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1. CHOOSING THE APPROPRIATE STATISTICAL TEST TO COMPARE THE DISTRIBUTIONS OF A QUANTITATIVE VARIABLE IN TWO POPULATIONS (SEE THE TABLE BELOW):

Sample sizes (n_1, n_2)	Type of samples	Type of distribution	Parameters compared	Test name
n_1 <30 ($n_1 \geq 30$) n_2 <30 ($n_2 \geq 30$)	independent	Normal probability distribution *or* Student's t distribution	means	Student's t-test with equal variances or Student's t-test with unequal variances (Welch test)
n_1 <30 ($n_1 \geq 30$) n_2 <30 ($n_2 \geq 30$)	dependent	Normal probability distribution *or* Student's t distribution	means	Student's t-test for dependent samples

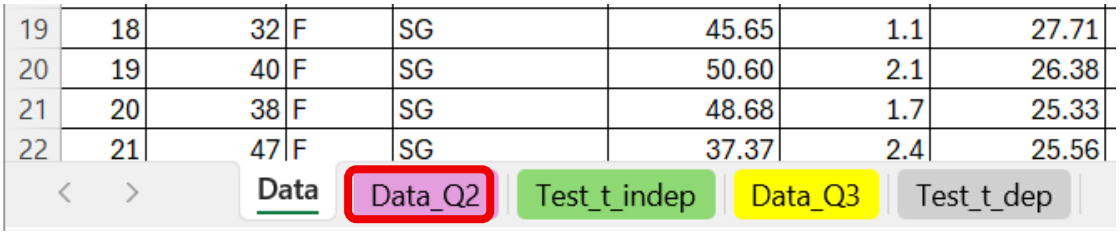
2. STATING THE NULL AND ALTERNATIVE HYPOTHESES FOR THE TWO-TAILED STUDENT'S T-TEST:

Null hypothesis (H_0): **There is no statistically significant difference** between the **MEANS** of the study variable **in the two populations** (from which the samples were drawn) (⇔ the difference in means is equal to 0; where ⇔ = OR)

Alternative hypothesis (H_1): **There is a statistically significant difference** between the **MEANS** of the study variable **in the two populations** (from which the samples were drawn) (⇔ the difference in means differs significantly from 0)

3. IMPORTING THE DATABASE AND CHECKING THE VARIABLES

- Before importing data from an **Excel file** into **JAMOVI**, always check that the **worksheet containing the desired data** is **selected in Excel**; in our case, the worksheet named **"Data_Q2".**



- The structure of the **Data_Q2** worksheet will be as follows:

	A	B
1	**Surgery_type (SG/MM)**	**BMI_Final (kg/m2)**
2	SG	24.96
3	SG	35.47
4	SG	26.59
5	SG	33.05
6	SG	31.83
7	SG	24.37
8	SG	31.70
9	SG	28.78
10	SG	27.98
11	SG	31.02
12	SG	33.55
13	SG	26.76
14	SG	31.10
15	SG	29.65

- In **JAMOVI**: ☰(menu) → **Open** → **Browse** → choose the file → **Open**.

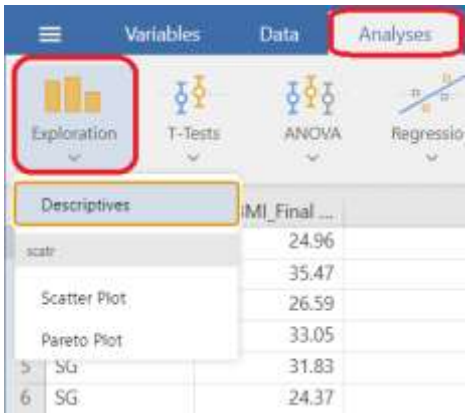
Attention! *The import steps are identical to those in the Lab 05 Instructions, section 1.*

- Check the type of each variable (double-click on the column name → the **Measure type** field).
- For quantitative variables, make sure that, in the **Measure type** selection area, the **Continuous** option is selected. For qualitative variables, make sure that, in the **Measure type** selection area, the **Nominal** or **Ordinal** option is selected, depending on the type of variable.

