Nonparametric tests

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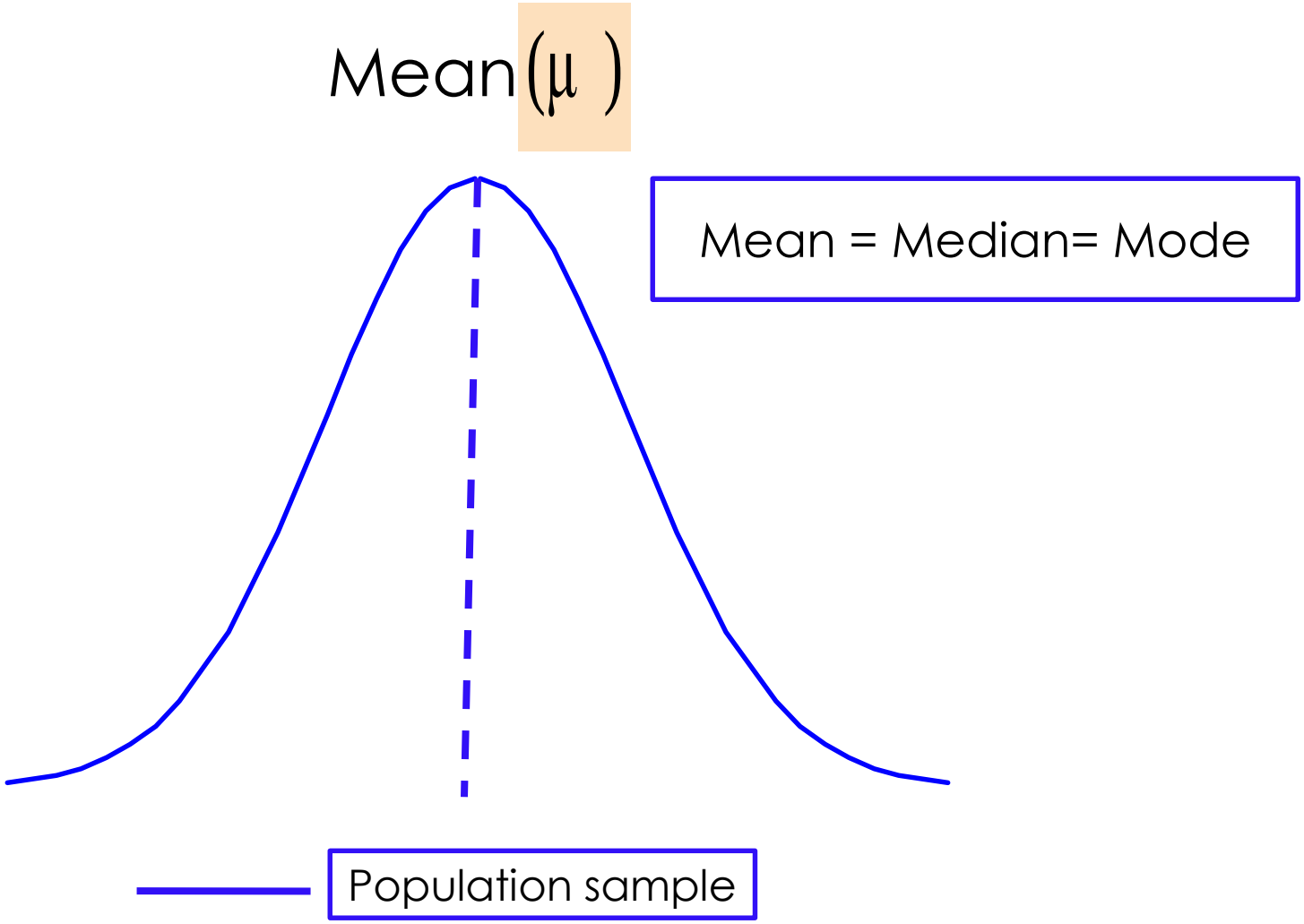
Outline

- What is nonparametric test?
- When to use
- Nonparametric tests used for comparative study design
- Steps in data interpretation for nonparametric test

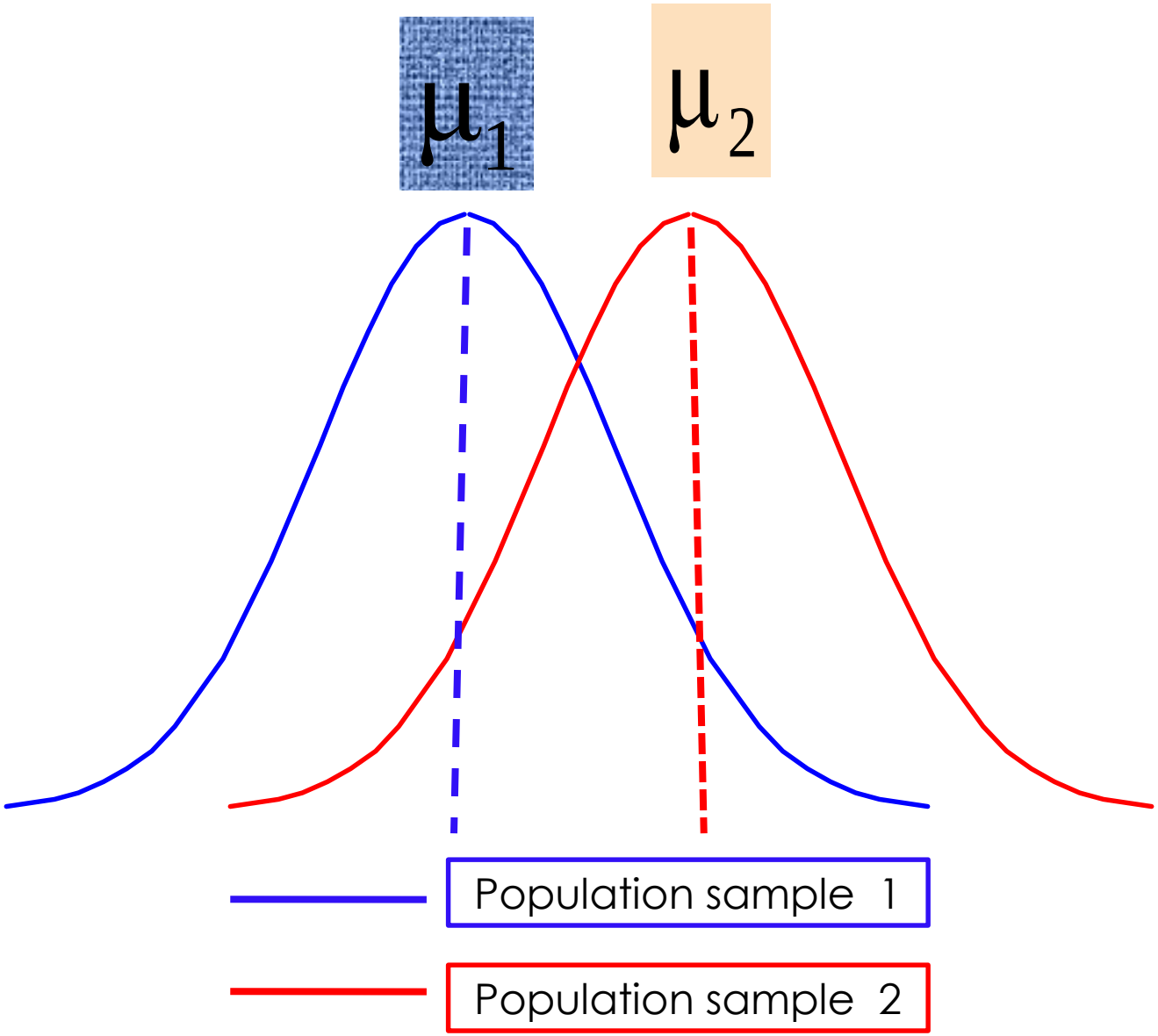
What is nonparametric test?

