Effect of Cognitive Behavioural and Family Treatment on Weight Changes in Anorexia nervosa

Pakorn Sagulkoo 6380064520

Content

Part 1: Introduction

Part 2: Data Analysis by R

Part 3: Regression analysis by R

Part 4: Conclusion and discussion

Part 1: Introduction What is Anorexia nervosa?

Anorexia nervosa is a serious psychiatric eating disorder which usually occurs in adolescent and adult female patients. The clinical features of AN patients are severe weight loss, malnutrition, amenorrhea, and electrolyte and acid-base imbalance. Weight loss is taken place primarily by diminished food intake caused by a fear of overweight perception. The main treatments of AN are psychiatrically pharmacological treatment and supportive care. However, There is a poor prognosis in AN patients. AN patients usually deny eating that causes severe malnutrition and end up with death from severe electrolyte and acid-base disturbance.

From this study, it is a randomized control trial to AN patients by separating patients into 3 groups. The first group is control patients which is treated by conventional medication. The second and third group have conventional treatment combined with alternative treatments which are cognitive behavioural therapy (CBT) and family therapy (FT) respectively. The sample size of each groups are 30 patients. Patients in each groups are measure the weight before and after treatment in kilogram unit. The duration of treatment is 30 days

Part 2: Data Analysis by R

1. Import data frame from pivot table in Excel

```
data_AN <- read.csv("D:\\Bioinfor MSc\\Stat for Bioinfo\\Project\\Pivot table
\\Anorexia.csv")
attach(data_AN)
head(data_AN)
```

```
##   Treat Age Height Pre.wt Post.wt Wt.diff
## 1  Cont  31  166.4  36.68   36.45   -0.23
## 2  Cont  32  167.3  40.64   36.41   -4.23
## 3  Cont  15  152.0  41.73   39.27   -2.46
## 4  Cont  40  169.1  33.64   39.23    5.59
## 5  Cont  22  147.5  35.50   34.59   -0.91
## 6  Cont  32  155.1  40.14   35.50   -4.64
```

2. General summary of dataframe

Every patient is measure height, age, pre-treatment and post-treatment weight, and weight difference, then we will summarize the data frame.

```
summary(data_AN)
```

```
##     Treat                Age            Height          Pre.wt
##  Length:90          Min.   :15.00   Min.   :141.0   Min.   :31.82
##  Class :character   1st Qu.:21.00   1st Qu.:156.0   1st Qu.:36.02
##  Mode  :character   Median :28.00   Median :165.5   Median :37.52
##                     Mean   :27.21   Mean   :163.0   Mean   :37.36
##                     3rd Qu.:32.75   3rd Qu.:170.4   3rd Qu.:39.03
##                     Max.   :40.00   Max.   :179.5   Max.   :43.14
##     Post.wt         Wt.diff
##  Min.   :32.41   Min.   :-5.540
##  1st Qu.:36.21   1st Qu.:-0.595
##  Median :38.62   Median : 1.150
##  Mean   :39.03   Mean   : 1.668
##  3rd Qu.:41.63   3rd Qu.: 4.228
##  Max.   :48.90   Max.   :14.880
```

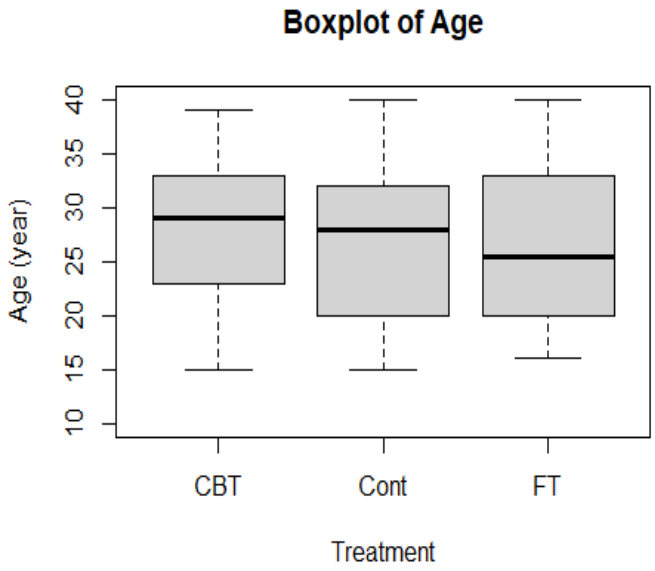
3. Test randomization

Every patient should be grouped randomly. Then I look the boxplot of age in each group.

```
names(data_AN)
```

```
## [1] "Treat"   "Age"     "Height"  "Pre.wt"  "Post.wt" "Wt.diff"
```

```
plot(factor(Treat),Age,xlab="Treatment",ylab="Age (year)", main="Boxplot of A
ge",ylim=c(10,40))
```

