A Regression Analysis: The Effect of Gender on Student Athletes’ Strength Gains

An Honors Thesis (HONRS 499)

by

Blake Vanderbush

Thesis Advisor
Dr. Jack Foley

Ball State University
Muncie, Indiana

May 2011

Expected Date of Graduation

May 2011
Abstract

What role does gender play in possible strength gains among high school student athletes? This question was the driving force behind this paper. This thesis utilized regression analysis to quantify the differences that can be expected in strength gains based on many variables, including gender. The data from 545 high school athletes was recorded over the course of 10 years. Various regression models were included and explained in this paper.

Acknowledgements

I would like to thank Dr. Jack Foley, for providing insight and guidance during the writing and research of my thesis.

I would also like to thank Kevin Vanderbush, for allowing me full access to the data that he has collected over the years.
The purpose of this thesis is to describe, analyze and evaluate the advanced physical education program at Ben Davis High School. The thesis will be divided into three sections. The first section will be a description of the Advanced P.E. course, including details about the justification of different aspects of the program. The next section will include a literary review of relevant articles about specific topics that relate to this thesis. The third section will include results of the regression analysis along with conclusions based on these findings.

Section I

The advanced physical education program at Ben Davis High School was started in 1984. Currently, there are five periods of the class offered, with an enrollment of 350-450 students each semester. A prerequisite for the course is to be on a varsity or junior varsity roster for an IHSAA sanctioned sport. Every boys’ and girls’ sport at Ben Davis is represented among these students. Many teams have 100% participation.

The advanced physical education class is held in the Ben Davis weight room four days a week, and the other day is spent in one of the auxiliary gyms doing power training. A certified strength and conditioning specialist is assigned to teach all five advanced physical education classes. At least two other coaches have duties in the weight room. The equipment consists primarily of free weights and single station machines. There are at least five stations for each of the advanced physical educations lifts, as well as other machines that are used in the after school program or for injured athletes.

On the first couple of days in the class each semester, the students attend an orientation program which includes a slide show on the lifts and spotting procedures that are used in the program. The students hear a lecture on strength training principles and class organization
A Regression Analysis: The Effect of Gender on Student Athletes' Strength Gains

procedures. Many of the sophomore students have already been exposed to the strength training program as a part of the spring freshman orientation sessions or as a part of the summer weight program.

Four (Monday, Tuesday, Thursday, Friday) of the five days in the class are spent in the weight room. Wednesdays are used for power training. On two of the days students are assigned to upper body lifts, and on the other two days the students are assigned to lower body lifts. On any given lifting day, half of the students are lifting lower body and the others are lifting upper body. The five upper body stations are bench press, bicep curl, dumbbell military press, a combination station of lat pull down and tricep push down, and a combination station which includes back extension and abdominal work. The five lower body stations are squat, heel raises, power clean, leg extension, and leg curl.

The Wednesday workout is designed to enhance the athletes' upper body power, lower body power, footwork, and flexibility. The exercises that are utilized on Wednesdays include jumps in place, repeated jumps, and medicine ball passes that emphasize plyometric principles involving short ground contact time and quick explosive change of direction.

Each student has a workout partner. Every student is given a workout card. The workout card is uniquely numbered in a way that will assign each pair to a different starting station, machine number, and region of the body. Each day a sign is posted telling the students which side of the body he or she will be working on and which station that pair will start at.

The class periods at Ben Davis High School are fifty-five minutes in length. The athletes pick up their cards and move to their assigned starting station. The warm-up procedure begins with two to three minutes of simulated rope jumping at the first station. All of the
A Regression Analysis: The Effect of Gender on Student Athletes' Strength Gains

athletes then do fifteen pushups if they are on their upper body day, and fifteen air squats if they are on their lower body day. After the warm-up is completed, the students begin with the first exercise. The students are at each exercise for seven minutes. A clock keeps track of the time on the wall and beeps to signify when athletes should rotate to the next station. The entire workout takes thirty-five minutes.

The athletes are tested every nine weeks. The program is cycled to ready the students for this testing. The sets and repetitions are listed in the table below.

