Non-parametric test

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Outlines

- Parametric Tests
- Two Independent Samples
- Two Related Samples
- More Than Two Independent Samples

Learning outcomes

- Able to perform selected non-parametric tests for comparison between samples for numerical/ordinal outcomes.

Non-parametric Test

Non-parametric Test

- Statistical test that requires:
  - Distribution free, sample data come from population NOT modeled by specific statistical distribution
  - e.g. cholesterol level of sample ← cholesterol level of population of unknown distributional form.
  - No specific parameters to be tested -- dependent on test used
  - Different or not (non-parametric) VS MEAN is different or not (parametric).

Non-parametric Test

- Statistical test that requires (cont.):
  - More flexible, can perform analysis when assumptions for parametric not fulfilled.
  - e.g. data not normally distributed.
  - LESS powerful than parametric test.

Non-parametric Test

- Non-parametric tests for comparison of samples for numerical outcomes:
  - Two independent samples: Mann-Whitney U test.
  - Two related samples: Wilcoxon Signed-Rank test.
  - More than two independent samples: Kruskal-Wallis test.

Two independent samples: Mann-Whitney U test

Two independent samples: Mann-Whitney U test

- Purpose: Compare RANKS of TWO independent samples/groups.
- Assumptions:

    1. Numerical/ordinal outcome.

Two independent samples: Mann-Whitney U test

Research objective:

To compare cholesterol level between male and female.

Research question:

Is there any difference in cholesterol level between male and female populations?

Two independent samples: Mann-Whitney U test

RQ: Is there any difference in cholesterol level between male and female populations?

Alternative Hypothesis:
Cholesterol level of male population is different from female population

