Unit 7: Inferential Statistics and Hypothesis Testing

Unit 7 Seminar- Inferential Statistics Workshop

Exercise 7.1B (Diet Comparison - Basic Statistics)

Results for Diet B:

- **Sample size (n):** 50
- **Mean weight loss:** 3.710 kg
- **Standard deviation (SD):** 2.769 kg

Interpretation:
Diet A (Mean = 5.341 kg, SD = 2.536) shows higher average weight loss than Diet B (Mean = 3.710 kg), suggesting greater effectiveness (Fernandez, 2020). However, Diet B has slightly more variability (SD = 2.769 vs. 2.536), indicating less consistent results among participants. A formal t-test would be needed to confirm statistical significance.

Exercise 7.2B (Diet Comparison - Quartile Statistics)

Results for Diet B:

- **Median:** ~3.65 kg
- **First quartile (Q1):** ~1.85 kg
- **Third quartile (Q3):** ~5.49 kg
- **Interquartile range (IQR):** 3.64 kg

Interpretation:
Diet A (Median = 5.642 kg, IQR = 3.287) outperforms Diet B (Median = 3.65 kg, IQR = 3.64) in central tendency. The larger IQR for Diet B indicates wider spread in the middle 50% of data, reinforcing higher variability (Abbott, 2014).

Exercise 7.3D (Brand Preferences)

Area 2 Results:

Brand	Frequency	Percentage
A	19	21.1%
B	30	33.3%
Other	41	45.6%
Total	90	100%

Comparison with Area 1:

- **Brand A:** 21.1% (Area 2) vs. 15.7% (Area 1)
- **Brand B:** 33.3% (Area 2) vs. 24.3% (Area 1)
- **Other:** 45.6% (Area 2) vs. 60.0% (Area 1)

Interpretation:
Area 2 shows stronger preference for Brands A/B (54.4% combined) compared to Area 1 (40%). "Other" brands dominate in Area 1 (60%) but are less popular in Area 2 (45.6%). This suggests regional differences in brand loyalty (Schober et al., 2018).

Exercise 7.4G (Paired t-Test - Filtration Agents)

Key Results:

- **Mean impurity:** Agent1 = 8.26, Agent2 = 8.65
- **Difference:** -0.38 (Agent1 lower)
- **t-statistic:** -2.849, **p-value (one-tailed):** 0.0086

Conclusion:
Reject the null hypothesis ($p < 0.05$). Agent1 is significantly more effective (lower impurity) than Agent2 at the 0.05 significance level (LaMorte, 2021). The strong correlation ($r = 0.915$) confirms consistent batch trends (Schober et al., 2018).

Exercise 7.5 (One-Tailed t-Test Revisited)

Hypotheses:

- H_0: $\mu_1 \geq \mu_2$ (Agent1 not more effective)
- H_1: $\mu_1 < \mu_2$ (Agent1 more effective)

Conclusion:
The one-tailed *p*-value (0.0086) is less than 0.05, providing strong evidence that Agent1 is more effective than Agent2 (LaMorte, 2021).

Exercise 7.6C (Income Comparison - F-test & t-test)

Results:

- **F-test (variances):** $p = 0.218 > 0.05 \rightarrow$ Equal variances assumed.
- **t-test (means):**
    - **t-statistic:** 3.268, **p-value (one-tailed):** 0.0007
    - **Mean difference:** Males (52.91) > Females (44.23) by 8.68 units.

Conclusion:
Male cardholders have significantly higher income than females ($p < 0.05$) (McNeese, 2017).

Key Assumptions:

1. **Normality:** Data should be approximately normally distributed (validate via histograms or Shapiro-Wilk test).
2. **Independence:** Samples must be independent (e.g., no overlap between groups).
3. **Equal variances:** Confirmed via F-test ($p > 0.05$) (Field, 2018).

References

Abbott, M. (2014) *Understanding Educational Statistics Using Microsoft Excel and SPSS*. 1st edn. Hoboken: Wiley.

Fernandez, J. (2020) 'The statistical analysis t-test explained for beginners and experts'. *Towards Data Science*. Available at: https://towardsdatascience.com/the-statistical-analysis-t-test-explained-for-beginners-and-experts-fd0e358bbb62 [Accessed: 20 March 2025).

Field, A. (2018) *Discovering Statistics Using IBM SPSS Statistics*. 5th edn. London: Sage.

LaMorte, W. (2021) 'One Sample t-test'. *Boston University School of Public Health*. Available at: https://sphweb.bumc.bu.edu/otlt/MPH-Modules [Accessed: 23 March 2025].

McNeese, B. (2017) 'Interpretation of Alpha Value and p-Value'. *SPC for Excel*. Available at: https://www.spcforexcel.com/knowledge/basic-statistics/interpretation-alpha-and-p-value [Accessed: 23 March 2025].

Schober, P., Boer, C. & Schwarte, L. **(**2018) 'Correlation Coefficients: Appropriate Use and Interpretation'. *Anaesthesia & Analgesia*, 126(5), pp. 1763–1768. DOI: 10.1213/ANE.0000000000002864.