

The Independent-Samples and Paired-Samples t Tests in SPSS versions 21-22

This guide uses the **Rikers 1989** data set for Independent Samples test and the **NELS** dataset for the Paired Samples test.

All t Tests are means comparisons:

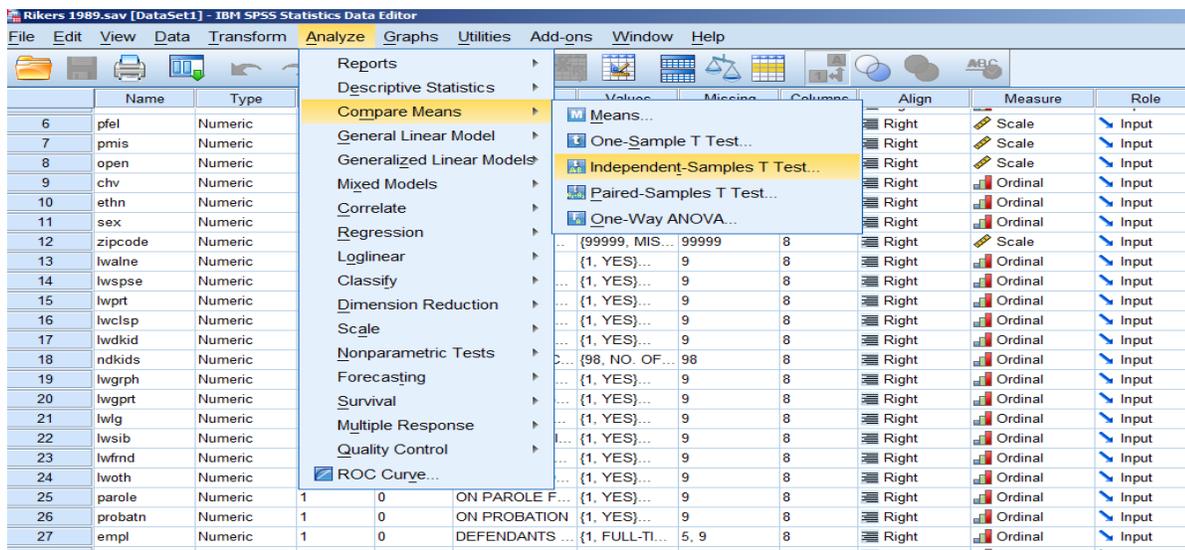
- A **One Sample t test** compares a sample average to a population mean.
- An **Independent Samples t test** compares the averages of two groups whose members are independent – that is, no one can be in both groups – on some dependent variable of interest. This test is often used to compare the averages of Men and Women, or to compare groups created by dichotomous variables (Yes/No variables).
- A **Paired Samples t test** compares members of one group at two points in time (for example, before and after some treatment or program) or on two quantitative variables.

