

How to Use the Mann-Whitney U Table to Determine Statistical Significance

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February 28, 2026

RECOMMENDED CITATION

stats writer (2026). *How to Use the Mann-Whitney U Table to Determine Statistical Significance*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=133244>

Defining the Mann-Whitney U Test and its Significance

The **Mann-Whitney U test**, often referred to as the Wilcoxon rank-sum test, is a cornerstone of **non-parametric statistics**. It is designed to evaluate whether there is a statistically significant difference between the distributions of two independent groups. Unlike parametric alternatives, this test does not assume that the underlying data follows a **normal distribution**, making it an essential tool for researchers dealing with skewed data or small sample sizes where normality cannot be verified. By focusing on the ranks of the observations rather than their absolute values, the test provides a robust framework for comparing groups across various scientific disciplines, including psychology, biology, and economics.

At the heart of this statistical procedure is the **Mann-Whitney U Table**, a reference resource that provides critical values necessary for hypothesis testing. When a researcher calculates a **test statistic**, specifically the U value, they must compare it against a standardized threshold to determine if the observed differences are likely due to chance or represent a true effect in the population. The table acts as a roadmap, allowing analysts to translate raw mathematical output into meaningful scientific conclusions. Without the guidance of these tabulated values, interpreting the results of the rank-sum procedure would be significantly more complex and prone to error.

The utility of the Mann-Whitney U Table extends beyond simple comparison; it offers a high degree of flexibility for different research designs. Whether a study involves **ordinal data**, such as Likert scale responses, or continuous data that violates the assumptions of a t-test, the table remains applicable. Its design accounts for various sample sizes for both groups, typically denoted as n_1 and n_2 , ensuring that the **statistical significance** is calculated with precision. By providing a structured way to assess the **null hypothesis**, the table empowers researchers to make data-driven decisions with confidence.

The Role of Non-Parametric Analysis in Modern Research

In the realm of data analysis, the choice between parametric and non-parametric tests is pivotal. Parametric tests, like the **independent samples t-test**, require stringent assumptions about the population parameters, such as homogeneity of variance and normality. However, real-world data is frequently messy, containing outliers or exhibiting heavy-tailed distributions that make parametric assumptions untenable. In such instances, the **Mann-Whitney U test** serves as a powerful alternative that preserves the integrity of the analysis without requiring data transformation or the removal of valuable data points.

Non-parametric methods are particularly favored when dealing with small sample sizes where the Central Limit Theorem does not yet guarantee a normal distribution of the mean. For example, in clinical trials involving rare diseases or pilot studies with limited participants, the **Mann-Whitney U**

Table provides the necessary **critical values** to validate findings. Because the test relies on the relative ordering of data rather than the specific distance between values, it is less sensitive to extreme outliers, which could otherwise skew the results of a standard t-test and lead to **Type I or Type II errors**.

Furthermore, the **Mann-Whitney U test** is the gold standard for analyzing **ordinal data**. In many social science surveys, participants provide responses in ranked categories (e.g., "strongly disagree" to "strongly agree"). Since the intervals between these ranks are not necessarily equal, treating them as interval data for a t-test is statistically inappropriate. The Mann-Whitney approach respects the ranked nature of the data, and the associated table allows researchers to determine if one group's rankings are systematically higher or lower than another's, providing a clear picture of group differences.

Calculating the U Statistic and Ranking Procedures

To utilize the Mann-Whitney U Table effectively, one must first understand the calculation of the U statistic itself. The process begins by combining all observations from both independent groups into a single dataset and ranking them from smallest to largest. If multiple observations have the same value, they are assigned the **average rank** for those positions. Once the ranks are assigned, they are summed for each group separately. These rank sums, typically denoted as R1 and R2, form the basis for the U calculation, which quantifies the number of times a value from one group precedes a value from the other group in the ordered sequence.

The mathematical formula for the U statistic incorporates the sample sizes and the rank sums. Specifically, U is calculated for each group, and the smaller of the two values is usually compared against the **Mann-Whitney U Table**. A small U value indicates that there is very little overlap between the two groups, suggesting a significant difference, whereas a large U value suggests that the groups are well-mixed and likely come from the same distribution. This ranking method ensures that the test focuses on the **stochastic dominance** of one group over another rather than just the difference in means.

Understanding this ranking procedure is crucial because it highlights why the Mann-Whitney U test is resistant to the influence of **outliers**. An extreme value at the very end of a distribution will only receive the highest possible rank, regardless of how far it sits from the rest of the data. In a parametric test, that same extreme value would disproportionately pull the mean, potentially creating a false sense of significance. By using the U statistic and referring to the critical values in the table, researchers ensure that their conclusions are based on the overall structure of the data rather than a few anomalous points.