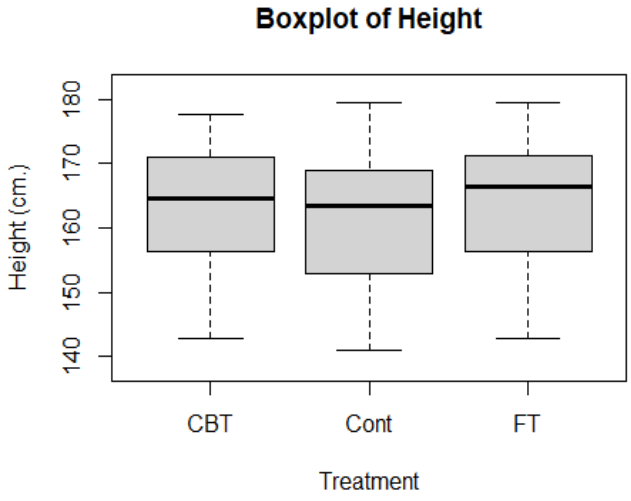


The boxplot indicates that there are no differences in height in three groups. I use one-way ANOVA to confirm the result.

```
summary(aov(Age~Treat))

##             Df Sum Sq Mean Sq F value Pr(>F)
## Treat        2     38   19.03   0.367  0.694
## Residuals   87   4513   51.87
```

Because the p-value is more than 0.05, there are no differences in the mean of age in 3 groups. Then, I confirm the randomization again by height approach.

```
plot(factor(Treat),Height,xlab="Treatment",ylab="Height (cm.)", main="Boxplot
of Height",ylim=c(138,182))
```



```
summary(aov(Height~Treat))

##             Df Sum Sq Mean Sq F value Pr(>F)
## Treat        2    122   61.05   0.615  0.543
## Residuals   87   8632   99.22
```

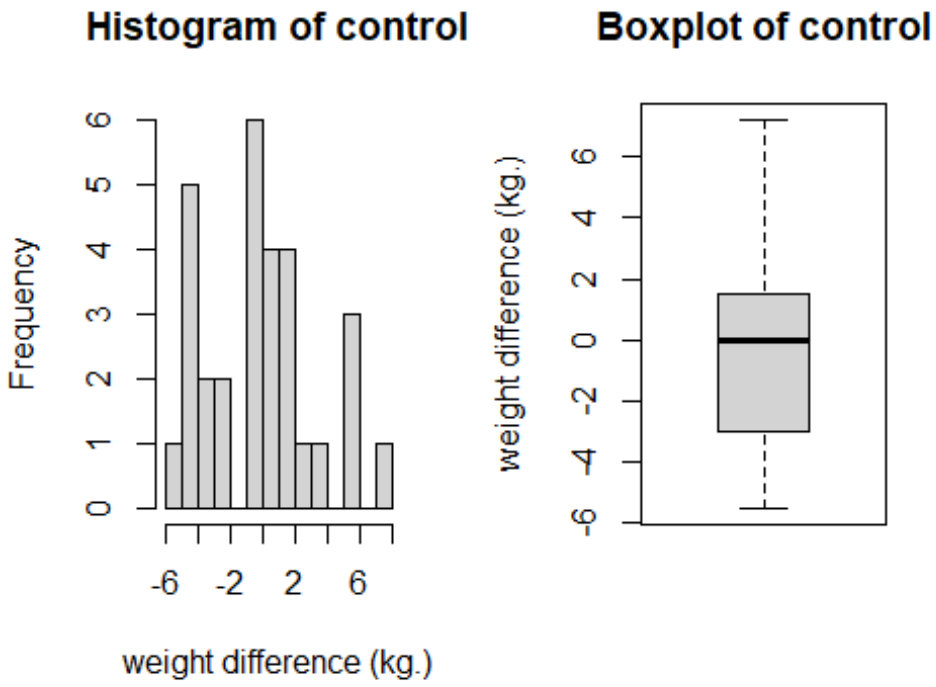
The p-value of ANOVA of height is also more than 0.05. It can be concluded that the patients are randomly grouped.

