A COMPARISON OF LOWER-BODY RESISTANCE TRAINING MODALITIES ON ATHLETIC ABILITY

By

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CHAPTER I

Introduction

Athletic conditioning programs have progressed rapidly during the last 40 years (Foran, 2001). Today more than ever, coaches and athletes understand the importance of a well-designed strength training program. In fact, many believe that enhancing strength is the key component to improving athletic performance (Silvester, Stiggins, McGown, & Bryce, 1981).

Several variables can be manipulated when designing a strength training program. The training frequency, volume of training, sets and repetitions, and the mode of resistance all contribute significantly to performance results. The optimal numbers of sets, repetitions, and training load have been researched extensively and general guidelines have been established (Baechle, Earle, & Wathen, 2000). The optimal modality of resistance, whether free weight (FW) or resistance training machines (RTMs), is still fiercely debated among coaches, athletes, exercise physiologists, and strength and conditioning professionals (Haff, 2000).

Since most athletic movements are initiated by the legs, particular attention is given to developing the musculature of the lower extremities for the athlete (Panariello, 1991). Traditionally this has been achieved by overloading the legs with heavy back squats (Gambetta, 1998). Though research has shown the back squat is very effective for improving athletic skills such as the vertical jump (Stone, Johnson, & Carter,1979; Silvester, Stiggins, McGown and Bryce, 1982; Pipes & Wilmore,1975) some concern exists that the amount of weight necessary to elicit a training response is more than the spine can safely accomodate (Gambetta, 1998). Resistance training machines (RTMs), such as the leg press and hack squat, at one time were considered acceptable alternatives to the squat. These RTMs allow the athlete to direct a large volume of work to the muscles of the lower body from a comfortable and stabilized position.

With the increased emphasis on functional and sport-specific training in recent years, it has become popular to condemn the use all RTMs when training the athlete. Many experts in the field of athletic enhancement have denounced RTMs claiming they have little carryover to performance due to their inability to develop critical skills such as balance, coordination, and power (Mejia, 2000; Stone & O'Bryant, 1987). In fact, functional training advocates have recently criticized the back squat as not being sport-specific because most athletic endeavors require force production on a single leg at a time and in a reciprocating fashion (Gambetta, 1998; Keogh, 1999; Santana, 2000). These experts recommend the use of lunges and step-ups as a way to unload the spine and enhance specificity of training (Gambetta, 1998; Keogh, 1999; Santana, 2001).

The literature indicates that similar gains in strength can be accomplished using both FW and RTMs, and both have been shown to improve athletic ability

(Haff, 2000). However, the superior modality of resistance for enhancing athletic skills, and ultimately athletic performance, has not yet been determined.

Statement of the Problem

The problem of this study was to compare two modalities of strength training, free weight and resistance training machine, for the lower extremities on three measures of athletic ability.

Hypotheses

The following hypothesis will be tested at the 0.05 level:

1) There will be no significant differences between the free weight group (FW) and the resistance training machine group (RTM) on agility.
2) There will be no significant differences between the free weight group (FW) and the resistance training machine group (RTM) on vertical jump height.
3) There will be no significant differences between the free weight group (FW) and the resistance training machine group (RTM) on anaerobic power as measured by the Lewis formula.
4) There will be no significant differences between the free weight group (FW) and the resistance training machine group (RTM) on leg speed.

Delimitations

The following delimitations were set by the investigator of this study.

1) Twenty eight apparently healthy male (N=20) and female (N=8) students between the ages of 18-25 years old enrolled in two university weight training classes were selected for participation in this study.
2) Subjects had not participated in any formal strength training program for the last 6 months.
3) The subjects did not participate on any athletic teams, and were not involved in any other type of performance enhancing treatment during the course of this study.
4) The only components of athletic performance tested were agility, vertical jump height, anaerobic power as measured by the Lewis formula and leg speed.

Limitations

The limitations in this study reflect the effect of the delimitations on the collection and interpretation of data and the ability to expand the scope of inference beyond the sample population.

1) Subjects were not randomly sampled.
2) Extracurricular activities were not controlled.

3) Participants were asked not to engage in any type of performance enhancing treatment which may enhance performance during the experimental period.
5) Diet and nutrition were not controlled beyond requesting subjects to eat as they typically would.
6) Subjects were not checked for use of any performance enhancing substances (i.e. ergogenic aids or drugs).
7) Strength training modalities for the lower body were limited to the FW and RTM exercises prescribed in this study.
8) Subjects were limited to 28 healthy college aged (18-25 year old) males and females.

Assumptions

The following statements were assumed true when analyzing the results of this study:

1) Subjects performed to their maximum capability during all testing and training sessions. It was noted that all participants in this study were encouraged through instruction to perform to their maximum capability. Subjects were instructed to wear similar attire during the pre-test, post-test, and training sessions in order to establish consistency and reduce any extraneous variables which may confound results or performance.

2) Subjects followed instructions not to participate in any type of performance enhancing training programs outside of this study during the experimental period.
3) Subjects followed instructions to refrain from using any type of ergogenic aids or drugs during the course of the experimental period.

Definition of Terms

The following section will provide a list of operational terms relevant to this research.

Agility - The ability to start, stop, and change directions rapidly and efficiently.

Back Squat - An exercise performed by placing a weighted barbell on the lifters shoulders and with the feet approximately shoulder width apart. The lifter flexes at the knees and hips until the midline of the thigh is parallel to the ground before returning back to the starting position.

Balance- The ability to sustain or return the body's center of mass or line of gravity over its base of support (Clark, 2001).

Closed Chain Exercises - An exercise in which the distal segment of the kinetic chain is fixed, and motion occurs distal and proximal to the axis of motion (Clark, 2001).

Concentric Contraction- A muscular action associated with a shortening in the length of a muscle (Fleck & Kraemer, 1997).

Coordination - The harmonious interaction or synchronization of all the muscles involved in the successful performance of an activity.

Carryover - The ability of a specific exercise to elicit enhancements in performance. Also referred to as the transfer of training effect.

Eccentric Movement- A type of muscular action in which the muscle lengthens in a controlled manner (Fleck & Kraemer, 1997).

Ergogenic Aid - Something which can increase either aerobic or anaerobic muscular work capacity (Clark, 2001)

Free weight- A freely moving body which does not inhibit the occurrence of maximal force or acceleration patterns and challenges the lifter to control, stabilize, and direct a movement (Stone, Collins, Plisk, Haff, & Stone, 2000).