<table>
<thead>
<tr>
<th>WEEK</th>
<th>BENCH-SQUAT-CLEAN “BIG 3” LIFTS</th>
<th>OTHER LIFTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 SETS OF 12 REPS.</td>
<td>3 SETS OF 12 REPS.</td>
</tr>
<tr>
<td>2</td>
<td>3 SETS OF 10 REPS.</td>
<td>3 SETS OF 10 REPS.</td>
</tr>
<tr>
<td>3</td>
<td>3 SETS OF 10 REPS.</td>
<td>3 SETS OF 10 REPS.</td>
</tr>
<tr>
<td>4</td>
<td>3 SETS OF 8 REPS.</td>
<td>3 SETS OF 10 REPS.</td>
</tr>
<tr>
<td>5</td>
<td>3 SETS OF 8 REPS.</td>
<td>3 SETS OF 10 REPS.</td>
</tr>
<tr>
<td>6</td>
<td>3 SETS OF 6 REPS.</td>
<td>4 SETS OF 8 REPS.</td>
</tr>
<tr>
<td>7</td>
<td>3 SETS OF 6 REPS.</td>
<td>4 SETS OF 8 REPS.</td>
</tr>
<tr>
<td>8</td>
<td>6 REPS./4 REPS./2 REPS.</td>
<td>4 SETS OF 8 REPS.</td>
</tr>
<tr>
<td>9</td>
<td>6 REPS./4 REPS./2 REPS.</td>
<td>4 SETS OF 8 REPS.</td>
</tr>
</tbody>
</table>

Students are tested for their one repetition maximum in the bench press, the squat, and the power clean over a period of three days, with one test completed per day. All of the students are allowed five attempts at each of the lifts, whether their attempts are missed or made. Their body weight and reach are also tested at this time. These results are recorded each nine weeks on
max-out sheets. These sheets are used to track the progress of the athlete during his or her tenure in the advanced physical education class. This data was the basis for the research that was completed for this thesis (K. Vanderbush, personal communication, March, 16, 2011).

Section II

This paper looks to study what specific changes in variables cause strength gains. This was done through the use of regression analysis. Regression analysis is used for modeling and analyzing several variables. Regression analysis artificially holds constant every variable except the two that are focused on, and then shows how those two co-vary. Alan Sykes, a professor at the University of Chicago, describes regression analysis as:

"...a statistical tool for the investigation of relationships between variables. Usually, the investigator seeks to ascertain the causal effect of one variable upon another—the effect of a price increase upon demand, for example, or the effect of changes in the money supply upon the inflation rate. To explore such issues, the investigator assembles data on the underlying variables of interest and employs regression to estimate the quantitative effect of the causal variables upon the variable that they influence. The investigator also typically assesses the 'statistical significance' of the estimated relationships, that is, the degree of confidence that the true relationship is close to the estimated relationship" (Sykes, 1992, p. 1).

The author of this thesis wishes to identify and quantify the factors that determine strength gains while participating in the advanced physical education class. The effect of gender will also be considered. At the outset of any regression study, one formulates some hypothesis about the relationship between the variables of interest. Some background information is
necessary in order to formulate these hypotheses. In order to make pertinent hypotheses, a literary review on relevant topics was completed.

In an article titled “Gender- and Height-related Limits of Muscle Strength in World Weightlifting Champions,” the authors assess the factors that limit human muscle strength and growth. The authors compared the relationship among various body dimensions and the sum of weights lifted. They plotted these results on graphs and used the graphs to make conclusions. By using weightlifting champions, they were assuming that other causes of variability were essentially nullified.

“Gender differences in strength and muscle growth are well known and expected. Women body builders cannot achieve the same muscle cross-sectional areas as men. This consideration leads to the expectation, found in lighter body-weight classes here, that women are taller than men in the same class. In the heavier classes, however, they were shorter than men of the same weight. The transition from taller at lighter weights to shorter at heavier weights was associated with increases in body thickness, indicated by the increased weight-height index, beginning at lighter weights for women. When corrections are made for the difference at which the transition occurred, the ratios of weight lifted to cross-sectional area for women and men were found to be a constant 70% across all body-weight-limited classes” (Ford, Detterline, Ho, Cao, 2000, Gender effects section, para. 1).

