Choosing the Suitable Statistical Test

By: Dr. Firas Albaaj

Q1: Bivariate Vs Multivariable

The first question we need to ask is whether we are dealing with bivariate analysis or multivariable analysis.

Bivariate analysis: studying the relationship between two variables.

For example: -

Age and height

– Type of treatment and complication

– Sex and smoking

– Smoking and coffee consumption

Multivariable: studying the effect of multiple variables on an outcome variable.

For example:

- Effect of smoking, sex, coffee consumption on blood pressure.
- Effect of smoking, sex, coffee consumption on having a heart attack

Q2: Difference Vs Correlation : we have to ask if we are studying a difference or a correlation.

Difference: to study the difference between two or more groups, or two or more conditions

For example:

- The difference between males and females regarding coffee consumption
- The difference in body weight before and after being on a specific diet.

Correlation: to study the association between two variables

- The association between age and weight
- The association between coffee consumption and the number of sleeping hours

Q3: Independent Vs Paired data If we are doing bivariate analysis, we have to ask if we are working with independent data or paired data

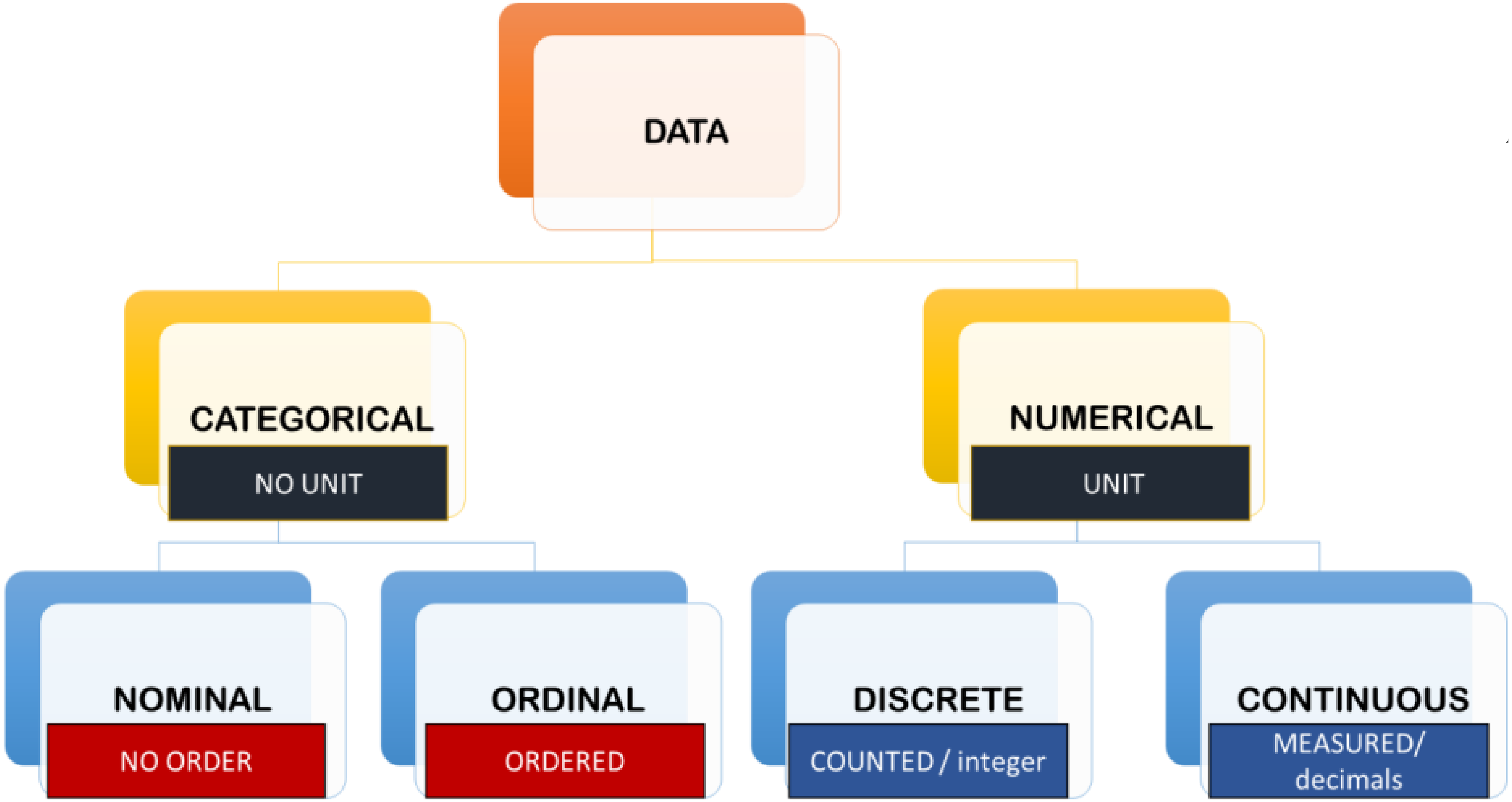
Independent (unpaired) The observations in each sample are not related. There is no relationship between the subjects in each sample.

