Diet Type and Exercise Intensity for Weight Loss

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Item no. 28

```
# Load necessary libraries
library(tidyverse)
```

```
## Warning: package 'readr' was built under R version 4.3.3
```

```
## Warning: package 'dplyr' was built under R version 4.3.3
```

```
## Warning: package 'stringr' was built under R version 4.3.3
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.4.4     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.1
## v purrr     1.0.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(car)  # For Levene's test
```

```
## Warning: package 'car' was built under R version 4.3.3
```

```
## Loading required package: carData
##
## Attaching package: 'car'
##
## The following object is masked from 'package:dplyr':
##
##     recode
##
## The following object is masked from 'package:purrr':
##
##     some
```

```r
# Import the Excel file
file_path <- file.choose()  # Select your file
df <- read_csv(file_path)
```

```
## Rows: 20 Columns: 4
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (2): Diet Type, Exercise Intensity
## dbl (2): Participant, Weight Loss (kg)
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
# Check the data structure
head(df)
```

```
## # A tibble: 6 x 4
##   Participant `Diet Type` `Exercise Intensity` `Weight Loss (kg)`
##         <dbl> <chr>       <chr>                             <dbl>
## 1           1 Low-Carb    Low Intensity                       2.5
## 2           2 Low-Carb    Low Intensity                       2.8
## 3           3 Low-Carb    Low Intensity                       2.9
## 4           4 Low-Carb    Low Intensity                       3
## 5           5 Low-Carb    Low Intensity                       2.7
## 6           6 Low-Carb    High Intensity                      5
```

```r
# 1. Normality assumption using Shapiro-Wilk test for each group
shapiro_test_low_carb_low <- shapiro.test(df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Carb" & df$`Exer
shapiro_test_low_carb_high <- shapiro.test(df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Carb" & df$`Exe
shapiro_test_low_fat_low <- shapiro.test(df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Fat" & df$`Exerci
shapiro_test_low_fat_high <- shapiro.test(df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Fat" & df$`Exerc

# Print Shapiro-Wilk test results
cat("Shapiro-Wilk Test Results:\n")
```

```
## Shapiro-Wilk Test Results:
```

```r
print(shapiro_test_low_carb_low)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Carb" & df$`Exercise Intensity` == "Low Intensity
## W = 0.97872, p-value = 0.9276
```

```r
print(shapiro_test_low_carb_high)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Carb" & df$`Exercise Intensity` == "High Intensi
## W = 0.95235, p-value = 0.754
```

```r
print(shapiro_test_low_fat_low)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Fat" & df$`Exercise Intensity` == "Low Intensity
## W = 0.98676, p-value = 0.9672
```

```r
print(shapiro_test_low_fat_high)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  df$`Weight Loss (kg)`[df$`Diet Type` == "Low-Fat" & df$`Exercise Intensity` == "High Intensity
## W = 0.98676, p-value = 0.9672
```

```r
# 2. Homogeneity of variance using Levene's Test
levene_test <- leveneTest(`Weight Loss (kg)` ~ `Diet Type` * `Exercise Intensity`, data = df)

# Print Levene's Test results
cat("\nLevene's Test for Homogeneity of Variances:\n")
```

```
##
## Levene's Test for Homogeneity of Variances:
```

