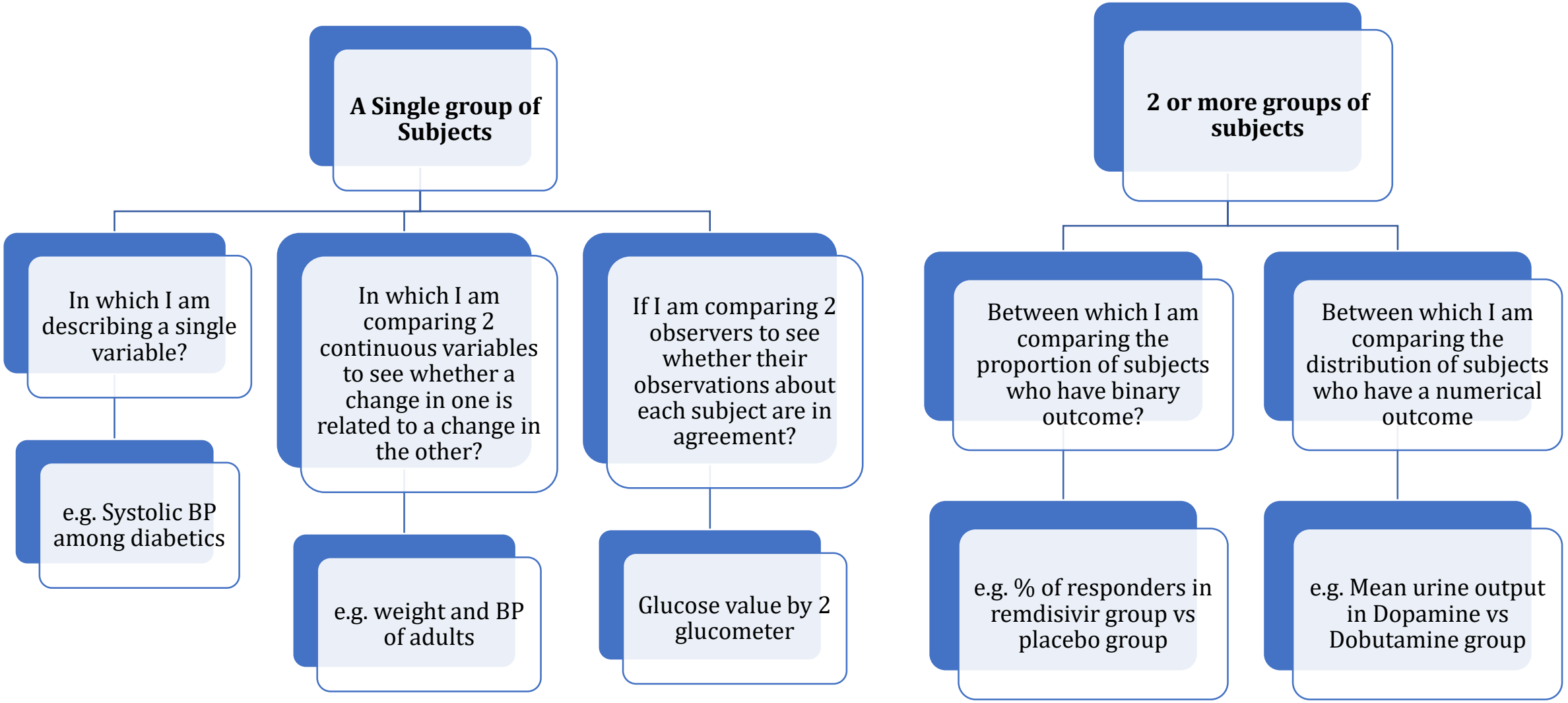
# Biostatistics in Health Research

*Statistical Hypothesis Testing*

*Which test we have to apply? & When?*

# What am I dealing with?



# How do you know our data is normally distributed?

- **Thumb Rule**

  ✓Appearance of Graph (Histogram, QQ Plot etc.)