From this article, it can be expected that males will be stronger than females and that height is not necessarily an indicator of strength. There was some evidence that being heavier allowed for an increased amount of cross-sectional muscle which in turn allowed a person to be stronger.
Another article, titled “Men vs. Women - Muscle, Strength, Exercise and Results,” suggests, “Male and female muscle tissue is essentially identical, and responds in similar manner to strength training... Although females typically have less muscle than males, the muscle adapts to progressive resistance exercise in the same way” (Westcott, 2007, para. 1). The author of the article, Wayne Westcott, goes on to examine the differences in genders through multiple lenses. He first looks at direct strength where he finds that men are approximately 50% stronger on a 10-repetition average of leg extension than women. Westcott claims that the comparison is not relevant, though, because the males weighed almost 50 pounds more than the females on average. His next analysis compared results that were adjusted for body weight. Males remained stronger than females with this comparison as well. He then contends that women’s body weight is made up of a higher percentage of fat than men’s. His next comparison used the weight lifted divided by the subjects’ lean (muscle) weight. With this comparison, Westcott found that both males and female could perform 10 leg extensions with about 75% of their lean weight (Westcott, 2007).

The next article that was considered stated similar results as the previous articles. In Jack Wilmore’s article, “Alterations in Strength, Body Composition and Anthropometric Measurements Consequent to a 10-Week Weight Training Program,” he gathered a group of 73 volunteers to participate in a 10-week training program:

“Assessments of strength, body composition and anthropometric girths, diameters and skinfolds were made at the beginning and at the conclusion of the study period. Both groups made similar relative gains in strength and absolute gains in body composition. The men were stronger than the women for all strength measures, although the women
exhibited greater leg strength when expressed relative to lean body weight” (Wilmore, 1974).

This study’s results suggest that relative strength gains and absolute gains during the 10 weeks of training were similar for males and females. Wilmore, much like Westcott, found that strength relative to lean muscle mass was similar in males and females. This is the first article that has suggested the possibility of females having greater leg strength when comparisons are made relative to lean muscle mass.

Section III

This thesis looks at 545 athletes, of which 351 are male and 194 are female, enrolled in Advanced Physical Education from 2001 to 2010. These 545 athletes were chosen using the following criteria:

- The athlete must have completed all three 1-rep maxes during the first testing period and last testing period on the max-out sheets. All athletes that were injured for one or more of the lifts, or were absent and didn’t make up the lift, were not included.
- All athletes must have also had a beginning and ending body weight and reach.
- Athletes with many semesters of incomplete lifts were also omitted.

Data entry was then completed. Data was transferred from paper max-out sheets to a computerized spreadsheet. Various check points were used to minimize errors during the transcribing process. Results from each athlete’s first bench, squat, and clean maxes were summed to represent a single beginning strength amount. This summation of bench, squat, and clean is known as the “Big 3”. Results from each athlete’s last testing period were also entered. The spreadsheet was utilized to calculate differences between first and last values. The
dependent variables that are being studied are: total strength change in “Big 3” maxes (LBSChange) and percentage change of “Big 3” maxes (PerChange). Descriptive statistics for these variables have been included in the Appendix.

- **LBSChange** is the difference from the first “Big 3” testing period results to the last testing period results:
  \[
  LBSChange = \text{Last “Big 3”} - \text{First “Big 3”}
  \]

- **PerChange** is the change in “Big 3” divided by the first “Big 3”:
  \[
  PerChange = \frac{LBSChange}{\text{First “Big 3”}}
  \]

The independent variables being used are: TestPeriods, WeightChange, ReachChange, Female, and FirstBig3.

- **TestPeriods** is the number of 9-week periods that a student is participating in the Advanced Physical Education class.
- **WeightChange** is the difference in pounds between the last body weight and the first body weight.
- **ReachChange** is the difference in inches between the last reach and the first reach.
- **Female** is a dummy variable that equals 1 if the athlete is female and 0 if the athlete is male.
- **FirstBig3** is the sum of the first bench max, first squat max, and first clean max.

The variable TestPeriods is used to measure the effectiveness of the program. Both WeightChange and ReachChange are used to represent physical changes that occur during the duration that the student is in the class. FirstBig3 is included to account for differences in
beginning strengths, and how the changes in strength will be affected by each athlete's beginning strength.