Null Hypothesis:
No difference in cholesterol level between the populations

Statistical Test

Alternative Hypothesis:
P-value ≤ **0.05**

Null Hypothesis:
P-value > **0.05**

Mann-Whitney U

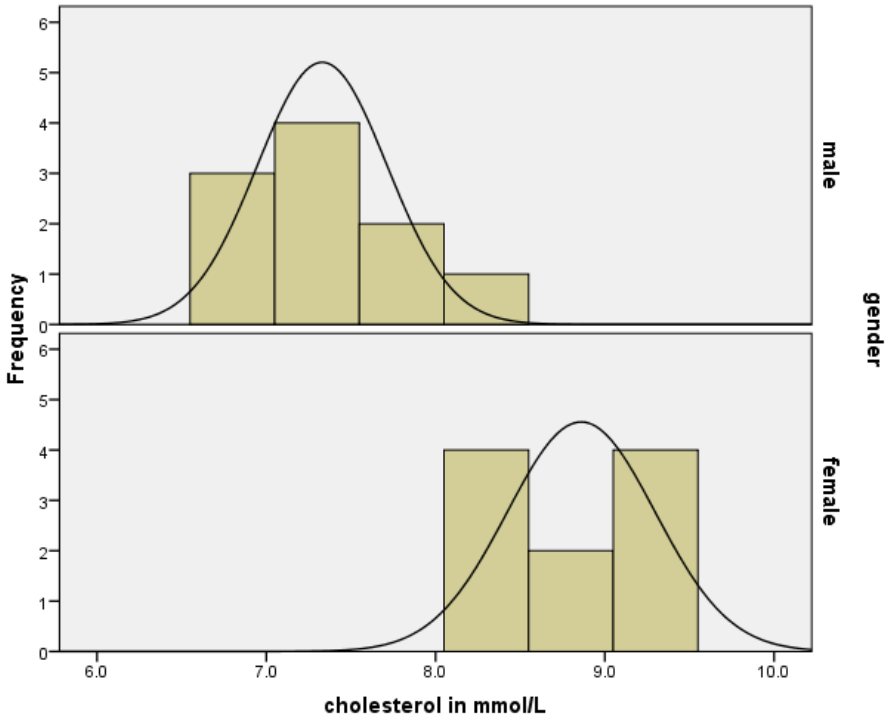
Mann-Whitney U test: Practical

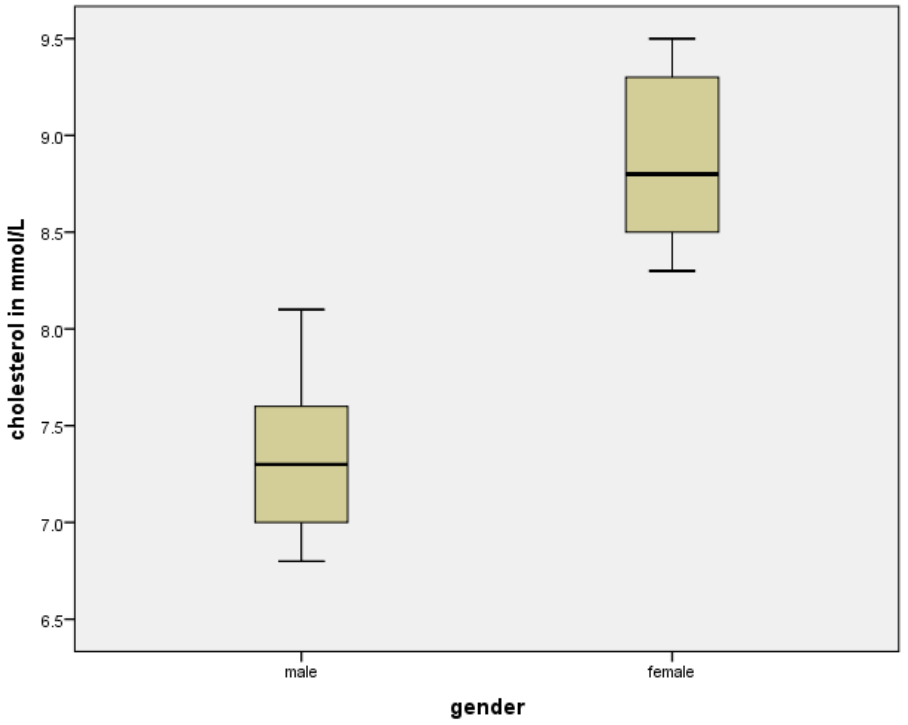
- Dataset: cholestrol2_np.sav
- Sample size: 10/group
- Group: 2 (male and female)
- Outcome: cholesterol level in mmol/L

Normality: Histogram & Boxplot

Self-practice: Obtain histogram & box-plot for each group.

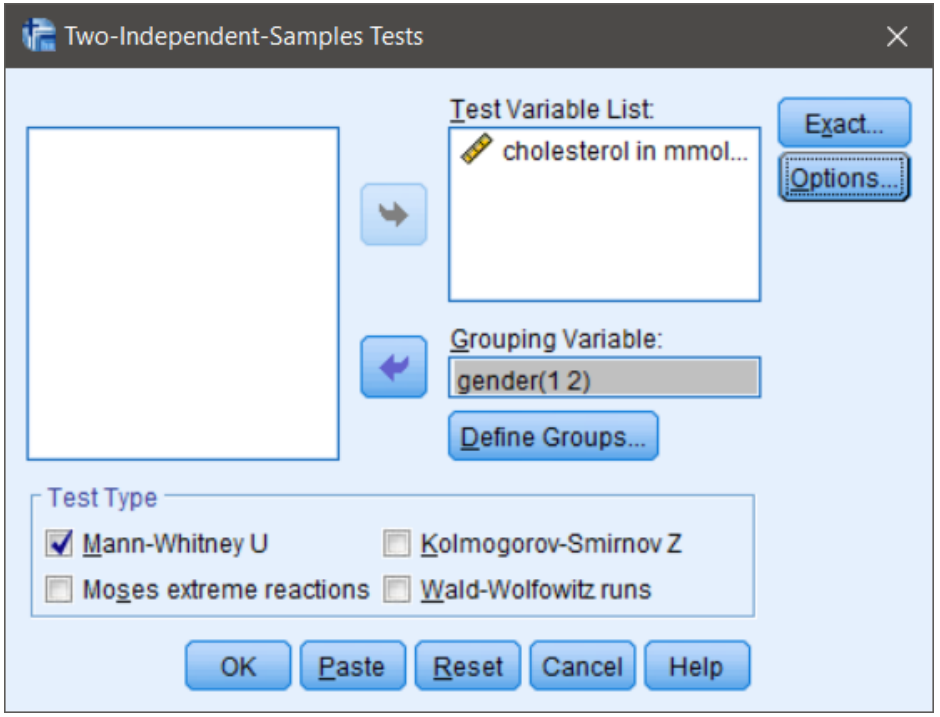
Normality





Normal?

