Statistics Tests
Part 1

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Types of Variables

Categorical Variables

- Organized into category
- No necessary order
- No quantitative measure
- Examples
    - Male, Female
    - Race
    - Marital Status
    - Treatment A and Treatment B

Types of Variables
Ordinal Data

- Ranked or ordered

- Examples:
- Strongly agree, agree, disagree
- Worse, no change, better
- 1st place, 2nd place, 3rd place

Types of Variables
Continuous Variables

- Have specific order
- Examples:
  - Weight
  - Temperature
  - Blood Pressure
  - Time
- May be converted to categorical or ordinal

Types of Statistics

- *Descriptive*

Summarize data for clearer understanding

- Inferential

Generalize results from sample to population

Make probability decisions

Descriptive Statistics

- *Measures of central tendency*
  - mean
  - mode
  - median
- *Measures of variability*
  - range
  - variance
  - standard deviation
  - standard error

Research Hypothesis

- *Null hypothesis:*
  - In all experiments, we have an initial belief
  - We always set up our null hypothesis so that we can reject the null hypothesis
  - Relationship among phenomena does not exist

- *Example:*
  - kids who attend daycare have no greater incidence of colds than kids who do not attend daycare

Steps for hypothesis testing

- *Null hypothesis:*
  1. State null hypothesis
  2. State type of data for explanatory and outcome variable
  3. Determine appropriate statistical test
  4. State summary statistics if possible
  5. Calculate p-value (stat package)
  6. Decide whether to reject or not reject the null hypothesis
     - NEVER accept null
  7. Write conclusion

Probability and p Values

- Definition: the probability of the observed result or something more extreme under the null hypothesis
- If p-value is small enough, we call the effect statistically significant

  - *p > 0.05*

    The two groups are not significantly different, but we cannot say that they are the same

  - *p < 0.05*

    1 in 20 or 5% chance groups are not different when we say groups are significantly different

  - *p < 0.01*

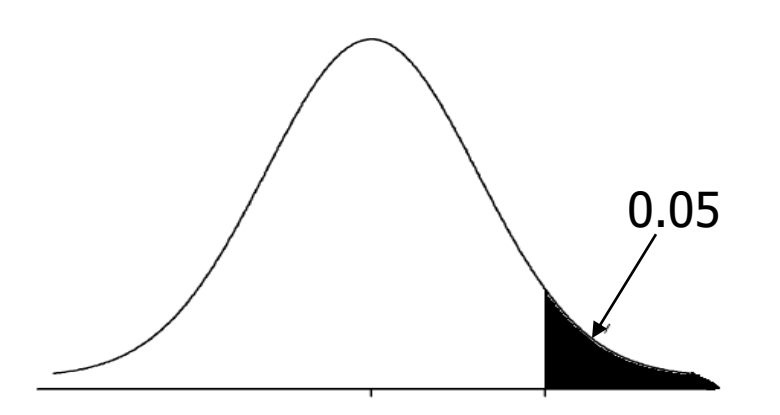
    1 in 100 or 1% chance of error

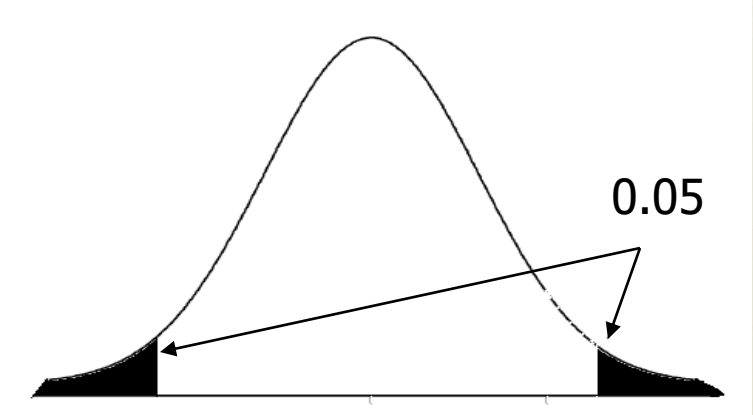
  - *p < 0.001*

    1 in 1000 or .1% chance of error

What is rare enough?

- This curve is the distribution of the statistic under the null hypothesis
- If the observed value is sufficiently rare under the null, we reject the null hypothesis
- 0.05 corresponds to a 1 out of 20 chance





Bias

- Is there something in my design that led to my result?

Reasons for differences between groups

1. Actual effect

   when there is a difference between the two groups

2. Chance

3. Bias

4. Confounding

❖ Statistical tests are designed to determine if the observed difference between the **groups was likely due to chance**

How is statistics related to each stage?

