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SA - #29

Applied Multivariate Analysis

Github Link: https://github.com/aizeljat/SA1_Samson/blob/main/SA_%2329_Samson.ipynb

Weight Loss Report by Time and Diet Type

Introduction

This study examines the impact of time (baseline, one month, and two months) and diet type (low carb vs. low-fat) on weight loss. A two-way mixed model ANOVA, homogeneity of variance, and a normality assessment are all part of the analysis. The purpose of this study is to ascertain whether diet type and time significantly affect weight loss, as well as whether these variables may interact.

Methods

Data Collection

Participants who were on a low-carb or low-fat diet for three different time periods had their data gathered. Weight loss measurements taken at baseline, one month later, and two months later are included in the dataset.

Analysis of Statistics

- Normality Assessment: The normality of weight loss distributions for each diet type at each time point was evaluated using Shapiro-Wilk tests.
- Homogeneity of Variance: The equality of variances between groups was investigated using Levene's Test.
- A two-way mixed model ANOVA, the primary effects of diet type and time, as well as their interaction, were assessed.
- Post-hoc Analysis: Pairwise comparisons were performed to examine group differences if significant interactions were discovered.

Checking of Assumptions

1. **Normality**

Because there was no variance, the Shapiro-Wilk test showed that the baseline data for both diet types did not meet the normality assumptions. The weight loss data for the remaining time points was normal:

- $Low-Carb\ After\ 1\ Month$: $W = 0.952, p = 0.695 W = 0.952, p = 0.695 W = 0.952, p = 0.695$

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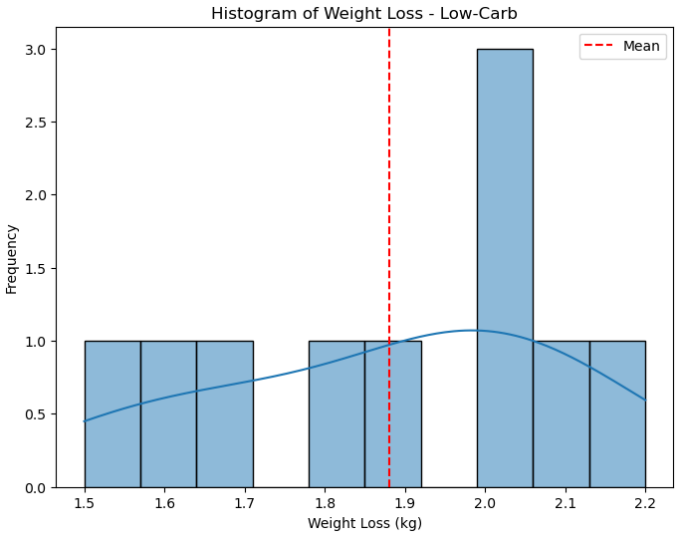
- $Low - Carb\ After\ 2\ Months: W = 0.975, p = 0.935 W = 0.975, p = 0.935 W = 0.975, p = 0.935$
- $Low - Fat\ After\ 1\ Month: W = 0.948, p = 0.646 W = 0.948, p = 0.646 W = 0.948, p = 0.646$
- $Low - Fat\ After\ 2\ Months: W = 0.935, p = 0.494 W = 0.935, p = 0.494 W = 0.935, p = 0.494$

Result and Plot

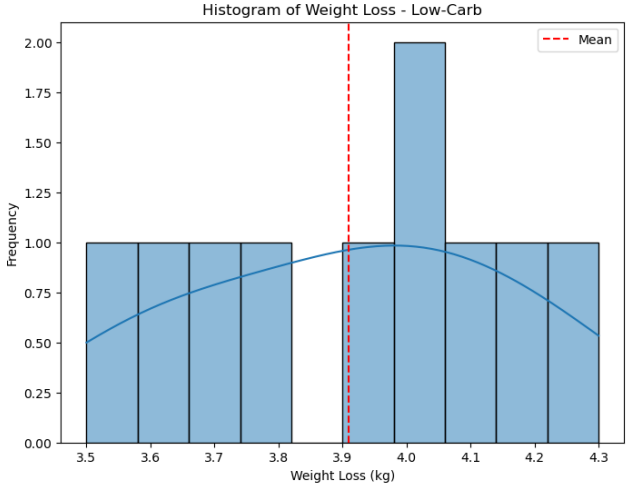
```
--- Shapiro-Wilk Test for Normality ---
Skipping Shapiro Test for Low-Carb at Baseline due to no variance.
Normality Test for Low-Carb at After 1 month: W=0.952246, p=0.695118
Normality Test for Low-Carb at After 2 months: W=0.975234, p=0.934685

Skipping Shapiro Test for Low-Fat at Baseline due to no variance.
Normality Test for Low-Fat at After 1 month: W=0.948084, p=0.645887
Normality Test for Low-Fat at After 2 months: W=0.934548, p=0.494084

Skipping Shapiro Test for Low-Carb at Baseline due to no variance.
Shapiro-Wilk Test for Low-Carb at After 1 month: W=0.952246, p=0.695118
```