Mann-Whitney: Steps



1. **Analyze > Nonparametric Tests > Legacy Dialogs > 2 Independent Samples...**
2. **Test Variable List: *cholestrol,* Grouping Variable: *gender***
3. **[Define Groups] > Group 1: 1, Group 2: 2 > Continue**
4. **Test Type: Mann-Whitney U [x]**
5. **OK**

Mann-Whitney: Results

Ranks

	gender	N	Mean Rank	Sum of Ranks
cholesterol in mmol/L	male	10	5.50	55.00
	female	10	15.50	155.00
	Total	20		

Test Statistics[a]

	cholesterol in mmol/L
Mann-Whitney U	.000
Wilcoxon W	55.000
Z	-3.790
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

a. Grouping Variable: gender

b. Not corrected for ties.

Descriptive: Median & IQR

Self-practice: Obtain Median and IQR for each group.

Descriptive: Median & IQR

Descriptives

	gender			Statistic	Std. Error
cholesterol in mmol/L	male	Mean		7.330	.1212
		95% Confidence Interval for Mean	Lower Bound	7.056	
			Upper Bound	7.604	
		5% Trimmed Mean		7.317	
		Median		7.300	
		Variance		.147	
		Std. Deviation		.3831	
		Minimum		6.8	
		Maximum		8.1	
		Range		1.3	
		Interquartile Range		.6	
		Skewness		.573	.687
		Kurtosis		.596	1.334

Descriptive: Median & IQR

	female	Mean		8.860	.1384
		95% Confidence Interval for Mean	Lower Bound	8.547	
			Upper Bound	9.173	
		5% Trimmed Mean		8.856	
		Median		8.800	
		Variance		.192	
		Std. Deviation		.4377	
		Minimum		8.3	
		Maximum		9.5	
		Range		1.2	
		Interquartile Range		.8	
		Skewness		.168	.687
		Kurtosis		-1.761	1.334

Two related samples: Wilcoxon Signed-Rank test

Two related samples: Wilcoxon Signed-Rank test

- Purpose: Compare SIGNED RANKS of the DIFFERENCES between TWO related samples, i.e. equal to ZERO if there is no difference.
- Assumptions:

    1. Numerical/ordinal outcome.

Two related samples: Wilcoxon Signed-Rank test

Research objective:

To compare cholesterol level of hypertensive patients before and after treatment.

Research question:

Is there any difference in cholesterol level of hypertensive patients before and after treatment?

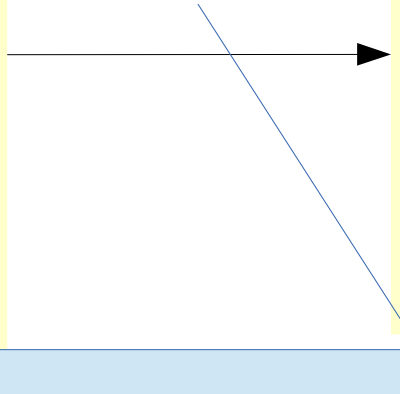
Two related samples: Wilcoxon Signed-Rank test

RQ: Is there any difference in cholesterol level of hypertensive patients before and after treatment?

Alternative Hypothesis:
Cholesterol level of HPT patients is different before and after treatment

Null Hypothesis:
No difference in cholesterol level of HPT patients before and after treatment