4. Test normality

4.1 Control group

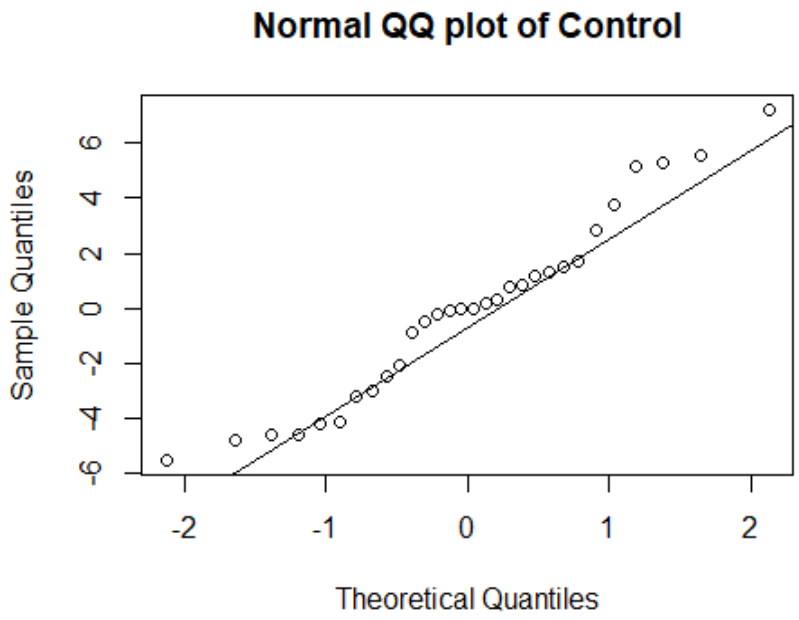
I show the histogram and boxplot of the weight difference in control group.

```
data_ctrl <- data_AN[1:30,6]
summary(data_ctrl)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  -5.540  -2.902  -0.025  -0.103   1.445   7.230

par(mfrow=c(1,2))
hist(data_ctrl,breaks=(-6:8),xlab="weight difference (kg.)",main="Histogram o
f control")
boxplot(data_ctrl,ylab="weight difference (kg.)",main="Boxplot of control")
```



The histogram of control group looks like normal distribution. As a result, it is tested by QQ plot.

```
qqnorm(data_ctrl,main="Normal QQ plot of Control")
qqline(data_ctrl)
```



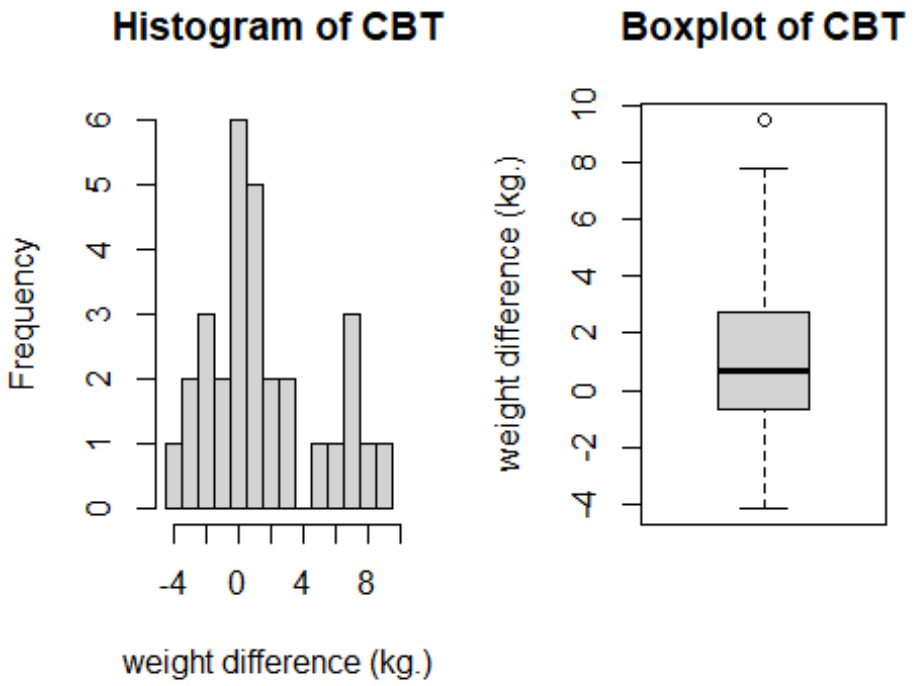
The QQ plot also looks like a normal distribution. It is confirmed by two statistical tests (Shapiro-Wilk and Anderson test).

```
shapiro.test(data_ctrl)

##
##  Shapiro-Wilk normality test
##
## data:  data_ctrl
## W = 0.95881, p-value = 0.2888

library(nortest)
ad.test(data_ctrl)

##
##  Anderson-Darling normality test
##
## data:  data_ctrl
## A = 0.41386, p-value = 0.3162
```

There is no statistical significance in both normality tests. It can co nclude that the data of the weight change in control is normal distribution.

