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Acute effects of traditional resistance training exercises with the addition of elastic bands on upper- and lower- body power output

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Acute Effects of Traditional Resistance Training Exercises with the Addition of Elastic Bands on Upper- and Lower-Body Power Output

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Capstone Approval Page

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ABSTRACT (100-200 WORDS):

This study was designed with the purpose of examining the acute effects of adding elastic bands to traditional resistance training exercises on upper- and lower-body muscular power output.

All of the tests utilized the same format of taking a pre-test power measurement, implementing an intervention exercise, and performing post-test power measurements. For the upper body tests, the intervention exercises included the standard bench press, the bench press with the addition of resistance bands, and a control with no exercise. Pre- and post-test power measurements were done using the bench press with a specified light weight. For the lower body

tests, the intervention exercises included the standard back squat, the back squat with the addition of resistance bands, and a control with no exercise. Pre- and post-test power measurements were done by timing a 10-yard sprint.

The only significant finding was that the post-test sprint times were lower between two and four minutes after performing the back squat with the addition of the resistance bands.

This finding could potentially be useful in implementing the use of these bands in the training of athletes looking to increase lower-body power output if confirmed in similar future studies.

Introduction

The way that athletes train for competition is constantly being changed as new techniques are developed, studied, and evaluated. Learning and mastering the latest and most proven exercises can be of utmost importance to those athletes who seek to stay ahead of the curve and gain a competitive advantage over opponents. Traditional resistance training exercises (i.e. using a barbell loaded with weight plates or using a dumbbell) have been one of the most commonly used ways of enhancing the performance of athletes for some time. Performing these same exercises, with the addition of elastic resistance bands, however, is something that is becoming more prevalent in the training programs of athletes whose competition requires an increased amount of muscular power output.

Muscular power refers to one's ability to produce a maximal amount of force in the least amount of time. Examples of these types of athletes can include short-distance sprinters, basketball players (most notably in jumping ability), and any types of throwers (i.e. quarterbacks in football, pitchers in baseball, and track and field throwers).

Resistance bands are being added to the traditional exercises due to the way that they slightly change the resistance load that is being moved for the exercises. The traditional lifts often utilize either a barbell loaded with weight plates or a dumbbell. In either case, the amount of resistance throughout the entire range of motion of the exercise remains exactly the same. As a result of this, there is a deceleration phase towards the end of the concentric portion of the exercise (i.e. raising the bar in the bench press or coming up during a back squat). Elastic bands, though, do not have a constant resistance load throughout the entire exercise. During the concentric portion of the exercise, the bands actually lengthen. As they lengthen, the tension in the bands increases, and the resistance level increases. So, as the load increases throughout the entire concentric movement, the athlete is forced to accelerate throughout the entire lift. This acceleration period then, in theory, better simulates the fast generation of force that is desired by the previously mentioned athletes whose sports require a high level of muscular power output (Wallace, Winchester, & McGuigan, 2006).

While elastic bands have been used for some time in rehabilitation, the bands used in performance enhancement training programs are much different, in that they are much thicker and are able to offer a rather high level of resistance. Because they are a somewhat new addition to the world of strength and conditioning, there is little actual scientific research on the way that their use impacts an athlete's muscular power output (Stevenson, Warpeha, Dietz, Giveans, and Erdman, 2010).

This study, then, was designed with the intent of examining how performing exercises with the addition of elastic bands acutely impacts upper- and lower-body power output, in comparison to the same exercises performed in a traditional manner without the bands.

Methods

Experimental Approach

In examining the effects of power output created by the differing resistance exercises, this study required seven days of testing per subject. All testing for all subjects was completed within a five week period. The first test day for each subject involved determining his/her 1-rep max (1-RM) for both the bench press and back squat. This is the maximum amount of weight that can be lifted for a single repetition. The 1-RM of each subject had no impact on the results of the study, but was necessary for determining the amount of resistance required for the other tests.