Navigating Critical Values and Alpha Levels

The **Mann-Whitney U Table** is organized by **alpha levels**, which represent the probability of rejecting the null hypothesis when it is actually true. Common alpha levels include .01, .05, and .10. Choosing an alpha level of .05, for example, means the researcher is willing to accept a 5% risk of a Type I error. The table provides a specific **critical value** for each combination of sample sizes (n_1 and n_2) at a given alpha level. If the calculated U statistic is less than or equal to the critical value found in the table, the result is considered statistically significant.

It is important to note that the interpretation of the Mann-Whitney U Table differs slightly from other statistical tables, such as the Z-table or T-table. In many tests, a calculated value *greater* than the critical value denotes significance. However, for the Mann-Whitney U test, **significance is achieved when the calculated U is less than or equal to the table value**. This is because a lower U value signifies a more distinct separation between the ranks of the two groups. Researchers must be diligent in this distinction to avoid incorrect interpretations of their experimental data.

The choice of alpha level often depends on the field of study and the consequences of an error. In medical research, a more stringent alpha of .01 might be used to ensure that a new treatment is truly effective before it is widely adopted. In contrast, exploratory social science research might use an alpha of .10 to identify potential trends that warrant further investigation. The **Mann-Whitney U Table** accommodates these needs by providing distinct critical value sets for each level, ensuring that the **statistical significance** is tailored to the specific requirements of the study.

Distinguishing Between One-Tailed and Two-Tailed Tests

When using the Mann-Whitney U Table, a fundamental decision involves choosing between a **one-tailed or two-tailed test**. A two-tailed test is used when the researcher wants to determine if there is *any* significant difference between the two groups, regardless of which group ranks higher. This is the more conservative approach and is generally preferred in scientific research unless there is a strong theoretical justification for predicting the direction of the difference. The tables provided below are specifically calibrated for two-tailed tests, which are the standard for most general inquiries.

A one-tailed test, on the other hand, is appropriate when the researcher has a specific **directional hypothesis**. For instance, a researcher might hypothesize that a new teaching method will specifically *improve* test scores compared to the traditional method, rather than just being different. To adapt the two-tailed Mann-Whitney U Table for a one-tailed test, one should double the alpha value. For example, if you are conducting a one-tailed test at the .05 level, you would look up the critical value in the two-tailed table for $\alpha = .10$. This adjustment allows the table to

remain a versatile tool for various hypothesis-testing strategies.

Correctly selecting the "tail" of the test is vital for the **statistical power** of the analysis. A one-tailed test can be more powerful because it focuses all the alpha into one direction of the distribution, making it easier to find significance if the effect exists in that specific direction. However, it also carries the risk of missing a significant effect in the opposite direction. Most peer-reviewed journals expect a two-tailed analysis unless the directional nature of the study is clearly established beforehand. Regardless of the choice, the **Mann-Whitney U Table** provides the foundational data needed to conclude the test accurately.

Mann-Whitney U Table Data and Critical Values

The following tables provide critical values for two-tailed Mann-Whitney U tests for various levels of alpha. These values are essential for determining if the difference between your two groups is statistically significant. When using these tables, locate the intersection of your two sample sizes (n1 and n2) to find the threshold for your U statistic.

For one-tailed tests, simply double the value of alpha and use the appropriate two-tailed table. This ensures that the probability distribution is correctly accounted for based on your specific hypothesis.

Read the Mann-Whitney U Test tutorial [here](#).

Critical Values for Alpha = .01 (Two-Tailed)

The alpha level of .01 represents a high threshold for **statistical significance**, often used when researchers want to be 99% confident that their results are not due to random chance. This level is common in rigorous scientific trials and peer-reviewed academic research.

n1 \ n2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2																			
3								0	0	0	1	1	1	2	2	2	2	3	3
4					0	0	1	1	2	2	3	3	4	5	5	6	6	7	8
5				0	1	1	2	3	4	5	6	7	7	8	9	10	11	12	13
6			0	1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	18
7			0	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24
8			1	2	4	6	7	9	11	13	15	17	18	20	22	24	26	28	30
9		0	1	3	5	7	9	11	13	16	18	20	22	24	27	29	31	33	36
10		0	2	4	6	9	11	13	16	18	21	24	26	29	31	34	37	39	42
11		0	2	5	7	10	13	16	18	21	24	27	30	33	36	39	42	45	46
12		1	3	6	9	12	15	18	21	24	27	31	34	37	41	44	47	51	54
13		1	3	7	10	13	17	20	24	27	31	34	38	42	45	49	53	56	60
14		1	4	7	11	15	18	22	26	30	34	38	42	46	50	54	58	63	67
15		2	5	8	12	16	20	24	29	33	37	42	46	51	55	60	64	69	73
16		2	5	9	13	18	22	27	31	36	41	45	50	55	60	65	70	74	79
17		2	6	10	15	19	24	29	34	39	44	49	54	60	65	70	75	81	86
18		2	6	11	16	21	26	31	37	42	47	53	58	64	70	75	81	87	92
19	0	3	7	12	17	22	28	33	39	45	51	56	63	69	74	81	87	93	99
20	0	3	8	13	18	24	30	36	42	46	54	60	67	73	79	86	92	99	105