Statistical Test



Alternative Hypothesis:
P-value ≤ **0.05**

Null Hypothesis:
P-value > **0.05**

Wilcoxon Signed-Rank

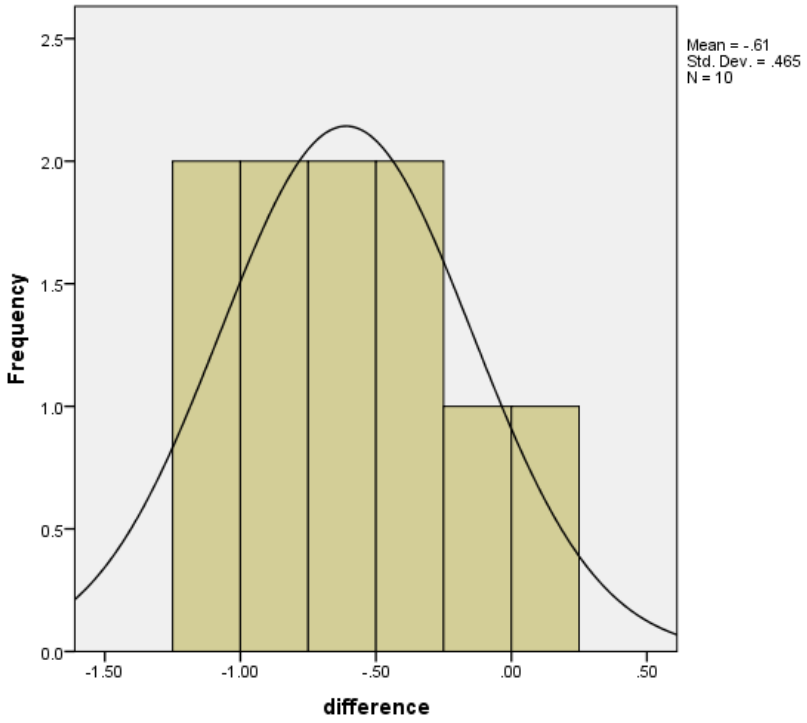
Wilcoxon Signed-Rank: Practical

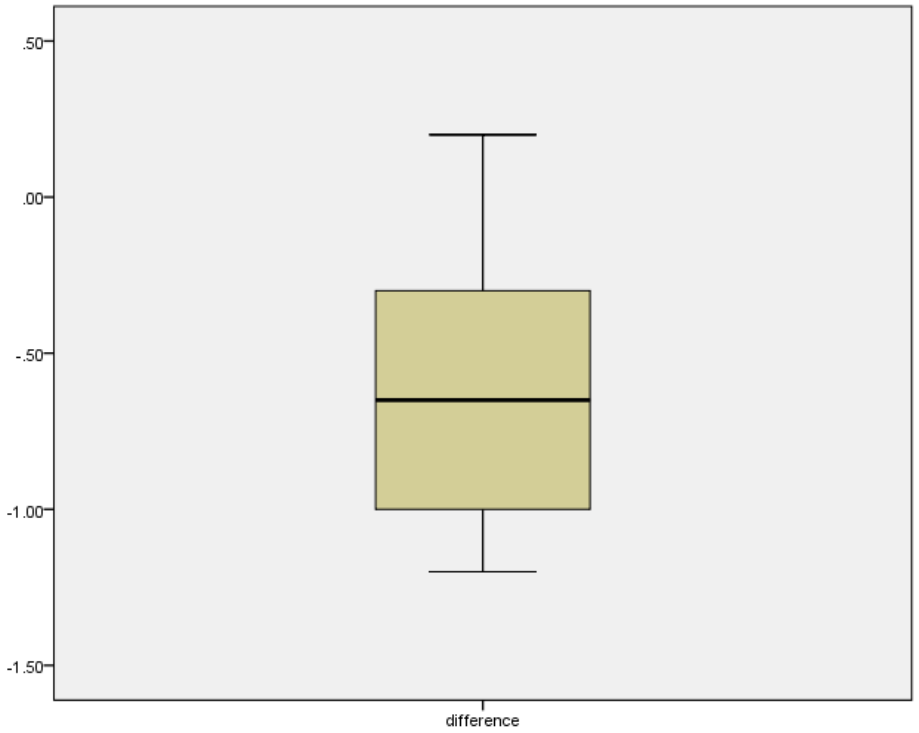
- Dataset: cholestrol_prepost_np.sav
- Sample size: 10 paired observations
- Repetition: 2 (before and after treatment)
- Outcome: cholesterol level in mmol/L

