Multivariate Analysis

MANOVA

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Question 1. What is the hypothesis?

Answer:
The purpose of this study is to study remedy effect of different therapies on ameliorating the koro symptoms measured by three instruments (i.e. SIKE, SFKDI, OAS). Therefore, I defined dependent variables as the difference between each instrument of koro symptoms. In other words, our dependent variables are as follows:

SIKE difference = post SIKE – pre SIKE
SFKDI difference = post SFKDI – pre SFKDI
OAS difference = post OAS – pre OAS

Therefore, the null hypothesis of the study can be defined as follows: Group mean vectors of remedy effect instruments (i.e. mean of *SIKE difference, SFKDI difference, OAS difference*) are all equal among groups (four groups treated with four different therapies)

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4, where\ \mu_n = \begin{pmatrix} mean(SIKE\ difference)\ of\ group\ n \\ mean(SFKDI\ difference)\ of\ group\ n \\ mean(OAS\ difference)\ of\ group\ n \end{pmatrix}$$

Question 2. Discuss overall results after conducting "all" analyses (MANOVA, univariate ANOVA, pairwise comparisons).

Answer:
First, I test assumptions for MANOVA by using Shapiro-Wilk Normality test and Box's M test, respectively. The result of Shapiro-Wilk Normality test says that the data meets the normality assumption of MANOVA since p value is not small enough to reject the null hypothesis *(p value = 0.4955).* In addition, Box's M test result shows that the data also meets the homogeneity assumption *(p value = 0.8866).*

Second, I conduct a MANOVA, and the result revealed that there is a significant multivariate main effect for therapy: *Wilk's lambda=0.4644, F(9, 82.898)=3.4126, p=0.0013 (<0.05), partial eta-square=0.2104, power=0.988.* Thus, we reject the null hypothesis.

```
          Df   Wilks approx F num Df den Df   Pr(>F)
therapy    3 0.46438   3.4126      9 82.898 0.001301 **
Residuals 36
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 1. Results of MANOVA

Given the significance of the overall test, the univariate main effects were examined. Significant univariate main effects for therapy were obtained for *SFKDI effect, F(3,)=7.5411 , p=0.0005 (<0.001), partial eta-square=0.3859, power=0.896.*

```
 Response SIKE_effect :
           Df Sum Sq Mean Sq F value  Pr(>F)
therapy     3  481.4 160.467  2.2699 0.09699 .
Residuals  36 2545.0  70.694
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

 Response SFKDI_effect :
           Df Sum Sq Mean Sq F value    Pr(>F)
therapy     3 1874.6  624.87  7.5411 0.0004871 ***
Residuals  36 2983.0   82.86
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

 Response OAS_effect :
           Df Sum Sq Mean Sq F value Pr(>F)
therapy     3  293.6  97.867  1.8408 0.1572
Residuals  36 1914.0  53.167
```

Figure 2. Results of univariate ANOVAs

In addition, we conduct pairwise comparisons of SFKDI effect between four therapy. As a result, we found that there are significant pairwise differences between ('Control therapy' and 'Abreaction therapy') and between ('Control therapy' and 'Behavioral therapy'). The mean differences in *SFKDI effect* between 'Control therapy' and 'Behavioral

therapy' is 15.0 with 'Behavioral therapy' is 15.0 higher. In addition, the mean differences in *SFKDI effect* between 'Control therapy' and 'Abreaction therapy' is 6.8, with 'Control therapy' is 6.8 lower.

```
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = SFKDI_effect ~ therapy, data = koro_preprocessed)

$therapy
                       diff       lwr        upr     p adj
Behavioral-Abreaction  -3.1 -14.06386  7.8638569 0.8711264
Cognitive-Abreaction   -6.8 -17.76386  4.1638569 0.3537727
Control-Abreaction    -18.1 -29.06386 -7.1361431 0.0004499
Cognitive-Behavioral   -3.7 -14.66386  7.2638569 0.8002175
Control-Behavioral    -15.0 -25.96386 -4.0361431 0.0039910
Control-Cognitive     -11.3 -22.26386 -0.3361431 0.0412916
```

Figure 3. Results of Tukey test

###R code

```
library(dplyr)
library(mvnormtest)
library(heplots)
library(stats)

setwd("/Users/suckwonhong/Desktop/multivariate_stats")

koro <- read.csv("koro.csv",header = TRUE)
koro_preprocessed <- select(koro, therapy)
koro_preprocessed$SIKE_effect <- koro$si_post - koro$si_pre
koro_preprocessed$SFKDI_effect <- koro$sf_post - koro$sf_pre
koro_preprocessed$OAS_effect <- koro$oa_post - koro$oa_pre

#Testing MANOVA assumptions
res.shapiro <-mshapiro.test(t(koro_preprocessed[,2:4]))#tests for multivariate normality
res.boxM <- boxM(Y=koro_preprocessed[,2:4], group = koro_preprocessed[,"therapy"]) #Box's
M test

#MANOVA
mod.manova <- manova(cbind(SIKE_effect,SFKDI_effect,OAS_effect) ~ therapy,
data=koro_preprocessed)
summary(mod.manova, test="Wilks")
etasq(mod.manova)
summary.aov(mod.manova)

koro_preprocessed %>%
  group_by(therapy) %>%
  dplyr::summarize(Mean = mean(SFKDI_effect+SIKE_effect+OAS_effect),na.rm=TRUE)
groupmean<-c(37,34.4,25.3,8.1)
power.anova.test(groups = 4, n = 10, between.var = var(groupmean),within.var=150,sig.level =
0.05)


#multiple ANOVA
mod.anova <-aov(SFKDI_effect~therapy, data=koro_preprocessed)
etasq(mod.anova)
summary.aov(mod.anova)
TukeyHSD(mod.anova)
koro_preprocessed %>%
  group_by(therapy) %>%
  dplyr::summarize(Mean = mean(SFKDI_effect),na.rm=TRUE)

groupmean<-c(19.1, 16,12.3,1)
power.anova.test(groups = 4, n = 10, between.var = var(groupmean),within.var=120,sig.level =
0.05)
```