The model for multiple linear regressions is:

\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n + \epsilon \]

Where:

- \( Y \) is the dependent variable
- \( X \)'s are the independent variables
- \( \mu \) is the random error term
- \( \beta_i, i = 1, 2, \ldots, n \) are unknown parameters
- \( \beta_0 \) is the constant

Assumptions:

1. The relationship between \( Y \) and \( X \) is linear and correctly specified.
2. The sample used in the study is a random sample of the athletes in the class that fit the criteria previously mentioned.
3. The error term has a zero mean.
4. The error term has a constant variance.
5. The error terms are not correlated.
6. No exact linear relationship between any combinations of the independent variables exists.

Multiple regressions were run with different independent variables used. A computer program called EViews7 was utilized to compute coefficients and other related statistics.

Printouts from many of the regressions will be included in later pages for review. Two of the most relevant runs will be described in detail below.
The regression model for the first is

\[ \text{LBSChange}_i = \beta_0 + \beta_1 \cdot \text{TestPeriods}_i + \beta_2 \cdot \text{WeightChange}_i + \beta_3 \cdot \text{ReachChange}_i + \beta_4 \cdot \text{Female}_i + \beta_5 \cdot \text{FirstBig3} + \epsilon \]

Dependent Variable: LBSCHANGE
Method: Least Squares
Date: 04/21/11  Time: 11:29
Sample: 1 545
Included observations: 545

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESTPERIODS</td>
<td>10.17799</td>
<td>0.740149</td>
<td>13.75129</td>
<td>0.0000</td>
</tr>
<tr>
<td>WEIGHTCHANGE</td>
<td>2.344370</td>
<td>0.210402</td>
<td>11.14232</td>
<td>0.0000</td>
</tr>
<tr>
<td>REACHCHANGE</td>
<td>4.036506</td>
<td>2.206175</td>
<td>1.829640</td>
<td>0.0679</td>
</tr>
<tr>
<td>FEMALE</td>
<td>-69.87001</td>
<td>8.174529</td>
<td>-8.547283</td>
<td>0.0000</td>
</tr>
<tr>
<td>FIRSTBIG3</td>
<td>0.053010</td>
<td>0.026080</td>
<td>2.032610</td>
<td>0.0426</td>
</tr>
<tr>
<td>C</td>
<td>44.47293</td>
<td>15.53138</td>
<td>2.863424</td>
<td>0.0044</td>
</tr>
</tbody>
</table>

R-squared 0.703049  Mean dependent var 171.6697
Adjusted R-squared 0.700294  S.D. dependent var 99.11678
S.E. of regression 54.26188  Akaike info criterion 10.83647
Sum squared resid 1587006.  Schwarz criterion 10.88382
Log likelihood -2946.938  Hannan-Quinn criter. 10.85498
F-statistic 255.2225  Durbin-Watson stat 1.998531
Prob(F-statistic) 0.000000

The estimated equation for males is

\[ \text{LBSChange}_i = 44.47 + 10.18 \cdot \text{TestPeriods}_i + 2.34 \cdot \text{WeightChange}_i + 4.04 \cdot \text{ReachChange}_i + .053 \cdot \text{FirstBig3} \]

The estimated equation for females is

\[ \text{LBSChange}_i = -25.397 + 10.18 \cdot \text{TestPeriods}_i + 2.34 \cdot \text{WeightChange}_i + 4.04 \cdot \text{ReachChange}_i + .053 \cdot \text{FirstBig3} \]
The meaning of $\hat{\beta}_0$:

$\hat{\beta}_0 = 44.47$. This implies that the LBSChange is equal to 44.47 when all other variables are equal to 0.

The meaning of $\hat{\beta}_1$:

$\hat{\beta}_1 = 10.18$. This implies that LBSChange will increase by 10.18 pounds when TestPeriods is increased by 1 and all other variables are held the same.

The meaning of $\hat{\beta}_2$:

$\hat{\beta}_2 = 2.34$. This implies that LBSChange will increase by 2.34 pounds when WeightChange is increased by 1 and all other variables are held the same.

The meaning of $\hat{\beta}_3$:

$\hat{\beta}_3 = 4.04$. This implies that LBSChange will increase by 4.04 pounds when ReachChange is increased by 1 and all other variables are held the same.

The meaning of $\hat{\beta}_4$:

$\hat{\beta}_4 = -69.87$. This implies that if the athlete is female, the beginning $\hat{\beta}_0$ will be decreased by 69.87 pounds.