I. STUDY DESIGN

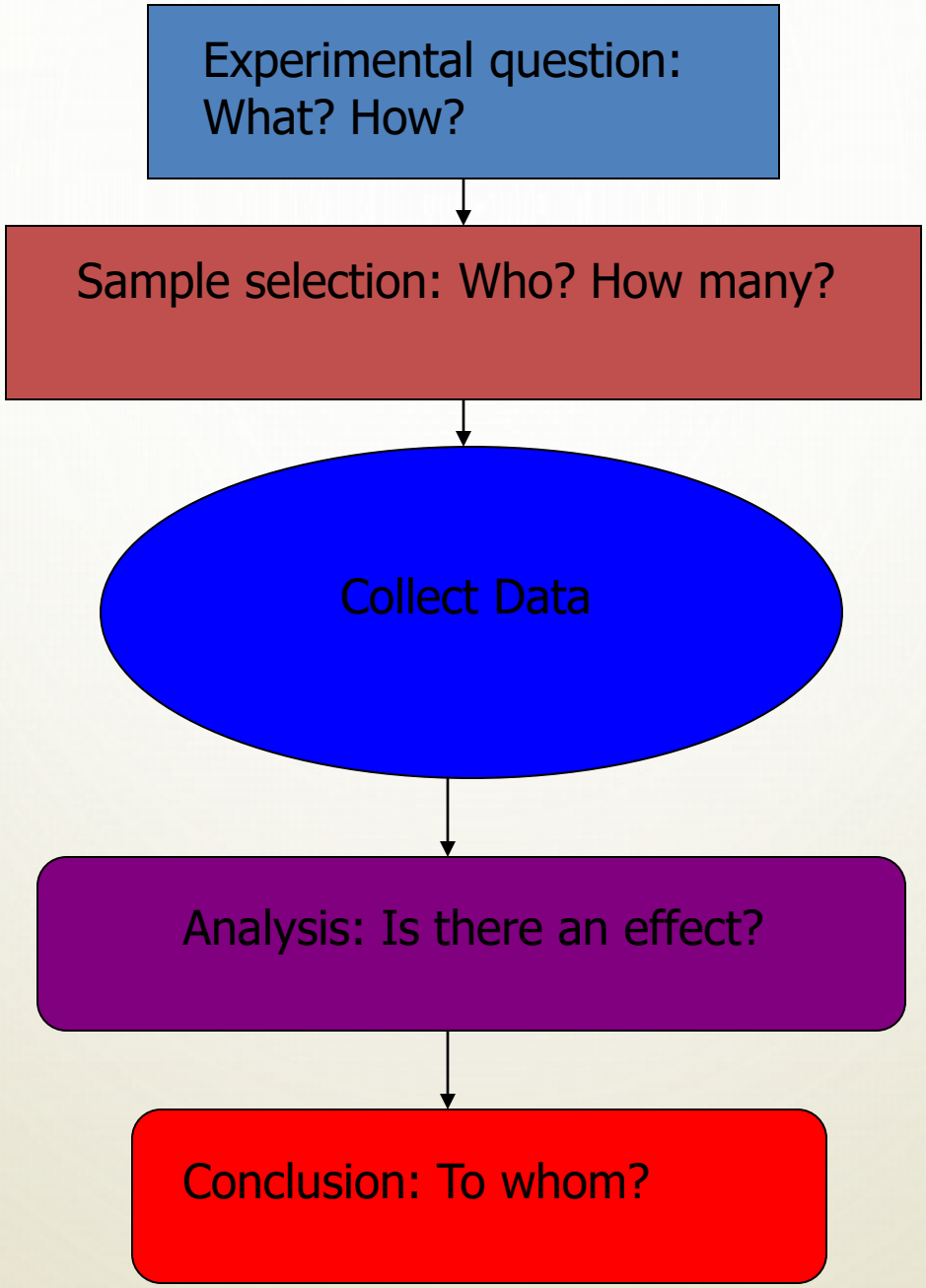
- Experimental question- define **outcome**, sources of variability, unit and **analysis plan**
- Sample selection- sample size, type of sample

II. DATA COLLECTION

- What to collect?

III. ANALYSIS OF DATA

- Results- **hypothesis test**
- Conclusion- significance of effect/generalizability


Experimental question:
What? How?
Sample selection: Who? How many?
Collect Data
Analysis: Is there an effect?
Conclusion: To whom?

Example

Multiple sclerosis is a progressive neurological disorder

We would like to find treatments that help patients

Unfortunately, it is very difficult to determine a patient's disease course because there are many things going on

How do we measure the change in the disease?

What is the outcome?

"That's what I want to say. See if you can find some statistics to prove it."

Outcome variables

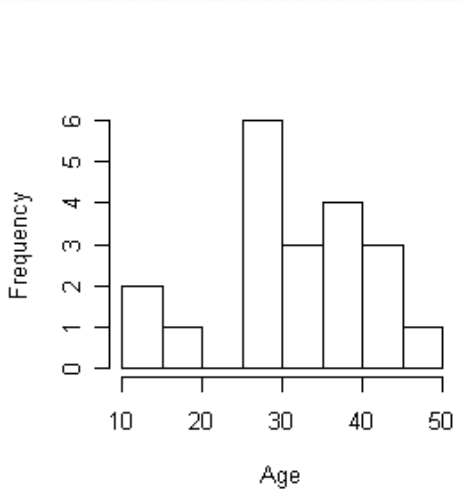
- An outcome variable is dependent variable of interest
- The common outcome variables in MS experiments are:
- Expanded disability status scale (EDSS)-ordinal measure of disease severity
- Presence/absence of disease progression
- Expression a cytokine of interest (ex. IFN-g)
- Time to next relapse