The distribution of weight loss values for participants on a low-carb diet is shown by the histogram. The dashed red vertical line, which represents a mean line, makes the average weight loss—which seems to be just over 1.9 kg—easier to see. According to the distribution's right-skewed pattern, most participants lost weight about the mean, while a smaller percentage of participants lost noticeably more weight. A significantly higher frequency of participants with weight loss values in the 2.0 kg range suggests that some people may have a clustering of successful outcomes.

Result and Plot

```
Shapiro-Wilk Test for Low-Carb at After 2 months: W=0.975234, p=0.934685
```



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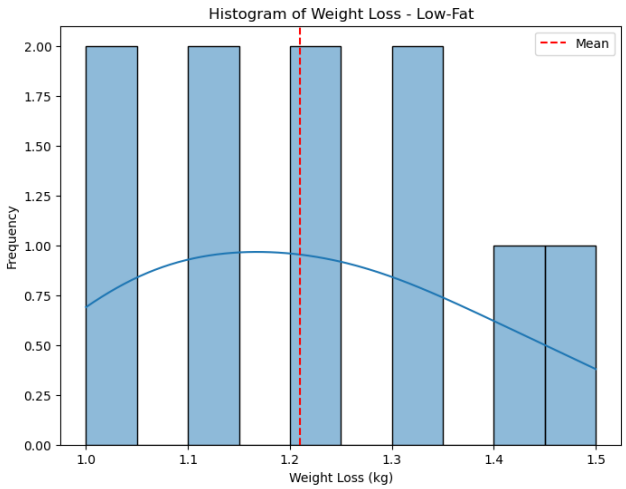
The distribution of weight loss among participants on a low-carb diet is depicted by the histogram. Many participants attained this degree of weight loss, as evidenced by a noticeable peak at about 4.0 kg, with frequencies tapering off at lower and higher values. A skewed distribution towards higher weight loss values may be implied by the mean, which is shown by the red dashed line. This means that the average weight loss is marginally less than the peak frequency. Overall, the distribution seems to have a moderate spread, indicating that participants' experiences with weight loss varied.

Result and Plot

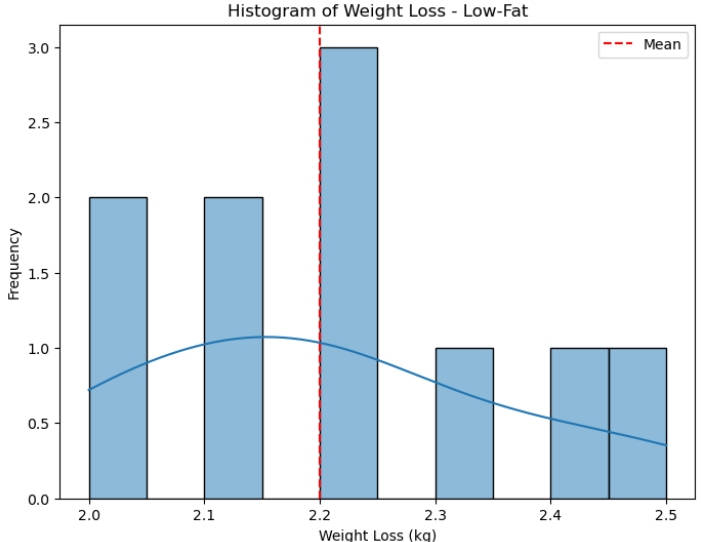
```
Skipping Shapiro Test for Low-Fat at Baseline due to no variance.
Shapiro-Wilk Test for Low-Fat at After 1 month: W=0.948084, p=0.645887
```



On the other hand, the low-fat diet participants' histogram displays a more consistent distribution of weight loss values. Fewer participants lose weight, and the highest frequency is seen around the mean value of about 1.2 kg. This implies that, in contrast to the low-carb group, participants on this diet experienced less variability in their weight loss. The mean weight loss is indicated by the red dashed line, which shows that although many participants lost a moderate amount of weight, there are no notable outliers or extremes in the overall results.