The meaning of $\hat{\beta}_5$:

$\hat{\beta}_5 = .053$. This implies that LBSChange will increase by .053 pounds when FirstBig3 is increased by 1 and all other variables are held the same.
Based on the literature review, most of these results were not surprising. A positive coefficient, when it comes to gains in strength from a progressive resistance program, is expected. This was confirmed with a t-statistic of 13.75129 which corresponds to greater than 99% confidence that the true value of the coefficient is positive. A positive coefficient for strength, from body weight increases, would also be expected. This was confirmed with a t-statistic of 11.14232 which also corresponds to greater than 99% confidence that the true value of this coefficient is positive. The reach change would correspond to a growing teenager which would also be expected to have a positive coefficient. The t-statistic for this was only 1.829640, which corresponds to over 90% confidence that the true value of this coefficient is positive.

From the literature reviewed, it would also be expected that females would not increase as drastically on a pure strength comparison. This was confirmed with a t-statistic of -8.547283 which corresponds to greater than 99% confidence that the coefficient is negative. The last variable was the FirstBig3. This was an interesting variable. It would be expected that an athlete starting at a higher strength would be closer to his or her potential. It would also be expected that a larger gain would be more easily attained among those with a higher starting strength. Given that this is the first time that many of the athletes had lifted, the latter prevailed, and the coefficient was positive. The t-statistic of 2.032610 corresponded to 95% confidence that the true value of the coefficient is positive.

The second regression model being analyzed is

\[
PerChang_{i} = \beta_0 + \beta_1 \ast TestPeriods_i + \beta_2 \ast WeightChange_i + \beta_3 \ast ReachChange_i \\
+ \beta_4 \ast Female_i + \beta_5 \ast FirstBig3_i + \epsilon
\]
A Regression Analysis: The Effect of Gender on Student Athletes' Strength Gains

Dependent Variable: PERCHANGE
Method: Least Squares
Date: 04/21/11  Time: 11:28
Sample: 1545
Included observations: 545

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESTPERIODS</td>
<td>2.281376</td>
<td>0.167650</td>
<td>13.60799</td>
<td>0.0000</td>
</tr>
<tr>
<td>WEIGHTCHANGE</td>
<td>0.429948</td>
<td>0.047658</td>
<td>9.021549</td>
<td>0.0000</td>
</tr>
<tr>
<td>REACHCHANGE</td>
<td>1.569995</td>
<td>0.499717</td>
<td>3.141771</td>
<td>0.0018</td>
</tr>
<tr>
<td>FEMALE</td>
<td>-19.69972</td>
<td>1.851598</td>
<td>-10.63931</td>
<td>0.0000</td>
</tr>
<tr>
<td>FIRSTBIG3</td>
<td>-0.074675</td>
<td>0.005907</td>
<td>-12.64119</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>50.66987</td>
<td>3.517986</td>
<td>14.40309</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.611730  Mean dependent var: 38.72794
Adjusted R-squared: 0.608128  S.D. dependent var: 19.63390
S.E. of regression: 12.29076  Akaike info criterion: 7.866521
Sum squared resid: 81422.86  Schwarz criterion: 7.913869
Log likelihood: -2137.627  Hannan-Quinn criter.: 7.885031
F-statistic: 169.8416  Durbin-Watson stat: 1.974241

The estimated equation for males is

\[ \text{PerChange}_i = 50.67 + 2.28 \times \text{TestPeriods}_i + 0.43 \times \text{WeightChange}_i + 1.57 \times \text{ReachChange}_i - 0.075 \times \text{FirstBig3}_i \]

The estimated equation for females is

\[ \text{PerChange}_i = 30.97 + 2.28 \times \text{TestPeriods}_i + 0.43 \times \text{WeightChange}_i + 1.57 \times \text{ReachChange}_i - 0.075 \times \text{FirstBig3}_i \]

The meaning of \( \hat{\beta}_0 \):

\( \hat{\beta}_0 = 50.67 \). This implies that the PerChange is equal to 50.67% when all other variables are equal to 0.
The meaning of $\hat{\beta}_1$:

$\hat{\beta}_1 = 2.28$. This implies that PerChange will increase by 2.28 percent when TestPeriods is increased by 1 and all other variables are held the same.