There were three tests each for both upper- and lower-body. All six of the tests used the same basic format, which consisted of taking power output measurements, inducing some sort of intervention exercise, and then retaking power output measurements. The measurements for the upper-body tests were made using a traditional barbell bench press. Those for the lower-body tests were made using a 10-yard sprint. The three days each of testing for both upper-and lower-body included an intervention of a traditional resistance exercise (barbell bench press for upper-body and barbell back squat for lower-body), the same exercise with a portion of the resistance coming from bands, and a control day for which no intervention other than a rest period was utilized between power measurements.

Also, a standard dynamic warm-up routine was created and performed by each subject prior to testing on each day. A separate routine was designed for the upper- and lower-body test days.

Subjects

Eleven recreationally resistance-trained male students and one female, all from the Kinesiology and Physical Education (KNPE) Department at NIU volunteered and completed the study. Several others underwent parts of the study but were unable to complete it. Approval for the use of human subjects was requested and obtained from the NIU Institutional Review Board prior to any testing taking place. Also, all subjects completed a medical history form to confirm that no pre-existing conditions were present that would disqualify them from participation, which can be found in Appendix A.

Upper Body Testing

The upper-body portion of the study required three separate days of testing for each subject. None of these testing days were permitted to occur on consecutive days to avoid any possible soreness from previous tests having an impact on subject performance.

One of the testing days was used to examine the effects of using the standard barbell bench press as an intervention. For this, each subject first had his/her power output recorded by performing five repetitions of the bench press as fast as possible at 55% of the 1-RM. 55% of the

1-RM was chosen because it is approximated to be the amount of resistance that that allows for peak power production (Stevenson et al., 2010). The subjects then performed six sets of two repetitions of the bench press at 85% of the 1-RM with a 90-120 second rest between each set. Immediately following the final set, a post-test measurement of power was then taken. This was performed in the same manner as the pre-test, with the subjects bench pressing 55% of his/her 1-RM as fast as possible, but only for three repetitions this time. Four more post-test measurements were made with exactly 60 seconds between each measurement, resulting in a total of five post-test measurements of power output.

Another testing day was performed in the exact same way, with the only difference being in the resistance of the intervention exercise. Again, the subjects bench pressed 55% of their 1-RM as fast as possible for five repetitions for the pre-test measurements. As in the other test, the intervention required the subjects to perform six sets of two repetitions of the bench press at 85% of the 1-RM with 90-120 second breaks between each set. This time, however, 30-40% of the resistance for each repetition of the bench press came from bands, with the remaining portion still coming from the barbell and weight plates. Thus, the total amount of weight lifted was the same for each test, but this one utilized the elastic bands as a percentage of that resistance. Following the final set, as in the previous test, a post-test measurement of power output was taken immediately with the subject performing three repetitions of the bench press at 55% 1-RM as fast as possible. Four more measurements were made with 60 seconds occurring between each, for a total of five post-test measurements.

The final upper-body test day was a control test. The purpose of the control test was to confirm that the lapse in time between pre- and post-test power measurements was not at all responsible for any potential differences between the measurements. For this, the same exact pre-test format was used as in the other two tests. Instead of using any sort of intervention, no exercises were performed, and the subject simply rested for a five minute period. Following the five minutes, the subject then performed the same post-test format as the other two tests to obtain a total of five measurements of power output.

Lower-Body Testing

The lower-body tests also required the subjects to complete three days of testing. The basic format was very similar to that of the upper-body tests, with only minor differences. Again, testing on consecutive days was not allowed in the study.

The first day of lower-body tests involved using the standard barbell back squat as an intervention exercise. Pretest timings of three 10-yard sprints were initially made. Following the sprints, subjects performed six sets of two repetitions of the back squat at 85% 1-RM with 90-120 second breaks between each set. Following the final set, another 10-yard sprint was timed immediately. Four more sprints were timed at exact 60 second intervals, for a total of five post-test timings.

The second day of lower-body tests again included three timed pre-test 10-yard sprints. Following the sprints, six sets of two repetitions of the back squat were performed at 85% 1-RM with 90-120 seconds rest between sets. This test, however, differed from the previous one in that 30-40% of the resistance in this test was the result of bands. Again, as in the upper-body tests, the total resistance for each repetition in both the standard exercise and standard exercise with bands was the exact same amount, with the only difference being that the bands comprised part of the total resistance in this one. A 10-yard sprint was timed immediately following the final set of squats. Four more sprints were timed at exact 60 second intervals, for a total of five post-test timings.

