Medical Research Consulting Project

School of Public Health at University of Minnesota

Study of Moderate Exercise Effect on Cholesterol Level

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Introduction and Overview

Hypercholesterolemia, also called high cholesterol, is the causative agent of atherosclerosis, or the hardening and narrowing of the arterial walls and is important independent risk factor for coronary heart disease, stroke, peripheral artery disease and kidney disease (Stefanick et al., 1998). Hypercholesterolemia, a total cholesterol of 240 and above, is called the "silent killer" as it is not symptomatic that it is likely to be diagnosed after the damage already began to occur. Many patients are monitored at borderline levels of 200 to 239 and recommended to reduce the LDL cholesterol level by means of dietary therapy, physical therapy, and mostly medication through Statins. The effect of dietary and therapy has been shown to reduce the incidence of coronary heart disease among men with hypercholesterolemia; however, the clear mechanism reducing LDL cholesterol level through exercise remains unfound.

This study aimed to observe validity of moderate exercise in daily life in related to total cholesterol reduction primarily among population whose cholesterol are over 200mg/dL. However, we decided to include the normal cholesterol group, less than 200mg/dL to compare the effectiveness of the treatment between different baseline levels. Thirty-six normal and another thirty-six high cholesterol islanders were randomly selected from three islands. With random assignment of treatment, the treatment and control group repeated brisk walking for 30 minutes and sitting 10 minutes respectively three times a week for two weeks. Before the experiment, each subject's baseline cholesterol as well as some demographic information including gender, age, sex, residency, weight, and diet (healthy or not healthy) were collected. While our primary objective to examine effectiveness of moderate exercise remains, observing these additional variables can extend the discussion of how they can interact with the moderate exercise. Finally, the subjects' cholesterol levels were recorded again at the end of experiment.

Data Exploration

The table below, Table 1, describes baseline demographics of subjects participated in this experiment. Notice that among the treatment group, four subjects withdrew their participation from the experiment.

Total	**Exercise (brisk walk for 30mins)**	**No Exercise (sitting for 10 minutes)**
Sample Size	32	36
Cholesterol (High:Normal)	15:17	18:18
Gender (Males : Females)	17:15	19:17
Age	40.19 +/- 9.39	39.25 +/- 9.36
Weight (kg)	72.25 +/- 14.39	71.95 +/- 14.42
Diet (Healthy : Unhealthy)	21:11	23:13
Initial Cholesterol (mg/dL) (mean +/- se)	190.59 +/- 23.21	187.14 +/- 23.28

Table 1. Baseline Demographic of Exercise and No-Exercise group

Despite unequal sample size due to unexpected withdrawal of four subjects from the treatment group, the baseline demographics are similar. The distribution of male and females for both groups are balanced, as well as age and weight are comparable for both groups. The initial cholesterol levels, normal or high, are relatively balanced as well. Mean initial cholesterol level are also balanced between the treatment and control group. This study was designed to compare four different groups: exercise and high cholesterol (ExH), exercise and normal cholesterol (ExN), no-exercise and high cholesterol (NExH), and no-exercise and normal cholesterol (NExN). Appendix 1 provides the breakdown of baseline demographic information of four groups. Because of withdrawal of four subjects, the sample size was not equal for each group but not significantly unbalanced. Interestingly, the baseline weight and diet habits appeared to be slightly different for the high-cholesterol and normal-cholesterol groups and can shed light on a possible discussion of their relationships with cholesterol.

Figure 1 provides two boxplots that show the change of initial – final cholesterol. The top plot is comparison of exercise and no-exercise group, whereas plot on the bottom is a comparison for four different groups.

