

*** The next section of the notes describes how to use various statistical tests in SPSS. You may also find the web page **Which Statistical Test?** useful.
www.som.soton.ac.uk/learn/resmethods/statisticalnotes/which_test.htm

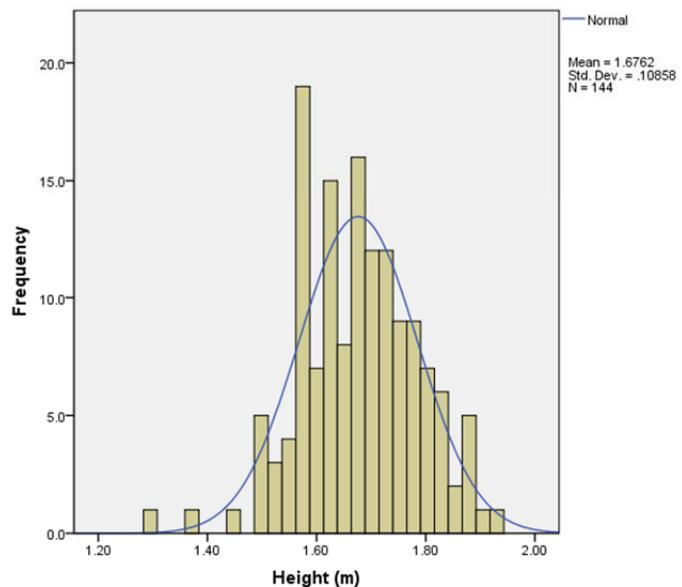
24 Comparing Means and Medians

Suppose you wish to compare the means heights of females and males in our study. If you want to use parametric statistical procedures, then your assumption is that the data you have sampled was taken from a Normal distribution.

You can check your assumption by producing a Histogram with a Normal curve superimposed (**Graphs | Chart Builder** -select Histogram from the

Chooses from panel and drag  into the Chart preview area. An Elements properties dialogue will be displayed.

Drag **Height (m)** from the variable list to the X-axis in the Chart preview window. Tick the **Display normal curve** box in the **Elements Properties** dialogue and click **Apply**.

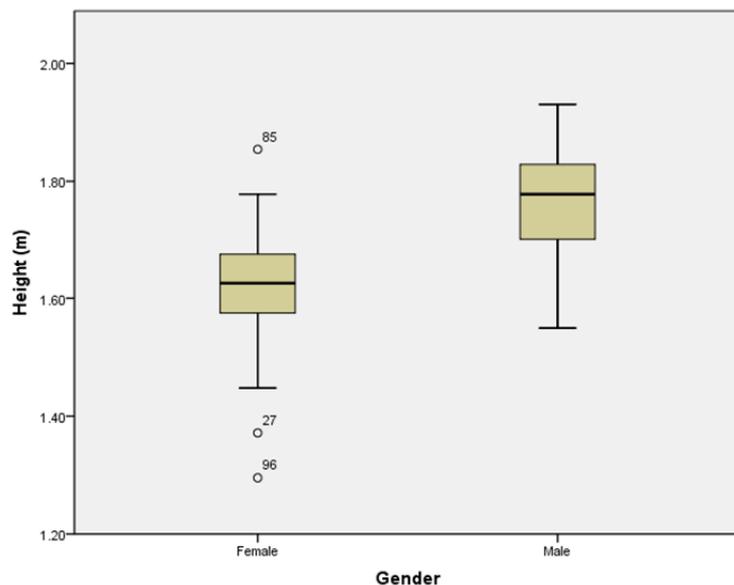


Before carrying out any statistical calculations, you should plot the data so that you can visually compare the data for the groups for any differences.

One approach could be to plot separate histograms for the groups (female and male). A better way to view the data is with a Box and

Whisker plot .

In the diagram opposite the Medians, represented by solid horizontal band, will be similar to the mean values for Normally distributed data. In this chart the medians are different and the boxes representing 50% of the data for each group and do not overlap. So you can hypothesise from this that the mean heights of females and males are different.