An Independent Samples T Test

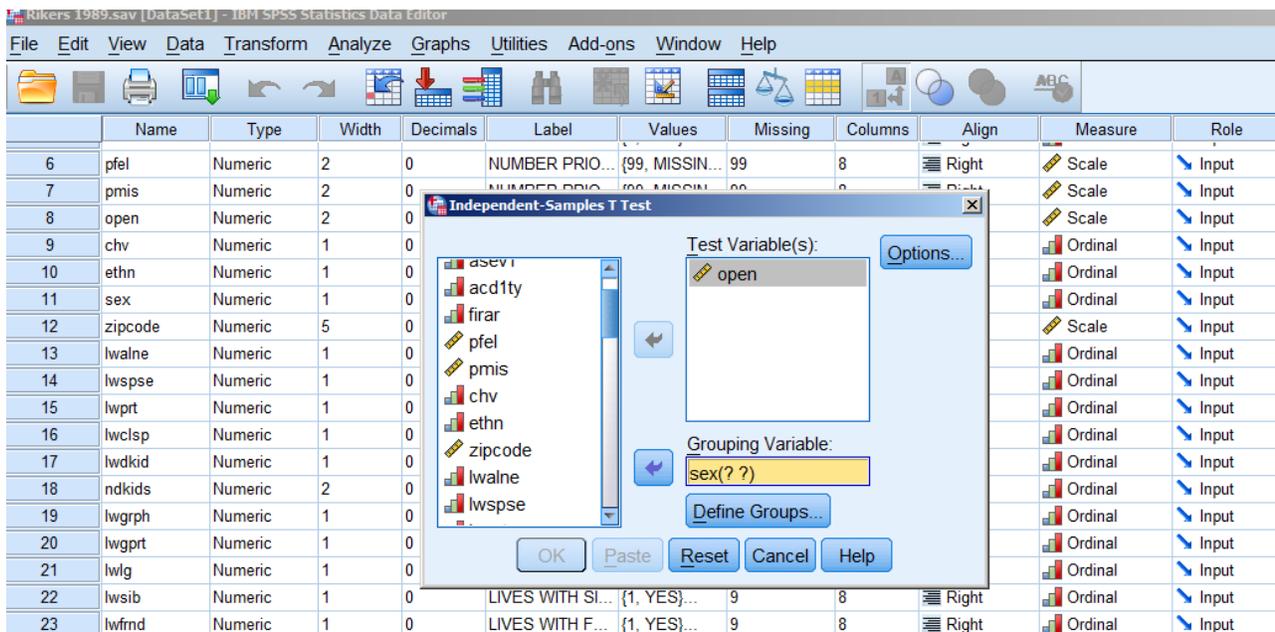
Let's test whether the average number of OPEN CASES reported in the Rikers 1989 dataset differs between Men and Women. SEX is the variable that splits our overall sample into groups – in this case, Men and Women. It is our independent variable because we are exploring whether *sex (or gender) has an effect on criminal activity as measured by open cases*. The dependent variable is **open** - we are looking to see if our two groups have the same average number of open cases or not.

The NULL HYPOTHESIS for this test is that the average criminal activity for men in New York in 1989 is the same as the average criminal activity for women at the same time. We are using the average number of open cases in our dataset sample to test a hypothesis about these groups in the general population. The Null Hypothesis is also expressed as: $H_0 : \mu_{\text{men}} = \mu_{\text{women}}$ or the mean for men is equal to the mean for women.

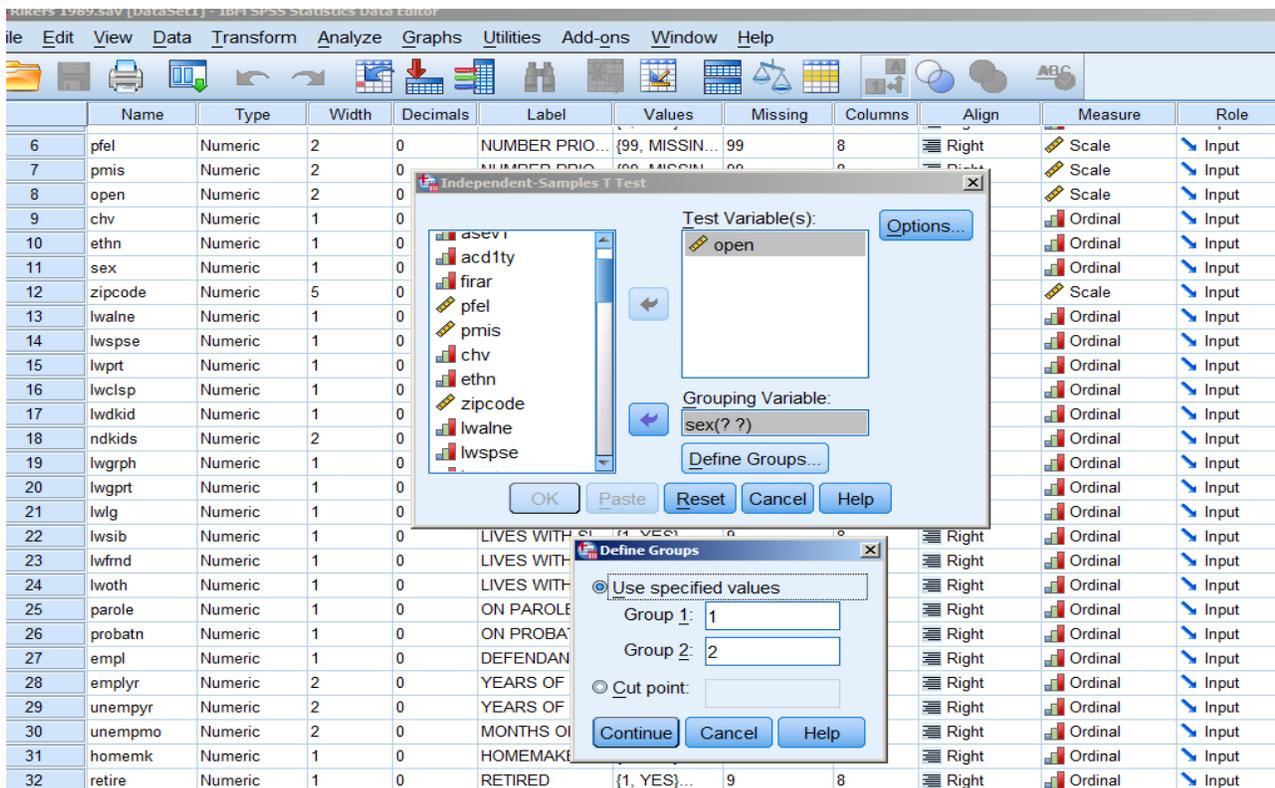
The Independent Samples T Test is found by clicking on Analyze > Compare Means > Independent-Samples T Test.