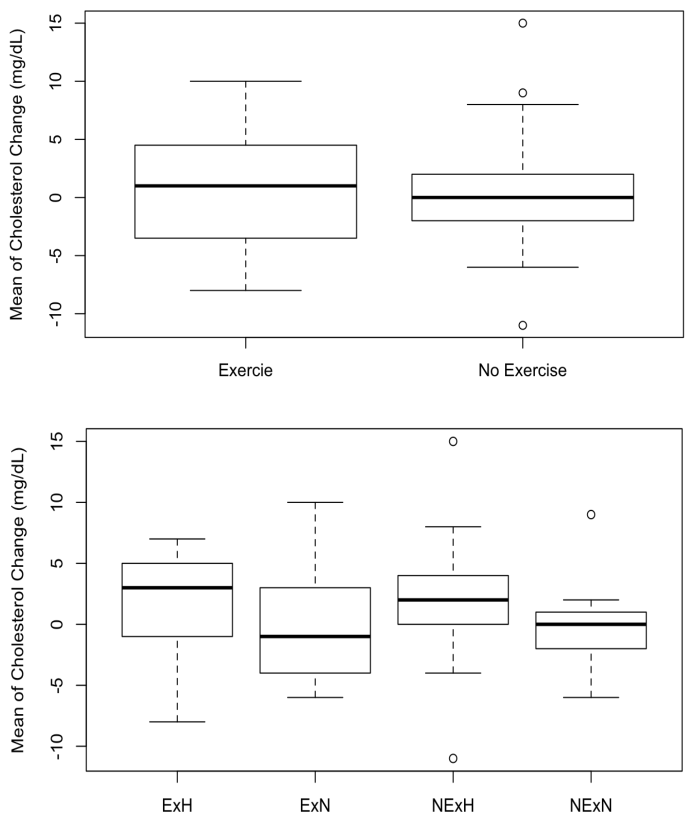

Figure 1. Comparison of change in cholesterol due to treatment and initial cholesterol

The plot that compares exercise and no-exercise group shows that the change between the two groups was not significantly different. On the other hand, when incorporating initial cholesterol status, there seems to be some difference between the four groups, when looking at the plot on the right in Figure 1. Unexpectedly, the cholesterol change for every group except exercise and normal cholesterol group (ExN) appeared to have positive trends, increased cholesterol over experimental period.

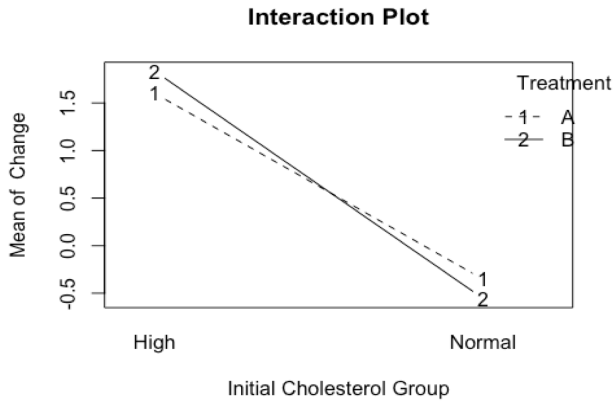

Figure 2. Interaction plot between A (exercise) and B (no-exercise) group

Figure 2 is an interaction plot between the treatment and the initial cholesterol groups. The interaction plot tells us how the relationship between treatment and change in cholesterol depends on the initial cholesterol groups. Since the lines in our plot are similar (almost parallel), we can assume that the relationship between treatment and change in cholesterol does not greatly depend on which initial cholesterol group subjects are in. Another way to interpret this is that your initial cholesterol group makes no significant difference in whether the treatment affects cholesterol.

Analysis Method

The primary purpose of this study was to examine the effectiveness of moderate exercise on cholesterol, two-sample t-test and analysis of variance (ANOVA) were used to compare the change in cholesterol between the exercise and non-exercise group. Inspections for assumptions were required to use the methods to compare the exercise and no-exercise group on the change in cholesterol in this study: randomness, independence, normality, and constant variance. First, each subject is independent, and the seventy-two subjects were randomly selected from a population so randomness is satisfied. Secondly, normality of the data, which means the change in cholesterol follows bell-shaped normal distribution, was checked. Statistically, a Q-Q plot is commonly used for normality check to see if the data points mostly follow the straight line. The result in Figure 3 shows the data is normally distributed.

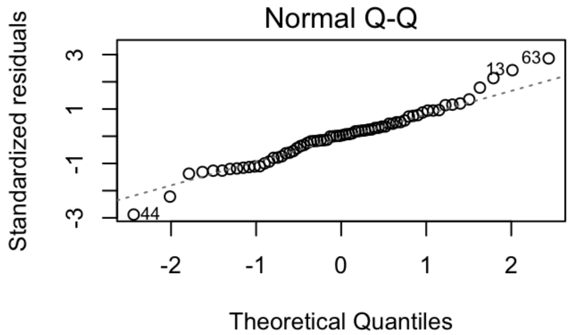

Figure 3. Q-Q plot assessing normality of the data

To further check the normality, box-cox transformation was examined but did not provide significant results. Thus, we continue with the assumption that our data is normally distributed. Lastly, residual plot is checked to assess whether there is constant variance in data. In the residual plot, a straight red line is interpreted as having constant variance, and the dataset used in this study was confirmed to have constant variance as shown in Figure 4.