Two Independent Samples: t-test

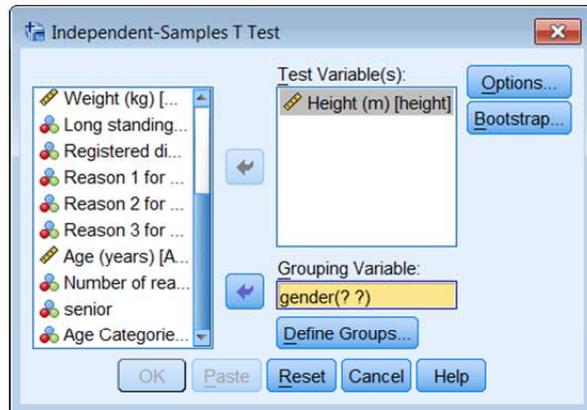
To test whether the observed difference between the mean heights of the female and male subjects in our study could have arisen by chance, select:

Analyze | Compare Means | Independent-Samples T Test

An Independent-Samples T Test dialogue box is opened.

Click on *Height (m) height* and the upper  to add this variable to the *Test Variable(s)* list.

Click on *gender*, the variable that defines the two categories and on the lower  on to add it as the Grouping Variable.



Gender is displayed as *gender(? ?)* in the *Grouping Variable* box.

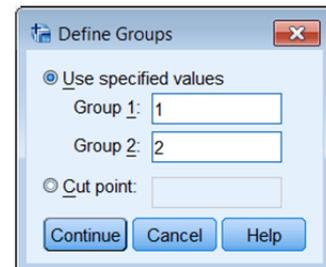
Click on the **Define Groups** button.

The Define Groups dialogue box allows the values that specify the two groups to be entered.

Enter 1 in the Group 1 box, press <tab>

Enter 2 in the Group 2 box.

Click on **Continue**.



The Grouping Variable box of the Independent-Samples T Test will display *gender (1 2)*.

The **Options** button in the Independent-Samples T Test dialogue box displays an *Options* dialogue box that allows the value for confidence intervals to be altered (default = 95%), value labels to be suppressed on the output and controls how missing values should be treated (List or Pairwise). These do not need to be altered.

Paste and **Run** the command.

Output from SPSS t-test is shown below. Two tables are produced, one for Group Statistics and the other for the Independent Samples Test.

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Height (m)	Female	93	1.6261	.08751	.00907
	Male	51	1.7675	.08035	.01125

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Height (m)	Equal variances assumed	.069	.793	-9.541	142	.000	-.14139	.01482	-.17069	-.11210
	Equal variances not assumed			-9.782	110.735	.000	-.14139	.01445	-.17004	-.11275

Before viewing the test statistics you should have decided if the variances (standard deviations squared) of the two groups are similar (equal) or not. If the variances are similar, the top row of the table (Equal variances assumed) is used. If the variance are not similar the bottom row (Equal variances not assumed) is used. The important columns are the Mean Difference (-.14139) and the 95% Confidence Interval of the Difference (-.17069 to -.11210) together with the Sig (2-tailed) column which displays the P value (.000).

Note the negative values for the Difference and the Confidence Intervals of the difference occur because the female group, which is lighter, is the first group. If the male group had been the first group the values would have been positive.

Comparing Two Medians: Mann-Whitney test

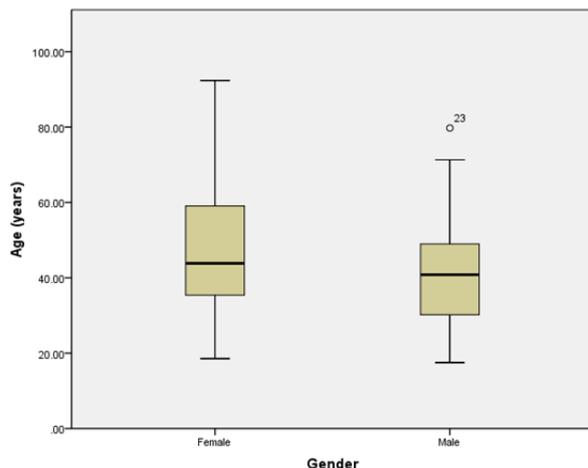
The Independent-Samples T Test used above assumes that the data are from populations that have a 'normal distribution', or that the sample sizes are large enough so that the distribution of the sample means is 'normal'. When the assumption of normality cannot be used, alternative techniques must be employed. These techniques are known as 'distribution-free' or 'non-parametric' statistics. They rely on the order or rank of the data rather than its distribution, 1 is smaller than 2; 4 is larger than 3. The fact that their differences are the same magnitude (2-1= 1 and 4-3 =1) is not a consideration.

