T-test for independent samples

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Effect of gender on aggression

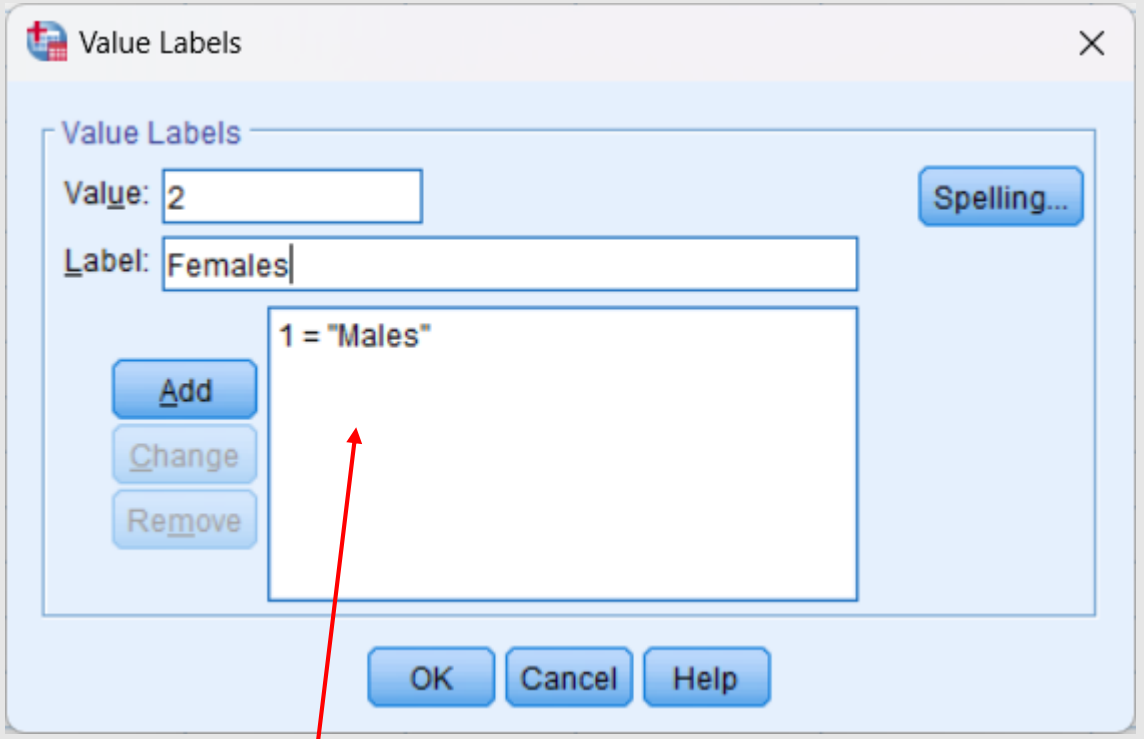
Effect of gender on aggression

Males (N=12)	Females (N=13)
12	12
18	9
12	12
10	8
10	10
14	8
14	7
18	13
12	16
8	11
14	15
14	13
	9

Null hypothesis (H_0): Males will not show higher levels of aggression than females. Alternatively, the levels of aggression are not different between males and females.

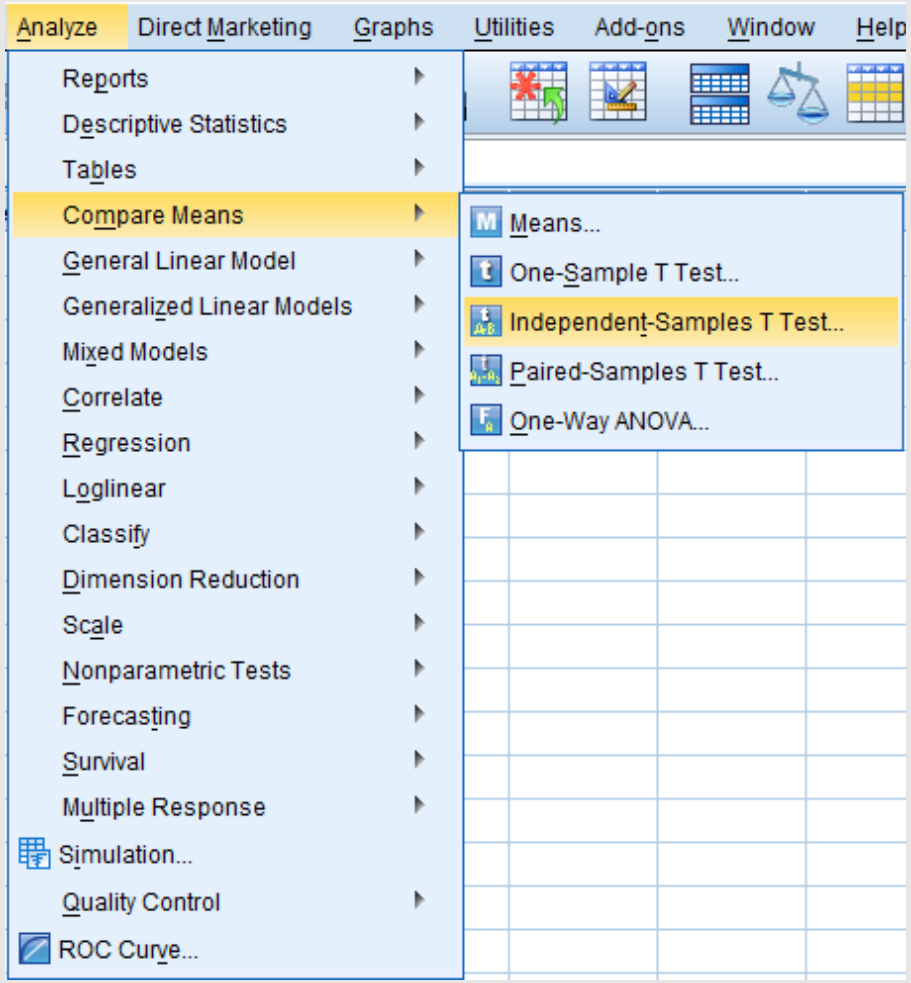
Entering data and defining variables

	sex	aggressiveness
1	1	12
2	1	18
3	1	12
4	1	10
5	1	10
6	1	14
7	1	14
8	1	18
9	1	12
10	1	8
11	1	14
12	1	14
13	2	12
14	2	9
15	2	12
16	2	8