The final lower-body test was the control test. Again, three 10-yard sprints were timed and recorded. Instead of performing any squats as an intervention, however, the subjects simply did no exercise and rested for five minutes. Five 10-yard sprints were then timed and recorded at 60 second intervals upon completion of the five minute rest period.

Equipment

EliteFTS Pro Bands were the specific resistance bands used in this study. Because the resistance offered by the bands varies as the length of the band changes, a chart showing the resistance of these bands at different lengths was used. These charts can be found in Appendix B. During testing, measurements of the height of the bar at its highest point of the exercise were made for both the bench press and back squat, allowing for the resistance to be properly calculated. Whatever weight was needed to reach the 85% 1-RM required for the intervention exercise was then added with the barbell and weight plates. Also, since most athletes are able to handle more resistance on the back squat than the bench press, a thicker band that offered a greater level of resistance was used for the back squat. For the bench press, the red *"Mini" EFS Pro Short Band* was used. For the back squat, the black *"Monster Mini" EFS Pro Long Band* was used.

The Dynofit Tendo Power Analyzer was used to measure the power output on the bench press in the upper-body tests in Watts. The device gave efficient and accurate readings and was borrowed from the NIU Athletic Department. Also, the 10-yard sprints in the lower-body tests were timed using the Brower Timing System. The device used sensors to automatically and accurately make measurements as precise as a hundredth of a second. It belonged to the KNPE Department at NIU. Both of these devices eliminated the human error aspect of making such measurements.

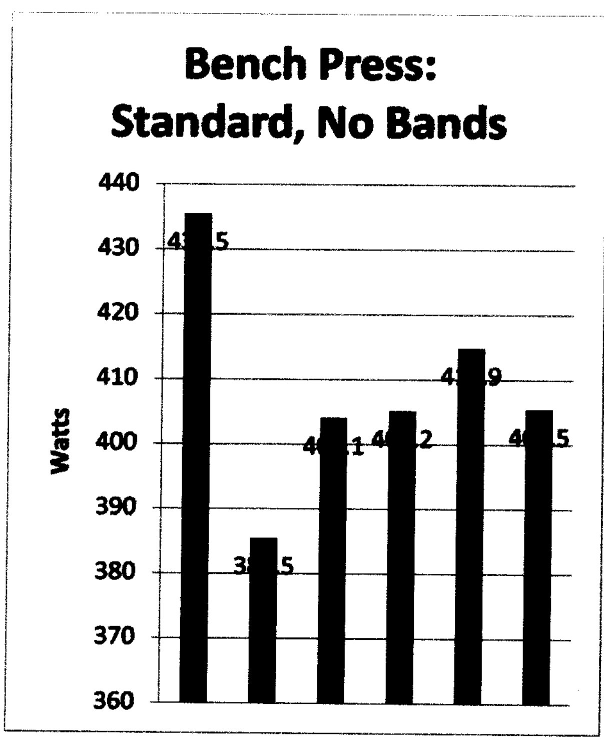
Results

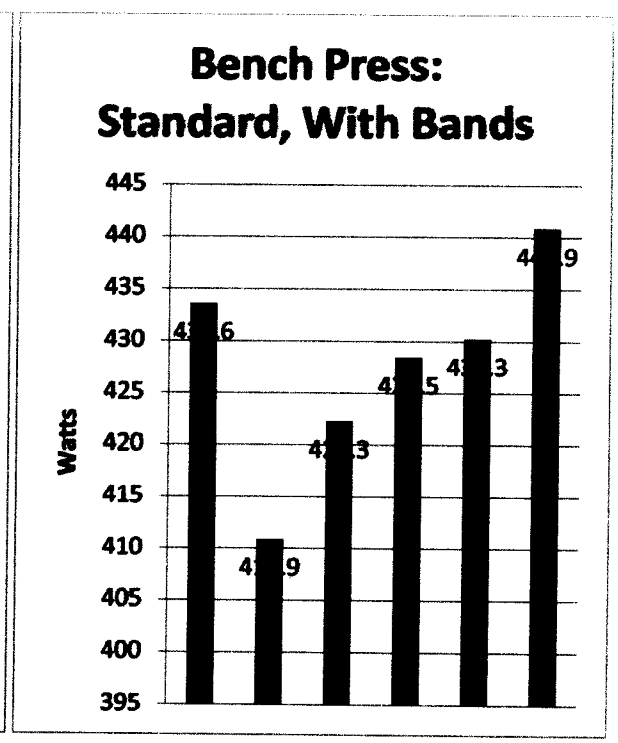
For each of the six tests (Upper/Lower Body Standard, Upper/Lower Body Standard with Bands, and Control), the mean averages and standard deviations were calculated for both pre-test and at each post-test time interval. The numbers for each individual post-test measurement (Immediate, 1-minute, 2-minute, 3-minute, and 4-minute) were compared to those of the pre-test measurements of the respective test, as to determine whether or not there was a significant difference between the specific post-test time interval and the pre-test values. All of these specific calculations can be found in Appendix C.

