## Jonckheere-Terpstra Test

Also known as the test for ordered alternatives or a nonparametric test for trend. The Jonckheere-Terpstra test is used when the assumption that the independent variable is nominal in the Kruskal-Wallis test is violated i.e. the groups have an explicit order. Since it allows the independent variable (the groups) to have an order it is more powerful than the Kruskal-Wallis test when the groups are ordered.

### Null Hypothesis

H0: There is no difference in median values between the groups.

HA: The median values of the groups increase in a specific predetermined sequence.

### Assumptions

1. The data have been collected from a randomly selected set of observations.
2. The data to be analysed are continuous and at least at the ordinal level of measurement.
3. The *k* groups must be ordinal with a predetermined order.
4. Under the null hypothesis it is assumed that each sample is from the same population.

### Method

1. Construct the null and alternative hypotheses and determine the level of significance, α.
2. Specify the order of the groups, which need not be equal sized.
3. Cast the data into a two-way table with the groups in the pre-specified order, arranged from smallest to largest.
4. Within each group order the data from smallest to largest.
5. Count the total number of times each value in the first group precedes (is lower than) a value in the subsequent groups this is the precedent count for the group.
6. Add ½ to each precedent count when a tie occurs between groups.
7. Find the precedent count for the remaining groups and sum over the groups to give *J*, the test statistic.
8. Compare this value to that in the tables for *J* (See Appendix XI). If the statistic is greater than or equal to the critical value in the Jonckheere-Terpstra test tables, the result is significant. If the result is significant, the null hypothesis is rejected in favour of the alternative hypothesis.

### Large sample size

When the sample size is large the distribution of *J* tends to a normal distribution, with mean  and standard deviation .

Where,

*N* = total sample size

*nj* = sample size of group j

*k* = number of groups

*Σ* = sum across groups.

A *z* statistic can then be calculated as follows: .

This *z* statistic can then be compared to the normal tables.

### Example

Mcm-2 values were collected in a breast cancer study. The median Mcm-2 value was expected to increase with histological grade (data below). This hypothesis was tested using the Jonckheere-Terpstra test.

|  |  |  |
| --- | --- | --- |
| Histological grade | | |
| 1 | 2 | 3 |
| 1.99 | 4.40 | 6.94 |
| 3.01 | 9.82 | 8.04 |
| 4.17 | 10.23 | 9.82 |
| 7.13 | 11.99 | 15.75 |
| 9.82 | 11.99 | 18.30 |
| 9.91 | 13.17 | 25.01 |
|  | 13.20 | 26.40 |
|  |  | 28.17 |

1. H0: The median Mcm-2 value is the same across histological grades.

HA: There is an increase is median Mcm-2 value as histological grade increases.

α=0.05.

1. The order of the groups is that of increasing histological grade.
2. The precedent counts for each pair of groups is in the table below.
3. ½ has been added to each precedent count with a tie between groups.

|  |  |  |
| --- | --- | --- |
| Precedent counts | | |
| Grade 1 & 2 | Grade 1 & 3 | Grade 2 & 3 |
| 7 | 8 | 8 |
| 7 | 8 | 5 + ½ |
| 7 | 8 | 5 |
| 6 | 7 | 5 |
| 5 + ½ | 5 + ½ | 5 |
| 5 | 5 | 5 |
|  |  | 5 |
| Total: 37.5 | 41.5 | 38.5 |

1. *J* = 37.5 + 41.5 + 38.5 = 117.5.
2. From the tables (*n1*=6, *n2*=7, *n3*=8, α=0.05) the critical value is 99. As 117.5>99, there is sufficient evidence to rejectthe null hypothesis and conclude that there is a significant increase in median Mcm-2 value as histological grade increases.

### Presentation of results

The results of the Jonckheere-Terpstra test could be reported in the following way:

The results of the Jonckheere-Terpstra test show that there is a trend for an increase in median Mcm-2 value as histological grade increases (*J*=117.5, p=0.003).

### Advantages and limitations

The main advantage of the Jonckheere-Terpstra test is that unlike the Kruskal-Wallis test it allows the groups to have an order therefore it is more powerful than the Kruskal-Wallis test if the groups have a pre-specified order. Since the Jonckheere-Terpstra test is a test for trend there is no need for post hoc tests to see where differences lie after a significant result.

The main limitation of the test is that the groups must have a pre-specified or explicit order. It is not possible to look for an order and then test for a trend. If there is no explicit order then a Kruskal-Wallis test should be used instead.

### Summary

The Jonckheere-Terpstra test is a more powerful alternative to the Kruskal-Wallis test when there is an explicit order to the groups. It is a test for trend of increasing medians between the groups. It is a much under used nonparametric test often the Kruskal-Wallis test is used where it would have been more appropriate to use the Jonckheere-Terpstra test.

## Summary of Several Independent Samples

In this section, five tests for use when the independent variable has more than two groups have been covered. The Chi-Square test and the Mantel-Haenszel test are to be used when the dependent variable is categorical. The Median and Kruskal-Wallis tests are to be used when the dependent variable is continuous but there is no order to the groups. The Jonckheere-Terpstra test is more powerful if there is an order to the groups.

If the assumptions of the Kruskal-Wallis test are satisfied, it is more powerful to use this test than the Median Test. That is the Kruskal-Wallis test is more likely to correctly reject the null hypothesis.