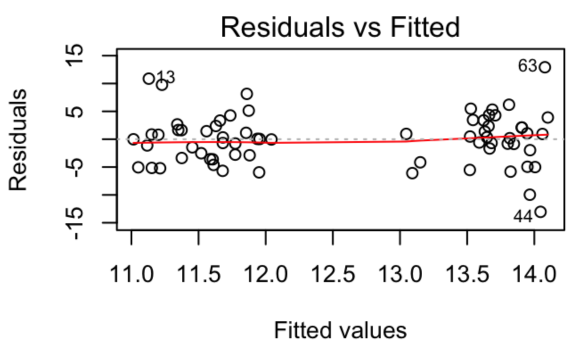

Figure 4. Residual plot assessing constant variance of the data

Data Analysis

For the two-way ANOVA to compare changes in cholesterol between four groups, following hypotheses were examined.

Hypothesis 1:

$$H_0: \mu_{exercise} = \mu_{no\ exercise}$$
$$H_a: \mu_{exercise} \neq \mu_{no\ exercise}$$

Hypothesis 2:

$$H_0: \mu_{high\ cholesterol} = \mu_{normal\ cholesterol}$$
$$H_a: \mu_{high\ cholesterol} \neq \mu_{normal\ cholesterol}$$

Hypothesis 3:

$$H_0: there\ is\ an\ interaction\ between\ exercise\ and\ cholesterol$$
$$H_a: there\ is\ no\ interaction\ between\ exercise\ and\ cholesterol$$

Appendix 2 provides the results of the two-way ANOVA test. The p-value that helps determine the significance of the result was 0.9466, which indicates that there is no statistically significant difference in mean of change in cholesterol between the four groups. This result shows that we have no evidence to reject the null hypothesis that all four groups produce the same mean difference in cholesterol. In other words, there is no evidence to support that exercise for high cholesterol subjects gives a greater decrease to cholesterol than no exercise for high cholesterol subjects, exercise for normal cholesterol subjects, or no exercise to normal cholesterol subjects.

Other information including gender, age, weight, and diet were also analyzed to assess their relationship with change in cholesterol. Figure 5 illustrates, the difference in means between groups depending on gender and diet seems to be not significant, as well as age, weight, and initial cholesterol do not have a strong effect on change in cholesterol.

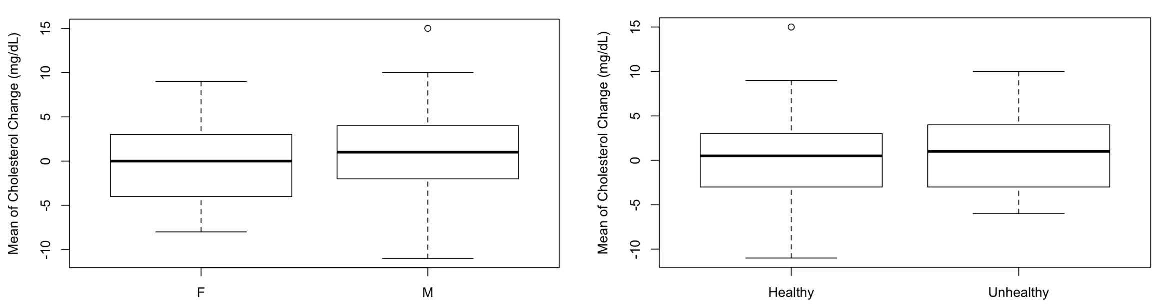

Figure 5. Comparison of mean of cholesterol change due to gender and diet

Looking at these other possible factors, we created a linear model that included gender, age, weight, diet, island, as well as treatment, cholesterol, and their interaction to predict change in cholesterol. Then we ran a regression test to see if any of the factors were significant predictors for change in cholesterol, demonstrated in Appendix 3. At a significance level of 0.05, the summary showed that none of the factors are significant in predicting difference, thus, we do not have any evidence that suggests other factors are significant for impacting decrease in cholesterol.