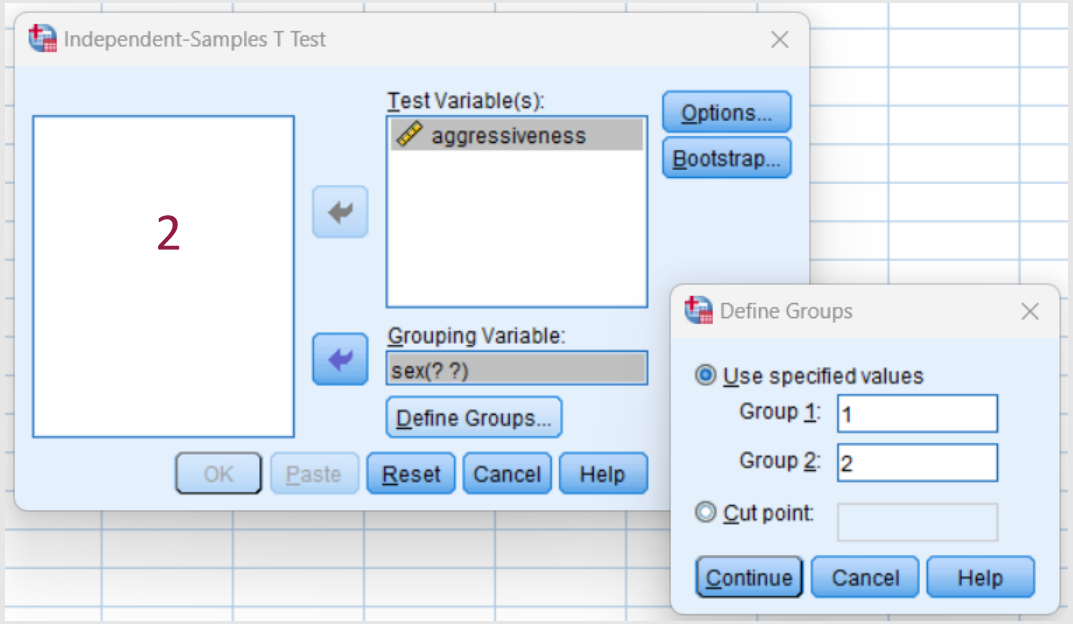


	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	sex	Numeric	8	0	Gender	{1, Males}...	None	8	Right	Nominal	Input
2	aggressiveness	Numeric	8	0		None	None	8	Right	Scale	Input

Running the Independent Samples T Test



1. To analyze the data, select **Analyze** from the menu, then choose **Compare Means** and **Independent-Samples T Test…**



2. In window (2) drag the variable **aggressiveness** from the left panel to the **Test Variable(s)** box, and the variable **sex** to the **Grouping Variable:** box**.** Press the **Define Groups…** button, define the two groups, and then press **Continue** and **OK**

Interpretation of the results

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
aggressiveness	Males	12	13.00	3.015	.870
	Females	13	11.00	2.799	.776

The variances between the two gender groups are equal, as the p-value of Levene's test is greater than 0.05 ($p > 0.05$). This result indicates that the variance in aggressiveness between males and females is not significantly different.

Since $p > 0.05$, we cannot reject the null hypothesis, and conclude that males do not show higher levels of aggressiveness then females ($t(23) = 1.720$, $p = 0.099$). Alternatively, the difference in aggressiveness between males and females is not statistically significant.

Independent Samples Test

		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
aggressiveness	Equal variances assumed	.002	.969	1.720	23	.099	2.000	1.163	-.405	4.405
	Equal variances not assumed			1.715	22.443	.100	2.000	1.166	-.416	4.416

Duration of relief between two analgesic drugs

Duration of relief between two analgesic drugs

Drug (N=16)	Time (N=16)
1	7.50
1	3.60
1	8.90
1	6.40
1	9.50
1	7.40
1	10.10
1	4.70
2	3.80
2	2.40
2	4.70
2	5.90
2	2.10
2	3.20
2	4.50
2	3.80

- Suppose we want to test whether there is a difference in relief times between two analgesic drugs (Drug 1 and Drug 2)
- To compare analgesic drugs 1 and 2, 16 patients were randomly assigned to two groups, each receiving a different drug

