S 8 Mon.Ceconomic procedures with percentages, Kruskal-Wallis test, Mann-Whitney test, Wilcoxon test

1. Mon.Caccounting procedures with percentages

THEORY

The assumption is that n is greater than 20 (it is clear that the percentage obtained from the survey of less than 20 people is an unreliable figure)

$$\% = \ -$$

b= the part of the file that we want to express as a percentage

Confidence interval for percentage data:

We perform the calculation from the values of the selection percentage that we want to generalize and from the scope of the selection. We take into account the probability with which we will assess the width of the interval. The confidence interval is given by:

$$(\%) = \ \pm \ \sqrt{\frac{}{(100 - \ )}}$$

p_{in} = sampling percentage t_p = probability at 99% = 2.58 and 95% = 1.96

EXAMPLE

Members of the prison service (n = 40) met the performance limit in the endurance run in the number of 30 people. We are interested in what percentage it is.

$$\% = \frac{30}{40}100 = 75\%$$

We therefore calculated that 75% of the prison staff met the performance limit in the endurance run. We want to find out the interval in which there is an unknown percentage of all members of the prison service in the Czech Republic (basic set).

$$(75\%) = 75 \pm 1.96\sqrt{\frac{75\ (100 - 75)}{40}} = 75 \pm 13{,}419$$

The confidence interval for 75% is with a probability of 95% in the range of 61.6-88.4%

2. Nonparametric variants of the T test

- Mann - Whitney U test,
- Kruskal - Wallis test
- Wilcoxon test

2.1 Mann - Whitney U test

This test is similar to the parametric T test for independent selections (seminar 3), but unlike it, it works with non-parametric data, or if the files with parametric data do not show the normality of the frequency distribution. Median hypotheses are tested.

The hypotheses tested are as follows:$_0$: The medians of both sets are equal. H_1 : The medians of both files are different.

The test criterion is calculated from the relationships:

$$_1 = \ _1 - \frac{_1(\ _1 + 1)}{2} \qquad _2 = \ _1 - \frac{_2(\ _2 + 1)}{2}$$

$AT_{1.2}$ ... Sums of rankings in individual groups

EXAMPLE

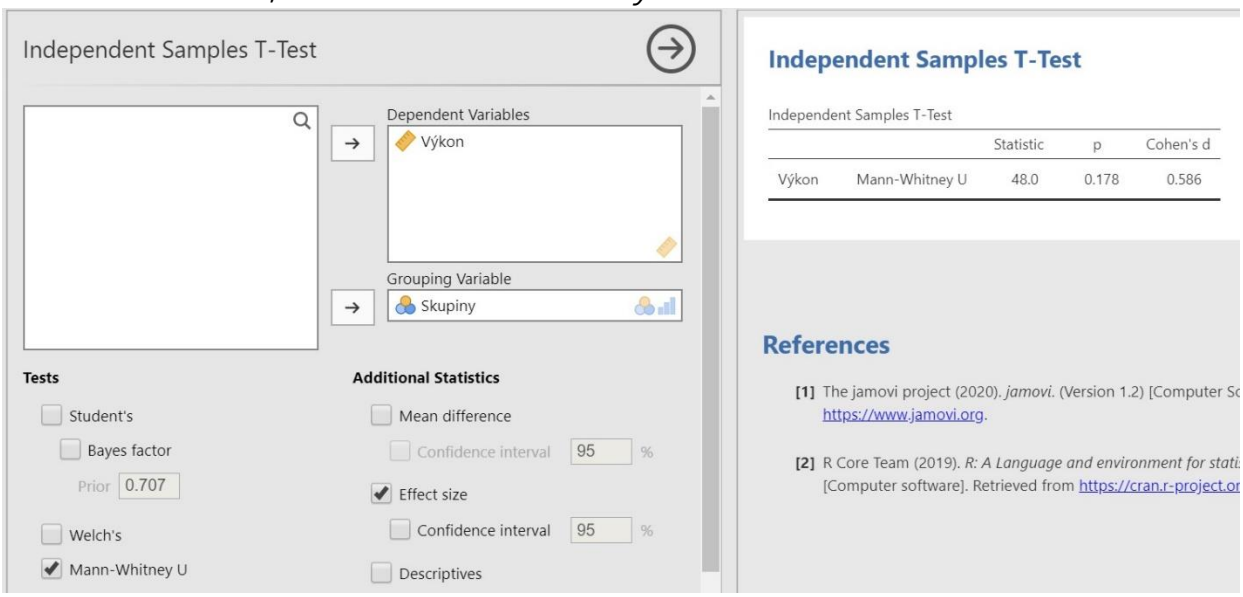
The table shows the randomizations of selected members of the two groups in shot put. Find out if there is a statistically significant difference between the groups.

