

STATISTICAL TEST

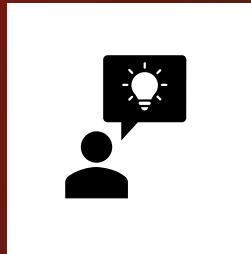
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huda@utm.my

A close-up photograph of a person's hand holding a black pen, writing in a white notebook. The background is a soft-focus blue surface.

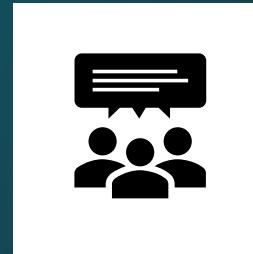
RECAP

Feature	Parametric Tests	Non-Parametric Tests
Assumption	Assumes data follows a specific distribution (usually normal)	No strict distribution assumptions
Data Type	Works best with continuous and normally distributed data	Works with ordinal, ranked, or non-normally distributed data
Sample Size	Requires larger sample sizes ($n > 30$ for reliability)	Works well with small sample sizes
Test Type	Tests means and variance	Tests medians and ranks
Statistical Power	More powerful when assumptions hold	Less powerful but robust for non-normal data
Examples	Paired t-test, ANOVA, Pearson correlation	Wilcoxon signed-rank test, Kruskal-Wallis, Spearman correlation

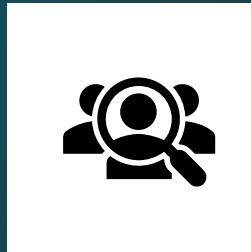
SPSS for Statistical Test



One Sample
Statistical Test:
Parametric and
Non-Parametric



Independent Group
Statistical Test:
Parametric and
Non-Parametric



Dependent (Paired)
Group Statistical Test:
Parametric and
Non-Parametric

First Skill

Second Skill

Third Skill

STATISTICAL HYPOTHESIS TEST

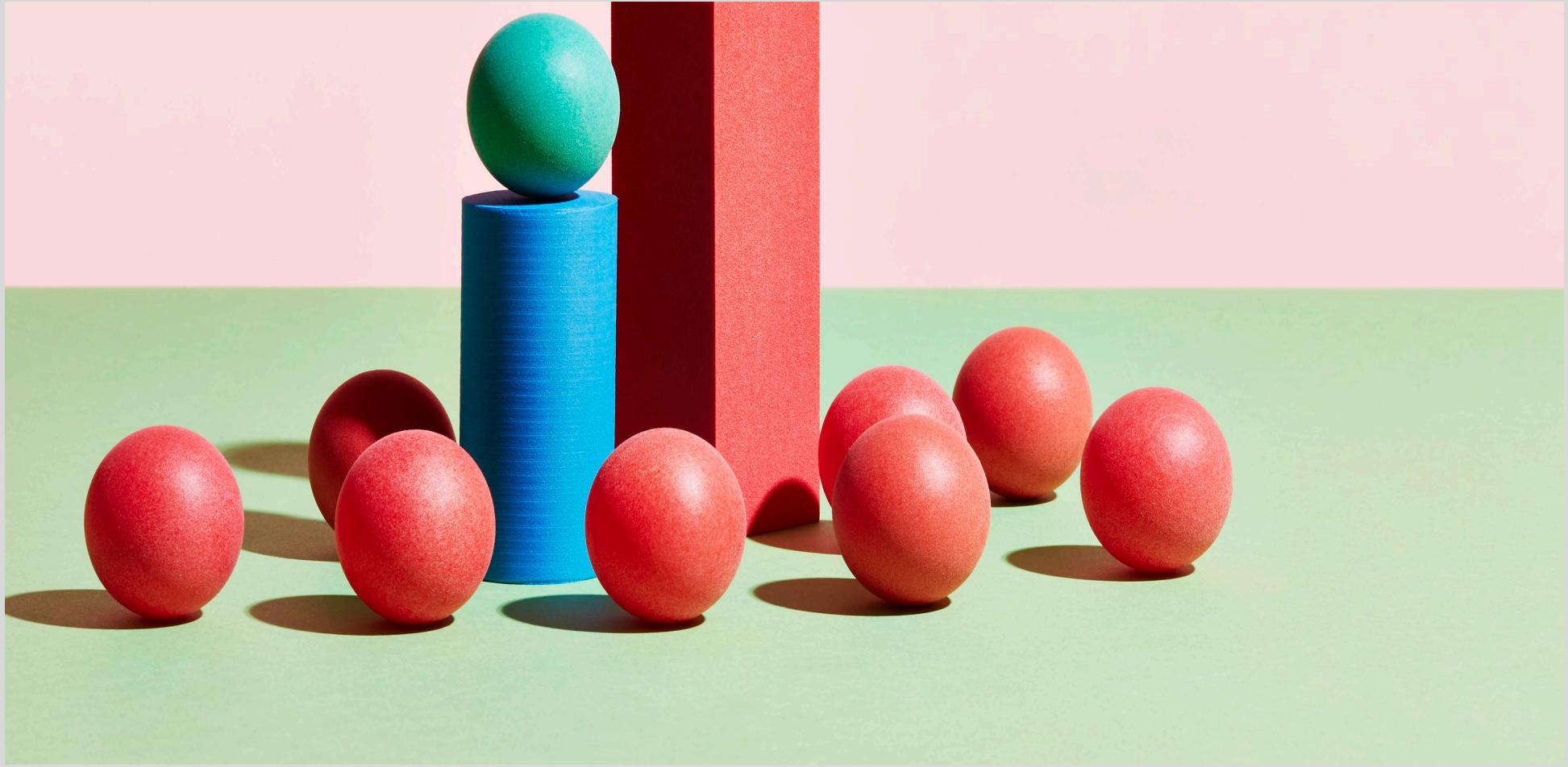
Single Population (one sample test):

- Uses the mean of a single sample to determine if the population mean is statistically different from a specified value.

Two Population (two sample test):

- **Independent Test:** Uses the mean of two samples to determine if the two populations are statistically different from each other. The group of these two samples is independent.
- **Paired Test:** Uses the difference of two paired samples to determine if the paired populations are statistically different. The group of these two samples is dependent.

PARAMETRIC STATISTICAL TEST





PARAMETRIC TEST
(SAMPLE DATA WHICH FOLLOW
NORMAL DISTRIBUTION)

Variables which
are
Numerical
(quantitative)

ONE SAMPLE

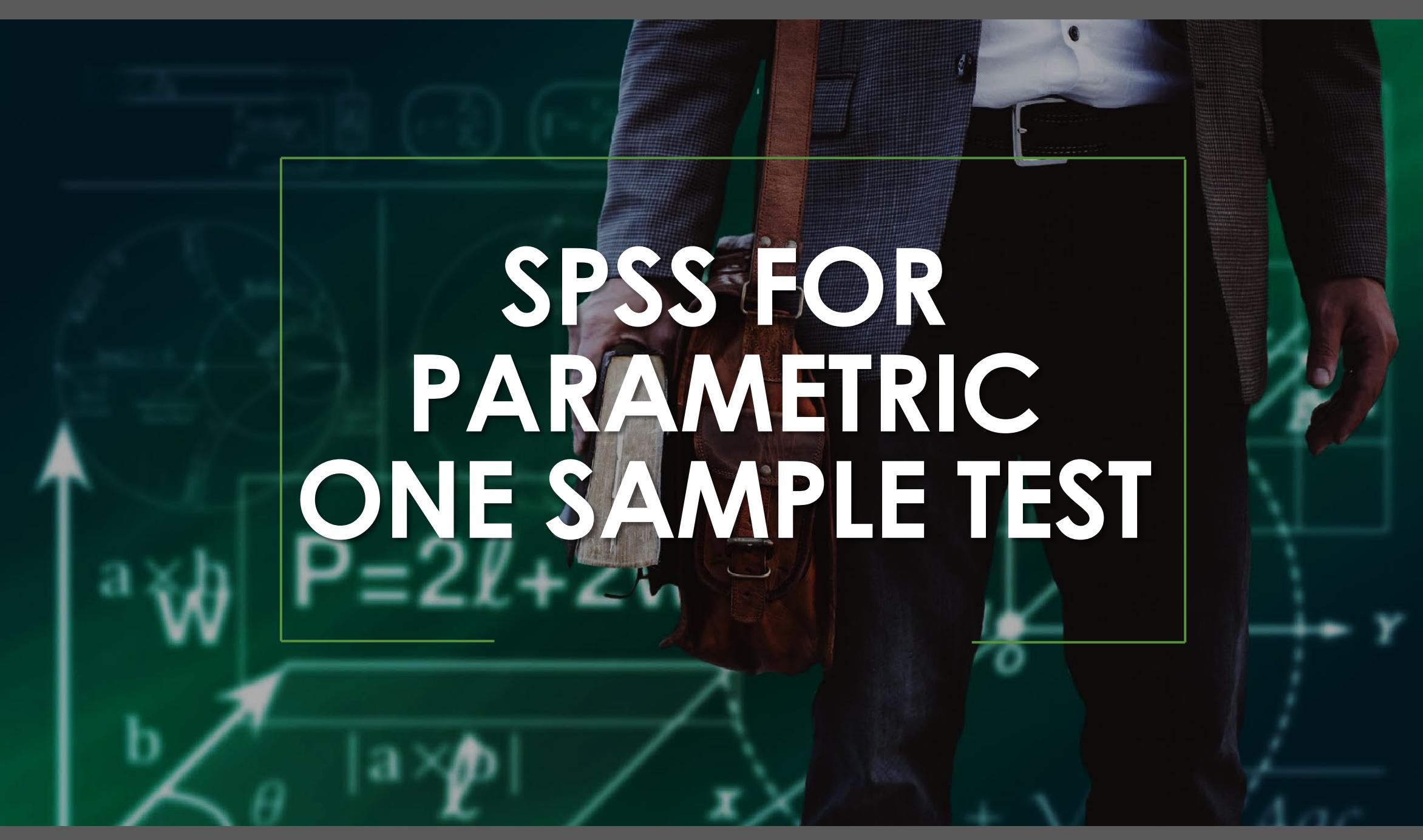
2 INDEPENDENT
SAMPLE

2 DEPENDENT
(PAIRED) SAMPLE

T-TEST

INDEPENDENT T-
TEST

PAIRED T-TEST



SPSS FOR PARAMETRIC ONE SAMPLE TEST

ONE GROUP SAMPLE TEST



Research Question:

Is the mean age population is the same with reported by the local authorities which is 45 years old?

Data Set: health survey.sav

Hypothesis Statement:

$$H_0 : \mu = 45 \text{ years (claim)}$$

$$H_A : \mu \neq 45 \text{ years}$$

This is two tailed hypothesis test

Checking Assumption:

1. Sample size?
2. Normal distribution or not?

*** Notes: For large sample size (say, $N > 30$), the normality assumption not holding doesn't really affect the results.

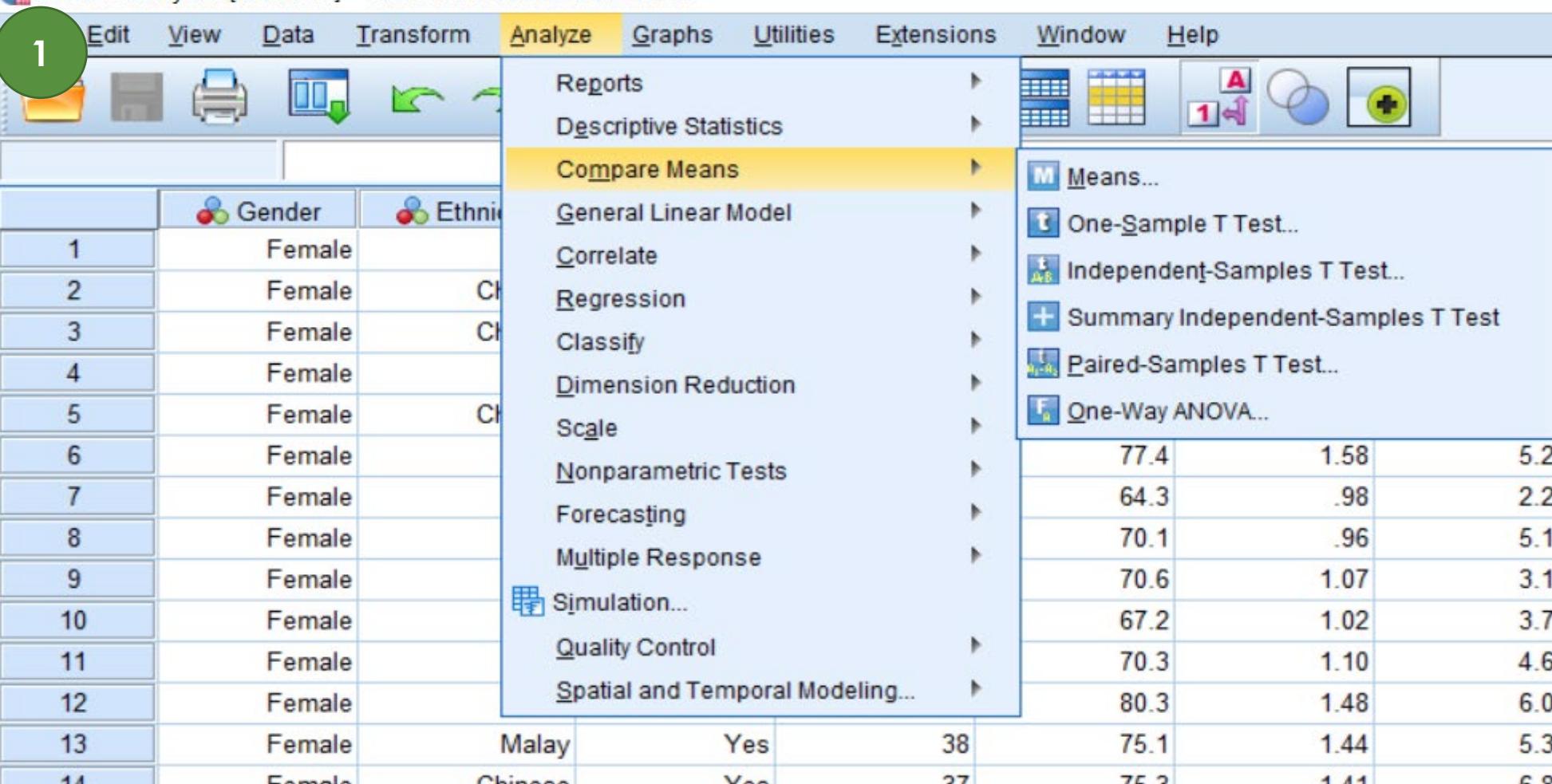
Parametric One-Sample statistical Test: t-test

Data Set: Health Survey.sav

Notes: We have checked normality (refer to previous notes). It shows that variable 'age' follows normal distribution. Therefore, for one sample test, we will use t-test.