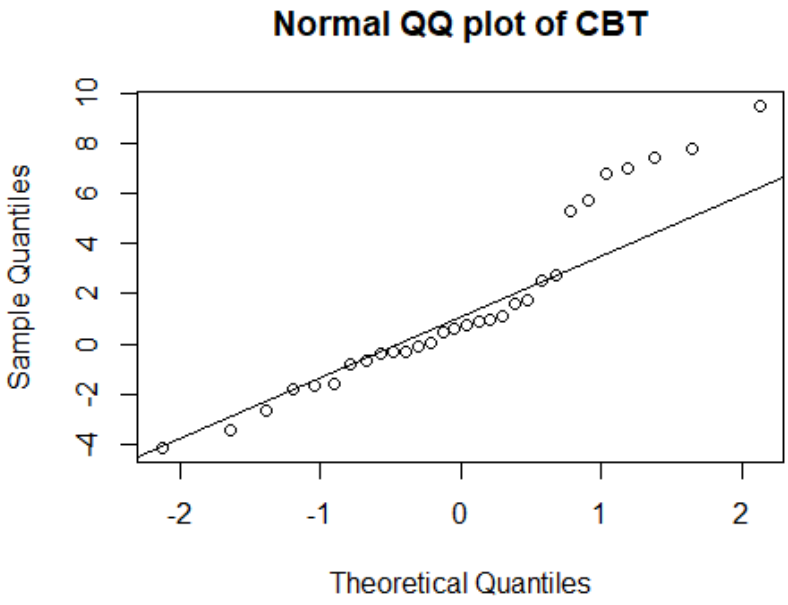
4.2 CBT group

```
data_cbt <- data_AN[31:60,6]
summary(data_cbt)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  -4.140  -0.570   0.685   1.499   2.708   9.500

par(mfrow=c(1,2))
hist(data_cbt,breaks=(-4.5:10),xlab="weight difference (kg.)",main="Histogram
of CBT")
boxplot(data_cbt,ylab="weight difference (kg.)",main="Boxplot of CBT")
```



The histogram of CBT is not normal distribution (right skewed pattern). The boxplot shows one upper outlier. The outlier cannot be deleted because the weight before and after treatment are measured accurately.

```
qqnorm(data_cbt,main="Normal QQ plot of CBT")
qqline(data_cbt)
```




```
shapiro.test(data_cbt)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  data_cbt
## W = 0.92155, p-value = 0.02943
```

```
ad.test(data_cbt)
```

```
##
##  Anderson-Darling normality test
##
## data:  data_cbt
## A = 1.0383, p-value = 0.008431
```

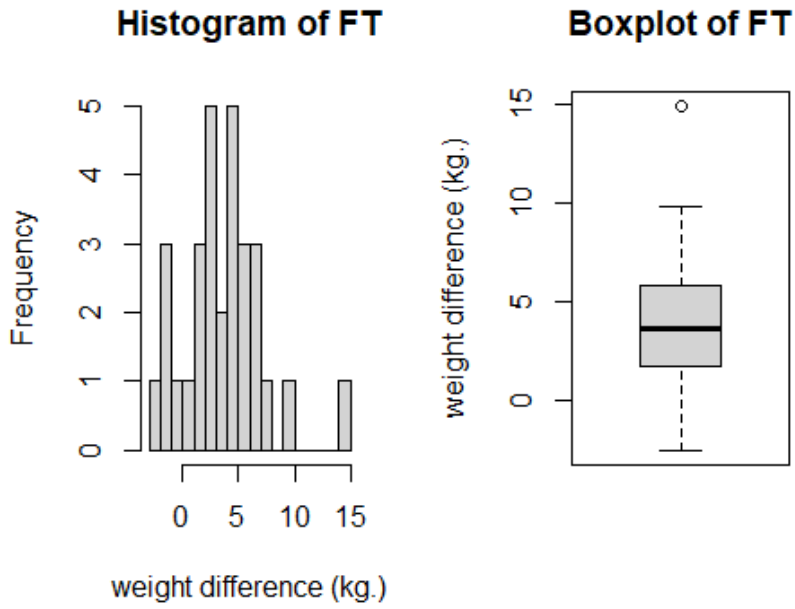
There is statistical significance in both normality test. The QQ plot a nd both normality tests give the information that the weight change in CBT gr oup is not normal distribution.

4.3 FT group

```
data_ft <- data_AN[61:90,6]
summary(data_ft)
```

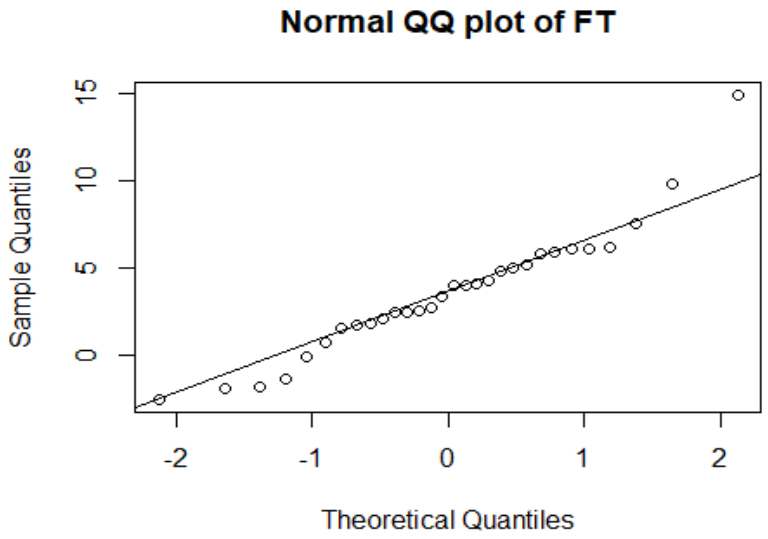
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  -2.480   1.790   3.675   3.608   5.690  14.880
```

```
par(mfrow=c(1,2))
hist(data_ft,breaks=(-3:15.5),xlab="weight difference (kg.)",main="Histogram
of FT")
boxplot(data_ft,ylab="weight difference (kg.)",main="Boxplot of FT")
```



The histogram of FT is normal distribution when exclude the outlier on the right. The boxplot shows one upper outlier. Nevertheless, the outlier cannot be deleted because the weight before and after treatment are measured accurately.

