Paired samples t-test

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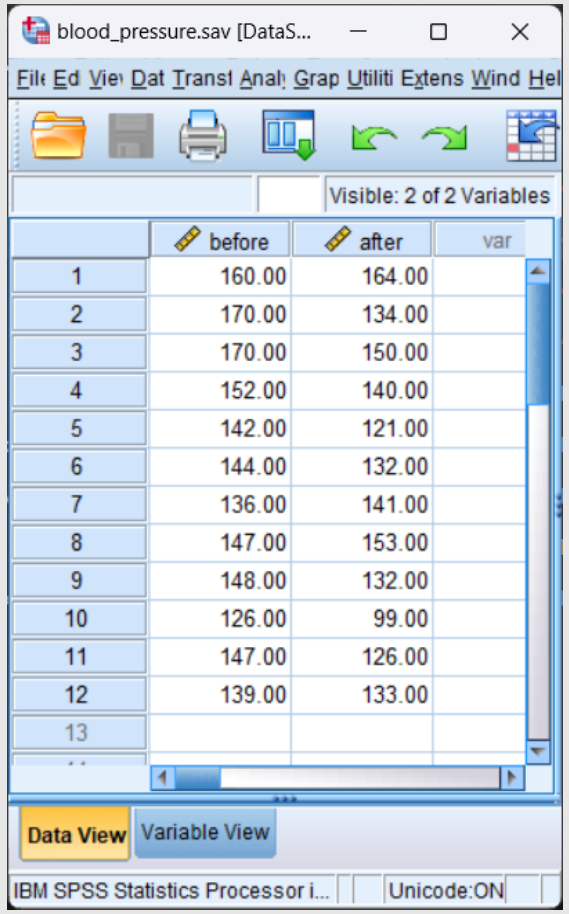
Evaluating the Effectiveness of Hypotensive Drug

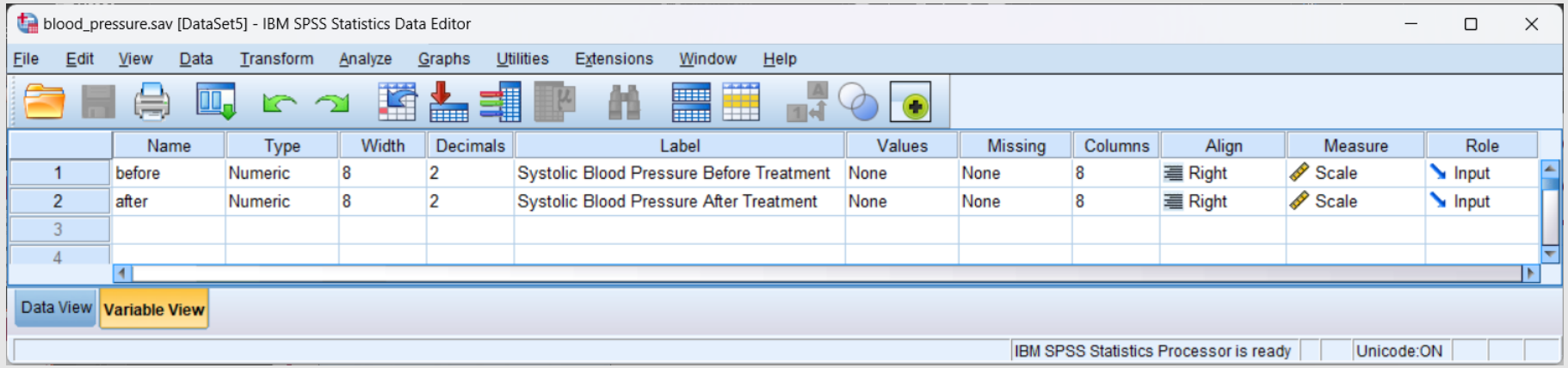
Evaluating the Effectiveness of Hypotensive Drug

Twelve people were given a drug believed to have hypotensive properties. The systolic blood pressure of these subjects, measured in millimeters of mercury, before and after drug administration, is shown on the next slide. We want to:

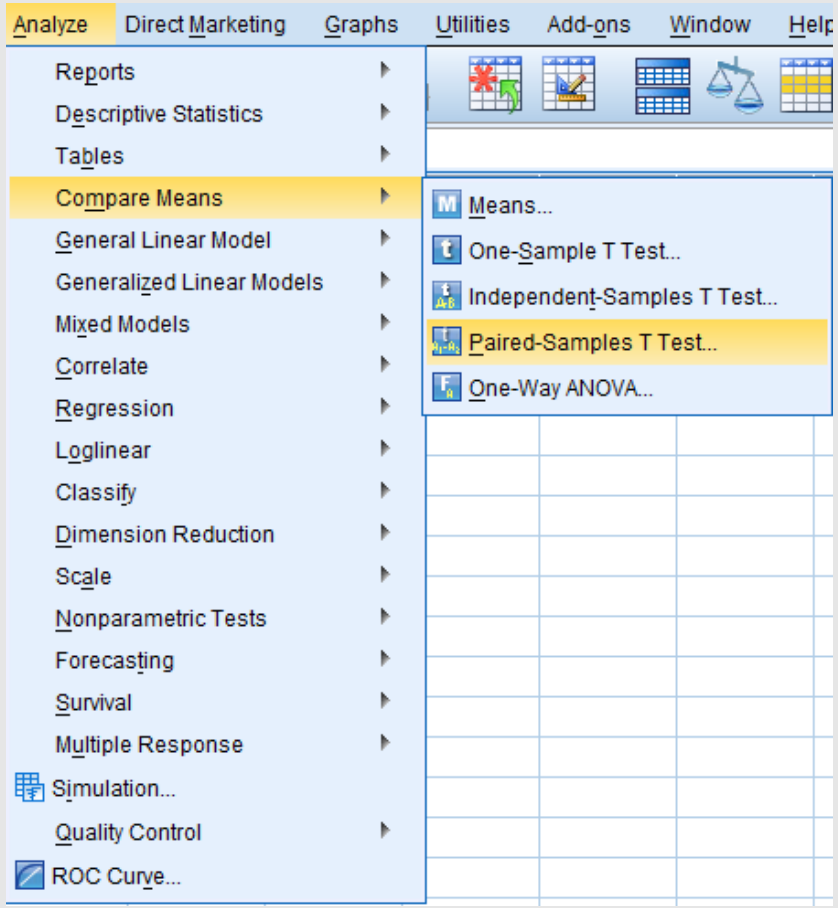
a. statistically evaluate the potential hypotensive activity of the drug and
b. establish the reliability limits of the mean hypotensive activity

