Statistics

for postgraduate students

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Paired t-test

Wilcoxon Signed Rank test

One-way ANOVA

Kruskal-Wallis test

Paired t-test

Q1	Q2	Q3	Q4	Q5	Statistical test
Bivariate /Multivariable	Difference /Correlation	Independent / Paired	Type of outcome (and Normality)	No of groups	
Bivariate	Difference	Dependent (paired)	Continuous (Normal)	2	Paired t-test

Usage:

- before/after measurements of the same variable
- to compare how a group of subjects perform under two different test conditions.

Assumptions:

Assumptions	How to check	What to do if the assumption is not met
Normality: paired differences should be normally distributed	Histograms of the difference / tests of normality (Shapiro-Wilk, Kolmogorov-Smirnov)	Wilcoxon signed rank test

Where to find in SPSS:

Analyze → Compare means → Paired-samples T-test

Table presentation of the result:

	Mean (SD)		Difference (95% CI) After-before	P-value
	Before the program	After the program		
Weight in Kg	71.61 (12.31)	63.79 (10.95)	-7.82 (-13.63, -2.01)	0.011
Hemoglobin mg/dl	11.37 (1.26)	11.98 (1.53)	0.61 (-0.28, 1.50)	0.168

Reporting significant results:

A paired-samples t test was used to compare the mean weight before the program to the mean weight after the program. The mean weight before the program was 71.61 (SD=12.31), and the mean weight after the program was 63.79 (SD=10.95). A statistically significant decrease of - 7.82 kg (95%CI, -13.63, -2.01) was found, p =0.011.

Reporting non-significant results:

A paired-samples t test was used to compare the mean hemoglobin before the program to the mean hemoglobin after the program. The mean hemoglobin before the program was 11.37 (SD=1.26), and the hemoglobin after the program was 11.98 (SD=1.53). No statistically significant difference was found, p=0.168.

Wilcoxon Signed Rank test

Q1	Q2	Q3	Q4	Q5	
Bivariate /Multivariable	Difference /Correlation	Independent / Paired	Type of outcome (and Normality)	No of groups	Statistical test
Bivariate	Difference	Dependent (paired)	Continuous (Non-normal)/ Ordinal	2	Wilcoxon signed-rank test

It is the non-parametric equivalent to the paired t-test

Where to find in SPSS:

Analyze → Nonparametric tests → 2 related samples

One-way ANOVA

Usage: Used to examine the difference in means of 3 or more independent groups.

ANOVA uses the ratio of the “between-group variance” to the “within-group variance” to decide whether there are statistically significant differences between the groups or not.

Assumptions:

Assumptions	How to check	What to do if the assumption is not met
Normality: dependent variables should be normally distributed within each group	Histograms / Tests of normality (Shapiro-Wilk, Kolmogorov-Smirnov)	Kruskall-Wallis test (non-parametric)
Homogeneity of variance	Levene's test	Welch test instead of ANOVA (adjusted for the differences in variance) or Kruskal-Wallis test

Where to find in SPSS:

Analyze → Compare means → One-Way ANOVA

Example:

Comparing the birthweight of a group of infants of mothers with different smoking status (never smoke, quit before pregnancy, smoke during pregnancy).

Step 1: We test if birth weight is normally distributed in the three groups using Shapiro-Wilk test, or Kolmogorov-Smirnov test. We should also have a look at the histograms.

Step 2: After confirmation that birth weight is normally distributed in the three groups, we run the one-way ANOVA test and the Levene's test for homogeneity of variance.

Step 3: We check the result of Levene's test for the homogeneity of variance, if there is no homogeneity of variance, we need to run the Welsh test from which we report the result.

Step 4: If the result of the one-way ANOVA is statistically significant ($p<0.05$), we need to do a post hoc test.

Post-hoc testing:

We use the post-hoc tests to make comparisons between each pair of the groups while adjusting the p-value. The aim is to reduce the probability of occurrence of type 1 error (the probability of having type 1 error increases as the comparisons increase). Bonferroni, Tukey, or Scheffe are commonly used post-hoc tests (adjustments). Some other tests can be used for different conditions.

Example

	Mean (SD)			
	Smoke during pregnancy **(N=10)**	Quit before pregnancy **(N=10)**	Never smoke **(N=10)**	**P-value**
Birth weight (g)	2606 (334)	2959 (490)	3101 (411)	0.037*
Age (years)	31.5 (6.6)	29.8 (4.4)	31.3 (6.4)	0.782

Reporting significant results:

We conducted a one-way ANOVA test to compare the birth weight of infants of mothers with different smoking behavior (never smoke, quit before pregnancy, smoke during pregnancy). A significant difference was found among the groups, $p=0.037$. Bonferroni test was used to determine the nature of the differences between those groups. This analysis revealed that the birth weight of infants to mothers who smoke during pregnancy was lower ($M = 2606$, $sd = 334$) than that of infants to mothers who never smoke ($M = 3101$, $sd = 411$). The birth weight of infants to mothers who quit smoking before pregnancy ($M = 2959$, $sd = 490$) was not significantly different from either of the other two groups.

Kruskal-Wallis test

Q1	Q2	Q3	Q4	Q5	Statistical test
Bivariate /Multivariable	Difference /Correlation	Independent / Paired	Type of outcome (and Normality)	No of groups	
Bivariate	Difference	Independent (un-paired)	Continuous (Non-normal)/ Ordinal	>2	Kruskal-Wallis test

It is the non-parametric equivalent to the one-way ANOVA

Usage: Kruskal-Wallis compares the medians of three or more samples to determine if the samples came from different populations. It is an extension of the Mann–Whitney U test to 3 or more groups.

Where to find in SPSS:

Analyze → Nonparametric tests →Independent samples

End of the lecture