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Comparison Between the Trap Bar Dead Lift and Back Squat Exercises on Vertical Jump

Douglas A. Young
Brigham Young University - Provo

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Douglas A. Young Jr.

A thesis submitted to the faculty of
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Master of Science

Philip E. Allsen, Chair
William J. Vincent
Todd R. Pennington

Department of Exercise Sciences

Brigham Young University

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ABSTRACT

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Douglas A. Young Jr.
Department of Exercise Sciences, BYU
Master of Science

The ability to produce power during competition is essential. Football requires explosive power in order to get off the ball faster, increase speed of the first step, and increase the height of the vertical jump. Most strength training professionals use the back squat to increase power of the lower extremities; however, as large forces are placed on the back, athletes are at greater risk for injury. The trap bar dead lift is similar to the back squat in movement and form, but the trap bar dead lift reduces the force on the lower back. After testing for maximum vertical jump, athletes at Timpview High School participated in a strength program using either back squats or trap bar dead lift for seven weeks. A pre-test, mid-test and post-test were performed to calculate the increase in maximum vertical jump, if any. It was found that neither lift was significantly different than the other when testing for maximum vertical jump. These results will allow strength training professionals to use the trap bar dead lift instead of the back squats in subjects similar to those participating in the study.

Keywords: back squat, dead lift, trap bar, vertical jump

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Introduction

The ability to produce power of the lower extremities during competition is essential to perform well in certain athletic events. Football players must make use of this explosive power in order to get off the ball faster, increase the speed of the first step, and increase the height of the vertical jump. Power is defined as the amount of work a muscle or muscle group can produce per unit of time[1, 2]. The equation for power is $F \, x \frac{D}{T}$. Therefore, to increase power output of the lower extremities, with all other components staying the same, the force that the muscles can produce must increase, the distance traveled must increase, or the time of the movement must decrease. Increasing power of the muscles will result in an increase in power output which allows the athlete to accomplish more work in a shorter period of time [3]. Strength and power training methods have been shown to increase functional performance (i.e. running and jumping) in athletic and non athletic populations [4, 5].

Vertical jump is one of the best predictors of power output of the lower extremities [1]. In order for a subject to increase their vertical jump height, the subject must generate a greater amount of explosive leg power. Leg power for vertical jump can be improved using strength training [6-8], plyometric training [6, 9], or electrical stimulation [10]. Vertical jump requires complex components including maximal force capacity, rate of force development, and muscle coordination [11]. In order to increase these components a subject must increase the amount of force he or she can produce, the velocity at which that force can be produced, or practice vertical jumps to coordinate the muscles. As stated earlier, strength training is essential to increasing

force and velocity of movement; therefore, a proper strength training program will increase at least two of these components [8].

The lower extremities of the body are very important in all aspects of sports. Strengthening the lower extremities will help athletes to improve vertical jump [1, 11] increase muscle mass [7], decrease 40m time [12], improve power [13], and enhance neuromuscular efficiency [14]. These are vital for athletes to excel at any given sport.

Two main lifting techniques used to strengthen the lower extremities are the back squat and the dead lift exercises [15]. The back squat exercise has been the most common exercise for strengthening the lower extremities, and is being used by athletic teams around the country. The back squat is included in strength training programs to increase strength for the quadriceps (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius), hamstrings (semimembranosus, semitendinosus, and biceps femoris), and the triceps surae (gastrocnemius, soleus); however, hip adductors and abductors and the erector spinae are also loaded [16]. Since this is the case, the back squat has been the major strength training lift used to increase power and strength of the lower extremities [17-19], and is recommended for almost all sports [3]. However, When large forces are placed on the back, there will be a greater chance of injury[20]. As a subject performs the squat, the lumbar spine must remain stable and straight in order to prevent injuries to the lower back. If the lumbar spine does not remain straight, compressive and shear forces on the lumbar spine will increase resulting in a greater chance of injury [19]. Since the lumbar spine is the only connecting column between the upper and lower body, all the forces placed on the back must be transferred through the spine to the lower extremities [21].

Different styles of dead lift exist namely sumo, conventional, and trap bar. The dead lift is used by football players for rehabilitation of the ACL [22, 23], but also to enhance hip, thigh, and back strength [23]. The sumo and conventional styles have been studied extensively due to the fact that they are Olympic lifts [15, 22-25]; however, there are very few studies that have been completed using the trap bar dead lift [26-28].

Since the back squat exercise could lead to injuries of the athletes, the dead lift is a safe exercise that can be used to strengthen the legs, and that has a similar movement to the back squat [23].The trap bar dead lift is safe and effective because a spotter is not needed, and the hand grip is to the side instead of in front of the body like the other techniques. It has typically been used as a lead up or warm up to the front squat exercise, but not as an exercise to produce the same results as the back squat [3]. A proper strength training program using dead lift is the best way to improve the dead lift physiologically, hormonally, biomechanically, and neurologically. Those sports that place a high demand on strengthening knee, hip, and trunk extensors, such as football, should incorporate the dead lift into their strength programs [24].

Problem Statement

The purpose of the study was to compare the results of the trap bar dead lift exercise and the back squat exercise on vertical jump in beginning high school football players following a seven week strength training program.

Limitations of Study

1. All subjects were high school football players within an age range of 13-15 years.
2. Subjects were all male.

3. Training periods consisted of two times a week for seven weeks.
4. Daily activities of subjects were not controlled.
5. Outside activities were not able to be monitored.
6. Study can only be generalized to other football programs similar to Timpview High School.

Definitions

1. Power- the amount of work a muscle or muscle group can produce per unit of time
2. Power equation- $F \times \frac{Displacement\ in\ the\ direction\ of\ force}{Time}$
3. Strength- the ability to exert force against resistance
4. Vertical jump-a power movement where a person jumps as high as possible to reach a maximum height as measured by the Probiotics Just Jump Mat (8602 Esslinger Ct., Huntsville, AL 35802).
5. RM-Repetition maximum- maximum amount of weight lifted for a certain number of repetitions.

Methods

Subjects

Eighth and ninth grade male athletes (13-15 years old) from Timpview High School were used in this study. Each group consisted of approximately 25 subjects. All subjects were healthy and free of disease or injury before beginning the study. This was monitored by checking that each subject had received a physical examination. Each subject signed an approved informed consent form before beginning the study, which states that they participated in the study and that

the study neither affected their grade in the class nor position on the football team [Appendix A]. All parents/guardians also signed an approved informed consent form for their son [Appendix B]. The principal of Timpview High School and the head football coach gave approval for the research study [Appendix C]. The Institutional Review Board of Brigham Young University approved the study [Appendix D]. Athletes were defined as those students that will play football for Timpview High School the following year. Subjects were already a part of the Timpview High School football lifting program that met two times during the week.

Design

All subjects were tested on the Probiotics Just Jump Mat [29] at the beginning of the research. Leard found that a Pearson r correlation between the Probiotics Just Jump Mat and video analysis of maximum vertical jump height was 0.967 [29]. Once tested, the subjects were evaluated on their jump height (in) from highest to lowest in order to randomize the subjects. For each school grade, the highest jumper participated in the back squats (A), with the next highest jumper participating in the trap bar dead lift (B), with the next jumper participating in the trap bar dead lift (B), with the next jumper participating in the back squats (A), and so on until all subjects were assigned to one of the two leg lifts. Eighth and ninth grade subjects lifted at different times of the day.

Procedures

Subjects met at the Timpview weight room at their assigned time. Ninth graders met from 10-11:30 am and eighth graders met from 3-4:30 pm. Since the school schedule must be followed, each group met twice a week for seven weeks. Since a warm-up has been shown to

optimize and enhance performance [30, 31], the subjects in both groups began each day by jogging in place, performing high knees, performing glut-heel touches (i.e. butt kickers), performing a ski jump from side to side, performing arm circles (forward and backward), and performing 10-15 push-ups. Each warm up exercise, with exception of the push-ups were completed for thirty seconds for a total of two minutes and thirty seconds of warm up activity.