Entering data and defining variables

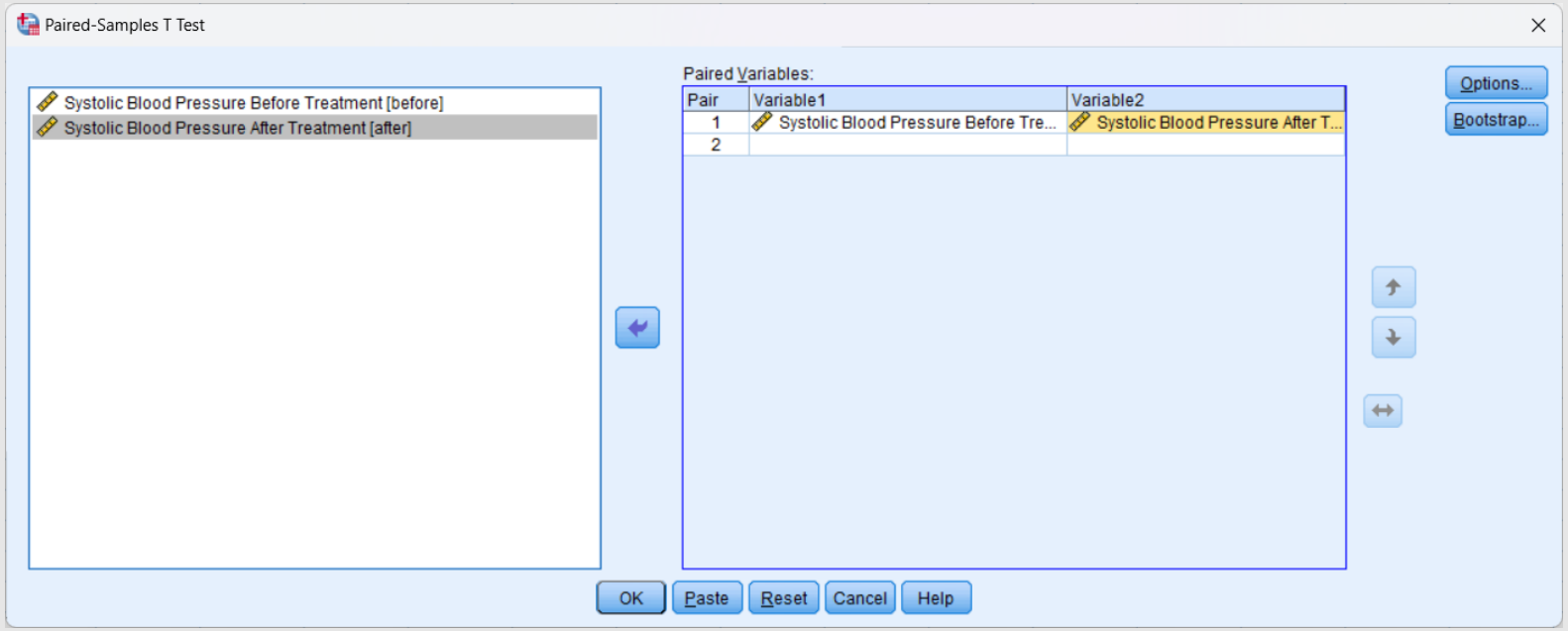




Running the Paired-Samples T Test



1. To analyze the data, select **Analyze -> Compare Means -> Paired-Samples T Test…** (1)



2. Drag the two variables from the left panel to the **Paired Variables** box, and press **OK**

Results and interpretation

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Systolic Blood Pressure Before Treatment	148.4167	12	13.10419	3.78285
	Systolic Blood Pressure After Treatment	135.4167	12	16.63763	4.80287

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Systolic Blood Pressure Before Treatment & Systolic Blood Pressure After Treatment	12	.625	.030

Paired Samples Test

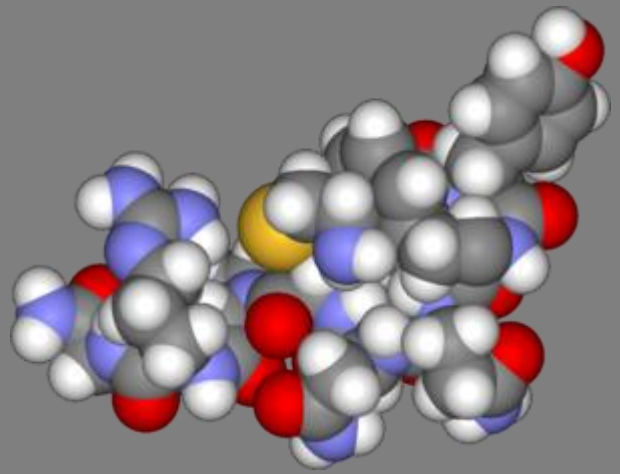
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Systolic Blood Pressure Before Treatment - Systolic Blood Pressure After Treatment	13.00000	13.26650	3.82971	4.57087	21.42913	3.395	11	.006

- The drug indeed possesses hypotensive effects ($p < 0.05$, statistically significant)
- Mean hypotensive response was estimated to be 13.0 mm Hg
- With a 95% confidence internal (CI), the true mean hypotensive response lies between 4.57 και 21.43. Since 0 is not included in the 95% CI, we conclude that the mean response is statistically significant

Mean difference $= 148.42 - 135.42 = 13$

t = (Mean difference)/SE=13/3.83=3.39

Change in the Amount of Hormone in the Blood



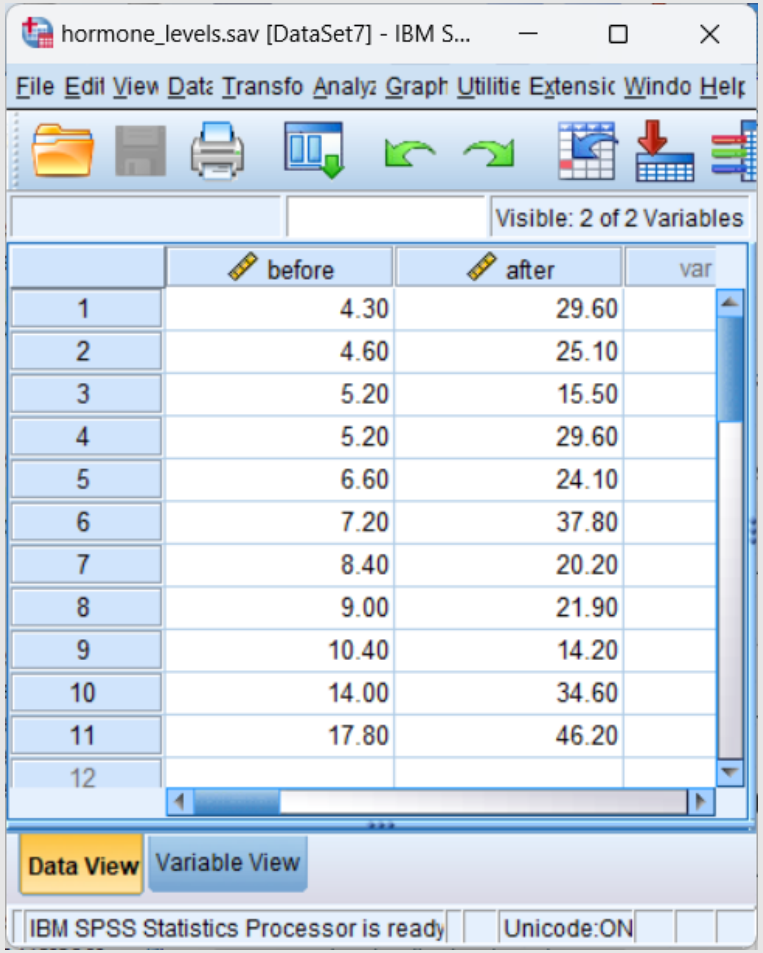
Change in the Amount of Hormone in the Blood