In the dialog box, you will move the dependent variable into the Test Variable(s) box and the independent variable into the Grouping Variable box.



You will need to define the groups you are comparing in the Grouping Variable box. In this data set, Males are coded "1" and Females are coded "2". Click inside the grouping variable box to make the Define Groups button available and click on it. Type each of the relevant codes into the Group boxes and click **Continue**.



Now you can click OK. The output window now opens and you will see two tables.

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
NUMBER OF OPEN CASES	MALE	915	1.71	1.694	.056
	FEMALE	115	1.94	2.779	.259

This first table gives you the descriptive statistics for your two groups. The average number of open cases or unresolved arrests for male arrestees was 1.71. The average number of open cases or unresolved arrests for female arrestees was 1.94. You can see that there appears to be a difference but without the hypothesis test, we can't say if the difference is real (statistically significant) or if it's caused by sampling error. By sampling error we mean the expected variability that would come from working with samples instead of the whole population.

The second table holds the result of the statistical comparison.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
NUMBER OF OPEN CASES	Equal variances assumed	8.135	.004	1.234	1028	.217	-.225	.183	-.584	.133
	Equal variances not assumed			-.850	124.861	.397	-.225	.265	-.750	.299

Copy & Paste NOTE: Working from SPSS output and planning to paste into a Word document - the best-looking tables will result from using COPY SPECIAL > RTF in SPSS. Then, after you PASTE (and see that your table spills off the edge of the your page in Word, select the table > then from Table Tools, use the LAYOUT menu to see the **Autofit** options, then choose **Autofit Window**.

Understanding the results of a Independent Samples Test

SPSS runs three tests when you request an independent-samples t test. The first test is the **Levene's Test for Equality of Variances** (the first two statistics boxes in the above table – highlighted in yellow). The null hypothesis in Levene's test is that the variances are equal. If the Sig. (p) value for this test is greater than .05, then we accept the null hypothesis and assume the variances are equal. If the Sig. value is less than .05, we reject the null hypothesis and assume the variances are not equal. You can also look at the standard deviations of the two groups – if they are different, the variances are different.

The next two tests are the *t* test run two ways – with equal variances assumed and with equal variances not assumed. Based on the results of the Levene's test, we interpret and report only one of these tests as the actual hypothesis test we ran to see if there is a difference between our two groups.

So, according to the above results, the Levene's test **is statistically significant**, the test value of *F* is 8.135, and $p = .004$. We reject the null hypothesis and cannot assume the variances are equal. The standard deviations for the distributions of the two groups are different, 1.694 for men and 2.779 for women. (Women arrestees have more diversity in the number of open cases they have.) Because of this result, we will use the bottom line of the *t* test results (highlighted in blue) and ignore the top line. The highlighted test value of *t* is $-.850$ and the Sig. value is $.397$. Because $p > .05$, we accept the null hypothesis in this test as well and say that there is no statistically significant difference in the average number of open cases for men and for women in 1989 in New York City. Even though there was a numerical difference in the means, this difference is probably due to sampling error; specifically, the probability that the difference we see is due to sampling error and not a real difference between males and females is greater than 5% (39.7% according to the test). Another way to think about this is where on the *x* axis a *z* value of $-.85$ would fall. It would be between $z = 0$ at the mean and $z = -1$... very likely to occur.

