

Stat 401 A XM Homework 11
On-Campus Due Date: Wednesday, December 3
Off-Campus Due Date: Wednesday, December 10

1. An exercise physiologist wanted to compare the body-fat-reducing effects of three exercise programs (*A*, *B*, and *C*) and varying levels of a dietary supplement (0, 1, 1.5, and 2 g/day). A total of 24 males between 28 and 35 years of age were used for the study. The males were assigned in a completely randomized manner to the 12 combinations of exercise program and dietary supplement level. After completing 12 months of training according to the assigned exercise program and consuming the dietary supplement at the assigned rate, the body fat of each male was measured. The body fat of each male also had been measured prior to the start of the treatment regimes. The variable *bfchange* in the SAS code accompanying this assignment gives the body fat before treatment minus body fat after treatment for each subject. Use the code and output to answer the following questions. Please assume that the multiple regression model fits the data well and that all the assumptions of multiple regression are satisfied.
- (a) Estimate the mean change in body fat for each exercise program when no dietary supplement is consumed. Also provide a 95% confidence interval for the exercise-program-*C*/no-supplement mean in addition to the estimated mean.
 - (b) Is there a statistically significant difference between the estimated means for exercise programs *A* and *C* computed in problem 1? Provide an appropriate test statistic, *p*-value, and conclusion.
 - (c) By how much does the mean change in body fat for exercise-program-*C* subjects taking 2 g/day of the supplement differ from the mean change in body fat for exercise-program-*C* subjects taking 1 g/day of the supplement? Provide a 95% confidence interval for the difference in means.

```
data one;
  input exprog $ dietsupp bfchange;
  cards;
A 0.0 0.6
A 0.0 0.3
A 1.0 1.4
A 1.0 1.9
A 1.5 1.8
A 1.5 2.3
A 2.0 2.5
A 2.0 2.7
B 0.0 0.6
B 0.0 0.4
B 1.0 0.7
B 1.0 1.2
B 1.5 1.3
B 1.5 1.5
B 2.0 1.6
B 2.0 1.8
C 0.0 0.7
C 0.0 0.1
C 1.0 0.5
```

```

C 1.0 0.6
C 1.5 0.8
C 1.5 0.9
C 2.0 0.9
C 2.0 1.0
;

```

```
data one; set one;
```

```

x1=dietsupp;
if exprog='A' then x2=1;
else x2=0;
if exprog='B' then x3=1;
else x3=0;
x4=x1*x2;
x5=x1*x3;

```

```
run;
```

```
proc reg;
```

```
model bfchange=x1 x2 x3 x4 x5;
```

```
run;
```

Dependent Variable: bfchange

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	10.96687	2.19337	50.44	<.0001
Error	18	0.78271	0.04348		
Corrected Total	23	11.74958			

Root MSE	0.20853	R-Square	0.9334
Dependent Mean	1.17083	Adj R-Sq	0.9149
Coeff Var	17.81026		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.36286	0.13422	2.70	0.0145
x1	1	0.28857	0.09970	2.89	0.0097
x2	1	0.12571	0.18981	0.66	0.5162
x3	1	0.09000	0.18981	0.47	0.6411
x4	1	0.77714	0.14099	5.51	<.0001
x5	1	0.32000	0.14099	2.27	0.0358

2. An experiment was conducted to examine the ability of four drugs (A, B, C, and D) to delay atrophy in denervated muscles. A certain leg muscle in each of 48 rats was deprived of its nerve supply by surgically severing the appropriate nerves. The rats were divided into four groups of 12 rats each. Each drug was assigned to one of the groups. After 14 days, the 12 rats from each group were killed. The weight of the denervated muscle (in grams) was obtained from each of the sacrificed rats.

The denervated muscles should undergo atrophy and begin to shrink in size. A treatment effectively delays atrophy if it seems to prevent or reduce muscle shrinkage during the 14-day period. The best way to measure atrophy would be to take the weight of the muscle before treatment minus the weight of the muscle after treatment. Unfortunately the weight of the muscle before treatment cannot be obtained without killing the rat. Consequently the initial total body weight (in grams) of each sacrificed rat was measured. It is assumed that this figure is closely related to the initial weight of the muscle. Ultimately we will want to look for differences in mean after-treatment muscle weight among the drugs, while controlling/adjusting for differences in initial weight. The data is contained in the file *denervated.sas*.

- (a) One way to analyze the data would be to assume that the muscle weights before treatment were about the same for each rat. Then the only relevant data are the after-treatment muscle weights for the 12 rats in each treatment group. A high mean after-treatment muscle weight will suggest that a treatment is effective. Drugs A, B, and C are experimental drugs. Drug D is a control – simply a saline solution that could not affect atrophy. Assuming that the muscle weights before treatment were about the same for each rat, are any of the experimental drugs more effective than the control? If so, which ones? Provide appropriate statistical evidence to support your answer.
- (b) If the before-treatment muscle weights were not the same for each rat, the analysis in part 1 would be inefficient at best and perhaps flawed. Examining the initial body weights of the rats suggests that there was probably quite a bit of variation in before-treatment muscle weights. This needs to be accounted for in analysis. One way to account for differences in before-treatment muscle weights would be to conduct a multiple regression analysis. The response variable would be after-treatment muscle weight. The explanatory variables would include initial body weight and indicator variables for the drug (i.e., treatment) factor. It would then be possible to make comparisons among the drugs while adjusting for the effect of body weight. For example, we could make a statement like

“Among rats with the same initial body weight, the mean after-treatment muscle weight for rats treated with drug A was estimated to be _____ grams larger than the mean after-treatment muscle weight for rats treated with the control (95% confidence interval _____ to _____ grams larger).”

Conduct such an analysis for this data set. When adjusting for differences in body weight, are any of the experimental drugs more effective than the control? If so, which ones? Provide appropriate statistical evidence to support your answer.

- (c) The analysis in part (b) assumes that there is no interaction between the drug factor and initial body weight. In other words, the analysis assumes that the differences in the mean after-treatment muscle weights among the four drug treatments are the same for any initial body weight. Is that assumption appropriate? Provide appropriate statistical evidence to support your answer.
- (d) The 48 rats were kept in a large cage prior to treatment. The researchers had to reach in the cage and capture each of the 48 rats used in the experiment. Rather than randomly assigning rats to treatments, the researchers arbitrarily assigned the first 12 rats captured to Drug D, the next 12 to Drug C, the next 12 to Drug B, and the last 12 to Drug A. The variable *rat* in the dataset corresponds to the reverse order in which the rats were captured. Rat 48 was captured first, followed by rat 47, etc. Is there any indication that capture order was associated with the initial weight of the rat? Provide appropriate statistical evidence to support your answer.

(e) Given your discovery in part (d), can you explain why the results in parts (a) and (b) differed? A plot of the data might be helpful.