```
qqnorm(data_ft,main="Normal QQ plot of FT")
qqline(data_ft)
```



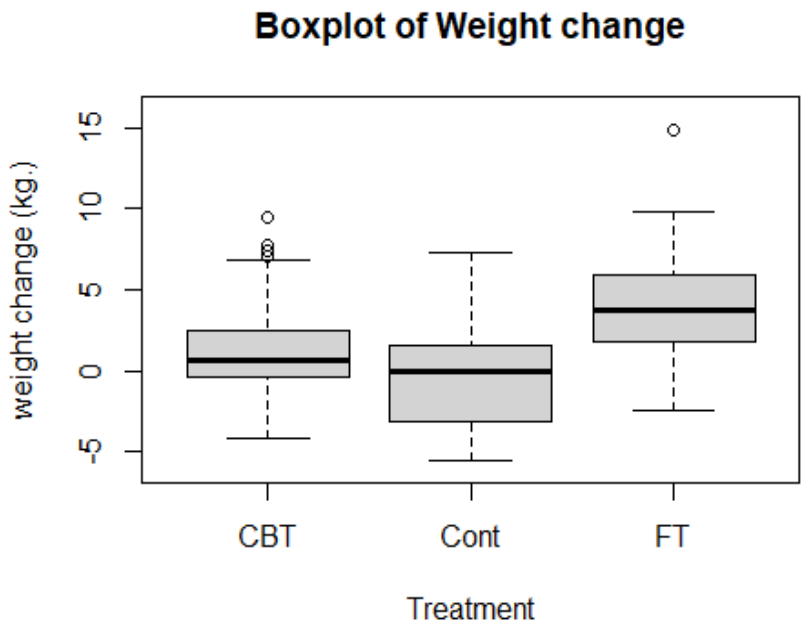
```
shapiro.test(data_ft)

##
##  Shapiro-Wilk normality test
##
## data:  data_ft
## W = 0.94048, p-value = 0.09373

ad.test(data_ft)

##
##  Anderson-Darling normality test
##
## data:  data_ft
## A = 0.44742, p-value = 0.2615
```

The QQ plot and both normality tests provide the information that the weight change in FT group is normal distribution.

5. Statistical analysis

Because the data of weight difference of three groups are not normal distribution, the ANOVA cannot be used. Kruskal-Willis test, the non parametric test, should be used.

```
plot(factor(Treat),Wt.diff,xlab="Treatment",ylab="weight change (kg.)", main="Boxplot of Weight change",ylim=c(-6,16))
```



```
kruskal.test(Wt.diff ~ Treat, data = data_AN)

##
##  Kruskal-Wallis rank sum test
##
## data:  Wt.diff by Treat
## Kruskal-Wallis chi-squared = 14.645, df = 2, p-value = 0.0006605
```

The test shows a statistical significance in experiments. Then, pairwise-comparison is performed.

```
pairwise.wilcox.test(Wt.diff,Treat,p.adj= "BH")