1. Analyze > Compare Means > One-Sample T test

Health Survey.sav [DataSet2] - IBM SPSS Statistics Data Editor



The screenshot shows the IBM SPSS Statistics Data Editor interface. On the left, there is a data view window displaying a table with columns for Gender, Ethnicity, and Age. The 'Gender' column has values like 'Female', 'Female', etc., and the 'Age' column has values like 77.4, 64.3, etc. On the right, the 'Analyze' menu is open, with 'Compare Means' highlighted. A sub-menu for 'Compare Means' is displayed, containing options: Means..., One-Sample T Test..., Independent-Samples T Test..., Summary Independent-Samples T Test, Paired-Samples T Test..., and One-Way ANOVA... . The 'One-Sample T Test...' option is also highlighted with a blue box.

	Gender	Ethnicity	Age
1	Female	Chinese	77.4
2	Female	Chinese	64.3
3	Female	Chinese	70.1
4	Female	Chinese	70.6
5	Female	Chinese	67.2
6	Female	Malay	70.3
7	Female	Malay	80.3
8	Female	Chinese	75.1
9	Female	Malay	1.58
10	Female	Malay	.98
11	Female	Malay	.96
12	Female	Malay	1.07
13	Female	Malay	1.02
14	Female	Chinese	1.10
			3.18
			3.79
			4.64
			6.04
			5.38
			6.80

Parametric One-Sample statistical Test: t-test

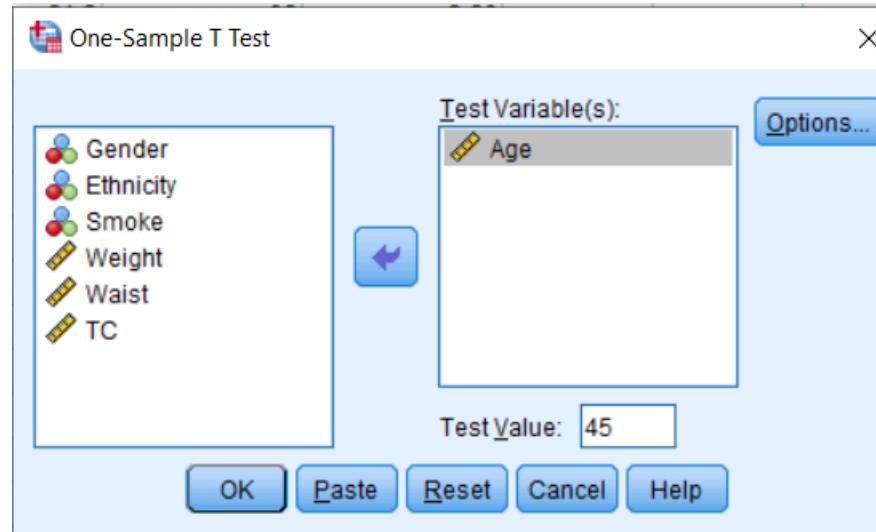
Data Set: Health Survey.sav

2. Select variable Age as Test Variable(s).

Put Test Values = 45. This is the hypothesized value.

Click Option if you want to change the confidence interval (CI) percentage. By default the CI percentage is 95% (or $\alpha = 0.05$)

2



OUTPUT → Parametric One-Sample statistical Test: t-test

Data Set: Health Survey.sav

$$H_0 : \mu = 45 \text{ years} \text{ (claim)}$$

$$H_A : \mu \neq 45 \text{ years}$$

This is two tailed hypothesis test

1

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Age	350	40.00	6.708	.359

One-Sample Test

Test Value = 45

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Age	-13.944	349	.000	-5.000	-5.71	-4.29

To summarize:

- We **reject** the null hypothesis that the mean age in the sample is equal to the reported age.
- There is a **significant difference** in age mean between the sample and the overall reported.
- Thus, we conclude the average age of the sample is about **5 years younger** than the overall reported.

A blue checkers board with white grid lines. Various colored checkers are scattered across the board, including red, green, yellow, and blue pieces. Some pieces are in their original starting positions, while others are moved.

LET US PRACTICE

A government health department is analyzing healthcare expenditure to determine whether patients in a specific region spend **less** on healthcare compared to the national average. According to recent reports, the **national average annual healthcare expenditure per patient is \$5,000**.

A study was conducted using **a random sample of 137 patients** from the region to analyze their **annual healthcare expenditure**. The objective is to determine whether the **average healthcare expenditure in this region is significantly lower than the national average**. Data set is **Healthcare_Expenditure.xlsx**

Using the provided dataset, answer the following:

1. Perform a normality test to check if the data follows a normal distribution.

1. Is the assumption of normality met for conducting a **one-sample parametric test (t-test)**?

2. Conduct a one-sample t-test to test the following hypothesis:

Null Hypothesis (H_0): The average annual healthcare expenditure per patient is **greater than or equal to \$5,000**.

Alternative Hypothesis (H_1): The average annual healthcare expenditure per patient is **less than \$5,000**.

3. Interpret the results:

1. What is the **p-value** and **t-statistic**?

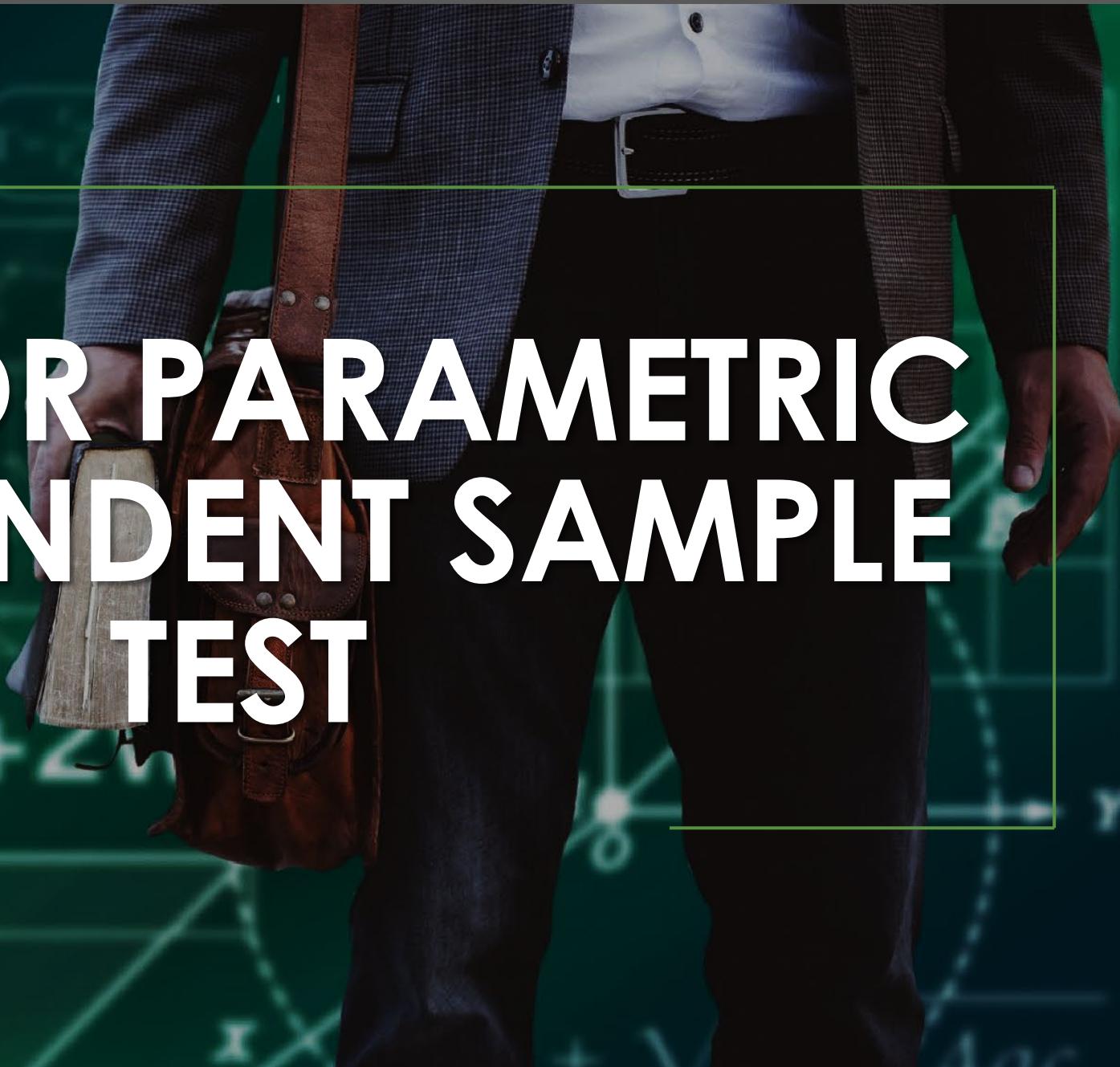
2. Based on a **significance level of 0.05**, should the null hypothesis be rejected?

3. Can we conclude that the average healthcare expenditure in this region is **significantly lower than the national average**?

TWO GROUP SAMPLE TEST



SPSS FOR PARAMETRIC INDEPENDENT SAMPLE TEST



Research Question:

Is there any significant difference in the age among male and female in the study population?

Data Set: health survey.sav

Hypothesis Statement:

$$H_0 : \mu_{\text{male}} = \mu_{\text{female}}$$

$$H_A : \mu_{\text{male}} \neq \mu_{\text{female}} \text{ (claim)}$$

This is two tailed hypothesis test

Checking Assumption:

1. Dependent Variables should be in continuous scale.
2. Independent Variables should be in 2 group categorical only.
3. Observations are independent (not related or measured twice)
4. No significant outliers
5. Dependent should be normally distributed
6. Homogeneity of variances should be need. (Levene's Test)

Parametric Independent Sample Test: Student's t test

Data Set: Health Survey.sav

Notes: We have checked normality (refer to previous notes). It shows that variable 'age' follows normal distribution.

1. Analyze > Compare Means > Independent-Samples T test

Health Survey.sav [DataSet2] - IBM SPSS Statistics Data Editor

The screenshot shows the IBM SPSS Statistics Data Editor interface. The title bar reads "Health Survey.sav [DataSet2] - IBM SPSS Statistics Data Editor". The menu bar includes File, Edit, View, Data, Transform, Analyze, Graphs, Utilities, Extensions, Window, and Help. The "Analyze" menu is currently selected and expanded, showing various statistical options. A green circle with the number "1" is overlaid on the left side of the menu. The "Compare Means" option is highlighted with a yellow background. Under "Compare Means", the "Independent-Samples T Test..." option is also highlighted with a yellow background. To the right of the menu, there is a list of other test options: Means..., One-Sample T Test..., Independent-Samples T Test..., Summary Independent-Samples T Test, Paired-Samples T Test..., and One-Way ANOVA... . Below the menu, a portion of the data table is visible, showing columns for Gender, Ethnicity, and Age.

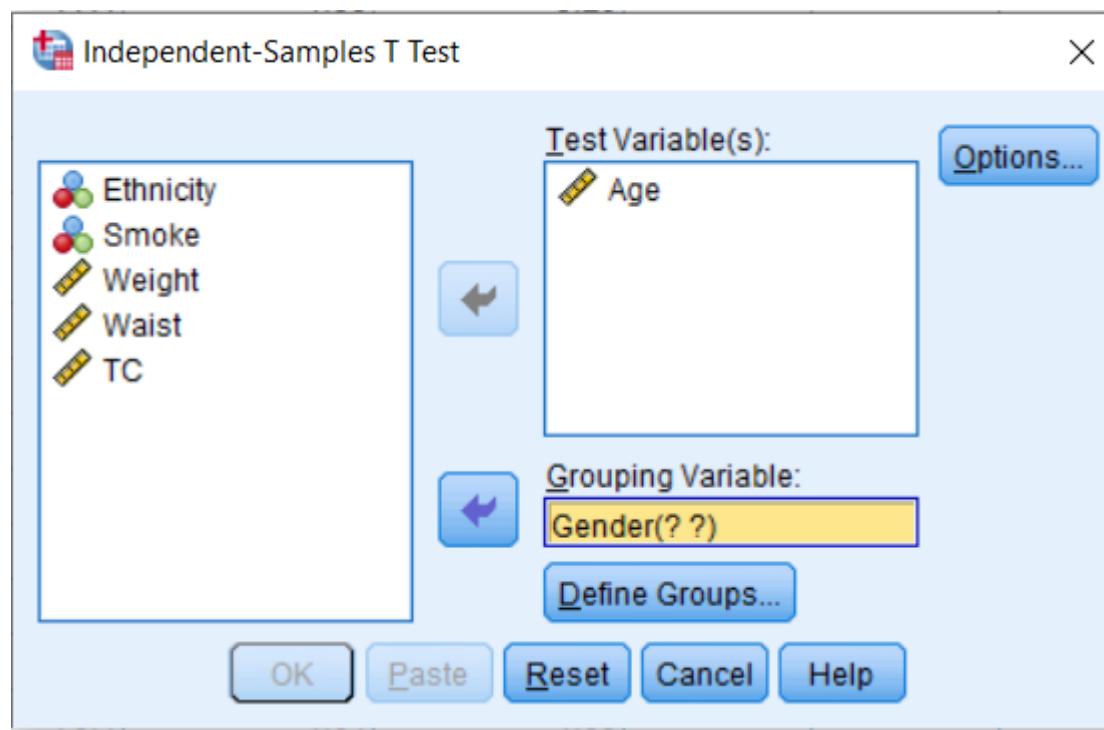
	Gender	Ethnicity	Age	Std. Deviation	N
1	Female	Chinese	77.4	1.58	5.29
2	Female	Chinese	64.3	.98	2.20
3	Female	Chinese	70.1	.96	5.11
4	Female	Chinese	70.6	1.07	3.18
5	Female	Chinese	67.2	1.02	3.79
6	Female	Malay	70.3	1.10	4.64
7	Female	Malay	80.3	1.48	6.04
8	Female	Malay	75.1	1.44	5.38
9	Female	Chinese	75.3	1.41	6.80
10	Female	Malay	74.0	1.27	5.14
11					
12					
13					
14					
15					