  ✓Normal  when SD< ½ of mean

  ✓Median is far away from mean

- **Statistical Tests**

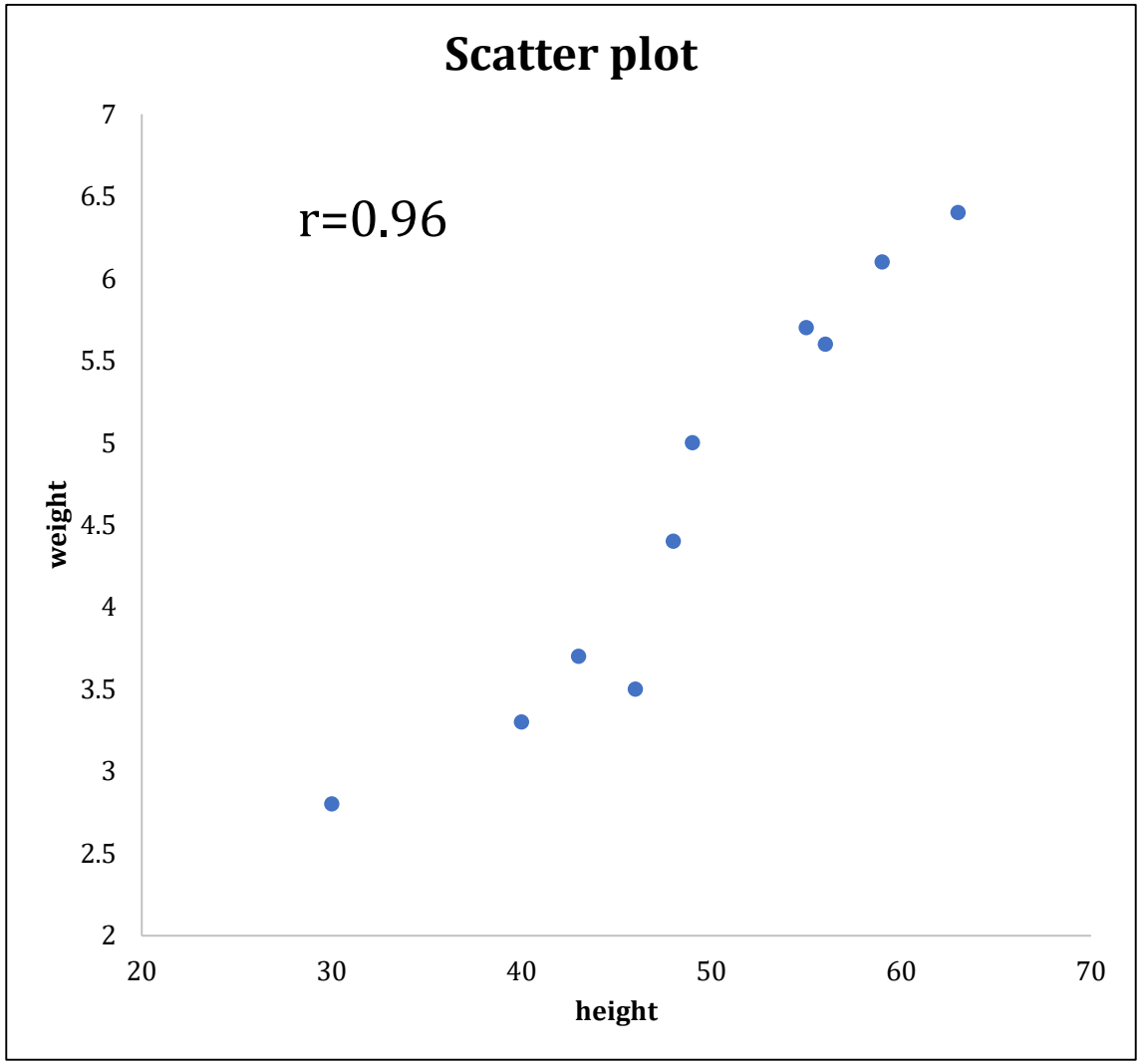
  ✓Shapiro wilk test

  ✓K-S test

  } If p value of test is < 0.05 the distribution is Skewed

  ✓Probability Plot

# Correlation between 2 variables




If any one has skewed distribution use

**Spearman's coefficient**

If both have normal distribution use

**Pearson's coefficient**

# Agreement between 2 observers

- If variable is categorical

  - Kappa Statistics

    *range from 0 to 1*

    *if k is 0 then no agreement*

    *if k tends to 1 higher agreement*

- If variable is numerical

  - Lin's Coefficient of concordance

    *Lin's CCC = 1 perfect concordance*

    *= 0 no systematic concordance*

  - Bland-Altman Plot (Difference plot)