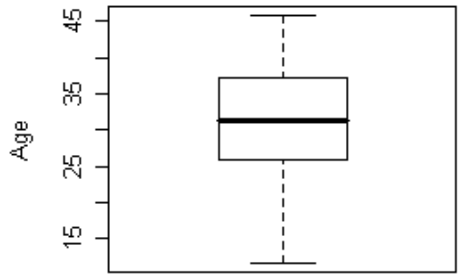
Types of variables

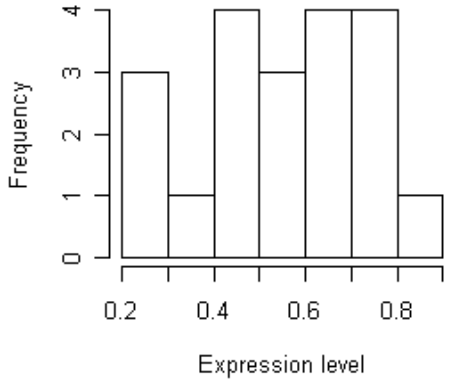
- Continuous variable: Age, expression level
- Dichotomous variable: Dead/alive, Wild type/mutant
- Categorical variable: Race, nominal scales
- Ordinal variable: Mild/Moderate/Severe, level of stat knowledge
- Count outcomes: Number of lesions
- Time to event outcome: Time to death

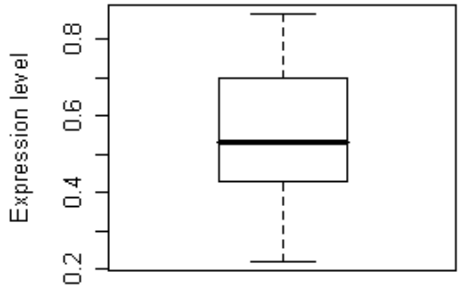
Continuous variables

- Summary statistics
  - **Location**
    - Mean
    - Median
  - **Variability**
    - Standard deviation
- Graphs









Dichotomous variables
Or
Categorical variables

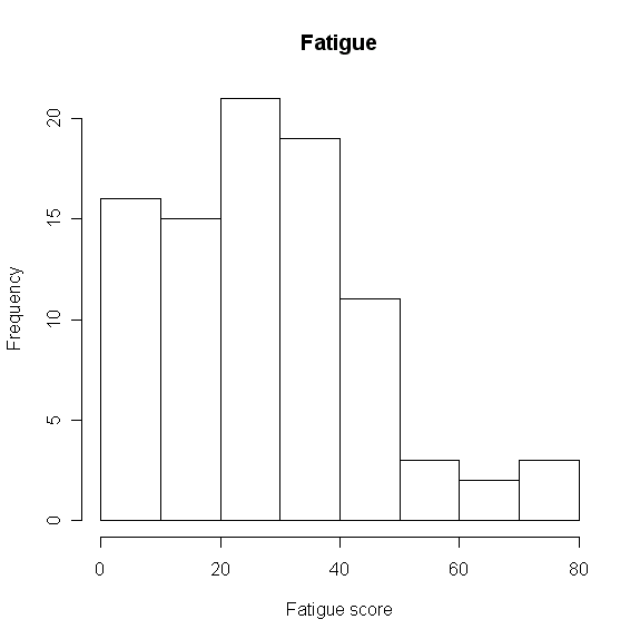
- Summary statistics
  - **Table**
  - **Proportion**

	Male	Female
Number	20	30
Percent	40	60

- Graphs

Ordinal variable

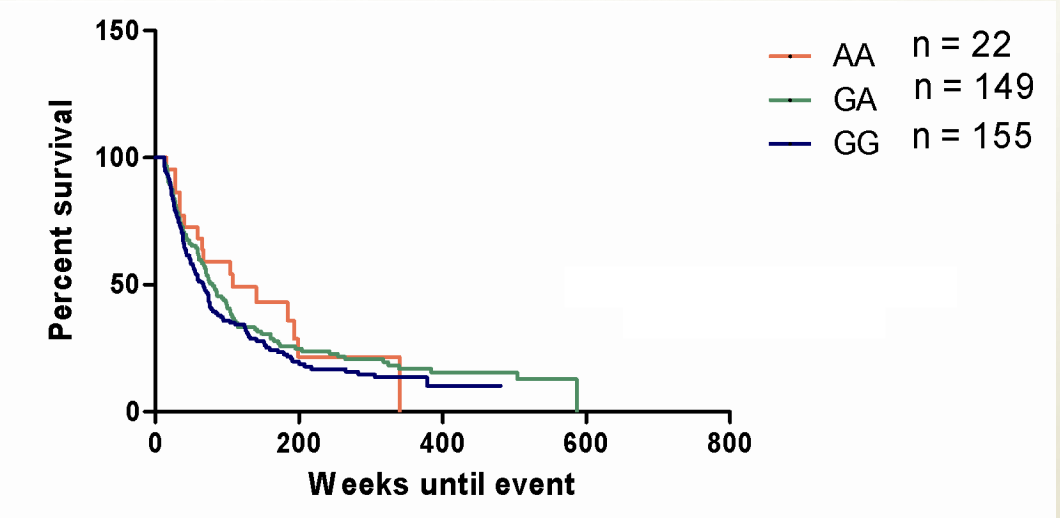
- Summary statistics
- Mean- may be appropriate for **scales or questionnaires**
- Ordered table- appropriate for ordered **categories** with uncertain difference in magnitude
- Rank



	Mild	Moderate	Severe
Number	14	15	4

Time to event

- Survival time
  - Median
- Graph
  - Kaplan-Meier curve



Description vs. comparison

- In many instances, description of the outcome variable is the focus
- Estimate and confidence interval
- Based on results from survey, description is not enough, rather comparison is of interest
- What do we need for comparison?
- Second variable-usually called explanatory variable

Explanatory variables

- Explanatory variables are the **independent variables** that we believe affect the outcome variables in some way
- In clinical studies, this can be
  - Presence of disease
  - Intervention/treatment (clinical trial)
  - Genotype
  - Expression of another cytokine
  - Time

Type of Statistical Test to Use

- *Continuous variable as end point*

  2 groups: t-test

  3 or more groups: ANOVA

- *Relation between 2 categorical variables:*

  Chi-square test

  Fisher's Exact test (2 x 2)

- *Relation between 2 continuous variables:*

  Regression analysis or correlation

T-test

- When comparing 2 independent groups

and

- end-point variable (dependent variable) is continuous
- May be:
  - Paired or
  - Unpaired

T-test

- Example:

1. Paired t-test

   Blood pressure before and after exercise program.