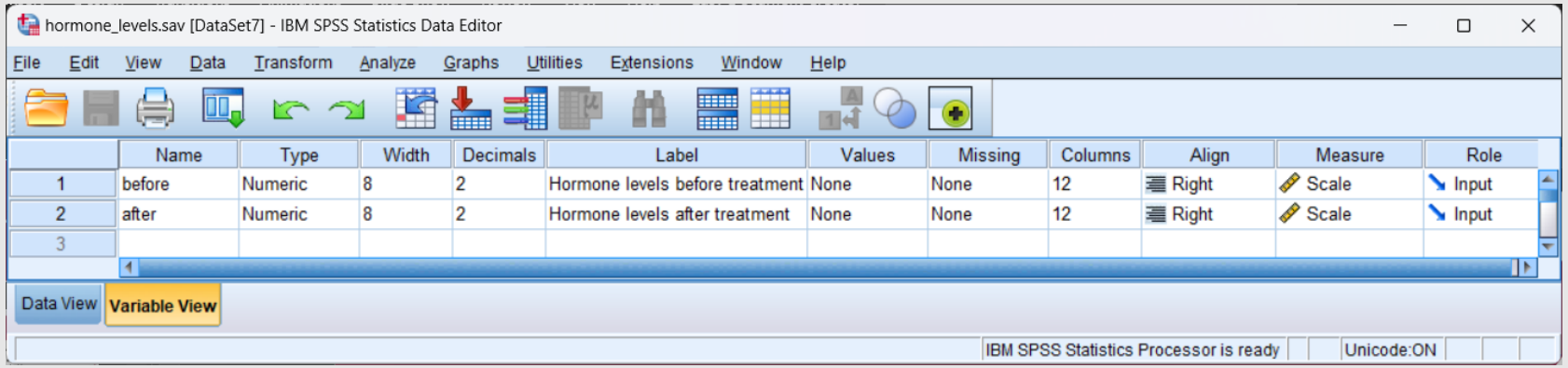
Before	After
4.30	29.60
4.60	25.10
5.20	15.50
5.20	29.60
6.60	24.10
7.20	37.80
8.40	20.20
9.00	21.90
10.40	14.20
14.00	34.60
17.80	46.20

The amount of a hormone found in the blood of eleven patients before and after treatment administration is provided. Did the treatment change the patients' average hormone levels?

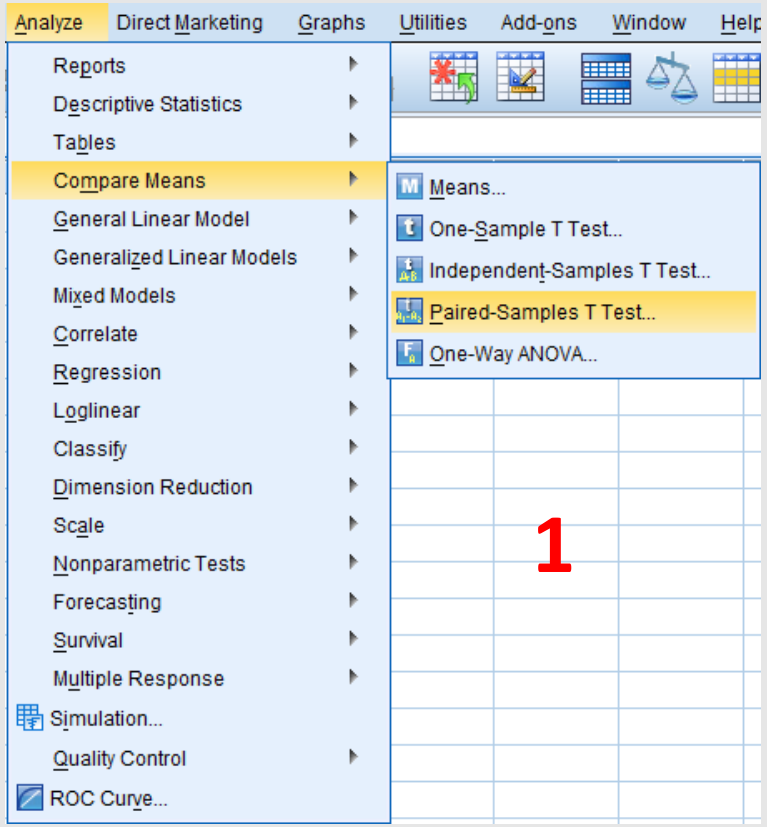
Null hypothesis (H_0): There is no significant difference in hormone levels before and after treatment administration