Group1 (cm)	Group 2 (cm)
886	776
992	547
997	887
857	993
654	569
534	449
765	943
458	659
991	499
667	668
994	865
995	599

After testing the normality of the frequency distribution (see seminar 3), we found that set A shows a violation of the normality of the distribution. (Shapiro-Wilk p = 0.042). Therefore, the Mann-Whitney test is needed to test the hypothesis of a difference between independent files.

After entering the data, we continue in the same way as when choosing the T test (seminar 3), ie:*Analyzes → T-Tests - Independent samples T-Test*

In the next selection, check the box *Man-Whitney test*.



p> 0.05, we cannot reject the null hypothesis, there is no statistically significant difference between the groups.

Note Because the files were randomly selected from the base file, we do not count materiality in this case. If this is necessary, we check the appropriate option to calculate Cohen's d. See results.

2.2 Kruskal - Wallis test

This test is an extension of the previous Mann-Whitney test to more than 2 groups. The scale must be at least ordinal, all values are found in random samples.

The test criterion is the H value, which is calculated according to the formula

$$= [\quad \frac{12}{(+ 1)} \sum \quad \frac{2}{]} - 3 (+ 1)$$

N = total frequency of all values

R$_{and}$ = sum of rankings in individual groups*n*$_{and}$ = frequencies of values in individual groups

EXAMPLE

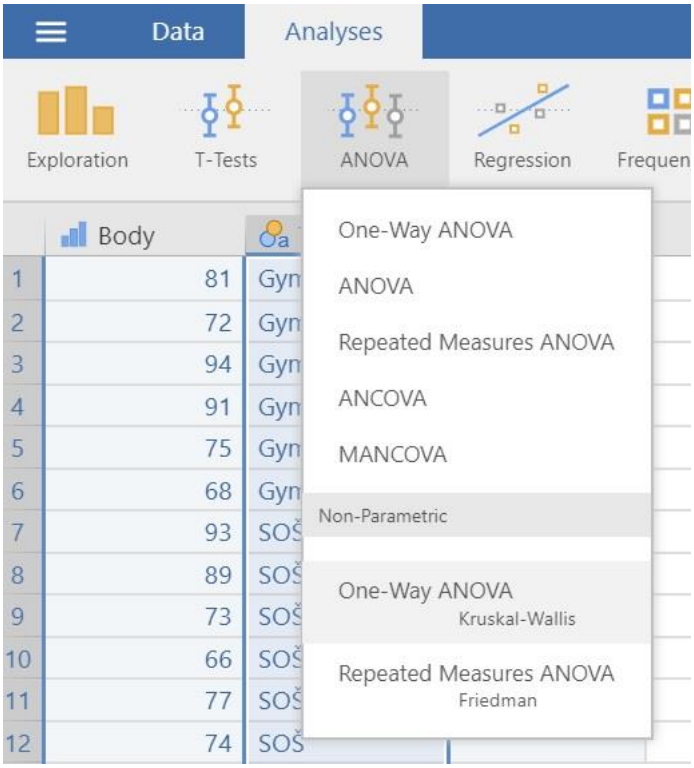
A written test on the issues of a general overview in the field of physical culture and sports is included for the admission procedure of applicants for the bachelor's study program in the field of TVS. We want to assess whether the test results differ significantly according to the type of schools from which the applicant applies for the field. We will randomly select 6 applicants from individual types of schools (Gymnázia, SOŠ, SOU). We set the level of significance at 0.05%