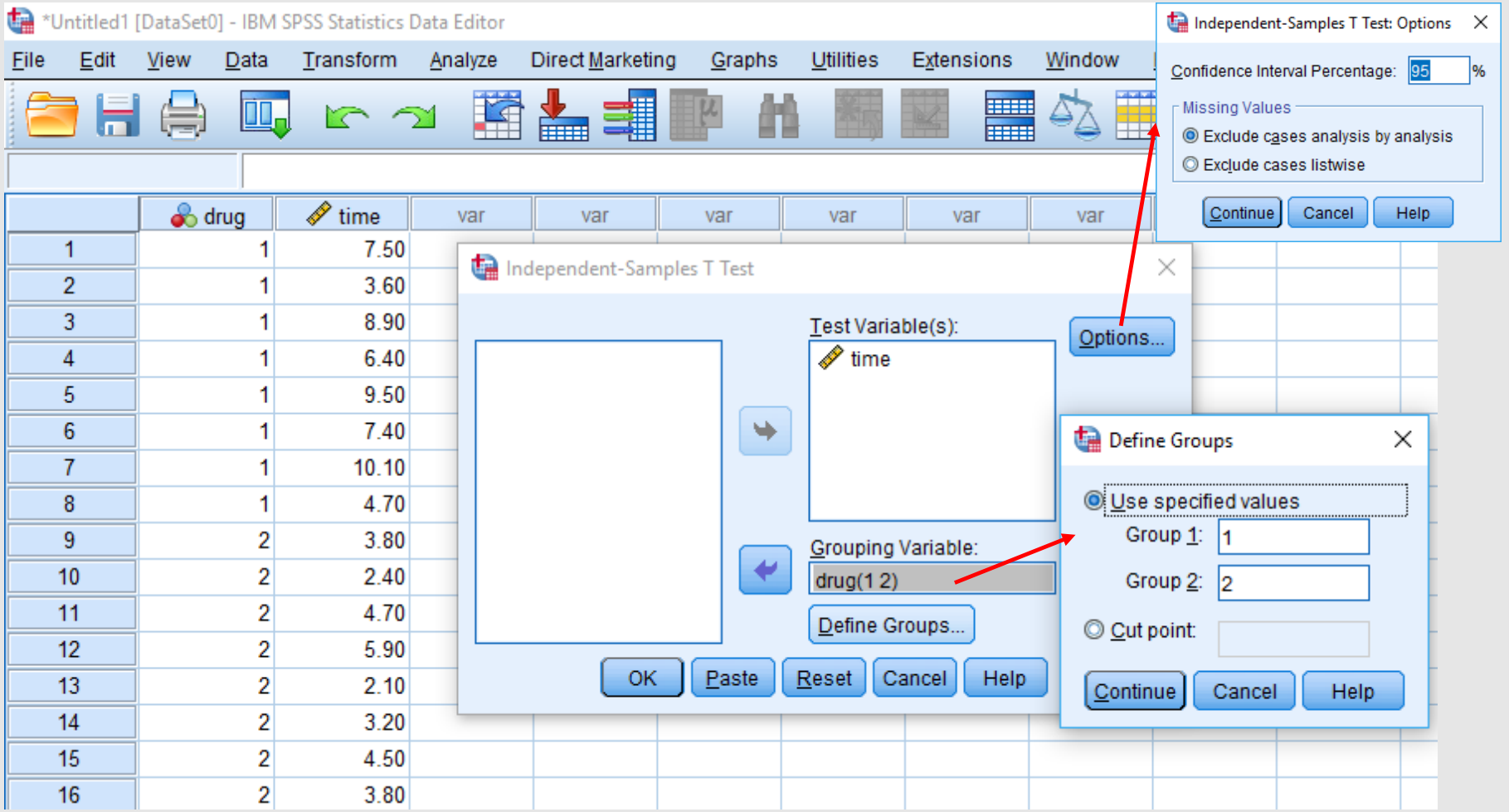
- First, in the **Variable View**, name the two variables (**drug** and **time**). Then, enter the drug types and the relief times observed for each patient.

Null hypothesis (H_0): There is no difference in the duration of relief between the two analgesic drugs

Data entry and running of the Independent Samples T Test

- To determine if there is a difference between the two drugs, we will apply the **independent t-test** and assess the **significance level (p-value)**
- Suppose we want to calculate the **95% confidence interval (CI)** for the mean difference between the two drugs

- From the menu choose **Analyze-> Compare Means-> Independent Samples T-test**



T-Test

[DataSet0]

Group Statistics

	drug	N	Mean	Std. Deviation	Std. Error Mean
time	1	8	7.2625	2.28469	.80776
	2	8	3.8000	1.24900	.44159

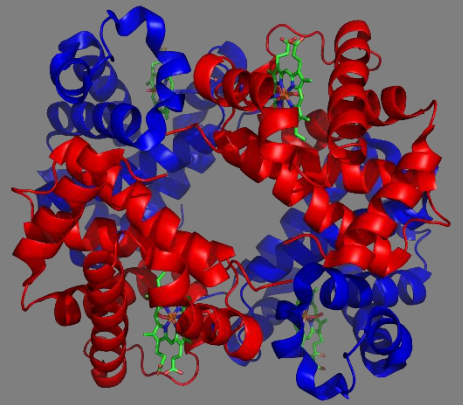
The variances between the two groups are equal, as the p-value of Levene's test is greater than 0.05 ($p > 0.05$)

- Since the p-value is less than 0.05 ($p < 0.05$), we reject the null hypothesis and conclude that there is a significant difference in mean relief duration between the two groups ($t(14) = 3.761$, $p = 0.002$)
- With 95% confidence interval (CI), the true difference lies between 1.488 and 5.437. Since 0 is not included in the 95% confidence interval (CI), we conclude that the difference is statistically significant

Independent Samples Test

		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
time	Equal variances assumed	2.592	.130	3.761	14	.002	3.46250	.92059	1.48804	5.43696
	Equal variances not assumed			3.761	10.841	.003	3.46250	.92059	1.43267	5.49233

Hemoglobin change after administration of two EPO drugs



Hemoglobin change after administration of two EPO drugs

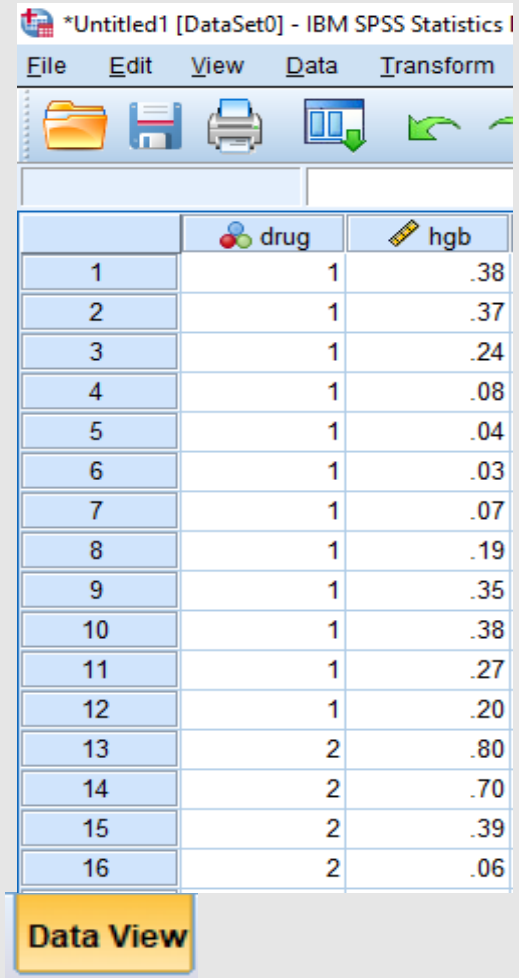
Test	Reference
0.38	0.80
0.37	0.70
0.24	0.39
0.08	0.06
0.04	0.49
0.03	0.07
0.07	0.63
0.19	0.83
0.35	0.62
0.38	0.95
0.27	0.92
0.20	0.81

Suppose we want to compare the hemoglobin change after administration of two erythropoietin (EPO) drugs, Test (T) and Reference (R). 12 patients received the Test and 12 the Reference drug.