Entering data and defining variables

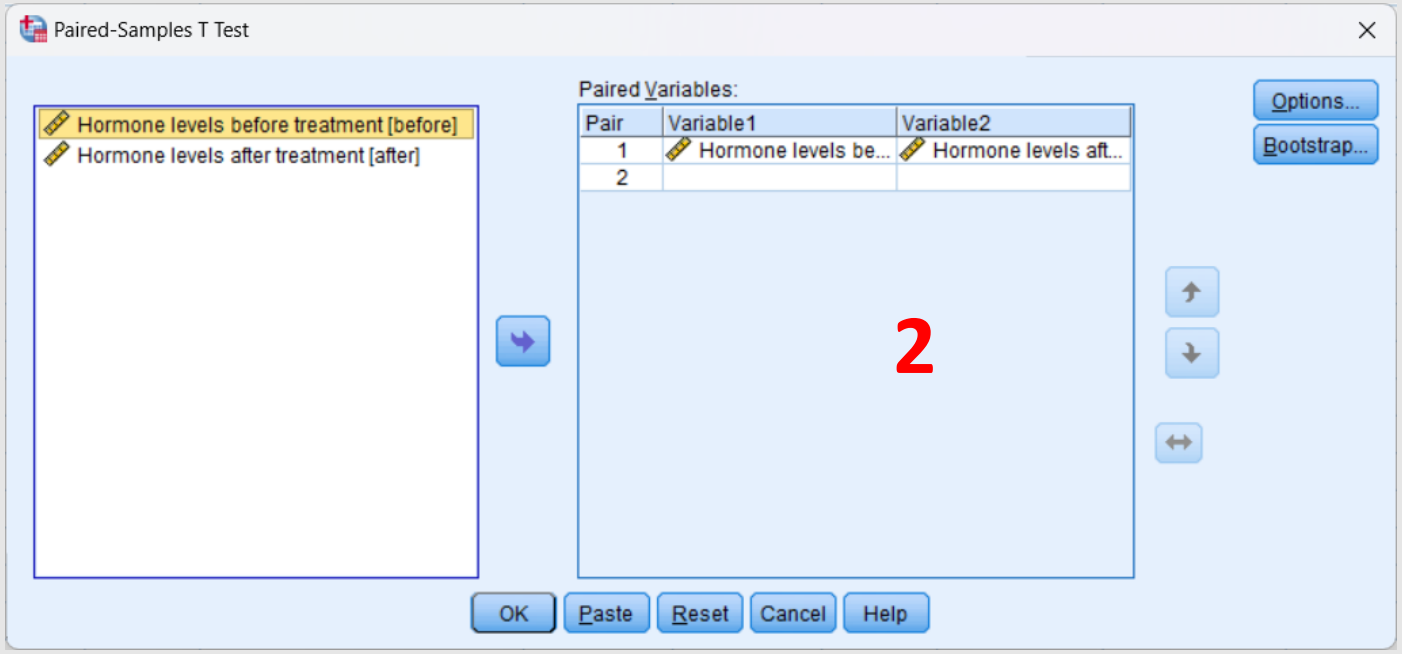




Running the Paired-Samples T Test



1. To analyze the data, select **Analyze -> Compare Means -> Paired-Samples T Test…** (1)



2. Drag the two variables from the left panel to the **Paired Variables** box, and press **OK** (2)

Result and interpretation

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Hormone levels before treatment	8.4273	11	4.24832	1.28092
	Hormone levels after treatment	27.1636	11	9.67794	2.91801

Paired Samples Correlations

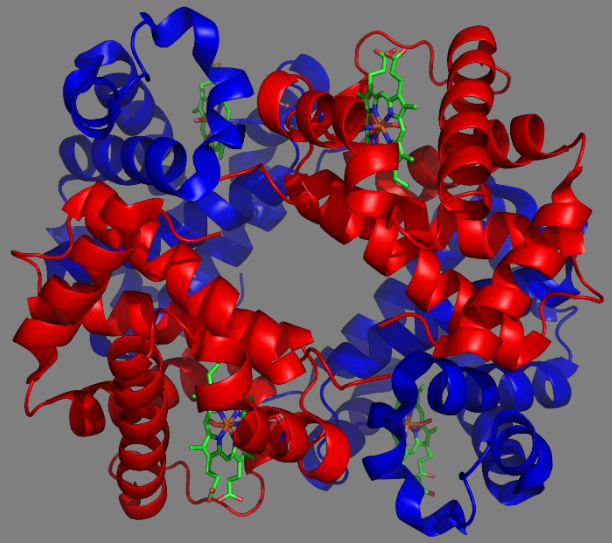
		N	Correlation	Sig.
Pair 1	Hormone levels before treatment & Hormone levels after treatment	11	.515	.105

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	Hormone levels before treatment - Hormone levels after treatment	-18.73636	8.32974	2.51151	-24.33236	-13.14037	-7.460	10	.000

- The treatment significantly increases the hormone levels in the blood ($t(10)=-7.46$, $p<0.001$)
- The mean increase in hormone levels was estimated to be 18.74 units
- With 95% confidence interval (CI), the true increase lies between 13.14 and 24.33. Since 0 is not included in the 95% confidence interval (CI), we conclude that the increase is statistically significant

Hemoglobin change after administration of EPO



Hemoglobin change after administration of EPO

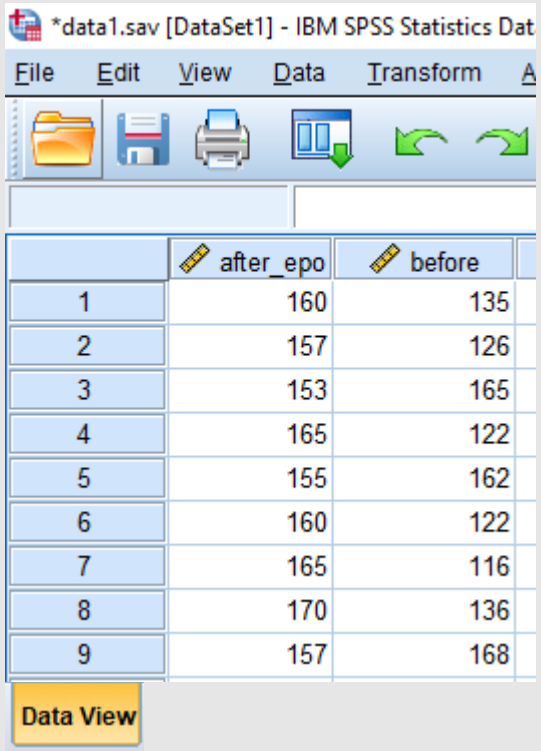
Suppose we want to compare the hemoglobin change after administration of erythropoietin (EPO) in 9 patients. The data (g/L) are as follows::

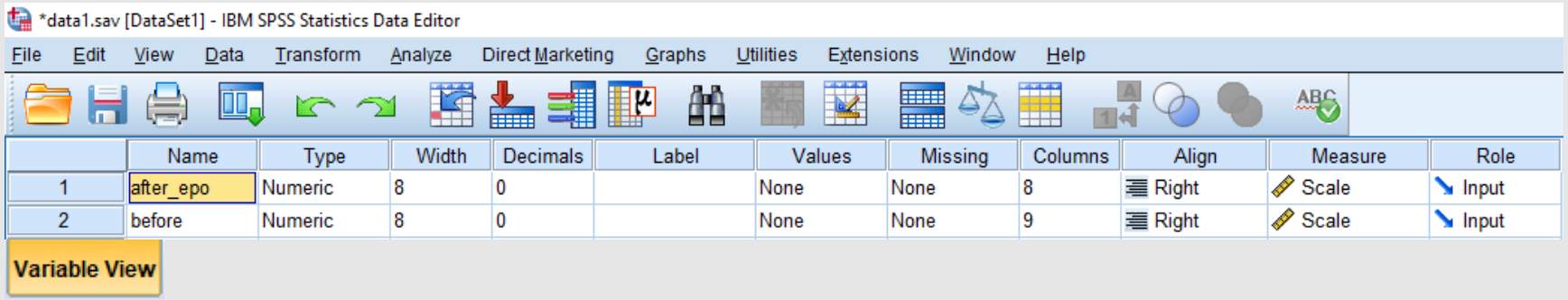
Subject	After use of EPO	Before
1	160	135
2	157	126
3	153	165
4	165	122
5	155	162
6	160	122
7	165	116
8	170	136
9	157	168

Null hypothesis (H_0): There is no change in hemoglobin levels in the patients before and after erythropoietin administration.

