stcp-marshallowen-6b

The following resources are associated:

Data_for_tutor_training_SPSS_workbook.xls

Tutor_training_SPSS_workbook.pdf

SOLUTIONS to SPSS workbook for New Statistics Tutors

(Based on SPSS Versions 21 and 22)

This workbook is aimed as a learning aid for new statistics tutors in mathematics support centres

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Exercise 1: *Data types*

Identify the type of variables and key questions of interest for the **Titanic** dataset

Titanic - Details for passengers travelling on the Titanic when it sank:

Name	class	Survived 0 = died	Country of residence	Gender	Age	No. of siblings/ spouses on board	No. of parents/ children on board	price of ticket
Abbing, Anthony	3	0	USA	male	42	0	0	7.55
Abbott, Rosa	3	1	USA	female	35	1	1	20.25
Abelseth, Karen	3	1	UK	female	16	0	0	7.65
a) Type of variable	Ordinal	Binary (nominal)	Nominal	Binary (nominal)	Continuous (Scale)	Discrete	Discrete	Cont/ Scale

b) Key question(s)

Were wealthy people more likely to survive? Which variables would you use to investigate this question?

Survival is the outcome. Wealthy could be measured using either class or price of ticket.

Quick question: What percentage of people survived the sinking of the Titanic? 38.2%

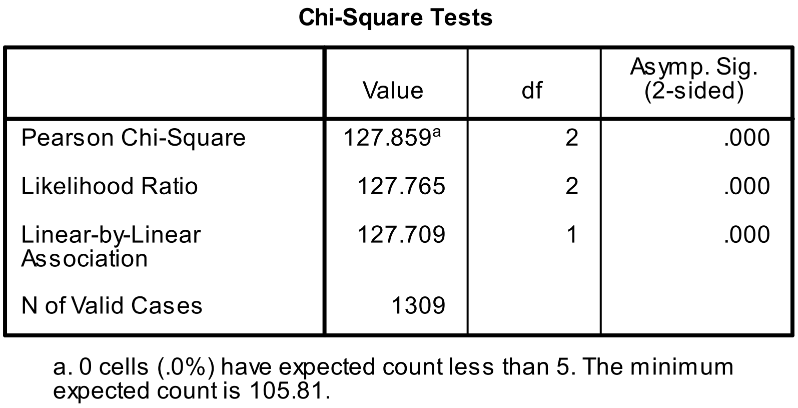
Quick question: What percentage of people survived the sinking of the Titanic in each class?

1st = 62%, 2nd = 43%, 3rd = 26%

Exercise 2: Chi-squared

Investigate whether class and survival were related

a) Interpret the results of the Chi-squared test. If there is evidence of a relationship, what is the relationship?



Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	127.859[a]	2	.000
Likelihood Ratio	127.765	2	.000
Linear-by-Linear Association	127.709	1	.000
N of Valid Cases	1309		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 105.81.

As $p < 0.001$ for the Pearson's Chi-squared, there is evidence to suggest that there is a relationship between class and survival.

If you find significant evidence of a relationship, produce some %'s and/ or a chart to show the relationship.

The percentage of those surviving decreases with 2nd and 3rd class. 62% of those in 1st class survived compared to only 38% of those in 3rd class.

Data collected on 1309 passengers aboard the Titanic was used to investigate whether class had an effect on chances of survival. A chi-squared test gave a p-value of $p < 0.001$ so there is strong evidence to suggest a relationship between class and survival. *Figure 1* shows that as class decreases, the percentage of those surviving also decreases from 62% in 1st Class to 26% in 3rd Class.

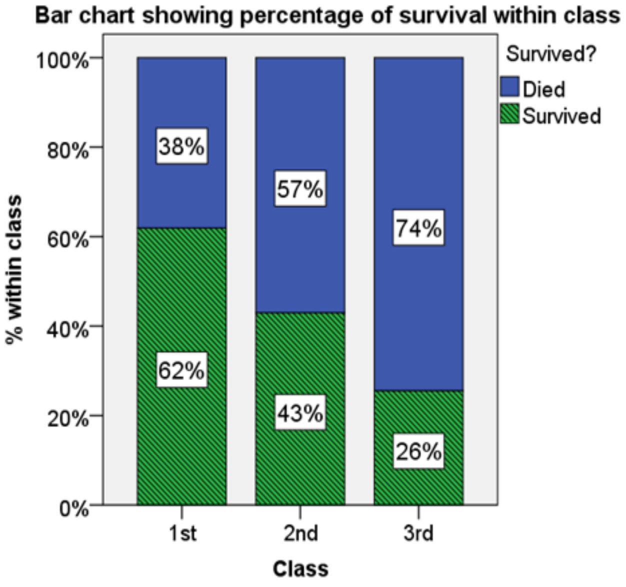


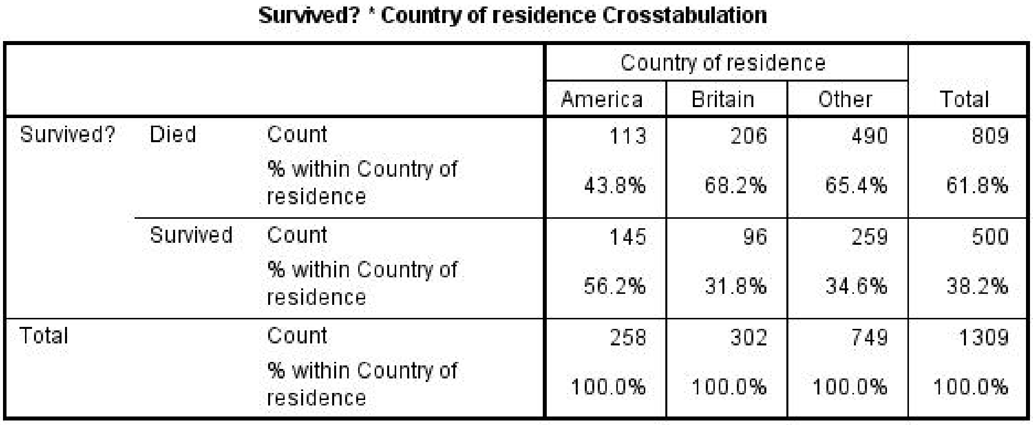
Figure 1: Bar chart showing % survival within classes

b) What would you do if you had a 2x2 contingency table?

Note: If each variable only has two categories, the contingency table is a 2 x 2 table. In this situation, use the line with 'Continuity Correction' in the main SPSS output or the Fishers Exact test to get the p-value for the test. They both automatically appear in the output for a 2x2 table.

Exercise 3: Nationality and survival

Investigate whether nationality and survival were related

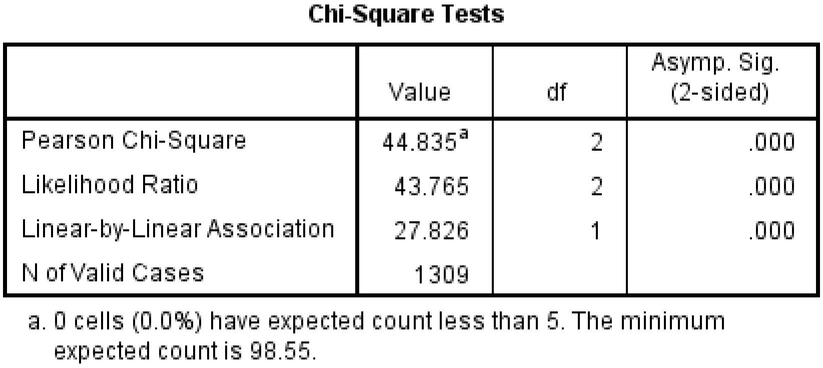


Survived? * Country of residence Crosstabulation

			Country of residence			Total
			America	Britain	Other	
Survived?	Died	Count	113	206	490	809
		% within Country of residence	43.8%	68.2%	65.4%	61.8%
	Survived	Count	145	96	259	500
		% within Country of residence	56.2%	31.8%	34.6%	38.2%
Total		Count	258	302	749	1309
		% within Country of residence	100.0%	100.0%	100.0%	100.0%

Test Statistic = 44.835, p-value < 0.001, reject null. i.e. there is significant evidence to suggest that there was a relationship between nationality and survival.