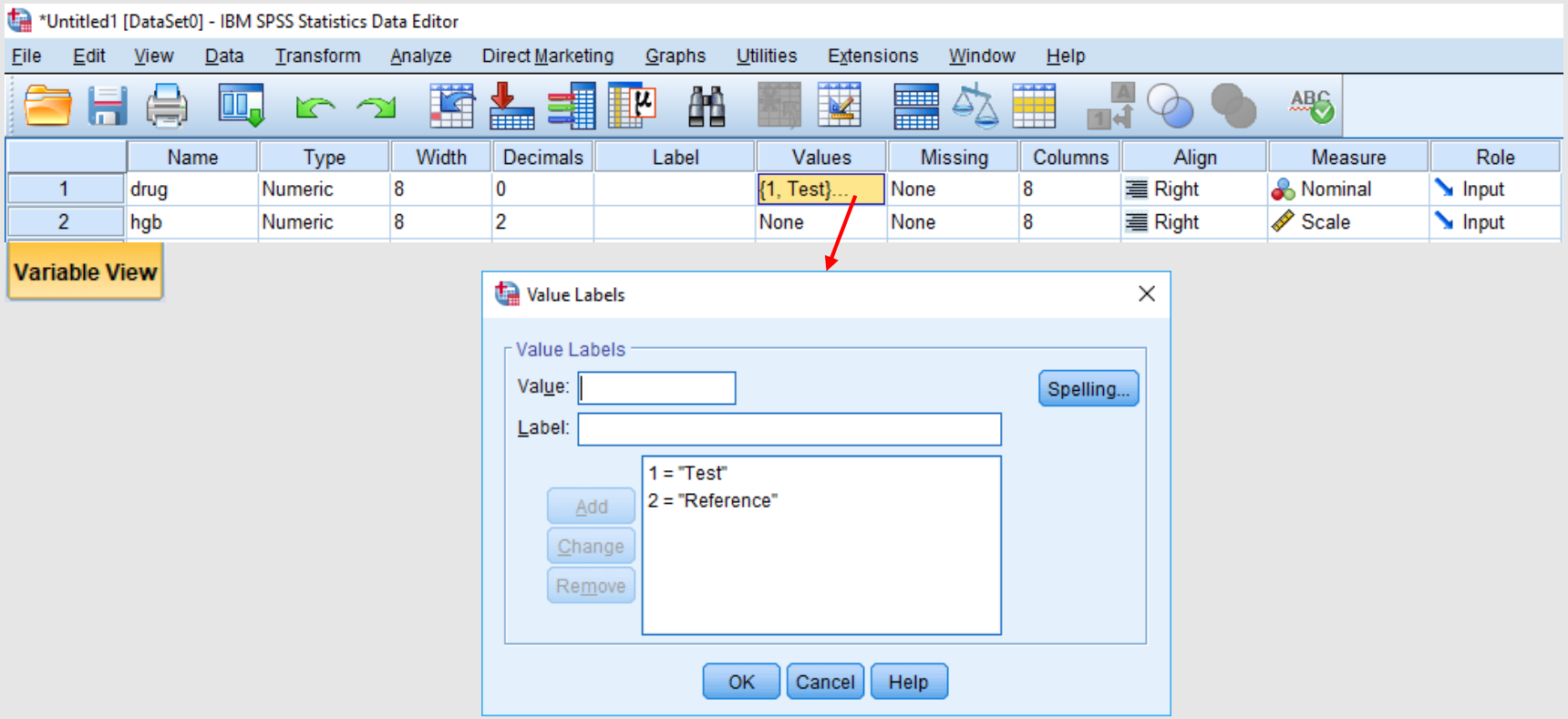
Null hypothesis (H_0): There is no difference in the mean hemoglobin change between the Test and Reference drug.

Note that these two measures are independent of each other.