Entering data and defining variables

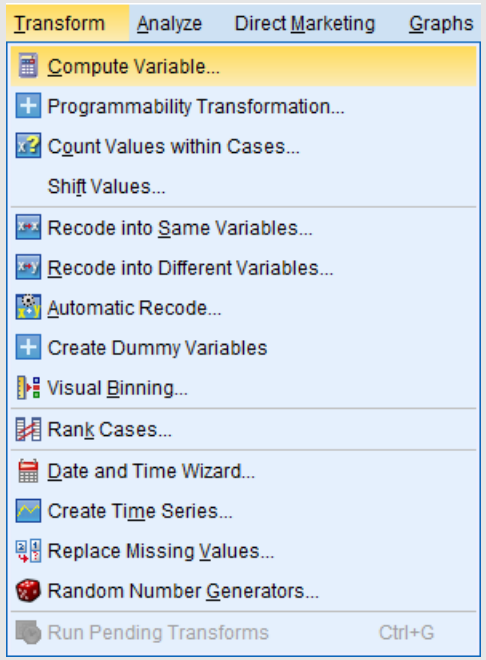
We enter the data in the **Data View** and define the variables in the **Variable View** as shown below

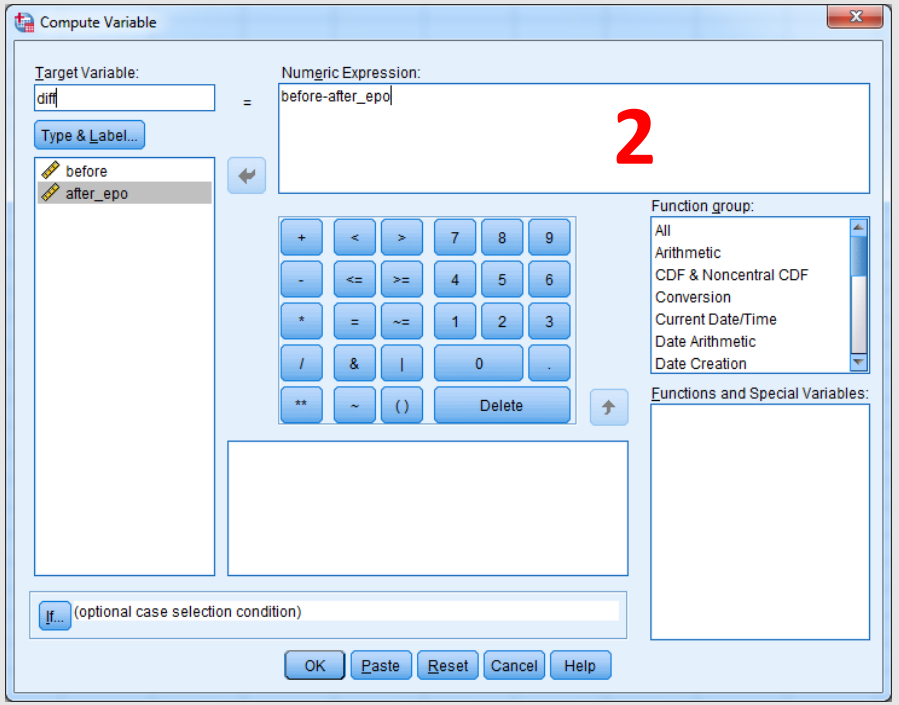




Test of normality

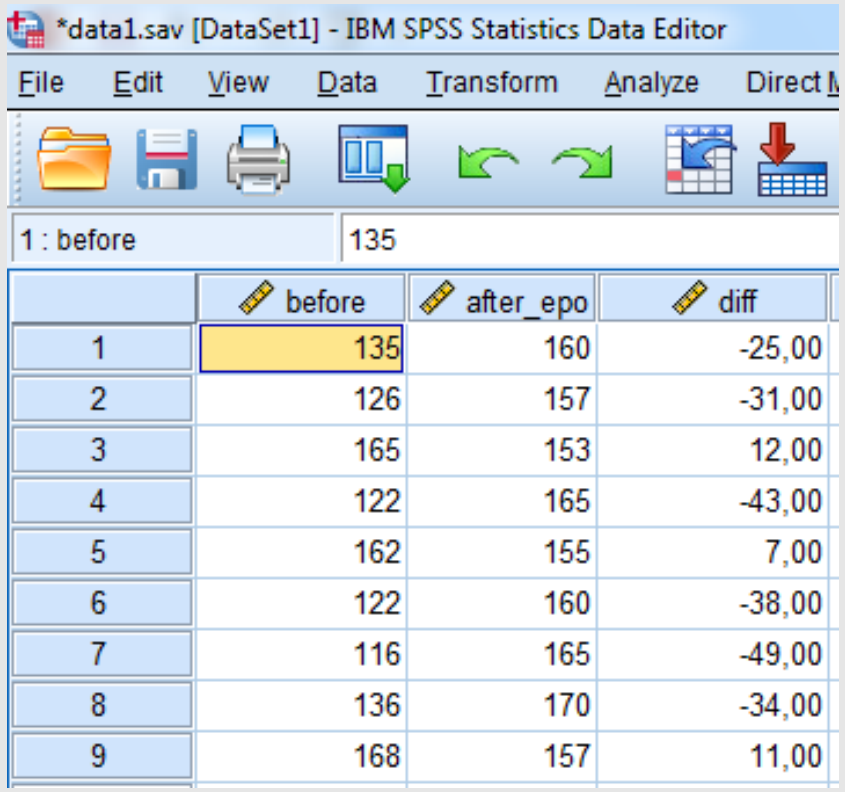
Since these are **paired observations**, the normality test will be conducted on the difference between them. To compute this, select **Transform -> Compute Variable** from the menu. In the window that appears (2), drag the before variable into the **Numeric Expression:** box, type a minus sign, then drag the after_epo variable into the same box. Enter the name diff for the new variable in the **Target Variable:** field and click **OK**.





