FA10

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```
## Installing packages into 'C:/Users/josep/AppData/Local/R/win-library/4.4'
## (as 'lib' is unspecified)
```

```
## package 'tidyverse' successfully unpacked and MD5 sums checked
## package 'afex' successfully unpacked and MD5 sums checked
## package 'emmeans' successfully unpacked and MD5 sums checked
## package 'report' successfully unpacked and MD5 sums checked
## package 'effectsize' successfully unpacked and MD5 sums checked
## package 'broom' successfully unpacked and MD5 sums checked
## package 'scico' successfully unpacked and MD5 sums checked
## package 'rstatix' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
##  C:\Users\josep\AppData\Local\Temp\Rtmp42GFOb\downloaded_packages
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.6
## v forcats   1.0.1     v stringr   1.6.0
## v ggplot2   4.0.1     v tibble    3.3.0
## v lubridate 1.9.4     v tidyr     1.3.1
## v purrr     1.2.0
```

```
## -- 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
## Loading required package: lme4
##
## Loading required package: Matrix
##
##
## Attaching package: 'Matrix'
##
##
## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
##
##
## ************
## Welcome to afex. For support visit: http://afex.singmann.science/
##
## - Functions for ANOVAs: aov_car(), aov_ez(), and aov_4()
## - Methods for calculating p-values with mixed(): 'S', 'KR', 'LRT', and 'PB'
```

```
## - 'afex_aov' and 'mixed' objects can be passed to emmeans() for follow-up tests
## - Get and set global package options with: afex_options()
## - Set sum-to-zero contrasts globally: set_sum_contrasts()
## - For example analyses see: browseVignettes("afex")
## ************
##
##
## Attaching package: 'afex'
##
##
## The following object is masked from 'package:lme4':
##
##     lmer
##
##
## Welcome to emmeans.
## Caution: You lose important information if you filter this package's results.
## See '? untidy'
##
## 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
##
##
##
## Attaching package: 'rstatix'
##
##
## The following objects are masked from 'package:effectsize':
##
##     cohens_d, eta_squared
##
##
## The following object is masked from 'package:stats':
##
##     filter
```

```r
data <- read.csv("Cholesterol_R2.csv")

# Convert Margarine to factor
data$Margarine <- factor(data$Margarine)

#Convert from WIDE → LONG format
```

```r
data_long <- pivot_longer(
  data,
  cols = c(Before, After4weeks, After8weeks),
  names_to = "Time",
  values_to = "Cholesterol"
)

data_long$Time <- factor(
  data_long$Time,
  levels = c("Before","After4weeks","After8weeks"),
  labels = c("Before","Week4","Week8")
)
# Assumption Checks
#Outliers ((Within each Margarine × Time cell))
data_long %>%
  group_by(Margarine, Time) %>%
  identify_outliers(Cholesterol)
```

```
## # A tibble: 6 x 6
##   Margarine Time      ID Cholesterol is.outlier is.extreme
##   <fct>     <fct>  <int>       <dbl> <lgl>      <lgl>
## 1 B         Before     5        8.43 TRUE       TRUE
## 2 B         Before     7        8.05 TRUE       TRUE
## 3 B         Before     9        5.77 TRUE       FALSE
## 4 B         Before    18        5.73 TRUE       FALSE
## 5 B         Week4      5        7.71 TRUE       FALSE
## 6 B         Week8      5        7.67 TRUE       FALSE
```

```r
#Normality/Shapiro
model <- aov_ez(
  id = "ID",
  dv = "Cholesterol",
  between = "Margarine",
  within = "Time",
  data = data_long,
  anova_table = list(correction = "GG", es = "pes")
)
```

```
## Contrasts set to contr.sum for the following variables: Margarine
```

```r
resid_vals <- residuals(model$lm)
shapiro.test(resid_vals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid_vals
## W = 0.9233, p-value = 0.001997
```

```r
#Homogeneity of Variance
#Only applies to Margarine, because it is between-subjects.
leveneTest(Cholesterol ~ Margarine, data = data_long)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value   Pr(>F)
## group  1  10.505 0.002079 **
```

