statstutor

community project

encouraging academics to share statistics support resources

stcp-marshall-ANOVAS

The following resources are associated:
Statistical Hypothesis testing, Checking normality in SPSS and the SPSS dataset 'Diet.sav'

One-way (between-groups) ANOVA in SPSS

Dependent variable: Continuous (scale/interval/ratio),

Independent variable: Categorical (at least 3 unrelated/ independent groups)

Common Applications: Used to detect a difference in means of 3 or more independent groups. It can be thought of as an extension of the independent t-test for and can be referred to as 'between-subjects' ANOVA.

Data: The data set 'Diet.sav' contains information on 78 people who undertook one of three diets. There is background information such as age, gender and height as well as weight lost on the diet (a positive value means they lost weight). The aim of the study was to see which diet was best for losing weight so the independent variable (group) is diet and weight lost is the dependent.

	Person	gender	Age	Height	preweight	Diet	weight10weeks	weightLOST
1	1	0	22	159	58	1	54.2	3.8
2	2	0	46	192	60	1	54.0	6.0
3			55	170	64	1	63.3	.7
4			33	171			61.1	2.9

Female = 0

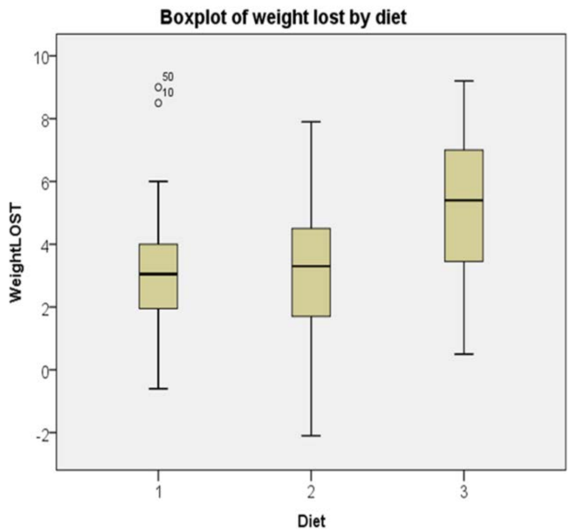
Diet 1, 2 or 3

Weight lost after 10 weeks

Before carrying any analysis, summarise weight lost by diet using a confidence interval plot or box-plot and some summary statistics. Do the group means and standard deviations look similar or very different?

		Diet		
		1	2	3
Weight lost on diet (kg)	Mean	3.30	3.03	5.15
	Standard Deviation	2.24	2.52	2.40

Diet 3 seems better than the other diets as the mean weight lost is greater. The standard deviations are similar so weight lost within each group is equally spread out.



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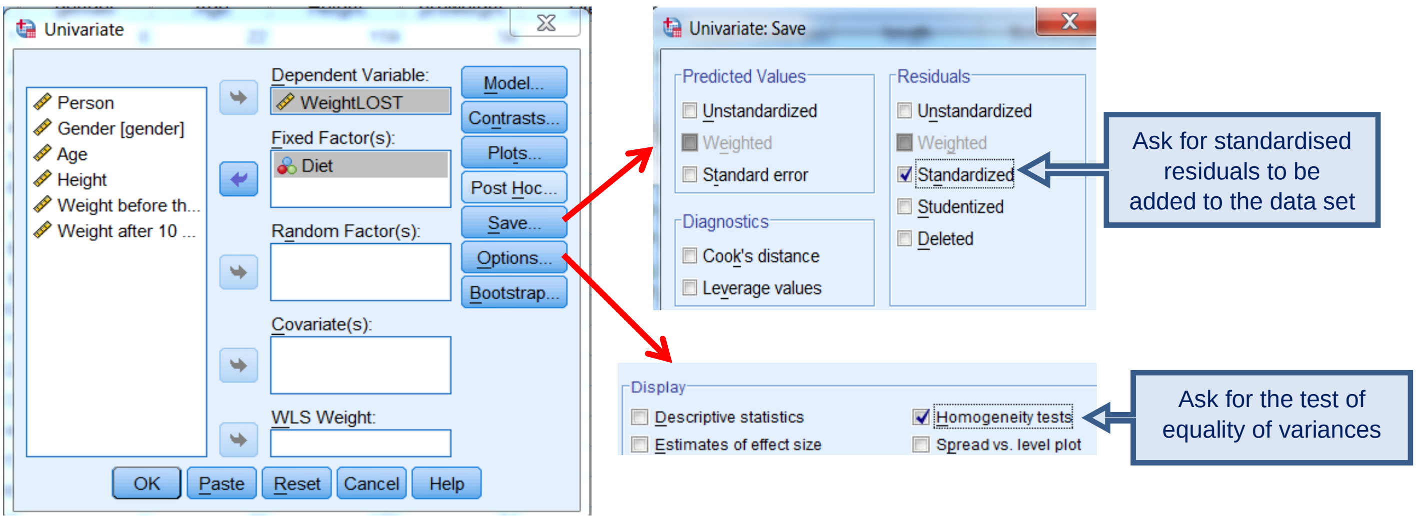
Reviewer: Alun Owen
University of Worcester