Forty-Yard Dash- A test used to determine speed. This test measures the amount of time taken to cover a distance of 40 yards.

Functional Training- A program which focuses on the use of exercises conducted in a proprioceptively enriched environment, require multi-joint movements, in all three planes of motion (saggital, transverse, and frontal), and use the entire muscle contraction spectrum (concentric, isometric and eccentric) (Clark 2001; Gambetta, 1998; Santana, 2001).

Hack Squat - A RTM exercise performed by the lifters positioning the shoulders between a yoke attached to a sliding platform. With the feet approximately shoulder width apart the lifter extends the legs, rotates the stop bars on both sides with their hands, flex at the knees and hips until the midline of the thigh is parallel to the force platform before returning back to the starting position. Typically these machines are designed in a manner which requires the lifter to lie on the apparatus at a 45° angle.

Hypertrophy - An increase in muscular size.

Isokinetic- A muscular action performed at a constant angular limb velocity (Fleck & Kraemer, 1997).

Isometric Contraction- A muscular action which occurs when there is no change in the joint angle (Fleck & Kraemer, 1997; Siff, 1993).

Isotonic- A muscular action in which the training load is constant regardless of the speed of movement (Fleck & Kraemer, 1997; Kovleski, Heitman, Trundle, and Gilley, 1995).

Leg Press - An RTM performed from a seated position by exerting force with the feet, either horizontally or diagonally, against a footplate.

Lewis Formula - This is a statistical method used to assess anaerobic power. This formula is expressed mathematically as: √4.9 x bodyweight in kilograms x height jumped.

Modality- A method of applying resistance to the musculature of the body in order to cause an adaptation response.

Open Chain Exercises - An exercise in which motion occurs distal to the axis of involvement with the distal segment free to move (Clark, 2001).

Overloading - The process of applying a stressor to the musculoskeletal system which it is not accustomed to in order to cause an adaptation response (Clark, 2001; Fleck & Kraemer, 1997).

Power - The ability to exert force in the shortest amount of time (Clark, 2001).

Reciprocating - Performed in an alternating fashion.

Repetition- One complete motion, from start to finish of an exercise (Clark, 2001)

Repetition Max (RM)- The maximum amount of weight that can be lifted for a specified number of repetitions.

Resistance Training- A type of exercise which causes a positive adaptation in the body's musculature by adding increasingly heavier loads. Also referred to as weight training or strength training.

Resistance Training Machine (RTM)- A device which applies resistance to the body in a guided or restricted manner (Stone, Collins, Plisk , Haff, & Stone, 2000)

Set - The number of times an exercise is performed.

Speed - The time taken to cover a fixed distance (Harmon & Pandorf, 2000).

Sport-Specific Training - A type of training which involves selecting exercises similar to the actual sport or activity in which performance enhancements are sought in order to maximize transference.

Step-Up - A free weight exercise in which the lifter is required to lift the lead leg until it is parallel to the ground and place it onto a box at the same height. The lifter then applies force to the box using the power of the front leg to push the body upward until the trail leg is positioned safely on top of the box. The lifter is then required to step backwards using the same leg they initiated the exercise with and return to the starting position.

Strength - The ability to apply or resist force with no emphasis on time.

Strength Training- A type of exercise which causes a positive adaptation in the body's musculature by adding increasingly heavier loads. Also referred to as weight training or resistance training.

T-Test- A test of four directional agility and body control which is used to evaluate a persons ability to change directions rapidly while maintaining balance and without loss of speed (Pauole, Madole, Garhammer, Lacourse, & Rozenek, 2000 ; Seminick, 1990).

Training Frequency - The number of training sessions in a given time period (Fleck & Kraemer, 1997; Tan, 1999). Typically, referring to the number of training sessions per week.

Training Volume - The number of sets multiplied by the number of repetitions per set (Tan, 1999).

Transfer of Testing Effect - The ability of a specific exercise to carryover to a specific testing measure.

Transfer of Training Effect - The ability of a specific exercise to elicit enhancements in performance. Also referred to as carryover.

Vertical Jump- A test frequently used to assess anaerobic power of the lower extremities (Semenick, 1990).

Walking Lunge- A free weight exercise that requires the lifter to take a moderately large step forward so that the leg is parallel to the ground, and the knee is located directly above or slightly behind the knee, so that the opposite leg knee is slightly behind the hips and just above the level of the floor. Using the power of the front leg, the lifter pushes forward and up until the trail leg comes through and past the lead leg so that with each repetition the lifter is one stride further away from the starting position. The lifter may add external resistance to this exercise through the use of barbells, dumbbells, medicine balls, etc.

Weight Training- A type of exercise which causes a positive adaptation in the body's musculature by adding increasingly heavier loads. Also referred to as Resistance Training or Strength Training.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The literature review covered two major components related to the study: weight training using FWs and RTMs, and the ability to accurately measure gains in athletic performance as a result of weight training. In comparing FWs and RTMs, the literature review will focus on the effects of each mode of training and the transfer of each mode of training to athletic ability. The literature supporting the selection of the exercises used in this study will also be discussed. In the section covering testing and measurements, the reasons and rationale behind testing athletic ability will be reviewed.

In most traditional performance enhancing programs, exercises for the lower body generally emphasize bilateral force production with the feet either exerting force against the ground or a force plate, such as the back squat, leg press and hack squat (Gambetta, 1998; Santana, 2001). In an article written by Santana (2001), the author questions the effectiveness of these exercises for improving athletic ability. Although muscular capacities are altered through these training methods and the body may become more efficient at performing these movements, the body must then attempt to reeducate the muscles to perform specific movement patterns related to sporting activities (Stegeman, 1981). In order to yield the largest carryover effect, several authors and experts in the field of performance enhancement recommend utilizing free weight exercises that are ground based, require the legs to work in a reciprocating manner, and require force production on a single leg at a time, such as the lunge or the step-up (Gambetta, 1998;Hydock, 1997; Keogh, 1999; Santana, 2001).