• Subjects in the first group cannot also be in the second group

Dependent (Paired): paired samples include:

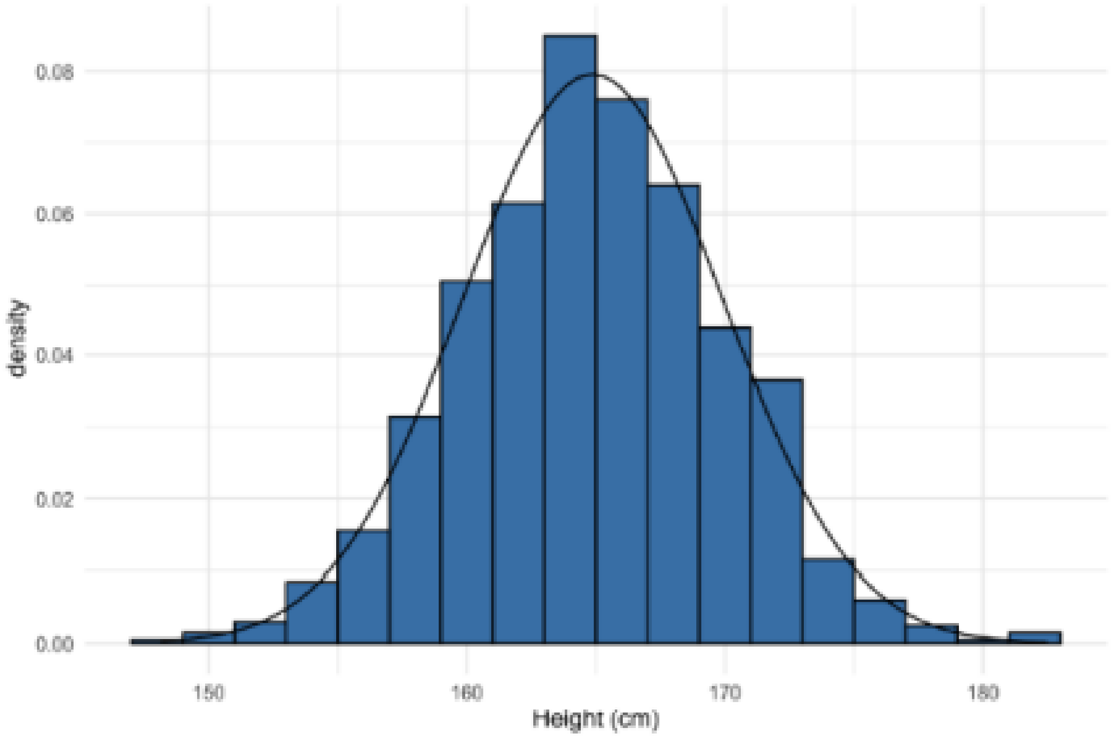
- Pre-test/post-test samples (a variable is measured before and after an intervention)
- When a variable is measured twice or more on the same individual

Q4: Type of outcome and normality of distribution Whatever the analysis we are doing, it is important to identify the types of data variables we are studying.



Normality of distribution

It is important before doing some statistical tests to determine if a numeric variable is normally distributed or not. This histogram shows normally distributed variable.



- How to test for normality?

1- Plotting a histogram or QQ plot

2- Using a statistical test The statistical tests for normality are the Shapiro-Wilk and Kolmogorov-Smirnoff tests

We usually do both, the graph and the statistical tests.

- The hypotheses of the Shapiro-Wilk and Kolmogorov-Smirnoff tests

Ho: the variable is normally distributed

H1: the variable is not normally distributed

We accept the null hypothesis (say that it is normally distributed) if the P-value > 0.05.