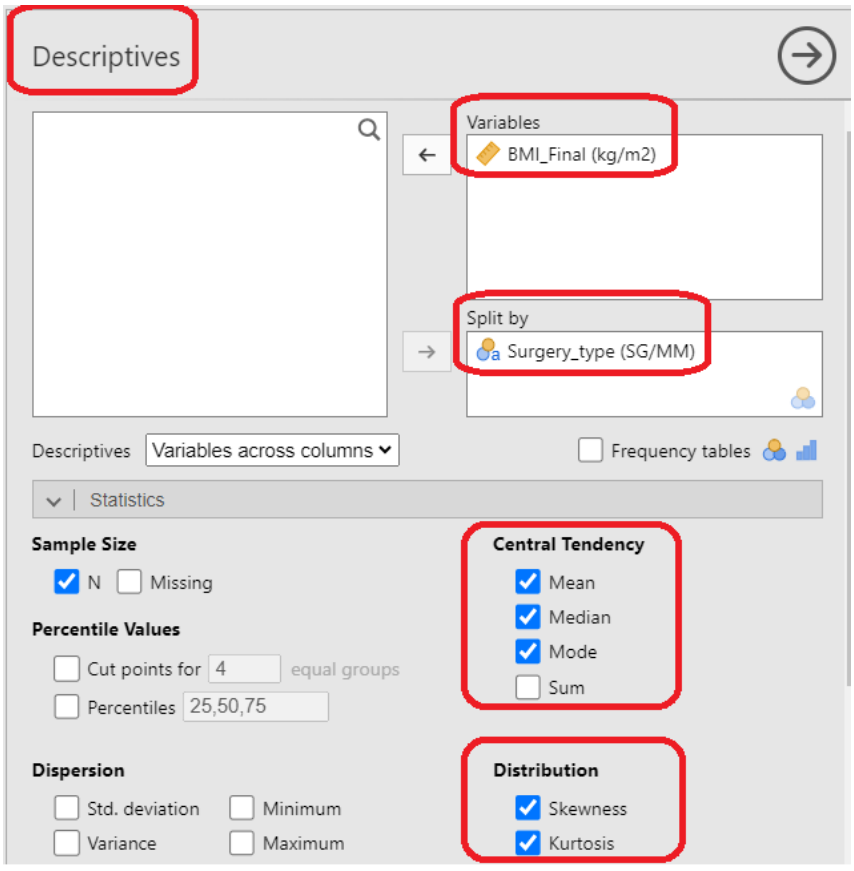
Attention! *The steps for checking the variable types are identical to those in the Lab 05 Instructions.*

4. COMPUTING DESCRIPTIVE STATISTICS by group

- To compute descriptive statistics, use the option **EXPLORATION** → **Descriptives**



- In the **Variables** field, enter the variable **BMI_Final.**
- In the **Split by** field, enter the variable Surgery_type – this way, the statistics are computed separately for each group.
- To obtain the descriptive statistics of BMI_Final by type of surgery, select under **Statistics**: the measures of central tendency, skewness and kurtosis.



- The output will look like this:

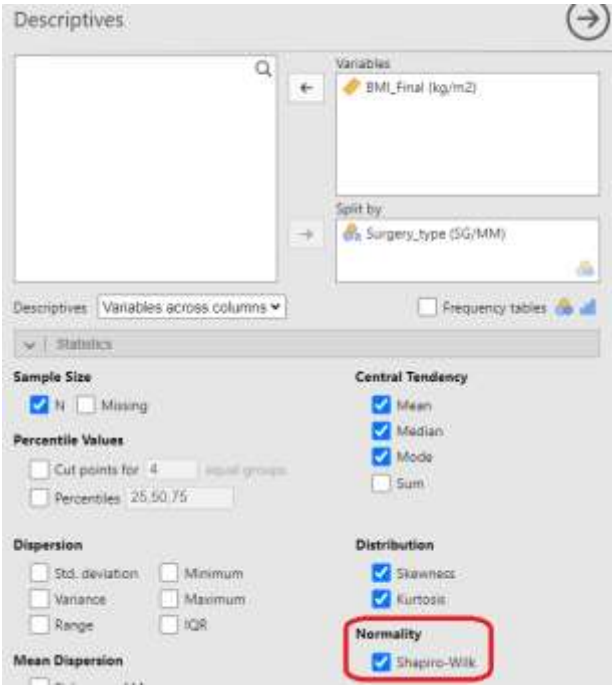
Descriptives

	Surgery_type (SG/MM)	BMI_Final (kg/m2)
N	SG	60
	MM	60
Mean	SG	29.3
	MM	34.3
Median	SG	29.4
	MM	34.4
Mode	SG	30.1
	MM	32.5*
Skewness	SG	0.169
	MM	−0.128
Std. error skewness	SG	0.309
	MM	0.309
Kurtosis	SG	−0.329
	MM	0.579
Std. error kurtosis	SG	0.608
	MM	0.608

* More than one mode exists, only the first is reported

5. NORMALITY TEST (SHAPIRO-WILK)

- In the same **EXPLORATION** → **Descriptives** analysis, select Exploration → Statistics → Normality



- The output will look like this:

Shapiro-Wilk W	SG	0.984
	MM	0.986
Shapiro-Wilk p	SG	.636
	MM	.742

[a] More than one mode exists, only the first is reported

Interpretation of the test:

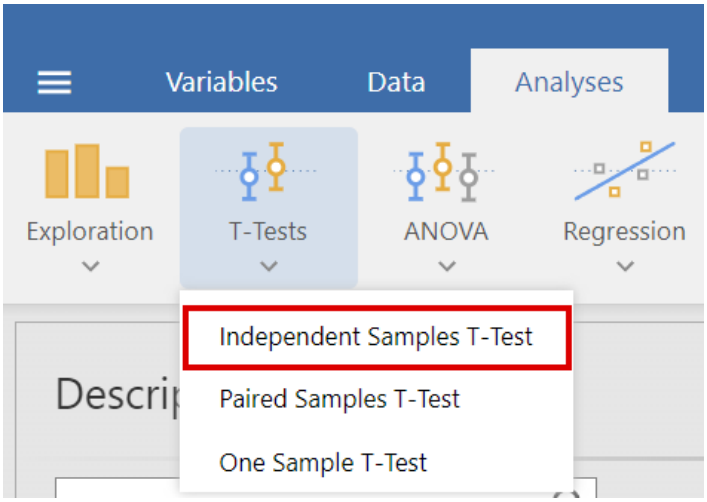
Null hypothesis (H0): The data follow a normal distribution in patients treated with SG.

Alternative hypothesis (H1): The data do NOT follow a normal distribution in patients treated with SG.

Since the **p**-value of the test in patients treated with SG was p **= 0.636 > 0.05** ⇨ we do NOT reject H_0 ⇨ there is not enough evidence to say that the data are not normally distributed in patients treated with SG.

6. STUDENT'S t-test for two INDEPENDENT samples

- In the **Analyses** tab, click the **T-Tests** button, then select **Independent Samples T-Test** from the menu.



- To compare the effectiveness of the two surgical techniques, we need to group the data by type of surgery. Therefore, select the variable **Surgery_type** and click the arrow button next to the **Grouping Variable** field.
- Then, since we want to compare **BMI_Final** values between the two groups, select the variable **BMI_Final** and click the arrow button next to the **Dependent variables** field.

- Also, in the **Tests** section, select the options **Student's** (Student's t-test with equal variances) and Welch's test (Student's t-test with unequal variances).
  - *The appropriate test is chosen based on the result of the test for equality of variances (Levene's test).*
- In the **Assumption checks** section, select the **option Homogeneity test,** which will produce a test for the equality of variances.
- **Additional options:** *Mean difference, Confidence interval and Descriptive plots.*

- In the end, you will obtain something similar to the image below:



- The program will generate a table with the results of Student's t-test on the right-hand side.