After the warm up, the subjects used the Probiotics Just Jump Mat to test their vertical jump height (in). Each subject performed four jumps. The best height of the four jumps was recorded to ensure that the recorded jump was the best that the subject could achieve. The Probiotics Just Jump Mat was used to test vertical jump height during the first, fourth, and seventh week of the strength training program. After the first jump session, measurements were put into an Excel spreadsheet [Appendix E] and sorted from highest jump to lowest jump with the subjects ID number next to their jump. The subjects were then assigned using an ABBA randomization system as explained previously. When the vertical jump testing was completed, each subject was assigned to either a back squat or trap bar dead lift group. Both groups engaged in the same strength program with the exception of the back squat and the trap bar dead lift exercises.

On the first day demographic data including age, height, weight, body mass index (BMI), grade level, and ethnicity were collected for all subjects [Appendix F]. Once all subjects had tested their vertical jump, the strength training program was introduced to them. Since these subjects are young and most inexperienced, a demonstration of each group's lifting technique was explained and demonstrated. Appendix G contains an explanation of the strength program. They began by practicing their lift with three sets of ten at a sub maximal weight (45 lbs or

higher). After finishing, they practiced other lifts that were used throughout the strength training program. All subjects found a six RM for each of the major lifts (squat or dead lift, power cleans, and bench press). The six RM was used to calculate a one RM using the NSCA table [Appendix H]. A percentage of the one RM was then used over the course of the program in order to periodize the strength training program [Appendix G]. At the end of the first week, the subjects received the strength training program, and the program was explained and demonstrated so that subjects were able to familiarize themselves with the workout. Each workout remained the same for all the subjects, in order to control for all other lifting, except for the back squats and trap bar dead lift.

Subjects met at their assigned time to engage in the strength training workout. All subjects had approximately one and a half hours to complete the workout. They began each day with the designated warm-up. Following the warm-up, the subjects followed the recommended schedule for that day performing back squats or trap bar dead lift at the beginning of the workout [Appendix G]. Research has found that the seven week period was enough to ensure strength development [1, 3, 12, 13, 32]

Measurements and Methodologies

All subjects tested their vertical jump on the Probiotics Just Jump Mat. For all three jump sessions, each subject was told to stand with their feet shoulder width apart and with their hands at their sides. When the subject was ready to begin, they were told to squat to their desired depth and jump. Subjects were then told to reach their maximum height while keeping their legs straight and then subjects rebounded to the mat with a bent leg. Once completed the next subject stepped onto the mat and performed a maximum vertical jump. This continued until all subjects

had performed four maximum vertical jumps. The highest of the four vertical jumps were recorded and analyzed. The first test determined the baseline and which group the subjects were assigned to. The two following tests determined improvements to the subject's previous jump. Once all tests were completed, the data were analyzed to show the improvement in jump height for each group (trap bar dead lift and back squats).

Variables

The dependant variable was vertical jump using the Probiotics Just Jump Mat. The independent variable was based on the group that the subjects were randomly assigned to (back squats and trap bar dead lift).

Data Analysis

The effect of training on the performance in each group was evaluated with a 2 (groups) x 3 (trials) statistical analysis (ANOVA with repeated measures). The vertical jump heights of the back squat subjects were compared with the trap bar dead lift subjects. F values for group, trials, and interaction were calculated to determine if there was a significant difference between the groups on pre, mid, or post tests. In addition, comparison of each group within pre, mid, and post tests were determined. If any of the F values were significant at $p \leq 0.05$, post hoc tests using Tukey's Honestly Significant Difference method was used to determine individual cell differences. Once all tests were completed, a power analysis was conducted to find out if this study could be generalized across the population of similar age high school football players. The level of significance was set at $p \leq 0.05$ for all statistical analyses. As a result of the findings, conclusions and recommendations, regarding the research, were drawn.

Results

After testing was completed, we found that there was a dropout rate among both the trap bar dead lift and back squat groups. The study began with n=85 and completed the study with n=51. For an ABBA randomization this is a large problem; however, although the dropout rate was substantially large, the groups remained fairly equal in size (Trap Bar n=26, Back Squats n=25) and jump height (Trap Bar x=20.558 sd=2.8052, Back Squats x=19.524 sd=3.228) (Table 1).

Mauchly's test for Sphericity (GG=.991, HF=1.000) indicates that the assumption of sphericity was met (Table 2). As a general rule, if $\varepsilon \geq .75$, the violation is considered to be insignificant [33].

There was not a significant difference in maximum vertical jump height between the two training groups (F=1.270, p=0.265) (Figure 1). There was a significant difference between the three trials (F=41.974, p=0.001) (Figure 1). Interaction between the two training groups was not significant (F=0.153, p=0.859) (Figure 1). Effect size was determined by Eta^2. Eta^2 was 0.461. This indicates that 46% of the total variance can be attributed to the treatment.

For both the trap bar dead lift and the back squat exercises, there was a significant increase between the pre-test and mid-test (p=0.001) (Figure 1). A significant increase was also found between the mid-test and post-test (p=0.004) (Figure 1). There was also a significant increase between the pre-test and post-test (p=0.001) (Figure 1). These values were calculated using Tukey's Honest Significant Difference test.

Observed power to generalize for maximum vertical jump height was 1.000 (Table 3). Based upon these results, sample size was sufficient to generalize to a larger population of subjects similar to those used in this study.

Discussion

As stated in the results, there was no significant difference in maximum vertical jump height between the back squat and trap bar dead lift groups. This is found both in a four week and an eight week strength training period. These results indicate that either lift could be used to increase the height of maximum vertical jump by increasing power in the lower extremities of beginning high school age athletes.

In both groups, a significant increase in maximum vertical jump height was seen between the pre-test (zero weeks) and the mid-test (four weeks) as well as between the mid-test (four weeks) and post-test (eight weeks). There was a greater significance found between the pre and mid-tests ($p=0.001$) than found between the mid and post-tests ($p=.004$). This indicates that for beginning athletes the first four weeks of training maybe more essential in developing power of the lower extremities. Similar results were found in college age athletes [34] and male and female college age students [1, 13].

According to Escamilla the dead lift and back squat exercises have similar movements [23]. The trap bar dead lift focuses on strengthening the erector spinae, the quadriceps group, and hamstring group but also loads the hip adductors and abductors and triceps surae. Similarly, the back squat exercise strengthens the quadriceps group, hamstring group, and triceps surae while also loading the erector spinae and hip adductors and abductors [16]. Since both lifts strengthen

and load similar muscle groups, a similar increase in jump height may be due to the development of this musculature.

Since many of these athletes were new to weight training, most had neither performed the trap bar dead lift nor the back squat exercises before. After teaching correct technique, most of the athletes were able to master the trap bar dead lift technique sooner than those performing the back squat technique. This allowed the trap bar participants to increase the amount of weight at a greater rate than the back squat participants. Therefore, the trap bar dead lift may be a better lift for athletes that are new to weight training. It may also help these athletes better perform the back squat technique because of similar motion and muscle groups used. Additional studies should be performed to find if the trap bar dead lift technique is easier to learn than the back squat technique.

Most injuries while performing the back squat exercise are due to inexperience or poor technique [19, 35]. The ability to master the trap bar dead lift technique may help reduce injuries among those that are new to weight training. During the eight weeks, two injuries were incurred. Both lifters were performing the back squat exercise, and both were due to poor lifting technique. The injuries were incurred from descending too quickly resulting in a strain of the hamstring. The trap bar dead lift allows the athlete to quickly drop the weight if the muscles become compromised. For this reason the trap bar dead lift may be a better technique than the back squats for athletes new to weight training.