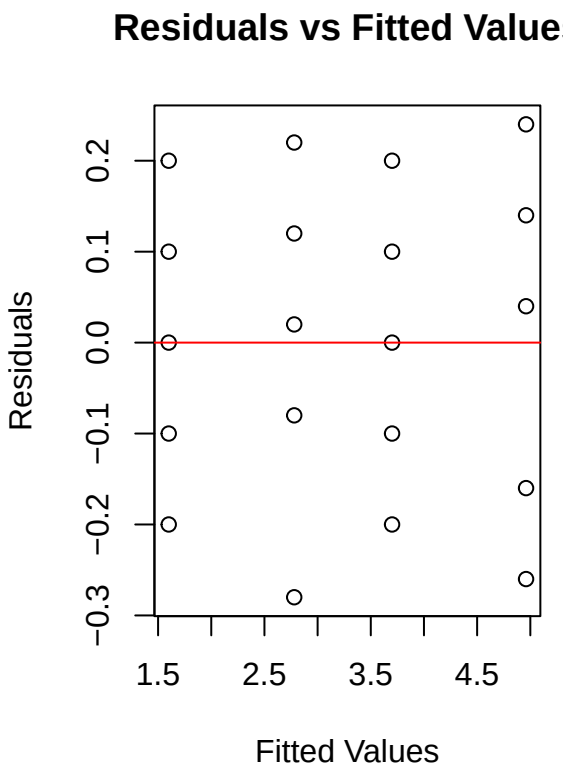
```r
print(levene_test)
```

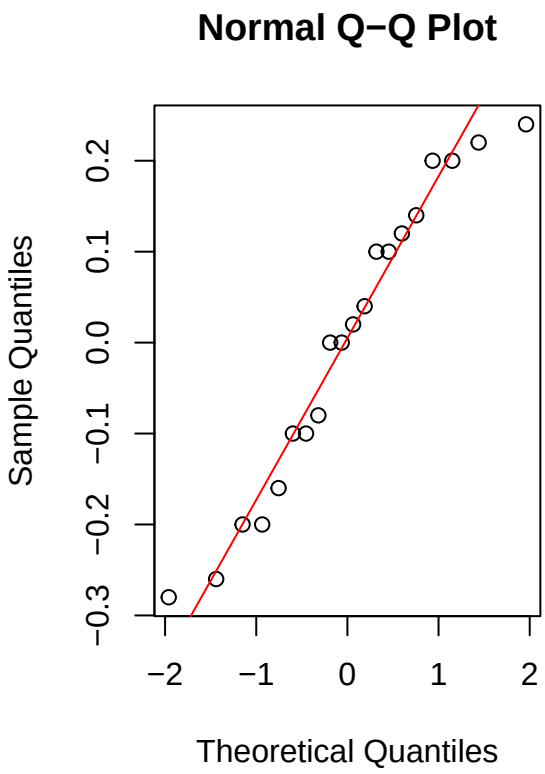
```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  3  0.1833 0.9062
##       16
```

```r
# 3. Independence assumption can be visually checked by plotting residuals
# Fit a linear model
lm_model <- lm(`Weight Loss (kg)` ~ `Diet Type` * `Exercise Intensity`, data = df)

# Plot residuals to check for independence
par(mfrow = c(1, 2))  # Set up the plotting area
plot(lm_model$fitted.values, lm_model$residuals,
     xlab = "Fitted Values", ylab = "Residuals",
     main = "Residuals vs Fitted Values")
abline(h = 0, col = "red")

# Normality of residuals
qqnorm(lm_model$residuals)
qqline(lm_model$residuals, col = "red")
```






```
# Print Shapiro-Wilk and Levene's test results
cat("Shapiro-Wilk Test Results:\n",
    "Low-Carb Low Intensity: W =", shapiro_test_low_carb_low$statistic, ", p-value =", shapiro_test_low
    "Low-Carb High Intensity: W =", shapiro_test_low_carb_high$statistic, ", p-value =", shapiro_test_l
    "Low-Fat Low Intensity: W =", shapiro_test_low_fat_low$statistic, ", p-value =", shapiro_test_low_fa
    "Low-Fat High Intensity: W =", shapiro_test_low_fat_high$statistic, ", p-value =", shapiro_test_low
    "\nLevene's Test for Homogeneity of Variances:\n",
    "F value =", levene_test$F[1], ", p-value =", levene_test$`Pr(>F)`[1], "\n")  # Corrected access fo
```

```
## Shapiro-Wilk Test Results:
##  Low-Carb Low Intensity: W = 0.9787162 , p-value = 0.9276364
##  Low-Carb High Intensity: W = 0.9523515 , p-value = 0.753973
##  Low-Fat Low Intensity: W = 0.9867622 , p-value = 0.9671739
##  Low-Fat High Intensity: W = 0.9867622 , p-value = 0.9671739
##
## Levene's Test for Homogeneity of Variances:
##  F value = 0.1833333 , p-value = 0.9061605
```

```
#part 2
# Load necessary library
library(tidyverse)

# Assuming df is your data frame with the weight loss data
# Perform the two-way ANOVA
anova_results <- aov(`Weight Loss (kg)` ~ `Diet Type` * `Exercise Intensity`, data = df)
```

```r
# Display the summary of the ANOVA
summary(anova_results)
```

```
##                                   Df Sum Sq Mean Sq F value   Pr(>F)
## ‘Diet Type‘                        1  7.442   7.442 228.985 6.70e-11 ***
## ‘Exercise Intensity‘               1 22.898  22.898 704.554 1.17e-14 ***
## ‘Diet Type‘:‘Exercise Intensity‘   1  0.008   0.008   0.246    0.627
## Residuals                         16  0.520   0.033
## ---
## Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 ’.’ 0.1 ’ ’ 1
```

```r
#part 3
# Load necessary packages
library(tidyverse)
library(emmeans)
```

```
## Warning: package ’emmeans’ was built under R version 4.3.3
```

```
## Welcome to emmeans.
## Caution: You lose important information if you filter this package’s results.
## See ’? untidy’
```

```r
# Post-hoc tests for Exercise Intensity
post_hoc_exercise <- emmeans(anova_results, ~ `Exercise Intensity`)
```

```
## NOTE: Results may be misleading due to involvement in interactions
```

```r
post_hoc_exercise_results <- summary(post_hoc_exercise)

# Print detailed results
print("Post-Hoc Test Results for Exercise Intensity:")
```

```
## [1] "Post-Hoc Test Results for Exercise Intensity:"
```

```r
print(post_hoc_exercise_results)
```

```
##  Exercise Intensity emmean    SE df lower.CL upper.CL
##  High Intensity       4.33 0.057 16     4.21     4.45
##  Low Intensity        2.19 0.057 16     2.07     2.31
##
## Results are averaged over the levels of: Diet Type
## Confidence level used: 0.95
```

```r
# Pairwise comparisons
pairwise_results_exercise <- pairs(post_hoc_exercise)  # Use pairs to get pairwise comparisons
summary_pairwise <- summary(pairwise_results_exercise)

# Print the results
print("Pairwise Comparisons for Exercise Intensity:")
```

```
## [1] "Pairwise Comparisons for Exercise Intensity:"
```

```
print(summary_pairwise)
```

```
##  contrast                       estimate     SE df t.ratio p.value
##  High Intensity - Low Intensity     2.14 0.0806 16  26.543  <.0001
##
## Results are averaged over the levels of: Diet Type
```