Entering data and defining variables

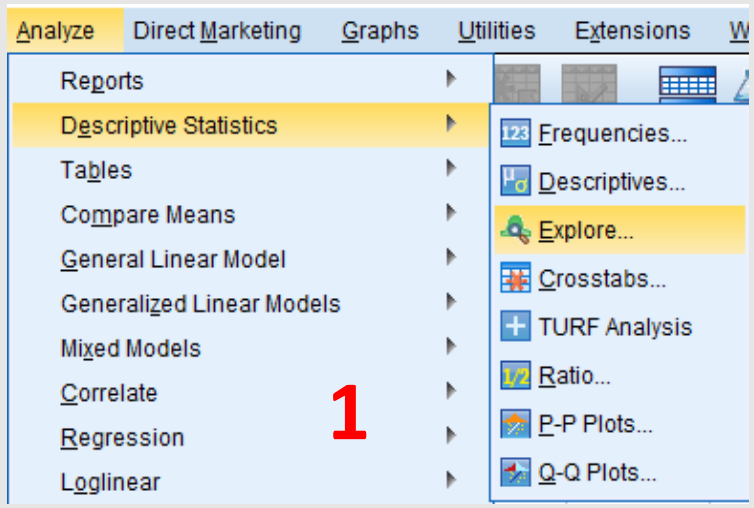


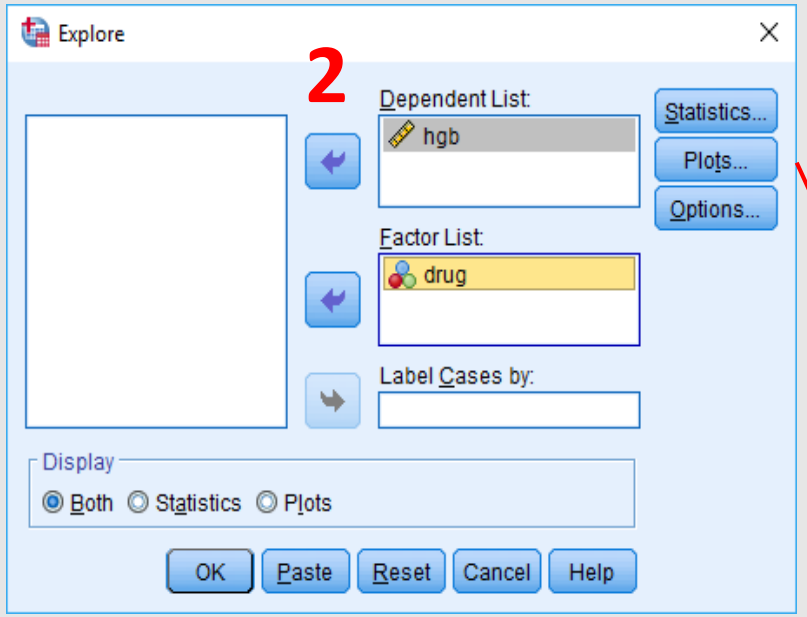
We enter the data in the **Data View** and define the variables in the **Variable View** as shown in the images

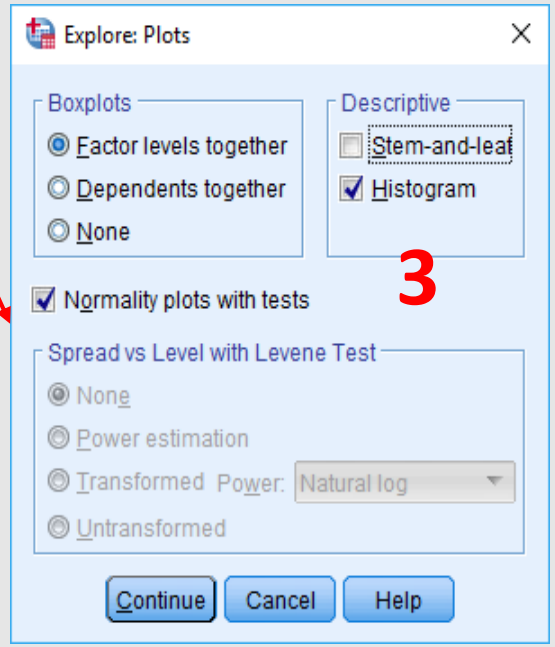


Descriptive statistics

First we display descriptive statistics using the menu **Analyze -> Descriptive -> Statistics -> Explore**. In window (2) drag the variable **hgb** from the left panel to the **Dependent List** box, and the variable **drug** to the Factor List box.







In window (3), select **Histogram** and **Normality plots with tests**. Then press **Continue** and **OK**.

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	drug	N	Percent	N	Percent	N	Percent
hgb	Test	12	100.0%	0	0.0%	12	100.0%
	Reference	12	100.0%	0	0.0%	12	100.0%

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	drug	Statistic	df	Sig.	Statistic	df	Sig.
hgb	Test	.175	12	.200*	.886	12	.106
	Reference	.185	12	.200*	.887	12	.109

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the **Shapiro – Wilk** test (n < 50), we conclude that the hemoglobin values for both the test and reference drugs follow a normal distribution, as the p-value (Sig.) is greater than 0.05.

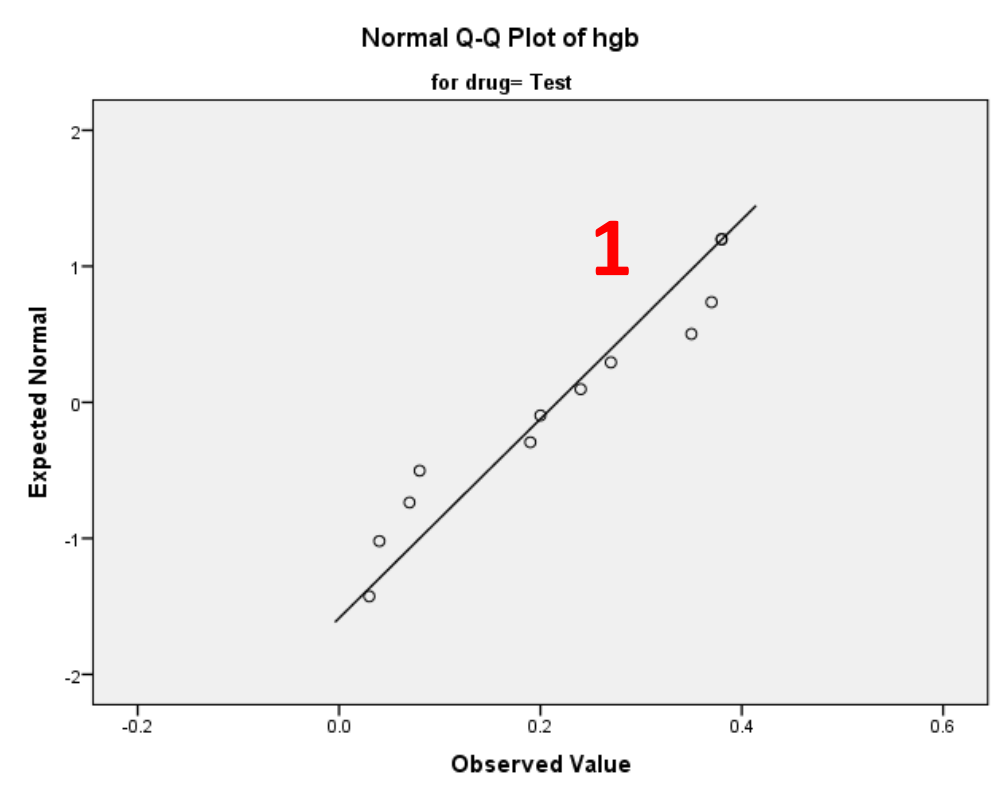
Note: The test of normality **Kolmogorov-Smirnov** is used when the number of patients exceeds 50.