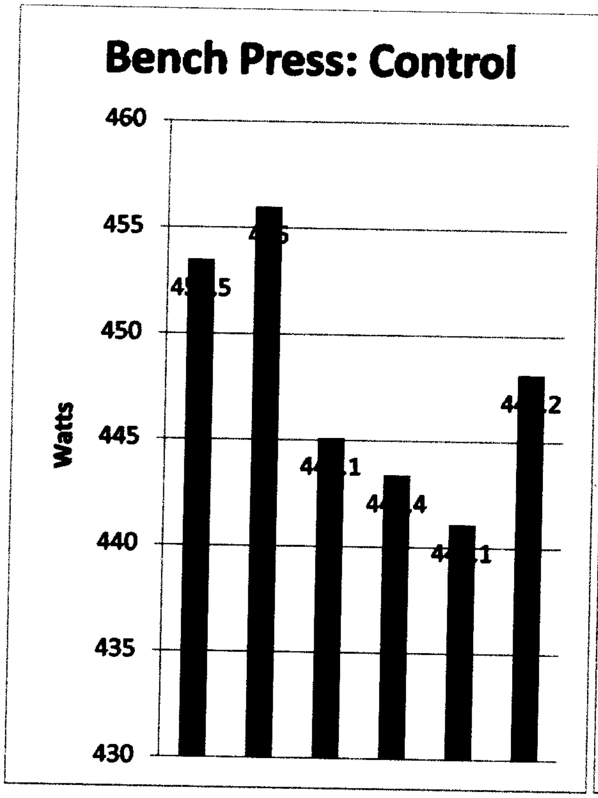
For the upper body test, there was found to be a statistically significant decrease in power output in the immediate post-test when the standard bench press was used without bands, as compared to the pre-test output. Nothing significant was found at any other time interval. There was also a significant decrease in power output when bench press with bands was used as an intervention in the immediate post-test, though no other time intervals in the post-test showed any significant differences. The control test showed no significant differences between the pre-test power output measurements and any of the post-test measurements.

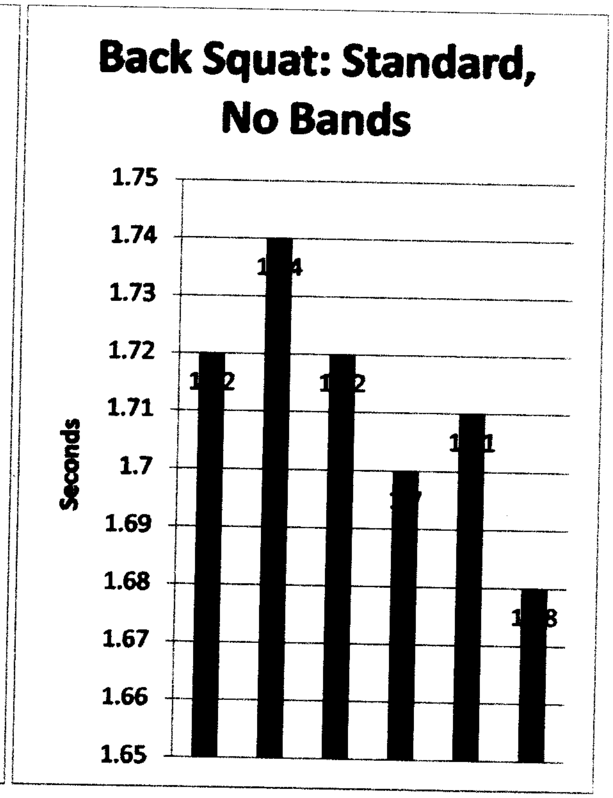
For the lower-body test, no significant differences in the sprint times were discovered in any of the post-test intervals when the standard back squat was performed. The test that used the back squat with the bands, however, did show a significant decrease in sprint time in the post-tests at between the two- and four-minute intervals when compared to the pre-test times. The control test showed no significant differences in sprint times at any of the post-test intervals.