The Effects of FWs Versus RTMs on Strength Gains

Several studies have compared strength gains made through the use of FW and RTMs. Silvester, Stiggins, McGown and Bryce (1982) conducted two experiments comparing these modes of training. In the first experiment Group1 utilized a Nautilus compound leg machine performing two exercises: the leg extension and leg press, Group 2 used a Universal leg press machine, and Group 3 performed free weight squats. Subjects were tested using a cable tension test to record maximum isometric knee and hip extension. After an analysis of variance on the gain scores with the pretests as a covariate, all scores were tested at the 0.05 level. The authors found no significant differences between the groups in strength variables (p= 0.05), however improvements in vertical jump were enhanced to a greater extent in the free weight and Universal trained group than in the Nautilus trained group. In a second experiment conducted by Silvester, Stiggins, McGown and Bryce (1982) subjects were randomly assigned into four groups performing the biceps curl using either barbells or a Nautilus Omni Biceps machine. Subjects were tested using a cable tension strength test for the biceps at various joint angles. Analysis of variance on gain scores with the pre-test as a covariate. Differences were set at the 0.05 confidence level. All four groups significantly increased strength, without significant differences between the groups at any joint angle.

In contrast, Stone, Johnson, and Carter (1979) reported FWs produced superior gains in strength, as well as jumping height. The authors compared Nautilus training equipment and training protocols against free weight training on leg strength and power. Subjects (N= 34 males) trained for 4 weeks using a combination of free weights and Nautilus equipment. They were then divided into two groups, one performing only Nautilus exercises, the other only free weight exercises. Each group trained 3 times per week for 5 weeks. Comparisons were made using ANCOVA with an alpha level set at 0.05. After nine weeks of training the FW training group showed greater improvement on the 1 RM squat (120.0 $\pm$ 1.7) and vertical jump (53.8 $\pm$ .07) than the Nautilus trained group (106.4 $\pm$ 1.8, 51.3 $\pm$ 0.7). From the data obtained, the authors determined that free weight training was superior to machine training for improving strength and vertical jumping ability, although no significant difference was found between the FW group (102.6 kg. $\pm$ 2.9 kg) and RTM group (107.1 $\pm$ 2.9)on the 1 RM Nautilus Leg press or power (FW = 95.4 $\pm$ 1.5 ; RTM = 90.5 $\pm$ 1.7.) when using the Lewis Formula. The significance of these findings remains unclear for two reasons. First, the Nautilus trained group performed a single set of each exercise compared to the free weight group, which performed multiple sets. Several sources (Kraemer, 1997; Kraemer, Stone, Conley, Johnson, Neiman, Honeycutt, & Hoke, 1997) report performing multiple sets yields larger gains in strength than single set training. Second, the free weight group may have had an advantage over the Nautilus trained group on the 1RM squat due to specificity of testing between the exercises performed in the training regimen and those used for evaluation. It is logical to assume that the Nautilus group should have performed better on the 1 RM leg press, because it was more similar to their training methods than the group performing squats. However, no significant differences were found between the FW and RTM groups. Research indicates there appears to be a greater transfer of testing effect between FW to RTMS than the converse (Stone, 2001; Stone & O'Bryant, 1987).

Research by Jessee, McGee, Gibson, and Stone (1998) supported these results. The effects of Nautilus training equipment and free weight training equipment, as well as Nautilus and periodized training methods were compared on leg and hip strength. Subjects were divided into two free weight training groups and two Nautilus training groups. Within these subdivisions one group utilized Nautilus training principles while the other utilized a periodized training program. All groups trained three days per week for seven and a half weeks. ANOVA from the pre to posttest showed all groups improved significantly on strength in the 1RM squat. After analysis of between group differences on adjusted means using ANCOVA (training method X type of equipment, pretest as the covariate revealed a main effect for type of equipment used in training ($p < 0.05$) on the 1RM squat with both FW groups showing superior results over the groups that trained on the Nautilus equipment. No difference was found in the groups on the 1RM leg press. This may be due to specificity of testing and/or the ability of free weights to transfer to other testing modalities with greater ease (Stone, 2000).

Augustson, Esko, Thomee, and Svantesson (1998) indicated that a program of free weight squat training (closed kinetic chain) had a greater impact on vertical jumping ability than a program of isokinetic knee extension and hip adduction (open kinetic chain). In another study, Kovleski, Heitman, Trundle, and Gilley (1995) found isotonic training yielded greater strength improvements than isokinetic training on 32 recreationally active college students after six weeks of training. These findings differ from those of Pipes and Wilmore (1975) who reported training on isokinetic equipment elicited greater strength gains than isotonic training after an eight-week treatment.

The Effects of FWs Versus RTMs on Improving Athletic Ability

The literature indicates that strength improvement as a result of training with FWs and RTMs significantly improves performance on numerous tests of athletic ability. Silvester, Stiggins, McGown and Bryce (1982) found that training with FWs and Universal leg press produced statistically equal gains in vertical jumping ability. In contrast, Pipes and Wilmore (1975) found that isokinetic training increased performance in the vertical jump, softball throw and 40 yard dash; isotonic training showed no significant improvement. In contrast, Wathen (1980) compared increases in the vertical jump for 52 football players assigned to train on either an isokinetic Mini-Gym Leaper or FW squats. The Mini-gym Leaper group showed no significant improvement in vertical jumping ability. However the free weight group showed significance beyond the 0.01 level.

Although the literature indicates that both FWs and RTMs are effective at enhancing performance, the opinion of most coaches, exercise physiologists, and strength and conditioning professionals is FWs are the superior mode of training for performance enhancement (Clark, 2001; Gambetta, 1998; Santana, 2001; Plisk, as cited in Brown, 1999 Nosse & Hunter, 1985). In a two-part article by Garhammer (1981) and Stone (1982), both authors claim the superiority of FWs over RTMs. These articles are often cited by FW and functional training advocates as further evidence that FW training is superior to RTM training. Carpenelli (as cited in Haff, 2000) criticizes these articles for being based on little research and more on the authors biased opinions.

Reasons and Rationale for Testing Athletic Ability

Testing is used extensively by coaches and strength and conditioning professionals to assess current athletic ability. Coaches must determine whether an individual has the ability to play a sport at the competitive level of the team. If the candidate has already excelled in a given sport this decision becomes more simple. However, for those candidates who have not successfully demonstrated their abilities or lack experience in a sport more information must be collected before a coach can make an informed decision. For this reason coaches often use different field tests related to a given sport to assess an athletes ability to successfully perform at the selected level of play. (Hagerman, 2001; Harmon & Pandorf, 2000; Pauole, Madole, Garhammer, Lacourse, & Rozenek, 2000).

Testing is also used to evaluate areas in need of improvement. If an athlete performs poorly on a test or tests related to successfully performing in a given sport or activity, the strength and conditioning professional can alter the athletes training program to focus on improving these skills and enhance the potential for success in the selected activity (Harmon & Pandorf, 2000).