Normality: Histogram & Boxplot

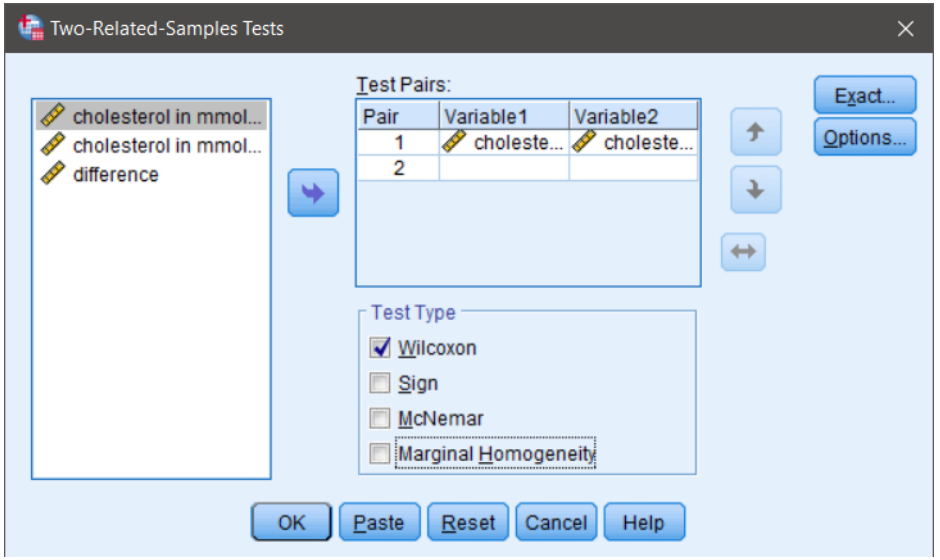
Self-practice: Obtain histogram & box-plot for the difference.

Normality of the difference





Wilcoxon Signed-Rank: Steps



1. **Analyze > Nonparametric Tests > Legacy Dialogs > 2 Related Samples...**
2. **Select both *cholestrol_before, cholestrol_after* → Test Pairs**
3. **Test Type: Wilcoxon [x]**
4. **OK**

Wilcoxon Signed-Rank: Results

Ranks

		N	Mean Rank	Sum of Ranks
cholesterol in mmol/L post treatment - cholesterol in mmol/L before treatment	Negative Ranks	9[a]	5.89	53.00
	Positive Ranks	1[b]	2.00	2.00
	Ties	0[c]		
	Total	10		

a. cholesterol in mmol/L post treatment < cholesterol in mmol/L before treatment

b. cholesterol in mmol/L post treatment > cholesterol in mmol/L before treatment

c. cholesterol in mmol/L post treatment = cholesterol in mmol/L before treatment

Test Statistics[a]

	cholesterol in mmol/L post treatment - cholesterol in mmol/L before treatment
Z	-2.601[b]
Asymp. Sig. (2-tailed)	.009

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Descriptive: Median & IQR

Self-practice: Obtain Median and IQR for before and after treatment.

Descriptive: Median & IQR

cholesterol in mmol/L before treatment	Mean		8.280	.1009
	95% Confidence Interval for Mean	Lower Bound	8.052	
		Upper Bound	8.508	
	5% Trimmed Mean		8.289	
	Median		8.300	
	Variance		.102	
	Std. Deviation		.3190	
	Minimum		7.6	
	Maximum		8.8	
	Range		1.2	
	Interquartile Range		.4	
	Skewness		-.697	.687
	Kurtosis		1.854	1.334

Descriptive: Median & IQR

cholesterol in mmol/L post treatment	Mean		7.670	.1795
	95% Confidence Interval for Mean	Lower Bound	7.264	
		Upper Bound	8.076	
	5% Trimmed Mean		7.672	
	Median		7.550	
	Variance		.322	
	Std. Deviation		.5677	
	Minimum		6.8	
	Maximum		8.5	
	Range		1.7	
	Interquartile Range		1.1	
	Skewness		.233	.687
	Kurtosis		-.947	1.334

More than two independent samples: Kruskal-Wallis test

More than two independent samples: Kruskal-Wallis test

- ANOVA on ranks.
- Purpose: Compare RANKS of THREE/MORE independent samples/groups.
- Assumptions:
    1. Numerical/ordinal outcome.

More than two independent samples: Kruskal-Wallis test

Research objective:

To compare cholesterol level between Group A, B and C treatment groups.

Research question:

Is there any difference in cholesterol level between Group A, B and C treatment groups?

More than two independent samples: Kruskal-Wallis test

RQ: Is there any difference in cholesterol level between any (i.e. A-B, AC, or B-C pairs) of the treatment groups?

Alternative Hypothesis:
Cholesterol level between any of the populations are different.