In our data set you can consider that Age is not from a normal distribution because no case is under 17 years old (the subjects were sampled from a voting list). The distribution is truncated to the left.

Suppose you ask, is there a difference in the Ages of the females and males in this study?

The Box and Whisker plot compares the female and male data. This shows that the medians are very similar and there is complete overlap of the distributions.

Note: From this figure you might conclude that there is no point in testing for a difference because the median are similar. However we will demonstrate use of the procedure.



You can test for a difference between the ages of females and males by using the non-parametric equivalent of the T Test, the Mann-Whitney test. Select:

Analyze | Nonparametric Tests| Legacy Dialogs | 2 Independent Samples

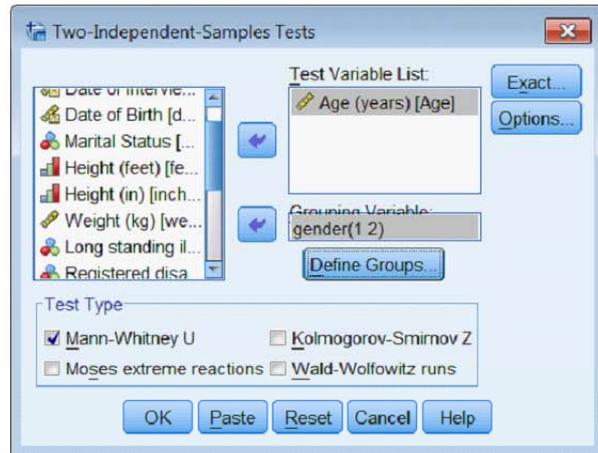
Highlight *Age of Respondent* and click the upper  button to add it to the Test Variable list.

Select *Gender* as the grouping variable.
Define Groups as 1 and 2.

Paste and **Run** the command.

	Age (years)
Mann-Whitney U	2008.000
Wilcoxon W	3386.000
Z	-1.782
Asymp. Sig. (2-tailed)	.075

a. Grouping Variable: Gender



Tests statistics given by the non-parametric Two-Independent Samples Test shown above, provide very little useful information. The item of interest in this table is the **Asymp. Sig (2-tailed)**, or P value (.075). This indicates that there is no significant difference between the ages of females and males which could have been predicted by looking at the box plot.

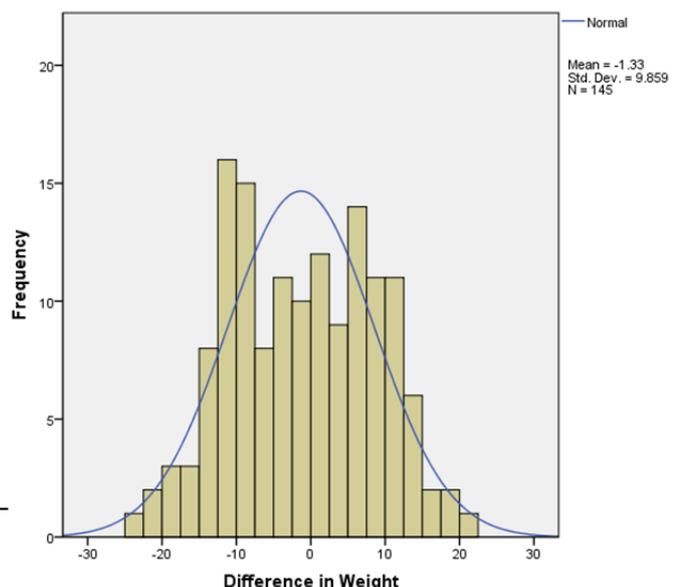
Note: The output from all of the Non-parametric procedures in SPSS is poor. Typically, the only useful statistics the Asymp. Sig (2-tailed). You must use other SPSS procedures to obtain the medians of each group (e.g. Explore); confidence intervals are not calculated but can be obtained using the Confidence Interval Analysis Program, CIA.