Finally, testing provides reference values to evaluate the effectiveness of specific training regimens (Harmon & Pandorf, 2000). Testing athletes regularly provides the coach with valuable information needed to modify the training program so that specific goals are met (Hagerman, 2001).

Summary

The literature indicates that significant gains in strength and athletic performance have been achieved through the use of FW and RTM training. In reviewing the literature it is evident that previous studies comparing the effects of FWs against RTMs have had problems that may have confounded the data obtained.

Previous studies have used different set and rep combinations among comparison groups, for example the studies Stone et al, (1979), Wathen, (1980) Silvester, Stiggins, McGown and Bryce (1982). This confounds the data collected considerably, because one group performed a larger volume of training than the other.

Testing measures selected for comparing FW s and RTMs have typically favored one modality of training over the other, or measured gains may have been masked by non-specific testing measures (Jessee, McGee, Gibson, & Stone,1998; Silvester, Stiggins, McGown & Bryce,1982) In a study conducted by Augustsson, Esko, Thomee, and Svantesson (1998) groups performing closed kinetic chain exercises and experienced greater increases on closed kinetic chain tests than groups that trained on open kinetic chain exercises. No differences were found in the isotonic trained group on isokinetic knee extension. This agrees with other findings that FW training seems to have a larger transfer of testing effect to RTM tersting than the converse(Haff, 2000).

Many studies comparing FWs to RTMS have compared exercises which utilize different types of muscle movements (Augustson, Esko, Thomee, & Svantesson,1998; Pipes and Wilmore, 1975; Wathen, 1980). Wathen (1980) found that FW squatting increased vertical jumping ability to a greater extent than training on an isokinetic Mini-Gym Leaper. Differences in mechanical similarity between the two exercises and the vertical jump may explain improvement differences between the groups. FW squatting, like the vertical jump, requires use of the full muscle contraction spectrum (concentric, eccentric, and isometric) in order to be performed successfully. The Mini-gym leaper isokinetic equipment only requires a concentric movement.

Stanforth, Painter, and Wilmore (1992), comparisons were made between groups which trained 12 weeks using either a concentric only or concentric/eccentric contraction program. Though both groups showed increases in strength, the magnitude of improvement depended on the type of contraction performed. There was little carryover when the concentric group was tested using concentric/eccentric exercises and vice versa.

CHAPTER III

METHODS AND PROCEDURES

The problem of this study was to compare two modalities of strength training, FWs and RTMs, for the lower extremities on agility, anaerobic power, and leg speed during a twelve week period.

Preliminary Procedures

Subjects

Subjects involved in this research consisted of 28 healthy 18-25 year old male (N=20) and female (N=8) students enrolled in two weight training courses at a university. In accordance with the American College of Sports Medicine (1999), individuals within this age range did not require a prior exercise test to participate and a physician did not need to be present during testing.

Assignment to Groups

A sample of convenience was used; thus, subjects were not randomly selected. Subjects were randomly divided into two groups: those performing free weight exercises for the lower-body (FW), or those performing resistance training machines for the lower-body (RTM). Each subject received an individual identification number. This identification number was written on a piece of paper and placed into one jar. The letters FW or RTM were written on twenty-eight pieces of paper and placed into another jar. The primary researcher randomly assigned subjects into two groups by drawing an identification number from one jar and immediately drawing a piece of lettered paper from the second jar. The slips of paper from the second jar determined group assignment.

Equipment

A Speed Trap I timer, manufactured by Brower (Salt Lake City, Utah), was loaned to the primary investigator by the University of Tulsa for the duration of this study. This device was used to assess speed improvement and is accurate to 1/100th of a second. Weight training equipment used in this study included a plate-loaded leg press machine, a plate loaded hack squat machine, and a seven - station gym manufactured by Flex Fitness (Murrieta, California). An Olympic bench press, adjustable incline utility bench, Olympic weight plates, Olympic bars, cast iron dumbbells, and three step-up boxes of various heights were used.

Operational Procedures

Instrumentation

After permission to conduct this research was granted by the Institutional Review Board at Oklahoma State University and by Oklahoma City University.

Subjects selected a testing time during a one-week period and were requested to wear clothing that would not restrict movement (i.e. shorts, sweats, and athletic wear) and to wear a good pair of athletic shoes. Prior to testing, subjects were required to read and sign an informed consent form (Appendix A), describing the purpose and risks associated with participation in the study and a health risk questionnaire (Appendix B) to determine eligibility for participation in this study. Finally, demographic questionnaire was given to each subject to gather relevant information about each subject regarding this study, such as age, weight, and gender. Each subject was provided an identification number for confidentiality purposes (Appendix C). All forms were kept in a locked file cabinet by the primary investigator and destroyed at the conclusion of the study. Subjects were encouraged to ask questions regarding any information on the forms that seemed unclear or confusing.

<u>Selected Measures of Athletic Ability</u>

The tests selected in this study were the T-test, vertical jump, and 40-yard dash. These tests are often chosen as indicators of athletic performance because they measure various skills which are primary components of most sports.

The first test administered was the T –test using the protocol outlined by Pauole et. al. (2001). Agility is critical to successfully perform various athletic skills and to help reduce the likelihood of injury. The T-test is described as a test of four directional agility and body control that evaluates the ability to change directions rapidly while maintaining balance and without loss of speed (Pauole et. al., 2000: Seminick, 1990). Pauol et al. (2000) found that the T-test is highly reliable measures a combination of components related to athletic performance, including leg speed, leg power and agility.

Time required to complete each trial was measured with a Speed Trap I automatic timing device. The best of three trials was recorded, and rounded to the nearest .10 of a second.

The second test performed was the vertical jump using the testing protocol outlined by Seminick (1990). In sporting events that require jumping, sprinting, throwing and striking power production is critical for success. The vertical jump is commonly performed in numerous sports and is often chosen by coaches, trainers, and researchers to test anaerobic power of the lower body. Several studies have used the vertical jump as an indicator of athletic ability (Baur, Thayer,& Baras1990; Silvester et al., 1982; Stone, Johnson & Carter, 1979; Wathen & Shutes, 1981).

Subjects were instructed to put chalk on the fingertips of their preferred hand, and stand erect with their side to the wall. They were then instructed to reach as high as possible with both feet flat on the ground, and make a mark on the wall with the chalked fingers. Without moving his or her feet the subject flexed the knees and hips and jumped making a second chalk mark on the wall as high as possible. The distance between the first chalk mark and the highest mark was measured and rounded to the nearest one-half inch. The best of three trials was recorded.