Critical Values for Alpha = .05 (Two-Tailed)

An alpha level of .05 is the standard benchmark for significance in most fields of study. It strikes a balance between being rigorous enough to avoid false positives while being sensitive enough to detect real effects in the data. This table is the most frequently used reference for the **Mann-Whitney U test**.

n1 \ n2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2							0	0	0	0	1	1	1	1	1	2	2	2	2
3				0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
4			0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14
5		0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6		1	2	3	5	6	7	10	11	13	14	16	17	19	21	22	24	25	27
7		1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8	0	2	4	6	7	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9	0	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
10	0	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11	0	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12	1	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13	1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14	1	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15	1	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16	1	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17	2	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18	2	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19	2	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
20	2	8	13	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127

Critical Values for Alpha = .10 (Two-Tailed)

The alpha level of .10 is often utilized in exploratory research or pilot studies where the goal is to identify potential relationships that may warrant further, more controlled investigation. It provides a more lenient threshold for **hypothesis testing**.

n1 \ n2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2				0	0	0	1	1	1	1	2	2	3	3	3	3	4	4	4
3		0	0	1	2	2	3	4	4	5	5	6	7	7	8	9	9	10	11
4		0	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
5	0	1	2	4	5	6	8	9	11	12	13	15	16	18	19	20	22	23	25
6	0	2	3	5	7	8	10	12	14	16	17	19	21	23	25	26	28	30	32
7	0	2	4	6	8	11	13	15	17	19	21	24	26	28	30	33	35	37	39
8	1	3	5	8	10	13	15	18	20	23	26	28	31	33	36	39	41	44	47
9	1	4	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54
10	1	4	7	11	14	17	20	24	27	31	34	37	41	44	48	51	55	58	62
11	1	5	8	12	16	19	23	27	31	34	38	42	46	50	54	57	61	65	69
12	2	5	9	13	17	21	26	30	34	38	42	47	51	55	60	64	68	72	77
13	2	6	10	15	19	24	28	33	37	42	47	51	56	61	65	70	75	80	84
14	3	7	11	16	21	26	31	36	41	46	51	56	61	66	71	77	82	87	92
15	3	7	12	18	23	28	33	39	44	50	55	61	66	72	77	83	88	94	100
16	3	8	14	19	25	30	36	42	48	54	60	65	71	77	83	89	95	101	107
17	3	9	15	20	26	33	39	45	51	57	64	70	77	83	89	96	102	109	115
18	4	9	16	22	28	35	41	48	55	61	68	75	82	88	95	102	109	116	123
19	4	10	17	23	30	37	44	51	58	65	72	80	87	94	101	109	116	123	130
20	4	11	18	25	32	39	47	54	62	69	77	84	92	100	107	115	123	130	138

Practical Considerations and Best Practices

While the **Mann-Whitney U Table** is an invaluable resource, it is important to remember that it is most effective when the assumptions of the test are met. The two groups being compared must be independent of one another, meaning the observations in one group should not influence the observations in the other. Furthermore, the **measurement scale** should be at least ordinal. If these criteria are not met, the results derived from the table may be misleading. Analysts should always perform a preliminary check of their experimental design before proceeding with rank-sum calculations.

Another consideration is the size of the samples. For very large samples, the distribution of the U statistic approaches a normal distribution. In these cases, researchers often use a **Z-score** approximation rather than the Mann-Whitney U Table. Most modern statistical software packages will automatically provide a **p-value** based on this approximation for large n. However, the table remains the definitive source for smaller samples where the normal approximation is less accurate. It serves as a vital safeguard for researchers working with localized or specialized datasets.

Finally, always report the U statistic, the sample sizes, and the alpha level used in your final report. Transparency in reporting allows other scientists to verify your findings and ensures that the **reproducibility** of the study is maintained. By correctly utilizing the Mann-Whitney U Table and

interpreting the results within the broader context of your research, you contribute to a more robust and accurate scientific understanding of the differences between independent groups.

Mann-Whitney U Table Reference

The tables provided above serve as a primary reference for calculating **statistical significance** using the Mann-Whitney method. These values are meticulously calculated to ensure accuracy across various sample sizes. Researchers are encouraged to bookmark this resource for ongoing data analysis projects requiring non-parametric testing.

By comparing your calculated U value to these benchmarks, you can determine whether to reject the **null hypothesis**. Remember that if your U value is lower than the one in the table, you have evidence of a significant difference between your two groups at that specific alpha level.

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