Paired samples t-test

Note The following is for illustration only. The data set you are using does not include any paired data.

A paired test is used when the data are matched or paired in some way. Often the subjects are used as their own control For example measuring something ‘before’ and ‘after’ an event. The paired t-test calculates the difference between paired data items and tests whether the average difference between paired measurements is different from zero.

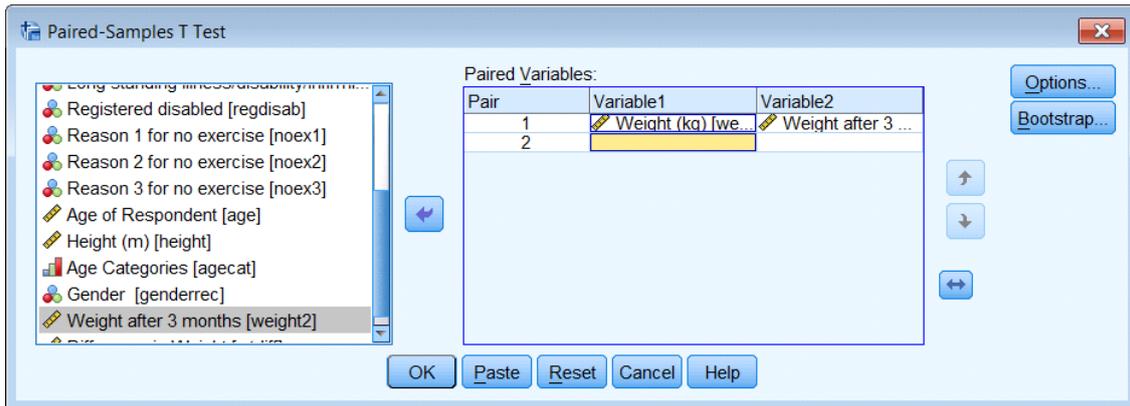
Suppose you measure the weight of subjects, prescribe a new diet and measure their weight three months later. If the new diet reduces weight, the average change in weight of our subjects should be different from zero. This can be visualised by calculating the difference between weights (**Transform | Compute**) and plotting a histogram of the difference (weight - weight2) (**Graphs | Chart Builder - Histogram**) as shown opposite.



Note: The paired Sample *t*-test can be used to test the difference between two variables where the original data are not from a Normal distribution if the distribution of the differences between the two readings approximate to a Normal distribution.

The SPSS procedure would be: **Analyze | Compare Means | Paired Samples T Test**

The data for this procedure must be entered as two variables. These are selected by scrolling the list of variables and **clicking** on a variable and then clicking on  to add it to the **Paired Variables** panel. If you select an incorrect variable, **clicking** on it in the Paired Variables panel (it will be highlighted in blue) and click  to remove it.



The order of the variables (Weight 1 – Weight 2 or Weight 2 – Weight 1) can be set by clicking the  button.

Output for the Paired Samples procedure is shown below. The mean difference of -1.3257 before minus after values) suggests that our subjects lost weight! However, this difference is not significant ($p = 0.108$) and the change is due to random chance. You can tell this because the 95% confidence interval (-2.9940 to .2927) includes zero and also because the Sig (2-tailed) is 0.108.