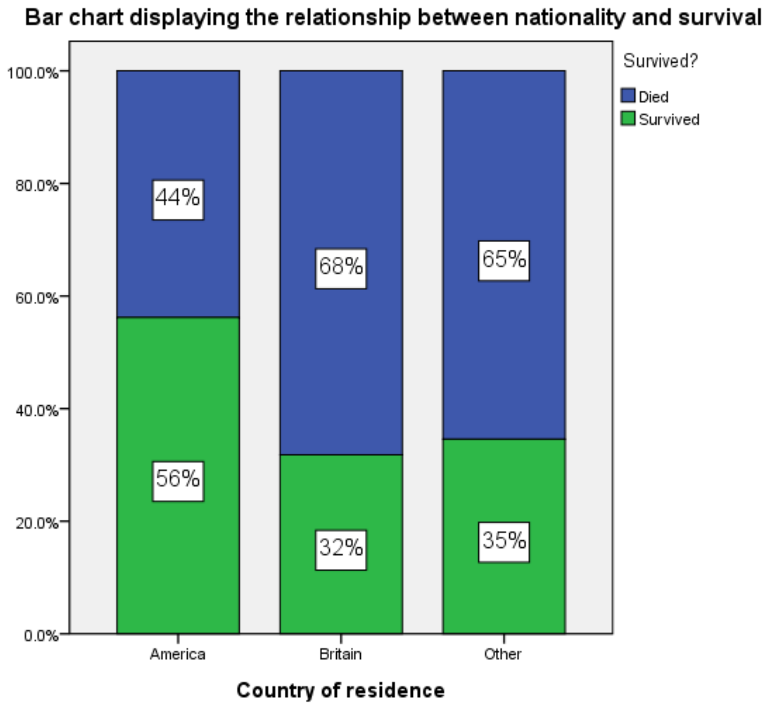
56% of Americans survived compared to 32% of British passengers and 32% of other nationalities.



Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	44.835[a]	2	.000
Likelihood Ratio	43.765	2	.000
Linear-by-Linear Association	27.826	1	.000
N of Valid Cases	1309		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 98.55.

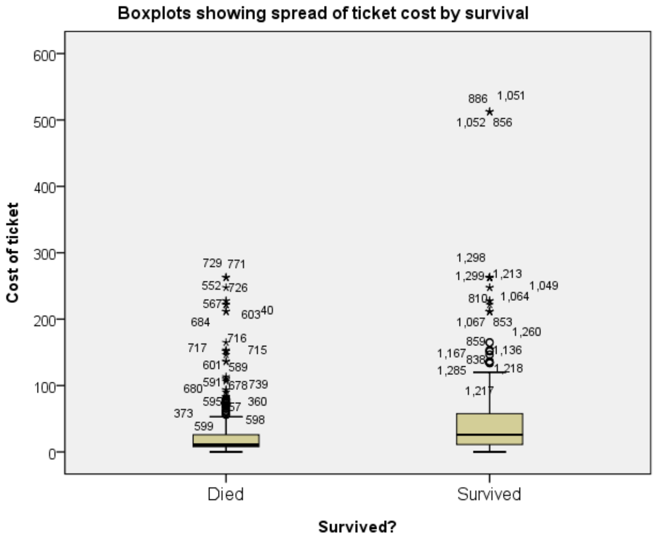


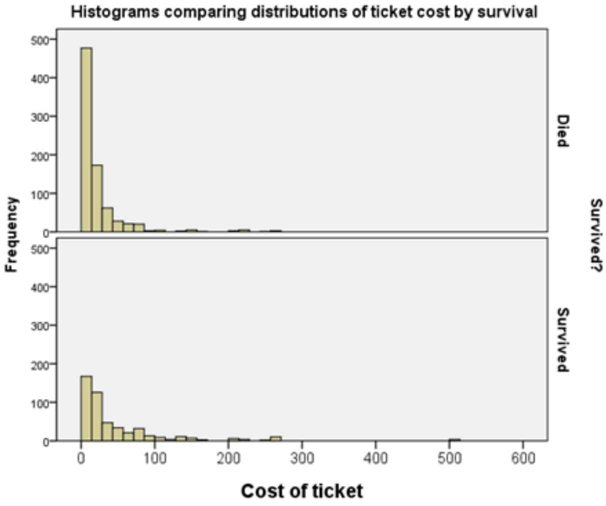
Bar chart displaying the relationship between nationality and survival

Exercise 4: Comparison of continuous data by group

Did the cost of a ticket affect chances of survival?

Cost of ticket	Survived?	
	Died	Survived
Mean	23.35	49.36
Median	10.50	26.00
Standard Deviation	34.15	68.65
Interquartile range	18.15	46.56
Minimum	0.00	0.00
Maximum	263.00	512.33


Boxplots showing spread of ticket cost by survival


Histograms comparing distributions of ticket cost by survival

a) Is there a big difference in average ticket price by group?
Yes. The mean and median ticket prices are much higher in the group who survived

b) Which group has data which is more spread out?
The standard deviation is double in the group who survived so there is much more variation in that group

c) Is the data skewed? Yes – it's very positively skewed. There a lot of people with cheap tickets and not so many with expensive tickets. This can be seen clearly from the graphs but also by comparing the mean and the median. If there is a big difference, the data is skewed

d) Is the mean or median a better summary measure? The median as the data is very skewed.

If you are going to transform data, change the y axis in the graph to a log scale via the graph properties to see if taking the log of the variable will help.

Exercise 5: Weight before the diet by gender

a) **Fill in the following table using the summary statistics table in the output.**

	Female = 0	Male = 1
Minimum	-70	71
Maximum	82	88
Mean	64	79
Median	66	79
Standard Deviation	21.6	5

b) **Interpret the summary statistics by gender. Which group has the higher mean and which group is more spread out?**

Standard deviation: The standard deviation for men of 5, is much smaller than the standard deviation for women of 21.6 so the weights for women are more spread out.

Averages: Females had a mean weight of 64kg and median of 66kg before the diet. There's quite a difference between the two measures suggesting that the data may be skewed. Males had a mean and median pre-weight of 79kg suggesting that the data is normally distributed.

Minimum/ maximum: Are there any extreme outliers? Someone weighed -70kg before the diet which is clearly an error. Outliers cannot always be removed/ changed but here the real weight might be 70kg so make that adjustment and re-run the analysis. What effect has this had on the summary statistics?

c) **How could the chart be improved and is there anything odd?**

Better labelling of variables. Someone weighed -70kg which is clearly wrong

Before the next section, change the error of -70 to 70. Outliers should not normally be changed unless they are clearly data entry errors as in this case. Give the variables sensible labels and label gender with 0 = Female and 1 = Male. **Re-run explore to see how the change has affected the summary statistics. Which summary statistics have changed the most?**

	Female with outlier	Female after changing outlier
Minimum	-70	58
Maximum	82	82
Mean	64	67
Median	66	67
Standard Deviation	21.6	5.6

The mean, standard deviation, minimum and maximum are more influenced by outliers than the median and interquartile range.

Which diet seems the best and which diet has the most variation in weight loss? Diet 3 is the best for losing weight. Diet 2 has the most variation but the standard deviations are all similar.

Exercise 6: Confidence intervals

Use Explore to get the confidence intervals of weight lost by diet.

Diet	Mean	95% Confidence interval
1	3.3	(2.35, 4.25)
2	3.03	(2.03, 4.02)
3	5.15	(4.2, 6.1)

What is the correct definition of a confidence interval?

- A range of values (a, b) which will include the true population mean 95% of the time.
- A 95% CI means that if you could sample an infinite number of times:
    - 95% of the time the CI would contain the true population parameter.
    - 5% of the time the CI would fail to contain the true population parameter.

How would you explain a confidence interval to a student?

We use the sample mean to represent the population mean but a group of different people would have a different mean. To allow for this variation in means, a confidence interval is used when estimating a population mean from a sample. It gives a range of possible values (a, b) within which the true population mean is likely to lie. A 95% confidence interval means that we would expect 95% of confidence intervals to contain the real population mean weight lost on that diet.

The population mean weight lost on diet 1 is likely to be between 2.35 and 4.25 kg.