```
##       52
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Check Sphericity (aov_ez() already does this)
model
```

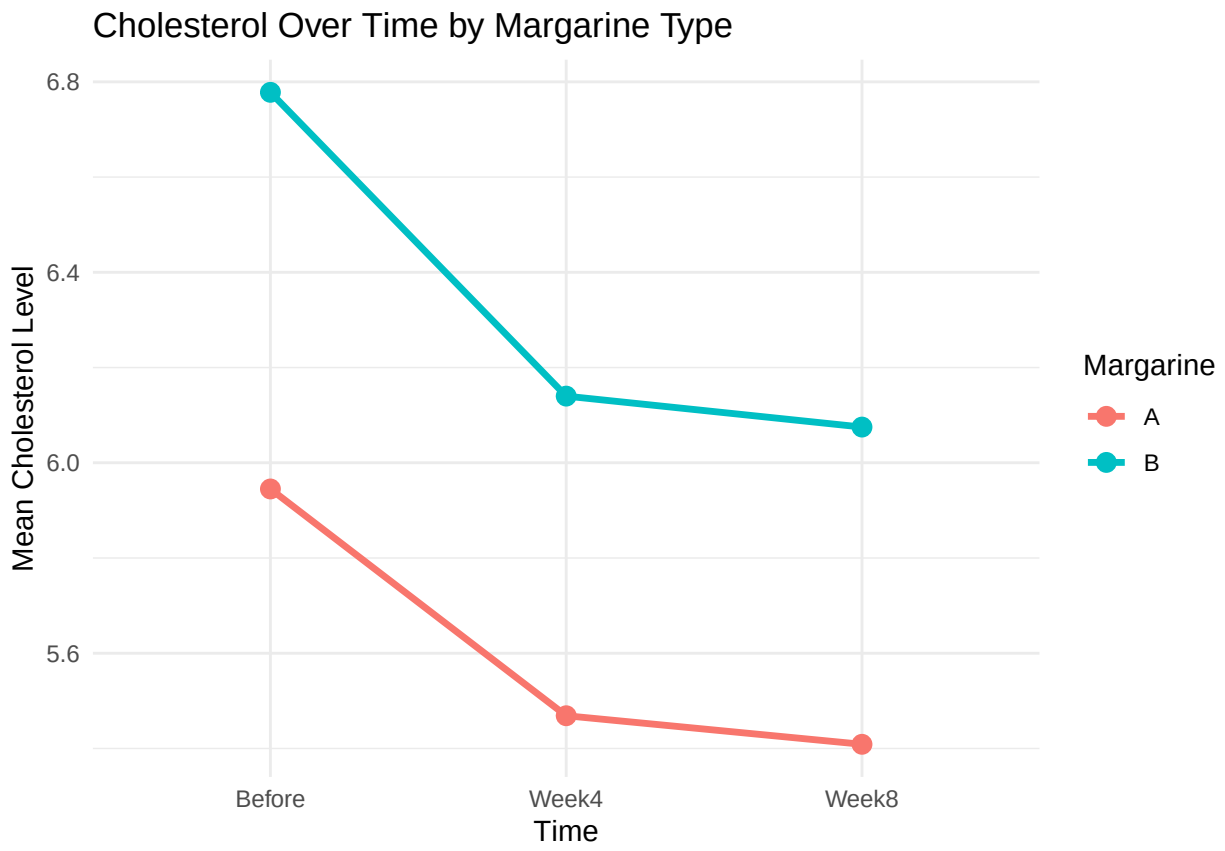
```
## Anova Table (Type 3 tests)
##
## Response: Cholesterol
##           Effect          df  MSE          F  pes p.value
## 1      Margarine       1, 16 3.68       1.90 .106    .187
## 2           Time 1.30, 20.81 0.01 249.01 *** .940   <.001
## 3 Margarine:Time 1.30, 20.81 0.01     4.81 * .231    .031
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1 ' ' 1
##
## Sphericity correction method: GG
```

```
# Running Mixed ANOVA
anova_results <- model$anova_table
anova_results
```

```
## Anova Table (Type 3 tests)
##
## Response: Cholesterol
##                num Df den Df    MSE        F     pes    Pr(>F)
## Margarine      1.0000 16.000 3.6804   1.8963 0.10596   0.18745
## Time           1.3004 20.806 0.0128 249.0080 0.93962 6.672e-14 ***
## Margarine:Time 1.3004 20.806 0.0128   4.8139 0.23128   0.03141 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Interaction Plot
ggplot(data_long,
       aes(Time, Cholesterol, color = Margarine, group = Margarine)) +
  stat_summary(fun=mean, geom="line", size=1.2) +
  stat_summary(fun=mean, geom="point", size=3) +
  theme_minimal() +
  labs(title="Cholesterol Over Time by Margarine Type",
       y="Mean Cholesterol Level")
```