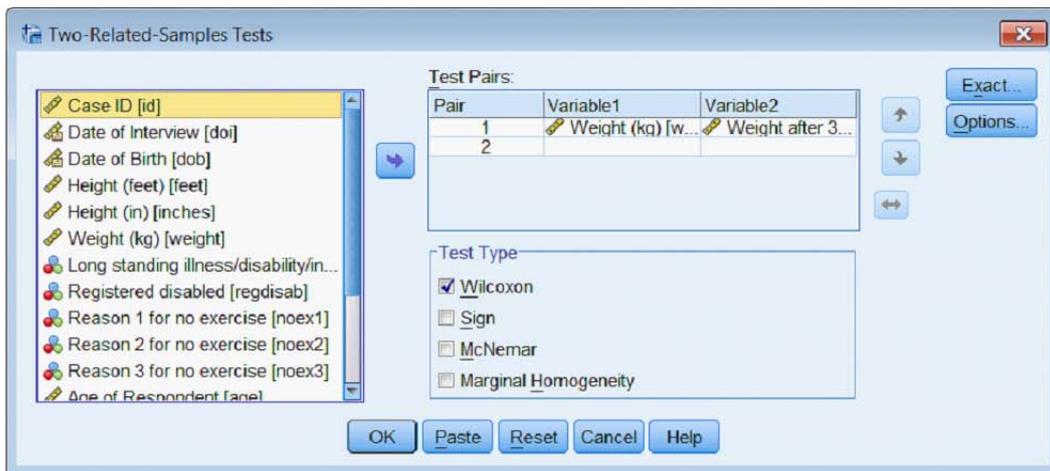
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Weight (kg) - Weight after 3 months	-1.3257	9.8594	.8188	-2.9440	.2927	-1.619	144	.108

Non parametric Paired Samples: Wilcoxon

The nonparametric equivalent of the paired *t*-test is the Wilcoxon signed-rank test. This considers whether the difference is above or below zero. The procedure would be:

Analyze | Nonparametric Tests | Legacy Dialogs | 2 Related samples

Variables are selected in the same way as for the paired samples t-test procedure.



The only useful information displayed is the Asymp. Sig (2-tailed) (P value), .108.

The calculation is Variable2 – Variable 1 which the reverse of the paired t-test!

	Weight after 3 months - Weight (kg)
Z	-1.606 ^a
Asymp. Sig. (2-tailed)	.108

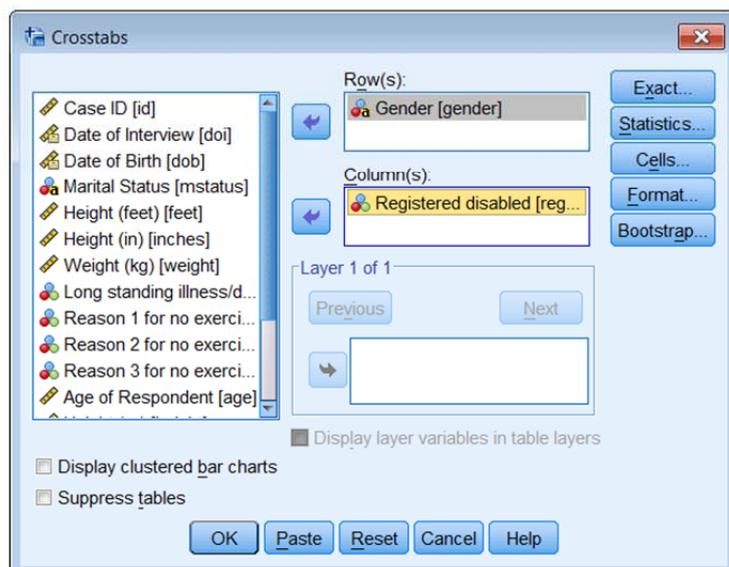
a. Based on negative ranks.
b. Wilcoxon Signed Ranks Test

25 Comparing Proportions 2x2 tables

We are often interested in examining the relationship between two categorical variables. This may be achieved by cross-tabulating them in a contingency table. A useful convention (when appropriate) is for the rows of the table to correspond to the exposure values and the columns to the outcomes. You might ask whether gender is associated with registered disability, so gender is the “exposure” and regdisab (registered disabled) is the “outcome”.