Parametric Independent Sample Test: Student's t test

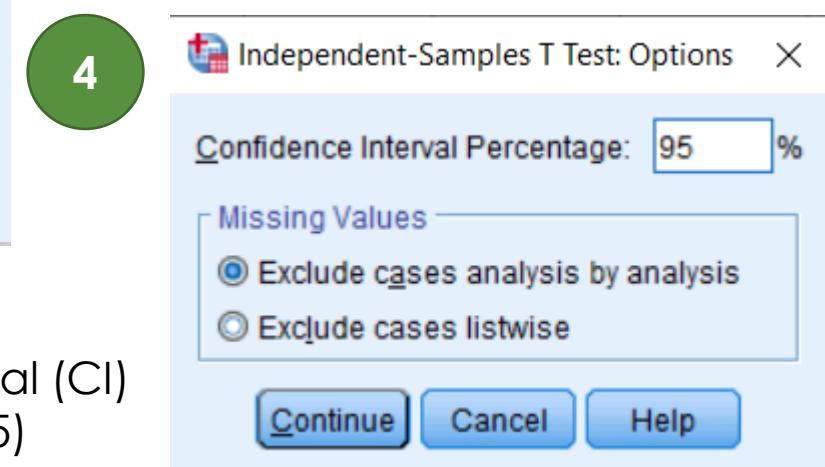
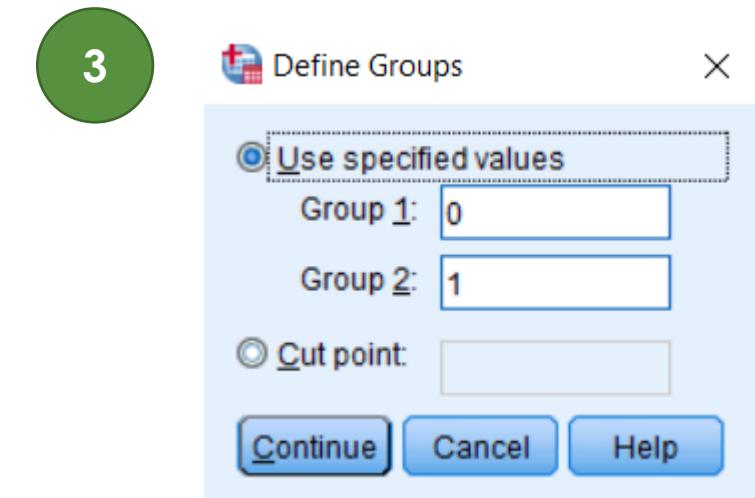
Data Set: Health Survey.sav

2. Select variable Age as Test Variable(s).

Select variable Gender as grouping variable and click Define Groups..



3. Define the group variable. For Gender, 0 = female and 1 = male



4. Click Option if you want to change the confidence interval (CI) percentage. By default the CI percentage is 95% (or $\alpha = 0.05$)

OUTPUT → Parametric Independent Sample Test: Student's t test

Data Set: Health Survey.sav

Levine test for test variance homogeneity
 H_0 : Variance is homogeneity
 H_A : Variance is not homogeneity

Parametric Independent Sample Test

$$H_0: \mu_{\text{male}} = \mu_{\text{female}}$$

$$H_A: \mu_{\text{male}} \neq \mu_{\text{female}} \text{ (claim)}$$

Group Statistics					
Age	Gender	N	Mean	Std. Deviation	Std. Error Mean
	Female	234	38.21	6.112	.400
Male		116	43.60	6.428	.597

Independent Samples Test

Age	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
Equal variances assumed	.855	.356	-7.630	348	.000	-5.387	.706	-6.776	-3.999
Equal variances not assumed			-7.501	219.422	.000	-5.387	.718	-6.803	-3.972

To summarize:

- Check the homogeneity of variance through Levine's test: p-value = 0.356 thus, accept H_0 which indicate that the variance is homogeneity.
- P-value is small compare to α , and therefore we reject H_0 that there is a statistical significant differences in the mean age between male and female
- Thus, we conclude the average age of the sample is about 5.387 years younger (-6.776, -3.999) than the overall reported.

A blue checkers board with white grid lines. Various colored checkers are scattered across the board, including red, green, yellow, and blue pieces. Some pieces are in their original starting positions, while others are moved to different squares.

LET US PRACTICE

Research Question:

Is there any significant difference in weight among smokers and non smokers in the study population?

Data Set: health survey.sav

Hypothesis Statement:

$$H_0 : \mu_{\text{smokers}} = \mu_{\text{nonsmokers}}$$

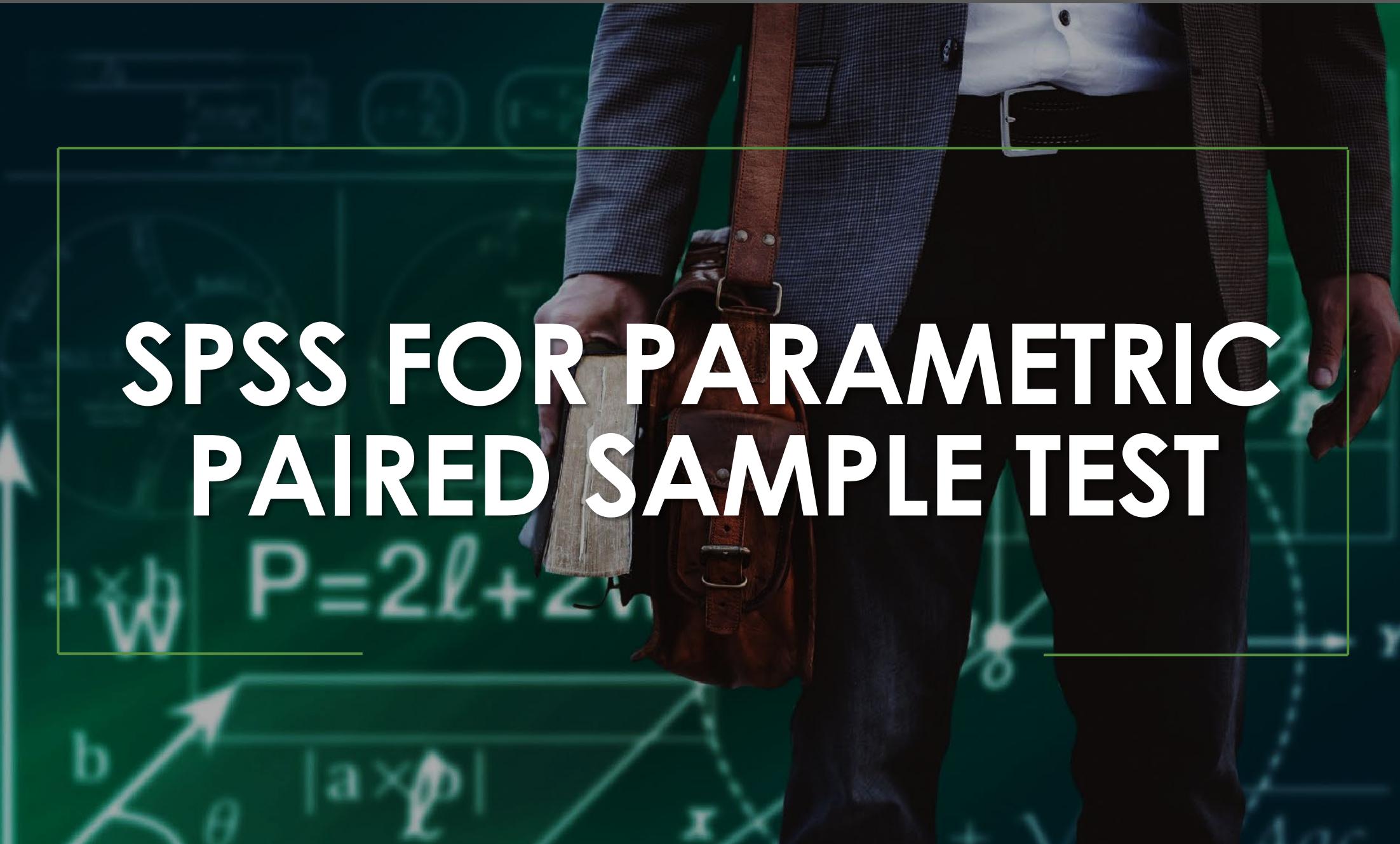
$$H_A : \mu_{\text{smokers}} \neq \mu_{\text{nonsmokers}} \text{ (claim)}$$

This is two tailed hypothesis test

Checking Assumption:

1. Dependent Variables should be in continuous scale.
2. Independent Variables should be in 2 group categorical only.
3. Observations are independent (not related or measured twice)
4. No significant outliers
5. Dependent should be normally distributed
6. Homogeneity of variances should be need. (Levene's Test)

SPSS FOR PARAMETRIC PAIRED SAMPLE TEST



Problem Statement

A hospital is conducting a clinical study to evaluate the effectiveness of a new antihypertensive drug.

Researchers collected **systolic blood pressure readings from 40 patients** before and after taking the drug for 30 days. The goal is to determine whether the drug significantly reduces blood pressure using a **parametric paired sample t-test** at a **5% significance level**.

Research Question

"Does the new antihypertensive drug significantly reduce systolic blood pressure after 30 days of use?"

Data Set: large_blood_pressure.xlsx

Hypothesis Statement:

H_0 : There are **no differences** on systolic blood pressure reading before and after the treatment

H_A : There are **differences** on systolic blood pressure reading before and after the treatment



Parametric Paired Sample Test: Student's t test

Data Set: large_blood_pressure.xlsx

Normality Test Assessment

1

2

The screenshot shows the IBM SPSS Statistics Data Editor interface. On the left, the 'Analyze' menu is open, with 'Descriptive Statistics' selected. Under 'Descriptive Statistics', 'Explore...' is highlighted. The main data view shows two variables: 'Patient' (row labels 1-29) and 'BeforemmHg' (Column 1) and 'AftermmHg' (Column 2). The 'Explore' dialog box is open, with 'Patient' selected as the 'Dependent List'. 'Before (mmHg)' and 'After (mmHg)' are listed under 'Plots...'. The 'Explore: Plots' sub-dialog is also visible, showing options for 'Boxplots', 'Normality plots with tests', and 'Histogram'. The status bar at the bottom indicates 'IBM SPSS Statistics Processor is ready'.

Patient	BeforemmHg	AftermmHg
1	154.967	141.275
2	148.617	137.761
3	156.477	147.055
4	165.230	156.736
5	147.658	145.051
6	147.659	141.258
7	165.792	158.095
8	157.674	142.389
9	145.305	133.587
10	155.426	154.241
11	145.366	145.366
12	145.343	137.268
13	152.420	145.804
14	130.867	117.809
15	132.751	117.596
16	144.377	129.721
17	139.872	134.068
18	153.142	144.689
19	140.920	129.263
20	135.877	120.999
21	164.656	157.052
22	147.742	138.850
23	150.675	146.207
24	135.753	131.734
25	144.556	130.494
26	151.109	134.328
27	138.490	128.850
28	153.757	138.739
29	143.994	132.185

Parametric Paired Sample Test: Student's t test

Data Set: large_blood_pressure.xlsx

Normality Test Assessment

Tests of Normality

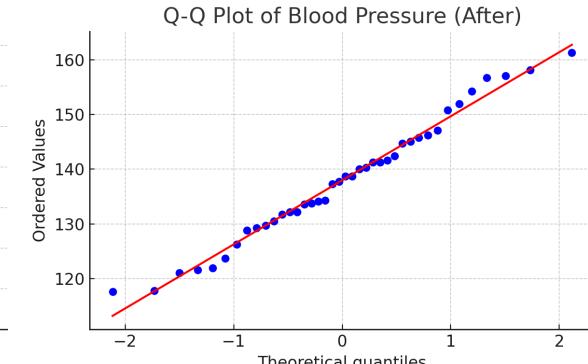
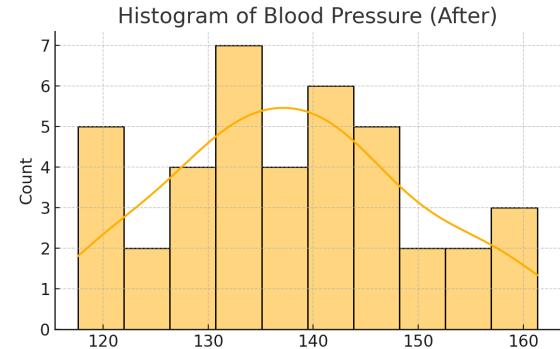
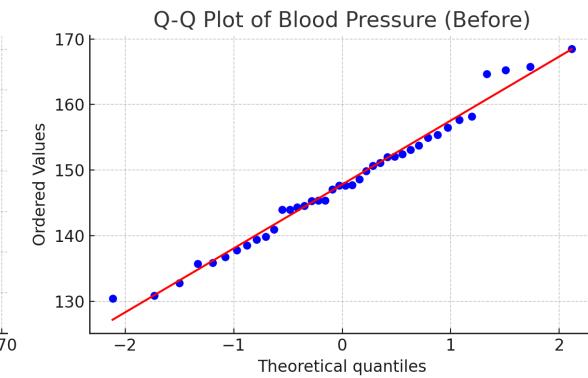
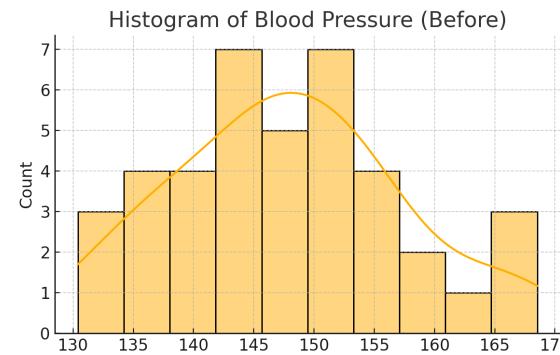
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Before (mmHg)	.069	40	.200*	.979	40	.660
After (mmHg)	.075	40	.200*	.978	40	.620

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

a. Lilliefors Significance Correction

From the result of Shapira Wilk (due to sample size < 50) since both **p-values > 0.05**, we **fail to reject the null hypothesis of normality**, indicating that both datasets **follow a normal distribution**.

