

Chapter 13

Unpaired Continuous Data with Three or More Groups (One Way Analysis of Variance, Kruskal-Wallis, 30 Patients)

1 General Purpose

In studies of different treatments often parallel groups receiving different treatments are included. Unlike repeated measures studies (Chaps. 9, 10, 11, 12), they involve independent treatment effects with a zero correlation between the treatments. One way analysis of variance (ANOVA) is appropriate for analysis.

2 Schematic Overview of Type of Data File

Outcome	predictor (3 or more categories, e.g., 1, 2, and 3)
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.	.
.	.
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.	.
.	.
.	.
.	.

Just like unpaired t-tests, one way analyses of variance are for comparing parallel-groups. However, they allow for more than two parallel-groups. They can not include more than a single predictor in the analysis, often three or more parallel treatment modalities. The outcome data of the parallel-groups are assumed to be normally distributed.

3 Primary Scientific Question

Do parallel treatment modalities produce significantly different mean magnitudes of treatment effects.

4 Data Example

Hours of sleep	Group	Age (years)	Gender	Co-morbidity
6,00	0,00	45,00	0,00	1,00
7,10	0,00	45,00	0,00	1,00
8,10	0,00	46,00	0,00	0,00
7,50	0,00	37,00	0,00	0,00
6,40	0,00	48,00	0,00	1,00
7,90	0,00	76,00	1,00	1,00
6,80	0,00	56,00	1,00	1,00
6,60	0,00	54,00	1,00	0,00
7,30	0,00	63,00	1,00	0,00
5,60	0,00	75,00	0,00	0,00

The entire data file is in extras.springer.com, and is entitled “chapter13unpairedcontinuousmultiplegroups”. Start by opening the data file in SPSS.

5 One Way ANOVA

For analysis the module Compare Means is required. It consists of the following statistical models:

Means,
 One-Sample T-Test,
 Independent-Samples T-Test,
 Paired-Samples T-Test and
 One Way ANOVA.

Command:

Analyze....Compare Means....One-way Anova....Dependent lists: effect treat....
 Factor: enter group....click OK.

ANOVA effect treatment

	Sum of squares	df	Mean square	F	Sig.
Between groups	37,856	2	18,928	14,110	,000
Within groups	36,219	27	1,341		
Total	74,075	29			

A significant difference between the three treatments has been demonstrated with a p-value of 0,0001. Like with the paired data of the previous chapter the conclusion is drawn: a difference exists, but we don't yet know whether the difference is between treatments 1 and 2, 2 and 3, or 1 and 3. Three subsequent unpaired t-tests are required to find out. Similarly to the tests of Chap. 5, a smaller p-value for rejecting the null-hypothesis is recommended, for example, 0,01 instead of 0,05. This is, because with multiple testing the chance of type 1 errors of finding a difference where there is none is enlarged, and this chance has to be adjusted.

Like the Friedman test can be applied for comparing three or more paired samples as a non-Gaussian alternative to the paired ANOVA test (see Chap. 6), the Kruskal-Wallis test can be used as a non-Gaussian alternative to the above unpaired ANOVA test.

6 Alternative Test: Kruskal-Wallis Test

For analysis the statistical model K Independent Samples in the module Nonparametric Tests is required.

Command:

Analyze....Nonparametric....K Independent Samples....Test Variable List: effect treatment....Grouping Variable: group....click Define range....Minimum: enter 0....Maximum: enter 2....Continue....mark: Kruskal-Wallis....click OK.

Test statistics^{a,b}

	Effect treatment
Chi-Square	15,171
df	2
Asymp. Sig.	,001

^aKruskal Wallis Test

^bGrouping Variable: group

The Kruskal-Wallis test is significant with a p-value of no less than 0,001. This means that the three treatments are very significantly different from one another.

7 Conclusion

The analyses show that a significant difference between the three treatments exists. This is an overall result. We don't know where the difference is. In order to find out whether the difference is between the treatments 1 and 2, 2 and 3, or 1 and

3 additional one by one treatment analyses are required. With one way ANOVA the advice is to perform three additional unpaired t-tests, with nonparametric testing the advice is to perform three Mann-Whitney tests to find out. Again, a subsequent reduction of the p-value or a Bonferroni test is appropriate.

8 Note

More background, theoretical, and mathematical information is available in *Statistics applied to clinical studies* 5th edition, Chap. 2, Springer Heidelberg Germany, 2012, from the same authors.