(Why is the *t* value negative? Because females had a higher average than males (1.71 – 1.94). The sign of a *t* test has no significance. If you want to prove this to yourself, go back and enter the values of the sex variable in the Grouping box the other way, first 2, then 1. The result will be a positive *t* value of the same size .. $.850$.)

When we write up these results, it will look something like this:

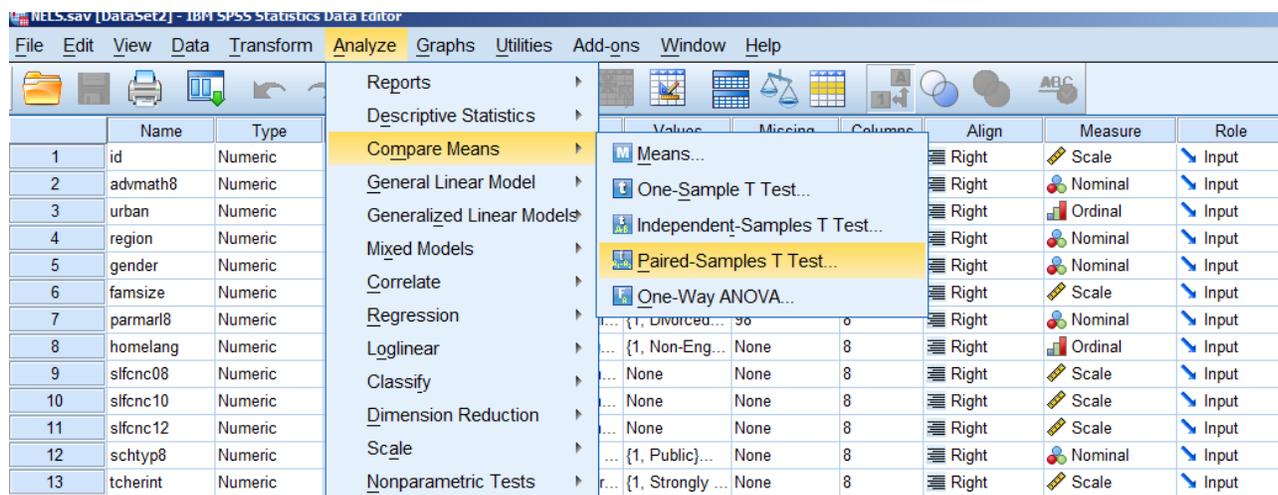
There was no statistically significant difference in the average number of open cases in 1989 between men and women in New York, $t(124) = -.850, p = .397$.

The last thing the SPSS results table tells us is what the confidence interval of the difference is. The Null Hypothesis predicts that the difference in the population averages for men and women will be zero. We observe a difference in our samples of $-.23$ ($-.225$ in three decimal places). **What inference can we make?** The t test results give us in three ways how to make that decision: the test value, the sig. or probability and the confidence interval.

