# 12. Non-parametric tests

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# Agenda

1. Introduction to non-parametric tests
2. The Wilcoxon rank-sum test
    - Theory
    - Conducing the analysis and reporting results

3. The Mann-Whitney test
    - Theory
    - Conducing the analysis and reporting results

4. The Kruskal-Wallis Test
    - Theory
    - Conducing the analysis and reporting results

5. Friedman´s Anova
    - Theory
    - Conducing the analysis and reporting results

# 1. Introduction to non-parametric tests

- Sometimes the data you have violates the assumptions of parametric tests
- No matter how hard you may want to try there is simply no way possible for you to fix the problems in your data
- Good news though
  - The family of non-parametric tests is there for you

# 1. Introduction to non-parametric tests

- Non-parametric tests or the assumption-free tests
- Do not make the assumptions that you find in parametric tests
- Technically parametric tests are more powerful
- The range of robust tests in SPSS is quite limited
- Non-parametric tests a nice option to test a hypothesis by still claiming to use a statistical test

# 1. Introduction to non-parametric tests

- **The non-parametric tests you can use**

1. **The Wilcoxon rank-sum test & Mann-Whitney test- comparing two independent conditions**
2. **The Wilcoxon signed-rank test- Comparing two related conditions**
3. **The Kruskal-Wallis test-Differences between several independent groups**
4. **Friedman`s Anova- Differences between several independent groups**

# 2. The Wilcoxon rank-sum test & Mann-Whitney test

- If you want to test for differences between two groups
- Similar logic to t-tests
- Both tests will do the job for you

# 2. The Wilcoxon rank-sum test & Mann-Whitney test

- Elegant logic behind both tests
- Ranking data
- Higher ranks in one group and lower in the other: your expectation
- IF groups are unequal in numbers of participants the test statistic for the Wilcoxon rank-sum is the sum of ranks in the group which has the lowest number of participants
- If groups as similar then this value corresponds to the smaller summed rank

# 2. Understanding ranks

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Score | 3 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 17 | 24 | 27 | 28 | 29 | 30 | 32 | 35 | 35 | 35 | 36 | 39 |
| Potential Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Actual Rank | 1 | 2 | 3.5 | 3.5 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 17 | 17 | 19 | 20 |
| Group | C | C | C | C | C | C | C | C | C | N | N | N | N | C | N | N | N | N | N | N |
| | | | | | | | | | | | | | | | | | | | | |
| Sum of ranks for C= 59 | | | | | | | | | Sum of ranks for N= 151 | | | | | | | | | | | |

# 2. Conducting the test

- Conducting the test
- Calculating effect sizes

$$r=\frac{z}{\sqrt{N}}$$

# 2. Reporting Mann-Whitney test results

- Report
- Means of groups
- U-score, z-score, r-value and p-value

# 3. The Wilcoxon signed-rank test

- Used in cases when you are comparing two sets of scores that come from the same participants
- Ideal for cases of measuring pre-post test scores
- The test itself is based on the differences between scores in the two conditions
- Once the differences are calculated, they are ranked.