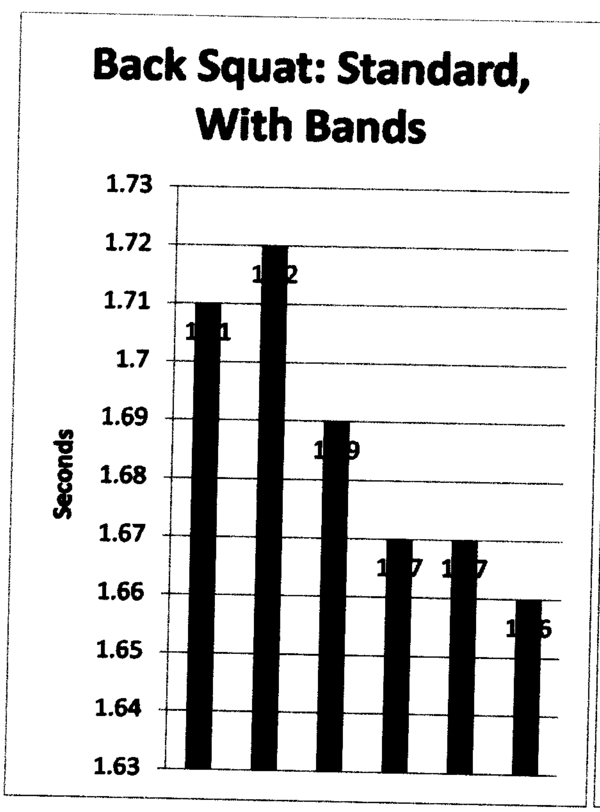
The following graphs depict the mean averages of the initial pre-test measurements in comparison to the mean averages of the five post-test measurements for each respective test.

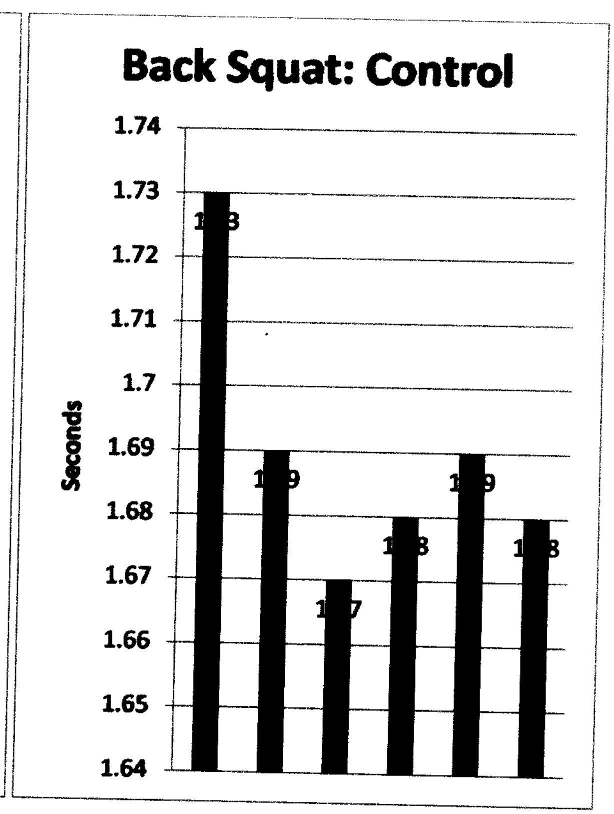





Bench Press: Control
Watts
460
455
450
445
440
435
430


Back Squat: Standard, No Bands
Seconds
1.75
1.74
1.73
1.72
1.71
1.7
1.69
1.68
1.67
1.66
1.65