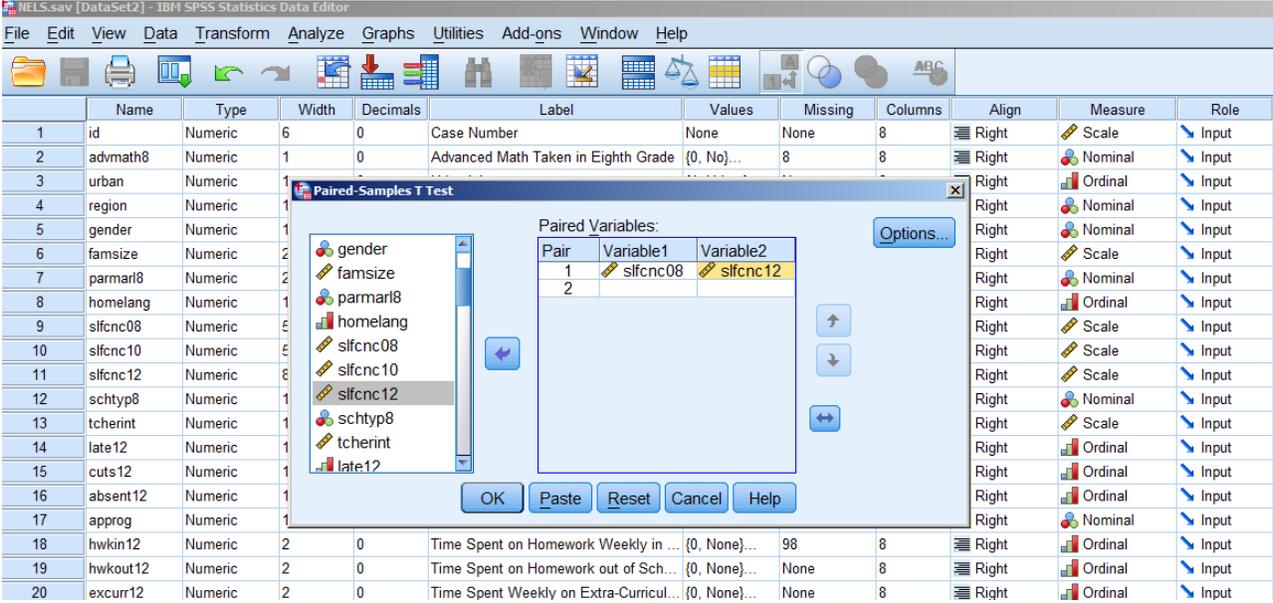
- The test value is $-.850$ And it would be not even close to the critical zone defined by $\alpha = .05$.
- The sig. or probability value of $.397$ tells us that this result would happen by chance in 39.7% of the samples.
- The confidence interval of the difference predicted by this sample is: $-.75$ as a lower bound to $.299$ as the upper bound. In other words, in the distribution of possible samples of 1038 that we could have chosen to work from, the difference in means could have been $-.75$ (with women having an even higher average than we observed) to an upper bound of $.229$ (with men having a higher average number of open case than women) Since, the confidence interval contains zero, we accept the Null Hypothesis.

A Paired Samples T Test

Open the NELS data set for this example. We will look at two variables that give us measurements of SELF CONCEPT of the 500 high school students in the NELS data set. The scale used on this variable is quantitative – with a high score indicating positive self concept and a low score the reverse. The students are tested in Eighth Grade and in Twelfth Grade. We will use a Paired Sample test to see if the average self concept has changed between Eighth Grade and Twelfth Grade. The implied independent variable is **time**. The paired-samples t test is found by clicking on Analyze → Compare Means → Paired-Samples T Test.



We now need to move both of the variables we’re comparing over into the Paired Variables box. Click on **slfcnc08** and move it over by clicking on the arrow button. Now do the same for **slfcnc12** and click OK.



The output window will show three tables – the first looks like this:

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean	
Pair 1	Self-Concept in Eighth Grade	21.06	500	5.971	.267
	Self-Concept in Twelfth Grade	31.48	500	7.231	.323

These are the descriptive statistics. The average score on the Self Concept scale in Eighth Grade is 21.06. The average score on the Self Concept scale in Twelfth Grade is 31.48. Again, there appears to be a difference in the means we’re comparing but we have to run the hypothesis test to find out if the difference is statistically significant and not due to sampling error.

Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 Self-Concept in Eighth Grade & Self-Concept in Twelfth Grade	500	.444	.000

The second table provides the correlation. If you used Analyze > Correlate > Bivariate. You would get this same result. It is a different measure of association for these two variables.

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Self-Concept in Eighth Grade - Self-Concept in Twelfth Grade	-10.418	7.045	.315	-11.037	-9.799	33.064	499	.000

This is the result of the Paired Samples *t* test. The Null Hypothesis is that the average self concept in Eighth Grade is the same as the average self concept in twelfth Grade or $H_0 : \mu_{8th} = \mu_{12th}$

Again, we have three ways to make a decision on the Null Hypothesis:

- The test value is 33.064 ... it's LARGE! And it would be very, very far away from the mean, or $z = 0$.
- The sig. or probability value of .000 (less than .001) tells us that this result would happen by chance in fewer than 1 in 1000 samples.
- The confidence interval of the difference predicted by this sample is: -11.037 as a lower bound to -9.799 as the upper bound. In other words, in the distribution of possible samples of 500 that we could have chosen to work from, the difference in average self concept between Eighth Graders and Twelfth Graders could have been AT LEAST an increase of 9.799 and perhaps as much as 11.037.

All three results confirm that we will reject the Null Hypothesis. Time and age DOES HAVE a statistically significant influence on self concept in high school students.

FINAL SUMMARY POINT: Both the Independent and Paired Samples T Tests compare the observed difference to an **expected difference of zero** – the difference predicted by the Null Hypothesis.