# 3. The Wilcoxon signed-rank test

- Report
- Means of groups
- T-score, z-score, r-value and p-value

# 4. The Kruskal-Wallis test

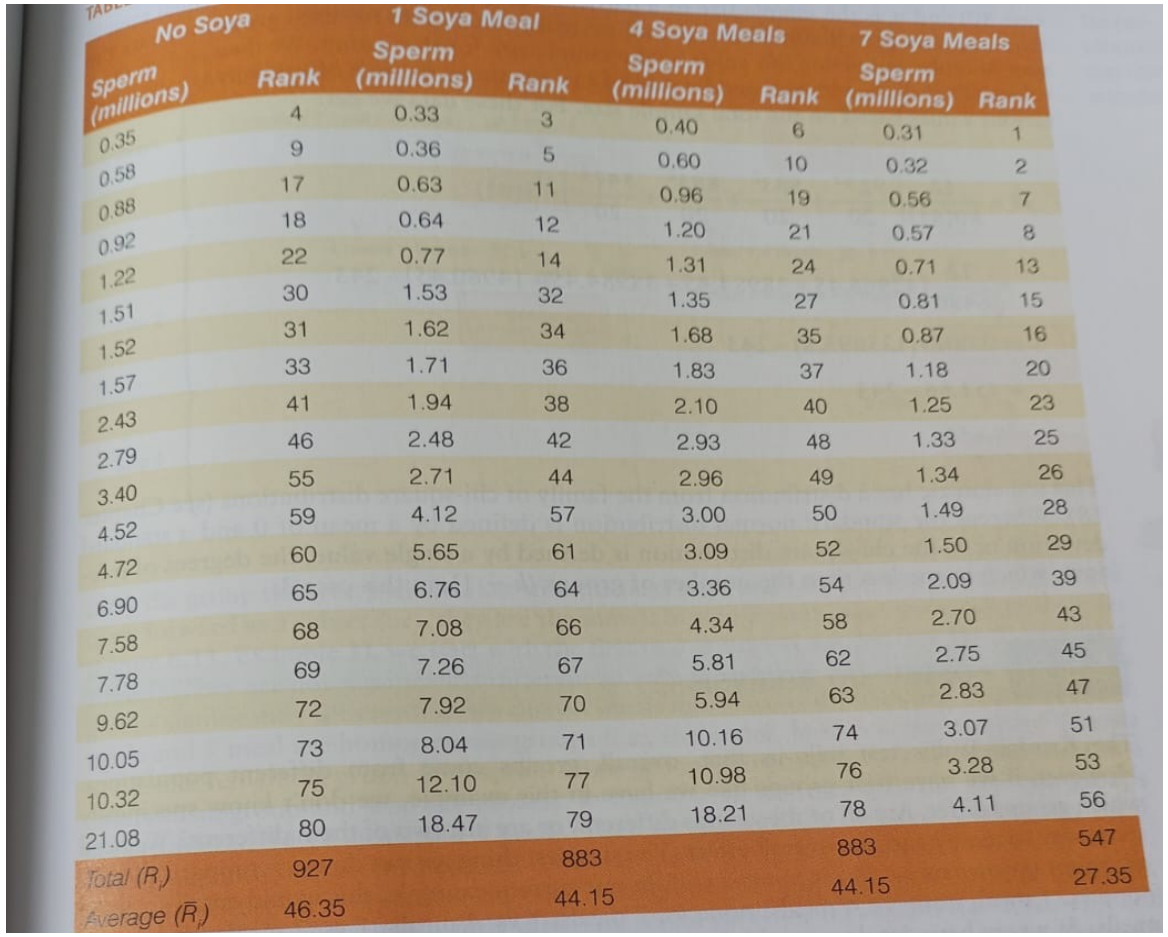
- Differences between several independent groups
- The hypothesis of the test is that your groups come from different populations
- The test looks at the differences between groups of scores
- E.G. take 50 students and divide them in 4 groups and each groups gets a special drink (i.e. tea, water etc.)

# 4. The Kruskal-Wallis test

- The same logic for data ranking as the Mann-Whitney exept:

1. Order the scores from the lowest to the highest
2. Assign ranks starting with 1
3. Divide by groups
4. Find the total score and the average

# 4. The Kruskal-Wallis test



| No Soya | | 1 Soya Meal | | 4 Soya Meals | | 7 Soya Meals | |
|---|---|---|---|---|---|---|---|
| Sperm (millions) | Rank | Sperm (millions) | Rank | Sperm (millions) | Rank | Sperm (millions) | Rank |
| 0.35 | 4 | 0.33 | 3 | 0.40 | 6 | 0.31 | 1 |
| 0.58 | 9 | 0.36 | 5 | 0.60 | 10 | 0.32 | 2 |
| 0.88 | 17 | 0.63 | 11 | 0.96 | 19 | 0.56 | 7 |
| 0.92 | 18 | 0.64 | 12 | 1.20 | 21 | 0.57 | 8 |
| 1.22 | 22 | 0.77 | 14 | 1.31 | 24 | 0.71 | 13 |
| 1.51 | 30 | 1.53 | 32 | 1.35 | 27 | 0.81 | 15 |
| 1.52 | 31 | 1.62 | 34 | 1.68 | 35 | 0.87 | 16 |
| 1.57 | 33 | 1.71 | 36 | 1.83 | 37 | 1.18 | 20 |
| 2.43 | 41 | 1.94 | 38 | 2.10 | 40 | 1.25 | 23 |
| 2.79 | 46 | 2.48 | 42 | 2.93 | 48 | 1.33 | 25 |
| 3.40 | 55 | 2.71 | 44 | 2.96 | 49 | 1.34 | 26 |
| 4.52 | 59 | 4.12 | 57 | 3.00 | 50 | 1.49 | 28 |
| 4.72 | 60 | 5.65 | 61 | 3.09 | 52 | 1.50 | 29 |
| 6.90 | 65 | 6.76 | 64 | 3.36 | 54 | 2.09 | 39 |
| 7.58 | 68 | 7.08 | 66 | 4.34 | 58 | 2.70 | 43 |
| 7.78 | 69 | 7.26 | 67 | 5.81 | 62 | 2.75 | 45 |
| 9.62 | 72 | 7.92 | 70 | 5.94 | 63 | 2.83 | 47 |
| 10.05 | 73 | 8.04 | 71 | 10.16 | 74 | 3.07 | 51 |
| 10.32 | 75 | 12.10 | 77 | 10.98 | 76 | 3.28 | 53 |
| 21.08 | 80 | 18.47 | 79 | 18.21 | 78 | 4.11 | 56 |
| Total ($R_i$) | 927 | | 883 | | 883 | | 547 |
| Average ($\bar{R}_i$) | 46.35 | | 44.15 | | 44.15 | | 27.35 |