Hypothesis Statement for normality test
 H_0 : Variable is normally distributed
 H_A : Variable is Not Normally distributed



Parametric Paired Sample Test: Student's t test

Data Set: large_blood_pressure.xlsx

Analyze > Compare Means > Paired-Samples T Test

The screenshot shows the IBM SPSS Statistics Data Editor interface. The menu bar at the top includes File, Edit, View, Data, Transform, Analyze, Graphs, Utilities, Extensions, Window, and Help. The Analyze menu is open, showing various statistical options. A green circle labeled '1' highlights the 'Compare Means and Proportions' option under the Analyze menu. The main window displays a dataset with three columns: Patient, Before mmHg, and After mmHg. The data shows blood pressure measurements for 18 different patients.

Patient	Before mmHg	After mmHg
1	154.967	
2	148.617	
3	156.477	
4	165.230	
5	147.658	
6	147.659	
7	165.792	
8	157.674	
9	145.305	
10	155.426	
11	145.366	
12	145.343	
13	152.420	
14	130.867	
15	132.751	
16	144.377	
17	139.872	
18	153.142	
	144.689	

Select the variable as Pair -> Option (to change the confidence level) -> OK

2: Option if you want to change the significance level, else by default it will be 95% significance level ($\alpha = 0.05$)

The screenshot shows the 'Paired-Samples T Test' dialog box. In the 'Paired Variables' section, 'Pair 1' is selected with 'Before (mmHg)' and 'After (mmHg)' listed. A green circle labeled '2' highlights the 'Options...' button. Other settings include a 'Confidence Interval Percentage' of 95%, 'Missing Values' set to 'Exclude cases analysis by analysis', and 'Estimate effect sizes' checked. At the bottom are 'OK', 'Paste', 'Reset', 'Cancel', and 'Help' buttons.

Paired-Samples T Test

Paired Variables:

Pair	Variable1	Variable2
1	Before (mmHg)	After (mmHg)
2		

Options...

Paired-Samples T Test: Options

Confidence Interval Percentage: 95 %

Missing Values

Exclude cases analysis by analysis

Exclude cases listwise

Estimate effect sizes

Calculate standardizer using

Standard deviation of the difference

Corrected standard deviation of the difference

Average of variances

OK | Paste | Reset | Cancel | Help

Parametric Paired Sample Test: Student's t test

Data Set: large_blood_pressure.xlsx

To summarize:

- Since the **p-value (1.13×10^{-15})** is much smaller than the significance level **$\alpha = 0.05$** , we **reject the null hypothesis**. This confirms that the drug has a **statistically significant effect** in reducing systolic blood pressure after 30 days.

Confidence Interval Analysis (Paired t-test)

The **95% confidence interval (CI) for the mean difference** in systolic blood pressure before and after taking the drug is:

(8.31, 11.40) (8.31, 11.40) (8.31, 11.40)

Interpretation

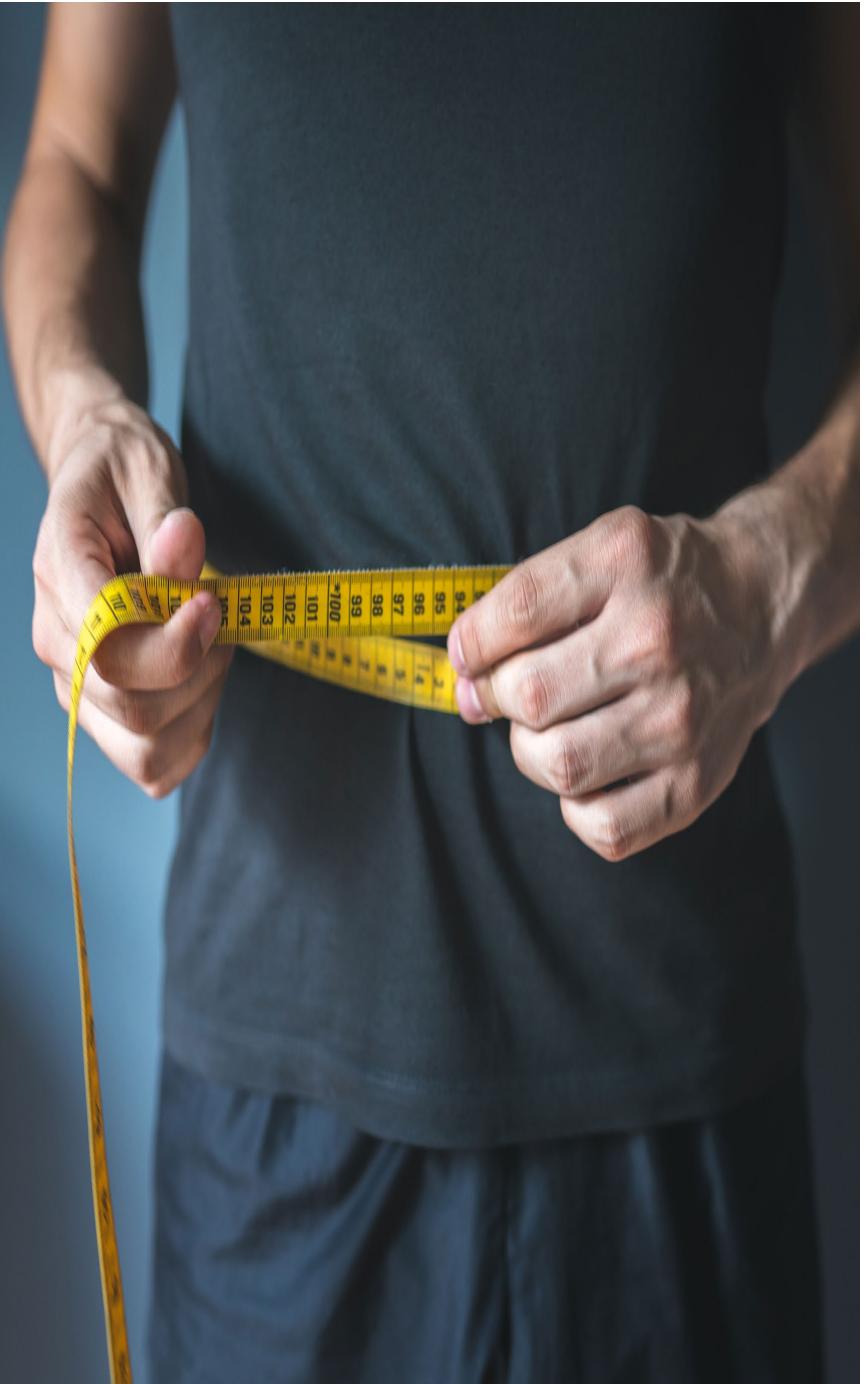
- We are **95% confident** that the **true mean reduction** in systolic blood pressure due to the drug lies **between 8.31 mmHg and 11.40 mmHg**.
- Since the **confidence interval does not include 0**, it further supports the conclusion that the drug has a **statistically significant effect** in reducing blood pressure.

Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	Paired Differences		t	df	Significance		
				Lower				95% Confidence Interval of the Difference		
Pair 1	Before (mmHg) - After (mmHg)	9.854783	4.823838	.762716	8.312044	11.397521	12.921	39	<.001	<.001

A blue checkers board with white grid lines. Various colored checkers are scattered across the board, including red, green, yellow, and blue pieces. Some pieces are in their original starting positions, while others are moved.

LET US PRACTICE



Problem Statement:

A healthcare research institute is evaluating the effectiveness of a 12-week weight loss program. The institute recruited 50 participants and measured their Body Mass Index (BMI) before and after the program. The goal is to determine whether the weight loss program significantly reduces BMI. Test the hypothesis at a 5% significance level.

Research Question:

"Does the 12-week weight loss program significantly reduce participants' BMI?"

Data Set: BMI_Weight_Loss_Program.xlsx

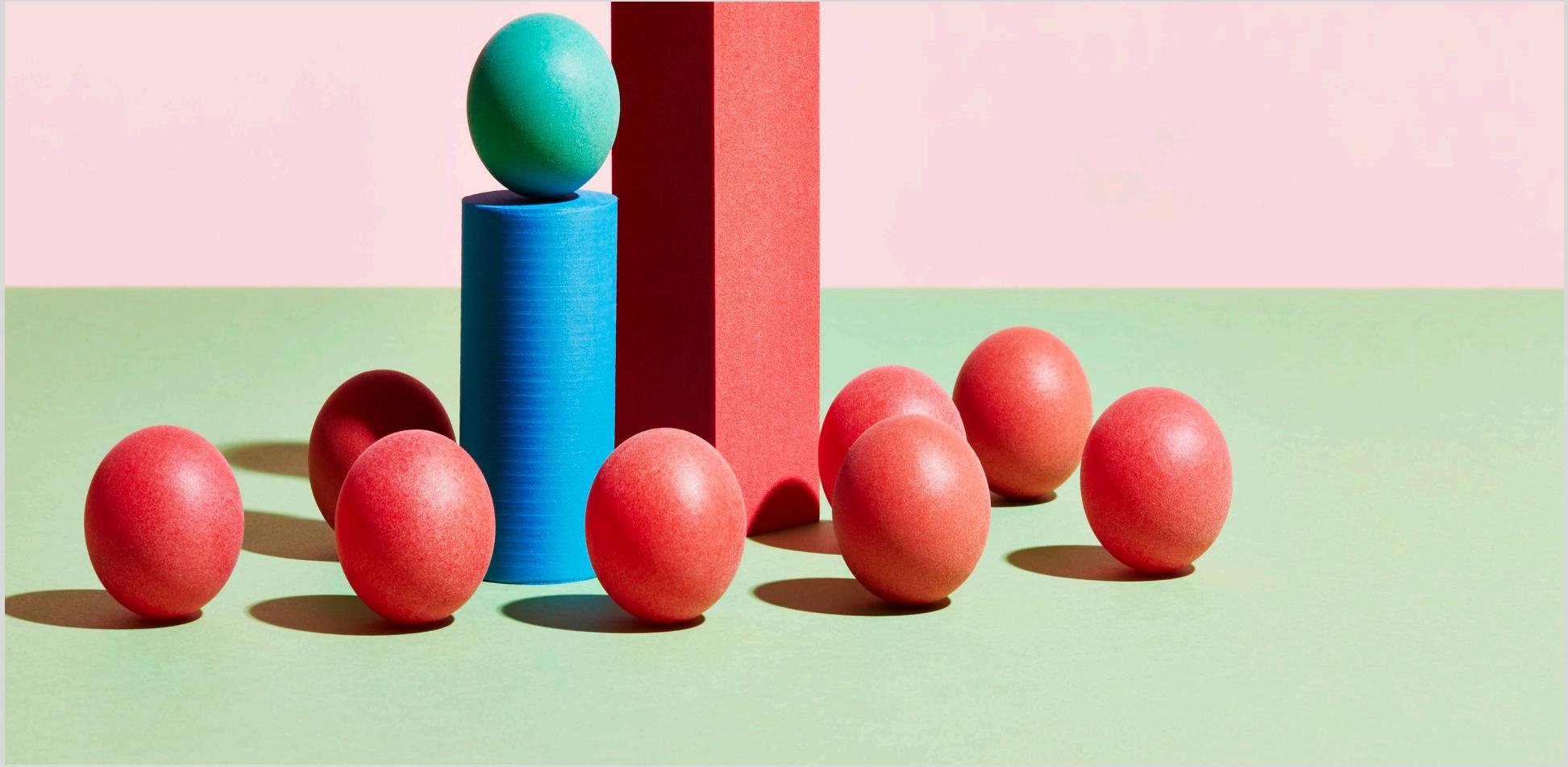
Hypothesis Statement:

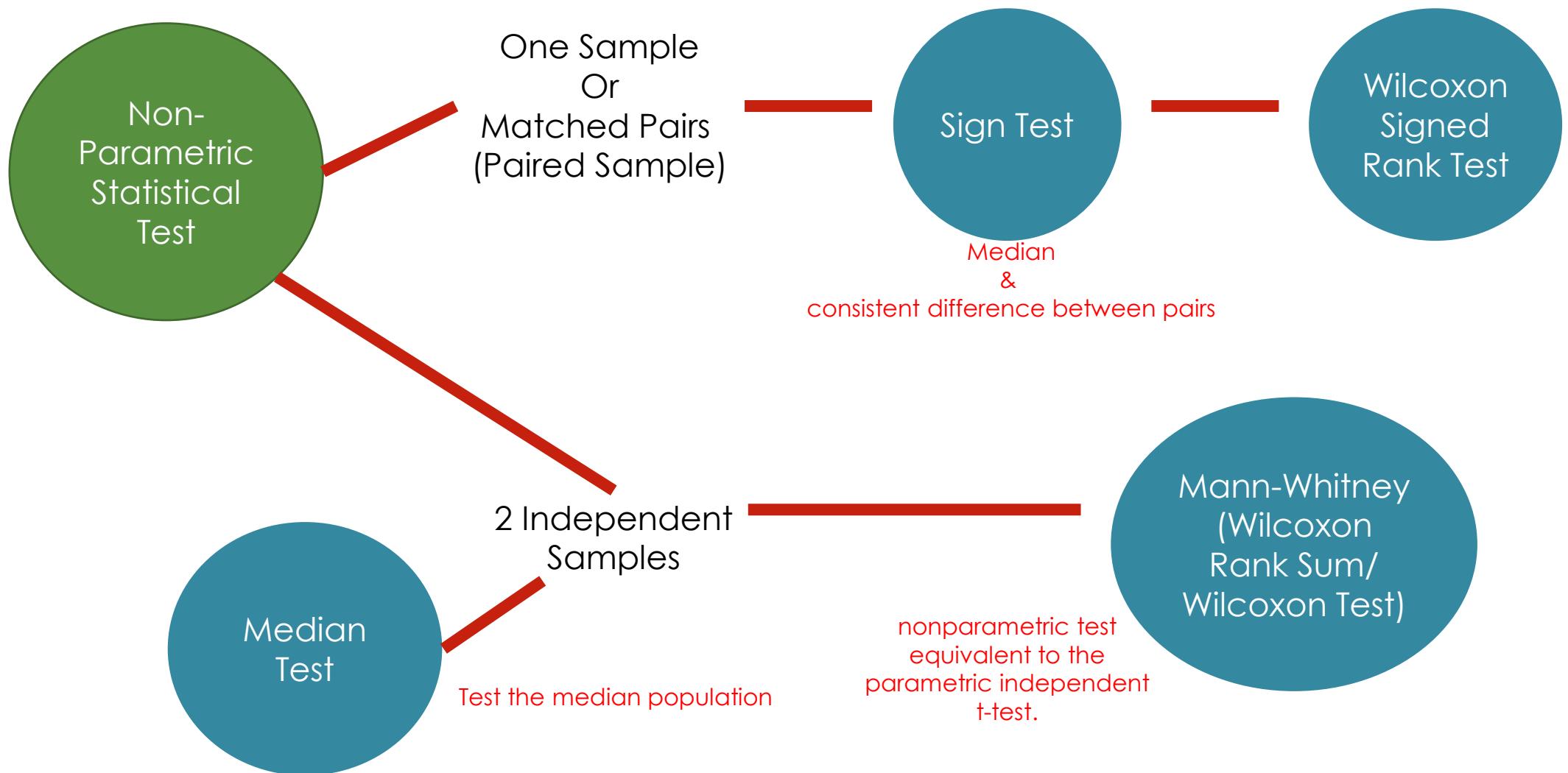
H_0 : There are **no differences** on BMI reading before and after the treatment

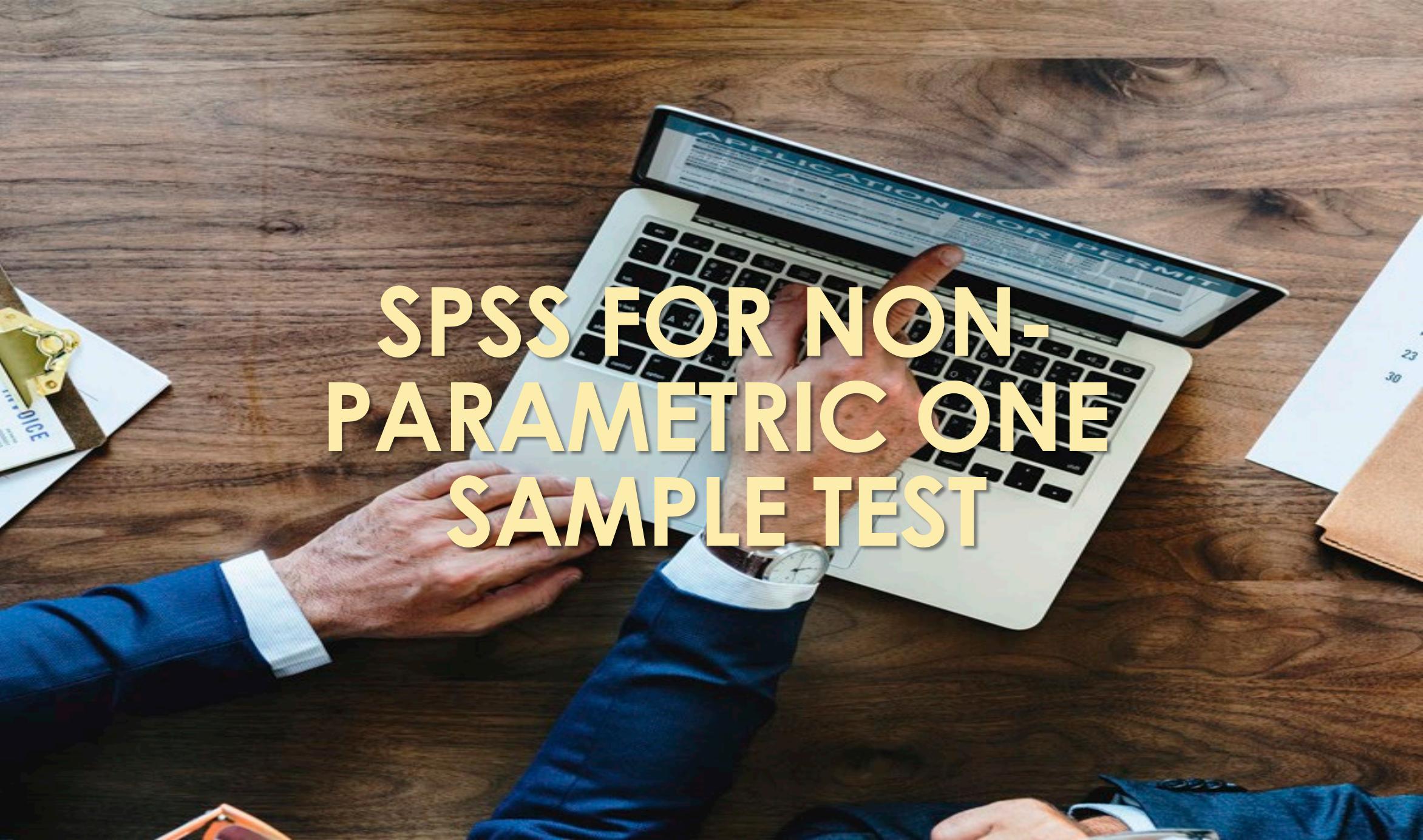
H_A : There are **differences** on BMI reading before and after the treatment

This is two tailed hypothesis test

NON-PARAMETRIC STATISTICAL TEST







SPSS FOR NON- PARAMETRIC ONE SAMPLE TEST



Problem Statement:

A hospital wants to evaluate whether a **new pain relief drug** is effective. They collected **pain scores from 18 patients** after receiving the drug. The pain score is measured on a **scale from 0 (no pain) to 100 (extreme pain)**. A pain relief treatment is considered effective if the **median pain score** after treatment is **less than 40**.

Data Set: Pain_Scores.xlsx

Research Question:

"Does the new pain relief drug result in a median pain score lower than 40?"

H_0 : The population median pain score is ≥ 40 .

H_a : The population median pain score is < 40 .

Checking Assumption:

- Sample size? $n = 13$
- Normal distribution or not?

Descriptive Statistics and Normality Test

Data Set: pain_scores.xlsx

Normality Test Assessment

Hypothesis Statement for normality test
 H_0 : Variable is normally distributed
 H_A : Variable is Not Normally distributed

Tests of Normality						
Kolmogorov-Smirnov ^a			Shapiro-Wilk			
Statistic	df	Sig.	Statistic	df	Sig.	
Pain Score (After Drug)	.132	18	.200*	.964	18	.679

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

a. Lilliefors Significance Correction

From the result of Shapira Wilk (due to sample size < 50) since both **p-values > 0.05**, we **fail to reject the null hypothesis of normality**, indicating that variable pain_scores **follow a normal distribution**.

However, since the sample size ($n= 18$) is small, therefore using parametric test is not suitable.

Small sample size, n (< 30), non-parametric tests are still widely used as they are **robust and do not rely on strict assumptions**.

Descriptive Statistics and Normality Test

Data Set: pain_scores.xlsx

1. Analyze > Nonparametric Tests > One Sample..

1

The screenshot shows the SPSS application window. In the top menu bar, the 'Analyze' option is highlighted. A dropdown menu for 'Nonparametric Tests' is open, showing several sub-options: 'One Sample...', 'Independent Samples...', 'Related Samples...', 'Quade Nonparametric ANCOVA', and 'Legacy Dialogs'. The 'One Sample...' option is currently selected, indicated by a gray background. To the left of the menu, a data view window displays a table with two columns: 'Patient' and 'PainScoreAfter Drug'. The data consists of 18 rows, each containing a patient number and a corresponding pain score.

Patient	PainScoreAfter Drug
1	39.967
2	33.617
3	41.477
4	50.230
5	32.658
6	32.659
7	50.792
8	42.674
9	30.305
10	40.426
11	30.366
12	30.343
13	37.420
14	15.867
15	17.751
16	29.377
17	24.872
18	38.142

Data Set: pain_scores.xlsx

2. Objective tab, checked Customize Analysis

One-Sample Nonparametric Tests X

2

Objective Fields Settings

Identifies differences in single fields using one or more nonparametric tests. Nonparametric tests do not assume your data follow the normal distribution.

What is your objective?

Each objective corresponds to a distinct default configuration on the Settings Tab that you can further customize, if desired.

Automatically compare observed data to hypothesized

Test sequence for randomness

Customize analysis

Description

'Customize analysis' allows you fine-grained control over the tests performed and their options. The Wilcoxon Signed-Rank test is also available on the Settings tab.

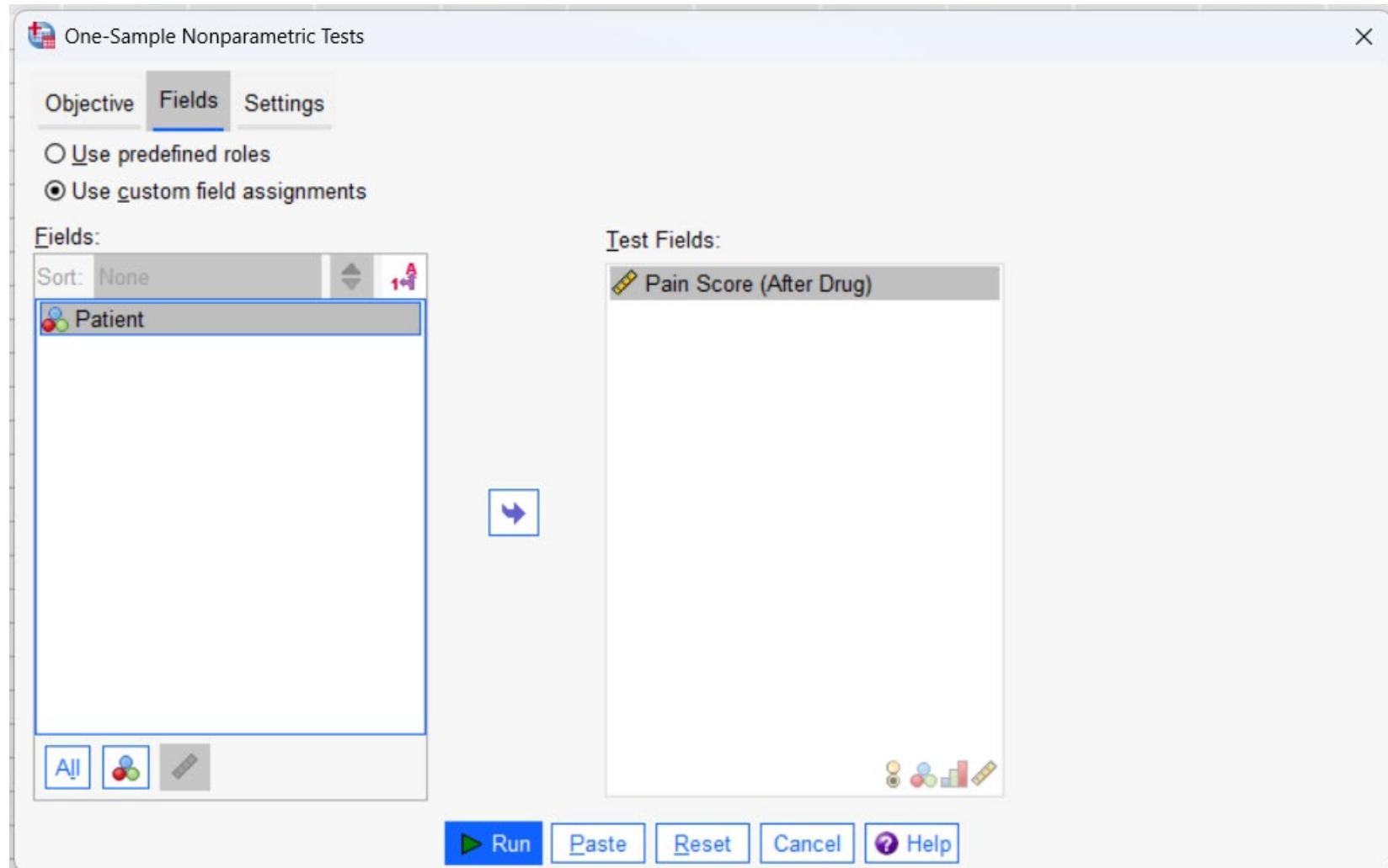
Run **Paste** **Reset** **Cancel** **Help**

Descriptive Statistics and Normality Test

Data Set: pain_scores.xlsx

3

3. Fields tab, checked Use custom field assignments. Then select Rating family car as Test Field



Descriptive Statistics and Normality Test

Data Set: pain_scores.xlsx

4. Settings tab, checked Customize Tests. Then select compare median to hypothesized. The hypothesized median is 40 (as stated in the hypothesis).
5. Click Run

One-Sample Nonparametric Tests

Objective Fields Settings

Select an item:

Choose Tests Test Options User-Missing Values

Automatically choose the tests based on the data

Customize tests

Compare observed binary probability to hypothesized (Binomial test)
Options...