To create the table in SPSS select: **Analyze | Descriptive Statistics | Crosstabs**

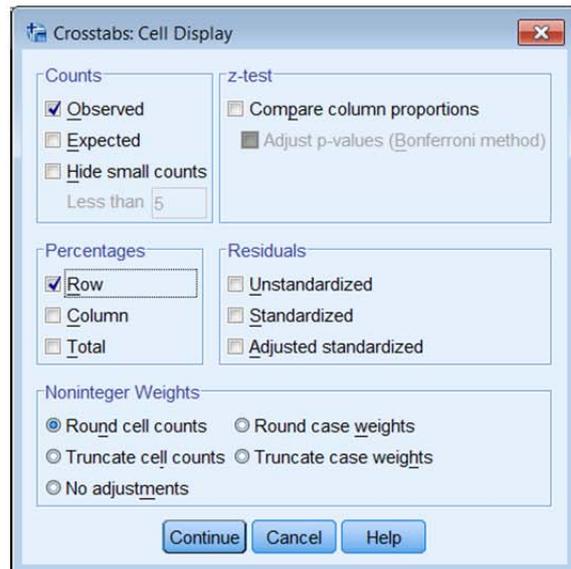
Use *Gender* as the Row variable and *Registered Disabled [regdisab]* as the Column variable.



To improve the presentation and allow more detailed examination of the association by including marginal totals and percentages, click the **Cells** button and check the **Row Percentages**.

Click **Continue**

Click **Paste** and Run the command.



The output is shows that there are 15.8% of females who are registered disabled and 0% of males.

A word of caution the number of Registered Disabled is very small so care must be taken with any statistical testing.

Gender * Registered disabled Crosstabulation

		Registered disabled		Total	
		Yes	No		
Gender	Female	Count	3	16	19
		% within Gender	15.8%	84.2%	100.0%
	Male	Count	0	12	12
		% within Gender	.0%	100.0%	100.0%
Total	Count	3	28	31	
	% within Gender	9.7%	90.3%	100.0%	

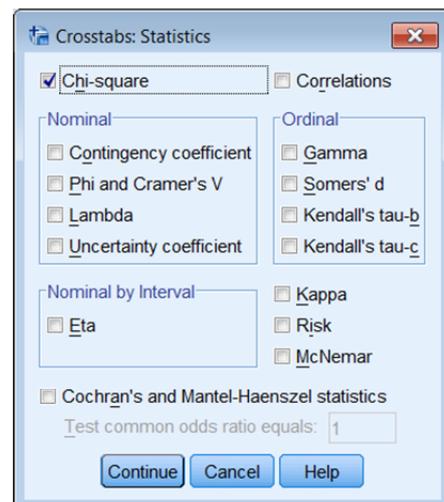
Chi-squared test for a 2x2 table

Suppose you wish to assess the strength of the association between gender and registered disability. Use the Recall dialog button  to recall the Crosstab procedure. Click the **Statistics** button.

Check the **Chi-square** box.

Click **Continue**

Paste and Run



The viewer will display as output:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.098 ^a	1	.148		
Continuity Correction ^b	.680	1	.410		
Likelihood Ratio	3.138	1	.076		
Fisher's Exact Test				.285	.216
N of Valid Cases	31				

a. 2 cells (60.0%) have expected count less than 5. The minimum expected count is 1.16.
b. Computed only for a 2x2 table

Interpreting the output

In this example you have small numbers, SPSS warns you in footnote b of the table above. Therefore the Pearson chi-square statistic which is the χ^2 test statistic is not appropriate in

this circumstance; Fishers Exact test should be used here (see below).
If you had sufficient data you would use the (Asymp. Sig. 2-sided) = 0.148 which is the P-value and observe that is not significant.

Yates' continuity correction

Some statisticians argue that the chi-squared test for a 2x2 table can be improved by using a continuity correction, (Yates' continuity correction). In the output above the *P*-value is increased to .410.

Fisher's exact test

In this example an Exact test should be used to compare two proportions when the numbers in the 2x2 table are very small, leading to an expected value (in any cell) of less than 5. SPSS will report if any cells have expected values of less than 5 in which case the Fisher's exact test *P*-value should be reported. So you should report $P=0.265$.

Other statistics from Crosstabs

Paired Data (McNemar's test)

This is used when you have paired data for before and after studies, for example the presence of a condition (e.g. skin rash) is observed in subjects before and after an intervention. The χ^2 test is not appropriate because the data are not independent.

An example of this is: Seventy seven patients with diabetic nephropathy had one eye chosen at random to be treated while the other eye remained untreated. After five years follow-up the response variable (blind or not) was recorded for both eyes.