Null Hypothesis:
No difference in cholesterol level between any of the populations

Statistical Test

Alternative Hypothesis:
P-value ≤ **0.05**

Null Hypothesis:
P-value > **0.05**

Kruskal-Wallis

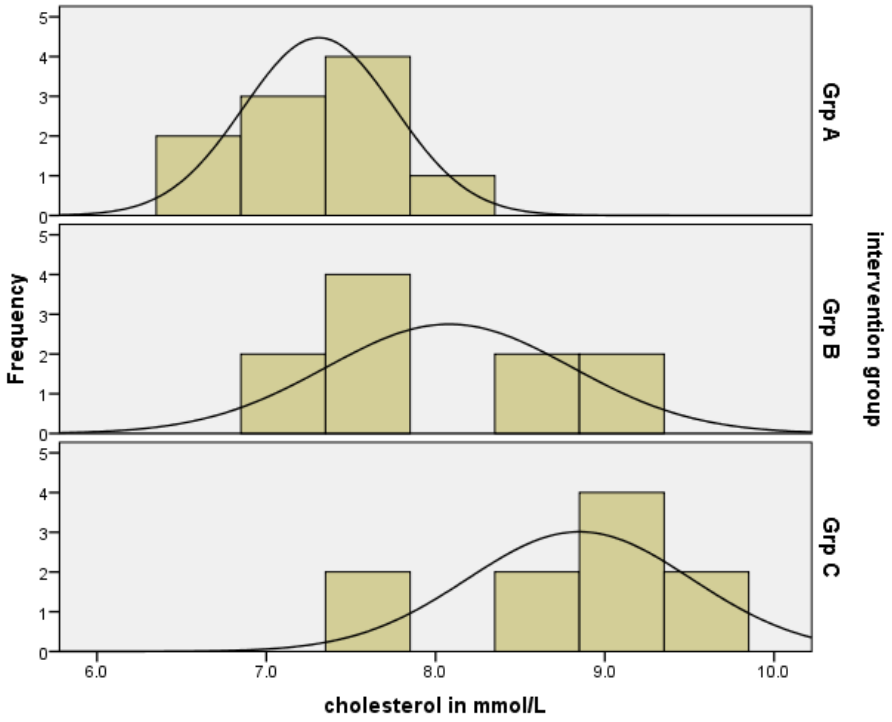
Kruskal-Wallis test: Practical

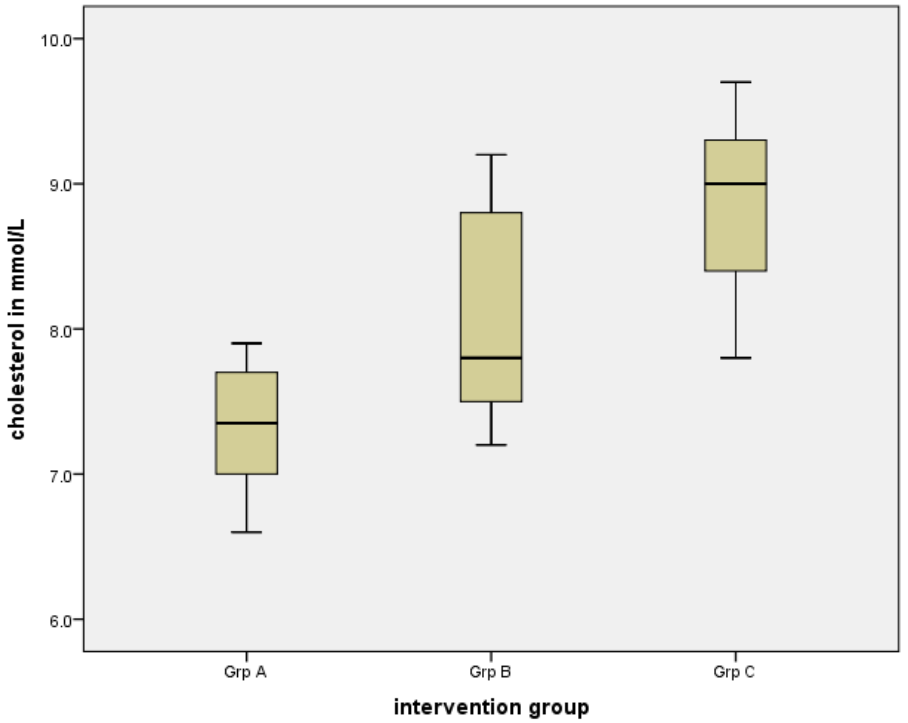
- Dataset: cholestrol3_np.sav
- Sample size: 10/group
- Group: 3 (Grp A, B and C)
- Outcome: cholesterol level in mmol/L

