistics offers a more comprehensive view of the data's story, allowing stakeholders to see exactly how much the fuel efficiency improved or declined.

Formal Reporting of the Wilcoxon Signed Rank Test Results

The final stage of the **data analysis** process is the formal write-up. Academic and professional standards require that you report the test used, the purpose of the analysis, the sample size, and the specific test statistics including the Z-score and the p-value. Clear reporting ensures that your findings are reproducible and that your conclusions are transparent to other researchers or decision-makers.

For the fuel treatment experiment, a formal summary would look like this: A **Wilcoxon Signed Rank Test** was conducted to evaluate whether a new fuel treatment resulted in a statistically significant change in the average miles per gallon (mpg) of vehicles. The analysis included a sample of 12 cars, each measured under both treated and untreated conditions. This **non-parametric** approach was chosen to ensure the validity of the results regardless of the distribution of the underlying data.

The results of the analysis indicated a statistically significant difference between the two groups, with a **Z-statistic** of -2.013 and a **p-value** of 0.044. Because the p-value fell below the standard .05 significance level, the null hypothesis was rejected. These findings suggest that the fuel treatment significantly influenced the fuel efficiency of the vehicles tested. By following this structured reporting format, you provide a clear and authoritative account of your statistical findings.

Summary of Best Practices for SPSS Analysis

Performing a **Wilcoxon Signed Rank Test** in **SPSS** is a straightforward yet powerful way to handle paired data that does not meet the requirements for parametric testing. By utilizing the "Legacy Dialogs" menu and carefully configuring your variable pairs, you can unlock insights into

related samples that might be obscured by outliers or non-normal distributions. Always remember to check your data structure and ensure that your variables are truly related before proceeding with this specific test.

Beyond the technical steps, successful **statistical significance** testing requires a deep understanding of what the numbers represent. The transition from raw ranks to a **Z-score** and eventually a **p-value** is a mathematical journey that confirms whether your experimental interventions are having a real impact. Whether you are testing medical treatments, educational programs, or automotive additives, the Wilcoxon test remains a cornerstone of **non-parametric statistics**.

In conclusion, mastering this procedure in **IBM SPSS Statistics** enhances your analytical toolkit, allowing you to provide more accurate and nuanced interpretations of your research data. By adhering to the steps outlined in this guide--from initial data entry to final reporting--you ensure that your statistical conclusions are grounded in rigorous methodology and presented with professional clarity.