The confidence Interval plot shows more clearly that on average, those on diet 3 lost more weight than those on diets 1 and 2. ANOVA is the appropriate test to look for significant differences in the mean weight lost by diet but confidence intervals and hypothesis testing are strongly related. If confidence intervals don't overlap, it's likely that there will be a significance difference between groups. This chart suggests that there will be no difference between diets 1 and 2 as the confidence intervals overlap a lot but the upper limit of diet 2 is close to the lower limit of diet 3 suggesting that there may be evidence of a difference.

Exercise 7:ANOVA

a) Explain briefly why ANOVA is called Analysis of variance instead of Analysis of means.

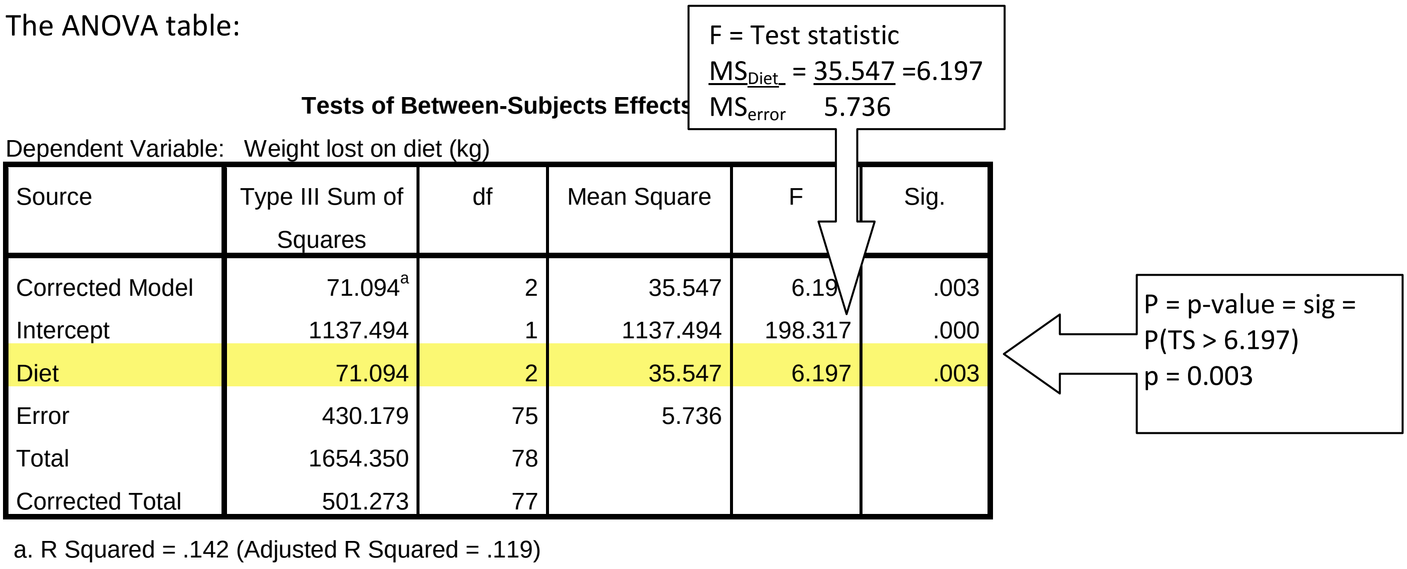
It is called an 'Analysis of variance' test as it uses the ratio of between group variation to within group variation when deciding if there is a difference between the groups. The reason we do this is this compares two different estimates of the population variance, which if the null hypothesis is true should be the same (or similar!)

b) What are the assumptions for ANOVA and how can they be tested?

Assumption	**How to check**
Normality: The residuals (difference between observed and expected values) should be normally distributed	Histograms/ QQ plots/ normality tests of residuals
Homogeneity of variance (each group should have a similar standard deviation)	Levene's test

Exercise 8: ANOVA output

The ANOVA table:



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	6.19	.003
Intercept	1137.494	1	1137.494	198.317	.000
Diet	71.094	2	35.547	6.197	.003
Error	430.179	75	5.736		
Total	1654.350	78			
Corrected Total	501.273	77			

a. R Squared = .142 (Adjusted R Squared = .119)

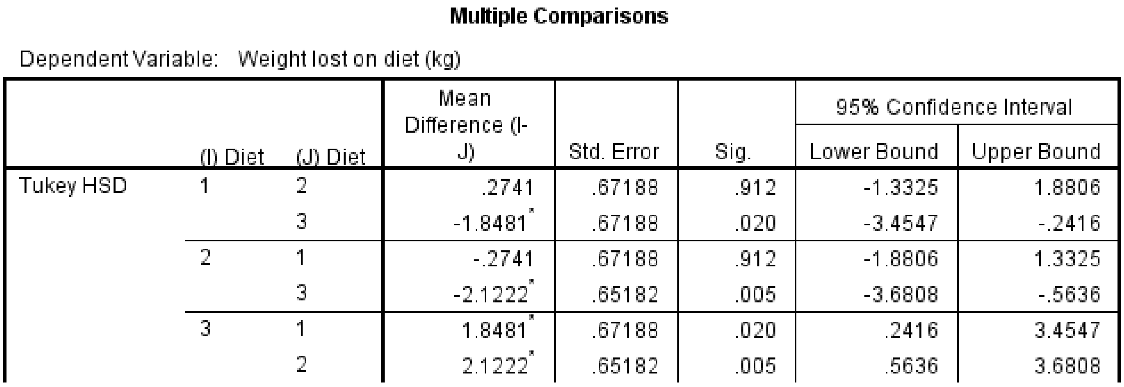
F = Test statistic

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

P = p-value = sig = P(TS > 6.197)

p = 0.003

ANOVA uses the F-test to test the null hypothesis that all the group means are the same. If the p-value is less than 0.05, reject the null hypothesis and conclude that there is a significant difference between at least one pair of means. When reporting the p-value, never report p = 0. Here, the p-value would be reported as p = 0.003, so there is highly significant evidence to suggest a difference between at least one pair of means. To find out where the differences lie, post hoc tests are needed. Here, just the Tukey tests are reported.



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	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
	3	1	1.8481*	.67188	.020	.2416	3.4547
		2	2.1222*	.65182	.005	.5636	3.6808

Summary of pairwise comparisons:

Test	p-value
Diet 1 vs Diet 2	P = 0.912
Diet 1 vs Diet 3	P = 0.02
Diet 2 vs Diet 3	P = 0.005

There is no significant difference between Diets 1 and 2 but there is between diet 3 and both the others. Looking back at the descriptive statistics, the mean weight lost on Diets 1 (3.3kg) and 2 (3kg) is less than the mean weight lost on diet 3 (5.15kg). Therefore, for those looking to lose weight, Diet 3 would be recommended.

Explaining a p-value

If you repeated a study numerous times you would get a variety of test statistics which form a distribution. p-value = probability of getting a test statistic as extreme as the one calculated, **if the null is true.** The smaller the p-value, the smaller the chance of rejecting the null hypothesis when it is actually true.

p-value example

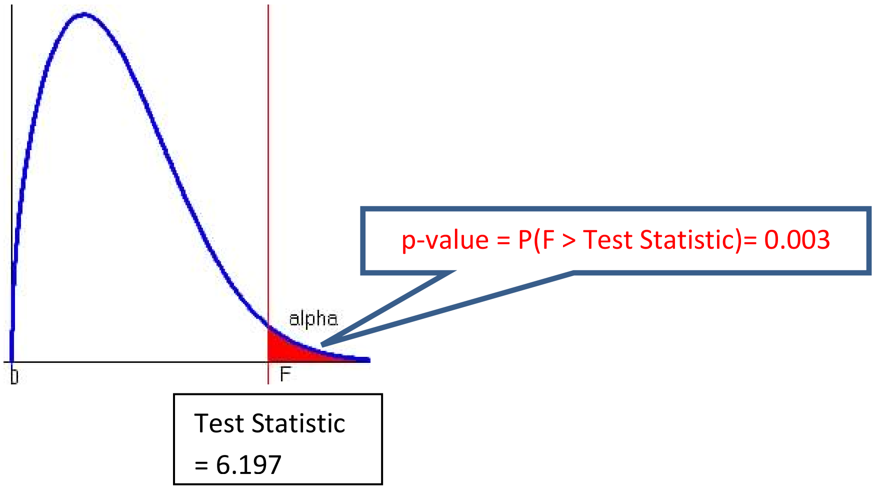
Null hypothesis: The mean weight lost on each diet is the same

Alternative: The mean weight lost on each diet is NOT the same

Test Statistic = F = $\frac{\text{Mean between group sum of squared differences}}{\text{Mean within group sum of squared differences}}$

P – value = probability of getting a test statistic as large as ours (or larger) IF the null is true (i.e. no difference between means). The p-value is calculated using the F-distribution for ANOVA which is a skewed distribution.