# 4. The Kruskal-Wallis test

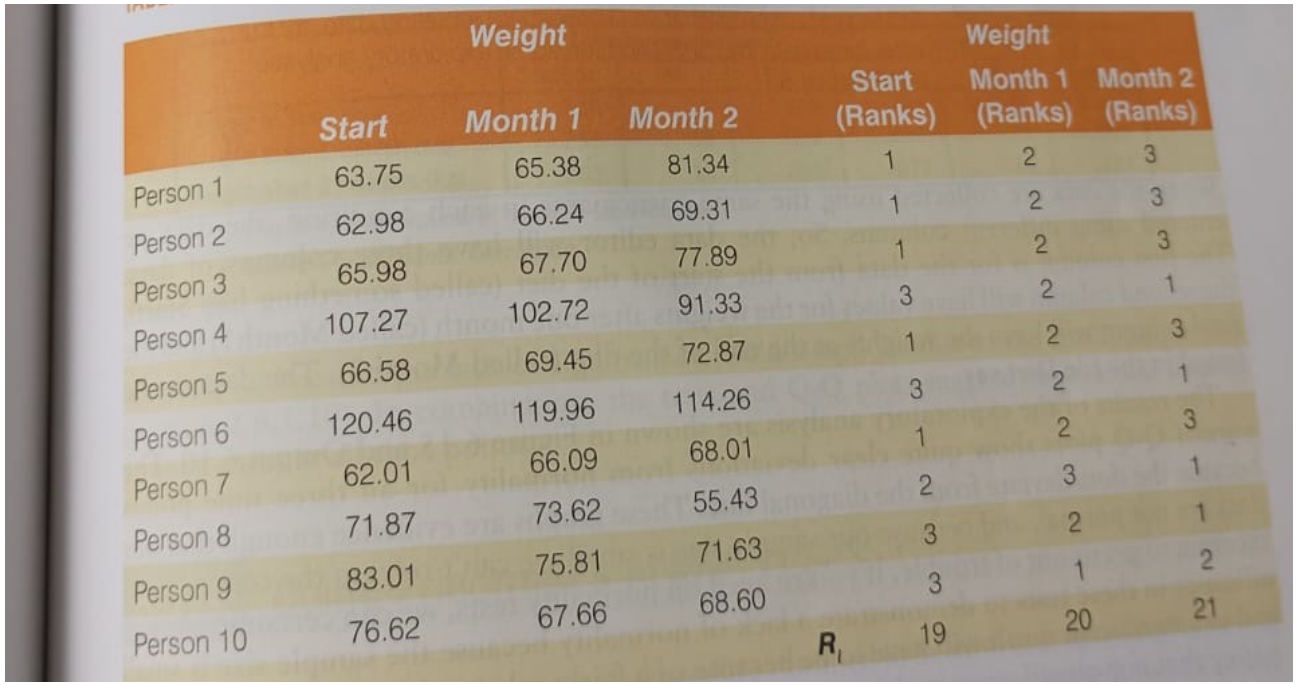
- Conducting the analysis
- Pairwise comparisons
- None vs. 1, none vs. 2, 1 vs 2 etc

# 4. Conducing the Kruskal-Wallis test

- Calculate effect size
- Report H- score, degrees of freedom, p-value, r-value

# 5. Friedman`s Anova

- Differnces between several related groups
- More than 2 conditions and the same entities have provided scores for all conditions



| | Weight | | | Weight | | |
|---|---|---|---|---|---|---|
| | Start | Month 1 | Month 2 | Start (Ranks) | Month 1 (Ranks) | Month 2 (Ranks) |
| Person 1 | 63.75 | 65.38 | 81.34 | 1 | 2 | 3 |
| Person 2 | 62.98 | 66.24 | 69.31 | 1 | 2 | 3 |
| Person 3 | 65.98 | 67.70 | 77.89 | 1 | 2 | 3 |
| Person 4 | 107.27 | 102.72 | 91.33 | 3 | 2 | 1 |
| Person 5 | 66.58 | 69.45 | 72.87 | 1 | 2 | 3 |
| Person 6 | 120.46 | 119.96 | 114.26 | 3 | 2 | 1 |
| Person 7 | 62.01 | 66.09 | 68.01 | 1 | 2 | 3 |
| Person 8 | 71.87 | 73.62 | 55.43 | 2 | 3 | 1 |
| Person 9 | 83.01 | 75.81 | 71.63 | 3 | 2 | 1 |
| Person 10 | 76.62 | 67.66 | 68.60 | 3 | 1 | 2 |
| | | | | $R_i$ | 19 | 20 | 21 |

# 5. Conducting the analysis and reporting it

- Calculate effect size
- Report x- score, degrees of freedom, p-value, r-value

**THANK YOU**

**Questions are welcome :)**