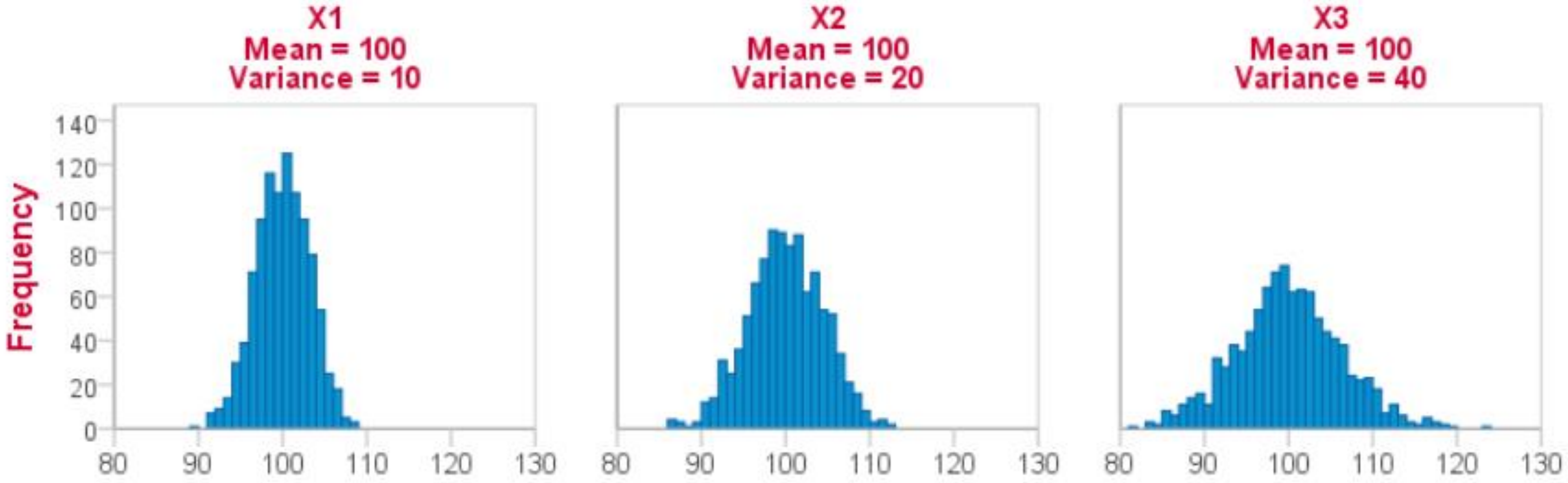
Assumption of Homogeneity of variances Homogeneity of variances (similar standard deviations) means that the variable we are studying has the same variance across groups. We need to test for the equality of variances between groups when using some statistical tests, e.g. **Independent t-tests and one-way ANOVA.**

Homogeneity of variances is tested using **Levene's test**.

Interpretation of the test result: If the p-value is < 0.05 reject H0 and conclude that the assumption of equal variances has not been met.

We accept the null hypothesis (say that there is equal variance) if the P-value > 0.05.

The following graph shows the distribution of three groups that have equal means but not equal variances



Numerical data analysis : Independent Sample t test, Man-Whitney U test, Paired samples t test, Wilcoxon Signed Rank test, one-way ANOVA, Kruskal Wallis test

Parametric and non-parametric tests: Statistical tests are either parametric or non-parametric tests:

- Parametric tests are used to compare means of the groups while non-parametric tests are used to compare the medians.
- Parametric tests are used to compare samples with normally distributed numeric data.
- Non-parametric tests are used to compare samples with non-normally distributed numeric data, or with ordinal data.
- Parametric tests use the actual values of the variable.
- Non-parametric tests use the ranks of the values.

The following table shows how the raw data (used in the parametric tests) are transformed to ranked data (used for the non-parametric tests)

Raw data		Sorted data		Ranks		Ranked data
15		8		1		1
8		10		2	→	3
27		10		3	→	3
25		10		4	→	3
10		12		5		5
23		14		6		6
12		15		7	→	7.5
18		15		8	→	7.5
14		18		9		9
10		23		10		10
15		25		11		11
10		27		12		12

Parametric tests	Non-parametric tests
Independent Sample t test	Man-Whitney U Test
Paired samples t test	Wilcoxon Signed Rank Test
One way ANOVA	Kruskal Wallis test

Independent (student) t test

Q1	Q2	Q3	Q4	Q5	Statistical test
Bivariate /Multivariable	**Difference /Correlation**	**Independent / Paired**	**Type of outcome (and Normality)**	**No of groups**	
Bivariate	Difference	Independent (un-paired)	Continuous (Normal)	2	Student's t-test

Where to find in SPSS:

Analyze → Compare Means → Independent-Samples T Test.

Example: Comparing hemoglobin level of patients in the treatment and control groups. Steps:

Step 1: We test if hemoglobin is normally distributed in both groups using Shapiro-Wilk test, or Kolmogorov-Smirnov test. We should also have a look at the histogram.

Step 2: After confirmation that hemoglobin is normally distributed in both groups, we use the independent sample t test.

Step 3: We check the result of Levene's test for the homogeneity of variance which is part of the output in SPSS to decide which row should be used for reporting the result (The first row is for equal variance, and the second is for the non-equal variance).

Interpretation of the result: If the p-value < 0.05 (or another chosen significance level), there is a statistically significant difference between the means of the two groups.

Table presentation of the result:

	Mean (SD)		Difference (95% CI)	P-value
	Treatment group (N=20)	Control Group (N=20)		
Age in years	32.55 (5.60)	30.15 (5.69)	2.4 (-1.21, 6.01)	0.187
Hemoglobin mg/dl	12.86 (1.69)	11.37 (1.26)	1.49 (0.53, 2.45)	0.003

Reporting significant results: An independent-samples t-test was done to determine if there were differences in hemoglobin level between treatment and control groups. The hemoglobin level was higher in the treatment group (12.86 ± 1.69) than the control group (11.37 ± 1.26), a statistically significant difference of 1.49 (95%CI: 0.53, 2.45) was found, p = .003.

Thank you