2. Independent t-test

   Compare blood pressure in two groups

   1. Undergoing cardiac rehab
   2. Not undergoing rehab

Analysis of Variance (ANOVA)

- Statistical analysis used to compare several groups for a particular measure
- It is one way where it deals with the relationship between one particular measure (dependent variable) and one factor (independent variable)
- Independent variable is continuous

Why Not T-Test?

- If we compare the main score of satisfaction among people living in 4 villages A, B, C, and D. we can use t test to compare between 2 means, this necessitate doing these tests: AB, AC, AD, BC, BD and CD, this means that t test is required to be repeated 6 time to decide where is the difference? ANOVA does it in one step.
- ANOVA answer the statistical question whether the group means differ from each other

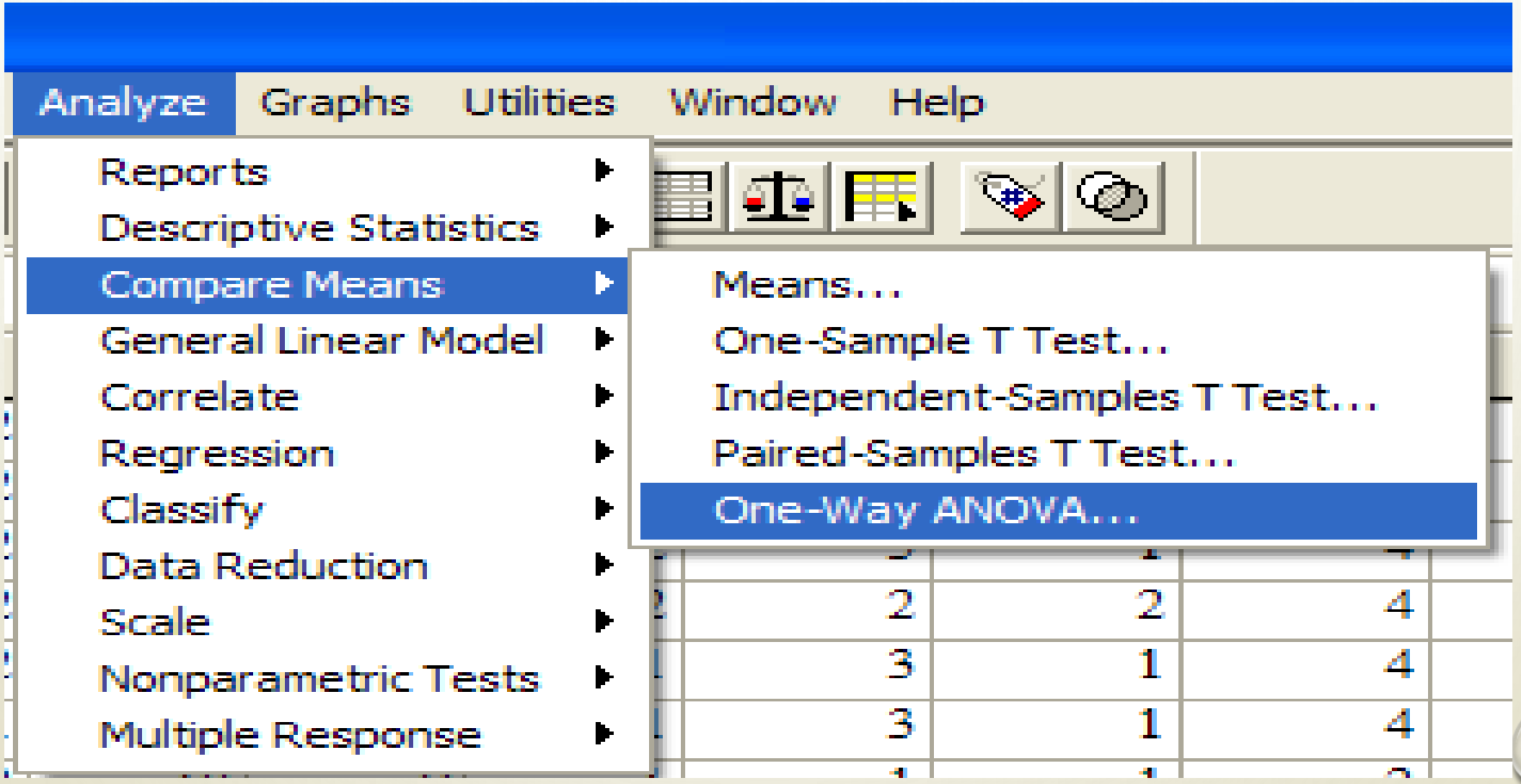
Data for ANOVA:

- Dependent variable = Continuous
- Independent variable = Discrete = Factors (strata, groups, or classes)

Multiple group comparisons (Post-Hoc tests)

- A significant F test does not mean that every group in the analysis is different from every other group
- Many scenarios for these differences could be present and similarities between some are possible
- Scheffe test is used to measure the statistical significant differences between different group means

SPSS FOR ANOVA



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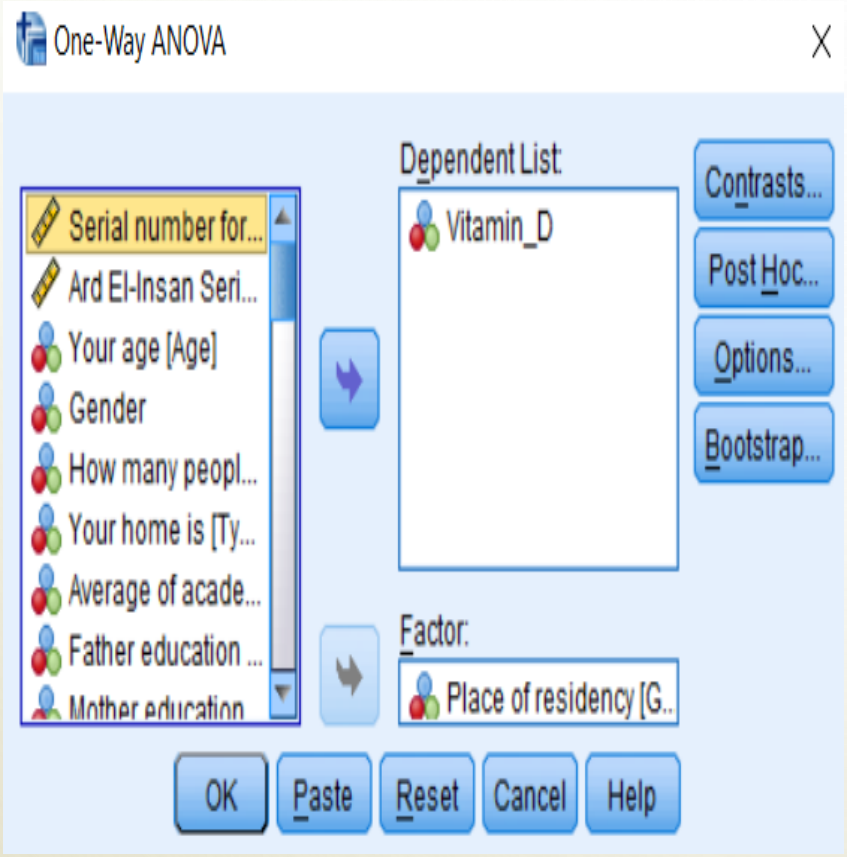
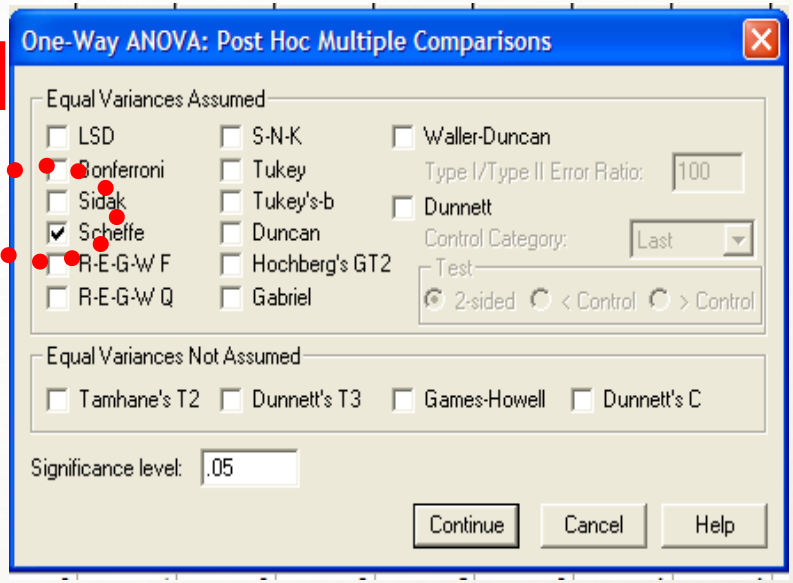
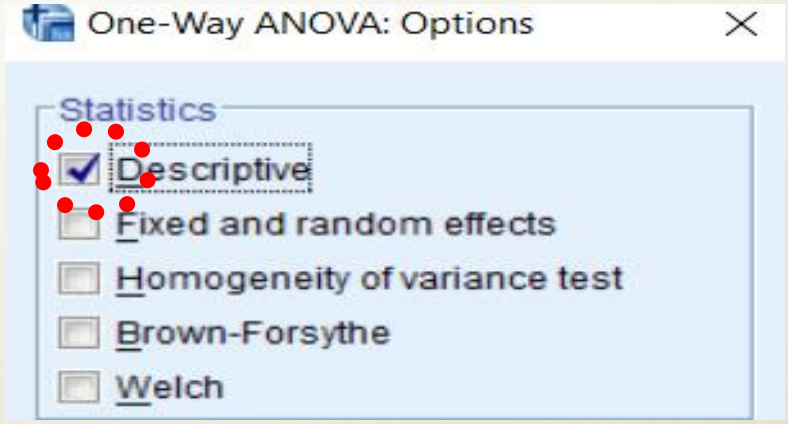