Back Squat: Standard, With Bands
Seconds
1.73
1.72
1.71
1.7
1.69
1.68
1.67
1.66
1.65
1.64
1.63


Back Squat: Control
Seconds
1.74
1.73
1.72
1.71
1.7
1.69
1.68
1.67
1.66
1.65
1.64

Discussion

The only significant and useful finding in this study appears to be the decrease in 10-yard sprint times in the range of two to four minutes after performing the squats with the addition of the resistance bands. Utilizing heavy resistance bands as a means of warming up just prior to competition, as was simulated in this study, could potentially enhance the peformance of certain athletes, according to these results. Were this to be expounded upon and found to be true in similar future studies, this could in fact alter the way athletes warm-up for competition that involves a need for a high level of power output. These athletes include, but are not limited to, track sprinters and football players. Any other athlete who often uses short sprints would also fall into this category. Again, this study was formulated due to the fact that there appears to be a lack of much scientific literature that examines the effects of using the bands, so more investigation is required for any firm conclusions to be drawn.

The only other statistical differences that were found in the study were in the immediate post-test measurements of the standard bench press and the bench press with bands. These are not all that surprising, though, as the subjects were most likely tired from just completing the sixth set of bench pressing a heavy weight (85% 1-RM) and were not allowed any rest period. This does not simulate a real-life competitive situation very well, in that it is unlikely that an athlete would do a heavy resistance exercise and immediately begin competition without any break period. Thus, this decrease in performance is not very meaningful.

While this study focused on the acute effects of using the resistance bands in a standard exercise on power output, it is important to note that the long-term effects of training with these bands has yet to be examined in much detail. All of the subjects in this study informally commented on how much different the exercises felt when the bands were used. Though some liked the difference more than others, the fact that they all noted the difference between the two types of lifting is very important. How specific an athlete trains to his/her sport can have a large impact on enhancing that athlete's performance. Thus, utilizing the difference in the way the bands cause a person to exercise, an athlete whose primary focus is muscular power may have a lot to gain from undergoing a long-term workout program that focuses on the use of these bands. Though this was not investigated in this study, it is not unreasonable to think that future studies could come to this conclusion.

References

Stevenson, Mark, W., Warpeha, Joseph, M., Dietz, Cal, C., Giveans, Russell, M., & Erdman, Arthur, G. (2010). Acute Effects of Elastic Bands During the Free-Weight Barbell Back Squat Exercise on Velocity, Power, and Force Production. *Journal of Strength and Conditioning Research, 24(11)*, 2944-2954.

Wallace, Brian, J., Winchester, Jason, B., & McGuigan, Michael, R. (2006). Effects of Elastic Bands on Force and Power Characteristics During the Back Squat Exercise. *Journal of Strength and Conditioning Research, 20(2)*, 268-272.

HEALTH HISTORY QUESTIONNAIRE
KINESIOLOGY AND PHYSICAL EDUCATION RESEARCH

Name: ________________________________ Email:________________________

Phone:________________________

Gender: ________________ Age: ______________

PART I: KNOWN DISEASES

Do you currently have:

______Cardiovascular disease, peripheral vascular disease, and/or cerebrovascular disease?
______Asthma?
______Interstitial lung disease?
______Cystic fibrosis?
______Chronic Obstructive Pulmonary Disease (COPD)?
______Diabetes (Type 1 or 2)?
______Any thyroid disorders?
______Renal or liver disease?

PART II: SIGNS AND SYMPTOMS

______Do you experience pain and/or discomfort in the chest, neck, jaw, arms, or other areas during mild exercise?
______Do you feel short of breath at rest, with typical, daily activities, or with mild exercise?
______Do you feel short of breath while lying down flat?
______Are you awoken in the middle of night due to feeling short of breath and/or severe coughing/weezing?
______Do you often feel dizzy at rest or with mild exercise?
______Do you suddenly pass out or lose consciousness while at rest or with mild exercise?
______Have you experience ankle edema (swollen ankles)?
______Do you have heart palpitations and/or tachycardia at rest or with mild exercise?
______Do you suffer from muscle cramping, burning, numbness, or fatigue in your calf muscles at rest or with mild exercise?
______Do you have a known heart murmur?
______Do you have unusual fatigue with typical, daily activities?
______Are you pregnant (if female)?