Compare observed probabilities to hypothesized (Chi-Square test)
Options...

Test observed distribution against hypothesized (Kolmogorov-Smirnov test)
Options...

Compare median to hypothesized (Wilcoxon signed-rank test)
Hypothesized median:

Test sequence for randomness (Runs test)
Options...

Run Paste Reset Cancel Help

5

4

The screenshot shows the 'One-Sample Nonparametric Tests' dialog box in SPSS. The 'Settings' tab is active. Under 'Select an item:', 'Customize tests' is selected. In the list, 'Compare median to hypothesized (Wilcoxon signed-rank test)' is checked, and the 'Hypothesized median' is set to 40. Other options like Binomial, Chi-Square, and Kolmogorov-Smirnov tests are available but not selected. Buttons for Run, Paste, Reset, Cancel, and Help are at the bottom.

Descriptive Statistics and Normality Test

Data Set: pain_scores.xlsx

Hypothesis Statement:

H_0 : The population median pain score is ≥ 40 .

H_a : The population median pain score is < 40 .

Hypothesis Test Summary

Null Hypothesis	Test	Sig. ^{a,b}	Decision
1 The median of Pain Score (After Drug) equals 40.000.	One-Sample Wilcoxon Signed Rank Test	.043	Reject the null hypothesis.

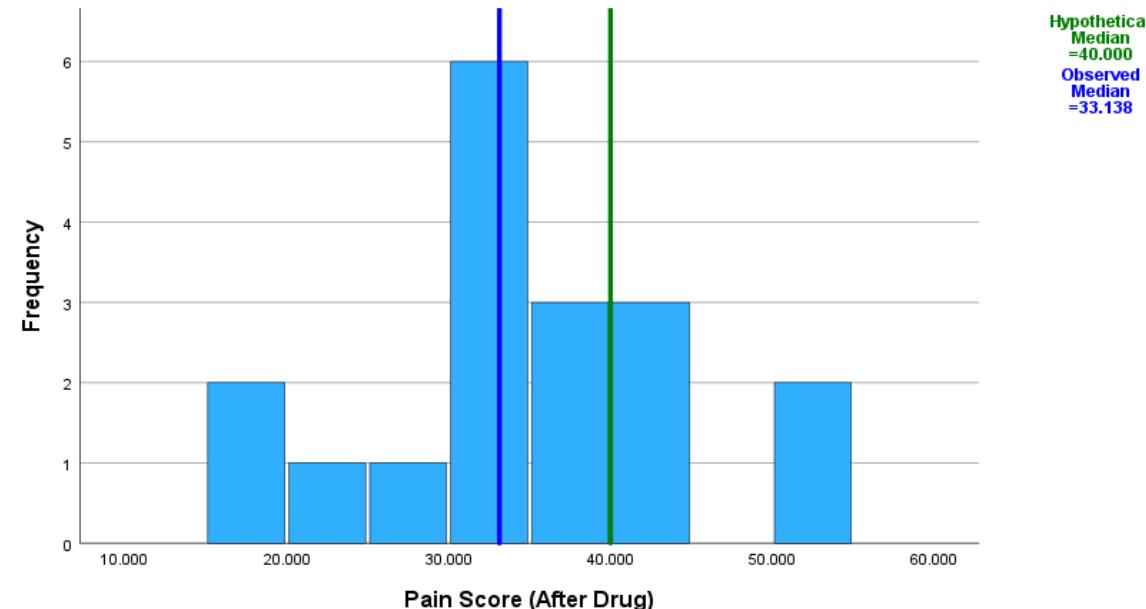
a. The significance level is .050.

b. Asymptotic significance is displayed.

One-Sample Wilcoxon Signed Rank Test Summary

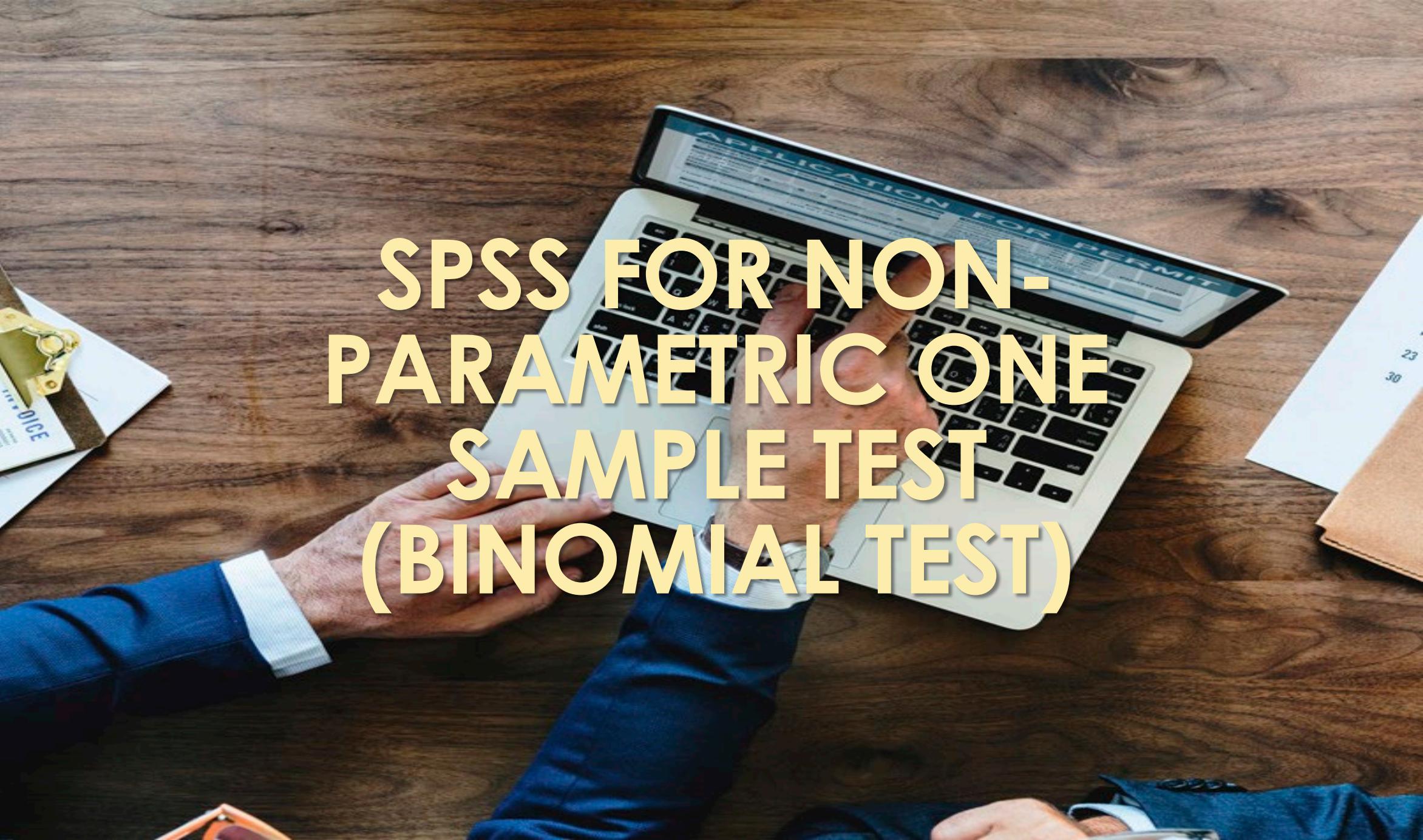
Total N	18
Test Statistic	39.000
Standard Error	22.962
Standardized Test Statistic	-2.025
Asymptotic Sig.(2-sided test)	.043

One-Sample Wilcoxon Signed Rank Test



To summarize:

Since the **p-value (0.0216) < 0.05**, we **reject the null hypothesis** at a **5% significance level**. This indicates that the **pain relief drug significantly reduces pain scores, with a median score lower than 40**.



SPSS FOR NON-PARAMETRIC ONE SAMPLE TEST (BINOMIAL TEST)

Problem Statement:

A public health department claims that a new **vaccine prevents infection in at least 80%** of vaccinated individuals. To test this claim, researchers **randomly select 20 vaccinated individuals** and record whether they contracted the infection (**Yes/No**).

Research Question:

"Is the proportion of vaccinated individuals who remain infection-free lower than 80%?"

Data Set: Vaccine_Effectiveness_Outcomes.xlsx

Hypothesis Statement:

H_0 : The population proportion of vaccinated individuals who remain infection-free is $\geq 80\%$.

H_a : The population proportion of vaccinated individuals who remain infection-free is $< 80\%$.

This is one tailed hypothesis test



Non Parametric One-Sample Population Proportion Statistical Test: Binomial test

Data Set: Vaccine_Effectiveness_Outcomes.xlsx

1. Analyze > Nonparametric Tests > Legacy Dialogs > Binomial

The screenshot shows the SPSS interface with the Analyze menu open. The "Nonparametric Tests" option is highlighted, and its sub-menu is visible. The sub-menu includes "One Sample...", "Independent Samples...", "Related Samples...", "Quade Nonparametric ANCOVA", and "Legacy Dialogs".

1

	Individual	InfectionFre e1Yes0No
1	1	Yes
2	2	No
3	3	Yes
4	4	Yes
5	5	Yes
6	6	Yes
7	7	Yes
8	8	No
9	9	Yes
10	10	Yes
11	11	Yes
12	12	No
13	13	No
14	14	Yes
15	15	Yes
16	16	Yes
17	17	Yes
18	18	Yes

One-Sample Nonparametric Tests X

2

Objective Fields Settings

Identifies differences in single fields using one or more nonparametric tests. Nonparametric tests do not assume your data follow the normal distribution.

What is your objective?

Each objective corresponds to a distinct default configuration on the Settings Tab that you can further customize, if desired.

Automatically compare observed data to hypothesized

Test sequence for randomness

Customize analysis

Description

'Customize analysis' allows you fine-grained control over the tests performed and their options. The Wilcoxon Signed-Rank test is also available on the Settings tab.

Run **Paste** **Reset** **Cancel** **Help**

Non Parametric One-Sample Population Proportion Statistical Test: Binomial test

Data Set: Vaccine_Effectiveness_Outcomes.xlsx

3

One-Sample Nonparametric Tests

Objective Fields Settings

Select an item:

Choose Tests

Automatically choose the tests based on the data

Customize tests

Compare observed binary probability to hypothesized (Binomial test)

Options...

Compare observed probabilities to hypothesized (Chi-Square test)

Options...

Test observed distribution against hypothesized (Kolmogorov-Smirnov test)

Options...

Compare median to hypothesized (Wilcoxon signed-rank test)

Hypothesized median:

Test sequence for randomness (Runs test)

Options...

Run Paste Reset Cancel Help

4. Change the hypothesized proportion to 80% or 0.8

Binomial Options

Hypothesized proportion:

Confidence Interval

Clopper-Pearson (exact)

Jeffreys

Likelihood ratio

Define Success for Categorical Fields

Use first category found in data

Specify success values

Success Values:

Value

Define Success for Continuous Fields

Success is equal to or less than

Sample midpoint

Custom cut point

Cut point:

OK Cancel Help

4

Non Parametric One-Sample Population Proportion Statistical Test: Binomial test

Data Set: Vaccine_Effectiveness_Outcomes.xlsx

H_0 : The population proportion of vaccinated individuals who remain infection-free is $\geq 80\%$.

H_a : The population proportion of vaccinated individuals who remain infection-free is $< 80\%$.

Hypothesis Test Summary			
Null Hypothesis	Test	Sig. ^{a,b}	Decision
1 The categories defined by Infection-Free (1=Yes, 0=No) = Yes and No occur with probabilities .800 and .200.	One-Sample Binomial Test	.589 ^c	Retain the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

c. Exact significance is displayed for this test.

2

Binomial Test					
	Category	N	Observed Prop.	Test Prop.	Exact Sig. (1-tailed)
Infection-Free (1=Yes, 0=No)	Group 1 Yes	16	.8	.8	.589 ^a
	Group 2 No	4	.2		
	Total	20	1.0		

4

a. Alternative hypothesis states that the proportion of cases in the first group $< .8$.