Independent Samples T-Test

							95% Confidence Interval	
		Statistic	df	p	Mean difference	SE difference	Lower	Upper
BMI_Final (kg/m2)	Student's t	−8.84	118	< .001	−5.03	0.569	−6.16	−3.91
	Welch's t	−8.84	110	< .001	−5.03	0.569	−6.16	−3.90

Note. H_a $\mu_{SG} \neq \mu_{MM}$

Assumptions

Homogeneity of Variances Test (Levene's)

	F	df	df2	p
BMI_Final (kg/m2)	2.85	1	118	.094

Note. A low p-value suggests a violation of the assumption of equal variances

Interpretation of the LEVENE test result for independent samples: since the **p**-value of the test **= 0.094 > 0.05** ⇨ we do **NOT** reject H_0 ⇨ At a 5% risk of error, we found no statistically significant difference between the variances of BMI one year after surgery in obese T2DM patients treated with SG and those treated with MM; therefore, to compare the mean final BMI values, we will choose Student's t-test with equal variances.

- ***Note: if Levene's test had returned a significant result (p<0.05), we would have decided to use Student's t-test with unequal variances to compare the means.***

Interpretation of the STUDENT'S t-test result for independent samples: since the **p**-value of the test **< 0.05** ⇨ we reject H_0 ⇨ the evidence supports H_1 ⇨ At a 5% risk of error, there is a statistically significant difference between the mean BMI values one year after surgery in obese T2DM patients treated with SG and those treated with MM.

Interpretation of TEST RESULT	**TABLE 1**
Hypotheses formulation	
Formulation of the null hypothesis (H0)	There is no statistically significant difference between the mean BMI values one year after the intervention in obese patients with T2DM treated with SG and those treated with MM
Formulation of the alternative hypothesis (H1)	There is a statistically significant difference between the mean BMI values one year after the intervention in obese patients with T2DM treated with SG and those treated with MM
Definition of the significance level (alpha)	0.05
Definition of the rejection region (RR)	(-∞, -1.98] U [1.98, ∞)
Calculated value of the t test statistic	-8.84
Test decision based on RR	Because -8.84 belongs to RR ⇔ we reject H0 ⇔ we favor H1 ⇔ With a 5% risk of error, there is a significant difference between the mean BMI values one year after surgery in obese patients with T2DM treated with SG and those treated with MM.
Test decision based on the p-value	Because p < 0.05 ⇔ we reject H0 ⇔ we favor H1 ⇔ With a 5% risk of error, there is a significant difference between the mean BMI values one year after surgery in obese patients with T2DM treated with SG and those treated with MM.

7. CONFIDENCE INTERVAL (95% CI) for the difference in means between two independent groups

- 95% CI for the difference in means between two independent groups with equal variances:

Independent Samples T-Test

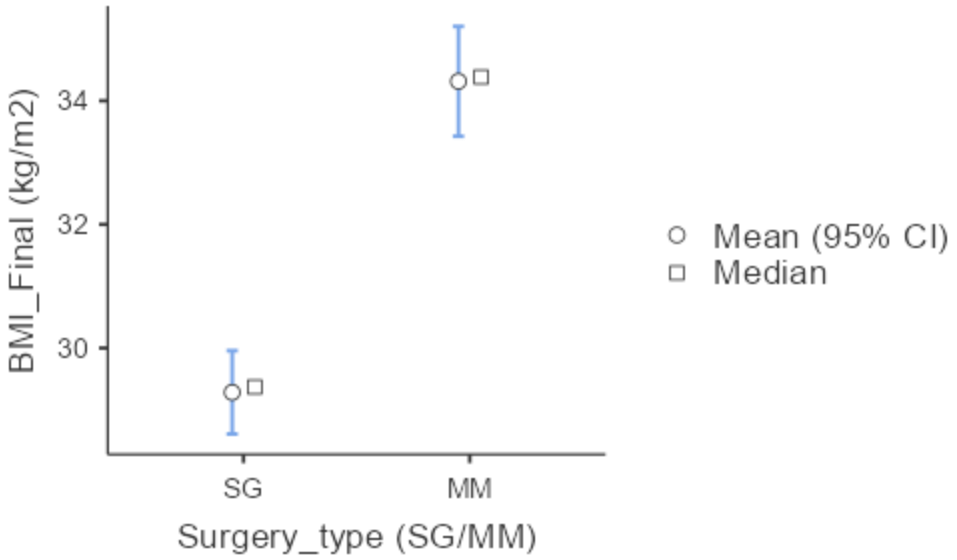
							95% Confidence Interval	
		Statistic	df	p	Mean difference	SE difference	Lower	Upper
BMI_Final (kg/m2)	Student's t	−8.84	118	< .001	−5.03	0.569	−6.16	−3.91
	Welch's t	−8.84	110	< .001	−5.03	0.569	−6.16	−3.90

Note. H_a $\mu_{SG} \neq \mu_{MM}$

Interpretation of the 95% CI for the difference in means: We are 95% confident that the interval [-6.2; -3.9] contains the difference between the mean BMI_FINAL values of patients treated with SG and those treated with MM. Since 0 does not lie within this interval → **there is a significant difference between the mean BMI_FINAL values of patients treated with SG and those treated with MM (at a 5% risk of error).**

8. MEANS PLOT (95% CI) for two INDEPENDENT groups

- Within the same analysis, selecting the **Descriptive Plots** option will produce the plot below:



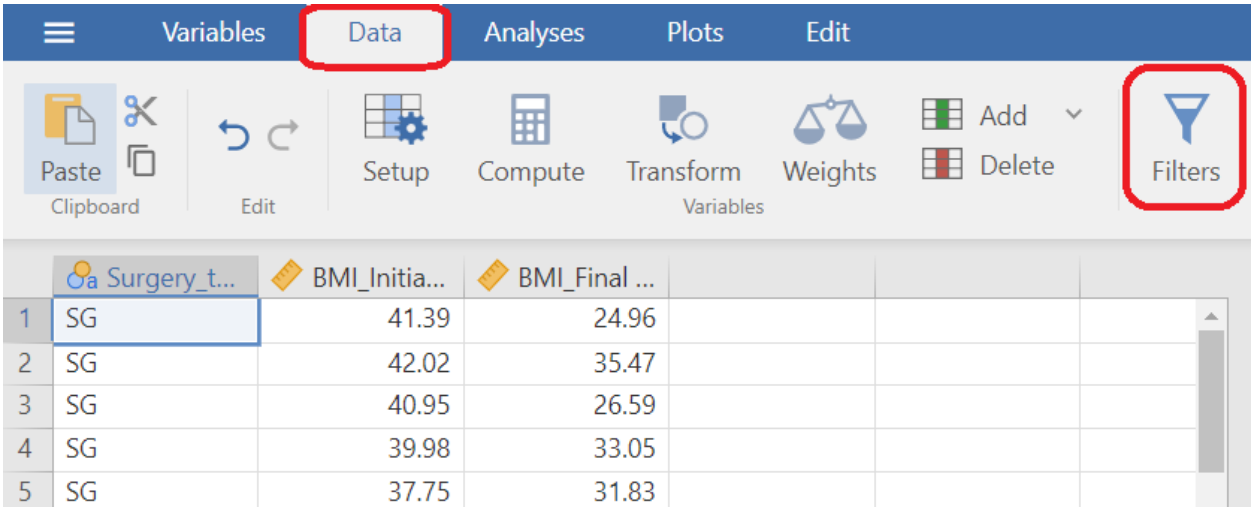
9. STUDENT'S t-test for two DEPENDENT samples

