STATISTICAL ANALYSIS 101

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OBJECTIVES

• Distinguish descriptive from inferential statistics

• Apply the decision path in determining statistical tests to use in data analysis

• Determine appropriate parametric or nonparametric statistical tests to use in data analysis
Research Purpose

Describe data
- Frequencies
- Percentages
- Means (SD)

Examine differences
- 2 Groups
  - Pre-test / Post-test
    - t-test
    - Mann-Whitney U test
    - Wilcoxon
    - Chi-Squared
  - > 2 Groups
    - ANOVA
    - ANCOVA
    - MANOVA
    - Pre-test / Post-test
      - RM-ANOVA

Examine relationships
- Correlation
  - Pearson's r
  - Spearman Rho
  - Kendall's Tau
  - Chi-Square

Predict relationships
- Regression Analysis
  - Linear Regression
  - Multiple regression
  - Logistic regression
<table>
<thead>
<tr>
<th>Nominal</th>
<th>Ordinal</th>
<th>Interval</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Gender</td>
<td>• Pain scale (0-10)</td>
<td>• Temperature</td>
<td>• Age</td>
</tr>
<tr>
<td>• Ethnicity</td>
<td>• Age groups (18-25, 26-35, etc.)</td>
<td>• IQ</td>
<td>• Height</td>
</tr>
<tr>
<td>• Marital status</td>
<td>• Grade (A, B, C, D, &amp; F)</td>
<td>• SAT score</td>
<td>• Weight</td>
</tr>
<tr>
<td>• Zip code</td>
<td>• Satisfaction scale (poor, acceptable, good)</td>
<td>• Depression score</td>
<td>• BP</td>
</tr>
<tr>
<td>• Religious affiliation</td>
<td>• Performance scale (Below average, average,</td>
<td>• Time of day</td>
<td>• HR</td>
</tr>
<tr>
<td>• Medical diagnosis</td>
<td>above average)</td>
<td>• Dates (years)</td>
<td>• Years of experience</td>
</tr>
<tr>
<td>• Names of medications</td>
<td></td>
<td></td>
<td>• Time to complete a task</td>
</tr>
</tbody>
</table>
CATEGORIES OF STATISTICS

- **Descriptive Statistics**
  - Describe situations and events
  - Summary (numbers, percentages)
  - Central Tendency
  - Charts / Graphs

- **Inferential Statistics**
  - Allows conclusions about variables
  - Statistical tests are performed
  - Comparisons
  - Associations
  - Predictions
DESCRIPTIVE STATISTICS

- Describe, Summarize & Organize data
  - Frequency distributions
  - Graphs/Tables
- Measures of Central Tendency/Dispersion
  - Mean (M)
  - Standard deviation (SD)

Table 1: Socio-demographic characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>(n)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>112</td>
<td>30.9</td>
</tr>
<tr>
<td>Male</td>
<td>251</td>
<td>69.1</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>95</td>
<td>26.2</td>
</tr>
<tr>
<td>Married</td>
<td>268</td>
<td>73.8</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23–29</td>
<td>148</td>
<td>40.8</td>
</tr>
<tr>
<td>30–40</td>
<td>135</td>
<td>37.2</td>
</tr>
<tr>
<td>41–50</td>
<td>43</td>
<td>11.8</td>
</tr>
<tr>
<td>51 and over</td>
<td>37</td>
<td>10.2</td>
</tr>
<tr>
<td>Participation in sports activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One day in a week</td>
<td>75</td>
<td>20.6</td>
</tr>
<tr>
<td>Two-three days in a week</td>
<td>50</td>
<td>13.8</td>
</tr>
<tr>
<td>One day in two weeks</td>
<td>51</td>
<td>14.1</td>
</tr>
<tr>
<td>Never</td>
<td>187</td>
<td>51.5</td>
</tr>
</tbody>
</table>
DESCRIPTIVE STATISTICS

- Distribution of data
  - Normal distribution
- Skewness
  - Negative skew
  - Positive skew

Examples of normal and skewed distributions:

(a) Negatively skewed
(b) Normal (no skew)
(c) Positively skewed
INFERENTIAL STATISTICS

- Probability
  - Likelihood an outcome will occur
  - Helps identify risk
  - Confidence Interval (CI)

- Alpha level (α-level) or significance level
  - Defines statistical significance
  - Most common in healthcare: .05 and .01
  - \( p \)-value

- Examine relationships among variables
  - Correlation statistics
  - Predict relationships among variables
  - Regression analysis

- Examine / Compare differences between variables
  - \( t \)-test
  - ANOVA
PARAMETRIC VS NONPARAMETRIC

PARAMETRIC STATISTICAL TESTS

- Assumptions
  - Data must be normally distributed
  - Interval or ratio data
  - Independence of data
- Need sample size >30
- More powerful

NONPARAMETRIC STATISTICAL TESTS

- No assumptions of distribution
- Small sample size
- Level of measurement
  - Nominal or ordinal
WHAT STATISTICAL TEST TO USE? PARAMETRIC OR NONPARAMETRIC

Example:
- Sample of critically ill patients
  - Length of stay
- 20 females
  - Mean = 60
  - Median = 31.5
- 19 males
  - Mean = 30.9
  - Median = 30
EXAMINE RELATIONSHIPS

• **Correlation Statistics**
  - Exploratory studies
  - Examines relationship between variables
    - Direction of relationship
    - Doesn’t specify IV & DV

**EXAMPLES**
- Association between overtime hours worked and medication errors in RNs
- Relationship between social support and stress in elderly rural women
- Relationship between time on ventilator and LOS in ICU patients
CORRELATION COEFFICIENTS

- Direction of relationship

- Strength of relationship (-1 to +1)
  - $\geq .10 \rightarrow$ weak
  - $\geq .30 \rightarrow$ moderate
  - $\geq .50 \rightarrow$ strong

- Statistical significance
PEARSON’S CORRELATION COEFFICIENT ($r$)

- Parametric test
- Assumptions
  - Normal distribution / Interval or ratio
  - Related pairs / Absence of outliers
  - Linearity / Homoscedasticity
- Interval or ratio data level
- Reported as:
  - $r = .78$, $p < 0.001$
NONPARAMETRIC TESTS

- **Spearman Rho**
  - Skewed distribution
  - One variable- ordinal level
  - Reported as:
    - $r_s = .82, \ p = .042$

- **Kendall’s Tau**
  - Skewed distribution
  - One variable- ordinal level
  - Reported as:
    - $r_t = .82, \ p = .042$

- **Chi Square test**
  - One variable- nominal
  - No direction or association reported
  - Reported as:
    - $\chi^2 (1) = 5.00, \ p = .025$

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Gender</th>
<th>Assessment to Physician Contact Time</th>
<th>Assessment to Medication Administration</th>
<th>Pain Score Prior to Schedule II</th>
<th>Sleep Disturbances</th>
<th>Diminished Ability With ADLs</th>
<th>Nonpharmacological Modalities Used*</th>
<th>Lack of Participation in Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>−0.27*</td>
<td>0.01</td>
<td>−0.17</td>
<td>0.15</td>
<td>−0.09</td>
<td>0.15</td>
<td>0.08</td>
<td>0.24</td>
</tr>
<tr>
<td>Assessment to pain relief time</td>
<td>0.27*</td>
<td>−0.01</td>
<td>0.52**</td>
<td>0.02</td>
<td>0.18</td>
<td>0.17</td>
<td>0.06</td>
<td>−0.09</td>
</tr>
<tr>
<td>Pain score prior to schedule II</td>
<td>−0.34*</td>
<td>0.11</td>
<td>0.20</td>
<td>—</td>
<td>0.34*</td>
<td>0.26</td>
<td>−0.07</td>
<td>0.28*</td>
</tr>
<tr>
<td>Pain score after schedule II</td>
<td>−0.25</td>
<td>0.22</td>
<td>0.07</td>
<td>0.48**</td>
<td>0.15</td>
<td>0.11</td>
<td>−0.12</td>
<td>0.22</td>
</tr>
<tr>
<td>Lack of therapy participation</td>
<td>−0.38*</td>
<td>0.20</td>
<td>0.01</td>
<td>0.28*</td>
<td>0.31*</td>
<td>0.45**</td>
<td>0.03</td>
<td>—</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>0.02</td>
<td>0.21</td>
<td>0.18</td>
<td>0.34*</td>
<td>—</td>
<td>0.70**</td>
<td>0.09</td>
<td>0.31*</td>
</tr>
<tr>
<td>Diminished appetite/weight loss</td>
<td>−0.24</td>
<td>0.37**</td>
<td>−0.21</td>
<td>0.14</td>
<td>0.07</td>
<td>0.07</td>
<td>−0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Resisting movement with care</td>
<td>−0.09</td>
<td>0.15</td>
<td>0.13</td>
<td>0.45**</td>
<td>0.67**</td>
<td>0.67**</td>
<td>−0.02</td>
<td>0.34*</td>
</tr>
<tr>
<td>Diminished psychological well-being</td>
<td>−0.01</td>
<td>0.17</td>
<td>0.11</td>
<td>0.33*</td>
<td>0.52**</td>
<td>0.44**</td>
<td>0.30</td>
<td>0.20</td>
</tr>
</tbody>
</table>