Achieved results (number of points) according to typu schools:

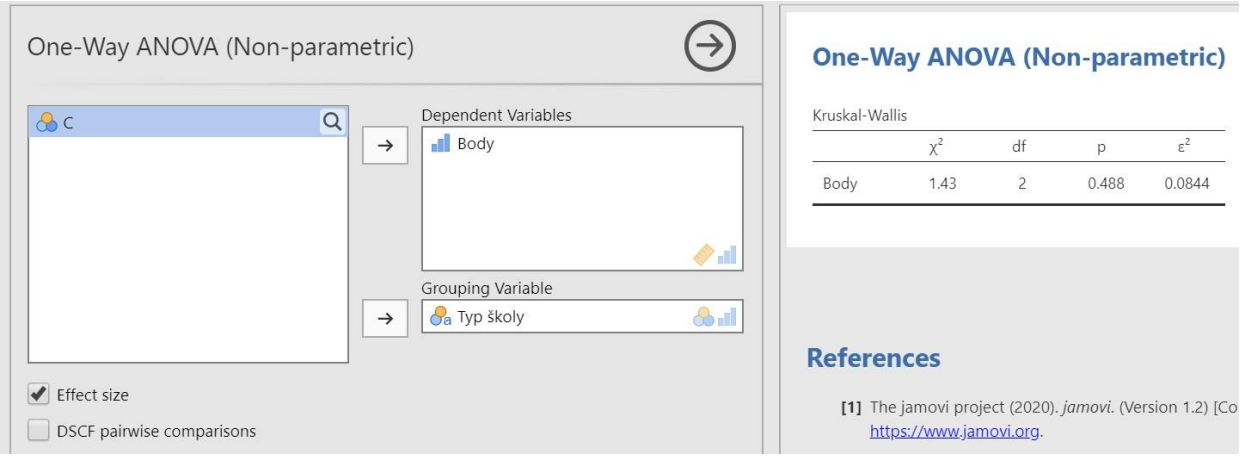
Applicant	Gymnasium	SOS	SHOW
AND	81	93	58
B	72	89	66
C	94	73	85
D	91	66	91
E	75	77	71
F	68	74	73

Solution: Enter the values in two columns and mark the appropriate groups and data type (points - ordinal and type of school - nominal). We continue through the elections:

Analyzes → ANOVA → One-Way ANOVA Kruskal-Wallis



Results:



Value $p > 0.05$ = there is no statistically significant difference between the groups. Effect size $_2 < 0.1$ = there is no material difference between the groups

2.3 Wilcoxon test

This test is a non-parametric equivalent of a paired T test (T test for dependent sets - see seminar 4)

Imagine that we are testing whether the strength skills of the tested probands have improved after the application of the training plan. We will perform initial testing (eg shot put), then we will apply the training plan and after its application we will perform the testing again. As already mentioned, it is important that the number of probands in the first and second measurements is the same, ie those probands who did not participate in both measurements must be excluded. It is now important to determine whether the performances in the shot put can be considered as normally distributed (see Seminar 3, Shapiro - Wilk test).

If the performances can be assessed as normally distributed, we would use a paired T-test (seminar 4). **We use the Wilcoxon test when a normal distribution of values cannot be inferred.**

(We will use the same test even if we process non-parametric data - usually ordinal).

In the paired T test, the null and alternative hypotheses relate to the mean. In the Wilcoxon paired test, the hypotheses relate to the median.

EXAMPLE

The data from the above example are shown in the following table. Verify that there is a statistically significant difference in performance before and after applying the training plan to develop explosive strength skills in eight randomly selected probands.

Measurement before (cm)	Measurement after (cm)
776	772
892	947
797	687
857	893
654	769
534	549
765	743
458	359
791	851
667	578

After data analysis (*Analyzes → Exploration, → Descriptives)* we detect a breach of data normality in the data set from the second measurement (p <0.05).