# Comparison between 2 Groups

e.g. Treated Vs. Untreated

Out Come Variable is Binary (e.g. Responders )

| | Remdisivir | No Remdisivir |
|---|---|---|
| Responded | | |
| Did not | | |

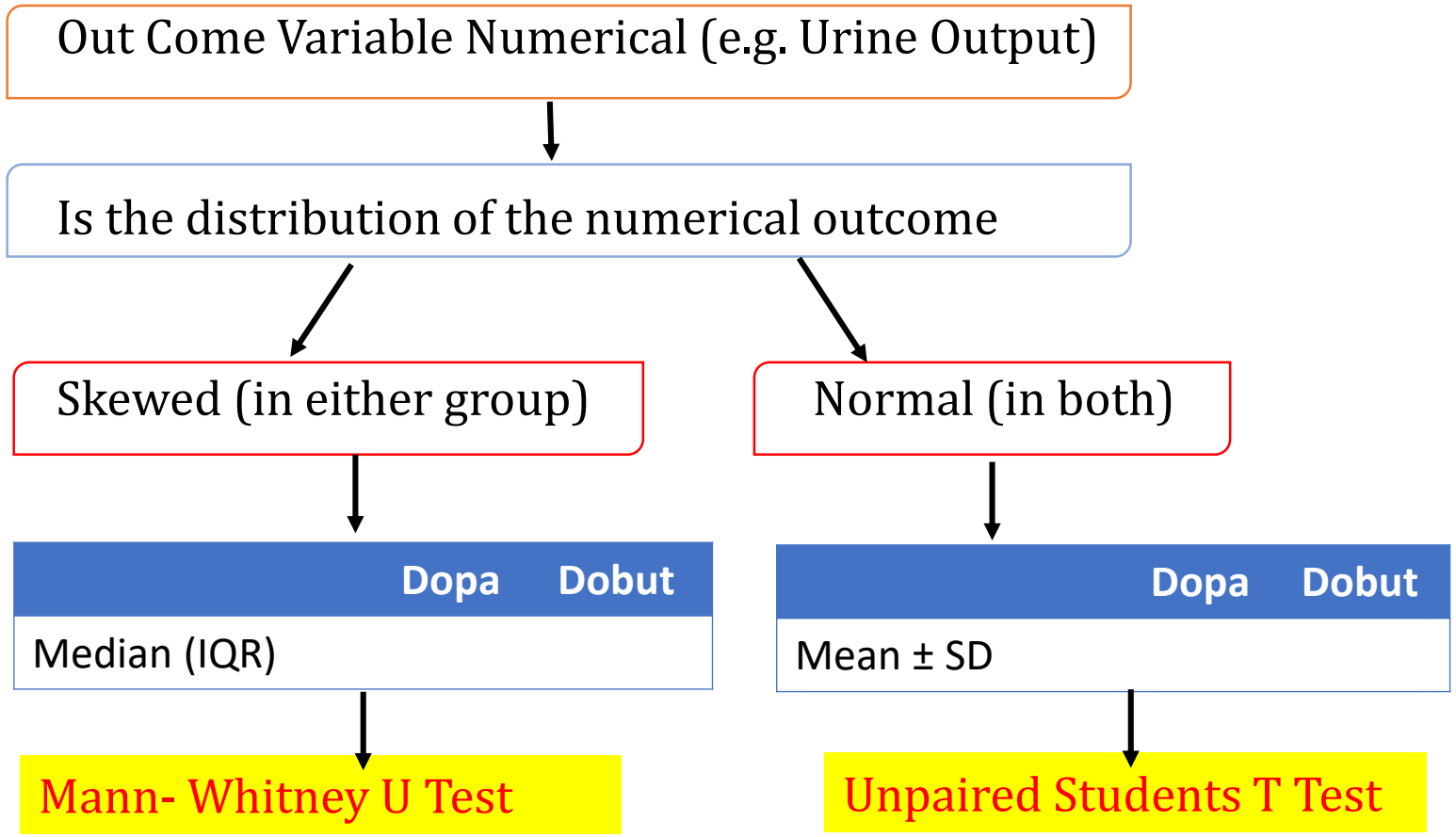
% responded in treated group vs % in untreated group