```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use `linewidth` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```




```
#Simple Main Effects
#(Only needed if interaction is significant)

#Margarine differences at each Time point
emmeans(model, pairwise ~ Margarine | Time, adjust = "bonferroni")
```

```
## $emmeans
## Time = Before:
##  Margarine emmean    SE df lower.CL upper.CL
##  A           5.95 0.405 16     5.09     6.80
##  B           6.78 0.363 16     6.01     7.55
##
## Time = Week4:
##  Margarine emmean    SE df lower.CL upper.CL
##  A           5.47 0.390 16     4.64     6.30
##  B           6.14 0.349 16     5.40     6.88
##
## Time = Week8:
##  Margarine emmean    SE df lower.CL upper.CL
##  A           5.41 0.382 16     4.60     6.22
##  B           6.08 0.342 16     5.35     6.80
##
## Confidence level used: 0.95
##
## $contrasts
## Time = Before:
```

```
##  contrast estimate    SE df t.ratio p.value
##  A - B      -0.833 0.544 16  -1.532  0.1451
##
## Time = Week4:
##  contrast estimate    SE df t.ratio p.value
##  A - B      -0.671 0.523 16  -1.283  0.2176
##
## Time = Week8:
##  contrast estimate    SE df t.ratio p.value
##  A - B      -0.666 0.512 16  -1.300  0.2119
```

```
#Time differences within each Margarine group
emmeans(model, pairwise ~ Time | Margarine, adjust = "bonferroni")
```

```
## $emmeans
## Margarine = A:
##  Time   emmean    SE df lower.CL upper.CL
##  Before   5.95 0.405 16     5.09     6.80
##  Week4    5.47 0.390 16     4.64     6.30
##  Week8    5.41 0.382 16     4.60     6.22
##
## Margarine = B:
##  Time   emmean    SE df lower.CL upper.CL
##  Before   6.78 0.363 16     6.01     7.55
##  Week4    6.14 0.349 16     5.40     6.88
##  Week8    6.08 0.342 16     5.35     6.80
##
## Confidence level used: 0.95
##
## $contrasts
## Margarine = A:
##  contrast       estimate     SE df t.ratio p.value
##  Before - Week4    0.476 0.0480 16   9.918  <.0001
##  Before - Week8    0.536 0.0572 16   9.382  <.0001
##  Week4 - Week8     0.060 0.0257 16   2.339  0.0980
##
## Margarine = B:
##  contrast       estimate     SE df t.ratio p.value
##  Before - Week4    0.638 0.0429 16  14.855  <.0001
##  Before - Week8    0.703 0.0511 16  13.751  <.0001
##  Week4 - Week8     0.065 0.0229 16   2.833  0.0360
##
## P value adjustment: bonferroni method for 3 tests
```

BW Mixed ANOVA REPORTING

A two-way mixed ANOVA revealed a significant main effect of time, indicating that cholesterol levels decreased across the three measurement points for all participants. However, the main effect of margarine brand was not significant,meaning that overall cholesterol levels did not differ between Brand A and Brand B when averaged across all time points.

A two-way mixed ANOVA was conducted to examine the effects of margarine type (A vs. B) and time (Before, Week 4, Week 8) on cholesterol levels. Several assumption checks indicated violations, including non-normal

residuals (Shapiro–Wilk W = .92, p = .002), unequal variances between margarine groups (Levene's F = 10.51, p = .002), and violations of sphericity for the repeated-measures factor (Mauchly's W = .46, p = .003). Greenhouse–Geisser corrections were therefore applied.

The main effect of Margarine was not significant, F(1, 16) = 1.90, p = .187, p^2 = .11, indicating no overall difference in cholesterol between brands. There was a large and significant main effect of Time, F(1.30, 20.81) = 249.01, p < .001, p^2 = .94, showing that cholesterol decreased substantially over the three time points. Importantly, the Margarine × Time interaction was significant, F(1.30, 20.81) = 4.81, p = .031, p^2 = .23, suggesting that the rate of cholesterol reduction differed between the two margarine types.

Simple main effects showed that cholesterol decreased over time for both margarines (all p < .001), although the two brands did not significantly differ at any individual time point (all p > .14). These findings suggest that both margarines effectively reduce cholesterol over time, with no clear advantage of one brand over the other.