PART III: CORONARY ARTERY DISEASE RISK FACTORS

______Are you a male older than 45 years, or a female older than 55 years?
______Do you have a close blood relative who has had a heart attack or heart surgery before the age of 55 (Dad, Brother) or age 65 (Mom, Sister)?
______Do you smoke, or did you just quit smoking within the past 6 months?
______For the last 3 months, do you get less than 30 minutes of moderate-intense exercise, less than 3 days per week?
______Are you at least 20lbs overweight?

______Is your blood pressure over 140/90 mmHg, or are you on blood pressure medication?
______Is your cholesterol greater than or equal to 200 mg/dL, or are you on cholesterol medication?
______Is your fasting glucose greater than or equal to 100 ml/dL?

PART IV: MUSCULOSKELETAL CONDITIONS

______Do you have musculoskeletal problems that limit what/how you exercise?
______Have you had a major musculoskeletal injury (broken bones, torn ligaments/tendons, etc.) that has limited your ability to exercise in the past 12 months?
______Do you have the "sickle cell" trait?
______Have you ever experienced compartment syndrome (compression of nerves, blood vessels, and muscle tissue inside closed space of a limb)?
______Have you ever experienced fasciotomy (fascia is cut to relieve tension/pressure due to compartment syndrome)?
______Have you ever experienced myoglobinuria (very, very dark urine)?

PART V: GENERAL SUPPLEMENTAL INFORMATION

Can you think of any other conditions that would be aggravated by maximal-effort exercise?

____

____

Are you taking prescription medications? If so, please list them and for what reasons you are taking them.

____

____

Do you know of ANY OTHER REASON(S) for why you shouldn't partake in moderate to high-levels of intense exercise?

____

Appendix B

EFS Pro Long Band Calibrations

Length (in)	Micro Mini	Mini	Monster Mini	Light	Average	Strong
	Band Tension (lb)					
36	13.8	25.5	39.4	56.8	86.9	122.9
38	14.7	27.0	42.1	60.5	92.7	132.6
40	15.5	28.5	44.8	64.2	98.5	142.0
42	16.4	30.0	47.5	67.8	104.1	151.1
44	17.2	31.4	50.1	71.3	109.6	159.9
48	18.0	32.9	52.6	74.7	115.0	168.5
50	18.8	34.3	55.2	78.1	120.3	176.8
52	19.6	35.6	57.6	81.4	125.4	184.8
54	20.3	37.0	60.1	84.7	130.5	192.5
56	21.1	38.3	62.5	87.8	135.4	199.9
58	21.8	39.6	64.8	90.9	140.2	207.1
60	22.5	40.8	67.1	94.0	145.0	214.0
62	23.1	42.1	69.4	96.9	149.6	220.6
64	23.8	43.3	71.6	99.8	154.0	227.0
66	24.4	44.4	73.8	102.6	158.4	233.0
68	25.0	45.6	76.0	105.4	162.6	238.8
70	25.6	46.7	78.1	108.1	166.8	244.3
72	26.2	47.8	80.1	110.7	170.8	249.5
74	26.8	48.9	82.1	113.3	174.7	254.5
76	27.3	49.9	84.1	115.7	178.5	259.2
78	27.8	50.9	86.0	118.1	182.2	263.5
80	28.3	51.9	87.9	120.5	185.7	267.7
82	28.8	52.9	89.7	122.7	189.2	271.5
84	29.2	53.8	91.5	124.9	192.5	275.1