Discussions and Conclusions

After analyzing the data, we do not have evidence from this experiment that suggests that exercise can significantly lower cholesterol for subjects with high cholesterol. The interaction analysis showed that initial cholesterol level did matter when looking at the treatment against change in cholesterol. We also do not have the evidence that suggests that any other factors play a role in helping or hurting change in cholesterol for subjects receiving treatment.

Limitations of this experimental study are discussable. First, duration of the experiment was short. Maybe continuing the moderate exercise, brisk walk for 30 minutes three times a week or equivalent exercise in this study, could provide a different conclusion if it lasts for more than 2 weeks in future studies. Second, there are many possible predictors that could affect change in cholesterol but could not be measured through this research. In fact, numerous studies found that there are correlations between cholesterol and some diseases, like heart diseases and kidney diseases (Stefanick et al., 1998). Future studies are suggested as they could control other variables that could play a role in reducing or increasing cholesterol. Dietary that explains what you usually eat, occupation that explains how much one’s job make him or her do a light exercise, and maybe heredity if one’s parents had high cholesterol are examples that can be examined.

Reference

Stefanick, M. L., Mackey, S., & Sheehan, M. (1998). Effects of Diet and Exercise in Men and Postmenopausal Women with Low Levels of HDL Cholesterol and High Levels of LDL Cholesterol. N Engl J, 339, 12-20.

Appendix

High Cholesterol Group	**Exercise (brisk walk for 30mins)**	**No Exercise (sitting for 10 minutes)**
Sample Size	15	18
Gender (Males : Females)	9:6	13:5
Age	42.13 +/- 9.19	37.95 +/- 8.12
Weight (kg)	81.78 +/- 11.69	83.93 +/- 8.35
Diet (Healthy : Unhealthy)	7:8	9:9
Normal Cholesterol Group	**Exercise (brisk walk for 30mins)**	**No Exercise (sitting for 10 minutes)**
Sample Size	17	18
Gender (Males : Females)	9:8	6:12
Age	38.47 +/- 10.64	41.65 +/- 9.75
Weight (kg)	63.84 +/- 9.70	59.98 +/- 9.54
Diet (Healthy : Unhealthy)	14:3	14:4

Appendix 1. Baseline Demographic of four different groups

```
            Two-way ANOVA Test

anova(mod)
## Analysis of Variance Table
##
## Response: Change
##                      Df  Sum Sq Mean Sq F value  Pr(>F)
## Treatment            1     0.10   0.099  0.0045 0.94662
## Cholesterol          1    80.95  80.951  3.6995 0.05888 .
## Treatment:Cholesterol  1   0.80   0.803  0.0367 0.84867
## Residuals            64 1400.43  21.882
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Appendix 2. The result of two-way ANOVA comparing exercise and no-exercise group

```
              Regression test for Factors

> model_finaltemp = lm(newChange ~ Treatment*Cholesterol + Gender + Weight +
Diet + Age + Island)
> summary(model_finaltemp)

Call:
lm(formula = newChange ~ Treatment * Cholesterol + Gender + Weight +
    Diet + Age + Island)

Residuals:
     Min       1Q   Median       3Q      Max
-12.8152  -3.2133   0.0123   2.4597  12.6984

Coefficients:
                             Estimate Std. Error t value Pr(>|t|)
(Intercept)                  13.36340    6.43698   2.076   0.0423 *
TreatmentB                    0.25412    1.73373   0.147   0.8840
CholesterolNormal            -2.04833    2.14414  -0.955   0.3433
GenderM                       0.46198    1.42079   0.325   0.7462
Weight                       -0.00222    0.06929  -0.032   0.9746
DietUnhealthy                -0.04710    1.36575  -0.034   0.9726
Age                           0.02864    0.06611   0.433   0.6665
Island                       -0.45908    0.82700  -0.555   0.5809
TreatmentB:CholesterolNormal -0.37843    2.45796  -0.154   0.8782
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.845 on 59 degrees of freedom
Multiple R-squared:  0.06556, Adjusted R-squared:  -0.06114
F-statistic: 0.5175 on 8 and 59 DF,  p-value: 0.8386
```

Appendix 3. The summary of regression test