The meaning of $\hat{\beta}_2$:

$\hat{\beta}_2 = .43$. This implies that PerChange will increase by .43 percent when WeightChange is increased by 1 and all other variables are held the same.

The meaning of $\hat{\beta}_3$:

$\hat{\beta}_3 = 1.57$. This implies that PerChange will increase by 1.57 percent when ReachChange is increased by 1 and all other variables are held the same.

The meaning of $\hat{\beta}_4$:

$\hat{\beta}_4 = -19.7$. This implies that if the athlete is female, the beginning $\hat{\beta}_0$ will be decreased by 19.7 percent.

The meaning of $\hat{\beta}_5$:

$\hat{\beta}_5 = -.075$. This implies that PerChange will decrease by .075 percent when FirstBig3 is increased by 1 and all other variables are held the same.

Much like with the last regression, most of these results were not surprising. A positive coefficient, when it comes to gains in strength from a progressive resistance program, is expected. This was confirmed with a t-statistic of 13.61 which corresponds to greater than 99% confidence that the true value of the coefficient is positive. A positive coefficient for strength
from increases in body weight would also be expected. This was confirmed with a t-statistic of 9.022 which also corresponds to greater than 99% confidence that the true value of this coefficient is positive. The reach change would correspond to a growing teenager which would also be expected to have a positive coefficient. The t-statistic for this was 3.14. A change in reach was shown to be significant with 99% confidence. The variable FirstBig3 was used to offset any advantage that females may have from starting at a lower starting strength. Just as expected, the variable had a negative coefficient with a t-statistic of -12.64 which is also significant at a very high level. From the literature reviewed, it would be expected that females would begin to close the gap on males in percentage increases in response to a program like this. The coefficient was still found to be negative with a t-statistic of -10.639 which corresponds to greater than 99% confidence that the coefficient is negative.

This study was different than most of the others reviewed, because it considers increases in strength rather than just strength. Most studies tend to use untrained subjects and run for a shorter duration of time. It is also common to pre-test subjects. The fact that all of the athletes in this study had strength trained for at least 9 weeks makes these results difficult to compare to other studies. It is also difficult to evaluate the effects of different training regimens and/or subjects when varying pre-training statuses have been compared. "A regression analysis can demonstrate correlation, but it doesn't prove cause. X can cause Y; Y can cause X; or it may be that some other factor is causing both X and Y. A regression alone can't tell you whether it snows because it's cold, whether it's cold because it snows, or if the two just happen to go together" (Levitt & Dubner, 2009, p. 164-165). Just like the snow and cold example, it is tough to say whether strength gains cause body weight gain or whether body weight gain causes strength gains. Based on regression alone, it is difficult to tell.
Given all of this, the results were still fairly conclusive. The $R^2$ values from both of the regression runs show the "goodness of fit" of the independent variables in explaining the dependent variable. For the first regression run that was analyzed, the adjusted $R^2$ value was .700294. This means that close to 70% of the variation in LBSChange can be explained by the independent variables used. For the second regression run that was analyzed, the adjusted $R^2$ value was .608128. This means that close to 61% of the variation in PerChange can be explained by the independent variables. The variables used were both pretty successful in explaining the variation in pure strength gained and relative strength gained.
Bibliography


Appendix
A Regression Analysis: The Effect of Gender on Student Athletes’ Strength Gains