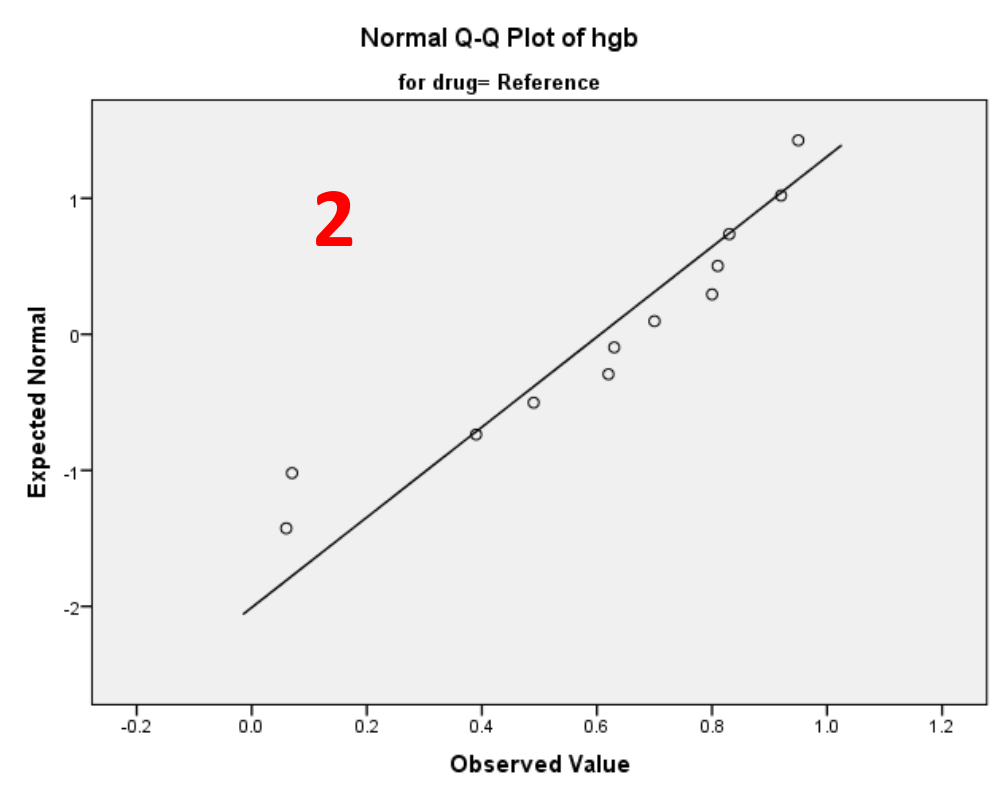
Descriptives

	drug			Statistic	Std. Error
hgb	Test	Mean		.2167	.03943
		95% Confidence Interval for Mean	Lower Bound	.1299	
			Upper Bound	.3035	
		5% Trimmed Mean		.2180	
		Median		.2200	
		Variance		.019	
		Std. Deviation		.13660	
		Minimum		.03	
		Maximum		.38	
		Range		.35	
		Interquartile Range		.29	
		Skewness		-.124	.637
		Kurtosis		-1.634	1.232
	Reference	Mean		.6058	.08710
		95% Confidence Interval for Mean	Lower Bound	.4141	
			Upper Bound	.7975	
		5% Trimmed Mean		.6170	
		Median		.6650	
		Variance		.091	
		Std. Deviation		.30174	
		Minimum		.06	
		Maximum		.95	
		Range		.89	
		Interquartile Range		.41	
		Skewness		-.907	.637
		Kurtosis		-.173	1.232

Test of normality using Q-Q Plots

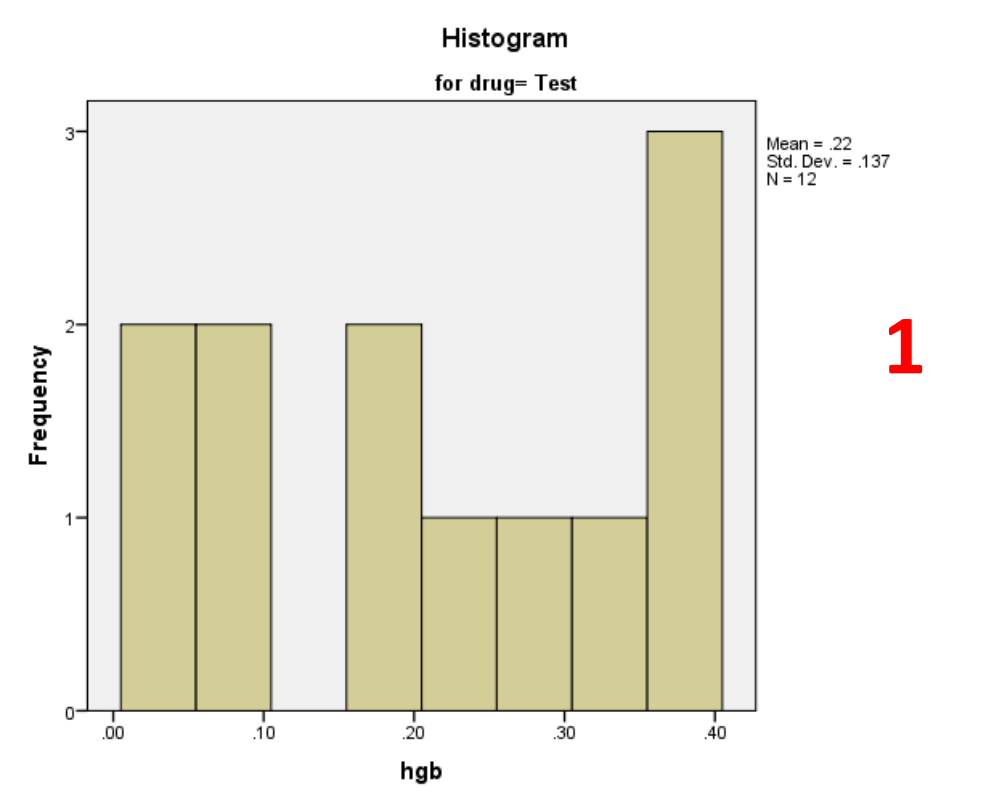
Figures 1 and 2 show the **Q-Q plots** of the patients' hemoglobin values for the Test and Reference drugs. These plots indicate that the hemoglobin values **approximate a normal distribution well**