Although either lift has been found to increase the power of the lower extremities, this may not be the same for other schools or ages. The football athletes of Timpview High School may not be typical of surrounding Utah schools. This may be due to the history of the Timpview

football program as well as the open boundary policy in the state of Utah. Timpview has won eight state championships since the school opened in the 1970s. Five of these have come in the last seven years. Also in the state of Utah students are allowed to choose which school they would like to attend prior to their sophomore year. Students do no have to live in school boundaries in order to attend that school. However, most athletes know where they would like to play and begin to participate with that school starting prior to their ninth grade year. Because of these reasons many football athletes choose to attend Timpview High School in order to be a part of this football history. This helps explain why Timpview may not be typical of other high schools. Therefore, similar results may not be found at different types of schools.

Conclusion

As a result of the findings, it was concluded that their was no significant difference between the trap bar dead lift and the back squat exercises on vertical jump in beginning high school football players.

A practical application of this study is that beginning high school football players of similar age and ability may consider using the trap bar dead lift instead of the back squat because it may decrease the chance of injury.

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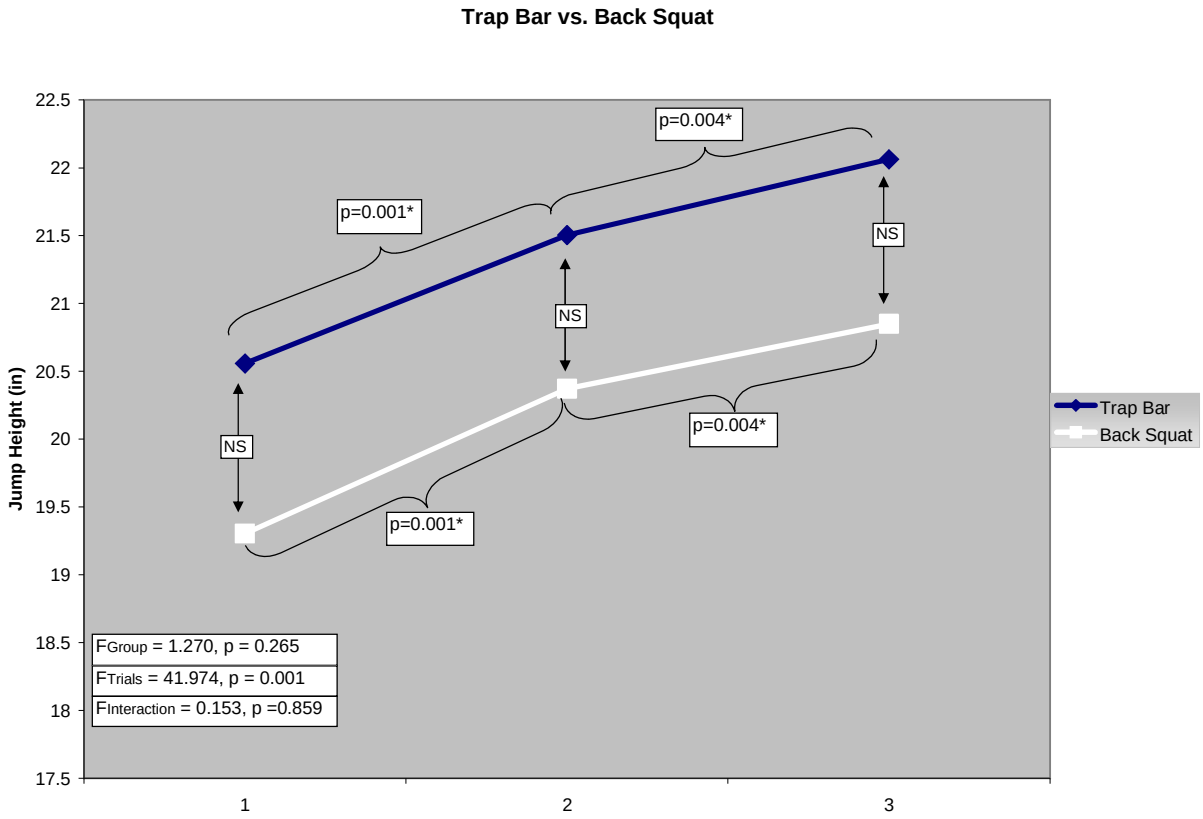
Figure 1



***** Tukey's Honest Significant Difference Test

Table 1

Descriptive Statistics

	Lift Group	Mean	Std. Deviation	N
Pre-Test (in)	Trap Bar	20.558	2.8052	26
	Back Squats	19.524	3.228	25
Mid-Test (in)	Trap Bar	21.504	3.0789	26
	Back Squats	20.66	3.2266	25
Post-Test (in)	Trap Bar	22.062	2.9816	26
	Back Squats	21.112	3.0851	25

Table 2

Measure:VertJump Mauchly's Test of Sphericity

Within Subjects Effect	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
VertJump	0.991	1.000	0.5

Table 3

Source		Observed Power[a]
VertJump	Sphericity Assumed	1.000

a. Computed using alpha = .05

Prospectus

Chapter 1: Introduction

The ability to produce power of the lower extremities during competition is essential to perform well in certain athletic events. Football players must make use of this explosive power in order to get off the ball faster, increase the speed of the first step, and increase the height of the vertical jump. Power is defined as the amount of work a muscle or muscle group can produce per unit of time[1, 2]. The equation for power is $F \, x \frac{D}{T}$. Therefore, to increase power output of the lower extremities, with all other components staying the same, the force that the muscles can produce must increase, the distance traveled must increase, or the time of the movement must decrease. Increasing power of the muscles will result in an increase in power output which allows the athlete to accomplish more work in a shorter period of time [3]. Strength and power training methods have been shown to increase functional performance (i.e. running and jumping) in athletic and non athletic populations [4, 5].

Strength training programs are designed to improve certain aspects of power. Displacement in the direction of force divided by time equals velocity; therefore force and velocity are the key components to improving power. Force is the product of mass and acceleration. Increasing the force of an object requires either increasing the cross sectional area of the muscle, or increasing the acceleration through the movement of that force. The non athletic population, might benefit from increasing the cross sectional area; however the athletic population, whom are already involved in strength training, will benefit mostly from increasing the acceleration of the movement [36]. When the resistance against the muscle increases, the acceleration of a given mass decreases [2]. Strength training will allow the subject to then increase the acceleration with that same amount of force. Strength training programs are

effective at increasing the cross sectional area of the muscle and the speed or acceleration at which the force is taken through the motion.

Vertical jump is one of the best predictors of power output of the lower extremities [1]. In order for a subject to increase their vertical jump height, the subject must generate a greater amount of explosive leg power. Leg power for vertical jump can be improved using strength training [6-8], plyometric training [6, 9], or electrical stimulation [10]. Vertical jump requires complex components including maximal force capacity, rate of force development, and muscle coordination [11]. In order to increase these components a subject must increase the amount of force he or she can produce, the velocity at which that force can be produced, or practice vertical jumps to coordinate the muscles. As stated earlier, strength training is essential to increasing force and velocity of movement; therefore, a proper strength training program will increase at least two of these components [8].

The lower extremities of the body are very important in all aspects of sports. Strengthening the lower extremities will help athletes to improve vertical jump [1, 11] increase muscle mass [7], decrease 40m time [12], improve power [13], and enhance neuromuscular efficiency [14]. These are vital for athletes to excel at any given sport.

Two main lifting techniques used to strengthen the lower extremities are the back squat and the dead lift exercises [15]. The back squat exercise has been the most common exercise for strengthening the lower extremities, and is being used by athletic teams around the country. The back squat is included in strength training programs to increase strength for the quadriceps (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius), hamstrings (semimembranosus, semitendinosus, and biceps femoris), and the triceps surae (gastrocnemius,

soleus); however, hip adductors and abductors and the erector spinae are also loaded [16]. Since this is the case, the back squat has been the major strength training lift used to increase power and strength of the lower extremities [17-19], and is recommended for almost all sports [3]. However, When large forces are placed on the back, there will be a greater chance of injury[20]. As a subject performs the squat, the lumbar spine must remain stable and straight in order to prevent injuries to the lower back. If the lumbar spine does not remain straight, compressive and shear forces on the lumbar spine will increase resulting in a greater chance of injury [19]. Since the lumbar spine is the only connecting column between the upper and lower body, all the forces placed on the back must be transferred through the spine to the lower extremities [21].