ANOVA stands for 'Analysis of variance' as it uses the ratio of between group variation to within group variation, when deciding if there is a statistically significant difference between the groups. ***Within group variation*** measures how much the individuals vary from their group mean. Each difference between an individual and their group mean is called a **residual**. These residuals are squared and added together to give the sum of the squared residuals or the within group sum of squares (SS_{within}). ***Between group variation*** measures how much the group means vary from the overall mean ($SS_{between}$).

Steps in SPSS

To carry out an ANOVA, select *Analyze → General Linear Model → Univariate*
Put the dependent variable (weight lost) in the *Dependent Variable* box and the independent variable (diet) in the *Fixed Factors* box. Then click on the **Save** and **Options** buttons for additional options.



The ANOVA output

F = Test statistic
$\frac{MS_{Diet}}{MS_{error}} = \frac{35.547}{5.736} = 6.197$

Tests of Between-Subjects Effects

Dependent Variable: Weight lost on diet (kg)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	71.094[a]	2	35.547	6.197	.003
Intercept	1137.494	1	1137.494	198.317	.000
Diet $SS_{Between}$	71.094	**2**	35.547	**6.197**	**.003**
Error SS_{within}	430.179	**75**	5.736		
Total	1654.350	78			
Corrected Total	501.273	77			

P = p-value = sig = P(F > 6.197)
p = 0.003

When writing up the results, it is common to report certain figures from the ANOVA table.

$F(df_{between}, df_{within})$= Test Statistic, p = → F(2, 75)= 6.197, p =0.003

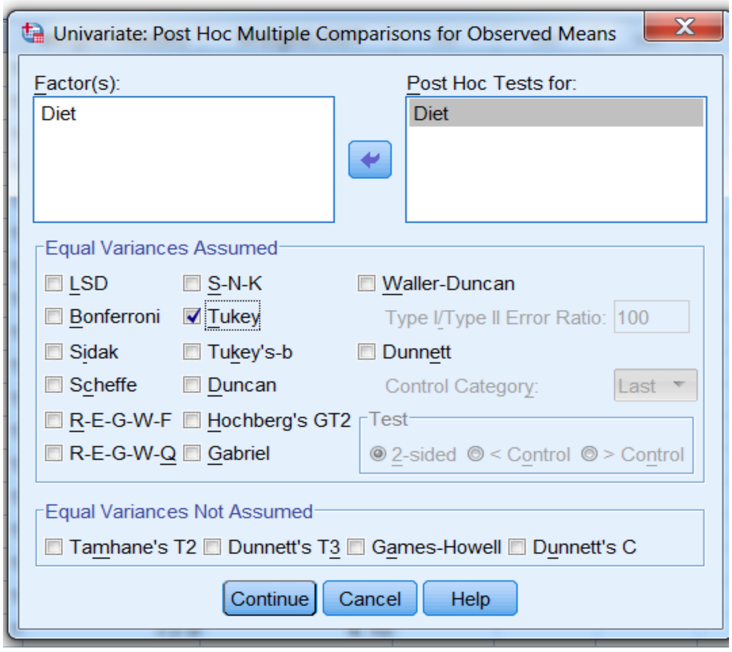
There was a significant difference in mean weight lost [F(2,75)=6.197, p = 0.003] between the diets.