Distribution of test statistics if the null is true

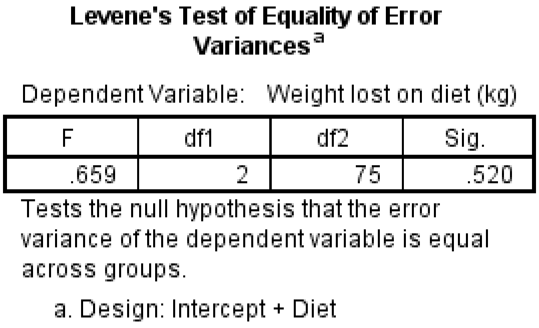


p-value = P(F > Test Statistic)= 0.003

Test Statistic = 6.197

The p-value is the probability of getting a test statistic of at least 6.197 if there really was no difference between the groups. There is a 0.3% chance of rejecting the null when it is actually true so we can be very confident with our decision to reject the null and conclude that there is a difference between the means.

Exercise 9: Testing the assumptions of homogeneity and normality:



Levene's Test of Equality of Error Variances[a]

Dependent Variable: Weight lost on diet (kg)

F	df1	df2	Sig.
.659	2	75	.520

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

a. Design: Intercept + Diet

Can equal variances be assumed?

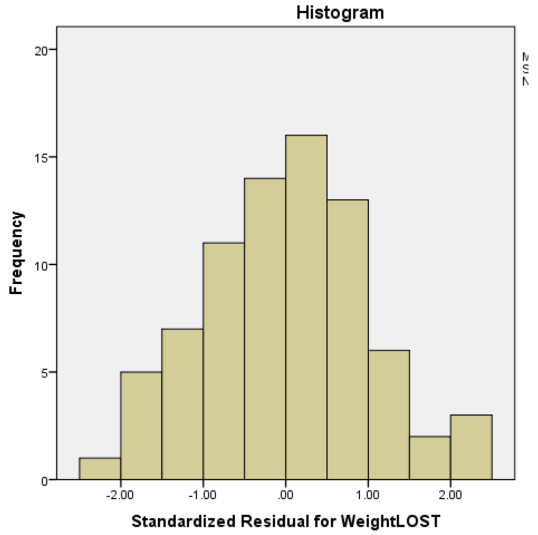
Null: The variances are the same. $H_0 : \sigma_1^2 = \sigma_2^2 = \sigma_3^2$

Test Statistic: 0.659

p-value = 0.52

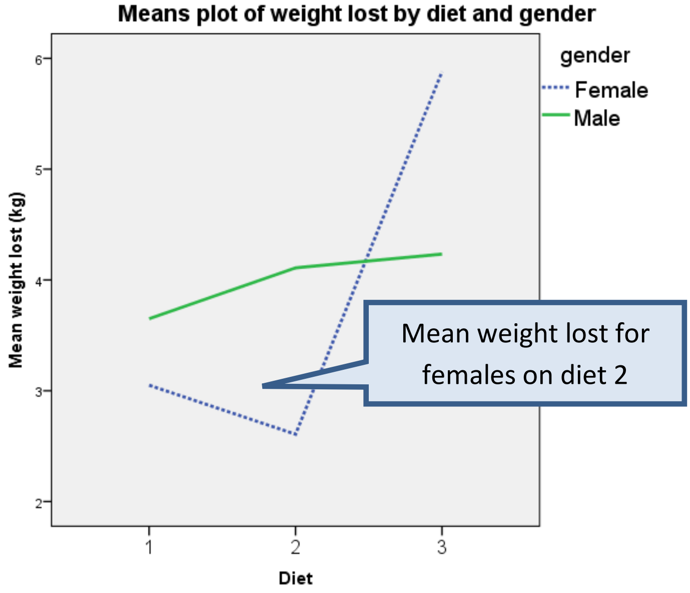
Here p = 0.52, which is above 0.05, so the assumption is met and the normal output is used.

Are the residuals normally distributed?



SPSS produces two normality tests but it's clear from the histogram that the residuals are normally distributed.

Quick question: Is there an interaction between gender and diet when it comes to weight lost?



Mean weight lost for females on diet 2

The chart shows how the diets affected weight lost by gender. For males there is not much difference between the diets but for women diet 3 led to a higher weight loss.

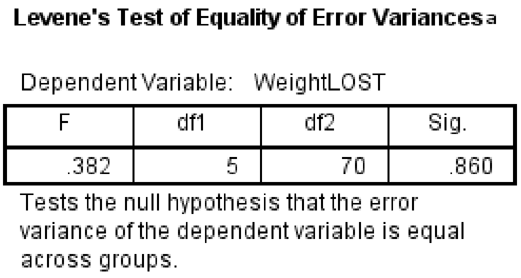
An interaction effect is when the effect of one variable on the dependent variable is altered when another variable is taken into consideration. This is important to know when doing statistical analysis. Here there is an interaction between gender and diet.

Exercise 10: Two way ANOVA

Tests 3 hypotheses:

1. Mean weight loss does not differ by diet
2. Mean weight loss does not differ by gender
3. There is no interaction between diet and gender

Results of two-way ANOVA:



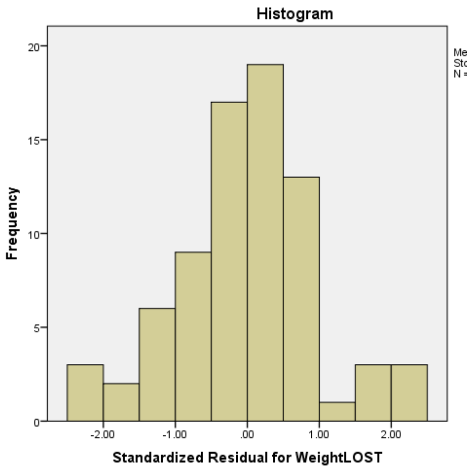
Levene's Test of Equality of Error Variances[a]

Dependent Variable: WeightLOST

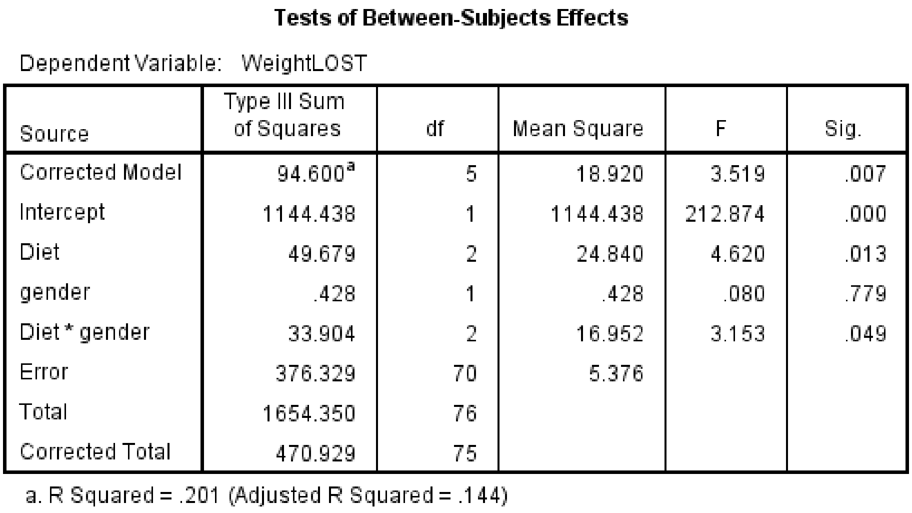
F	df1	df2	Sig.
.382	5	70	.860

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 so the first assumption has been met



The residuals look a little skewed but you can easily get histograms like this when sampling which is normally distributed. Plus the data peak approximately in the middle so normality can be assumed.