<table>
<thead>
<tr>
<th>Change in Big 3</th>
<th>Percent Change in Big 3</th>
<th>First Big 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>171.67</td>
<td>38.73</td>
</tr>
<tr>
<td>Standard Error</td>
<td>4.25</td>
<td>0.84</td>
</tr>
<tr>
<td>Median</td>
<td>165</td>
<td>36.21</td>
</tr>
<tr>
<td>Mode</td>
<td>95</td>
<td>50</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>99.12</td>
<td>19.63</td>
</tr>
<tr>
<td>Sample Variance</td>
<td>9824.14</td>
<td>385.49</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.02</td>
<td>0.64</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.65</td>
<td>0.73</td>
</tr>
<tr>
<td>Range</td>
<td>505</td>
<td>121.19</td>
</tr>
<tr>
<td>Minimum</td>
<td>5</td>
<td>1.67</td>
</tr>
<tr>
<td>Maximum</td>
<td>510</td>
<td>122.86</td>
</tr>
<tr>
<td>Sum</td>
<td>93560</td>
<td>21106.73</td>
</tr>
<tr>
<td>Count</td>
<td>545</td>
<td>545</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in Body Weight</th>
<th>Change in Reach</th>
<th>Last Big 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>12.4569</td>
<td>0.9312</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.575</td>
<td>0.0525</td>
</tr>
<tr>
<td>Median</td>
<td>11</td>
<td>0.5</td>
</tr>
<tr>
<td>Mode</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>13.4239</td>
<td>1.2256</td>
</tr>
<tr>
<td>Sample Variance</td>
<td>180.2008</td>
<td>1.5022</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.7873</td>
<td>11.0129</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.5497</td>
<td>2.5853</td>
</tr>
<tr>
<td>Range</td>
<td>121</td>
<td>11.5</td>
</tr>
<tr>
<td>Minimum</td>
<td>-50</td>
<td>-1</td>
</tr>
<tr>
<td>Maximum</td>
<td>71</td>
<td>10.5</td>
</tr>
<tr>
<td>Sum</td>
<td>6789</td>
<td>507.5</td>
</tr>
<tr>
<td>Count</td>
<td>545</td>
<td>545</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Testing Periods</th>
<th>Mean</th>
<th>Standard Error</th>
<th>Median</th>
<th>Mode</th>
<th>Standard Deviation</th>
<th>Sample Variance</th>
<th>Kurtosis</th>
<th>Skewness</th>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Sum</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.3890</td>
<td>0.1524</td>
<td>10</td>
<td>12</td>
<td>3.5582</td>
<td>12.6609</td>
<td>-0.8947</td>
<td>-0.4493</td>
<td>13</td>
<td>2</td>
<td>15</td>
<td>5117</td>
<td>545</td>
</tr>
</tbody>
</table>
Covariance Analysis: Ordinary

Date: 04/28/11  Time: 11:17

Sample: 1545

Included observations: 545

<table>
<thead>
<tr>
<th>Correlation</th>
<th>FEMALE</th>
<th>FIRSTBIG3</th>
<th>LBSCHANGE</th>
<th>PERCHANGE</th>
<th>REACHCHANGE</th>
<th>TESTPERIODS</th>
<th>WEIGHTCHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALE</td>
<td>0.229253</td>
<td>1.000000</td>
<td>20283.60</td>
<td>20283.60</td>
<td>6965.813</td>
<td>108.1081</td>
<td>510.0187</td>
</tr>
<tr>
<td></td>
<td>-51.31423</td>
<td>-0.752502</td>
<td>633457</td>
<td>633457</td>
<td>6965.813</td>
<td>108.1081</td>
<td>510.0187</td>
</tr>
<tr>
<td>FIRSTBIG3</td>
<td>-30.03473</td>
<td>0.633457</td>
<td>-0.633457</td>
<td>-0.633457</td>
<td>0.493913</td>
<td>0.493913</td>
<td>0.493913</td>
</tr>
<tr>
<td>LBSCHANGE</td>
<td>-3.066476</td>
<td>-34.27296</td>
<td>1605.174</td>
<td>1605.174</td>
<td>9806.111</td>
<td>9806.111</td>
<td>9806.111</td>
</tr>
<tr>
<td>PERCHANGE</td>
<td>-0.326493</td>
<td>-0.122268</td>
<td>0.826354</td>
<td>0.826354</td>
<td>1.000000</td>
<td>1.000000</td>
<td>1.000000</td>
</tr>
<tr>
<td>REACHCHANGE</td>
<td>-0.154406</td>
<td>2.295135</td>
<td>45.76168</td>
<td>45.76168</td>
<td>11.07010</td>
<td>11.07010</td>
<td>11.07010</td>
</tr>
<tr>
<td>TESTPERIODS</td>
<td>-0.439384</td>
<td>108.1081</td>
<td>217.7175</td>
<td>217.7175</td>
<td>40.20011</td>
<td>40.20011</td>
<td>40.20011</td>
</tr>
<tr>
<td>WEIGHTCHANGE</td>
<td>-2.045202</td>
<td>510.0187</td>
<td>864.0903</td>
<td>864.0903</td>
<td>147.2816</td>
<td>147.2816</td>
<td>147.2816</td>
</tr>
</tbody>
</table>