One-Way ANOVA
Dependent List:
Vitamin_D
Serial number for...
Ard El-Insan Seri...
Your age [Age]
Gender
How many peopl...
Your home is [Ty...
Average of acade...
Father education ...
Mother education
Factor:
Place of residency [G...
Contrasts...
Post Hoc...
Options...
Bootstrap...
OK
Paste
Reset
Cancel
Help


One-Way ANOVA: Post Hoc Multiple Comparisons
Equal Variances Assumed
LSD
Bonferroni
Sidak
Scheffe
R-E-G-W F
R-E-G-W Q
S-N-K
Tukey
Tukey's-b
Duncan
Hochberg's GT2
Gabriel
Waller-Duncan
Type I/Type II Error Ratio: 100
Dunnett
Control Category: Last
Test
2-sided < Control > Control
Equal Variances Not Assumed
Tamhane's T2
Dunnett's T3
Games-Howell
Dunnett's C
Significance level: .05
Continue
Cancel
Help


One-Way ANOVA: Options
Statistics
Descriptive
Fixed and random effects
Homogeneity of variance test
Brown-Forsythe
Welch

Multiple Comparisons

Dependent Variable: Positive Psychological Attitudes

Scheffe

(I) Smoking History	(J) Smoking History	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Never Smoked	Quit Smoking	.5806	5.63409	.995	-13.3333	14.4946
	Still Smoking	27.0568*	7.05333	.001	9.6378	44.4757
Quit Smoking	Never Smoked	-.5806	5.63409	.995	-14.4946	13.3333
	Still Smoking	26.4761*	8.00145	.005	6.7157	46.2365
Still Smoking	Never Smoked	-27.0568*	7.05333	.001	-44.4757	-9.6378
	Quit Smoking	-26.4761*	8.00145	.005	-46.2365	-6.7157

*. The mean difference is significant at the .05 level.

Descriptives

Vitamin_D

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
North governorate	42	28.3667	15.83558	2.44348	23.4320	33.3014	9.60	74.90
Gaza	52	23.4654	7.87595	1.09220	21.2727	25.6581	12.70	47.10
Middle G	19	21.6368	8.71367	1.99905	17.4370	25.8367	10.60	44.20
Khanyounis G	15	13.0067	4.31152	1.11323	10.6190	15.3943	7.40	23.30
Rafah G	22	25.2864	7.75090	1.65250	21.8498	28.7229	14.10	39.90
Total	150	23.8273	11.32203	.92444	22.0006	25.6540	7.40	74.90

Vitamin_D

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2766.547	4	691.637	6.140	.000
Within Groups	16333.510	145	112.645		
Total	19100.058	149			

(I) Place of residency	(J) Place of residency	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Khanyounis G	North governorate	-15.36000*	3.19244	.000	-25.3214	-5.3986
	Gaza	-10.45872*	3.11061	.027	-20.1648	-.7527
	Middle G	-8.63018	3.66583	.242	-20.0687	2.8083
	Rafah G	-12.27970*	3.55385	.021	-23.3688	-1.1906
Rafah G	North governorate	-3.08030	2.79325	.875	-11.7961	5.6355
	Gaza	1.82098	2.69935	.978	-6.6018	10.2437
	Middle G	3.64952	3.32399	.877	-6.7223	14.0214
	Khanyounis G	12.27970*	3.55385	.021	1.1906	23.3688

CHI SQUARE (X^2) TEST

- When comparing 2 or more groups and the dependent variable is categorical
- Minimum frequency in any cell must be at least 5
- If less than 5 and a 2 x 2 analysis - use Fisher's Exact Test