Test of normality

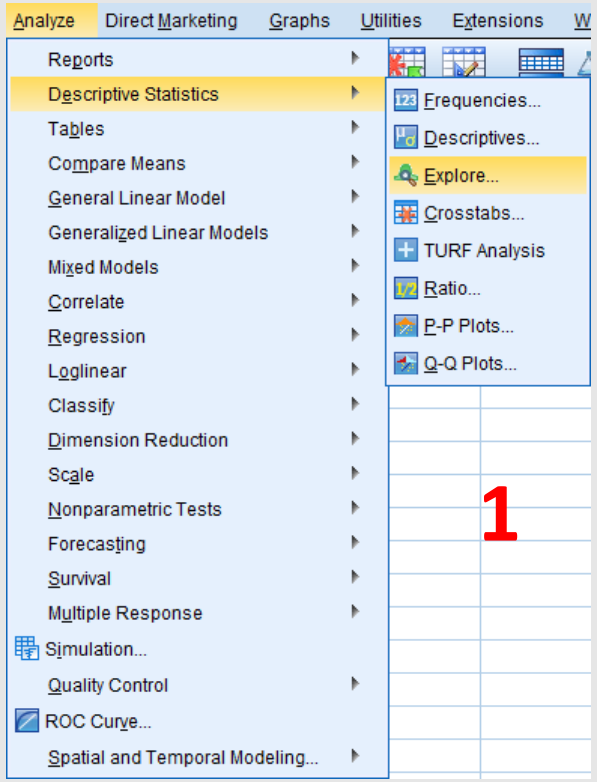
Immediately afterward, the new variable will appear in the Data Editor as shown in the image below. The variable type will be automatically set to **Scale.**

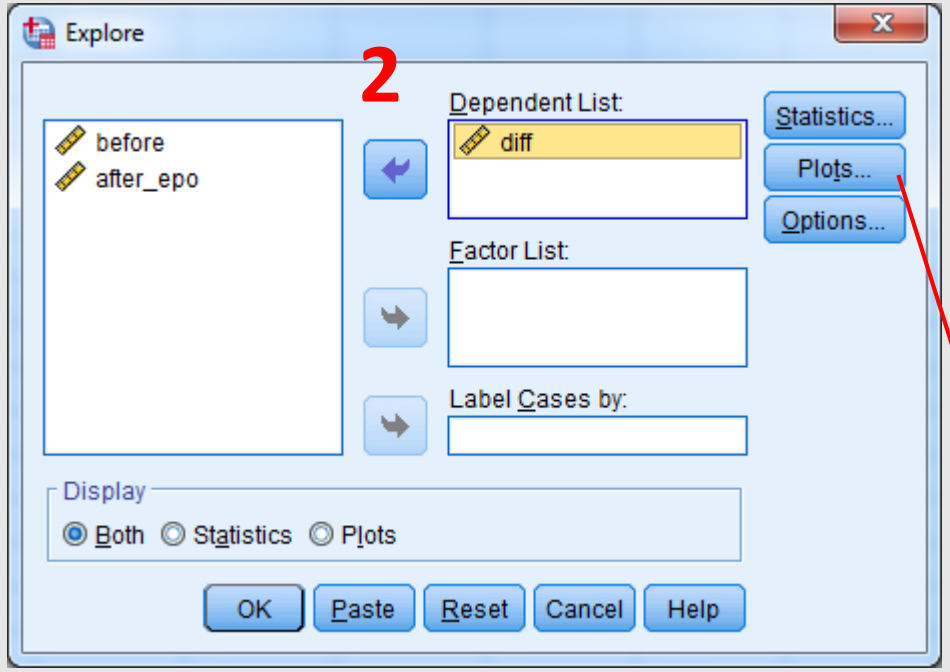


	before	after_epo	diff
1	135	160	-25,00
2	126	157	-31,00
3	165	153	12,00
4	122	165	-43,00
5	162	155	7,00
6	122	160	-38,00
7	116	165	-49,00
8	136	170	-34,00
9	168	157	11,00

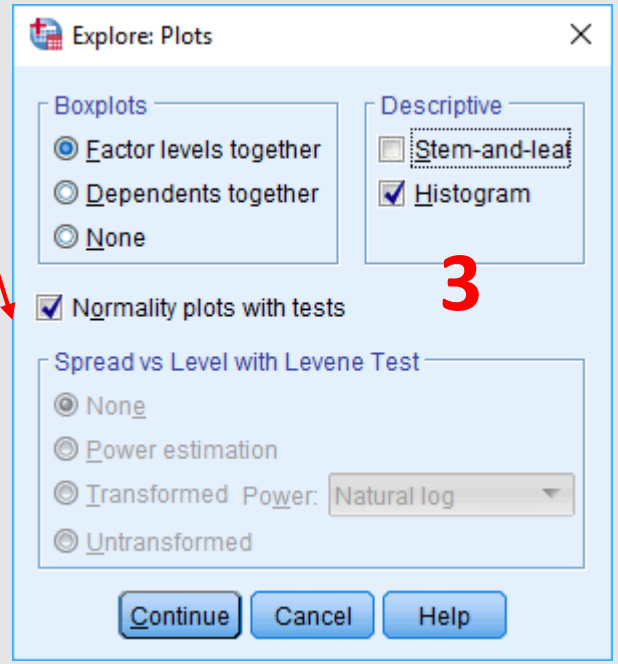
Test of normality

Next, select **Analyze -> Descriptive Statistics -> Explorer** from the menu. In the window that appears (2) drug the new **diff** variable from the left box to the **Dependent List:** box. Then, choose **Plots...** …





… In the window that appears (3), select **Histrogram** and **Normality plots with tests**. Press **Continue** and **OK**.



Test of normality

Among other results, the following appear in the SPSS output window.

Case Processing Summary 1

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
diff	9	100.0%	0	0.0%	9	100.0%

Tests of Normality 2

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
diff	.230	9	.186	.843	9	.062

a. Lilliefors Significance Correction

Based on the **Shapiro – Wilk** test (n < 50), we conclude that the differences in hemoglobin values follow a normal distribution, as the p-value (Sig.) is greater than 0.05 (p-value = 0.062).