EFS Pro Short Band Calibrations

Length (in)	Mini	Monster Mini	Light	Average	Strong	Heavy
	Band Tension (lb)					
24	47.2	65.2	87.3	121.5	203.0	235.6
26	50.3	70.4	93.9	132.3	220.0	256.2
28	53.3	75.3	99.9	142.0	235.3	274.8
30	56.0	79.8	105.4	150.7	248.9	291.3
32	58.5	84.0	110.3	158.3	260.7	305.7
34	60.9	87.8	114.6	164.8	270.8	318.1
36	63.0	91.3	118.3	170.3	279.2	328.3
38	64.9	94.5	121.5	174.7	285.8	336.5
40	66.7	97.3	124.1	178.1	290.6	342.6
42	68.2	99.7	126.1	180.5	293.8	346.6
44	69.6	101.8	127.6	181.7	295.2	348.5
46	70.7	103.6	128.5	182.0	294.9	348.3
48	71.7	105.0	128.9	181.1	292.8	346.1
50	72.5	106.1	128.7	179.2	289.0	341.7

BENCH PRESS RESULTS

- Standard 85% Condition (STD)
  - Pre-Test Average: 435.5 ± 108.7 Watts
  - Post-Test Immediate Average: 385.5 ± 102.6 Watts
  - 1min Post-Test Average: 404.1 ± 114.3 Watts
  - 2min Post-Test Average: 405.2 ± 117.8 Watts
  - 3min Post-Test Average: 414.9 ± 117.3 Watts
  - 4min Post-Test Average: 405.5 ± 120.2 Watts
  - Significant decrease in power performance in Post-Test Immediate, when compared to Pre-Test (F-value = 7.31, p-value < 0.001).

- No Weight Lifting Condition (CTRL)
  - Pre-Test Average: 453.5 ± 110.4 Watts
  - Post-Test Immediate Average: 456 ± 116.9 Watts
  - 1min Post-Test Average: 445.1 ± 118.7 Watts
  - 2min Post-Test Average: 443.4 ± 116.2 Watts
  - 3min Post-Test Average: 441.1 ± 123 Watts
  - 4min Post-Test Average: 448.2 ± 123.2 Watts
  - No significant different across testing times (F-value = 1.405, p = 0.233)

- 85% of Elastic Band Tension (BAND)
  - Pre-Test Average: 433.6 ± 100.6 Watts
  - Post-Test Immediate Average: 410.9 ± 105.2 Watts
  - 1min Post-Test Average: 422.3 ± 115.6 Watts
  - 2min Post-Test Average: 428.5 ± 115.4 Watts
  - 3min Post-Test Average: 430.3 ± 108.1 Watts
  - 4min Post-Test Average: 440.9 ± 116.4 Watts
  - Significant decrease in power performance in Post-Test Immediate, when compared to Pre-Test (F-value = 3.31, p-value = 0.009).

SPRINTING RESULTS

- Standard 85% Condition (STD)
  - Pre-Test Average: 1.72 ± 0.1 seconds
  - Post-Test Immediate Average: 1.74 ± 0.09 seconds
  - 1min Post-Test Average: 1.72 ± 0.13 seconds
  - 2min Post-Test Average: 1.7 ± 0.11 seconds
  - 3min Post-Test Average: 1.71 ± 0.11 seconds
  - 4min Post-Test Average: 1.68 ± 0.11 seconds
  - No significant differences across testing times (F-value = 1.935, p-value = 0.103)

- No Weight Lifting Condition (CTRL)
  - Pre-Test Average: 1.73 ± 0.08 seconds
  - Post-Test Immediate Average: 1.69 ± 0.1 seconds
  - 1min Post-Test Average: 1.67 ± 0.12 seconds
  - 2min Post-Test Average: 1.68 ± 0.12 seconds
  - 3min Post-Test Average: 1.69 ± 0.14 seconds

- 4min Post-Test Average: 1.68 ± 0.11 seconds
- No significant differences across testing times (F-value = 1.55, p-value = 0.19)

- 85% of Elastic Band Tension (BAND)
  - Pre-Test Average: 1.71 ± 0.09 seconds
  - Post-Test Immediate Average: 1.72 ± 0.08 seconds
  - 1min Post-Test Average: 1.69 ± 0.1 seconds
  - 2min Post-Test Average: 1.67 ±0.1 seconds
  - 3min Post-Test Average: 1.67 ± 0.1 seconds
  - 4min Post-Test Average: 1.66 ± 0.1 seconds
  - A significant decrease in sprint time from "Post-Test Immediate" to "Two Minutes Post-Test" to "Four Minutes Post-Test" (F-value = 4.27, p-value = 0.002)