The Lewis formula as described by Fox and Mathews (1981) was also used to determine anaerobic power of the lower body. This formula is expressed mathematically as: $\sqrt{4.9}$ x bodyweight in kilograms x height jumped. This formula provides greater insight as to power generation than the activity itself. For example, a person who weighs 200 pounds and can jump 12 inches is able to generate greater power than someone which is 160 pounds and jumps 12 inches because the 200-pound person is moving a greater mass. Harmon, Rosenstein, Frykman, Rosenstein, and Kraemer (1991) claim the Lewis Formula should be discontinued because it does not provide accurate estimate of peak or average power produced by the muscles during a jump. This formula was used by Seiler,Taylor, Layas, Newton, and Brown (1990) in an attempt to quantitatively measure anaerobic power

The last testing measure was the 40-yard dash. Speed is an important attribute for the athlete. The faster an athlete the greater advantage they posses over their competition. The 40-yard dash is frequently used to measure speed. Though the 40-yard dash has been criticized by some as not being sport-specific, it is commonly used in athletics to determine leg speed and power (Cook in Foran, 2000; Harmon & Pandorf, 2000; Gambetta, 1998). The 40-yard dash has been used as an indicator of performance improvements in previous studies (Pipes & Wilmore, 1975; Seiler et al.,1990).

To perform the 40-yard dash at least 60 yards of uncluttered running space was needed to ensure safety and maximal speed for the complete distance. The subjects positioned themselves behind the starting line with one hand on a weight sensitive timing pad,manufactured by Brower. The timer started when the subject released their hand from the pad, and stopped after sprinting the full 40-yard distance and crossing the infrared beam. The remaining 20 yards was used to decelerate. The best of three trials was recorded to the nearest 0.1 second.

Testing Procedures

All testing was conducted indoors at the University's recreation center in order to maintain a consistent testing surface and eliminate extraneous variables, such as wind or rain that may confound results. Before testing, each subject was required to perform an individual 5-10 minute warm-up, including light walking, jogging, and/or stretching. Once the warm-up was completed testing began. All tests were performed on the same day under the direction of the primary investigator. Tests were arranged in a manner to ensure that one test would not significantly affect the other. Tests that required highly skilled movements were performed before tests that induced substantial fatigue. The T-test was performed first followed by the vertical jump, and concluded with the 40-yard dash. Subjects received an oral and visual demonstration of the proper techniques required to successfully complete each test before they were asked to perform them. Subjects were allowed three sub-maximal trials to practice technique. Posttests were conducted 48 hours after the last training session, to allow for adequate recovery from training, and were conducted in the same manner as the pretest.

Experimental Design

Selected Exercises

The FW exercises selected for this study followed recommendations by Santana, (2001), Clark, (2001) and Gambetta (1998). They insist that training with FW exercises, such as the lunge and step-up, are more functional and will lead to a greater transfer of training to actual performance. These exercises also provide a sufficient training stimulus to the lower body while applying less stress to the spine.

The RTM exercises selected for this research were chosen because they are widely used by athletes as alternative exercises to FW training for the lower body and are typically found in most training facilities.

Preconditioning Period

After the pretest was completed subjects were allowed a two-week preconditioning period to familiarize themselves with the exercises to be utilized during the experimental period. The preconditioning period was modified according to the protocol outlined by O'Shea and Wegner (1981). In the O'Shea and Wegner study during the two week pretest conditioning program, subjects performed the bench press and squat at a moderate training intensity. Repetitions were set at a minimum of 8 and a maximum of 12 for three to four sets. Correct technique was emphasized and no one was permitted to attempt a 1RM. Exercise sessions were conducted three times per week

In the present study participants performed two sessions per week during the preconditioning period using three sets of 8 - 12 repetitions per exercise. The lower-body exercises performed in this study by the FW group included the walking lunge and step-up using cast iron dumbbells, while the RTM group performed the leg press and hack squat on a plate loaded leg press and hack squat machine manufactured by Flex Fitness. Both groups performed the following exercises for the upper-body: barbell bench press, lat pulldown, overhead dumbbell press, dumbbell bicep curl, triceps pressdown, and the abdominal crunch. Participants performed two sessions per week during the preconditioning period using three sets of 8 - 12 repetitions per exercise. Subjects were allowed to self-select the number of repetitions to be used during this period. They were encouraged to try to find there 8,10,and 12repetition maximum(RM). Both groups performed the following exercises for the upper-body: barbell bench press, lat pulldowns, overhead dumbbell presses, dumbbell biceps curl, triceps pressdown, and the abdominal crunch. FW group performed lunges and step-ups with dumbbells, while the RTM group performed the leg press and hack squat on a plate loaded leg press and hack squat machine manufactured by Flex Fitness.

Experimental Period

In this study, the same number of sets and repetitions were used by both groups throughout the experimental period. Since workloads are difficult to match between different modes of training both groups performed each exercise at an assigned repetition max (RM). This was done to ensure the same training volume was used by both groups regardless of the modality of training (Refer to the Table I).

Table I

Training Volume for 12-week Training Period

Week	Sets	Repetitions
1-2	3	8 - 12
3-5	3	10
6-8	3	8
9-12	3	6

Both groups underwent testing on the aforementioned exercises to determine 10RM and to ensure proper exercise technique was used. During the first three weeks of the experimental period, subjects performed 3 sets of 10 repetitions for each exercise per session. If subjects were able to complete more repetitions per exercise than the prescribed amount for two consecutive sets, the training load was increased until only the prescribed RM could be performed with proper technique. During weeks 4-6, the workout was again modified to 3 sets of 8 repetitions per exercise per session. 8 RM testing was used to determine the training load for this period. During the last four weeks each group completed 3 sets of 6 repetitions for each exercise. 6 RM testing was used to determine the training load for this period.

Statistical Analysis

To determine improvement in athletic ability the collected data was entered into a computer file suitable for statistical analysis using the SPSS 10.0 and the computer facilities at Oklahoma State University. The three dependent variables were analyzed separately using repeated measures ANOVA with appropriate post hoc tests. All hypotheses were tested at the 0.05 significance level.

The Lewis formula as described by Fox and Mathews (1981) was also used to provide greater insight on power generation of the lower body. This formula is expressed mathematically as: $\sqrt{4.9}$ x bodyweight in kilograms x height jumped.

CHAPTER IV

RESULTS AND DISCUSSION

Results

The problem of this study was to compare the effects of two modalities of strength training, FW and RTM, for the lower extremities on three measures of athletic ability: the T-test, vertical jump, and 40 yard dash.