Different styles of dead lift exist namely sumo, conventional, and trap bar. The dead lift is used by football players for rehabilitation of the ACL [22, 23], but also to enhance hip, thigh, and back strength [23]. The sumo and conventional styles have been studied extensively due to the fact that they are Olympic lifts [15, 22-25]; however, there are very few studies that have been completed using the trap bar dead lift [26-28].

Since the back squat exercise could lead to injuries of the athletes, the dead lift is a safe exercise that can be used to strengthen the legs, and that has a similar movement to the back squat [23].The trap bar dead lift is safe and effective because a spotter is not needed, and the hand grip is to the side instead of in front of the body like the other techniques. It has typically been used as a lead up or warm up to the front squat exercise, but not as an exercise to produce the same results as the back squat [3]. A proper strength training program using dead lift is the best way to improve the dead lift physiologically, hormonally, biomechanically, and

neurologically. Those sports that place a high demand on strengthening knee, hip, and trunk extensors, such as football, should incorporate the dead lift into their strength programs [24].

Problem Statement

The purpose of the study will be to compare the results of the trap bar dead lift exercise and the back squat exercise on vertical jump in beginning high school football players following a seven week strength training program.

Hypothesis

Null: There will be no significant difference in vertical jump values between the trap bar dead lift group and back squat group.

Limitations of Study

7. All subjects will be football players within as age range of 13-15 years of age.
8. Subjects are all male.
9. Training periods will consist of two times a week for seven weeks.
10. Daily activities of subjects will not be controlled.
11. Outside activities will not be able to be monitored.
12. Study can only be generalized to other football programs similar to Timpview High School.

Definitions

6. Power- the amount of work a muscle or muscle group can produce per unit of time

7. Power equation- F x $\frac{Displacement\ in\ the\ direction\ of\ force}{Time}$
8. Strength- the ability to exert force against resistance
9. Vertical jump-a power movement where a person jumps as high as possible to reach a maximum height as measured by the Probiotics Just Jump Mat (8602 Esslinger Ct., Huntsville, AL 35802).
10. RM-Repetition maximum- maximum amount of weight lifted for a certain number of repetitions.

Chapter 2: Literature Review

Proper technique while performing the back squat exercise is essential in order to enhance performance [16, 18], decrease injury [18, 37], and increase physical strength [19]. A study by Kritz found that there were many different techniques for performing the back squat exercise [19]. Most individuals use different lifting techniques for personal preference; however, others use certain techniques to isolate different muscle groups. After examining the different techniques used in the studies, the suggested biomechanical technique is performed by having the head look straight ahead, the thoracic spine slightly extended, the lumbar spine straight, the hip joints flexed but aligned with the shoulders, the knees aligned with the feet, a slightly wider than shoulder width stance, and the feet flat and not moving when performing the squat [16, 18, 19]. This technique should be maintained during the duration of the lift to ensure safety of the individual. The wider stance increased muscle activity in the medial thigh and buttocks, which could increase performance due to the amount of muscle fibers being utilized [16, 38, 39]. By using this technique, the lifter will be able to increase performance while decreasing their chance of injury.

The parallel back squat exercise is a complex lift that is referred to as the "pillar of strength" exercise [40]. The back squat exercise has been the most common exercise for strengthening the lower extremities, general fitness, and rehabilitation [37]. The back squat is included in strength training programs to increase strength for the quadriceps (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius), hamstring (semimembranosus, semitendinosus, and biceps femoris), and the triceps surae (gastrocnemius, soleus); however, hip adductors and abductors and the erector spinae are also loaded [16]. Since this is the case, the

back squat has been the major strength training lift used to increase power and strength of the lower extremities [17-19], and is recommended for almost all sports [3]. The squat exercise has been used by humans to perform daily activities; therefore, increasing the ability to perform a squat will help individuals with their everyday movements. A study by Yeung found that since many are in need of improved strength in the lower extremities, a back squat program would increase their strength and lifting load capacity [41]. The back squat exercise is also utilized for rehabilitation of the anterior cruciate ligament because it places less stress on the ligament than other exercises [16, 18, 37, 42].

Vertical jump is one of the best predictors of power output of the lower extremities [1]. Studies have found that using a back squat exercise prior to vertical jump testing will result in an increase of vertical jump height, although the gains found tended to be small [14, 43, 44]. Other studies however, found no significant difference in the gains in vertical jump following a five RM back squat exercise [31, 45]. By strengthening the lower extremities, individuals will be able to improve vertical jump height [1, 11, 46]. Lamont found that by using a lower body strength training program for six weeks individuals would be able to increase the height of their vertical jump height [13]. Another study by Chelly found that after performing the back half squat exercise two times a week for two months, subjects increased the height of their vertical jump significantly; however, Chelly stated that this was due to neural increases rather than strength increases [47] Skinner found that a four week back squat program was sufficient to increase vertical jump significantly but not as significantly as the back squat and hang clean exercises together [1].

Injuries to the spine and lower back are common, and about 15% of injuries in sports are to the spine or lower back [20]. The back squat exercise is commonly used among strength training professionals; however, when large forces are placed on the back, there will be a greater chance of injury [20]. Since the lumbar spine is the only connecting column between the upper and lower body, all the forces placed on the back must be transferred through the spine to the lower extremities [21]. Many injuries performing the back squat exercise are due to inexperience or poor technique [19, 35]. As a subject performs the squat, the lumbar spine must remain stable and straight in order to prevent injuries to the lower back. If the lumbar spine does not remain straight, compressive and shear forces on the lumbar spine will increase resulting in a greater chance of injury [19]. In the same study a two degree curve in the lumbar spine increases the compressive forces by 16% [19]. This is important because it has been found that as the weight increases, individuals hyperextend their lumbar spine to a significant degree [19]. A study by Russell found that the greatest factor in determining risk of lower back injury between the front and back squat exercises was the movement or inclination of the lumbar spine; however, the one exception was the difference in compressive forces placed on the back during the back squat exercise [35]. A study by Peeni found that the front squat exercise produced similar results, and would be a safer lift than the back squat because of the ability to release the weight without injury; however, the lumbar shear forces were the same or greater for the front squat exercise [34]. These compressive and shear forces that are placed on the back during the back squat exercise can be reduced when an individual uses a weight belt [48, 49]; however, the risk of injury due to the inclination of the lumbar spine remains the same.

Since the back squat exercise could lead to injuries of the athletes, the dead lift is a safe exercise that can be used to strengthen the legs, and that has a similar movement to the back

squat [23]. The dead lift exercise uses both concentric and eccentric phases of muscle activation, and it is commonly used by strength trainers as a basis for power and strength training of the back and legs [23, 26]. Football players must make use of explosive power in order to get off the ball faster, increase the speed of the first step, and increase the height of the vertical jump. Hales found that any individual that needs to increase the power and strength of the lower extremities could benefit from incorporating the dead lift into their strength training program [24]. The dead lift is used by rehabilitation professionals in rehabilitating the anterior cruciate ligament of the knee in the later stages [22, 23].

There are two different ways to perform the dead lift exercise mainly barbell and trap bar dead lift. The barbell style has been studied extensively due to the fact that it is an Olympic lift [15, 22-25]; however, there are very few studies that have been completed using the trap bar dead lift [26-28]. The barbell dead lift is performed by squatting with the barbell in front of the lifter's feet. The barbell is then lifted off the ground by extending the hips and knees until the lifter is standing erect. The barbell is then lowered to the ground slowly [24]. The main concern with the barbell style dead lift is that it places large amounts of force and strain on the lower spine [26]. This is due to the position of the trunk during the performance of the lift. During the barbell dead lift, the trunk is less erect which causes a greater risk in lower back injury. Since safety of the individual is a concern for strength training professionals, the trap bar dead lift seems to be the better choice when incorporating the dead lift into a strength training program.