##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  Wt.diff and Treat
##
##      CBT   Cont
## Cont 0.130 -
## FT   0.013 0.001
##
## P value adjustment method: BH
```

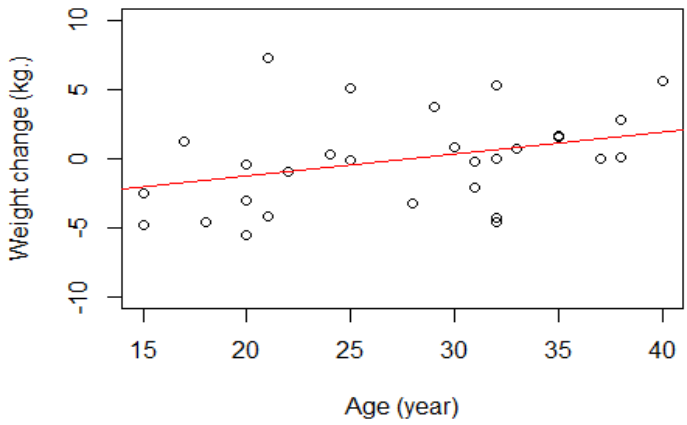
The pairwise-comparison test gives the information that Family treatment has an impact on weight changes more than control group in AN patients in statistically significant level. However, there are no statistically significant changes in the weight between cognitive behavioural therapy and control group.

Part 3: Regression analysis by R

In this part, I analyse the relationship between weight changes, and age and height in each group. There are patients but not normal people and each group of patients have received the effect of the treatment: control, CBT, and FT. This means that each of the factors that we treat to the patients may have an impact on the relationship between the weight changes and age and height. For example, in the patients which are family treatment (ft), the effect of responsive treatment may depend on the age. Patients in adolescence usually live and are dependent with the family more than adults. The former may change the weight more than the later. This is my reason to use the regression in this data.

1. Control group

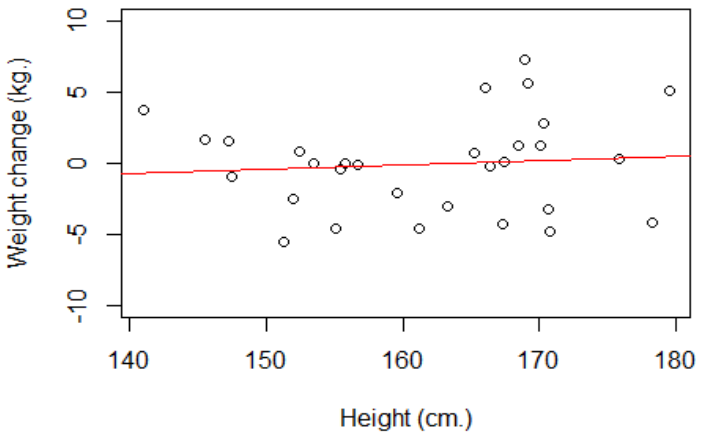
```
df_ctrl <- data_AN[1:30,]
plot(df_ctrl$Wt.diff ~ df_ctrl$Age,xlab="Age (year)",ylab="Weight change (kg.
)",ylim=range(-10:10))
abline(lm(df_ctrl$Wt.diff ~ df_ctrl$Age),col="red")
```




```
summary(lm(df_ctrl$Wt.diff ~ df_ctrl$Age))

##
## Call:
## lm(formula = df_ctrl$Wt.diff ~ df_ctrl$Age)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.3015 -2.4064 -0.0294  1.1360  8.2847
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -4.33109    2.23458  -1.938   0.0627 .
## df_ctrl$Age  0.15602    0.07953   1.962   0.0598 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.231 on 28 degrees of freedom
## Multiple R-squared:  0.1208, Adjusted R-squared:  0.08943
## F-statistic: 3.848 on 1 and 28 DF,  p-value: 0.05981
```

Because R-squared is close to 0 (0.12), the linear model is not fit to the data between weight change and age in control group.

```
plot(df_ctrl$Wt.diff ~ df_ctrl$Height,xlab="Height (cm.)",ylab="Weight change
(kg.)",ylim=range(-10:10))
abline(lm(df_ctrl$Wt.diff ~ df_ctrl$Height),col="red")
```




```
summary(lm(df_ctrl$Wt.diff ~ df_ctrl$Height))

##
## Call:
## lm(formula = df_ctrl$Wt.diff ~ df_ctrl$Height)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.1291 -2.7624  0.1187  1.8213  7.1215
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -4.87573   10.19614  -0.478    0.636
## df_ctrl$Height  0.02951    0.06292   0.469    0.643
##
## Residual standard error: 3.433 on 28 degrees of freedom
## Multiple R-squared:  0.007794,   Adjusted R-squared:  -0.02764
## F-statistic: 0.2199 on 1 and 28 DF,  p-value: 0.6427
```

Because R-squared is close to 0, the linear model is not fit to the dat
a between weight change and height in control group.

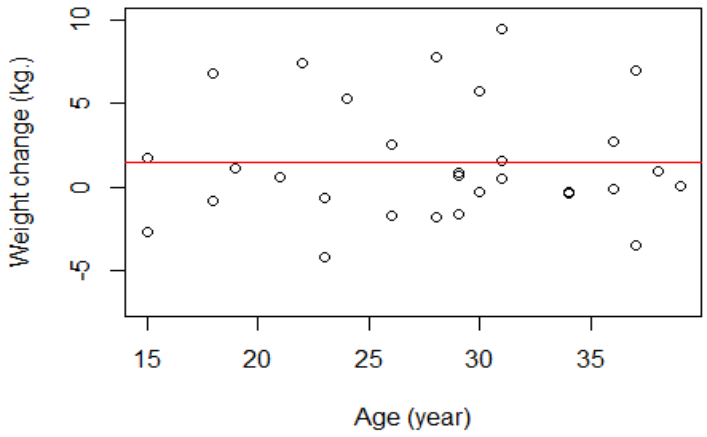
```
summary(lm(df_ctrl$Wt.diff ~ df_ctrl$Age + df_ctrl$Height))