	Test před	Test po
1	776	778
2	892	780
3	797	789
4	857	893
5	654	787
6	534	780
7	765	743
8	458	458
9	791	851
10	667	578
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		

Descriptives

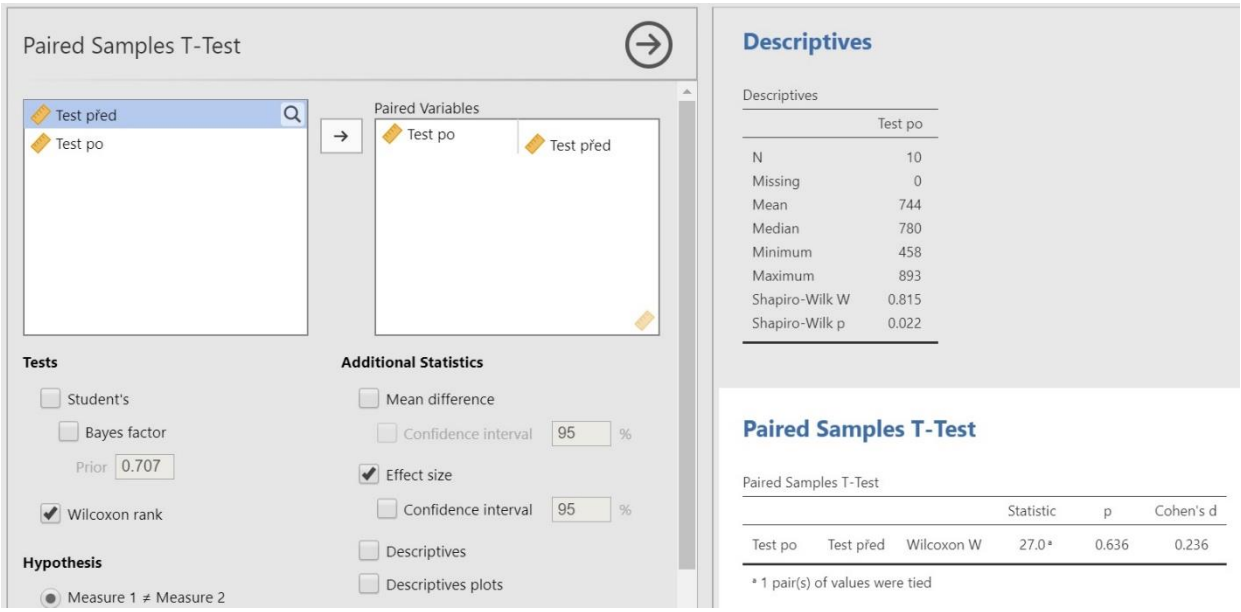
Descriptives	Test před
N	10
Mean	719
Median	771
Minimum	458
Maximum	892
Shapiro-Wilk W	0.922
Shapiro-Wilk p	0.375

Descriptives

Descriptives

Descriptives	Test po
N	10
Missing	0
Mean	744
Median	780
Minimum	458
Maximum	893
Shapiro-Wilk W	0.815
Shapiro-Wilk p	0.022

So we use the Wilcoxon test for the calculation. *Analyzes → T-Tests → Paired Samples Ttest.* Check the option *Wilcoxon rank.*



Resulting p value (0.636)> 0.05. The difference between performance before and after the application of the training plan is therefore statistically insignificant. Stimulation of strength skills has proven ineffective.

If our task were to determine materiality, we would use Cohen's d.

TASKS

1) In the subject "Development of motor skills", students passed the final test as part of the study control. We want to assess whether the test results differ according to the field of study. 10 students from each field of study were randomly selected. The table shows the point value he achieved in the test for each of them. Decide whether there is a statistically significant difference in the level of knowledge of the subject matter between the fields of study.

TVS full-time	TVS station wagon	Elementary school teaching	Secondary school teaching
19	27	13	30
25	30	23	23
18	22	24	31
18	29	30	28
15	22	11	22
24	21	21	20
29	24	20	13
16	13	21	24
23	22	15	25
13	15	28	15