*Note: Schedule II = schedule II analgesic medications; ADLs = activities of daily living.*  
*Nonpharmacological modalities that may have been used include massage, music therapy, pet therapy, social activities, repositioning, and communication and diversion techniques, including family and friend visitation.*  
*p < 0.05; **p < 0.01.
PREDICT RELATIONSHIPS

- Regression Analysis
  - Exploratory & Prediction studies
  - Quantifies a relationships among variables to predict future events
    - Estimates values for DV by known values of IV
      - Dependent variable (DV) – outcome variable
      - Independent variable (IV) – influencing variable
    - Makes inferences or predictions
  - Statistically significant correlations (≥ .50)
    - Measure strength of association
3 TYPES OF REGRESSION ANALYSIS

- **Linear regression**
  - Relationship between a single independent variable and a single interval- or ratio-level variable
  - Predicts the future value of dependent variable based on level of independent variable
  - Results report: $R$ and $R^2$

- **Multiple regression**
  - Make prediction about how 2 or more independent variables affects the dependent variable
  - Reported as $R^2$

- **Logistic regression**
  - Used when dependent variable is categorical (nominal or ordinal with 2 categories)
  - Generates an Odds Ratio (OR)
EXAMPLES

Investigate the relationship between gestational age at birth (weeks) & birth weight (lbs.)

• Simple linear regression
  • Significant relationship between gestation and birth weight ($r = .706, p < 0.001$).
  • Slope coefficient for gestation was 0.355
    • Weight of baby increases by 0.355 lbs. for each extra week of gestation.

Investigate the effect of age (years) and height (inches) on weight

• Multiple regression
  • Significant relationship between age and weight ($r = .476, p = .001$); height and weight ($r = .672, p = .001$)
    • Control for height, every year adds 1.71 lbs.
    • Control for age – every inch adds 10.37 lbs.
EXAMPLE: LOGISTIC REGRESSION

- **Purpose:** Identify factors that can be related to the occurrence of gestational arterial hypertension.

- **Dependent variable**
  - Momentary HTN – yes
  - Momentary HTN – no

- **Independent variables**
  - Anxiety
  - Depression
  - Obesity
  - Demographic variables
    - Age
    - Race
    - Education

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-white</td>
<td>8.18</td>
<td>1.39-48.10</td>
<td>0.020</td>
</tr>
<tr>
<td>Depression</td>
<td>No</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8.69</td>
<td>1.19-63.42</td>
<td>0.033</td>
</tr>
<tr>
<td>Obesity</td>
<td>No</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6.45</td>
<td>1.40-29.61</td>
<td>0.016</td>
</tr>
<tr>
<td>Anxiety</td>
<td>No</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>7.77</td>
<td>1.19-50.45</td>
<td>0.032</td>
</tr>
</tbody>
</table>