##
## Call:
## lm(formula = df_ctrl$Wt.diff ~ df_ctrl$Age + df_ctrl$Height)
##
```

```
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.1834 -2.3607  0.1808  1.1927  8.0076
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -11.89570   10.27291  -1.158   0.2570
## df_ctrl$Age      0.16398    0.08084   2.028   0.0525 .
## df_ctrl$Height   0.04544    0.06021   0.755   0.4569
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.256 on 27 degrees of freedom
## Multiple R-squared:  0.139,  Adjusted R-squared:  0.07522
## F-statistic: 2.179 on 2 and 27 DF,  p-value: 0.1326
```

In multiple linear regression (between weight change and age and height), there are weak correlations in the model (r square is 0.14).

2. CBT group

```
df_cbt <- data_AN[31:60,]
plot(df_cbt$Wt.diff ~ df_cbt$Age,xlab="Age (year)",ylab="Weight change (kg.)"
,ylim=range(-7:10))
abline(lm(df_cbt$Wt.diff ~ df_cbt$Age),col="red")
```

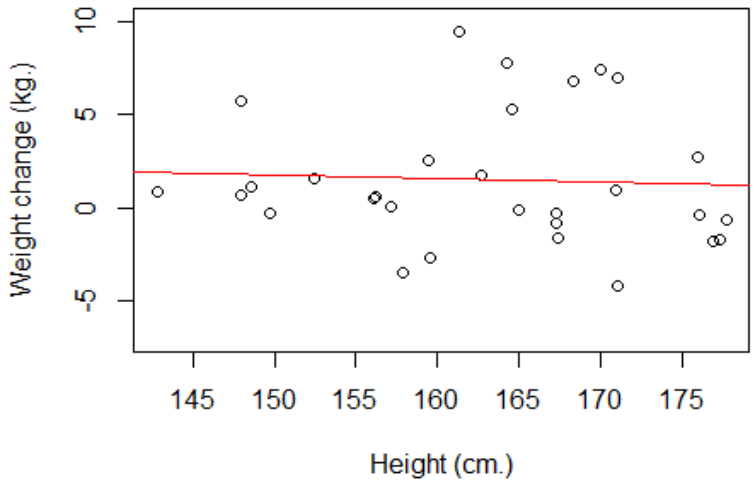



```
summary(lm(df_cbt$Wt.diff ~ df_cbt$Age))

##
## Call:
## lm(formula = df_cbt$Wt.diff ~ df_cbt$Age)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.6257 -2.0633 -0.8063  1.1926  7.9920
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.421580   2.769284   0.513    0.612
## df_cbt$Age  0.002787   0.096412   0.029    0.977
##
## Residual standard error: 3.606 on 28 degrees of freedom
## Multiple R-squared:  2.984e-05,  Adjusted R-squared:  -0.03568
## F-statistic: 0.0008355 on 1 and 28 DF,  p-value: 0.9771
```

Because R-squared is close to 0, the linear model is not fit to the dat a between weight change and age in CBT group.

```
plot(df_cbt$Wt.diff ~ df_cbt$Height,xlab="Height (cm.)",ylab="Weight change ( kg.)",ylim=range(-7:10))
abline(lm(df_cbt$Wt.diff ~ df_cbt$Height),col="red")
```




```
summary(lm(df_cbt$Wt.diff ~ df_cbt$Height))

##
## Call:
## lm(formula = df_cbt$Wt.diff ~ df_cbt$Height)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -5.485 -2.022 -1.040  1.377  7.967
```

```
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    4.65438   11.08223   0.420    0.678
## df_cbt$Height -0.01935    0.06786  -0.285    0.778
##
## Residual standard error: 3.601 on 28 degrees of freedom
## Multiple R-squared:  0.002896,   Adjusted R-squared:  -0.03271
## F-statistic: 0.08134 on 1 and 28 DF,  p-value: 0.7776
```

Because R-squared is close to 0, the linear model is not fit to the data between weight change and height in CBT group.

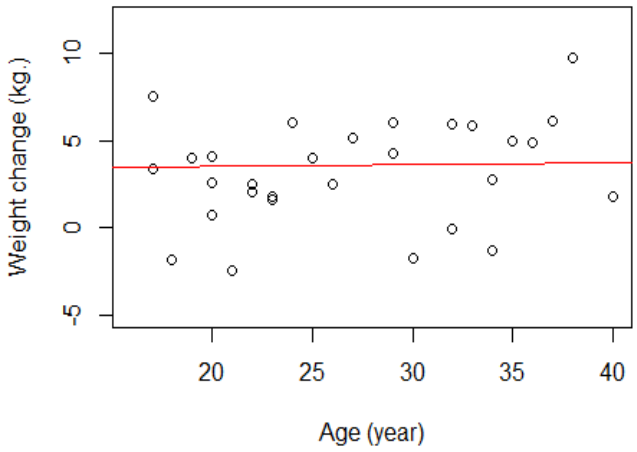
```
summary(lm(df_cbt$Wt.diff ~ df_cbt$Age + df_cbt$Height))
```