Tests of Between-Subjects Effects

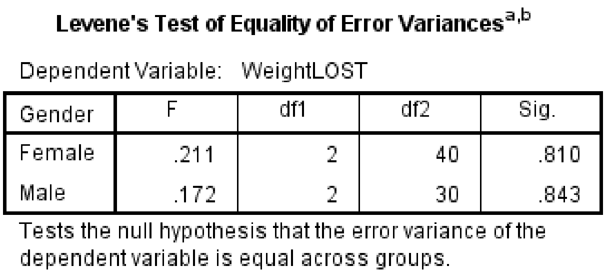
Dependent Variable: WeightLOST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	94.600[a]	5	18.920	3.519	.007
Intercept	1144.438	1	1144.438	212.874	.000
Diet	49.679	2	24.840	4.620	.013
gender	.428	1	.428	.080	.779
Diet * gender	33.904	2	16.952	3.153	.049
Error	376.329	70	5.376		
Total	1654.350	76			
Corrected Total	470.929	75			

a. R Squared = .201 (Adjusted R Squared = .144)

The interaction between diet and gender is significant ($p = 0.049$) so it is hard to interpret the main effects of diet and gender. Run separate ANOVA's by gender.

Results by gender:



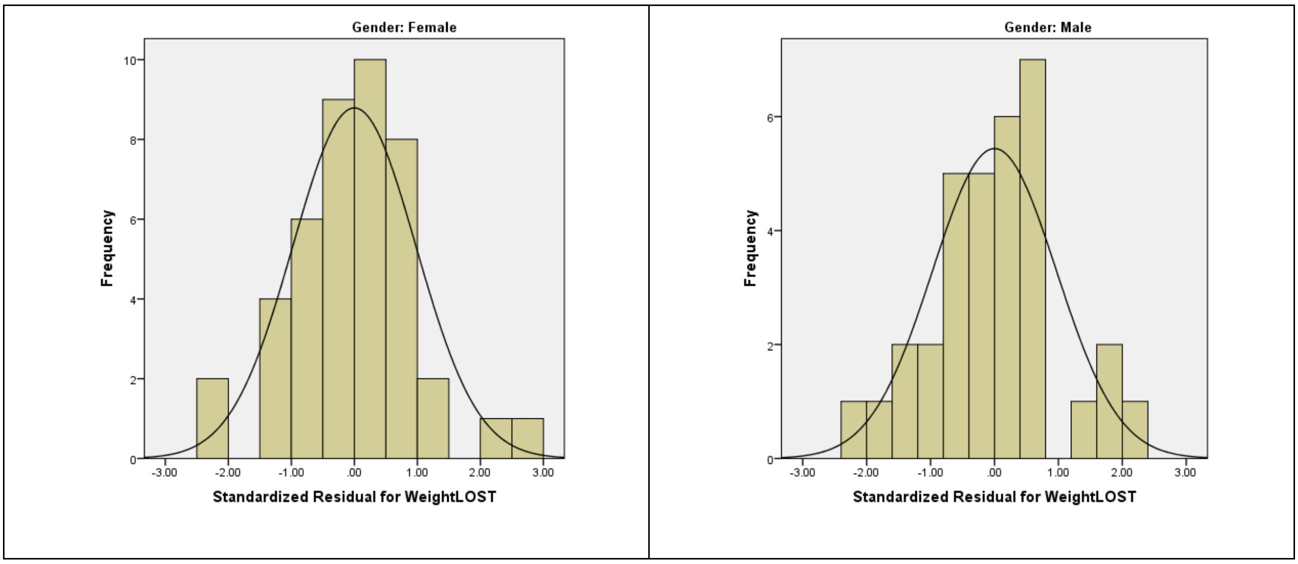
Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: WeightLOST

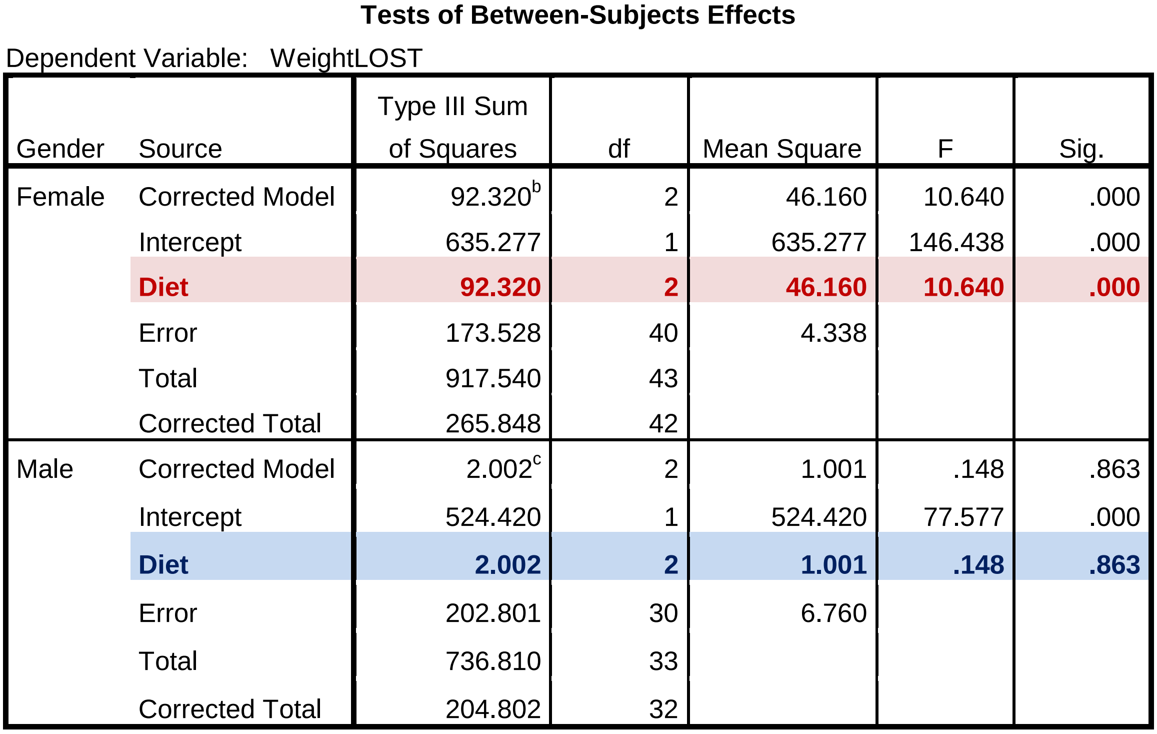
Gender	F	df1	df2	Sig.
Female	.211	2	40	.810
Male	.172	2	30	.843

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

Equal variances can be assumed for males and females.



Both histograms look approximately normally distributed.



Tests of Between-Subjects Effects

Dependent Variable: WeightLOST

Gender	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Female	Corrected Model	92.320[b]	2	46.160	10.640	.000
	Intercept	635.277	1	635.277	146.438	.000
	Diet	**92.320**	**2**	**46.160**	**10.640**	**.000**
	Error	173.528	40	4.338		
	Total	917.540	43			
	Corrected Total	265.848	42			
Male	Corrected Model	2.002[c]	2	1.001	.148	.863
	Intercept	524.420	1	524.420	77.577	.000
	Diet	**2.002**	**2**	**1.001**	**.148**	**.863**
	Error	202.801	30	6.760		
	Total	736.810	33			
	Corrected Total	204.802	32			

There is a difference between the mean weight lost on the 3 diets for females ($p < 0.001$) but not for males ($p = 0.863$). Only the post hoc tests for females should be interpreted.

Multiple Comparisons

Dependent Variable: WeightLOST

Tukey HSD

Gender	(I) Diet	(J) Diet	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Female	1	2	.4429	.78724	.841	-1.4732	2.3589
		3	-2.8300*	.77401	.002	-4.7139	-.9461
	2	1	-.4429	.78724	.841	-2.3589	1.4732
		3	-3.2729*	.77401	.000	-5.1567	-1.3890
	3	1	2.8300*	.77401	.002	.9461	4.7139
		2	3.2729*	.77401	.000	1.3890	5.1567
Male	1	2	-.4591	1.13602	.914	-3.2597	2.3415
		3	-.5833	1.11326	.860	-3.3278	2.1611
	2	1	.4591	1.13602	.914	-2.3415	3.2597
		3	-.1242	1.08530	.993	-2.7998	2.5513
	3	1	.5833	1.11326	.860	-2.1611	3.3278
		2	.1242	1.08530	.993	-2.5513	2.7998

Based on observed means.