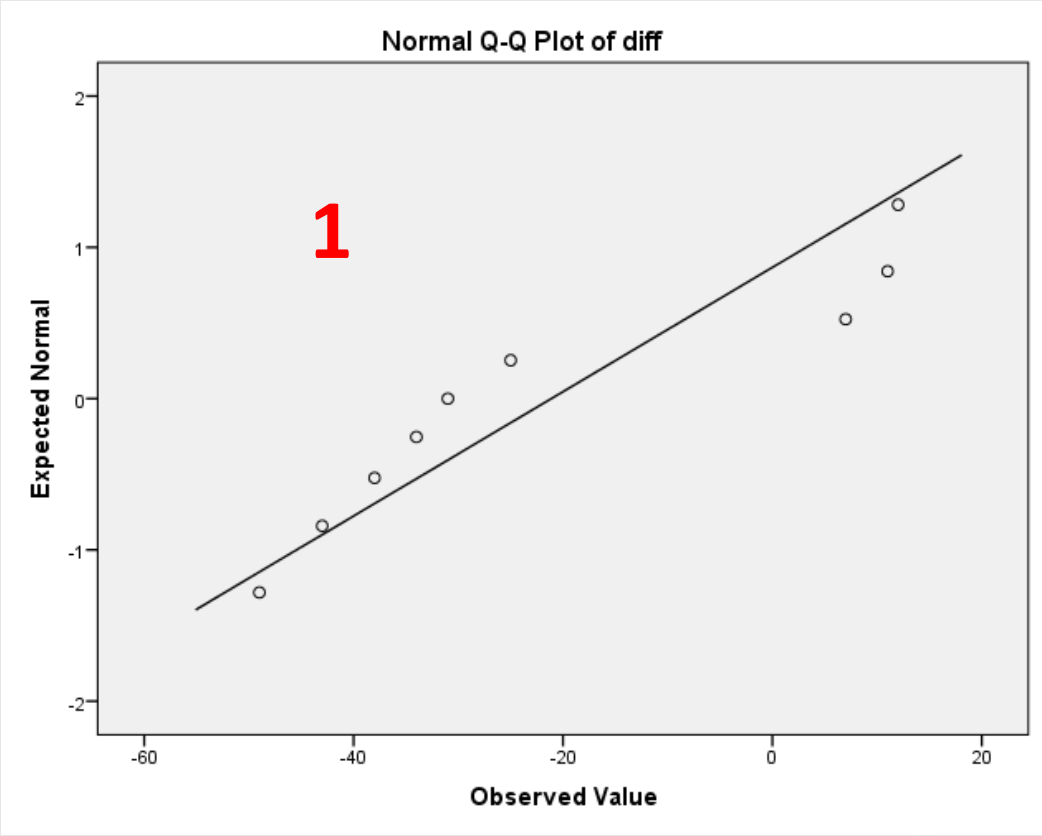
Note: The test of normality **Kolmogorov-Smirnov** is used when the number of patients exceeds 50.

Descriptives

			Statistic	Std. Error
diff	Mean		-21.1111	8.11282
	95% Confidence Interval for Mean	Lower Bound	-39.8193	
		Upper Bound	-2.4029	
	5% Trimmed Mean		-21.4012	
	Median		-31.0000	
	Variance		592.361	
	Std. Deviation		24.33847	
	Minimum		-49.00	
	Maximum		12.00	
	Range		61.00	
	Interquartile Range		49.50	
	Skewness		.574	.717
	Kurtosis		-1.638	1.400

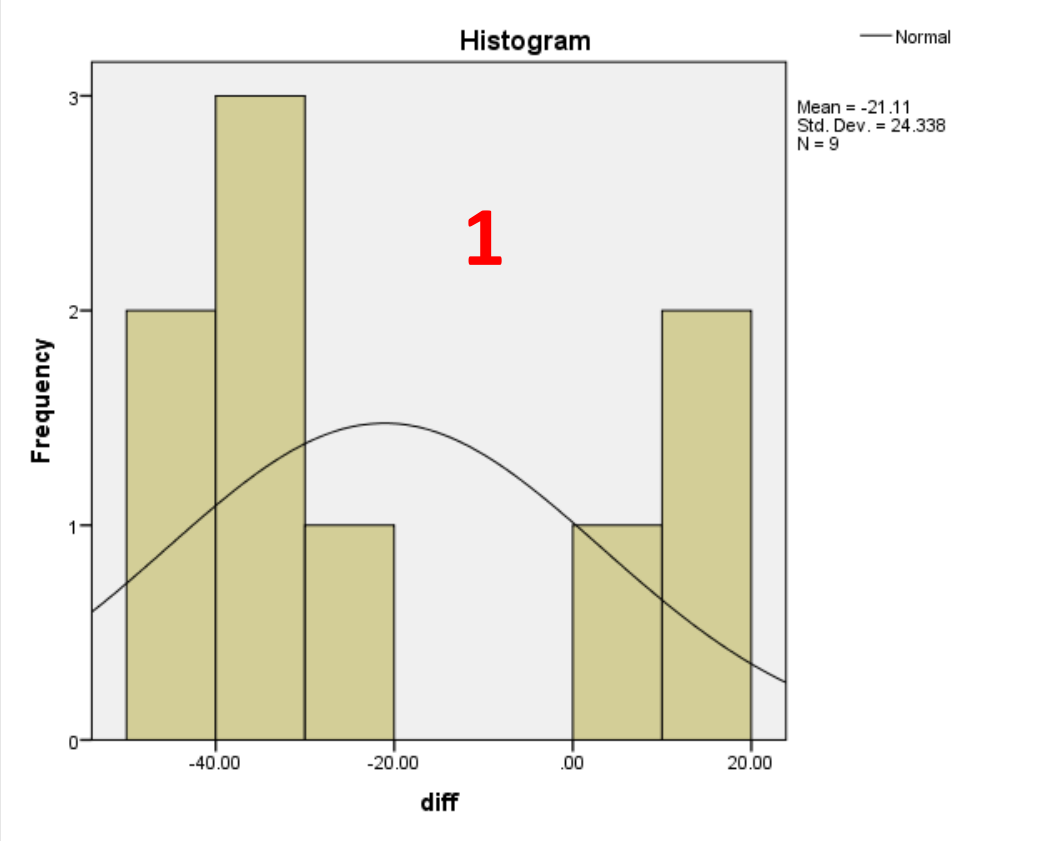
Test of normality using Q-Q plots

The figure (1) below shows the **Q-Q plot** of the differences in hemoglobin values, indicating that these values follow **a normal distribution well**