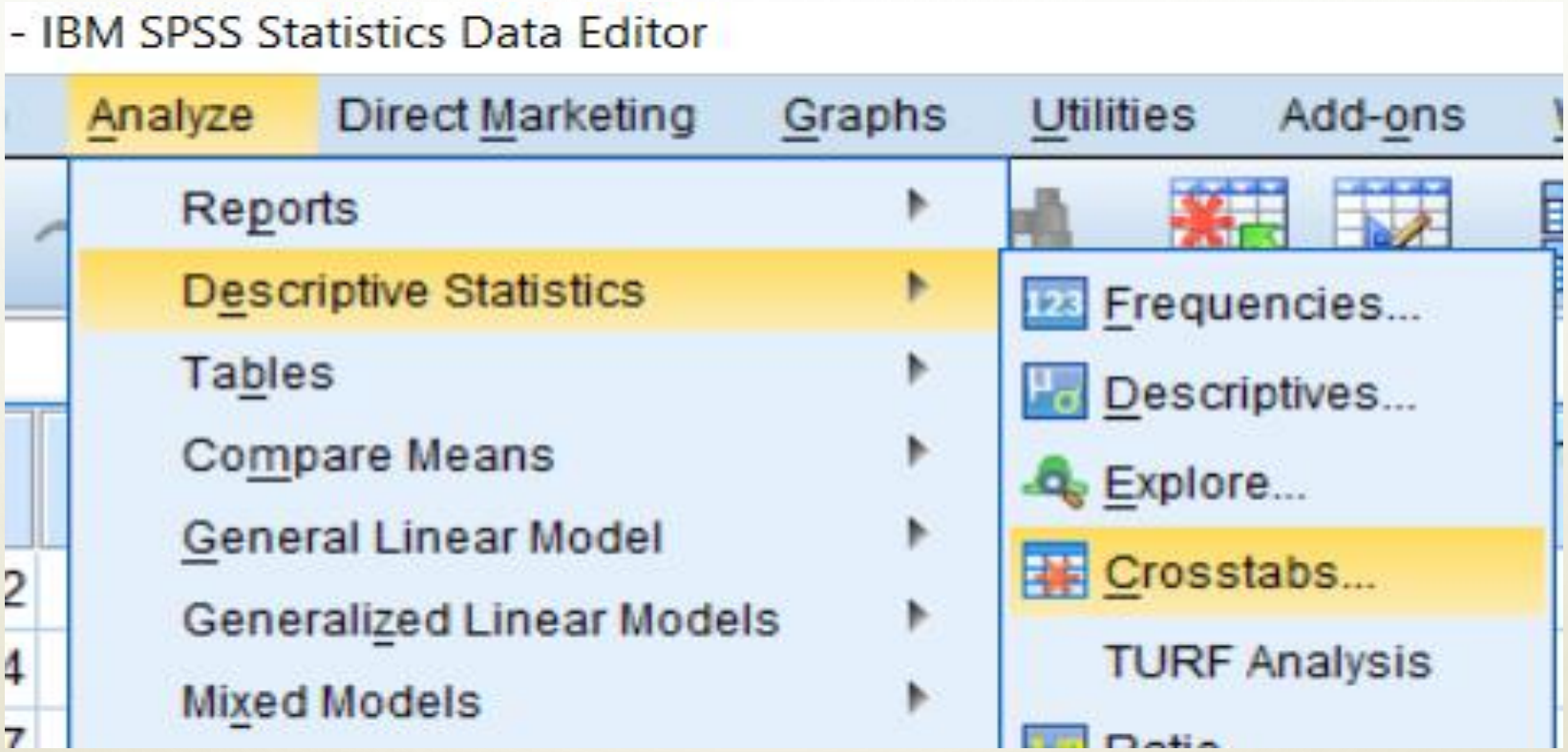
	Male	Female
Hypertensive	35	17
Not Hypertensive	22	68

Is there a relationship between hypertension and gender?
Chi square analysis - $p < 0.001$