- Before importing data from an **Excel file with several worksheets** into **Jamovi**, always check that the **worksheet containing the desired data** is **selected in Excel**; in our case, the worksheet named **"Data_Q3".**

19	18	32	F	SG	45.65	1.1	27.71
20	19	40	F	SG	50.60	2.1	26.38
21	20	38	F	SG	48.68	1.7	25.33
22	21	47	F	SG	37.37	2.4	25.56

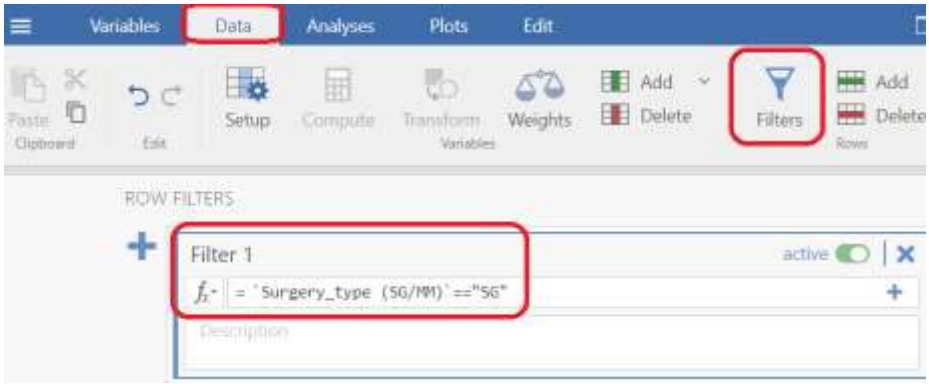
Data | Data_Q2 | Test_t_indep | Data_Q3 | Test_t_dep

- Since we are only interested in the subgroup of patients who underwent SG, we will filter the database by this criterion:
  - In the DATA tab, choose the option **FILTER.**



	Surgery_t...	BMI_Initia...	BMI_Final ...
1	SG	41.39	24.96
2	SG	42.02	35.47
3	SG	40.95	26.59
4	SG	39.98	33.05
5	SG	37.75	31.83

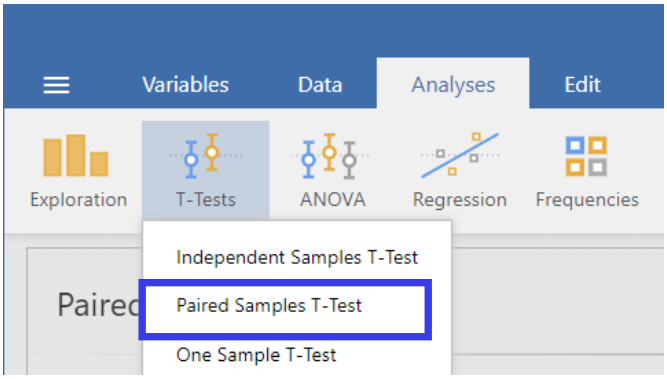
- In the f_x line, type the syntax: **`Surgery_type`=="SG"**