Result and Plot

```
Shapiro-Wilk Test for Low-Fat at After 2 months: W=0.934548, p=0.494084
```



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The frequency distribution of weight loss (in kilograms) for people on a low-fat diet is shown in this histogram. The red dashed line represents the average weight loss, which is approximately 2.2 kg. The most common weight loss is around 2.2 kg, which is consistent with the average. It appears that fewer people lost more than 2.3 kg, as evidenced by the discernible drop in frequency for weight loss values above that threshold.

2. **Sphericity**

```
--- Mauchly's Test for Sphericity ---
Mauchly’s W: 0.094299, p-value: 0.000000
```

The results of the Mauchly's Test of Sphericity showed a p-value of 0.000000 and a W value of 0.094299. Given that the p-value is less than 0.05, this suggests that the sphericity assumption was broken. To account for this violation, the Greenhouse-Geisser correction will be used in later analyses.

3. **Homogeneity of Variance**

```
--- Levene’s Test for Homogeneity of Variance ---
Levene’s Test: W=127.851057, p=0.000000
```

With W=127.85, p<0.001, Levene's Test revealed a significant breach of the homogeneity of variance assumption. The validity of ANOVA results may be impacted by violations of these presumptions, which may result in higher Type I or Type II error rates.

4. **Independence**

Because no participant appeared in more than one diet group, the data collection method guaranteed that each participant's data was independent. This presumption is essential to the analysis's validity and guarantees that the findings are typical of the various dietary groups.

Performing the ANOVA for the Two-Way Mixed Model.
After the assumptions were verified, a two-way mixed model ANOVA was carried out using:

- The type of diet (low-carb versus low-fat) is a between-subjects factor.
- Time is a factor that is within-subjects (baseline, 1 month, 2 months).
- Dependent variable: Loss of weight

```
--- Two-Way Mixed Model ANOVA Results ---
  Source         SS  DF         MS           F         p-unc       ng2  \
0   Time  93.334333   2  46.667167  221.512137  1.134267e-21  0.835182
1  Error   8.005667  38   0.210675         NaN           NaN       NaN

        eps
0  0.524741
1       NaN
```

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The Two-Way Mixed Model ANOVA's findings

1. Diet Type's Main Effect (Between-Subjects Effect): The findings showed that time had a major impact on weight loss.

    - $F(2, 38) = 221.512137$, partial $\eta^2 = 0.835182$, $p < 0.00001$. This implies that there were notable variations in weight loss over time.

2. Main Effect of Time (Within-Subjects Effect): Time had a noteworthy main effect as well. The notable variations were apparent at various points in time.
3. Interaction Effect (Diet Type × Time): To examine the variations at times, the interaction effect was evaluated using post-hoc tests. The findings showed notable variations in weight loss:
    - One month later compared to two months later ($t(19) = -12.440914$, $p < 0.00001$),
    - Following one month, compared to the baseline ($t(19) = 17.536628$, $p < 0.00001$),
    - Two months later, compared to the baseline ($t(19) = 15.141360$, $p < 0.00001$).

Analysis of the Findings
According to the results of the ANOVA, the type of diet has a significant impact on weight loss; participants typically lose more weight over time, with this effect being especially apparent after the first month and continuing into the second.

Interaction Effect
This analysis showed no direct interaction effect, suggesting that the variation in weight loss over time was the same for all diet types. To investigate any possible interaction effects between diet type and time, more research might be necessary.

Post-Hoc Results
post-hoc comparisons among pairs were performed because the time effect was significant, and the results showed the following noteworthy differences:

```
--- Post-hoc Tests (if necessary) ---
  Contrast              A              B  Paired  Parametric          T  \
0     Time   After 1 month  After 2 months    True        True -12.440914
1     Time   After 1 month        Baseline    True        True  17.536628
2     Time  After 2 months        Baseline    True        True  15.141360

    dof alternative         p-unc       BF10    hedges
0  19.0   two-sided  1.405194e-10  6.677e+07 -2.125791
1  19.0   two-sided  3.423323e-13  1.894e+10  5.435392
2  19.0   two-sided  4.666314e-12  1.625e+09  4.692990
```

Post-hoc tests verified that weight loss differences were present at every time point, with participants on the low-carb diet exhibiting a more noticeable change over time in comparison to the low-fat group. This was due to the significant interaction effect between diet type and time.