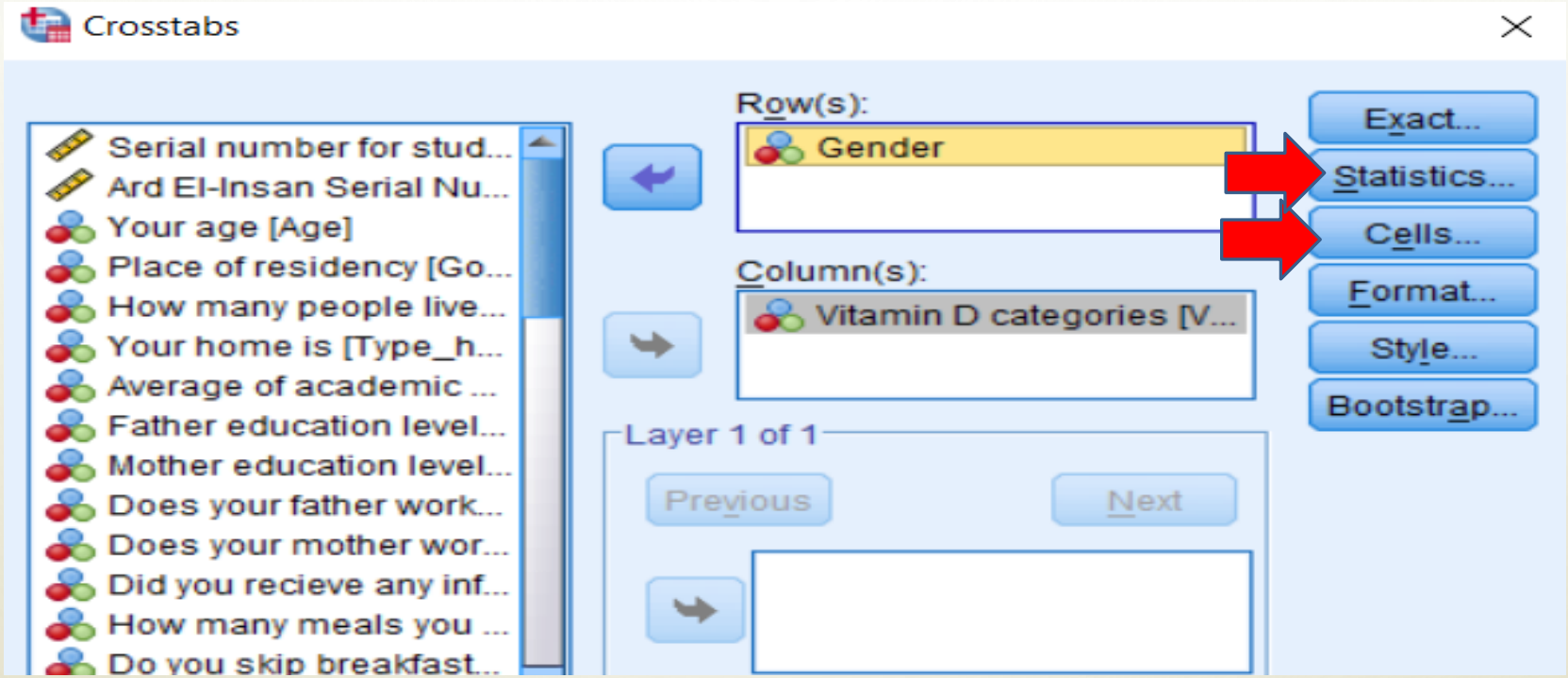
Chi Square Distribution

	Probability					
d.f.	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517

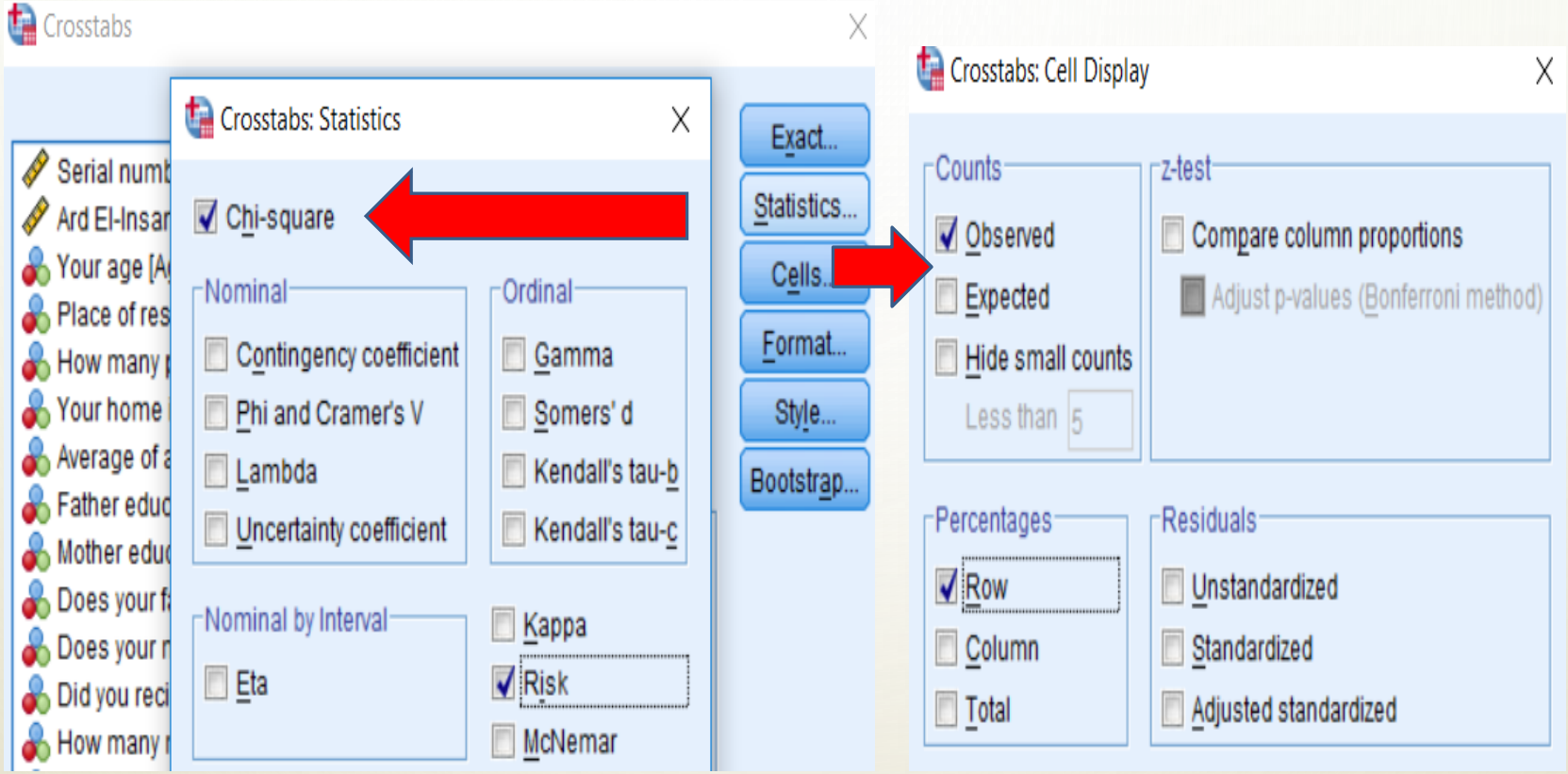
USE SPSS DATA SET THEN GO TO ANALYZE



SELECT THE DEPENDENT VARIABLE IN ROW AND INDEPENDENT VARIABLE IN COLUMN



SELECT: STATISTICS - CELLS



IS THERE A DIFFERENCE BETWEEN PERCENTAGE OF INSUFFICIENT VIT D BETWEEN MALES AND FEMALES?
DOES THE DIFFERENCE REACH STATISTICAL SIGNIFICANT LEVEL?

Gender * Vitamin D categories Crosstabulation

			Vitamin D categories		
			Insufficient	Sufficient	Total
Gender	Boys	Count	12	66	78
		% within Gender	15.4%	84.6%	100.0%
	Girls	Count	54	18	72
		% within Gender	75.0%	25.0%	100.0%
Total		Count	66	84	150
		% within Gender	44.0%	56.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	54.002[a]	1	.000		
Continuity Correction[b]	51.610	1	.000		
Likelihood Ratio	57.828	1	.000		
Fisher's Exact Test				.000	.000

THANK YOU