The trap bar dead lift is safer and more effective lift because the bar is diamond or hexagonal in shape which allows the lifter to stand in the middle of the bar. This allows the center of gravity to be more in line with the lifter's center of gravity [28]. The trap bar dead lift

allows a side hand grip instead of a front hand grip, which permits the lifter to be in a better anatomical position and places less stress on the wrists, elbows, and biceps [28]. According to the research, the best technique for performing a trap bar dead lift is by standing with the feet shoulder width apart with toes pointed slightly out. After lowering the body by bending the hips and extending the gluteal area, the lifter spreads the chest and locks the trunk in the erect position. The legs are then extended until in the standing position while looking straight ahead [3, 26, 28]. Stewart-Menteth found that when performing the trap bar dead lift, the lifter's trunk was more erect throughout the lift resulting in a decrease in strain to the lower back [26]. This suggests that the lift is safer to use than the barbell style lift because of less force and strain placed on the lower back. The trap bar has typically been used as a lead up or warm up to the front squat exercise, but not as an exercise to produce the same results as the back squat [3]. No studies have been done to find the effects of dead lift, neither trap bar nor barbell, on vertical jump performance.

Technique in lifting is one of the best methods to reduce the chance of injury; however, risks of injury are still present and increase as the amount of weight increases. The back squat exercise will continue to be used without hesitation of strength training professionals, because neither a safer nor better lift has been found to increase the power output of the lower extremities in the same manner as the back squat exercise. The front squat exercise produces the similar results, and allows the lifter to release the weight if necessary; however, injuries to the lower back are still at risk. According to the research, the back squat exercise places load and strain on the spine as does the barbell dead lift. Research indicates that the trap bar dead lift reduces this load and strain because of the position in which the individual lifts the load. The back squat exercise has shown an increase in vertical jump height, while no research has been completed

using the dead lift exercise. Research should be conducted to find the effects of using the dead lift exercise on vertical jump performance. Research should also be conducted to investigate whether the trap bar dead lift could replace the back squat exercise as a safer exercise producing the same results.

Chapter 3: Methods

Participants

Eighth and ninth grade male athletes (13-15 years old) from Timpview High School will be used in this study. Each group will consist of 25 subjects. All subjects will be healthy and free of disease or injury before beginning the study. This will be monitored by checking that each subject has received a physical examination. Each subject will sign an approved informed consent form before beginning the study, which states that they will participate in the study and that the study will neither affect their grade in the class nor position on the football team [Appendix A]. All parents/guardians will also sign an approved informed consent form for their son [Appendix B]. The principal of Timpview High School and the head football coach will give approval for the research study [Appendix C]. The Institutional Review Board of Brigham Young University will also approve the study [Appendix D]. Athletes are defined as those students that will play football for Timpview High School the following year. Subjects will already be part of the Timpview High School football lifting program that meets two times during the week.

Design

All subjects will be tested on the Probiotics Just Jump Mat [29] at the beginning of the research. Once tested, the subjects will be evaluated on their jump height (in) from highest to lowest in order to randomize the subjects. For each school grade, the highest jumper will participate in the back squats (A), with the next highest jumper participating in the trap bar dead lift (B), with the next jumper participating in the trap bar dead lift (B), with the next jumper

participating in the back squats (A), and so on until all subjects are assigned to one of the two leg lifts. Eighth and ninth grade subjects will lift at different times of the day.

Procedures

Subjects will meet at the Timpview weight room at their assigned time. Ninth graders will meet from 10-11:30 am and eighth graders will meet from 3-4:30 pm. Since the school schedule must be followed, each group will meet twice a week for seven weeks. Since a warm-up has been shown to optimize and enhance performance [30, 31], the subjects in both groups will begin the study by jogging in place, performing high knees, performing glut-heel touches (i.e. butt kickers), performing a ski jump from side to side, performing arm circles (forward and backward), and performing 10-15 push-ups. Each warm up exercise, with exception of the push-ups will be completed for thirty seconds for a total of two minutes and thirty seconds of warm up activity.

After the warm up, the subjects will use the Probiotics Just Jump Mat to test their vertical jump height (in). Each subject will perform four jumps. The best height of the four jumps will be recorded to ensure that the recorded jump was the best that the subject could achieve. The Probiotics Just Jump Mat will be used to test vertical jump height during the first, fourth, and seventh week of the strength training program. After the first jump session, measurements will be put into an Excel spreadsheet [Appendix E] and sorted from highest jump to lowest jump with the subjects name next to their jump. The subjects will be assigned using an ABBA randomization system as explained previously. When the vertical jump testing is completed, each subject will be assigned to either a back squat or trap bar dead lift group. Both groups will

engage in the same strength program with the exception of the back squat and the trap bar dead lift exercises.

On the first day demographic data including age, height, weight, body mass index (BMI), grade level, ethnicity, and speed (40 yd dash time) will be collected for all subjects [Appendix F]. Once all subjects have tested their vertical jump, the strength training program will be introduced to them. Since these subjects are young and most inexperienced, a demonstration of each group's lifting technique will be explained and demonstrated. Appendix G contains an explanation of the strength program. They will begin by practicing their lift with three sets of ten at a submaximal weight (45 lbs or higher). After finishing, they will practice other lifts that will be used throughout the strength training program. All subjects will find a six RM for each of the major lifts (squat or dead lift, power cleans, and bench press). The six RM will be used to calculate a one RM using the NSCA table [Appendix H]. A percentage of the one RM will be used over the course of the program in order to periodize the strength training program [Appendix G]. At the end of the first week, the subjects will receive the strength training program, and the program will be explained and demonstrated so that subjects will be able to familiarize themselves with the workout. Each workout will remain the same for all the subjects, in order to control for all other lifting, except for the back squats and trap bar dead lift.

Subjects will meet at their assigned time to engage in the strength training workout. All subjects will have approximately one and a half hours to complete the workout. They will begin each day with the designated warm-up. Following the warm-up, the subjects will follow the recommended schedule for that day performing back squats or trap bar dead lift at the beginning

of the workout [Appendix G]. Research has found that the seven week period will ensure strength development [1, 3, 12, 13, 32]

Measurements and Methodologies

All subjects will test their vertical jump on the Probiotics Just Jump Mat. For all three jump sessions, each subject will be told to stand with their feet shoulder width apart and with their hands at their sides. When the subject is ready to begin, they will be told to squat to their desired depth and jump. Subjects will be told to reach their maximum height while keeping their legs straight and then subjects will rebound to the mat with a bent leg. Once completed the next subject will step onto the mat and perform a maximum vertical jump. This will continue until all subjects have performed four maximum vertical jumps. The highest of the four vertical jumps will be recorded and analyzed. The first test will determine the baseline and which group the subjects will be assigned to. The two following tests will determine improvements, if any, to the subject's previous jump. Once all tests have been completed, data will be analyzed to show the improvement in jump height for each group (trap bar dead lift and back squats).

Variables

The dependant variable is vertical jump using the Probiotics Just Jump Mat. The independent variable will be based on the group hat the subjects are randomly assigned to (back squats and trap bar dead lift).

Data Analysis

The effect of training on the performance in each group will be evaluated with a 2 (groups) x 3 (trials) statistical analysis (ANOVA with repeated measures). The vertical jump

heights of the back squat subjects will be compared with the trap bar dead lift subjects. F values for group, trials, and interaction will be calculated to determine if there is a significant difference between the groups on pre, mid, or post tests. In addition, comparison of each group within pre, mid, and post tests will be determined. If any of the F values are significant at $p \leq 0.05$, post hoc tests using Tukey's Honestly Significant Difference method will be used to determine individual cell differences. Once all tests are complete, a power analysis will be conducted to find out if this study can be generalized across the population of similar age high school football players. The level of significance will be set at $p \leq 0.05$ for all statistical analyses. As a result of the findings, conclusions and recommendations, regarding the research, will be drawn.