EXAMINE DIFFERENCES

- **Experimental Designs**
  - Effect of IV on DV
    - 1 or more variables
    - 1 or more groups
  - Comparing results (means)
    - Between subjects
    - Within subjects

- **Statistical test to use depends on**
  - # of groups
  - Level of measurement
  - Type of sample
    - Independent samples
    - Dependent samples
PARAMETRIC TEST: Differences between 2 means

- **Students \( t \)-test**
  - One-sample \( t \)-test
  - Independent Samples \( t \)-test
  - Dependent Samples \( t \)-test

- **One-sample \( t \)-test**
  - Interval or Ratio data
  - Compare mean to known value
  - Results reported as
    \[ t (99) = 2.224, p = 0.028 \]
  - One-tailed or two-tailed test
PARAMETRIC TEST: Difference between 2 means

<table>
<thead>
<tr>
<th>INDEPENDENT SAMPLES</th>
<th>DEPENDENT SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>t-test</strong></td>
<td><strong>t–test</strong></td>
</tr>
<tr>
<td>• Interval or Ratio data</td>
<td>• Paired t–test</td>
</tr>
<tr>
<td>• Independent samples</td>
<td>• Interval or Ratio data</td>
</tr>
<tr>
<td>• Results reported as</td>
<td>• Dependent samples</td>
</tr>
<tr>
<td>$t (18) = 2.86, p = 0.011$</td>
<td>• Results reported as</td>
</tr>
<tr>
<td></td>
<td>$t (15) = 4.00, p = 0.001$</td>
</tr>
</tbody>
</table>
70 patients with leukemia
• Experimental group \((n=35)\)
  • 2 follow-up phone calls (IV)
• Control group \((n=35)\)
  • Routine care
  • Self-care (DV)

70 patients with hypertension
• Stress reduction classes
• SBP (pre & post)

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group ((n=35))</th>
<th>Control Group ((n=35))</th>
<th>(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-care</td>
<td>2.67 (\pm) 0.036</td>
<td>1.78 (\pm) 0.38</td>
<td>10.347*</td>
</tr>
</tbody>
</table>

\* \(p<.001\)

<table>
<thead>
<tr>
<th></th>
<th>Pre-class</th>
<th>Post-class</th>
<th>(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>178.92 (\pm) 24.6</td>
<td>131.47 (\pm) 6.38</td>
<td>4.467*</td>
</tr>
</tbody>
</table>

\* \(p<.001\)
NONPARAMETRIC TESTS: Differences between 2 medians

**MANN-WHITNEY U-TEST**
- Looks at differences in distribution of a variable
- Assumptions
  - Random samples
  - Independent samples
  - Level of measurement: Ordinal +
- Results of test are reported as
  - $U = 67.5, p = .034$
  - Wilcoxon Rank-Sum test
  - $W_s = 109.50, p = .008$

**WILCOXON RANKED-SIGN TEST**
- Looks at differences in distribution of a variable
- Assumptions
  - Random samples
  - Dependent samples
  - Level of measurement: Ordinal +
- Results of test are reported as
  - $(Mdn = 21.00), Z = -1.807, p = 0.071, r = -.84$
  - Wilcoxon Matched-Pairs test
CHI-SQUARE ($\chi^2$) STATISTIC

- Looks at differences in distribution of frequencies
- Level of Measurement: nominal or ordinal
- Independent groups
- Observed frequencies vs. Expected frequencies
- Results reported as
  - $\chi^2 (2, N = 218) = 14.14, p < 0.01$

## NONPARAMETRIC TESTS:
Differences between 2 frequencies

<table>
<thead>
<tr>
<th></th>
<th>Do not use Antihistamines</th>
<th>Use Antihistamines</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 30</td>
<td>105</td>
<td>32</td>
<td>137</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>72</td>
<td>9</td>
<td>81</td>
</tr>
<tr>
<td>Total</td>
<td>177</td>
<td>41</td>
<td>218</td>
</tr>
</tbody>
</table>
ANALYSIS OF VARIANCE (ANOVA)