- **Distribution-free tests**
  - Do not assume, like parametric test that the outcome is approximately normally distributed

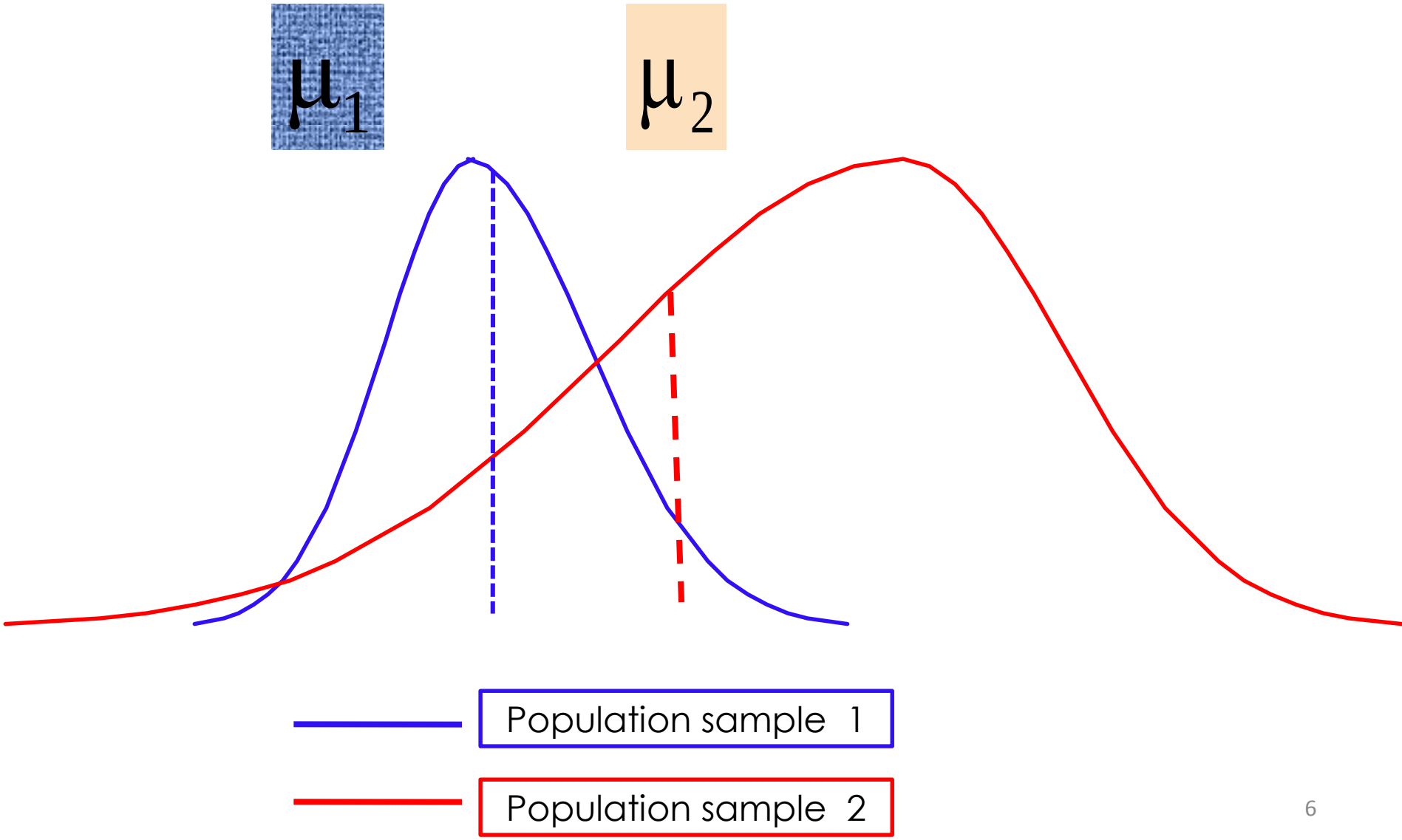
When to use



When to use



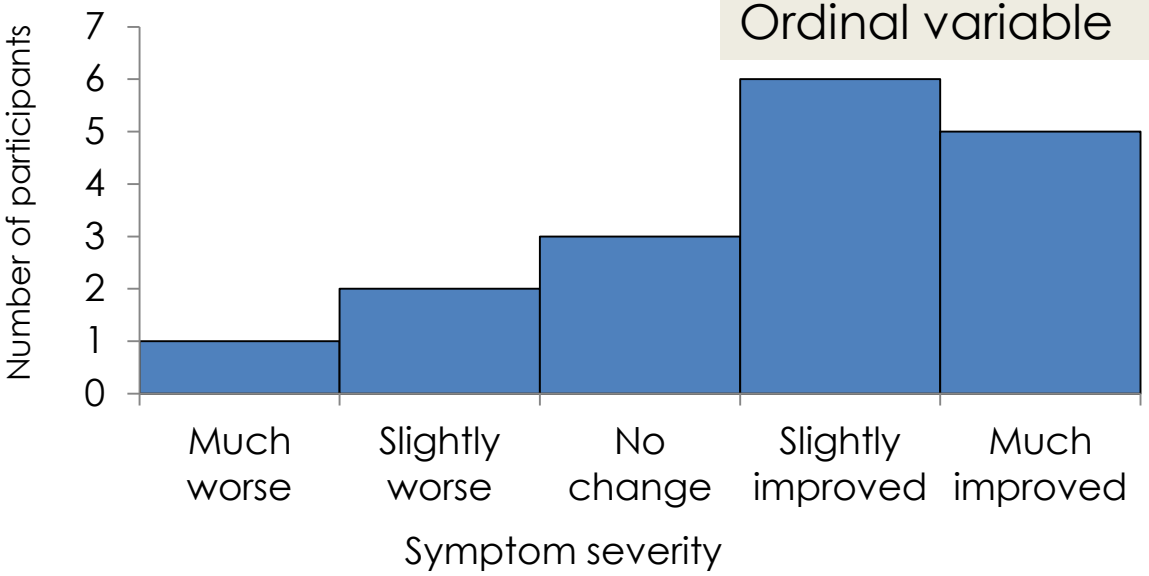
When to use



When to use

Situations does not follow normal distribution

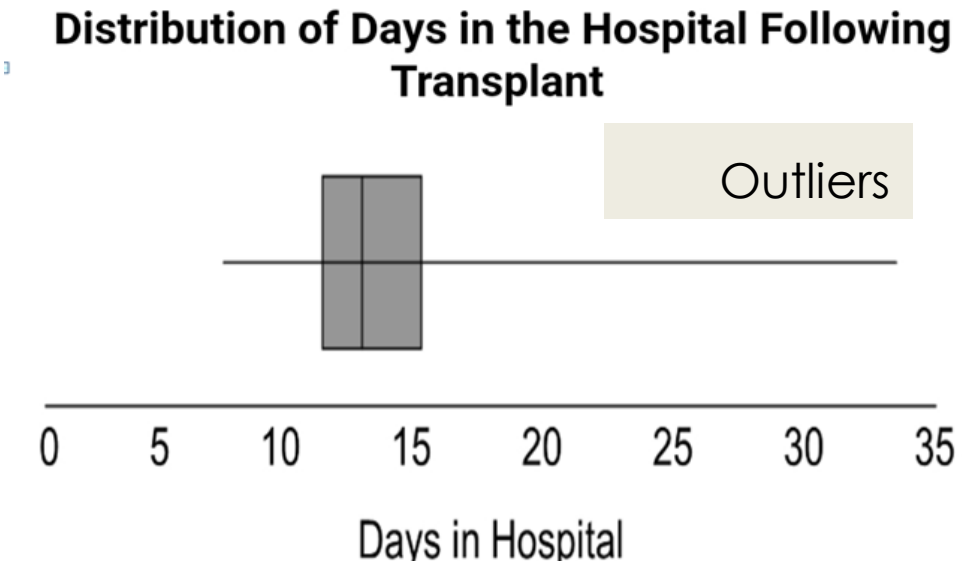
Ordinal variable



Limits of detection

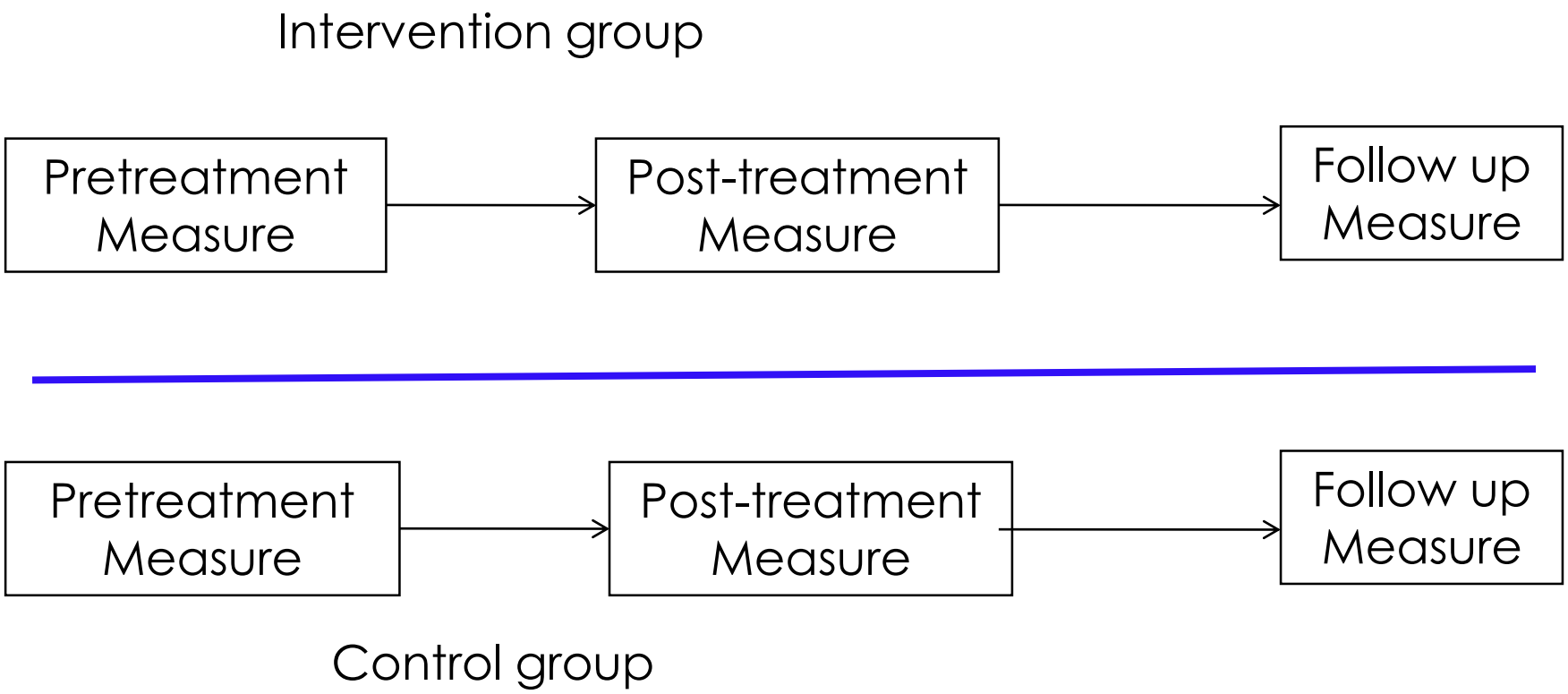
HIV viral load testing

Arrange from
Not detected or
below the level of detection
to 100 of millions of copies



Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation



Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Steps in data interpretation for nonparametric test

- Type of problem
- Variables used
- Research question
- Assumption (Which test will be used?)
- Result
- Presentation and Interpretation

Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation

Pretreatment Measure

Type of problem	**Single sample "Goodness of fit"**
Parametric test	-
Nonparametric test	Kolmogorov- Smirnov

Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Single sample "Goodness of fit"

Kolmogorov-Smirnov One Sample test

Variables

Preanxiety= Anxiety score of children before treatment intervention
Anxiety score (1=Not at all anxious to 7=extremely anxious)

id	group	Preanxiety
1	Intervention	7
2	Intervention	4
3	Intervention	6
4	Intervention	6
5	Intervention	3
6	Intervention	7
7	Intervention	6
8	Intervention	7
9	Intervention	5
10	Intervention	7
11	Control	3
12	Control	5
13	Control	5
14	Control	6
15	Control	6
16	Control	6
17	Control	7
18	Control	7
19	Control	7
20	Control	7

Id=children identification number; group=treatment intervention and control

Kolmogorov-Smirnov One Sample test

Research question

- To what extent do the pretreatment anxiety scores of children in our sample resemble a normal distribution ?

Kolmogorov-Smirnov One Sample test

Assumption

1. The sample variable should consist of a randomly set of observation
2. Data must be continuous and at least an ordinal scale
3. The theoretical distribution to which sample variable is being compared must be completely specified

-3 to +3 → 1 to 7 by adding 4 for each

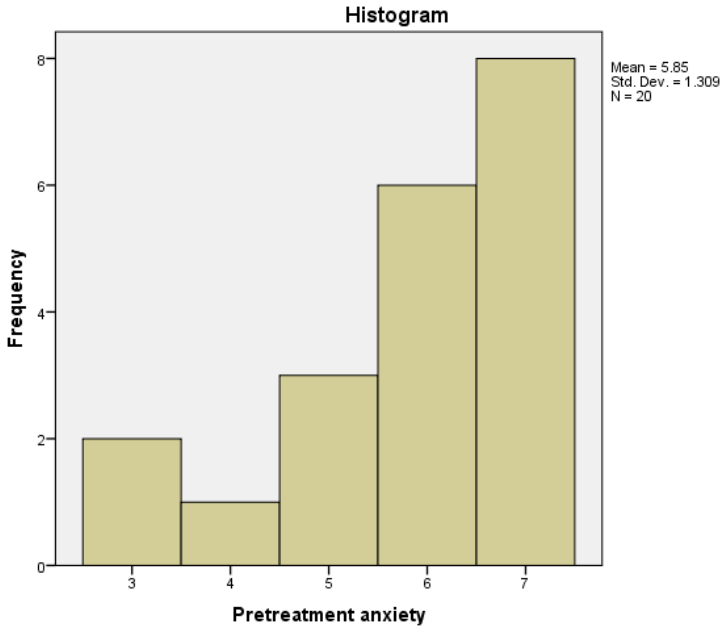
Kolmogorov-Smirnov One Sample test

Result

Report

Pretreatment anxiety

N	Mean	Median	Std. Deviation
20	5.85	6.00	1.309



Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretreatment anxiety	.246	20	.003	.812	20	.001

a. Lilliefors Significance Correction

Kolmogorov-Smirnov One Sample test

Data presentation and interpretation

Table: Distribution of anxiety level of children in the study before intervention

Anxiety scores	N	Mean	Median	Standard deviation	Kolmogorov-Smirnov	
					Z	*pvalue
					0.246	0.003
Pretreatment	20	5.8	6	1.4		

z=critical value

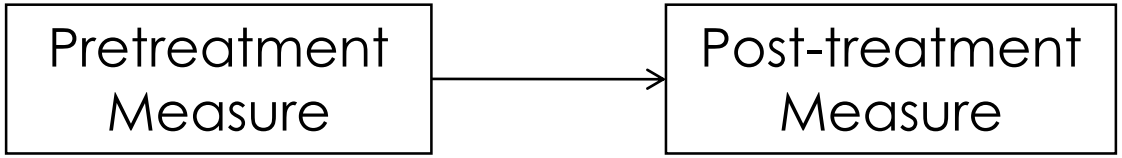
*The calculated two sided p value is for Kolmogorov-Smirnov one sample test

An examination of pretreatment anxiety scores using Kolmogorov-Smirnov one sample test indicates that the sample data were not normally distributed (z=0.246,pvalue=0.003)

Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation

Intervention group



Type of problem	**Repeated sample (2 time periods)**
Parametric test	Paired t test
Nonparametric test	Wilcoxon Signed Ranks test, Sign test

Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Repeated sample (2 measures)

Wilcoxon signed ranks test

Variables

id	group	Preanxiety	Postanxiety	Scoredifference
1	Intervention	7	5	-2
2	Intervention	4	4	0
3	Intervention	6	5	-1
4	Intervention	6	3	-3
5	Intervention	3	6	3
6	Intervention	7	3	-4
7	Intervention	6	5	-1
8	Intervention	7	5	-2
9	Intervention	5	4	-1
10	Intervention	7	5	-2

Id=children identification number; group=treatment intervention group
Preanxiety= Anxiety score of 10 children before treatment intervention
Postanxiety= Anxiety score of 10 children after treatment intervention
Socredifference= Postanxiety- Preanxiety
(Difference in post anxiety score and pre anxiety score for each children)
Anxiety score (1=Not at all anxious to 7=extremely anxious)

Wilcoxon signed ranks test

Research question

- Is there any difference in anxiety score level of the children in the intervention group from pretreatment to post treatment?

Wilcoxon signed ranks test

Assumption

1. Data must be paired observation from a single randomly selected sample
2. Data must be continuous and at least ordinal
3. Normal distribution violation in data

if violate, Paired t test

4. Distribution of difference in post to pre measurement in data must be symmetric (though not necessary normal)

if violate, Sign test
If ordinal, more preference on Wilcoxon signed ranks test

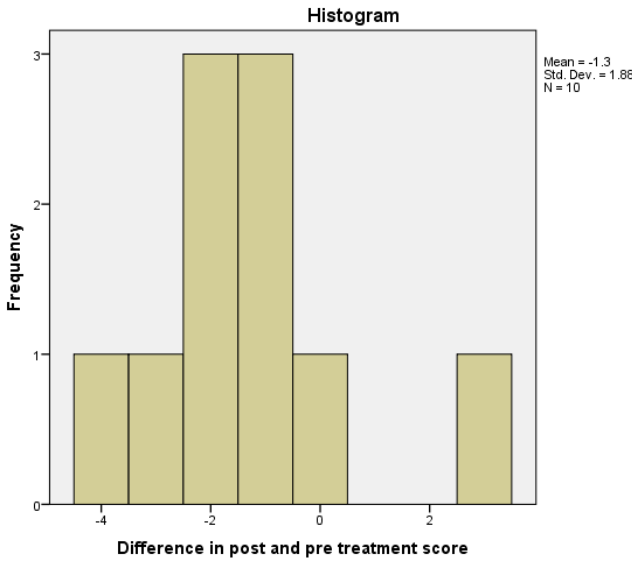
Wilcoxon signed ranks test

Assumption

Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Pretreatment anxiety	.257	10	.060
Posttreatment anxiety	.297	10	.013
Difference in post and pre treatment score	.237	10	.118

a. Lilliefors Significance Correction



Pre treatment anxiety score was not different from normal distribution (normally distributed, $p<0.05$)
but post treatment anxiety score was significant difference from normal distribution (not normally distributed, $p<0.05$)
We cannot use mean to compare the pre and post→ We cannot use pair t test

Difference in post and pre treatment score was symmetry and meet assumption, we no need to use Sign test

Wilcoxon signed ranks test

Result

Report

	Pretreatment anxiety	Posttreatment anxiety
N	10	10
Mean	5.80	4.50
Median	6.00	5.00
Std. Deviation	1.398	.972

Test Statistics[a]

	Posttreatment anxiety - Pretreatment anxiety
Z	-1.791[b]
Asymp. Sig. (2-tailed)	.073

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Not significant difference
in pre and post treatment anxiety score
($p<0.73$)

Wilcoxon signed ranks test

Data presentation and interpretation

Table: Anxiety scores of children before and after treatment intervention

Anxiety scores	N	Mean	Median	Standard deviation	*pvalue
					0.073
Pretreatment	10	5.8	6	1.4	
Post treatment	10	4.5	5	0.9	

*The calculated two sided p value is for Wilcoxon signed ranks test

The result of Wilcoxon signed ranks test indicated that the 10 children who took part in the clinical intervention were not significantly difference in their median anxiety level from pretreatment (Medium=6) to post treatment (Medium=5) (pvalue=0.03)

Repeated sample (2 measures)

Sign test

Test Statistics[a]

	Posttreatment anxiety - Pretreatment anxiety
Exact Sig. (2-tailed)	.039[b]

a. Sign Test

b. Binomial distribution used.

The calculated p value for Sign test is 0.039
That for Wilcoxon signed ranks test is 0.073

id	group	Preanxiety	Postanxiety	Scoredifference
1	Intervention	7	5	-2
2	Intervention	4	4	0
3	Intervention	6	5	-1
4	Intervention	6	3	-3
5	Intervention	3	6	3
6	Intervention	7	3	-4
7	Intervention	6	5	-1
8	Intervention	7	5	-2
	Intervention	5	4	-1
	Intervention	7	5	-2

So Wilcoxon assumption include
Distribution of difference in post to pre

measurement in data must be symmetric

Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation

Intervention group

Type of problem	**Repeated sample (>2 time periods)**
Parametric test	Repeated measure ANOVA
Nonparametric test	Friedman test

Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Repeated sample (>2 measures)

Friedman test

Variables

id	group	Preanxiety	Postanxiety	Followup
1	Intervention	7	5	6
2	Intervention	4	4	4
3	Intervention	6	5	5
4	Intervention	6	3	4
5	Intervention	3	6	4
6	Intervention	7	3	6
7	Intervention	6	5	5
8	Intervention	7	5	6
9	Intervention	5	4	4
10	Intervention	7	5	6

Id=children identification number; group=treatment intervention group
Preanxiety= Anxiety score of 10 children before treatment intervention
Postanxiety= Anxiety score of 10 children after treatment intervention
Followup=Anxiety score of 10 children two week after intervention
Anxiety score (1=Not at all anxious to 7=extremely anxious)

Friedman test

Research question

- What are the differences in the anxiety levels of 10 children who took part in the intervention across the three time periods (i.e pretreatment, post treatment and follow up)?

Friedman test

Assumption

1. Data must be paired and more than two observations from a single randomly selected sample
2. The subjects are independent
3. Data must be continuous and at least ordinal
4. Normal distribution violation in data

if violate, Repeated measure ANOVA

Friedman test

Assumption

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretreatment anxiety	.257	10	.060	.835	10	.038
Posttreatment anxiety	.297	10	.013	.868	10	.095
Follow up	.256	10	.063	.769	10	.006

a. Lilliefors Significance Correction

Pre treatment and Follow up anxiety score was not different from normal distribution (normally distributed, $p<0.05$)
But post treatment anxiety score was significant difference from normal distribution (not normally distributed, $p<0.05$)
We cannot use mean to compare the pre, post and follow up→ We cannot use repeated measure ANOVA

Friedman test

Result

Report

	Pretreatment anxiety	Posttreatment anxiety	Follow up
N	10	10	10
Mean	5.80	4.50	5.00
Median	6.00	5.00	5.00
Std. Deviation	1.398	.972	.943

Test Statistics[a]

N	10
Chi-Square	9.879
df	2
Asymp. Sig.	.007

a. Friedman Test

Significant difference in anxiety score over three time periods

Cannot tell where is difference?

Friedman test

Data presentation and interpretation

Table: Anxiety scores of children over three time periods during intervention

Anxiety scores	N	Mean	Median	Standard deviation	Friedman	
					X^2	*pvalue
					9.8	0.007
Pretreatment	10	5.8	6	1.4		
Post treatment	10	4.5	5	0.9		
Follow up	10	5.0	5	0.9		

X^2= Chi square value

*The calculated two sided p value is for Friedman test

The result of Friedman test indicated that there was a significant difference in median anxiety levels of the 10 children who took part in the intervention over the three time periods (pvalue=0.007)

Post hoc test

- By using Friedman test, we can only conclude that at least one of the median for the three time periods is significantly different from one of the others.
- Post hoc test will be needed to assess the direction (location of difference)
  - Score reduce from pre to post
  - Score reduce from pre to follow up
  - Score reduce from post to follow up

Post hoc test

Wilcoxon Signed Ranks tests

Test Statistics[a]

	Posttreatment anxiety - Pretreatment anxiety	Follow up - Pretreatment anxiety	Follow up - Posttreatment anxiety
Z	-1.791[b]	-2.309[b]	-1.186[c]
Asymp. Sig. (2-tailed)	.073	.021	.236

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

c. Based on negative ranks.

Research question:
Score reduce from pre to follow up
One direction, we use one tailed p value
=0.021/2=0.01

Post hoc test

- Should we use pvalue 0.05 as significant level for each direction?
  - No, we should not because it will increase Type I error for each direction
- What should we do?

0.05/3=0.017 and less should be as significant level for each direction

For one sided p value

- Post> pre score , 0.073/2=0.036 (>0.017)
- Follow up> pre score,0.021/2=0.01(<0.017)
- Follow up> post score,0.236/2=0.11 (>0.017)

*** significant reducing score from pre to follow up***

Post hoc test

Table: Anxiety scores of children over three time periods during intervention

Anxiety scores	N	Mean	Median	Standard deviation	Friedman	
					X^2	*pvalue
					9.8	0.01
Pretreatment	10	5.8	6	1.4		
Post treatment	10	4.5	5	0.9		
Follow up**	10	5.0	5	0.9		

X^2= Chi square value

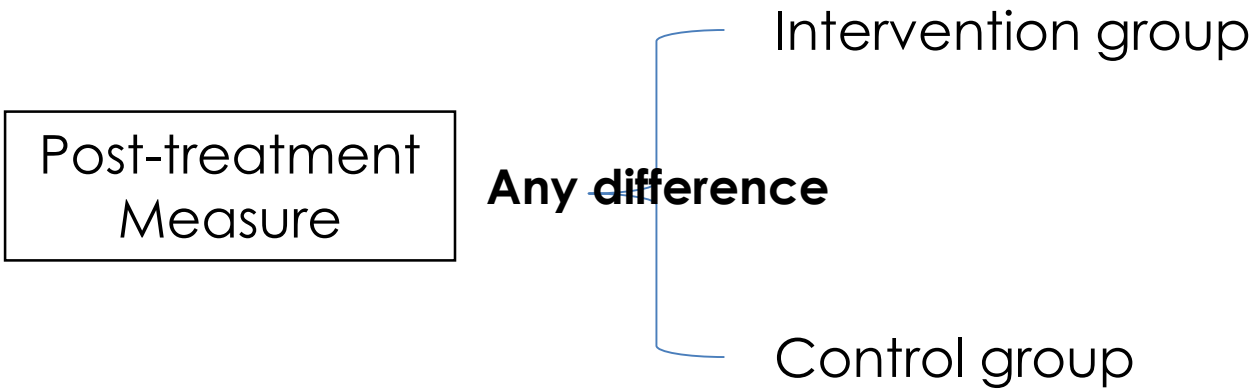
*The calculated two sided p value is for Friedman test

** The calculated one sided p value for significantly different from pretreatment, p=0.01 by Wilcoxon signed ranks test

The result of Post hoc test by Wilcoxon signed ranks test indicated that there was a significant decrease in the children reported anxiety from pretreatment (Medium=6) to follow up (Medium=5, each) (pvalue=0.01). No other groups had significant different median anxiety score.

Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation



Type of problem	Independent sample (2 levels)
Parametric test	Independent t test
Nonparametric test	Mann-Whitney U test, Median test

Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Independent sample (2 levels)

Mann-Whitney U test

Variables

id	group	Postanxiety
1	Intervention	5
2	Intervention	4
3	Intervention	5
4	Intervention	3
5	Intervention	6
6	Intervention	3
7	Intervention	5
8	Intervention	5
9	Intervention	4
10	Intervention	5
1	Control	3
2	Control	4
3	Control	5
4	Control	7
5	Control	7
6	Control	6
7	Control	7
8	Control	7
9	Control	7
10	Control	7

Id=children identification number; group=treatment intervention and control
Preanxiety= Anxiety score of 10 children before treatment intervention
Postanxiety= Anxiety score of 10 children after treatment intervention
Anxiety score (1=Not at all anxious to 7=extremely anxious)

Mann-Whitney U test

Research question

- Are there difference in post treatment anxiety among children who received the anxiety reduction intervention (Intervention group) and the children who do not receive the intervention (Control group)?

Mann-Whitney U test

Assumption

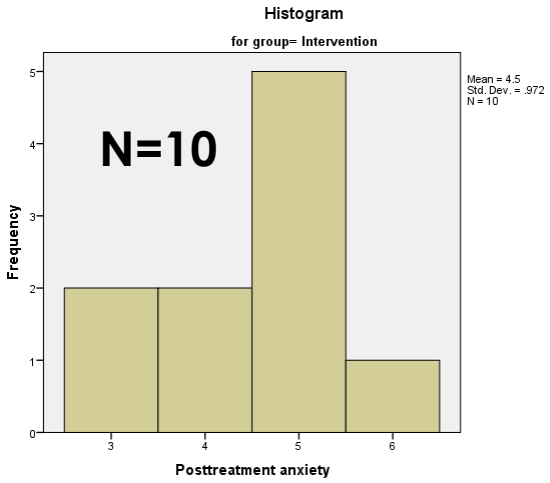
1. Data consists of a randomly selected sample of independent observation from two independent groups
2. Independent variable is dichotomous
3. Data of dependent must be continuous and at least ordinal **(If violate also in normally distributed, independent t test)**
4. Violation of normal distribution
5. The population distribution of the dependent variable for two independent group share a similar unspecified shape but with a difference in central tendency

(If violate, Median test)

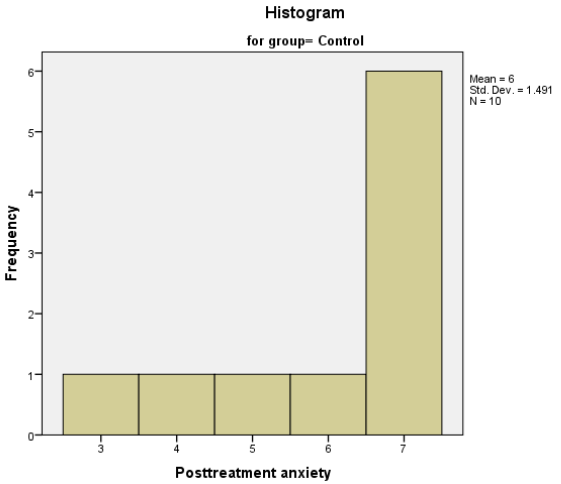
Mann-Whitney U test

Assumption

Post treatment anxiety by intervention group



Post treatment anxiety by control group



Tests of Normality

	Types of group	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Posttreatment anxiety	Intervention	.297	10	.013	.868	10	.095
	Control	.349	10	.001	.735	10	.002

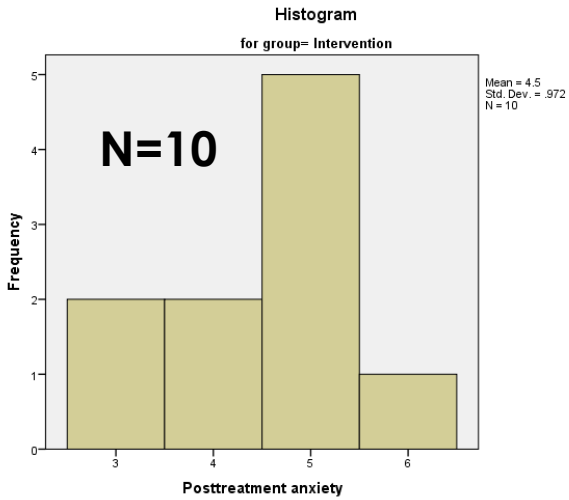
a. Lilliefors Significance Correction

Significant difference from normal distribution

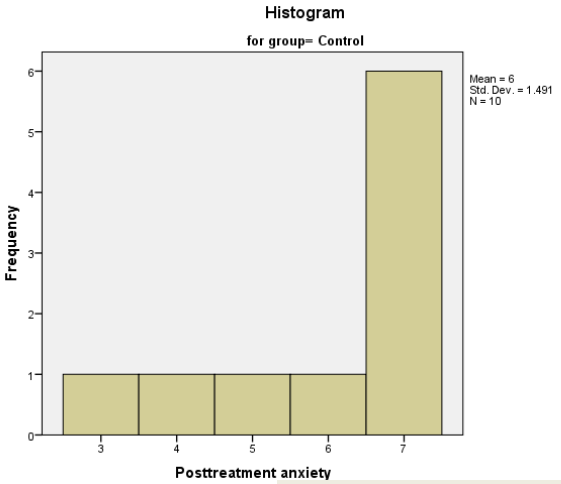
Mann-Whitney U test

Assumption by two-Sample Kolmogorov-Smirnov Test

Post treatment anxiety by intervention group



Post treatment anxiety by control group



Test Statistics[a]

		Posttreatment anxiety
Most Extreme Differences	Absolute	.600
	Positive	.600
	Negative	.000
Kolmogorov-Smirnov Z		1.342
Asymp. Sig. (2-tailed)		.055

a. Grouping Variable: Types of group

Not use independent t test

Not normal distribution but
Shape of distribution of post treatment anxiety of children in intervention and control group is the same

Not use Median test

Mann-Whitney U test

Result

Report

Posttreatment anxiety

Types of group	N	Mean	Median	Std. Deviation
Intervention	10	4.50	5.00	.972
Control	10	6.00	7.00	1.491
Total	20	5.25	5.00	1.446

Test Statistics[a]

	Posttreatment anxiety
Mann-Whitney U	20.000
Wilcoxon W	75.000
Z	-2.338
Asymp. Sig. (2-tailed)	.019
Exact Sig. [2*(1-tailed Sig.)]	.023[b]

a. Grouping Variable: Types of group

b. Not corrected for ties.

Significantly difference in post treatment anxiety score
in intervention and control group

Mann-Whitney U test

Data presentation and interpretation

Table: Anxiety scores after treatment among children in intervention and control group

Anxiety scores	Intervention			Control			Mann-Whithney	
	N	Mean	Median	N	Mean	Median	z	*pvalue
Post treatment							-2.3	0.019
	10	4.5	5	10	6	7		

Z= critical value

*The calculated two tailec p value is for Mann-Whitney U test

The result of Mann-Whitney U test indicated that the children in the anxiety reduction intervention program have significantly lower median levels of post treatment anxiety than the children in the control group (pvalue=0.009)

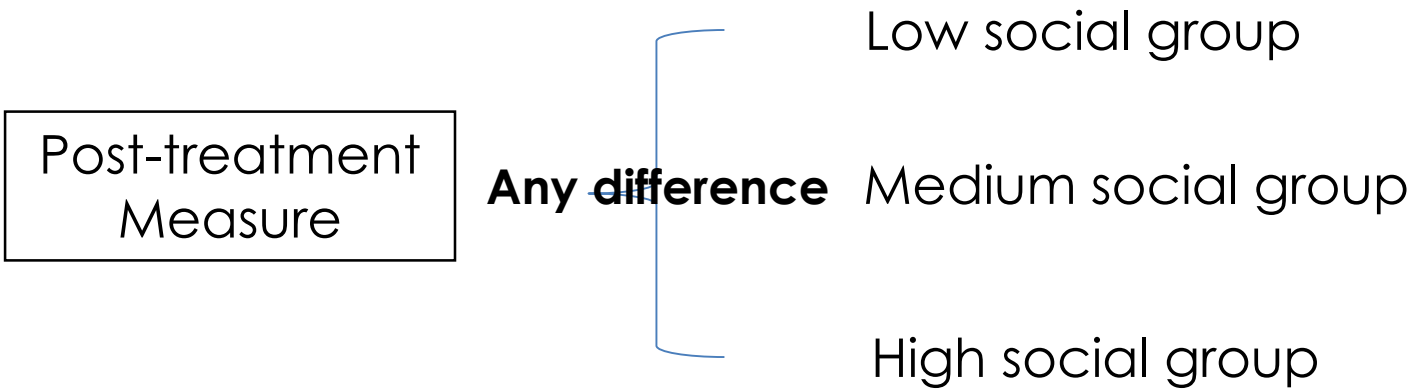
Median test

- If assumption by two-Sample Kolmogorov-Smirnov Test does not meet by Mann-Whitney U test is used

No similar shape of distribution of post treatment anxiety of children in intervention and control group.

Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation



Type of problem	Independent sample (>2 levels)
Parametric test	One way ANOVA
Nonparametric test	Kruskal-Wallis test, Median test

Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Independent sample (>2 levels)

Kruskal-Wallis test

Variables

id	group	Postanxiety	Socialstatus
1	Intervention	5	Low
2	Intervention	4	High
3	Intervention	5	Medium
4	Intervention	3	High
5	Intervention	6	Low
6	Intervention	3	Medium
7	Intervention	5	High
8	Intervention	5	Low
9	Intervention	4	Medium
10	Intervention	5	Medium
1	Control	3	High
2	Control	4	Medium
3	Control	5	High
4	Control	7	Low
5	Control	7	Medium
6	Control	6	Medium
7	Control	7	Low
8	Control	7	Medium
9	Control	7	Low
10	Control	7	Low

Id=children identification number; group=treatment intervention and control
Postanxiety= Anxiety score of 10 children after treatment intervention
Socialstatus=Social status in low, medium and high
Anxiety score (1=Not at all anxious to 7=extremely anxious)

Kruskal-Wallis test

Research question

- Are the differences in the median anxiety scores among three family social groups (low, medium and high)?

Kruskal-Wallis test

Assumption

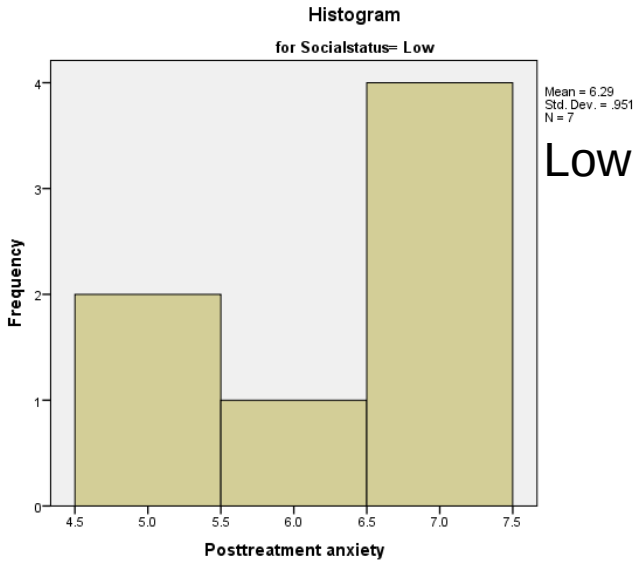
1. Data consists of a randomly selected sample from independent groups
2. Independent variable is nominal with > two levels
3. Data of dependent must be continuous and at least ordinal **(If violate also in normally distributed, One way ANOVA)**
4. The population distribution of the dependent variable for independent group share a similar unspecified shape but with a difference in central tendency

(If violate, Median test)

Kruskal-Wallis test

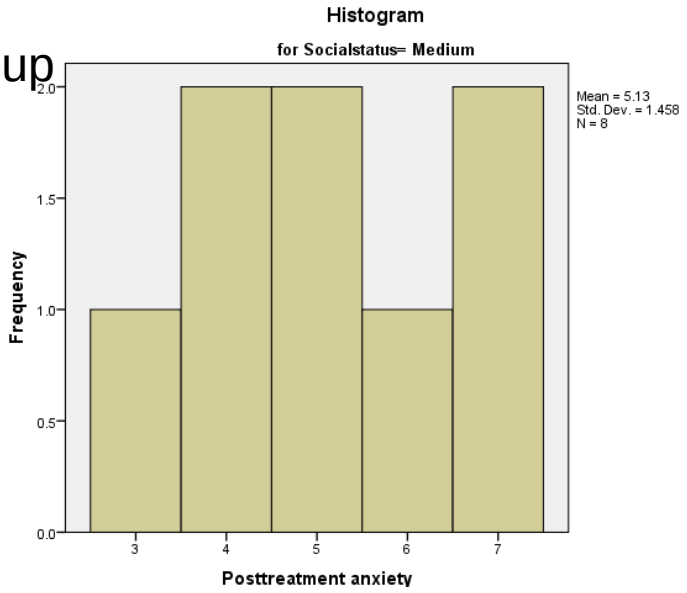
Assumption

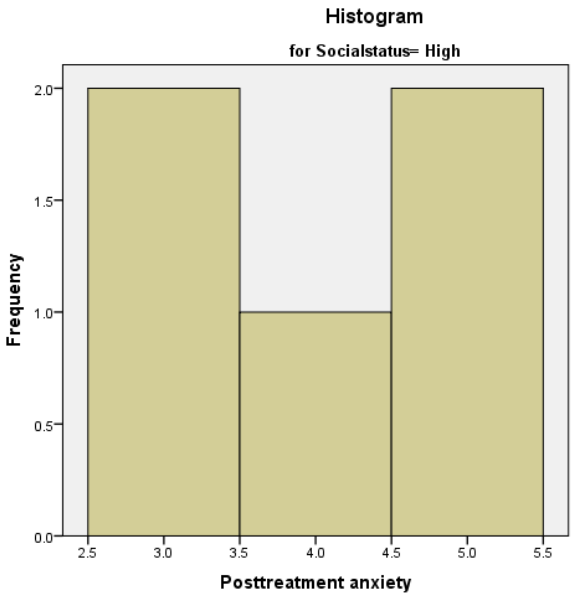
Post treatment anxiety score in three social group



Low

Medium





High

Not use One way ANOVA

Not normal distribution but
Shape of distribution of post treatment anxiety of children in intervention and control group is the same

Not use Median test

Kruskal-Wallis test

Assumption

Tests of Normality

	Social status	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Posttreatment anxiety	Low	.345	7	.012	.732	7	.008
	Medium	.159	8	.200*	.930	8	.516
	High	.241	5	.200*	.821	5	.119

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

a. Lilliefors Significance Correction

Not normally distributed in post treatment anxiety score in low social status group

Assumption by two-Sample Kolmogorov-Smirnov Test

Frequencies

	Social status	N
Posttreatment anxiety	Low	7
	Medium	8
	Total	15

Test Statistics[a]

		Posttreatment anxiety
Most Extreme Differences	Absolute	.375
	Positive	.375
	Negative	.000
Kolmogorov-Smirnov Z		.725
Asymp. Sig. (2-tailed)		.670

a. Grouping Variable: Social status

Not use One way ANOVA

Not normal distribution but Shape of distribution of post treatment anxiety of children in intervention and control group is the same

Not use Median test

Frequencies

	Social status	N
Posttreatment anxiety	Low	7
	High	5
	Total	12

Test Statistics[a]

		Posttreatment anxiety
Most Extreme Differences	Absolute	.714
	Positive	.000
	Negative	-.714
Kolmogorov-Smirnov Z		1.220
Asymp. Sig. (2-tailed)		.102

a. Grouping Variable: Social status

	Social status	N
Posttreatment anxiety	Medium	8
	High	5
	Total	13

Test Statistics[a]

		Posttreatment anxiety
Most Extreme Differences	Absolute	.375
	Positive	.000
	Negative	-.375
Kolmogorov-Smirnov Z		.658
Asymp. Sig. (2-tailed)		.780

a. Grouping Variable: Social status

Kruskal-Wallis test

Result

Report

Posttreatment anxiety

Social status	N	Mean	Median	Std. Deviation
Low	7	6.29	7.00	.951
Medium	8	5.13	5.00	1.458
High	5	4.00	4.00	1.000
Total	20	5.25	5.00	1.446

Test Statistics[a]

N	10
Chi-Square	9.879
df	2
Asymp. Sig.	.007

a. Friedman Test

Significantly differences in the median anxiety scores among three family social groups (low, medium and high)

Cannot tell where is difference?

Kruskal-Wallis test

Data presentation and interpretation

Table: Post treatment anxiety scores of children in different social group

Social status	N	Mean	Median	Standard deviation	Kruskal-Wallis	
					X^2	*pvalue
					9.8	0.007
Low	7	6.3	7	0.9		
Medium	8	5.1	5	1.4		
High	5	4.0	4	1.0		

X^2= Chi square value

*The calculated two sided p value is for Kruskal-Wallis test

The result of Kruskal-Wallis test indicated that there was a significant difference among the three social status groups with regard to their median anxiety levels after intervention(pvalue=0.007)

Post hoc test

- By using Kruskal-Wallis test, we can only conclude that be at least one difference among the median anxiety scores among three family social groups (low, medium and high)
- Post hoc test will be needed to assess the direction (location of difference in anxiety score) among three social status groups

Post treatment anxiety scores

- Low> High social group
- Low>Medium social group
- Medium> High social group

Post hoc test

Mann-Whitney U test

Ranks

	Social status	N	Mean Rank	Sum of Ranks
Posttreatment anxiety	Low	7	8.71	61.00
	High	5	3.40	17.00
	Total	12		

Test Statistics[a]

	Posttreatment anxiety
Mann-Whitney U	2.000
Wilcoxon W	17.000
Z	-2.615
Asymp. Sig. (2-tailed)	.009
Exact Sig. [2*(1-tailed Sig.)]	.010[b]

a. Grouping Variable: Social status

b. Not corrected for ties.

Significant difference in post treatment anxiety score in low and high social status

Post hoc test

Mann-Whitney U test

Ranks

	Social status	N	Mean Rank	Sum of Ranks
Posttreatment anxiety	Low	7	9.93	69.50
	Medium	8	6.31	50.50
	Total	15		

Test Statistics[a]

	Posttreatment anxiety
Mann-Whitney U	14.500
Wilcoxon W	50.500
Z	-1.632
Asymp. Sig. (2-tailed)	.103
Exact Sig. [2*(1-tailed Sig.)]	.121[b]

a. Grouping Variable: Social status

b. Not corrected for ties.

No significant difference in post treatment anxiety score in low and medium social status

Post hoc test

Mann-Whitney U test

Ranks

	Social status	N	Mean Rank	Sum of Ranks
Posttreatment anxiety	Medium	8	8.13	65.00
	High	5	5.20	26.00
	Total	13		

Test Statistics[a]

	Posttreatment anxiety
Mann-Whitney U	11.000
Wilcoxon W	26.000
Z	-1.353
Asymp. Sig. (2-tailed)	.176
Exact Sig. [2*(1-tailed Sig.)]	.222[b]

a. Grouping Variable: Social status

b. Not corrected for ties.

No significant difference in post treatment anxiety score in medium and high social status

Post hoc test

- Using pvalue ≤ 0.05 as significant level for each direction ?
  - In Mann-Whitney test , not adjusted for inflated Type I error created as a result of undertaking three tests on the same data set
  - Pvalue ≤0.05 as significant level use

For one sided p value for

- Low>high: 0.009/2=0.004 (<0.05 significant level)
- Low>medium:0.103/2=0.051 (>significant level)
- Medium>High:0.176/2=0.088 (> significant level)

*** significant level for anxiety score in low and high social status groups ***

Post hoc test

Table: Post treatment anxiety scores of children in different social group

Social status	N	Mean	Median	Standard deviation	Kruskal-Wallis	
					X^2	*pvalue
					9.8	0.007
Low**	7	6.3	7	0.9		
Medium	8	5.1	5	1.4		
High	5	4.0	4	1.0		

X^2= Chi square value

*The calculated two sided p value is for Kruskal-Wallis test

** The calculated one sided p value for significantly different from high social group, p=0.004 by Mann-Whiteney U tet

The result of Post hoc test by Mann-Whitney U test indicated that there was a significant higher in the children anxiety in low social group (Medium=7) to those in high social group (Medium=4) (pvalue=0.004). No other groups had significant different median anxiety score.

Nonparametric tests used for comparative study design

Effectiveness of treatment intervention on reducing anxiety level among children before operation

Post-treatment Measure

Measure of association

- Age (Continuous)
- Intervention and control (Dichotomous)

Type of problem	Measure of association
Parametric test	Pearson r
Nonparametric test	Spearman's rho test, Kendall's tau test for continuous, Point Biserial correlation test for dichotomous

Outcome measure: Anxiety level (1=Not at all anxiety to 7=Extremely anxiety)
Ordinal in measure

Measures of association

The Spearman Rank-Order correlation coefficient

Variables

id	group	age	Postanxiety
1	Intervention	13	5
2	Intervention	16	4
3	Intervention	15	5
4	Intervention	16	3
5	Intervention	14	6
6	Intervention	16	3
7	Intervention	16	5
8	Intervention	15	5
9	Intervention	14	4
10	Intervention	16	5
1	Control	15	3
2	Control	15	4
3	Control	14	5
4	Control	13	7
5	Control	11	7
6	Control	12	6
7	Control	13	7
8	Control	11	7
9	Control	12	7
10	Control	11	7

Id=children identification number; group=treatment intervention and control
age=Age of children (Years)
Postanxiety= Anxiety score of 10 children after treatment intervention
Anxiety score (1=Not at all anxious to 7=extremely anxious)

The Spearman Rank-Order correlation coefficient

Research question

- What is the relationship between children's post treatment anxiety and their age?

The Spearman Rank-Order correlation coefficient

Assumption

1. The two variables, X and Y are paired observations
2. The two randomly selected variables , X and Y (children's post treatment anxiety and age), are continuous with at least an ordinal level of measurement

(If X is normally distributed, Pearson r)

(If violate, esp Y is dichotomous, Rank Biserial correlation test)

The Spearman Rank-Order correlation coefficient

Result

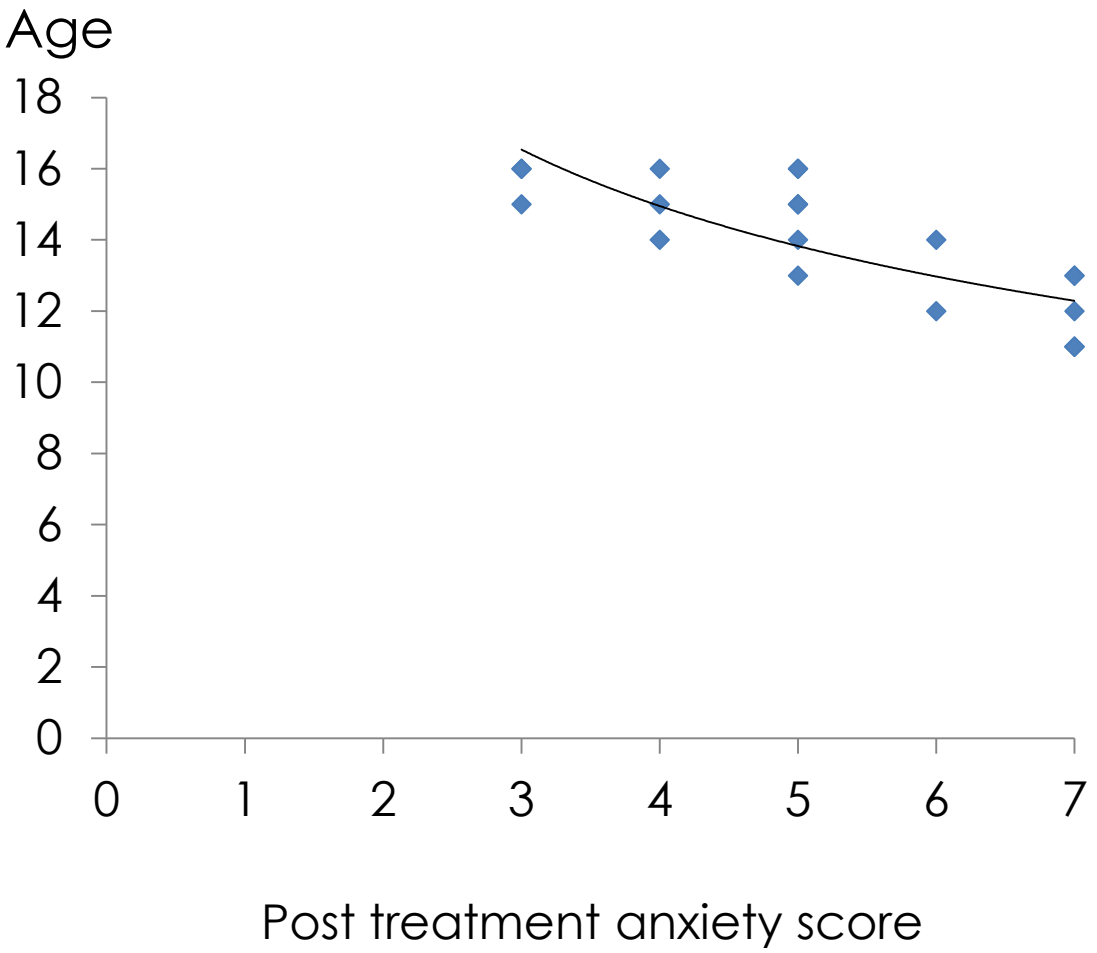


Figure Relationship between children's post treatment anxiety and their age

The Spearman Rank-Order correlation coefficient

Result

Correlations

			Posttreatment anxiety	Age of children (Years)
Kendall's tau_b	Posttreatment anxiety	Correlation Coefficient	1.000	-.694**
		Sig. (2-tailed)	.	.000
		N	20	20
	Age of children (Years)	Correlation Coefficient		
		Sig. (2-tailed)	.000	.
		N	20	20
Spearman's rho	Posttreatment anxiety	Correlation Coefficient	1.000	-.810**
		Sig. (2-tailed)	.	.000
		N	20	20
	Age of children (Years)	Correlation Coefficient	-.810**	1.000
		Sig. (2-tailed)	.000	.
		N	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

Direction and strength

The Spearman Rank-Order correlation coefficient

Data presentation and interpretation

Table: Correlation of post treatment anxiety scores and children's age

Correlation of	**Spearman Rank-Order correlation Coefficient**	
	rs	*pvalue
Children's post treatment anxiety and their age	-0.810	0.000

rs= Spearman correlation coefficient

*The calculated two sided p value is for the Spearmen Rank-Order correlation

The Spearmen Rank-Order correlation coefficient showed that children's post treatment anxiety was negatively associated with their age. The result of this analysis (r=-0.810, pvalue=0.000) indicated that children with higher age group were less likely to have lower post treatment anxiety. The strength of association was strong.

Measures of association

Point biserial correlation test

- It is used to find the strength of association of
  - Continuous variable (Dependent) and
  - Dichotomous variable (Independent)

Parametric test and their non parametric alternatives

Type of problem	Parametric test	Nonparametric test
Single sample "Goodness of fit"	-	Kalmogorov- Smirnov
Repeated sample		
2 time periods	Paired t test	Sign test, Wilcoxon signed ranks test
> 2 time periods	Repeated measures ANOVA (1 x c)	Friedman test
Independent sample		
2 levels	Independent t test	Median test, Mann-Whitney U test
> 2 levels	One way ANOVA	Median test, Kruskal Wallis test
Measure of association	Pearson r	Spearman's rho test, Kendall's tau test

Summary

Outcome: Ordinal/Rank

Research question	Test
Resemble a normal distribution?	Kolmogorov-Smirnov One Sample test
Difference from pre to post in the repeated sample?	Wilcoxon signed ranks test
Difference across > two time periods in the repeated sample?	Step 1: Friedman test Step 2: Wilcoxon signed ranks test (Post hoc test)
Difference in two independent sample?	Step 1: Assumption by two-Sample Kolmogorov-Smirnov Test Step 2: Mann-Whitney U test
Difference in >two independent sample?	Step 1: Kruskal-Wallis test Step 2: Mann-Whitney U test (Post hoc test)
Measure of association	The Spearman Rank-Order correlation coefficient (For numeric) Point biserial test (for dichotomous)