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Appendix A

INFORMED CONSENT TO BE A RESEARCH SUBJECT

Introduction and Explanation of the Exercise Tests

Doug Young and Phil Allsen are performing a research study on trap bar dead lift and vertical jump. Doug is currently a graduate student in the Exercise Science department at Brigham Young University (BYU), and he is conducting this study for his Master's thesis. Doug is also the varsity corner coach for the Timpview High School football team. Dr. Allsen is currently a professor in the Exercise Science department at BYU and is Doug's mentor for his graduate studies program. The purpose of this study is to compare the results of the trap bar dead lift exercise and the back squat exercise on vertical jump in beginning high school football players. The research will be conducted for seven weeks during the normal training sessions for the athletes.

You have been invited to participate in this study because you are a member, or will soon be a member, of the Timpview High School Football program. You will be required to perform a six repetition maximum for each of the major lifts (bench press, hang cleans, and trap bar dead lift or back squats). You will be required to test your maximum vertical jump three times during the course of the study using the Probiotics Just Jump Mat. These tests will take place throughout the seven week strength training program. You will also be required to perform two 40 yard dash sprints two times during the course of the study. The training will be completed as part of the program whether you participate in the research or not. All tests will be conducted on the scheduled day according to the calendar that you have received.

You will be randomized into either a back squat or trap bar dead lift group. You will complete the sets and repetitions for each lift of the strength training program. You will report to the Timpview weight room at your assigned time for all seven weeks. Ninth grade will report at their assigned class time (sixth period) and eighth grade will report after school from 3:00 p.m. to 4:30 p.m. Dr. Bayles (Principal of Timpview) and Louis Wong (head coach of the Timpview football team) support the research and the strength training program.

*You may stop your participation in the study at any time for any reason.

Risks and Discomforts

The risks associated with this test are minimal and include risks associated with normal workouts, practices, or games. These include muscle or tendon strain, ligament sprain, or muscle soreness. Coach Doug Young, Coach Louis Wong, and Bill Jones will supervise lifting to minimize risk. A demonstration and explanation of all lifts will be given in order to ensure proper lifting technique. Injury risk is possible while performing the vertical jump test, however, a proper jumping technique demonstration and explanation will decrease risk of injury during the test.

Responsibilities of the Participant

To ensure your safety and the integrity of the strength training program it is your responsibility to promptly report medical conditions or feelings of discomfort during the training program,

maximum lifting test, or the jump test. You are also required to complete all of the workouts of the strength training program and all testing.

Expected Benefits from Testing

The results obtained from the testing will inform you of your six repetition max for the bench press, hang clean, and back squat or trap bar dead lift. It will also inform you of your maximum jump height and 40 yard dash time. This information, based on the results made during the testing sessions, will be treated as confidential unless specified by your parents. This information may be used for statistical or scientific purposes with your right to privacy retained.

Inquiries

If you have any questions regarding any aspect of this research study you may contact Doug Young (cell phone 208-358-1576) or Dr. Phil Allsen (work phone 801-422-4650) at any time. If you have questions regarding your rights as a participant in this research, you may contact BYU IRB Administration at (801) 422-1461, A-285 ASB, Brigham Young University, Provo, Utah 84602, or irb@byu.edu.

Confidentiality

All data collected will be kept confidential. You will be assigned a subject identification number for the duration of the study. The data sheet will be kept in a secure place until all data have been used to complete the study (August 2011). Once it is completed, the data will be destroyed.

Freedom of Consent

Your permission is voluntary but it is required to participate in this study. Participation in the study will not affect your standing on the Timpview football team nor your grade in the class. You have the right to withdraw from the research at any time without consequences to your standing at the school or on the Timpview football team. If you have any serious health concerns, please avoid any unnecessary risk by dismissing yourself from participation.

I have read this form and I understand the test procedures that I will participate in. I consent to participate in this research as described.

_____ _____

Printed Name of Participant Signature of Participant

_____

Date

Appendix B

PARENTAL INFORMED CONSENT

Introduction and Explanation of the Exercise Tests

Doug Young and Phil Allsen are performing a research study on trap bar dead lift and vertical jump. Doug is currently a graduate student in the Exercise Science department at Brigham Young University (BYU), and he is conducting this study for his Master's thesis. Doug is also the varsity corner coach for the Timpview High School football team. Dr. Allsen is currently a professor in the Exercise Science department at BYU and is Doug's mentor for his graduate studies program. The purpose of this study is to compare the results of the trap bar dead lift exercise and the back squat exercise on vertical jump in beginning high school football players. The research will be conducted for seven weeks during the normal training sessions for the athletes.

Your son has been invited to participate in this study because he is a member, or will soon be a member, of the Timpview High School Football program. This study will require him to perform a six repetition maximum for each of the major lifts (bench press, hang cleans, and trap bar dead lift or back squats). Your son will be required to test his maximum vertical jump three times during the course of the study using the Probiotics Just Jump Mat. These tests will take place throughout the seven week strength training program. Your son will also be required to perform two 40 yard dash sprints two times during the course of the study. The training will be completed as part of the program whether your son participates in the research or not. All tests will be conducted on the scheduled day according to the calendar that you have received.

Your son will be randomized into either a back squat or trap bar dead lift group. Your son will complete the sets and repetitions for each lift of the strength training program. Your son will report to the Timpview weight room at his assigned time for all seven weeks. Ninth grade will report at their assigned class time (sixth period) and eighth grade will report after school from 3:00 p.m. to 4:30 p.m. Dr. Bayles (Principal of Timpview) and Louis Wong (head coach of the Timpview football team) support the research and the strength training program.

*You may stop your son's participation in the study at any time for any reason.

Risks and Discomforts

The risks associated with this test are minimal and include risks associated with normal workouts, practices, or games. These include muscle or tendon strain, ligament sprain, or muscle soreness. Coach Doug Young, Coach Louis Wong, and Bill Jones will supervise lifting to minimize risk. A demonstration and explanation of all lifts will be given in order to ensure proper lifting technique. Injury risk is possible while performing the vertical jump test, however, a proper jumping technique demonstration and explanation will decrease risk of injury during the test.

Responsibilities of the Participant

To ensure your son's safety and the integrity of the strength training program it is your son's responsibility to promptly report medical conditions or feelings of discomfort during the training

program, maximum lifting test, or the jump test. Your son is also required to complete all of the workouts of the strength training program and all testing.

Expected Benefits from Testing

The results obtained from the testing will inform your son of his six repetition max for the bench press, hang clean, and back squat or trap bar dead lift. It will also inform your son of his maximum jump height and 40 yard dash time. This information, based on the results made during the testing sessions, will be treated as confidential unless specified by you. This information may be used for statistical or scientific purposes with your son's right to privacy retained.

Inquiries

If you have any questions regarding any aspect of this research study you may contact Doug Young (cell phone 208-358-1576) or Dr. Phil Allsen (work phone 801-422-4650) at any time. If you have questions regarding your rights as a parent of a participant in this research, you may contact BYU IRB Administration at (801) 422-1461, A-285 ASB, Brigham Young University, Provo, Utah 84602, or irb@byu.edu.

Confidentiality

All data collected will be kept confidential. Your son will be assigned a subject identification number for the duration of the study. The data sheet will be kept in a secure place until all data have been used to complete the study (August 2011). Once it is completed, the data will be destroyed.

Freedom of Consent

Your permission is voluntary but it is required for your son to participate in this study. Participation in the study will not affect your son's standing on the Timpview football team nor his grade in the class. You have the right to withdraw your son from the research at any time without consequences to his standing at the school or on the Timpview football team. If your son has any serious health concerns, please avoid any unnecessary risk by dismissing him from participation.

I have read this form and I understand the test procedures that my son will participate in. I consent to allow my son to participate in this research as described.