- **Parametric Test**
  - Differences in means between >2 Groups

- **Post hoc tests**
  - Bonferroni
  - Tukey’s
  - Scheffé’s

- **Reported as an $F$ ratio**
  - $F(59, 56) = 7.77, p = .042$

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**Types of ANOVAs**

- One-way ANOVA
- ANCOVA
- Two-way ANOVA
- N-way (Factorial) ANOVA
- RM-ANOVA
- MANOVA
ONE-WAY ANOVA

- 3 or more Independent Groups
  - Comparing 3 or more means
- 1 independent variable (1 factor)
- 1 dependent variable
- Results reported as
  - $F(2, 27) = 4.98, p = 0.01$

Assumptions
- Normal distribution
- DV at least Interval level
- Variances in groups are same
- Independent samples
Smokers

• IV- methods to quit smoking
• DV- # cigarettes/day

• Ho: There is no significant difference in number of cigarettes per day between smokers who had counseling, used a nicotine patch, or used Chantix.
• Ha: There is a significant difference in number of cigarettes per day between smokers who had counseling, used a nicotine patch, or used Chantix.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counseling</td>
<td>Nicotine Patch</td>
<td>Chantix</td>
</tr>
<tr>
<td>16.6</td>
<td>19.2</td>
<td>34.0</td>
</tr>
<tr>
<td>n = 8</td>
<td>n = 10</td>
<td>n = 9</td>
</tr>
</tbody>
</table>

\[ F (2, 27) = 4.98, p = 0.01 \]
ANCOVA (Analysis of Covariance)

- 3 or more Groups
  - Comparing 3 or more means

- 1 Independent Variable (factors)
- 1 Dependent Variable

- Adjusts scores on dependent variable
  - Removes effect of confounding variables (covariates)

- Assumptions
  - Normal distribution
  - DV at least Interval level
  - Variances in groups are same
  - Independent samples
  - Independence between covariate & IV
  - Relationship between covariate & DV stays the same
EXERCISE STUDY

• IV- Exercise
  • No exercise
  • Exercise 1x / week
  • Exercise 3x’s / week
  • Exercise 5x’s / week

• DV- Health Problem Index
  • Confounding variable: weight

EXAMPLE using ANCOVA
EXAMPLE USING TWO-WAY ANOVA

• Smokers study
  • IV #1- Methods to quit smoking (Factor A)
  • IV #2- Gender (Factor B)
  • DV- # cigarettes/day

H⁰¹: There is no significant difference in the mean # cigarettes/day among participants getting counselling or the nicotine patch.
H⁰²: There is no significant difference in the mean # cigarettes/day among male or female participants.
H⁰³: There is no significant interaction effect between gender and method used.

<table>
<thead>
<tr>
<th>Factor B- Gender</th>
<th>Factor A- Treatment</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Counseling (1)</td>
<td>Patch (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female (1)</td>
<td>X₀₁b₁ = 22.0</td>
<td>X₀₂b₁ = 20.0</td>
<td>Xᵦ₁ = 21.0 (female)</td>
<td></td>
</tr>
<tr>
<td>Male (2)</td>
<td>X₀₂b₂ = 16.0</td>
<td>X₀₂b₂ = 30.0</td>
<td>Xᵦ₂ = 21.0 (male)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X₀₁ = 21.0 (treatment)</td>
<td>X₀₂ = 21.0 (treatment)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RM-ANOVA (Repeated Measures ANOVA)

- **Dependent Sample**
  - Comparing 3 or more means
    - DV measured at different times
    - >2 IV to same group

- 1 or more **Independent Variables**
- 1 or more **Dependent Variable**

- **Results reported as**
  - $F(1, 108) = 3.93, p < 0.001$

**Assumptions**
- Normal distribution
- DV at least Interval level
- Variances in groups are same
- Sphericity
# RM-ANOVA EXAMPLES