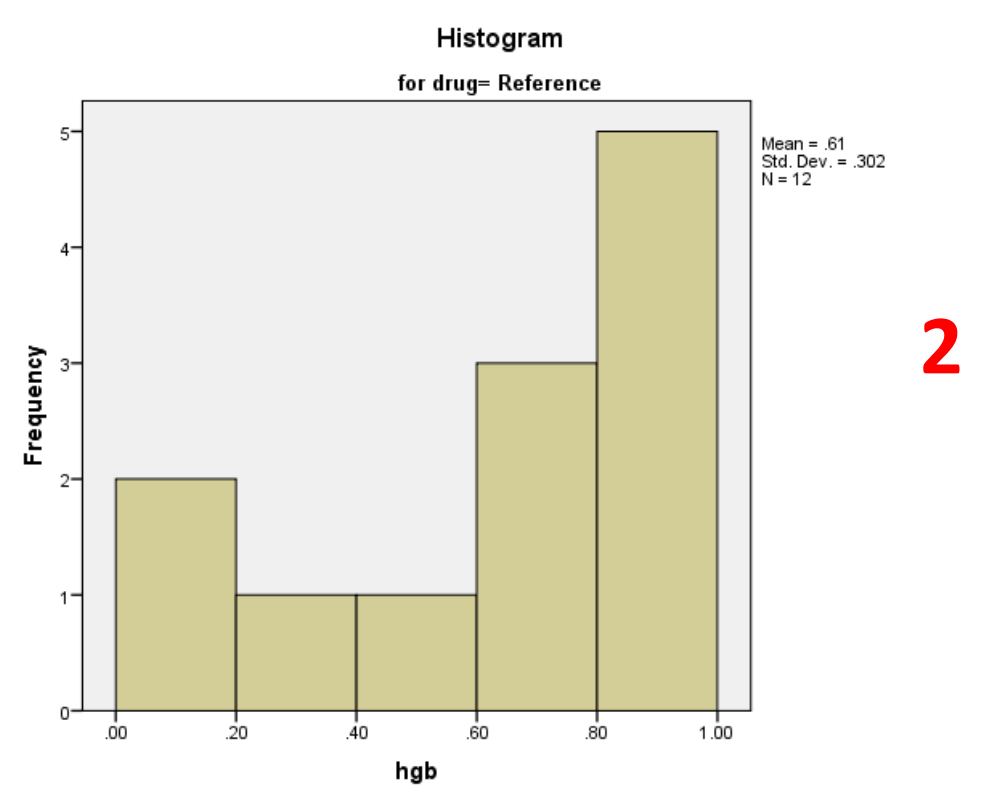


Test of normality using histograms

Figures 1 and 2 show the **Histograms** of the patients' hemoglobin values for the Test and Reference drugs. These plots indicate that the hemoglobin values **do not approximate a normal distribution well** (note that histograms can sometimes be misleading)