The error term is Mean Square(Error) = 6.760.

*. The mean difference is significant at the .05 level.

For females, diet 3 is significantly different to diet 1 (p = 0.002) and diet 2 (p < 0.001) but there is no evidence to suggest that diets 1 and 2 differ (p = 0.841).

Use summary statistics to report the differences:

		Diet 1	Diet 2	Diet 3
Female	Mean	3.05	2.61	5.88
	Standard Deviation	2.07	2.29	1.89
	Count	14	14	15
Male	Mean	3.65	4.11	4.23
	Standard Deviation	2.54	2.53	2.72
	Count	10	11	12

For females, the mean diet lost on diet 3 was 5.88kg compared to only 3.05kg and 2.61kg on diets 1 and 2 respectively.

Exercise 11: Non-parametric tests

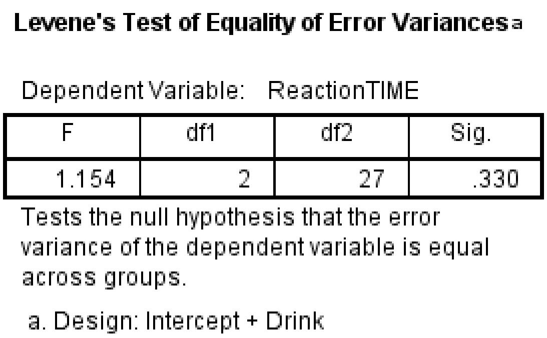
Parametric tests assume you can describe the distribution of the data using a particular distribution e.g normal. They are more likely to lead to a significant result than non-parametric tests, when the assumptions about the distribution of the data are true. Examples of non-parametric tests include t-tests, analysis of variance and linear regression.

Non-parametric tests are alternative data analysis techniques not assuming anything about the shape of the data. They are usually based on ranks or signs and can be used for ordinal, ranked or skewed scale data. Data is ordered and ranked and analysis is carried out on the ranks rather than the actual data.

Parametric test	What to check for normality	Non-parametric test
Independent t-test	Dependent variable by group	Mann-Whitney test
Paired t-test	Paired differences	Wilcoxon signed rank test
One-way ANOVA	Residuals/Dependent	Kruskal-Wallis test
Repeated measures ANOVA	Residuals	Friedman test
Pearson's Correlation Co-efficient	At least one of the variables should be normal	Spearman's Correlation Co-efficient
Linear Regression	Residuals	None - transform the data

Exercise 12: Kruskal-Wallis

Enter the data into a new SPSS sheet in a suitable way to be analysed using ANOVA/ Kruskall-Wallis. Carry out a one-way ANOVA and check the assumptions. Have the assumptions been met?



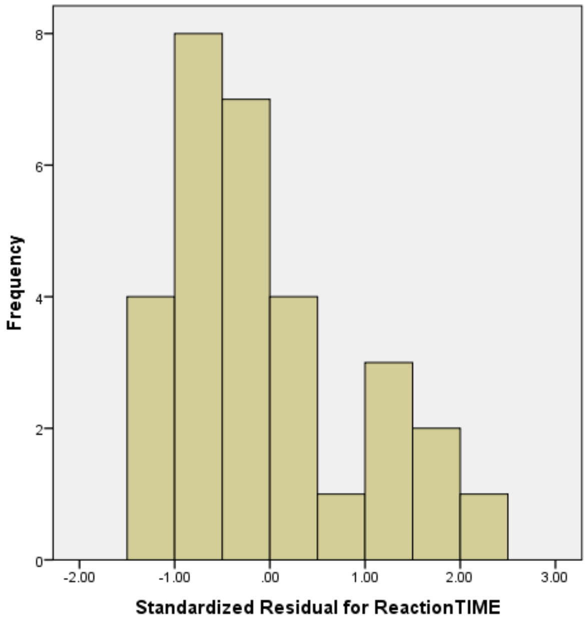
Levene's Test of Equality of Error Variancesa

Dependent Variable: ReactionTIME

F	df1	df2	Sig.
1.154	2	27	.330

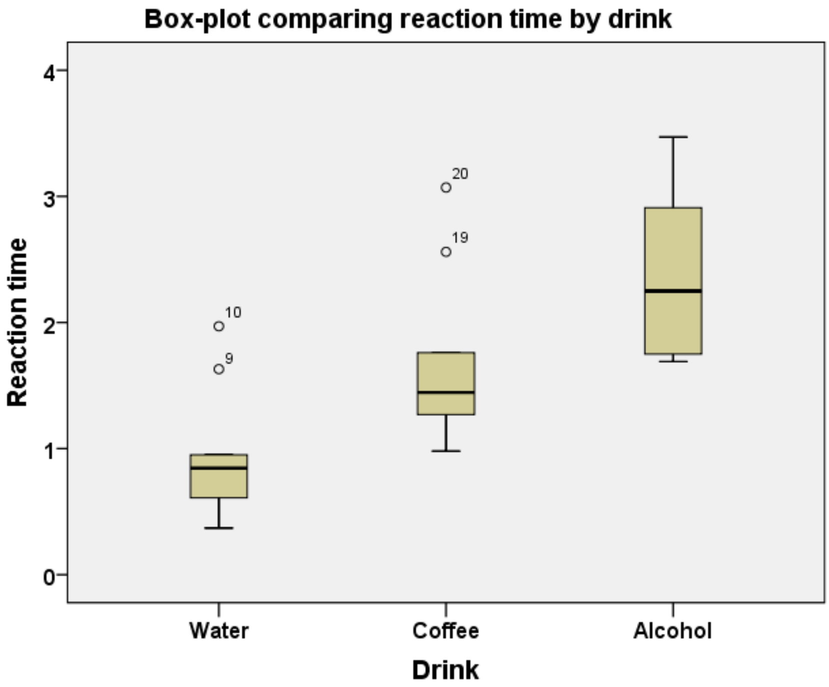
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Drink



Assumption of equal variances has been met but the residuals are not normally distributed so a Kruskal-Wallis test should be carried out.

Produce suitable summary statistics and follow the instructions below to perform the Kruskall-Wallis test.



A box-plot and the median with interquartile range are used when carrying out a non-parametric test.

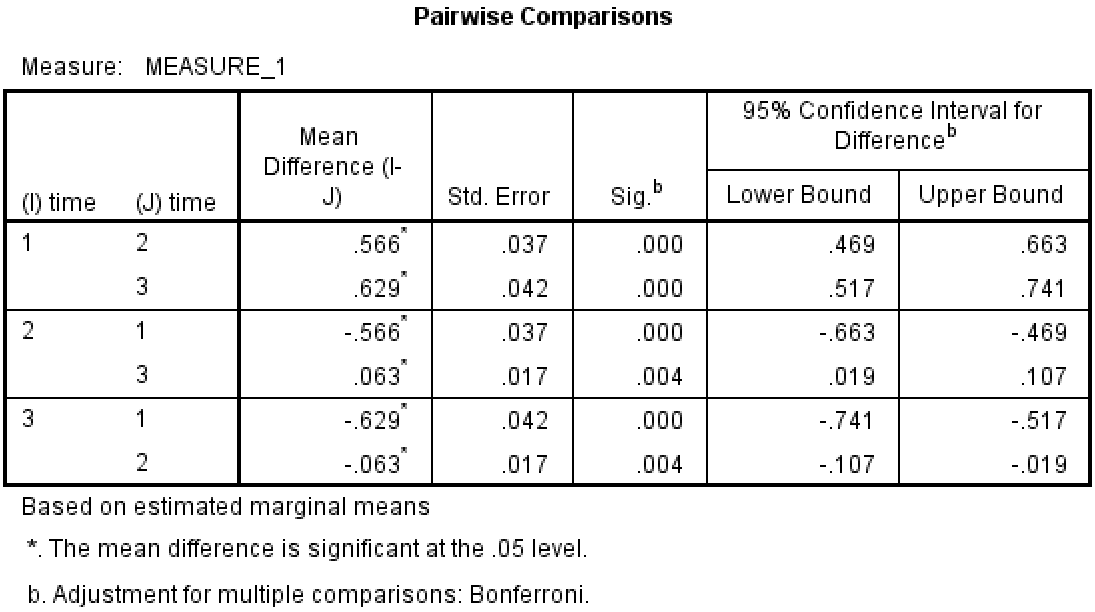
		Drink		
		Water	Coffee	Alcohol
Reaction time	Median	.85	1.44	2.25
	Percentile 25	.61	1.27	1.75
	Percentile 75	.95	1.76	2.91

It’s clear from the plot that those consuming alcohol have the slowest reaction times and the most spread out scores.