## Example 1

<table>
<thead>
<tr>
<th></th>
<th>n = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>m(SD)</td>
</tr>
<tr>
<td></td>
<td>16.6 (2.78)</td>
</tr>
<tr>
<td>Time 1</td>
<td>m(SD)</td>
</tr>
<tr>
<td></td>
<td>19.2 (1.51)</td>
</tr>
<tr>
<td>Time 2</td>
<td>m(SD)</td>
</tr>
<tr>
<td></td>
<td>34.0 (2.13)</td>
</tr>
</tbody>
</table>

DV: Quality of sleep

## Example 2

<table>
<thead>
<tr>
<th></th>
<th>n = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Game</td>
<td>m(SD)</td>
</tr>
<tr>
<td>(Weeks 1-4)</td>
<td>9.4 (1.96)</td>
</tr>
<tr>
<td>Music</td>
<td>m(SD)</td>
</tr>
<tr>
<td>(Weeks 5-8)</td>
<td>16.9 (3.05)</td>
</tr>
<tr>
<td>Television</td>
<td>m(SD)</td>
</tr>
<tr>
<td>(Weeks 9-12)</td>
<td>13.8 (2.63)</td>
</tr>
</tbody>
</table>

DV: Quality of sleep

## Example 3

<table>
<thead>
<tr>
<th></th>
<th>n = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Game</td>
<td>m(SD)</td>
</tr>
<tr>
<td>(Weeks 1-4)</td>
<td>Male: 12.4 (2.16)</td>
</tr>
<tr>
<td></td>
<td>Female: 14.9 (3.21)</td>
</tr>
<tr>
<td>Music</td>
<td>m(SD)</td>
</tr>
<tr>
<td>(Weeks 5-8)</td>
<td>Male: 16.9 (3.05)</td>
</tr>
<tr>
<td></td>
<td>Female: 18.3 (2.78)</td>
</tr>
<tr>
<td>Television</td>
<td>m(SD)</td>
</tr>
<tr>
<td>(Weeks 9-12)</td>
<td>Male: 13.8 (2.63)</td>
</tr>
<tr>
<td></td>
<td>Female: 15.5 (1.45)</td>
</tr>
</tbody>
</table>

DV: Quality of sleep
NONPARAMETRIC TESTS: Kruskal-Wallis

- **Compareds medians**
  - Any assumption of ANOVA testing is violated
  - Small sample size

- **Assumptions**
  - Random samples
  - Independent samples
  - Level of measurement: Ordinal, Interval, or Ratio

- Only tells that measurements differ
  - Mann-Whitney test provides which differ significantly
NONPARAMETRIC TESTS: Friedman’s ANOVA

- Nonparametric equivalent for **RM-ANOVA**
  - Uses ranked data
  - Any assumption of ANOVA testing is violated
  - Small sample size
- Assumptions
  - Independent measurements
  - Level of measurement: Ordinal, Interval, or Ratio
- Only tells that measurements differ
  - Wilcoxon Signed-rank test provides which differ significantly
Statistical Significance

- Results unlikely to caused by chance

- Dependent upon Power and # of subjects in a study

- The larger the sample the greater the power & probability of detecting significant results between variables

Clinical Significance

- Magnitude of risk reduction

- Precision of the treatment effect
  - Effect Size (ES)
    - Cohen’s d calculation
    - Confidence Interval (CI)
**EFFECT SIZE CALCULATION**

**COHEN’S \( d \)**

\[
\frac{\text{mean}^1 - \text{mean}^2}{\text{SD}^1 + \text{SD}^2/2}
\]

- **Small ES** \( \geq .20 \)
- **Medium ES** \( \geq .50 \)
- **Large ES** \( \geq .80 \)
EXAMPLE OF CLINICAL SIGNIFICANCE

- Research Question: “In teens, what is the effect of imagery on anxiety level?”
- 20 teens in Control Group, 20 teens in Experimental Group
  - Control group $\mu = 40$ (25)
  - Experimental group $\mu = 50$ (15)
  - $p = 0.15$
- Cohen’s $d$ $\frac{50-40}{\sqrt{25+15}/2}$ $\rightarrow \frac{10}{20}$ $\rightarrow 0.5$ or Medium Effect size