_____ _____

Printed Name of Parent or Guardian Signature of Parent or Guardian

_____

Date

Appendix C

Timpview High School
3570 Timpview Drive
Provo, Utah 84604
January 14, 2011

Institutional Review Board
Brigham Young University
A-285 ASB Brigham Young University
Provo, UT 84602

To Whom It May Concern:

We have reviewed the research and strength training program created by Doug Young, and would like inform you that we support this research. Being a state contender in football requires hard work and innovative ideas, and we are pleased to help Doug and BYU in finding new ways to increase the safety and strength of our athletes.

If you have any questions for us, or if we can be of further service to you, please call us at (801) 221-9720.

Thank you for allowing us this opportunity. We appreciate your willingness to serve others and look forward to working with Doug Young.

Sincerely,

Dr. George Bayles
Principal of Timpview High School

Louis Wong
Head Football Coach at Timpview High School

Appendix D

Institutional Review Board
for Human Subjects

Brigham Young University
A-285 ASB Provo, Utah 84602
(801) 422-3841 / Fax: (801) 422-0620

January 25, 2011

Doug Young
1087 Sara Circle
Orem, UT 84058

Re: Comparison between the trap bar and back squat exercises using vertical jump in beginning high school football players.

Dear Doug Young

This is to inform you that Brigham Young University's IRB has approved the above research study.

The approval period is from 1-25-2011 to 1-24-2012. Your study number is X110035. Please be sure to reference this number in any correspondence with the IRB.

Continued approval is conditional upon your compliance with the following requirements.

1. A copy of the 'Informed Consent Document' approved as of 1-25-2011 is enclosed. No other consent form should be used. It must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject must be given a copy of the signed consent form.

2. All protocol amendments and changes to approved research must be submitted to the IRB and not be implemented until approved by the IRB.

3. A few months before this date we will send out a continuing review form. There will only be two reminders. Please fill this form out in a timely manner to ensure that there is not a lapse in your approval.

If you have any questions, please do not hesitate to call me.

Sincerely,

Lane Fischer, PHD, Chair
Sandee M.P. Munoz, Administrator
Institutional Review Board for Human Subjects

Appendix E

	Lift Group (1/2)	Grade	Age (Y & month)	Position	Ethnicity	Height (in)	Weight (lbs)	BMI	Pre-Test (in)	Mid-Test (in)	Post-Test (in)	Pre-Speed (s)	Post-Speed (s)	Pre Max (lbs)	Post Max (lbs)
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															

Appendix F

Demographic Data

Name_____

Position_____

Grade_____

Age-Years_____

Months_____

Ethnicity ☐ White ☐ Black ☐ Asian/Pacific Islander

☐ Hispanic ☐ Multiethnicity

☐ Other_____

Height ___'___" Weight_____lbs

Jump Test_____inches Speed 40 yard dash_____seconds

Max

Bench-6 RM_____lbs 1 RM_____lbs

Squats/Deadlift-6 RM_____lbs 1 RM_____lbs

Cleans-6 RM_____lbs 1 RM_____lbs

Lifting Experience (check all that apply)

☐ No Lifting Experience

☐ Some Lifting Experience

☐ Lifting Classes

☐ Professional Lifter

Appendix G

Timpview Lifting Program
Week 1
Name:

Workout 1	Set/Rep	Weight	Max
Dead Lift/Squat			
	1x10	0	55%
Crunches 5x30	3x10	0	60%
Shoulder		0	60%
Combo 4x10		0	60%
			Max
Bench Press			
	1x10	0	55%
Scissor leg	3x10	0	60%
lifts 5x15		0	60%
Bicep Curls 4x10		0	60%
			Max
Hang Cleans			
	1x10	0	55%
Side to side	3x10	0	60%
touches 5x25		0	60%
Calf Raises 4x10		0	60%

Workout 2	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	1x10	0	55%
Crunches 5x30	3x10	0	60%
Shoulder		0	60%
Combo 4x10		0	60%
			Max
			0
Bench Press			
	1x10	0	55%
Scissor leg	3x10	0	60%
lifts 5x15		0	60%
Bicep Curls 4x10		0	60%
			Max
			0
Hang Cleans			
	1x10	0	55%
Side to side	3x10	0	60%
touches 5x25		0	60%
Calf Raises 4x10		0	60%

Timpview Lifting Program
Week 2
Name:

Workout 3	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	1x10	0	55%
Crunches 5x30	1x10	0	60%
Shoulder	1x8	0	65%
Combo 4x10	1x6	0	70%
			Max
			0
Bench Press			
	1x10	0	55%
Scissor leg	1x10	0	60%
lifts 5x15	1x8	0	65%
Bicep Curls 4x10	1x6	0	70%
			Max
			0
Hang Cleans			
	1x10	0	55%
Side to side	1x10	0	60%
touches 5x25	1x8	0	65%
Calf Raises 4x10	1x6	0	70%

Workout 4	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	1x10	0	55%
Crunches 5x30	1x10	0	60%
Shoulder	1x8	0	65%
Combo 4x10	1x6	0	70%
			Max
			0
Bench Press			
	1x10	0	55%
Scissor leg	1x10	0	60%
lifts 5x15	1x8	0	65%
Bicep Curls 4x10	1x6	0	70%
			Max
			0
Hang Cleans			
	1x10	0	55%
Side to side	1x10	0	60%
touches 5x25	1x8	0	65%
Calf Raises 4x10	1x6	0	70%

Workout 5	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	1x10	0	55%
Crunches 5x30	2x8	0	65%
Shoulder		0	65%
Combo 4x10	1x6	0	70%
			Max
			0
Bench Press			
	1x10	0	55%
Scissor leg	2x8	0	65%
lifts 5x15		0	65%
Bicep Curls 4x10	1x6	0	70%
			Max
			0
Hang Cleans			
	1x10	0	55%
Side to side	2x8	0	65%
touches 5x25		0	65%
Calf Raises 4x10	1x6	0	70%

Timpview Lifting Program
Week 3
Name:

Workout 6	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	1x10	0	55%
Crunches 5x30	2x8	0	65%
Shoulder		0	65%
Combo 4x10	1x6	0	70%
			Max 0
Bench Press			
	1x10	0	55%
Scissor leg	2x8	0	65%
lifts 5x15		0	65%
Bicep Curls 4x10	1x6	0	70%
			Max 0
Hang Cleans			
	1x10	0	55%
Side to side	2x8	0	65%
touches 5x25		0	65%
Calf Raises 4x10	1x6	0	70%

Workout 7	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	2x8	0	65%
Crunches 5x30		0	65%
Shoulder	2x6	0	70%
Combo 4x10		0	70%
			Max 0
Bench Press			
	2x8	0	65%
Scissor leg		0	65%
lifts 5x15	2x6	0	70%
Bicep Curls 4x10		0	70%
			Max 0
Hang Cleans			
	2x8	0	65%
Side to side		0	65%
touches 5x25	2x6	0	70%
Calf Raises 4x10		0	70%

Timpview Lifting Program
Week 4
Name:

Workout 8	Set/Rep	Weight	Max 0
Dead Lift/Squat			
	2x8	0	65%
Crunches 5x30		0	65%
Shoulder	2x6	0	70%
Combo 4x10		0	70%
			Max 0
Bench Press			
	2x8	0	65%
Scissor leg		0	65%
lifts 5x15	2x6	0	70%
Bicep Curls 4x10		0	70%
			Max 0
Hang Cleans			
	2x8	0	65%
Side to side		0	65%
touches 5x25	2x6	0	70%
Calf Raises 4x10		0	70%

Workout 9	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x10	0	50%
	1x8	0	60%
Crunches 5x30	3x6	0	65%
Shoulder		0	65%
Combo 4x10		0	65%
			Max 0
Bench Press	1x10	0	50%
	1x8	0	60%
Scissor leg	3x6	0	65%
lifts 5x15		0	65%
Bicep Curls 4x10		0	65%
			Max 0
Hang Cleans	1x10	0	50%
	1x8	0	60%
Side to side	3x6	0	65%
touches 5x25		0	65%
Calf Raises 4x10		0	65%