1

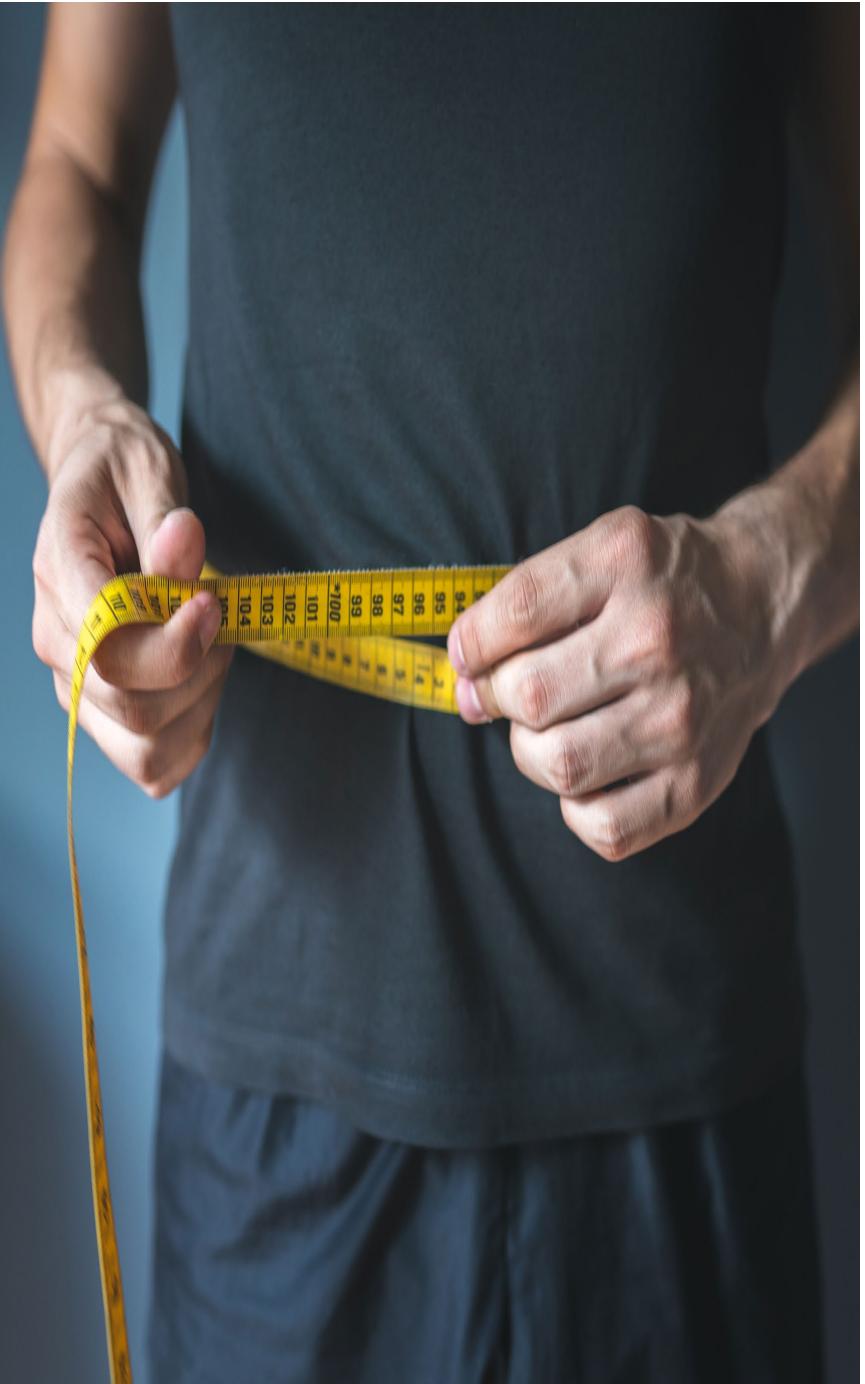
To summarize:

1. N: 16 out of 20 cases are vaccinated individuals who remain infection-free
2. The observed proportion for vaccinated individuals who remain infection-free is 0.8 or 80%
3. The hypothesized test proportion is 0.8 or 80%
4. p(denoted as "Exact Significance (1-tailed)") = 0.589: We generally ACCEPT our null hypothesis that the population proportion of vaccinated individuals who remain infection-free is $\geq 80\%$.

3

A blue checkers board with white grid lines. Various colored checkers are scattered across the board, including red, green, yellow, and blue pieces. Some pieces are in their original starting positions, while others are moved to different squares.

LET US PRACTICE



Problem Statement:

A healthcare research institute is evaluating the effectiveness of a 12-week weight loss program. The institute recruited 50 participants and measured their Body Mass Index (BMI) before and after the program. The goal is to determine whether the weight loss program significantly reduces BMI. Test the hypothesis at a 95% significance level.

Research Question:

"Does the 12-week weight loss program significantly reduce participants' BMI?"

Data Set: BMI_Weight_Loss_Program.xlsx

Hypothesis Statement:

H_0 : There are **no differences** on BMI reading before and after the treatment

H_A : There are **differences** on BMI reading before and after the treatment

This is two tailed hypothesis test

A photograph of a person's hands and arms in a blue suit sleeve working on a silver laptop. The laptop screen displays a document titled "APPLICATION FOR PERMIT". The background is a wooden desk with some papers and a badge.

SPSS FOR NON-PARAMETRIC INDEPENDENT SAMPLE TEST

Problem Statement:

A hospital is conducting a study to compare the effectiveness of two different pain management treatments for patients with chronic lower back pain. The study involves **two independent groups**:

Group A: Patients receiving a new non-invasive pain relief therapy

Group B: Patients receiving conventional physiotherapy

Each patient undergoes only **one** of the two treatments. After completing the treatment regimen, the pain level of each patient is measured using a standardized pain scale. **Is there a significant difference in post-treatment pain levels between the two independent groups?**

Data Set: pain_management.xlsx

Hypothesis Statement:

H_0 : The pain score between group A and group B are equal

H_A : The pain score between group A and group B are not equal

This is two tailed hypothesis test

Normality Test

Data Set: pain_management.xlsx

Normality Test Assessment

Hypothesis Statement for normality test
 H_0 : Variable is normally distributed
 H_A : Variable is Not Normally distributed

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pain Score	.140	120	<.001	.948	120	<.001

a. Lilliefors Significance Correction

From the result of Kalmogorov Smirnov(due to sample size >50) since the **p-values < 0.05**, we **reject the null hypothesis of normality**, indicating that variable pain_scores **does not follow a normal distribution**.

Non Parametric Independent-Sample statistical Test: Mann-Whitney Test

Data Set: pain_management.xlsx

1. Analyze > Nonparametric Tests > 2 Independent Samples

1

The screenshot shows the IBM SPSS Statistics Data Editor window. The menu bar at the top includes File, Edit, View, Data, Transform, Analyze, Graphs, Utilities, Extensions, Window, and Help. The 'Analyze' menu is open, revealing sub-options: Power Analysis, Meta Analysis, Reports, Descriptive Statistics, Compare Means and Proportions, General Linear Model, Correlate, Regression, Classify, Dimension Reduction, Scale, Nonparametric Tests, Forecasting, Multiple Response, Simulation..., Quality Control, and Spatial and Temporal Modeling... The 'Nonparametric Tests' option is highlighted. A sub-menu for 'Nonparametric Tests' is displayed, listing One Sample..., Independent Samples..., Related Samples..., Quade Nonparametric ANCOVA, and Legacy Dialogs. The 'Independent Samples...' option is also highlighted. The main data area shows a table with two columns: 'Group' and 'PainScore'. The 'Group' column contains 18 entries labeled 'New Therapy'. The 'PainScore' column contains 18 corresponding numerical values ranging from 2 to 6.

Group	PainScore
New Therapy	6
New Therapy	5
New Therapy	2
New Therapy	2
New Therapy	4
New Therapy	4
New Therapy	3
New Therapy	5
New Therapy	5
New Therapy	4
New Therapy	5
New Therapy	5
New Therapy	2
New Therapy	4
New Therapy	6
New Therapy	4
New Therapy	6
New Therapy	2
New Therapy	2

Non Parametric Independent-Sample statistical Test: Mann-Whitney Test

Data Set: adratings.sav

2

The screenshot shows the 'Nonparametric Tests: Two or More Independent Samples' dialog box in SPSS. The 'Fields' tab is selected. In the 'Fields' section, 'Sort: None' is chosen, and 'Group' is selected as the grouping variable. In the 'Test Fields:' section, 'Pain Score' is listed. At the bottom, 'Groups:' is set to 'Group of Patient'. The 'Run' button is highlighted.

2. Select the advert score (ad1, ad2 and ad3) as test variable list. Select Gender as grouping variable.
3. Define the groups

3



Objective Fields Settings

Select an item:

Choose Tests

Automatically choose the tests based on the data

Test Options

Customize tests

User-Missing Values

4

Compare Distributions across Groups

Mann-Whitney U (2 samples)

Kruskal-Wallis 1-way ANOVA (k samples)

Multiple comparisons: All pairwise

Kolmogorov-Smirnov (2 samples)

Test for ordered alternatives

(Jonckheere-Terpstra for k samples)

Test sequence for randomness
(Wald-Wolfowitz for 2 samples)

Hypothesis order: Smallest to largest

Multiple comparisons: All pairwise

Compare Ranges across Groups

Moses extreme reaction (2 samples)

Compute outliers from sample

Custom number of outliers

Outliers:

Compare Medians across Groups

Median test (k samples)

Pooled sample median

Custom

Median:

Multiple comparisons: All pairwise

Estimate Confidence Interval across Groups

Hodges-Lehmann estimate (2 samples)

Run

Paste

Reset

Cancel

Help

4. Customize Test ->
Select **Mann-Whitney U**.

OUTPUT → Non Parametric Independent-Sample statistical Test: Mann-Whitney Test

Data Set: adratings.sav

H_0 : The pain score between group A and group B are equal
 H_A : The pain score between group A and group B are not equal

Hypothesis Test Summary

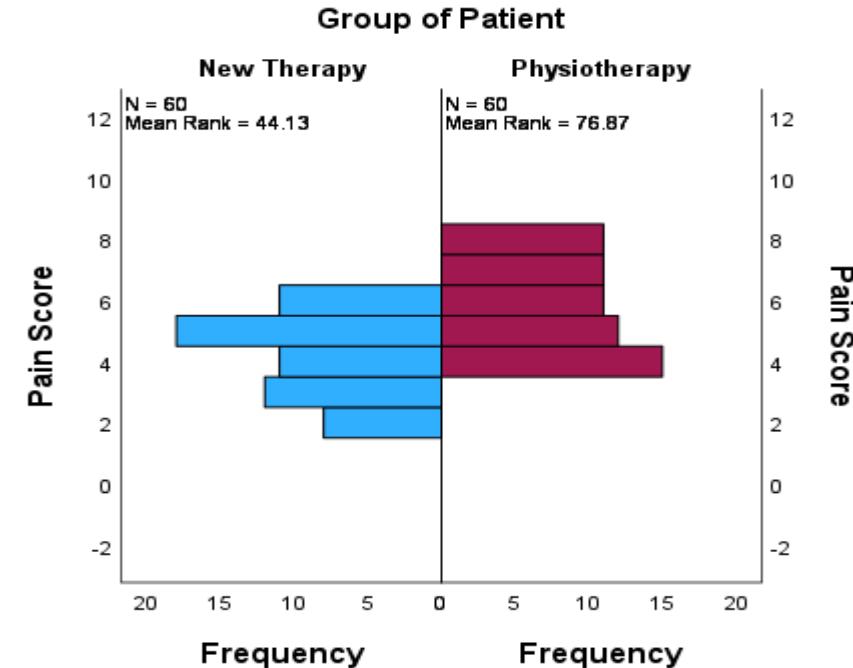
Null Hypothesis	Test	Sig. ^{a,b}	Decision
1 The distribution of Pain Score is the same across categories of Group of Patient.	Independent-Samples Mann-Whitney U Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Since the **p-value is extremely small (< 0.05)**, we reject the null hypothesis and conclude that **there is a significant difference in pain levels between the two groups**. This supports the claim that **the new therapy differs significantly from conventional physiotherapy in terms of pain reduction**.

Independent-Samples Mann-Whitney U Test



A blue checkers board with white grid lines. Various colored checkers are scattered across the board, including red, green, yellow, and blue pieces. Some pieces are in their original starting positions, while others are moved to different squares.

LET US PRACTICE



Research Question:

Is there any difference for the BMI between men and women are equal?

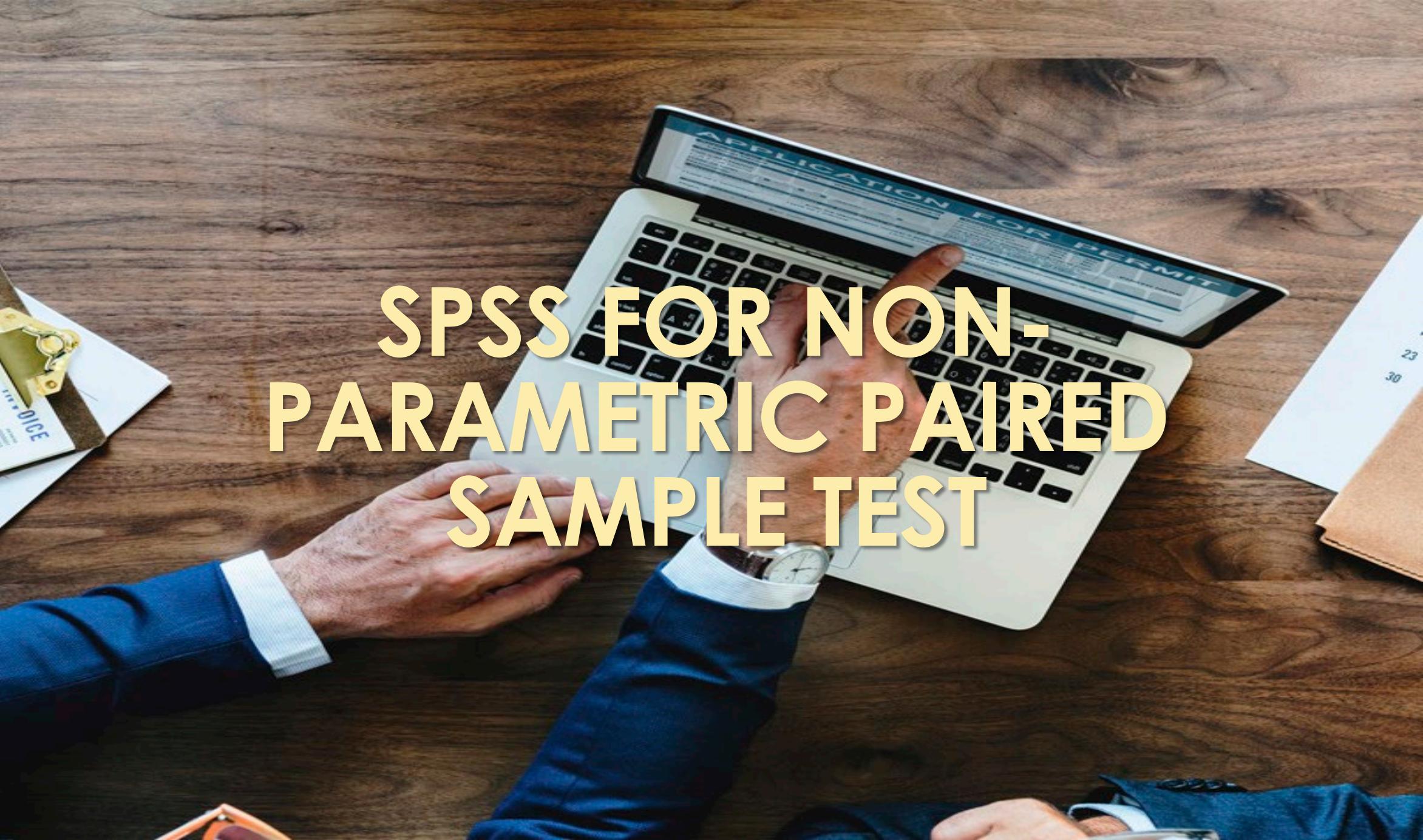
Data Set: BMI.sav

Hypothesis Statement:

H_0 : The BMI between men and women are equal

H_A : The BMI between men and women are not equal

This is two tailed hypothesis test



SPSS FOR NON-PARAMETRIC PAIRED SAMPLE TEST



Research Question:

Does arterial plaque within blood vessel thickness before & after treatment shows a significantly difference?