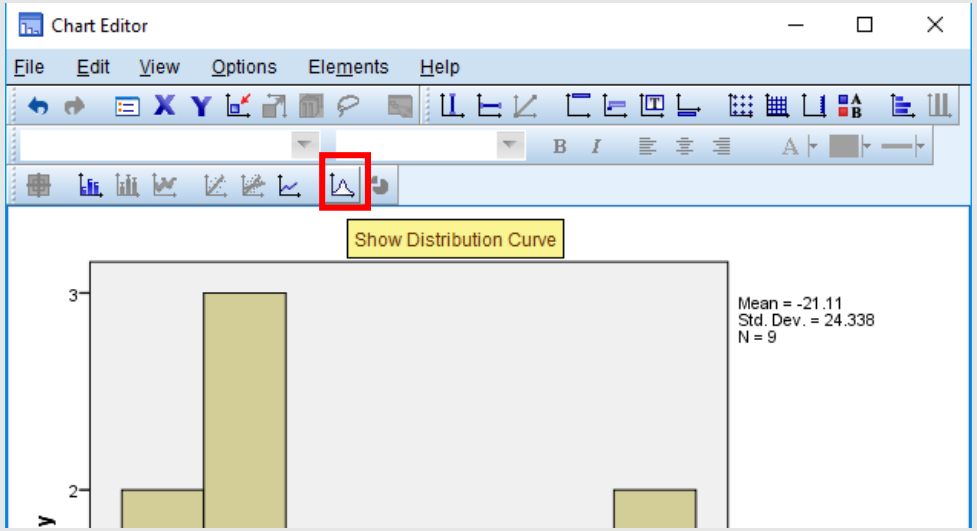


Test of normality using histograms

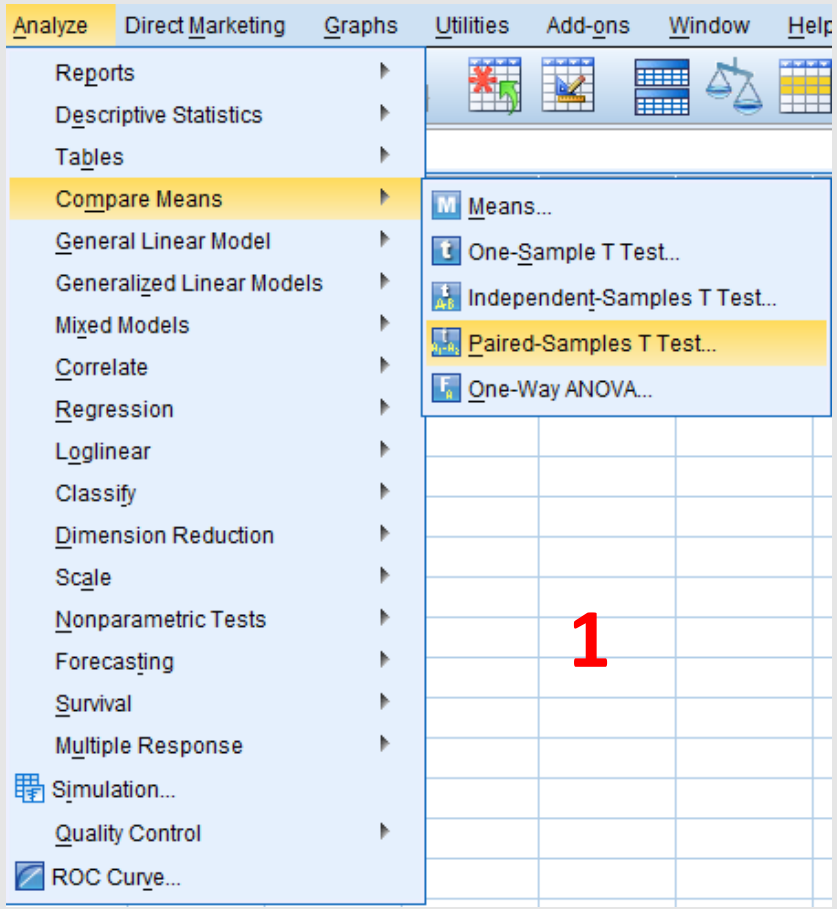
Figures 1 shows the **histogram** of the difference in the hemoglobin values, indicating that they **do not follow a normal distribution** (note that histograms can sometimes be misleading)



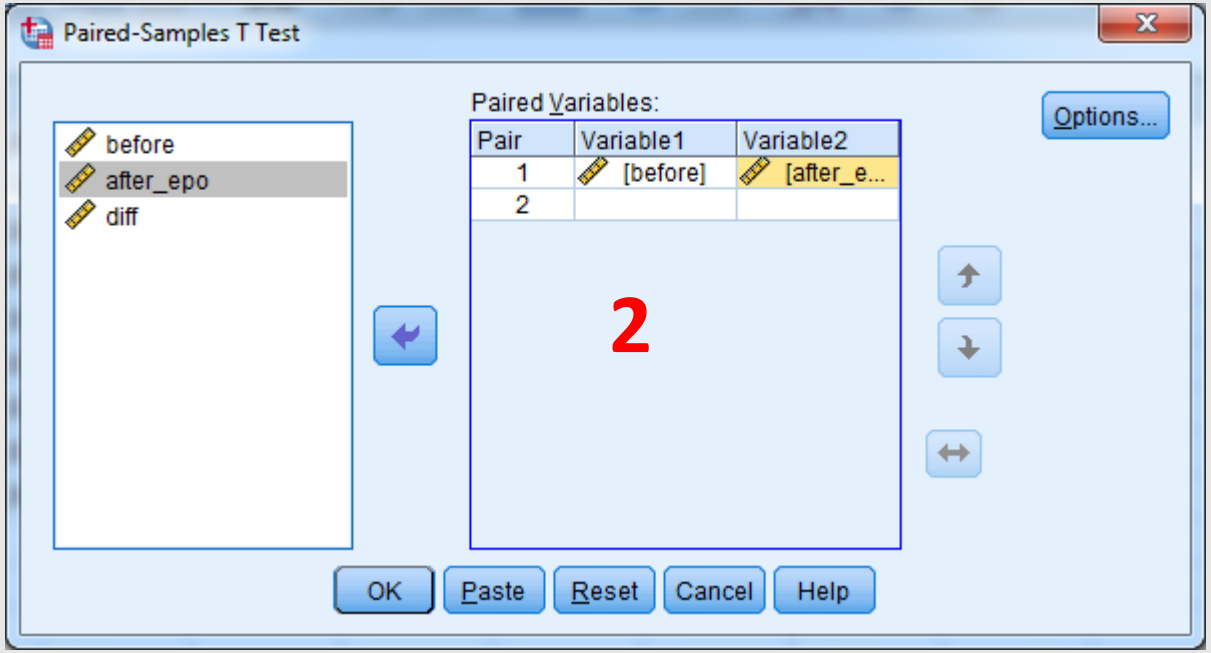
The **normality curve** was displayed by double-clicking on the histogram and selecting the **Show Distribution Curve** icon from the toolbar



Running the Paired-Samples T Test



1. To analyze the data, select **Analyze -> Compare Means -> Paired-Samples T Test…** (1)



2. Drag the two variables from the left panel to the **Paired Variables** box, and press **OK**

Results and Interpretation

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	before	139,11	9	20,454	6,818
	after_epo	160,22	9	5,495	1,832

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	before & after_epo	9	-,640	,064

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	before - after_epo	-21,111	24,338	8,113	-39,819	-2,403	-2,602	8	,032

- The administration of EPO indeed increased the hemoglobin levels
- The mean difference (21.111 g/L) in hemoglobin levels was found to be statistically significant at $p < 0.05$
- With 95% confidence interval (CI), the true mean difference lies between -39.819 and -2.403. Since 0 is not included in the 95% confidence interval (CI), we conclude that the mean difference is statistically significant