Timpview Lifting Program
Week 5
Name:

Workout 10	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	4x5	0	75%
Crunches 5x30		0	75%
Shoulder		0	75%
Combo 4x10		0	75%
			Max 0
Bench Press	1x8	0	60%
	4x5	0	75%
Scissor leg		0	75%
lifts 5x15		0	75%
Bicep Curls 4x10		0	75%
			Max 0
Hang Cleans	1x8	0	60%
	4x5	0	75%
Side to side		0	75%
touches 5x25		0	75%
Calf Raises 4x10		0	75%

Workout 11	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	4x5	0	75%
Crunches 5x30		0	75%
Shoulder		0	75%
Combo 4x10		0	75%
			Max 0
Bench Press	1x8	0	60%
	4x5	0	75%
Scissor leg		0	75%
lifts 5x15		0	75%
Bicep Curls 4x10		0	75%
			Max 0
Hang Cleans	1x8	0	60%
	4x5	0	75%
Side to side		0	75%
touches 5x25		0	75%
Calf Raises 4x10		0	75%

Timpview Lifting Program
Week 6
Name:

Workout 12	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	3x5	0	75%
Crunches 5x30		0	75%
Shoulder		0	75%
Combo 4x10	1x3	0	85%
			Max 0
Bench Press	1x8	0	60%
	3x5	0	75%
Scissor leg		0	75%
lifts 5x15		0	75%
Bicep Curls 4x10	1x3	0	85%
			Max 0
Hang Cleans	1x8	0	60%
	3x5	0	75%
Side to side		0	75%
touches 5x25		0	75%
Calf Raises 4x10	1x3	0	85%

Workout 13	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	3x5	0	75%
Crunches 5x30		0	75%
Shoulder		0	75%
Combo 4x10	1x3	0	85%
			Max 0
Bench Press	1x8	0	60%
	3x5	0	75%
Scissor leg		0	75%
lifts 5x15		0	75%
Bicep Curls 4x10	1x3	0	85%
			Max 0
Hang Cleans	1x8	0	60%
	3x5	0	75%
Side to side		0	75%
touches 5x25		0	75%
Calf Raises 4x10	1x3	0	85%

Timpview Lifting Program
Week 7
Name:

Workout 14	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	2x5	0	75%
Crunches 5x30		0	75%
Shoulder	2x3	0	85%
Combo 4x10		0	85%
			Max
			0
Bench Press	1x8	0	60%
	2x5	0	75%
Scissor leg		0	75%
lifts 5x15	2x3	0	85%
Bicep Curls 4x10		0	85%
			Max
			0
Hang Cleans	1x8	0	60%
	2x5	0	75%
Side to side		0	75%
touches 5x25	2x3	0	85%
Calf Raises 4x10		0	85%

Workout 15	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	2x5	0	75%
Crunches 5x30		0	75%
Shoulder	2x3	0	85%
Combo 4x10		0	85%
			Max
			0
Bench Press	1x8	0	60%
	2x5	0	75%
Scissor leg		0	75%
lifts 5x15	2x3	0	85%
Bicep Curls 4x10		0	85%
			Max
			0
Hang Cleans	1x8	0	60%
	2x5	0	75%
Side to side		0	75%
touches 5x25	2x3	0	85%
Calf Raises 4x10		0	85%

Workout 16	Set/Rep	Weight	Max 0
Dead Lift/Squat	1x8	0	60%
	1x5	0	75%
Crunches 5x30	3x3	0	85%
Shoulder		0	85%
Combo 4x10		0	90%
			Max
			0
Bench Press	1x8	0	60%
	1x5	0	75%
Scissor leg	3x3	0	85%
lifts 5x15		0	85%
Bicep Curls 4x10		0	90%
			Max
			0
Hang Cleans	1x8	0	60%
	1x5	0	75%
Side to side	3x3	0	85%
touches 5x25		0	85%
Calf Raises 4x10		0	90%

Appendix H

Max reps (RM)	1	2	3	4	5	6	7	8	9	10	12	15
%1RM	100	95	93	90	87	85	83	80	77	75	67	65
	10	10	9	9	9	9	8	8	8	8	7	7
	20	19	19	18	17	17	17	16	15	15	13	13
	30	29	28	27	26	26	25	24	23	23	20	20
	40	38	37	36	35	34	33	32	31	30	27	26
	50	48	47	45	44	43	42	40	39	38	34	33
	60	57	56	54	52	51	50	48	46	45	40	39
	70	67	65	63	61	60	58	56	54	53	47	46
	80	76	74	72	70	68	66	64	62	60	54	52
	90	86	84	81	78	77	75	72	69	68	60	59
	100	95	93	90	87	85	83	80	77	75	67	65
	110	105	102	99	96	94	91	88	85	83	74	72
	120	114	112	108	104	102	100	96	92	90	80	78
	130	124	121	117	113	111	108	104	100	98	87	85
	140	133	130	126	122	119	116	112	108	105	94	91
	150	143	140	135	131	128	125	120	116	113	101	98
	160	152	149	144	139	136	133	128	123	120	107	104
	170	162	158	153	148	145	141	136	131	128	114	111
	180	171	167	162	157	153	149	144	139	135	121	117
	190	181	177	171	165	162	158	152	146	143	127	124
	200	190	186	180	174	170	166	160	154	150	134	130
	210	200	194	189	183	179	174	168	162	158	141	137
	220	209	205	198	191	187	183	176	169	165	147	143
	230	219	214	207	200	196	191	184	177	173	154	150
	240	228	223	216	209	204	199	192	185	180	161	156
	250	238	233	225	218	213	208	200	193	188	168	153
	260	247	242	234	226	221	206	208	200	195	174	169
	270	257	251	243	235	230	224	216	208	203	181	176
	280	266	260	252	244	238	232	224	216	210	188	182
	290	276	270	261	252	247	241	232	223	218	194	189
	300	285	279	270	261	255	249	240	231	225	201	195
	310	295	288	279	270	264	257	248	239	233	208	202
	320	304	298	288	278	272	266	256	246	240	214	208
	330	314	307	297	287	281	274	264	254	248	221	215
	340	323	316	306	396	289	282	272	262	255	228	221
	350	333	326	315	305	298	291	280	270	263	235	228
	360	342	335	324	313	306	299	288	277	270	241	234
	370	352	344	333	322	315	307	296	285	278	248	241
	380	361	353	342	331	323	315	304	293	285	255	247
	390	371	363	351	339	332	324	312	300	293	261	254
	400	380	372	360	348	340	332	320	308	300	268	260
	410	390	381	369	357	349	340	328	316	308	274	267
	420	399	391	378	365	357	349	336	323	315	281	273
	430	409	400	387	374	366	357	344	331	323	288	280
	440	418	409	396	383	374	365	352	339	330	295	286
	450	428	419	405	392	383	374	360	347	338	302	293
	460	437	428	414	400	391	382	368	354	345	308	299
	470	447	437	423	409	400	390	376	362	353	315	306
	480	456	446	432	418	408	398	384	370	360	322	312
	490	466	456	441	426	417	407	392	377	368	328	319
	500	475	465	450	435	425	415	400	385	375	335	325
	510	485	474	459	444	434	423	408	393	383	342	332
	520	494	484	468	452	442	432	416	400	390	348	338
	530	504	493	477	461	451	440	424	408	398	355	345
	540	513	502	486	470	459	448	432	416	405	362	351
	550	523	512	495	479	468	457	440	424	413	369	358
	560	532	521	504	487	476	465	448	431	420	375	364
	570	542	530	513	496	485	473	456	439	428	382	371
	580	551	539	522	505	493	481	464	447	435	389	377
	590	561	549	531	513	502	490	472	454	443	395	384
	600	570	558	540	522	510	498	480	462	450	402	390