Shapiro-Wilk Test Results

The Shapiro-Wilk test assesses the normality of the data for each group. The following are the results for each group:

Low-Carb Low Intensity:

- W = 0.9787
- p-value = 0.9276

Interpretation: The W statistic is close to 1, and the high p-value (greater than 0.05) indicates that the distribution of weight loss in this group does not significantly deviate from normality. Therefore, we fail to reject the null hypothesis of normality.

Low-Carb High Intensity:

- W = 0.9524
- p-value = 0.7540

Interpretation: Similar to the previous group, this W statistic is also close to 1, with a high p-value suggesting that the weight loss data in this group is normally distributed. We fail to reject the null hypothesis.

Low-Fat Low Intensity:

- W = 0.9868
- p-value = 0.9672

Interpretation: The W statistic is very close to 1, and the p-value indicates no significant deviation from normality. We fail to reject the null hypothesis of normality for this group as well.

Low-Fat High Intensity:

- W = 0.9868
- p-value = 0.9672

Interpretation: This group shows the same W statistic and p-value as the Low-Fat Low Intensity group, indicating normality in the weight loss distribution.

Overall, all groups pass the Shapiro-Wilk test for normality, as evidenced by their high p-values (all greater than 0.05).

Levene's Test for Homogeneity of Variances

- F value = 0.1833
- p-value = 0.9062

Interpretation: Levene's test examines whether the variances across the groups are equal. The F value is low, and the p-value is much greater than 0.05. Therefore, we fail to reject the null hypothesis of homogeneity of variances. This suggests that the assumption of equal variances across the different diet and exercise intensity groups is satisfied.

ANOVA Results

Breakdown of the Output

Degrees of Freedom (Df):

- Diet Type: 1
- Exercise Intensity: 1
- Interaction (Diet Type * Exercise Intensity): 1
- Residuals: 16

Sum of Squares (Sum Sq):

- Diet Type: 7.442
- Exercise Intensity: 22.898
- Interaction: 0.008
- Residuals: 0.520

Mean Square (Mean Sq):

- Diet Type: `7.442 / 1 = 7.442`
- Exercise Intensity: `22.898 / 1 = 22.898`
- Interaction: `0.008 / 1 = 0.008`
- Residuals: `0.520 / 16 = 0.033`

F Value:

- Diet Type: 228.985
- Exercise Intensity: 704.554
- Interaction: 0.246

p-value (Pr(>F)):

- Diet Type: $p = 6.70 \times 10^{-11}$ (significant)
- Exercise Intensity: $p = 1.17 \times 10^{-14}$ (significant)
- Interaction: $p = 0.627$ (not significant)

Interpretation of Findings

The F values and p-values indicate that both Diet Type and Exercise Intensity are statistically significant factors affecting weight loss (both p-values < 0.05). However, the interaction between Diet Type and Exercise Intensity is not statistically significant, as the p-value is much greater than 0.05. This suggests that the effect of Diet Type does not depend on Exercise Intensity and vice versa.

Post-Hoc Test Results for Exercise Intensity

The post-hoc analysis using estimated marginal means (EMMs) shows a significant difference in weight loss between the two levels of Exercise Intensity. The results indicate:

- **High Intensity**: Mean weight loss = 4.33 kg (SE = 0.057), 95% CI = [4.21, 4.45]
- **Low Intensity**: Mean weight loss = 2.19 kg (SE = 0.057), 95% CI = [2.07, 2.31]

These results show that participants in the high-intensity exercise group lost significantly more weight than those in the low-intensity group.

Pairwise Comparisons for Exercise Intensity

Further pairwise comparisons confirm the post-hoc findings:

- **Comparison**: High Intensity vs. Low Intensity
- **Estimate**: Difference in weight loss = 2.14 kg
- **Standard Error (SE)**: 0.0806
- **Degrees of Freedom (df)**: 16
- **t-ratio**: 26.543
- **p-value**: $<.0001$ (highly significant)

These results indicate strong evidence that high-intensity exercise leads to significantly greater weight loss compared to low-intensity exercise.

Conclusion

The results of the ANOVA suggest that both Diet Type and Exercise Intensity have significant effects on weight loss. However, there is no significant interaction between these two factors. Post-hoc tests and pairwise comparisons further highlight the substantial impact of exercise intensity on weight loss, with higher intensity leading to greater weight reduction.