Post Hoc Tests

ANOVA tests the null hypothesis 'all group means are the same' so the resulting p-value only concludes whether or not there is a difference between one or more pairs of groups. Further 'post hoc' tests have to be carried out to confirm where those differences are. The post hoc tests are mostly t-tests with an adjustment to account for the multiple testing.

Repeat the ANOVA making the following adjustments in the **post hoc** window

Move the independent variable (factor) from the *Factor* to the *Post hoc Tests for* box at the top, then choose from the available tests. *Tukey's* and *Scheffe's* tests are the most commonly used post hoc tests. *Hochberg's GT2* is better where the sample sizes for the groups are very different.



Multiple Comparisons

Dependent Variable: Weight lost on diet (kg)

	(I) Diet	(J) Diet	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	1	2	.2741	.67188	.912	-1.3325	1.8806
		3	-1.8481*	.67188	.020	-3.4547	-.2416
	2	1	-.2741	.67188	.912	-1.8806	1.3325
		3	-2.1222*	.65182	.005	-3.6808	-.5636
Diet 3 – Diet 1	3	1	1.8481*	.67188	.020	.2416	3.4547
		2	2.1222*	.65182	.005	.5636	3.6808

Report each of the three pairwise comparisons e.g. there was a significant difference between diet 3 and diet 1 (p = 0.02). Use the mean difference between each pair e.g. people on diet 3 lost on average 1.85 kg more than those on diet 1 or use individual group means to conclude which diet is best.

Checking the assumptions for one-way ANOVA

Assumptions	How to check	What to do if the assumption is not met
Residuals should be normally distributed	Use the **Save** menu within GLM to request the standardised residuals for each subject to be added to the dataset and then use *Analyze* → *Descriptive Statistics* → *Explore* to produce histograms/ QQ plot / Shapiro Wilk tests of residuals.	If the residuals are very skewed, the results of the ANOVA are less reliable. The Kruskall-Wallis test should be used instead of ANOVA. For more details on checking normality, see the **Checking normality in SPSS** resource. For help carrying out a Kruskall-Wallis test, refer to the **Kruskall-Wallis in SPSS** resource.
Homogeneity (equality) of variance: The variances (SD squared) should be similar for all the groups.	The Levene's test is carried out if the *Homogeneity of variance test* option is selected in the **Options** menu. If p > 0.05, equal variances can be assumed.	If p < 0.05, the results of the ANOVA are less reliable. The Welch test is more appropriate and can be accessed via the **Options** menu using *Analyze* → *Compare Means* → *One-way ANOVA*. The Games Howell post hoc test should also be used instead of Tukey's.

Checking the assumptions for this data

Check equality of variances

Levene's Test of Equality of Error Variancesa

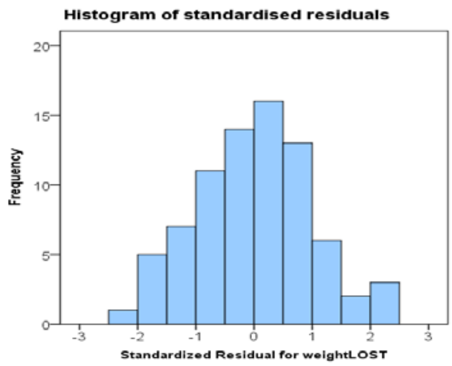
Dependent Variable: weightLOST

F	df1	df2	Sig.
.659	2	75	.520

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

As p > 0.05, equal variances can be assumed

Check normality



The residuals are normally distributed.

Reporting ANOVA

A one-way ANOVA was conducted to compare the effectiveness of three diets. Normality checks and Levene's test were carried out and the assumptions met.
There was a significant difference in mean weight lost [F(2,75)=6.197, p = 0.003] between the diets. Post hoc comparisons using the Tukey test were carried out. There was a significant difference between diets 1 and 3 (p = 0.02) with people on diet 3 lost on average 1.85 kg more than those on diet 3. There was also a significant difference between diets 2 and 3 difference (p = 0.005) with people on diet 3 lost on average 2.12 kg more than those on diet 2.