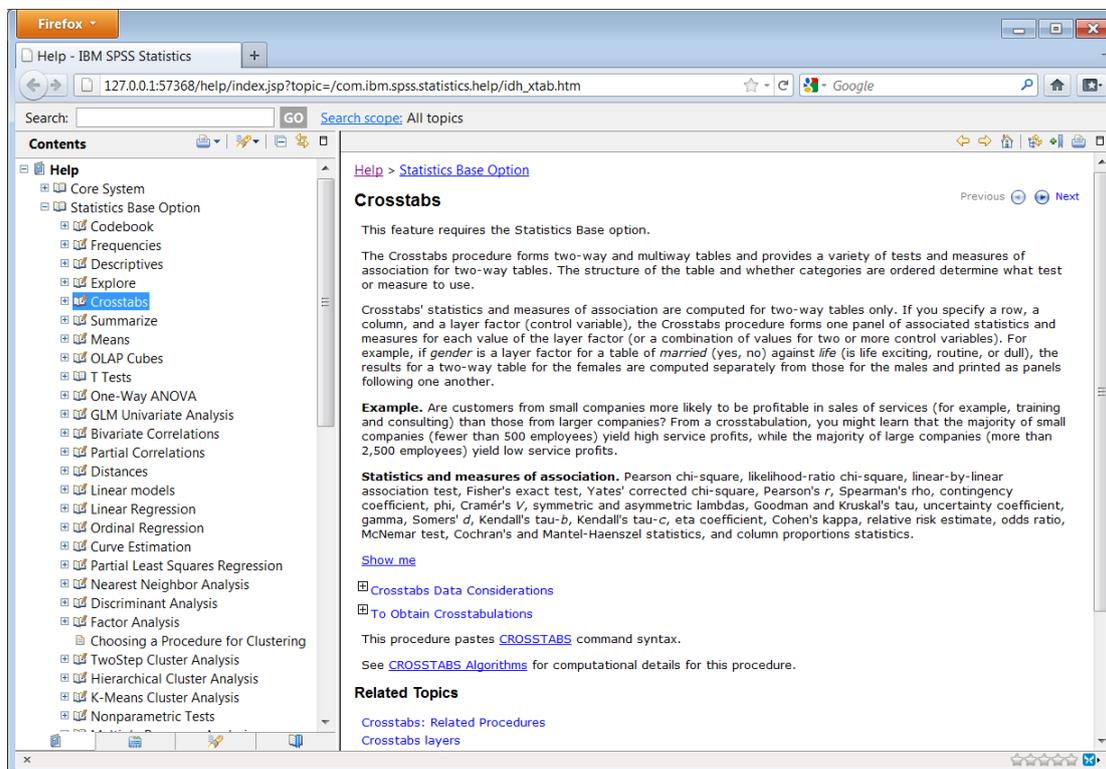
The kappa (κ) statistic

This allows you to assess the extent of the *reproducibility* of a measurement (also known as *reliability*), including:

- Agreement between different observers (inter-rater agreement) using the same measurement technique.
- Agreement between replicate measurements taken at different points in time.

26 Help with Statistical Procedures

To find out more about SPSS statistical procedures, Click the **Help** button in the procedure dialogue window, for example Crosstabs). A short description of the procedure is provided with an example and the statistics that can be calculated.



27 Further Reading

For a greater understanding of the issues and assumptions made when comparing means or medians you are advised to explore the following texts.

Practical Statistics for Medical Research, DG Altman, Chapman and Hall 1991. Chapter 9

An Introduction to Medical Statistics, 3rd Ed, M Bland, Oxford Medical Publications 2000. Chapters 10 and 12

Medical Statistics: A textbook for the Health Sciences. 4th Ed, MJ Campbell, D Machin & SJ Walters, Wiley 2007. Chapter 8

Essential Medical Statistics, 2nd Ed BR Kirkwood & JAC Sterne, Blackwell Science 2003. Chapters 7,9 & 30.

Medical Statistics at a Glance 3rd Ed, A Petrie & C Sabin, Wiley-Blackwell, 2009.