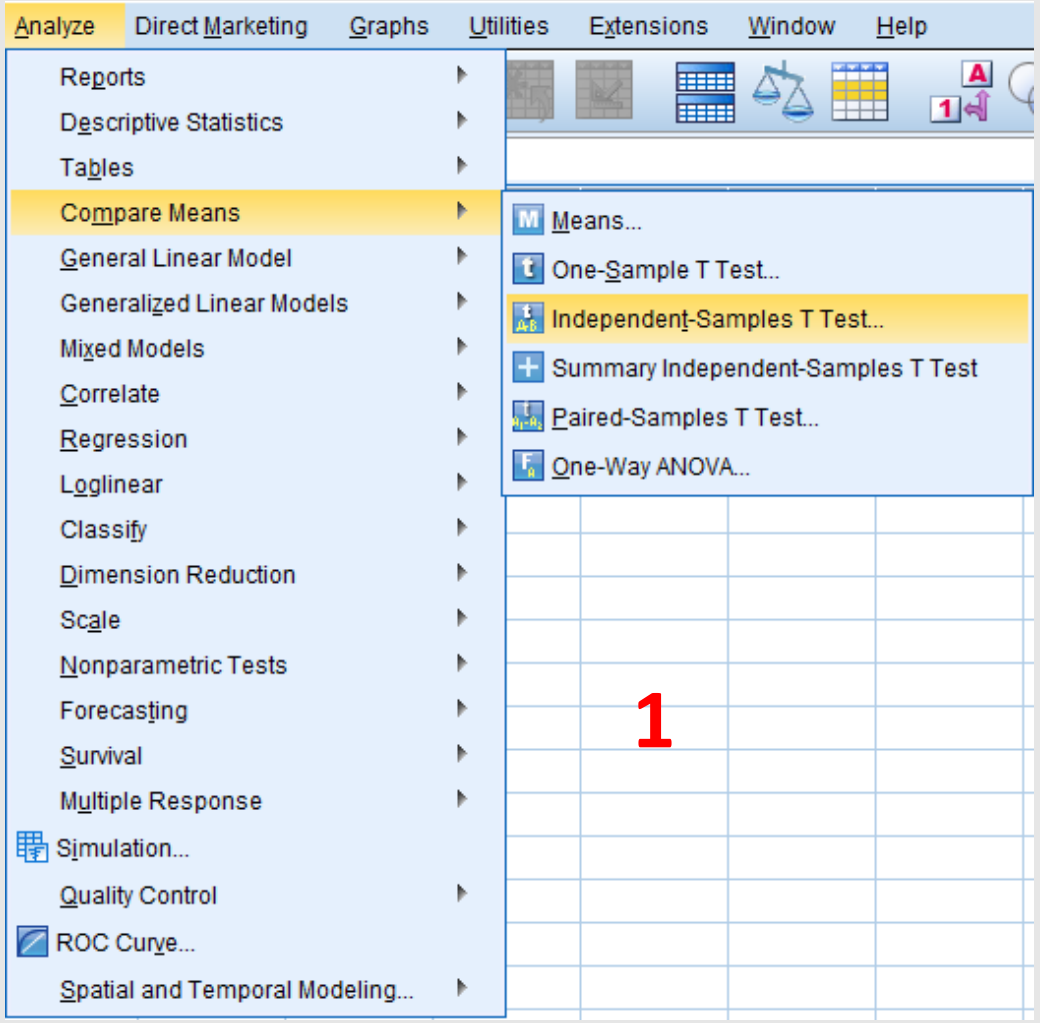


1

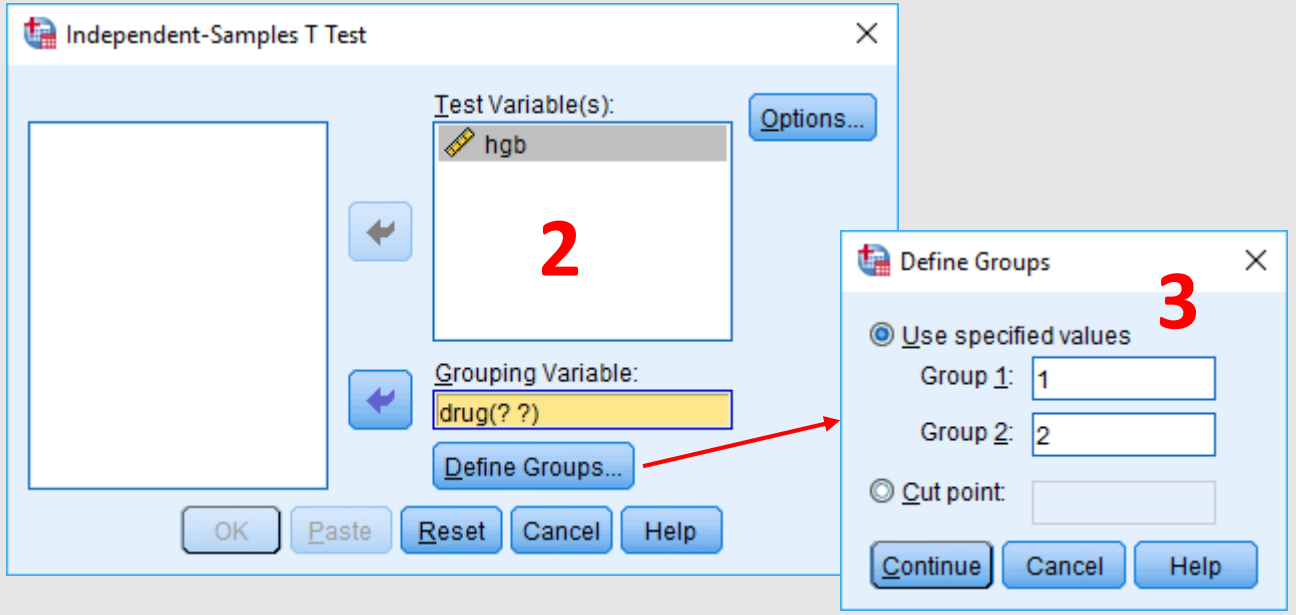


2

Running the Independent Samples T Test



1. To analyze the data, select **Analyze** from the menu, then choose **Compare Means** and **Independent-Samples T Test…(**1)



2. In window (2) drag the variable **hgb** from the left panel to the **Test Variable(s)** box, and the variable **drug** to the **Grouping Variable:** box**.** Press the **Define Groups…** button, define the two groups, and then press **Continue** and **OK**

Group Statistics

	drug	N	Mean	Std. Deviation	Std. Error Mean
hgb	Test	12	.2167	.13660	.03943
	Reference	12	.6058	.30174	.08710

The variances between the two drugs are not equal, as the p-value of Levene's test is less than 0.05 ($p < 0.05$)

Since the p-value is less than 0.05 ($p < 0.05$), we reject the null hypothesis and conclude that there is a significant difference in mean hemoglobin change between the two drugs ($t(15.327) = -4.070$, $p = 0.001$)

Independent Samples Test

		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
hgb	Equal variances assumed	5.019	.035	-4.070	22	.001	-.38917	.09561	-.58746	-.19087
	Equal variances not assumed			-4.070	15.327	.001	-.38917	.09561	-.59259	-.18575

- There is a difference in hemoglobin change of -0.389 between the test and reference drugs. This difference is statistically significant, as the p-value is less than 0.05 ($p < 0.05$)
- With 95% confidence interval (CI), the true difference lies between -0.593 and -0.186. Since 0 is not included in the 95% confidence interval (CI), we conclude that the difference is statistically significant

Practical exercise

The weight (kg) of newborn children born to 15 non-smoking women and 14 smoking women is presented in the following data :

Sample 1 Non-smokers	Sample 2 Smokers
3.99	3.18
3.79	2.84
3.60	2.90
3.73	3.27
3.21	3.85
3.60	3.52
4.08	3.23
3.61	2.76
3.83	3.60
3.31	3.75
4.13	3.59
3.26	3.63
3.54	2.38
3.51	2.34
2.71	

Is there a difference in the weight of newborn children between the two groups?