If all cells have expected count >= 5
**$\chi^2$ test**

If all cells have expected count < 5
**Fisher Exact Test**

# Comparison between 2 groups

e.g. Dopamine vs Dobutamine group



# What if Comparison between >= 3 groups

| Outcome Variable | Example | Test to be Used | Equivalent test if 2 groups |
|---|---|---|---|
| Binary | Drug A vs Drug B vs Placebo | Chi-square Test | Chi-square Test Or Fisher Exact Test |
| Skewed Numerical | Dopamine Vs Dobutamine Vs Adrenaline | Kruskal Wallis Test | Mann Whitney U Test |
| Normal Numerical | Dopamine Vs Dobutamine Vs Adrenaline | ANOVA | Student's **t** Test |

# What are “Related” Group?

**Single Group Providing 2 data sets:**

- Before and after data (paired) on some subjects
- 2 similar organs on same subjects
- E.g. one eye with ROP treated and another eye not treated

**2 groups:**

- Investigator deliberately selects subjects such that controls are matched with cases for certain characteristics
- subjects are matched by virtue of biology
- e.g. Twins enrolled with one in one group, another in other group

# What if Comparison between 2 related groups?

| Outcome Variable | Example | Test to be Used | Equivalent test if Unrelated 2 groups |
|---|---|---|---|
| Binary | Eyes of ROP patients randomized to 2 treatments | Mc-Nemar's test | Chi-square Test Or Fisher Exact Test |
| Skewed Numerical | Before and after bronchodilator | Wilcoxon Signed Rank Test | Mann Whitney U Test |
| Normal Numerical | Before and after anti-hypertensive | Paired t Test | Student's **t** Test |

# Quiz 1.

one measured gestation of 72 neonates

Mean (SD) = 31.6 (1.9)
Median = 32
Skewness = 0.88
Std. error of skewness = 0.28
KS test p value= 0.2

Is the distribution normal or skewed?

Normal

# Quiz 2.

- In an RCT mothers with preterm labor received tocolytics Mg or Ca channel blocker
- Outcome- duration till delivery
- Mg Group: Mean (SD) duration = 40 (23) hrs, median 58 hrs, KS test p value = 0.02
- CCB Group: Mean (SD) duration = 48 (5) hrs. median 46 hrs, KS test p value = 0.6

What test should we used?

Mann Whitney

# Quiz 3.

- Among patients with sepsis, quantitative CRP & qualitative procalcitonin were performed
- Mean (SD) CRP = 25 (16) KS p value = 0.023
- Aim is to find whether increase in procalcitonin corresponds to increase in CRP

What test should we Used?

Spearman's correlation

# Quiz 4.

- Doctors attending a research methodology workshop, a test were performed at the end of the workshop.
- Two old professors gave marks to each candidate independently.
- A statistical test was performed to determined how closely their marking.

Which test you have think that best fit for above?

Assuming data is normal we may use Lin's Coefficient or Bland Altman

| How Many Groups? | Variable being compared is | | | Test |
|---|---|---|---|---|
| | Numerical? | Normal? | Independent? | |
| Single | Numerical ( correlation) | Normal | NA | Pearson's Coefficient |
| | | Skewed | | Spearman's Coefficient |
| | Numerical (agreement) | Normal | | Lin's coefficient, Bland-Altman |
| | | Skewed | | No Consensus (GEE- Generalized Estimating Equation, Mann Whitney or Kruskal wallis) |
| | Categorical (agreement) | NA | | Kappa |
| Two | Numerical | Normal | Independent | Students t |
| | | | Related | Paired t |
| | | Skewed | Independent | Mann Whitney |
| | | | Related | Wilcoxon Signed Rank |
| | Categorical | NA | Independent | Chi-square, Fisher exact test |
| | | | Related | McNemar |
| > Two | Numerical | Normal | Independent | ANOVA |
| | | | Related | Repeated Measure ANOVA |
| | | Skewed | Independent | Kruskal-Wallis |
| | | | Related | Friedman's test |
| | Categorical | NA | Independent | Chi-square |
| | | | Related | Cochran's Q |