Twenty-eight untrained males (N=20) and female (N=8) students enrolled in two weight training courses at a university were tested before and after a 12-week training period on the following measures of athletic ability: t-test, vertical jump, and 40-yard dash. Table II reveals the average age, height, and weight for each group are provided. Subjects were randomly assigned to one of two groups: FW or RTM. The FW group performed lunges and step-ups with dumbbells, while the RTM group performed the leg press and hack squat on a plate loaded leg press and hack squat machine manufactured by Flex Fitness. Both groups performed the same upper-body exercises. The training protocols were identical with each group performing 3 sets of each exercise 2 days a week for 12 weeks. The assigned repetitions varied over the course of the study with subjects performing 8-12 repetitions during the first two weeks, 10 repetitions for weeks 3-5, 8 repetitions during weeks 6-8 and 6 repetitions for the remaining four weeks of the study.

Table II

Average Age, Height ,and Weight of Training Groups

Group	Age	Height	Weight
FW	20.64 yrs.	68.64 in.	162.78lbs
RTM	20.78 yrs.	67.28 in.	166.5lbs

To determine improvement in athletic ability the collected data was entered into a computer file suitable for statistical analysis using the SPSS 10.0 and the computer facilities at Oklahoma State University. The three dependent variables were analyzed separately using repeated measures ANOVA with appropriate post hocs. All hypotheses were tested at the .05 significance level.

Findings

The following null hypotheses were tested at the .05 level of significance, and the results are indicated in the following section.

Null Hypothesis One

There will be no significant differences between the FW and RTM groups on agility.

Results of the study indicated no significant differences between the FW and RTM groups on agility. Therefore null hypothesis 1 was accepted.

Table III reveals T-test mean scores from the pre to post tests for each group. Table IV displays the ANOVA results for the T-test. The only significant result was the main effect of Time, that is, there was an overall decrease across time between the pretest mean (11.85) and the posttest mean (11.21). However, there were no pretest to posttest differences in T-test scores within the two treatment groups.

Table III

Means ± Standard Errors for T-test

Group	Pretest	Posttest	Marginal
Machine (n=14)	11.847 ± .390	11.138 ± .342	11.493 ± .361
Free weight (n=14)	11.855 ± .390	11.282 ± .342	11.569 ± .361
Marginal	11.851 ± .276	11.210 ± .242	

Null Hypothesis Two

There will be no significant differences between the FW and RTM groups on vertical jump height.

Table IV

Repeated Measures ANOVA for T-test

Source	**SS**	**df**	**MS**	**F**
Group	. 081	1	. 081	. 022
Error	94.702	26	3.642	
Time	5.754	1	5.754	46.337*
Group X Time	. 065	1	. 065	. 525
Error	3.228	26	. 124	
Total	103.830			

*P< .01

Results of the study indicated no significant differences between the FW and RTM groups on vertical jump height. Therefore null hypothesis 2 was accepted.

Table V reveals vertical jump mean scores from the pre to post tests for each group. Table VI displays the ANOVA results for the vertical jump. The

Table V

Means $\pm$ Standard Errors for Vertical Jump

Group	Pretest	Posttest	Marginal
Machine (n=14)	17.536 $\pm$ 4.46	19.107 $\pm$5.792	18.321 $\pm$1.151
Free weight (n=14)	17.536 $\pm$ 3.64	17.500 $\pm$ 3.464	17.518$\pm$1.151
Marginal	17.536 $\pm$ .770	18.304 $\pm$ .902	

Table VI

Repeated Measures ANOVA for Vertical Jump

Source	SS	df	MS	F
Group	9.040	1	9.040	. 244
Error	965.223	26	37.124	
Time	8.254	1	8.254	3.679
Group X Time	9.040	1	9.040	4.030
Error	58.330	26	2.243	
Total	1059.287			

*P< .05

The only significant result was the main effect of vertical jumping height, that is, there was an overall increase across jumping height between the pretest mean (17.536) and the posttest mean (18.304). However, there were no pretest to posttest differences in vertical jump height within the two treatment groups. Results of the study indicated no significant differences between the FW and RTM groups on vertical jump height. Therefore null hypothesis 2 was accepted.

Null Hypothesis Three

There will be no significant differences between the FW and RTM groups on anaerobic power as determined by the Lewis Formula.

Table VII reveals the mean scores for anaerobic power as determined by the Lewis Formula, from the pre to post tests for each group. Table VIII displays the ANOVA results for anaerobic power as determined by the Lewis Formula.

The only significant result was the main effect of anaerobic power, that is, there was an overall increase in anaerobic power between the pretest mean (110.7834) and the posttest mean (113.6051). However, there were no pretest to posttest differences in anaerobic power as determined by the Lewis formula within the two treatment groups.

Null Hypothesis Four

There will be no significant differences between the FW and RTM groups on leg speed Results of the study indicated significant differences between the FW and RTM groups on leg speed. Therefore null hypothesis 4 was rejected.

Table VII

Means $\pm$ Standard Errors

Anaerobic power as determined by the Lewis Formula.

Group	Pretest	Posttest	Marginal
Machine (n=14)	109.17 $\pm$ 33.94	114.52 $\pm$ 34.27	111.84 $\pm$ 8.98
Free weight (n=14)	112.69 $\pm$ 34.18	112.69 $\pm$ 32.82	112.54 $\pm$ 8.98
Marginal	110.78 $\pm$ 6.44	113.61 $\pm$ 6.34	

Table VIII

Repeated Measures ANOVA

Anaerobic power as determined by the Lewis Formula.

Source	**SS**	**df**	**MS**	**F**
Group	6.873	1	6.873	. 003
Error	58786.546	26	2261.021	
Time	111.469	1	111.469	4.382
Group X Time	88.993 1		88.993	3.498
Error	661.443	26	25.440	
Total	59655.324			

*P< .05

Table IX reveals 40-yard dash mean scores from the pre to post tests for each group. Table X displays the ANOVA results for the 40-yard dash. The only significant result was the main effect of Time, that is, there was an overall decrease across time between the pretest mean (6.1586) and the posttest mean (6.0082). However, there were no pretest to posttest differences in 40-yard dash scores within the two treatment groups.

Discussion

The literature indicates that improving strength enhances athletic ability. Thus any modality used to enhance strength should improve athletic training can significantly improve athletic ability. However, no evidence was found to support the superiority of either training modality. In fact, this research indicates that statistically equal gains on measures of athletic ability were achieved through both modalities of training.