Exercise 13: Repeated measures example

Interpret the post hoc tests and check the assumption of normality.

There is a significant difference between each combination of time point. Cholesterol reduces by 0.566 after 4 weeks (p < 0.001) and then decreases by an additional 0.063 between 4 and 8 weeks (p = 0.004).



Pairwise Comparisons

Measure: MEASURE_1

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.566*	.037	.000	.469	.663
	3	.629*	.042	.000	.517	.741
2	1	-.566*	.037	.000	-.663	-.469
	3	.063*	.017	.004	.019	.107
3	1	-.629*	.042	.000	-.741	-.517
	2	-.063*	.017	.004	-.107	-.019

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Does the change in mean cholesterol look meaningful? To assess this, look at the starting mean. Cholesterol drops by approximately 9% after 4 weeks which is meaningful but only drops by approximately 1% between 4 and 8 weeks. This seems less meaningful. The reason such a small change is significant is the small standard error for the differences.

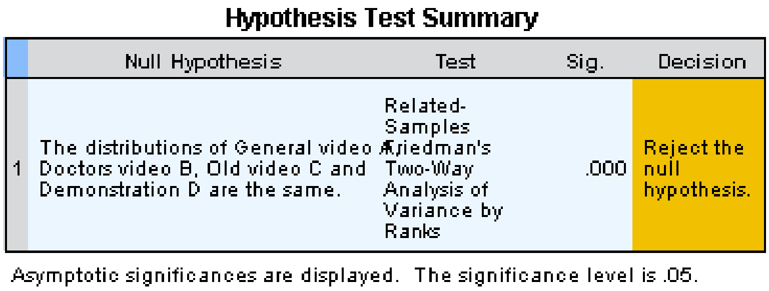
	Mean	Standard Deviation
Before	6.41	1.19
After 4 weeks	5.84	1.12
After 8 weeks	5.78	1.10

What test would you use instead if the assumption of normality has not been met?

Friedman

Exercise 14: Friedman example

Carry out the Friedman test and interpret the output including the post hoc tests

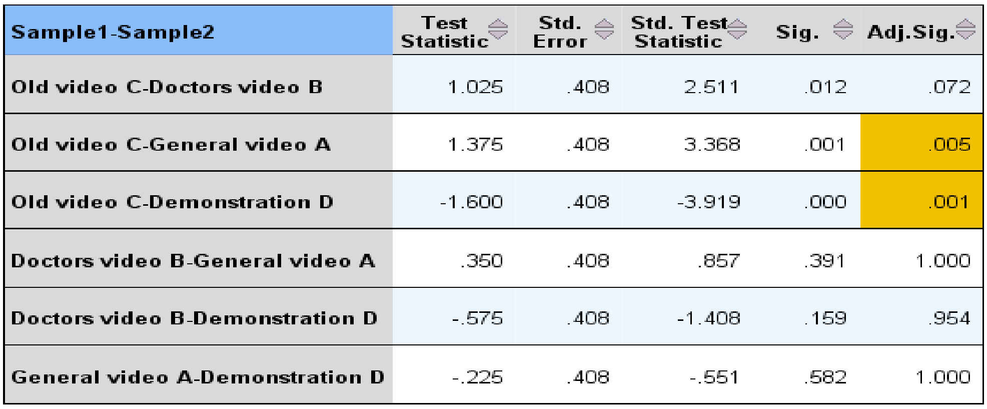


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distributions of General video A, Doctors video B, Old video C and Demonstration D are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	.000	Reject the null hypothesis.

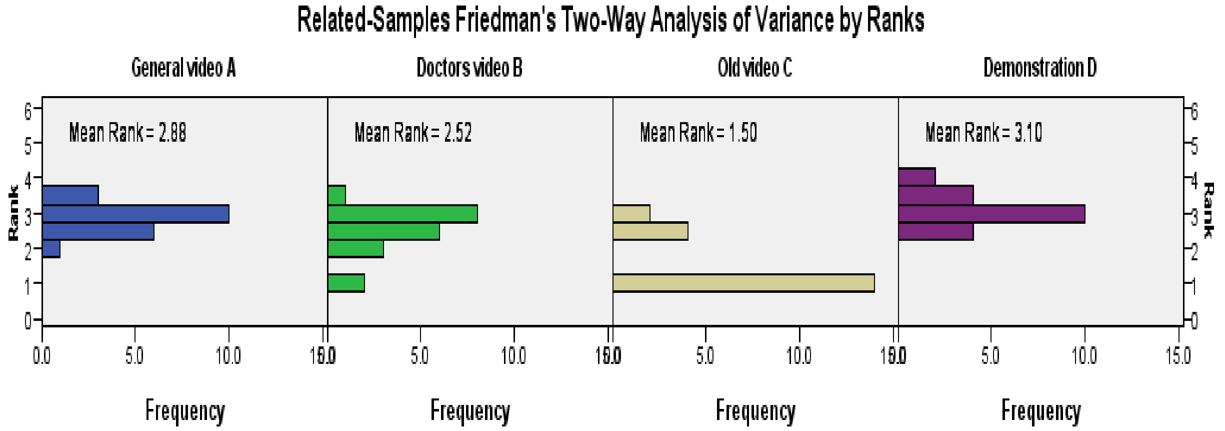
Asymptotic significances are displayed. The significance level is .05.

The Friedman test was significant (p < 0.001) so the distributions of the scores for the videos being compared are different. Bonferroni post hoc tests were carried out and there were significant differences between the Old video C and the General video A (p = 0.005), and also between the old video C and the demonstration D (p = 0.001). The difference between the Old video C and Doctors video B (which was a more technical video aimed at doctors) was borderline not significant (p=0.072).



Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Old video C-Doctors video B	1.025	.408	2.511	.012	.072
Old video C-General video A	1.375	.408	3.368	.001	.005
Old video C-Demonstration D	-1.600	.408	-3.919	.000	.001
Doctors video B-General video A	.350	.408	.857	.391	1.000
Doctors video B-Demonstration D	-.575	.408	-1.408	.159	.954
General video A-Demonstration D	-.225	.408	-.551	.582	1.000

The bar charts below show the distribution of scores for each product. The mean rank for the Demonstration video D was highest for understanding of the condition, followed by the General video A and then the Doctors video B.



Related-Samples Friedman's Two-Way Analysis of Variance by Ranks

Exercise 15: Regression assumptions

What are the assumptions for multiple regression?

Assumption	Plot to check
The relationship between the independent and dependent variables is linear.	Original scatter plot of the independent and dependent variables
Homoscedasticity: The variance of the residuals about predicted responses should be the same for all predicted responses.	Scatterplot of standardised predicted values and residuals
The residuals are normally distributed	Plot the residuals in a histogram
The residuals are independent. Are adjacent observations related? Example: Weather by day	If you suspect that the data may be autocorrelated you can use the Durbin Watson statistic. Note: Time series is beyond the scope of most students

Exercise 16: Scatterplots

Describe the relationship between gestational age, smoking and birth weight. Does it look like there is an interaction between smoking and gestational age?

There is a strong positive relationship between gestational age and birth weight. It looks like smokers may have lighter babies which is consistent as gestational age increases. There doesn't appear to be an interaction between smoking and gestational age

Exercise 17: Correlations

Interpret the correlations between birth weight, gestational age, height and weight of mother.