```
##
## Call:
## lm(formula = df_cbt$Wt.diff ~ df_cbt$Age + df_cbt$Height)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -5.466 -2.024 -1.046  1.357  7.956
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    4.565070  11.528676   0.396    0.695
## df_cbt$Age     0.003718   0.098094   0.038    0.970
## df_cbt$Height -0.019442   0.069142  -0.281    0.781
##
## Residual standard error: 3.667 on 27 degrees of freedom
## Multiple R-squared:  0.00295,    Adjusted R-squared:  -0.07091
## F-statistic: 0.03994 on 2 and 27 DF,  p-value: 0.9609
```

In multiple linear regression (between weight change and age and height), there are weak correlations in the model (r square is 0.003).

3. FT group

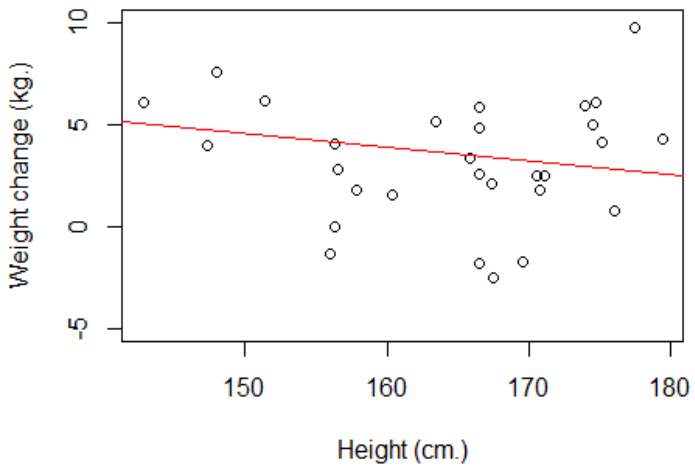
```
df_ft <- data_AN[61:90,]
plot(df_ft$Wt.diff ~ df_ft$Age,xlab="Age (year)",ylab="Weight change (kg.)",y
lim=range(-5:12))
abline(lm(df_ft$Wt.diff ~ df_ft$Age),col="red")
```




```
summary(lm(df_ft$Wt.diff ~ df_ft$Age))

##
## Call:
## lm(formula = df_ft$Wt.diff ~ df_ft$Age)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -6.0291 -1.9124  0.1259  2.0317 11.3829
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  3.33079    2.62274   1.270    0.215
## df_ft$Age    0.01040    0.09523   0.109    0.914
##
## Residual standard error: 3.66 on 28 degrees of freedom
## Multiple R-squared:  0.0004255,  Adjusted R-squared:  -0.03527
## F-statistic: 0.01192 on 1 and 28 DF,  p-value: 0.9138
```

Because R-squared is close to 0, the linear model is not fit to the dat a between weight change and age in FT group.

```
plot(df_ft$Wt.diff ~ df_ft$Height,xlab="Height (cm.)",ylab="Weight change (kg .)",ylim=range(-5:10))
abline(lm(df_ft$Wt.diff ~ df_ft$Height),col="red")
```




```
summary(lm(df_ft$Wt.diff ~ df_ft$Height))

##
## Call:
## lm(formula = df_ft$Wt.diff ~ df_ft$Height)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.8651 -1.8713 -0.3912  1.7061 10.2856
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  14.63848   11.03692   1.326    0.195
## df_ft$Height -0.06718    0.06710  -1.001    0.325
##
## Residual standard error: 3.597 on 28 degrees of freedom
## Multiple R-squared:  0.03456,    Adjusted R-squared:  8.423e-05
## F-statistic: 1.002 on 1 and 28 DF,  p-value: 0.3253
```

Because R-squared is close to 0, the linear model is not fit to the dat a between weight change and height in FT group.

```
summary(lm(df_ft$Wt.diff ~ df_ft$Age + df_ft$Height))

##
## Call:
## lm(formula = df_ft$Wt.diff ~ df_ft$Age + df_ft$Height)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
```

```
## -5.7305 -1.8126 -0.2373  1.6240 10.4964
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  14.37392   11.28357   1.274    0.214
## df_ft$Age     0.02267    0.09598   0.236    0.815
## df_ft$Height -0.06925    0.06882  -1.006    0.323
##
## Residual standard error: 3.659 on 27 degrees of freedom
## Multiple R-squared:  0.03656,    Adjusted R-squared:  -0.03481
## F-statistic: 0.5122 on 2 and 27 DF,  p-value: 0.6049
```

In multiple linear regression (between weight change and age and height), there are weak correlations in the model (r square is 0.037).

Part 4: Discussion and Conclusion

1. The patients are grouped randomly into 3 groups (control, CBT, and FT) because the one-way ANOVA of age and height in the groups is not statistically significant.

2. The statistical analysis reveals that family treatment give the result of the weight change better than the control but cognitive behavioural therapy does not give the result better than control.

3. In linear regression analysis, there are not any strong relationship between weight change, and age and height of patients in 3 groups.