The majority of coaches, exercise physiologists, athletic trainers, and strength and conditioning professionals express their opinion that FWs are superior when seeking improvements in athletic ability (Garhammer, 1981; Stone, 1982; Santana, 2000, Santana 2001; Gambetta, 1998). Evidence exists suggesting that resistance training exercise that more closely replicate sports movements have greater improvement values. Since, most sports require unrestricted, dynamic, movements and require balance, skill and coordination one would assume based on the concept of specificity FWs should have a larger impact on athletic ability. The results of this study did not support this assumption. Although FW exercises may require greater skill, balance, and coordination than RTM exercises this study provides no evidence this transfers to athletic performance.

FWs and RTMs have seldom been compared in the past, and when they have several problems have existed that preclude any definitive conclusions concerning comparisons between the modalities (Haff, 2000). Previous studies have used different volumes of training when comparing each modality (Stone, Johnson, & Carter, 1979; Wathen, 1980; Wathen & Shutes, 1981). Since one group performed a greater volume of training it is difficult to isolate the cause of the improvements obtained. This study attempted to equalize the workload between groups by prescribing the same training volume to each subject. Though the absolute load used to elicit the same desired training response differed, all subjects performed the same number of sets at a given RM to achieve the desired goal of training during the 12 week training period. (Baechle, Earle, & Wathen, 2000). It would appear based on these findings when the workload is assigned based on the training goal at a specified RM; equal gains in athletic ability can be achieved.

Other studies may have selected testing measures that impacted the results obtained. The transfer of testing effect states that the more similar the training exercises are to the testing measure used the greater the carryover to that specific testing measure. Augustsson, Esko, Thomee, and Svantesson (1998) found groups performing closed kinetic chain exercises scored better on closed kinetic chain testing than groups that performed open kinetic chain exercises. However, no significant differences were found between groups when testing on open kinetic chain exercises. Jessee, McGee, Gibson, and Stone (1979) found similar results. These studies indicate the improvement value of a particular training exercise is largely dependent on the testing method used to gauge that improvement. Since the purpose of the present study was to determine which type of training increases athletic ability, strength was not tested. Thus, if one group has an advantage over the other on the three dependent variables selected to assess gains in athletic ability it may provide greater insight as to which method of training is optimal for enhancing athletic ability and ultimately performance.

The purpose of this study was to determine which of two modalities of training yielded the largest improvement in athletic ability. Based on observation and the literature review one would assume FW training would be the superior modality of training. However this research did not support this supposition.

All the lower body exercise used in the present study were closed chain exercises and isotonic. Though not exactly the same, the exercises selected were very similar in terms of the musculature used and the types of muscular movements involved. This may explain why the results obtained in this study differed from those of Augustson, Esko, Thomee, and Svantesson (1998) and those of Koveleski, Heitman, Trundle, and Gilley (1995).

When seeking to enhance athletic ability it appears neither modality is superior to the other for improving performance on the three dependent variables. Each modality of training has its own theoretical advantages and disadvantages which been discussed in previous studies and articles (Haff, 2000; Gambetta, 1998; Garhammer, 1981). In light of this research several advantages and disadvantages were observed by the investigator. FWs are very versatile in regards to the number of exercises, which can be performed. Most RTMs only allow one or two exercises to be performed per machine, while the number of exercises which can be performed with free weights are almost limitless.

A possible disadvantage for the subjects in this study performing FW training was grip strength might have been a limiting factor. Often subjects complained that their hands would become fatigued from holding the dumbbells before their legs became fatigued. However, this may also be an advantage because one could assume that holding the dumbbells might enhance grip strength.

Advantages of RTMs include the ability to enhance strength of the lower body from a comfortable and stabilized position. Also little skill is necessary to perform these exercises. These exercises also tend to be less intimidating to the novice weight trainer. RTMs may also be an effective way to help maintain strength levels during the rehabilitation process. When an athlete has experienced an injury to the upperbody the use of RTMs allow them to continue training the lower body when they otherwise would not be able to hold FWs

A major disadvantage of RTMs is their cost. RTMs are typically very expensive. When designing a weight training facility this must be taken into consideration. Since, most RTMs are limited in the number of exercises that can be performed per piece of equipment buying predominately FW equipment may provide a more cost effective solution

Assuming all other factors that may have improved scores on the dependent variables were controlled, the improvements demonstrated were due to gains in strength from the resistance training program.

The results of this research indicate that both FW and RTM training, using the exercises selected in this study, are equally effective methods for improving agility as measured by the T-Test, jumping height as measured by the vertical jump, lower body anaerobic power as measured by the Lewis Formula, and speed in the 40-yard dash, and.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The problem of this study was to compare two modalities of strength training for the lower extremities and their effect on three measures of athletic ability; the T -test, vertical jump, and the 40-yard dash. Subjects were randomly divided into two groups: those performing free weight exercises for the lower-body (FW), or those performing resistance training machines for the lower-body (RTM). A pre and posttest was administered on these three dependent variables in order to compare improvement differences among the two experimental groups. The lower body exercises performed in this study by the FW group included the walking lunge and step-up using cast iron dumbbells, while the RTM group performed the leg press and hack squat on a plate loaded leg press and hack squat machine manufactured by Flex Fitness. Both groups performed the following exercises for the upper-body: barbell bench press, lat pulldown, overhead dumbbell press, dumbbell bicep curl, triceps pressdown, and the abdominal crunch. Both groups trained two days per week for twelve weeks. Statistical analysis revealed significant improvements by both training groups, but no significant improvement differences between the training groups.

Findings

Both training groups showed significant improvement ($p > 0.05$) on the dependent variables from pre to post test scores. No significant improvement differences ($p > 0.05$) were found between the groups.

The following null hypotheses were tested at the 0.05 level of significance, and the results are indicated in the following section.

Null Hypothesis One

There will be no significant differences between the FW and RTM groups on agility.

Results of the study indicated no significant differences between the FW and RTM groups on agility. Therefore null hypothesis 1 was accepted.

Null Hypothesis Two

There will be no significant differences between the FW and RTM groups on vertical jump height.

Results of the study indicated no significant differences between the FW and RTM groups on vertical jump height. Therefore null hypothesis 2 was accepted.

Null Hypothesis Three

There will be no significant differences between the FW and RTM groups on anaerobic power as determined by the Lewis Formula.

Results of the study indicated no significant differences between the FW and RTM groups on anaerobic power as determined by the Lewis Formula. Therefore null hypothesis 3 was accepted.