Data Set: arterial plague experiment.sav

Hypothesis Statement:

H_0 : There are no significantly difference on median blood vessel thickness before & after treatment
(Median_{post-pre} = 0)

H_A : There are significantly difference on median blood vessel thickness before & after treatment

(Median_{post-pre} ≠ 0)

This is two tailed hypothesis test

Normality test, Histogram and Descriptive Statistics

Data Set: arterial plague experiment.sav

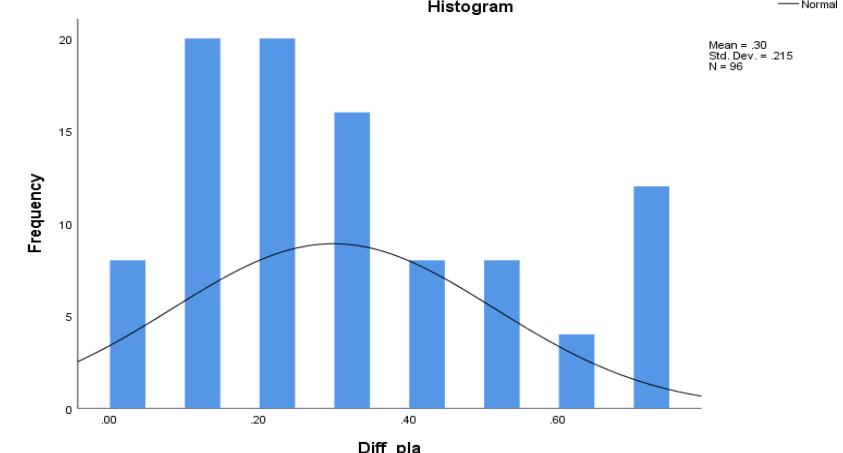
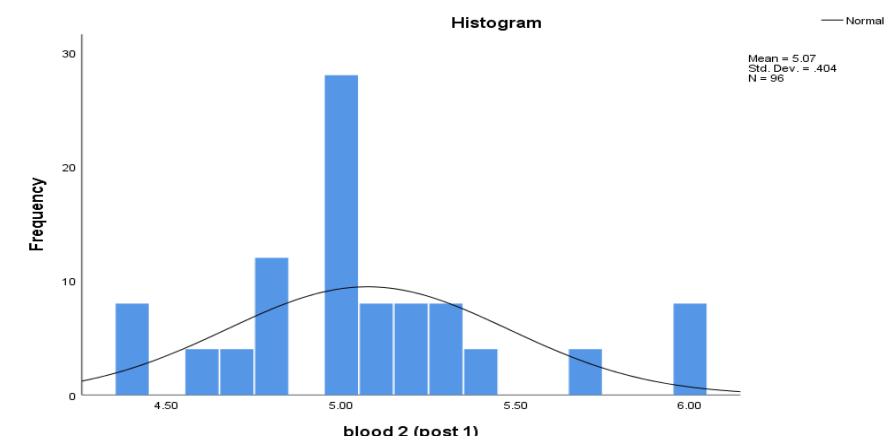
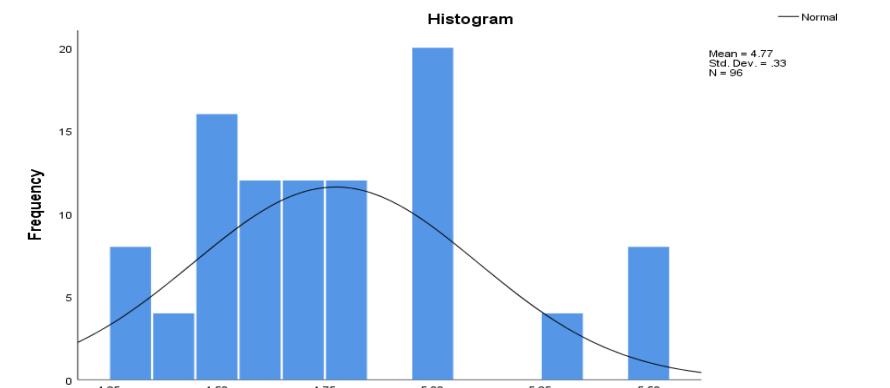
Tests of Normality

Kolmogorov-Smirnov ^a			Shapiro-Wilk			
Statistic	df	Sig.	Statistic	df	Sig.	
blood 1 (pre 1)	.136	96	.000	.916	96	.000
blood 2 (post 1)	.157	96	.000	.915	96	.000
Diff_pla	.179	96	.000	.901	96	.000

a. Lilliefors Significance Correction

Statistics

	blood 1 (pre 1)	blood 2 (post 1)	Diff_pla
N	Valid	96	96
	Median	4.7000	5.0000
Skewness	.714	.681	.595
Std. Error of Skewness	.246	.246	.246
Kurtosis	-.111	.484	-.735
Std. Error of Kurtosis	.488	.488	.488
Range	1.20	1.60	.70
Percentiles	25	4.5000	4.8000
	50	4.7000	5.0000
	75	5.0000	5.2750



Non Parametric Paired-Sample statistical Test: Wilcoxon SR Test

Data Set: arterial plague experiment.sav

*Arterial plague Experiment.sav [DataSet8] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

Reports

Descriptive Statistics

Compare Means

General Linear Model

Correlate

Regression

Classify

Dimension Reduction

Scale

Nonparametric Tests

Forecasting

Multiple Response

Simulation...

Quality Control

Spatial and Temporal Modeling...

One Sample...

Independent Samples...

Related Samples...

Legacy Dialogs

Chi-square...

Binomial...

Runs...

1-Sample K-S...

2 Independent Samples...

K Independent Samples...

2 Related Samples...

K Related Samples...

	pre1	post1	.70	.10	.10	.10	.70	.70	.60
1	4.50	5.20							
2	4.50	5.20							
3	4.50	5.20							
4	4.50	5.20							
5	4.70	4.80							
6	5.00	5.10							
7	4.70	4.80							
8	4.70	4.80							
9	4.50	5.20							
10	4.50	5.20							
11	4.40	5.00							
12	4.40	5.00							
13	4.70	4.80	.10						
14	5.00	5.10	.10						
15	4.70	4.80	.10						
16	4.70	4.80	.10						
17	4.50	5.20	.70						
18	4.50	5.20	.70						
19	4.40	5.00	.60						

OUTPUT → Non Parametric Paired-Sample statistical Test: Wilcoxon SR Test

Data Set: arterial plague experiment.sav

Positive rank = post (after) is higher than pre (before)

Negative rank = post (after) is lower than pre (before)

Ties = post (after) is similar with pre (before)

*** similar population distributions → when the signs (plus and minus) is distributed roughly evenly over ranks.

Ranks

		N	Mean Rank	Sum of Ranks
blood 2 (post 1) - blood 1 (pre 1)	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	88 ^b	44.50	3916.00
	Ties	8 ^c		
	Total	96		

a. blood 2 (post 1) < blood 1 (pre 1)

b. blood 2 (post 1) > blood 1 (pre 1)

c. blood 2 (post 1) = blood 1 (pre 1)



The sum of positive ranks is way larger (3916) than the sum of negative ranks. This indicate that the arterial plague within blood vessel thickness shows a difference after the treatment.

Test Statistics^a

blood 2 (post 1) - blood 1 (pre 1)	
Z	-8.181 ^b
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

$$H_0 : \text{Median}_{\text{post-pre}} = 0$$

$$H_A : \text{Median}_{\text{post-pre}} \neq 0$$

P-value is smaller than $\alpha = 0.05$, therefore, H-null is rejected. This indicate that there is a difference on median blood vessel thickness before & after treatment

A blue checkers board with white grid lines. Scattered across the board are various colored plastic pieces: red, green, and yellow. Some pieces are in their original circular positions, while others are moved to different spots, suggesting a game in progress or practice.

LET US PRACTICE

Problem Statement:

A hospital is conducting a study to assess the effectiveness of a new blood pressure medication in reducing systolic blood pressure (SBP) among patients with hypertension. The study involves a **dependent (paired) sample design**, where **the same group of patients** is measured **before and after** taking the medication for a specified period.

Research Question:

Is there a significant difference in patients' systolic blood pressure before and after taking the new medication?

Hypothesis Statement:

H_0 : There are no significantly difference on systolic blood pressure (SBP) before & after treatment (Median_{post-pre} = 0)

H_A : There are significantly difference on systolic blood pressure (SBP) before & after treatment (Median_{post-pre} ≠ 0)

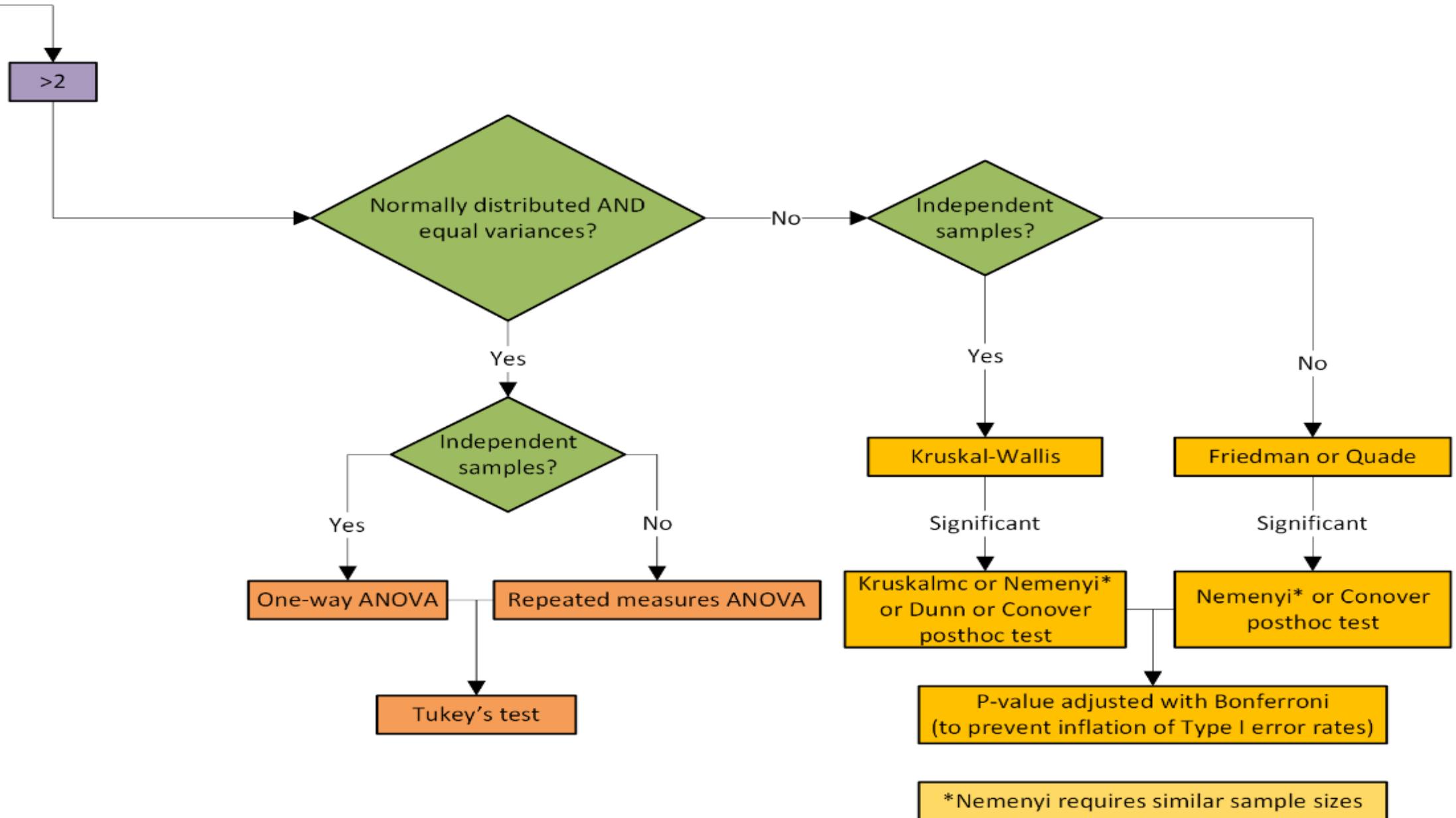
Data Set: Blood_Pressure_Study.xlsx





THE JOURNEY OF STATISTICAL TEST DOES NOT STOP HERE...

1. One Way ANOVA: to determine whether there are any statistically significant differences between the means of **three or more** independent (unrelated) groups.
2. Two-Way ANOVA: is used to estimate how the mean of a quantitative variable changes according to the levels of two categorical variables.
3. MANOVA: an ANOVA with several dependent variables.
4. ANCOVA: is a blend of analysis of variance (ANOVA) and regression. It is similar to factorial ANOVA



THANK YOU