Normality: Histogram & Boxplot

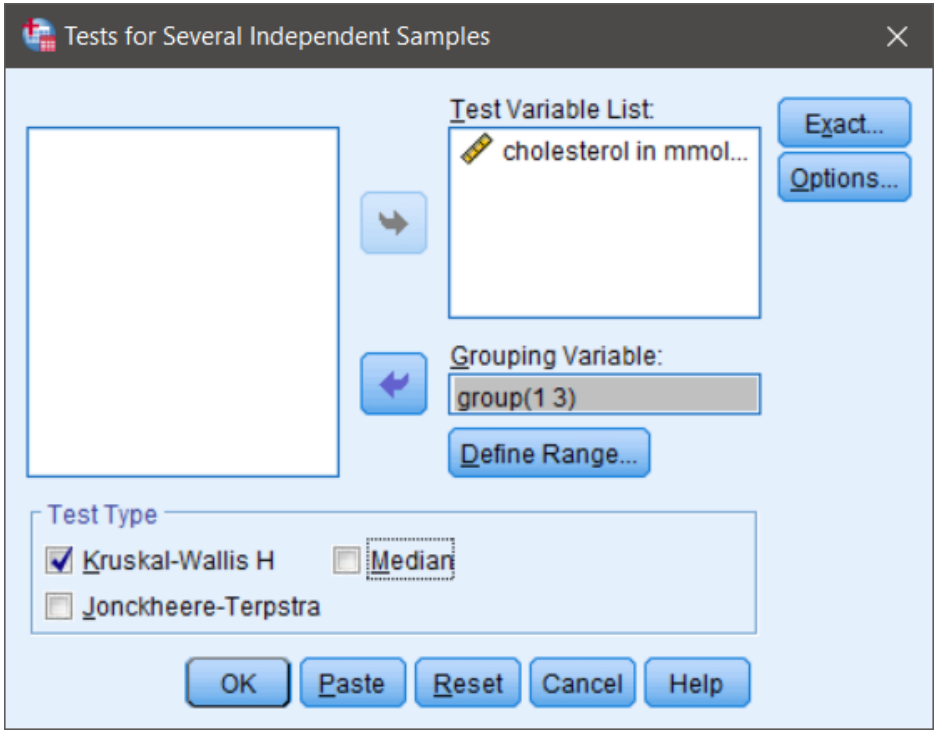
Self-practice: Obtain histogram & box-plot for each group.

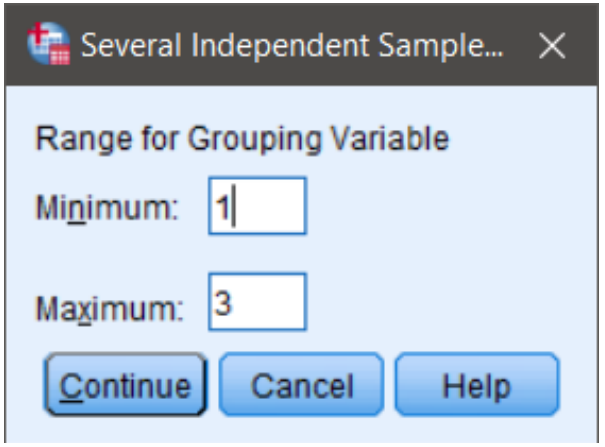
Normality


Frequency
Grp A
Grp B
Grp C
intervention group
cholesterol in mmol/L


cholesterol in mmol/L
Grp A
Grp B
Grp C
intervention group

Kruskal-Wallis: Steps





1. **Analyze > Nonparametric Tests > Legacy Dialogs > K Independent Samples...**
2. **Test Variable List: *cholestrol*, Grouping Variable: *group***
3. **[Define Groups] > Range for Grouping Variable: Minimum: 1 Maximum 3 > Continue**
4. **Test Type: Kruskal-Wallis [x]**
5. **OK**

Kruskal-Wallis: Results

Ranks

	intervention group	N	Mean Rank
cholesterol in mmol/L	Grp A	10	7.90
	Grp B	10	15.35
	Grp C	10	23.25
	Total	30	

Test Statistics[a,b]

	cholesterol in mmol/L
Chi-Square	15.294
df	2
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: intervention group

Descriptive: Median & IQR

Self-practice: Obtain Median and IQR for each group.

Descriptive: Median & IQR

Descriptives

	intervention group			Statistic	Std. Error
cholesterol in mmol/L	Grp A	Mean		7.310	.1410
		95% Confidence Interval for Mean	Lower Bound	6.991	
			Upper Bound	7.629	
		5% Trimmed Mean		7.317	
		Median		7.350	
		Variance		.199	
		Std. Deviation		.4458	
		Minimum		6.6	
		Maximum		7.9	
		Range		1.3	
		Interquartile Range		.8	
		Skewness		-.224	.687
		Kurtosis		-1.305	1.334

Descriptive: Median & IQR

Grp B	Mean		8.080	.2294
	95% Confidence Interval for Mean	Lower Bound	7.561	
		Upper Bound	8.599	
	5% Trimmed Mean		8.067	
	Median		7.800	
	Variance		.526	
	Std. Deviation		.7254	
	Minimum		7.2	
	Maximum		9.2	
	Range		2.0	
	Interquartile Range		1.4	
	Skewness		.371	.687
	Kurtosis		-1.594	1.334

Descriptive: Median & IQR

Grp C	Mean		8.850	.2094
	95% Confidence Interval for Mean	Lower Bound	8.376	
		Upper Bound	9.324	
	5% Trimmed Mean		8.861	
	Median		9.000	
	Variance		.438	
	Std. Deviation		.6621	
	Minimum		7.8	
	Maximum		9.7	
	Range		1.9	
	Interquartile Range		1.1	
	Skewness		-.655	.687
	Kurtosis		-.667	1.334

Post Hoc multiple comparison

Self-practice:

1. Perform Mann-Whitney U test for each pair: **Grp A-Grp B, Grp A-Grp C, Grp B-Grp C** (3 pairs).
2. For each P-value, calculate corrected P-value to adjust for multiple comparison (Bonferroni),

Bonferroni corrected P-value = P-value x number of pairs

Post Hoc: Results

Ranks

	intervention group	N	Mean Rank	Sum of Ranks
cholesterol in mmol/L	Grp A	10	7.60	76.00
	Grp B	10	13.40	134.00
	Total	20		

Test Statistics[a]

	cholesterol in mmol/L
Mann-Whitney U	21.000
Wilcoxon W	76.000
Z	-2.198
Asymp. Sig. (2-tailed)	.028
Exact Sig. [2*(1-tailed Sig.)]	.029[b]

a. Grouping Variable: intervention group

b. Not corrected for ties.

Bonferroni correction:
Corrected P-value = 0.028 x 3 = 0.084

Post Hoc: Results

Ranks

	intervention group	N	Mean Rank	Sum of Ranks
cholesterol in mmol/L	Grp A	10	5.80	58.00
	Grp C	10	15.20	152.00
	Total	20		

Test Statistics[a]

	cholesterol in mmol/L
Mann-Whitney U	3.000
Wilcoxon W	58.000
Z	-3.560
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

a. Grouping Variable: intervention group

b. Not corrected for ties.

Bonferroni correction:
Corrected P-value = 0 i.e. < 0.001

Post Hoc: Results

Ranks

	intervention group	N	Mean Rank	Sum of Ranks
cholesterol in mmol/L	Grp B	10	7.45	74.50
	Grp C	10	13.55	135.50
	Total	20		

Test Statistics[a]

	cholesterol in mmol/L
Mann-Whitney U	19.500
Wilcoxon W	74.500
Z	-2.317
Asymp. Sig. (2-tailed)	.021
Exact Sig. [2*(1-tailed Sig.)]	.019[b]

a. Grouping Variable: intervention group

b. Not corrected for ties.

Bonferroni correction:
Corrected P-value = 0.021 x 3 = 0.063

Q&A