Strong relationship: Birthweight and gestational age, Height and weight of mother

Moderate relationship: Birth weight with height and weight of mother

Weak relationship: Gestational age with height and weight of mother

Quick question: What is being tested in regression?

The slope. $H_0 : \beta = 0$

Exercise 18:Regression

Interpret the output from the regression including answering the following questions:

a) Which independent variables are significant and what is their relationship with the dependent variable?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-7.165	2.107		-3.400	.002
	Gestational age at birth (weeks)	.313	.053	.623	5.926	.000
	Smoker	-.665	.268	-.253	-2.485	.017
	Mothers pre-pregnancy weight (lbs)	.020	.009	.237	2.261	.030

a. Dependent Variable: Weight of baby at birth (lbs)

Gestational age ($p < 0.001$), being a smoker ($p = 0.017$) and weight of the mother ($p = 0.03$) are all significant predictors of birth weight. Birthweight increases with gestational age and weight of the mother but decreases for smokers whose babies are 0.67 lbs lighter on average.

b) What is the equation of the model?

$$y = \text{birth weight}, \quad x_1 = \text{gestational age}, \quad x_2 = \text{smoker yes} = 1, \; x_3 = \text{weight of mother (lbs)}$$

$$y = \text{-}7.17 + 0.31x_1 - 0.67x_2 + 0.02x_3$$

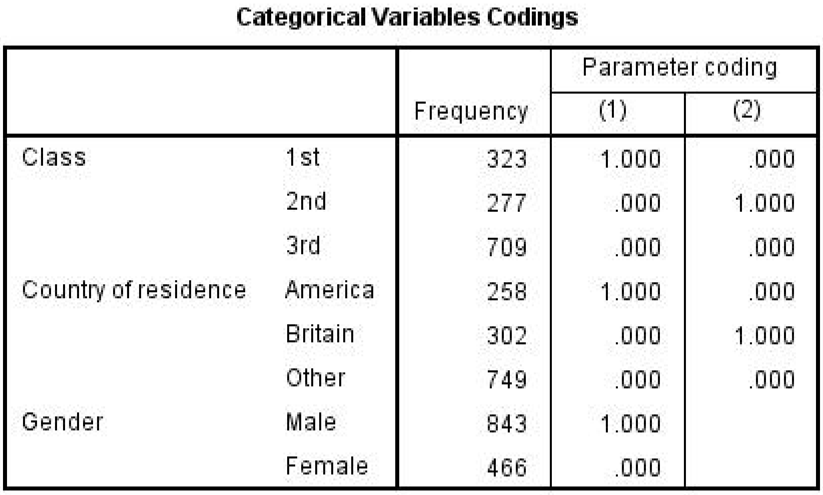
c) How reliable is the model?

R^2=0.61 so the model explains 61% of the variation in birthweight which is fairly reliable but there is still 39% of the variation unaccounted for.

Exercise 19: Logistic regression

Look at the relationship between nationality and survival but control for gender and class.

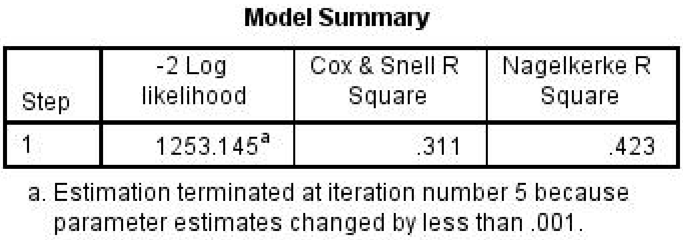
Which variables are significant? Interpret the odds ratio for those variables.



Categorical Variables Codings

		Frequency	Parameter coding	
			(1)	(2)
Class	1st	323	1.000	.000
	2nd	277	.000	1.000
	3rd	709	.000	.000
Country of residence	America	258	1.000	.000
	Britain	302	.000	1.000
	Other	749	.000	.000
Gender	Male	843	1.000	
	Female	466	.000	

Reference categories are 3rd class, 'Other' nationality and female.

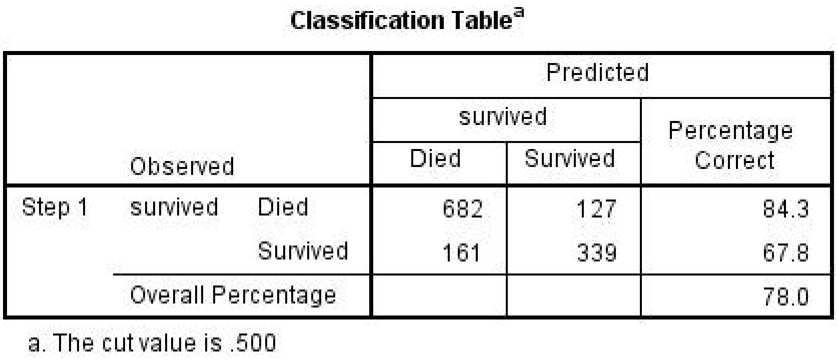


Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1253.145[a]	.311	.423

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

From the table above, we can conclude that based in Nagelkerke's R^2, 42.3% of the variation in survival can be explained by the model including nationality, gender and class.

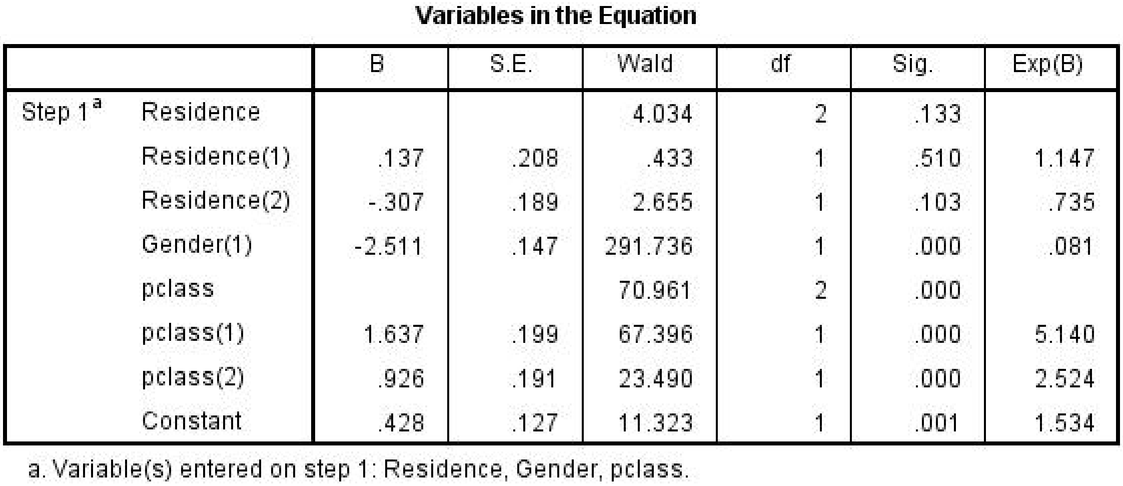


Classification Table[a]

			Predicted		
			survived		Percentage Correct
Observed			Died	Survived	
Step 1	survived	Died	682	127	84.3
		Survived	161	339	67.8
	Overall Percentage				78.0

a. The cut value is .500

The model correctly classifies 78% of those in the dataset.



Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Residence			4.034	2	.133	
	Residence(1)	.137	.208	.433	1	.510	1.147
	Residence(2)	-.307	.189	2.655	1	.103	.735
	Gender(1)	-2.511	.147	291.736	1	.000	.081
	pclass			70.961	2	.000	
	pclass(1)	1.637	.199	67.396	1	.000	5.140
	pclass(2)	.926	.191	23.490	1	.000	2.524
	Constant	.428	.127	11.323	1	.001	1.534

a. Variable(s) entered on step 1: Residence, Gender, pclass.

Whilst gender and class are significant, nationality becomes insignificant once these two factors are controlled for.

Since 3rd class is the reference category for class, the ratio of 5.14 for pclass(1) means that the odds of survival for those in 1st class were 5.14 times that for those in 3rd class. Similarly, the odds of survival for those in 2nd class were 2.5 times that for those in 3rd class

Since females are the reference category for gender, the odds ratio of 0.081 for Gender(1) means that the odds of survival for men was 0.081 times that for females (i.e. they were less likely to survive!).