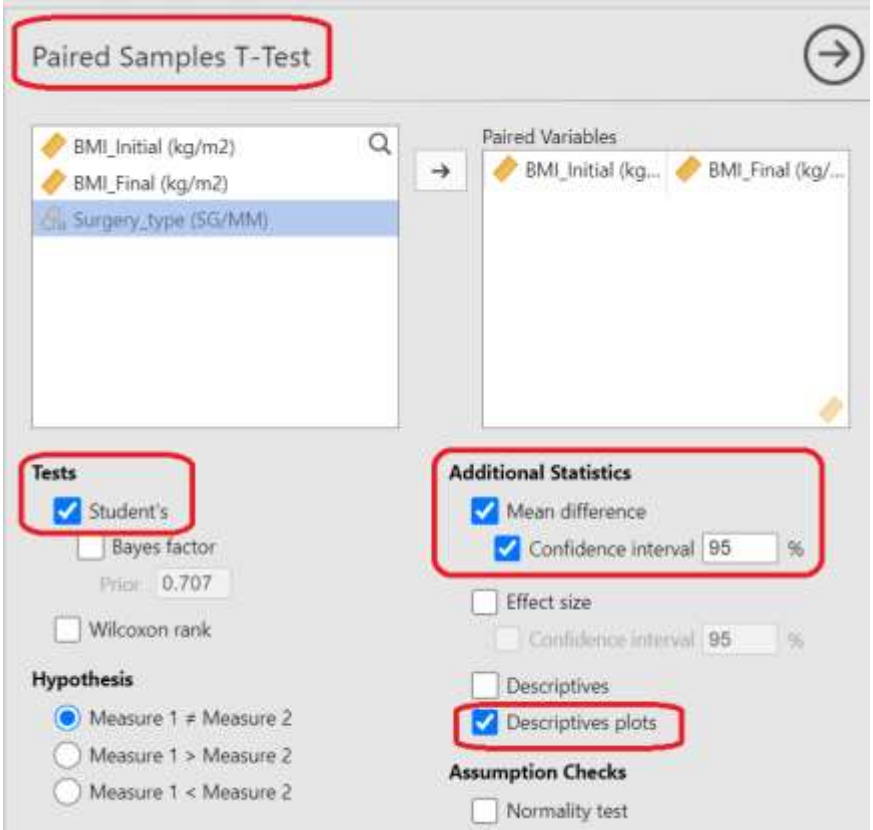
- Confirm the syntax by pressing **ENTER.**
- This will result in the <u>temporary removal</u> of the other group (patients treated with MM) from the database:

	Filter 1	Surgery_t...	BMI_Initia...	BMI_Final ...
46	✓	SG	42.59	26.43
47	✓	SG	38.16	29.39
48	✓	SG	38.00	26.00
49	✓	SG	41.57	30.28
50	✓	SG	38.37	29.86
51	✗	MM	44.69	32.77
52	✗	MM	44.61	36.94
53	✗	MM	41.51	37.22
54	✗	MM	43.98	39.10

- In the **ANALYSES** tab, click the **T-Tests** button, then select **Paired Samples T-Test** from the menu (Student's t-test for dependent samples).



- Select the variable **BMI_Initial** and click the arrow button next to the **Paired Variables** field. Then select the variable **BMI_Final** and click the arrow button next to the **Paired Variables** field.
- **Additional options:** *Mean difference, Confidence interval and Descriptive plots.*
- In the end, you will obtain something similar to the image below:



- The program will generate a table with the results of Student's t-test on the right-hand side.

Paired Samples T-Test

Paired Samples T-Test

			statistic	df	p
BMI_Initial (kg/m2)	BMI_Final (kg/m2)	Student's t	23.2	59.0	< .001

Note. H_a $\mu_{\text{Measure 1 - Measure 2}} \neq 0$

Interpretation of Student's t-test: since the p-value (<0.001) < 0.05 ⇨ **we reject H_0 ⇨ the evidence supports H_1 ⇨ At a 5% risk level, there is a significant difference between the mean BMI values before and one year after surgery in obese T2DM patients treated with SG.**

10. CONFIDENCE INTERVAL (95% CI) for the difference in means between two DEPENDENT groups

95% CI for the difference in means:

		95% Confidence Interval	
Mean difference	SE difference	Lower	Upper
13.6	0.587	12.4	14.8

Interpretation of the 95% CI for the difference in means: We are 95% confident that the interval [12.4; 14.8] contains the difference between the mean BMI values before and one year after surgery in obese T2DM patients treated with SG. Since 0 does not lie within this interval → **there is a significant difference between the mean BMI values before and one year after surgery in obese T2DM patients treated with SG (at a 5% risk of error).**

11. MEANS PLOT (95% CI) for two DEPENDENT groups

- Within the same analysis, selecting the **Descriptive Plots** option will produce the plot below:

