	Scale of Measurement		
Goal	**Interval/ratio**	**Ordinal**	**Nominal**
Describe one group	Mean, standard deviation	Median; interquartile range	proportion
Compare one group to a hypothetical value	One-sample ttest; Z-test (for true variance known; or very big sample size)	Wilcoxon signed rank test	Chi-square test
Compare two paired groups	Paired t-test	Wilcoxon signed rank test	McNemar's test
Compare two unpaired groups	Unpaired/ two-sample t-test	Mann-Whitney U test	Chi-square test
Compare three or more paired groups	ANOVA repeated measures	Friedman test	Cochraine Q
Compare three or more unpaired groups	ANOVA	Kruskal-Wallis	Chi-square test
Quantify association between 2 variables	Pearson correlation	Spearman correlation	Contigency coefficients
Predict value from another measured variable	Simple linear regression		

Test	When to use	Assumptions	Formula	Reject H0 if
One sample z-test	Compare one group (mean) to an hypothetical value if variance known or sample very large; For ratio/interval data Null hypothesis: H0: $\mu=\mu_0$	The sample comes from a population normally distributed; Random sampling; Independent observations;	$Z_{calc} = \frac{\bar{x}-\mu_0}{\frac{\sigma}{\sqrt{n}}}$ Where: $\bar{x}$ - sample mean (if paired sample, do mean of the differences); μ_0 - hypothetical value under the null hypothesis; σ - population standard deviation (SD), or, for a paired sample , standard deviation of the differences-> for very large samples it is approximated by the sample standard deviation; n - sample size	$\lvert Z_{calc} \rvert > \lvert Z_{\alpha} \rvert$ Where α is the significance level (generally 0.05); | | stands for absolute value
One sample or paired t-test	Compare one group to an hypothetical value, or two paired groups For ratio/interval data Null hypothesis: H0: $\mu=\mu_0$	The sample comes from a population normally distributed; Random sampling	$T_{calc} = \frac{\bar{x}-\mu_0}{\frac{s}{\sqrt{n}}}$ Where: $\bar{x}$ - sample mean (if paired sample, do mean of the differences); μ_0 - hypothetical population mean value under the null hypothesis (if paired sample, typically zero); *s* - sample standard deviation (for a paired sample , SD of the differences); n - sample size	$\lvert T_{calc} \rvert > \lvert T_{\alpha;\upsilon} \rvert$ I.e., Reject if absolute T_{calc} above absolute critical value $\lvert T_{\alpha;\upsilon} \rvert$ Where: α - significance level; ν - degrees of freedom: ν= n-1

Test	When to use	Assumptions	Formula	Reject H0 if
Unpaired/ two sample t-test	Compares two independent (mean) groups For ratio/interval data H0: $\mu_1=\mu_2$ or, equivalently H0: $\mu_1 - \mu_2 = 0$	The samples comes from normally distributed populations; Both populations have identical variances (i.e. $\sigma_1=\sigma_2$); Random sampling; Independent observations;	$T = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)_0}{S_P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$ Where: S_p – polled standard deviation, calculated by: $S_P = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$ and $\bar{x}_1$ - sample mean of population 1 $\bar{x}_2$ - sample mean of population 2 s_1 – sample SD of population 1 s_2 – sample SD of population 2 n_1 – sample size for population 1 n_2 – sample size for population 2 $(\mu_1-\mu_2)_0$– hypothesized difference between the means of the populations (generally zero)	$\vert T_{calc} \vert > \vert T_{\alpha;\upsilon} \vert$ I.e., Reject if absolute T_{calc} <u>above </u>absolute critical value ($\vert T_{\alpha;\upsilon} \vert$) Where: α - significance level; ν - degrees of freedom: $\nu= n_1 + n_2 -2$
Wilcoxon signed-rank test	Compare one group to an hypothetical value, or two paired groups For ordinal data (or ratio/interval if sample is small and data not normal) Null hypothesis: H0: $M=M_0$ (where M represents median)	Distribution symmetrical (does not need to be normal); Random sampling	T_+= sum of the ranks having a positive sign T_-= sum of the ranks having a negative sign How to do it: 1 For paired data: for each data point, calculate the differences between the 2 groups; For comparison of one group to an hypothetical value: for each data point, subtract the hypothesized median value 2 Rank the absolute differences, from smaller to larger (i.e., 1 for the smallest absolute difference) 3 Add the corresponding signs (+ for originally positive differences, - for negative ones) 4 Calculate T_+ and T_-. Note: if one of them is calculated, the other can be calculated from: $T_+=n(n-1)/2 - T_-$ Where n is the sample size	Choose T_+ or T_- (whichever is smallest) and compare with critical value (from table). Reject if <u>below or equal</u> to the critical value

Test	When to use	Assumptions	Formula	Reject H0 if
Mann-Whitney U test **(also called Wilcoxon rank-sum, or Wilcoxon-**	Compare one group to an hypothetical value, or two paired groups For ordinal data (or ratio/interval if sample is small and data not normal) Null hypothesis: H0: M_1=M_2 (where M represents median)	Random sampling; Independent observations;	$U_1 = R_1 - \frac{n_1(n_1+1)}{2}$ And $U_2 = R_2 - \frac{n_2(n_2+1)}{2}$ Alternative, one can be obtained from the other through: $U_1 + U_2 = n_1 n_2$ Where: R_1 – sum of the ranks for population 1 R_2 – sum of the ranks for population 2 n_1 – sample size for population 1 n_2 – sample size for population 2	Choose U_1 or U_2 (whichever is smallest) and compare with critical value (from table). Reject if <u>below or equal</u> to the critical value
Chi-square test	Compares two or more groups For nominal data H0: variable represented in the rows is independent of the variable represented in the columns	Random sampling; Independent observations;	First put data in the form of a contingency table, then calculate: $X^2_{calc} = \sum_{i=1}^{R}\sum_{j=1}^{C}\frac{(O_{ij}-E_{ij})^2}{E_{ij}}$ Where: R – total number of rows; C – total number of columns; O_{ij} – number of observations (frequency) in row *i*, column *j* E_{ij} – Expected frequency in row *i*, column *j*, which is calculated as: $E_{ij} = \frac{R_i C_j}{n}$ Where: R_i – sum of all the frequencies of row *i* (calculated as $\sum_{j=1}^{C} O_{ij}$); C_j – sum of all the frequencies of column *j* (calculated as $\sum_{i=1}^{R} O_{ij}$) n – Sample size. Sum of all frequencies. (calculated as $n = \sum_{i=1}^{R}\sum_{j=1}^{C} O_{ij}$)	$X^2_{calc} > X^2_{\alpha;\nu}$ I.e., Reject if absolute X^2_{calc} <u>above</u> critical value ($X^2_{\alpha;\nu}$) Where: α - significance level; ν - degrees of freedom: ν= n-1

Test	When to use	Assumptions	Formula	Reject H0 if
ANOVA	Compares three or more groups For ratio/interval data H0: $\mu_1=\mu_2=\mu_3 \ldots$	The samples comes from normally distributed populations; All populations have identical variances (i.e. $\sigma_1=\sigma_2=\sigma_{3\ldots}$); Random sampling; Independent observations;	$F_{calc} = \frac{MSTR}{MSE}$ Where MSTR – mean squared error of the treatment MSE – mean squared (residual) error Calculated as: $MSTR = \frac{SSTR}{df_{TR}}$ and $MSE = \frac{SSE}{df_E}$ Where: SSTR – sum of squares of the treatment SSTR – sum of squares of the (residual) error df_{TR} – degrees of freedom treatment; df_E – degrees of freedom (residual) error; Calculated as: $SSTR = \sum_{i=1}^{g} n_i(\bar{x}_i - \bar{\bar{x}})^2$ $SSE = \sum_{i=1}^{g}\sum_{j=1}^{n_i}(x_{ij} - \bar{x}_i)^2$ $df_{TR} = g - 1$ and $df_E = n - g$ Where: x_{ij} - observation *j* in group *i* $\bar{x}_i$ - mean of group *i* n_i - sample size of group *i* $\bar{\bar{x}}$ - total mean (averaging all values, independently of the group) g – total number of groups n - total sample size Also SST=SSTR+SSE Where SST is the total sum of squares	$F_{calc} >$ $F_{\alpha;(df_{TR};df_E)}$ I.e., Reject if absolute F_{calc} above critical value ($F_{\alpha;(df_{TR};df_E)}$) Where: α - significance level; df_{TR} – degrees of freedom treatment: df_{TR} = g-1 df_E – degrees of freedom (residual) error: df_E = n-g

			$SST = \sum_{i=1}^{g}\sum_{j=1}^{n_i}(x_{ij} - \bar{\bar{x}})^2$	