Null Hypothesis Four

There will be no significant differences between the FW and RTM groups on leg speed.

Results of the study indicated significant differences between the FW and RTM groups on leg speed. Therefore null hypothesis 4 was rejected.

Conclusions

The present study indicates that both modalities of strength training are equally effective for enhancing performance. When designing programs to enhance athletic performance coaches, trainers and athletes should focus on lower body exercises that are closed kinetic chain and isotonic.

Recommendations

1). Since initially untrained individuals experience gains in strength more rapidly than trained individuals further studies may consider using trained subjects.

2). Further studies may consider extending the training period longer than twelve weeks to observe further improvements.

3). Further research should consider using more subjects.

4). Further investigations may also consider comparing other types of closed chain FW exercises, such as single leg squats, lateral lunges and lateral step-ups, to closed chain RTM exercises, such as the Leg press and Hack squat.

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Appendix A

Informed Consent to Participate

in Research Form

Informed Consent to Participate in Research

Primary Investigator: James Jay Dawes, B.S, NSCA-CPT, ACSM-HFI, and ACE-CPT

Title of Study: A COMPARISON OF LOWER-BODY RESISTANCE TRAINING MODALITIES ON ATHLETIC ABILITY.

Purpose: The purpose of this study is to compare lower body resistance training modality to enhance athletic ability.

Benefits: Participants will have the opportunity to work one-on-one with a certified personal trainer to learn proper resistance training techniques, and receive an individualized strength training program designed to enhance strength, functional capacity, and overall quality of life.

Procedures: Subjects will be required to read and sign an informed consent form describing the purpose and risks associated with participation in the study, a demographic questionnaire, and a health risk questionnaire to determine the subjects eligibility to participate in this study and minimize risk for all those involved. Subjects will be encouraged to ask questions regarding any information on the forms that seems unclear or confusing. Once all forms have been completed, each subject will be randomly assigned to one of two groups: 1) those utilizing free weight exercises for the lower-body (FW), or 2). those using resistance training machines for the lower Lower-body(RTM) Three field tests will be used to determine improvements in athletic ability.

Once testing is completed, the subjects will be allowed a two-week preconditioning period to familiarize themselves with the exercises to be utilized during the experimental period. After the two-week preconditioning period is completed subjects will undergo testing to determine 10RM and to ensure proper exercise technique. During the first three weeks of the experimental period, subjects will perform three sets of ten repetitions for each exercise per session. If subjects are able to complete more repetitions per exercise than the prescribed amount, the training load will be increased until only the prescribed RM can be performed with proper technique. During weeks 4-6, the workout will again be modified to three sets of 8 repetitions per exercise per session. 8 RM testing will be used to determine the training load for this period. During the last four weeks each group will complete 3 sets of 6 repetitions per exercise per session. 6RM testing will be used to determine the training load for this period. At the completion of the 10-week experimental period posttests will be conducted to determine improvements in athletic ability.

Risks: As with all physical activities some risk of injury does exist. Associated risks include, but are not limited to, heart attacks, muscle strains/sprains, pulls or tears, broken bone, shin splints, heat prostration, knee/lower back/ foot injuries, soreness, nausea, and possible death.

Confidentiality: Every effort will be made to keep the information collected in this study confidential. Data will be stored in a locked cabinet and will only be made available to persons conducting the study unless participants specifically give permission in writing to do otherwise. No reference will be made in verbal or written reports, which could link you to the study.

Medical treatment: If any injuries occur during a subject's participation in this study the researcher should be notified immediately. In the event of physical injury resulting from your participation in this research, participants will be responsible for all costs. No compensation will be offered to subjects injured in this research.

Contact: If you have any questions about this study or the procedures involved, or you experience adverse side effect as a result of participating in this study, you may contact, Dr. Steve Edwards, at (405) 744-7476.You may also contact, Sharon Bacher, Oklahoma State University,203 Whitehurst Stillwater, OK 74074, or by phone at 744-5700.

Participation: Your participation in this study is voluntary, and you may decline to participate. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits. If you withdraw from the study prior to its completion your data will be returned to you or destroyed.

I hereby agree to all the above terms and conditions and voluntarily agree to participate in this study.

Subjects Signature______________________ Date __________

Appendix B

Risk Factor Questionnaire

Risk Factor Questionnaire

Name:____

Address: ____

Phone (H)__________________ (W)__________________

Other____________________

Height: __________ Weight: __________

Circle Yes or No in response to the following questions.

1. Have you ever had, or has your doctor ever diagnosed you as having, heart trouble or Coronary disease. Yes / No
2. Has anyone in your immediate family had heart problems or coronary disease? Yes /No
3. Do you have a history of high blood pressure? Yes / No
4. Have you recently had surgery or experienced bone, muscle, tendon, or ligament problems? (Especially in the knee or back)? Yes / No
5. Are you diabetic? Yes / No
6. Do you smoke? Yes / No
7. Do you ever have pains in your chest or heart? Yes / No
8. Do you often experience difficulty breathing? Yes / No
9. Are you asthmatic, or has your doctor ever said you have asthma? Yes / No
10. Have you ever been told you have high cholesterol (>240 mg/dl) Yes / No
11. Is there any other reason not mentioned above, that may hinder your participation in a formal exercise program? Yes/No

If yes please explain below.

Subjects Signature

Date

Appendix C

Demographic Questionnaire

Demographic Questionnaire

Please answer the following information as accurately as you can. All information will be kept strictly confidential. The number at the bottom of this page will be your identification number for all other questionnaires and data sheets. PLEASE PRINT.

Date:___________

Name:____

Age:___________________________ Sex_______________________________

Mailingaddress:____

Local Phone:_____________ Work phone:_________________

Height:___________ Weight:_____________________

Physicians Name:____

Physician Phone:____

EmergencyContact:____

Relationship:______________________Phone:______________________________

ID#___________________

Appendix D

Institutional Review Board Approval

Oklahoma State University
Institutional Review Board

Protocol Expires: 2/28/03

Date: Friday, March 01, 2002 **IRB Application No** ED0273

Proposal Title: A COMPARISON OF LOWER-BODY RESISTANCE TRAINING MODALITIES AND THEIR EFFECTS ON ATHLETIC ABILITY

Principal Investigator(s):

James Jay Dawes	Steven Edwards
2207 W 9th ave	432 Willard
Stillwater, OK 74074	Stillwater, OK 74078

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

Dear PI :

Your IRB application referenced above has been approved for one calendar year. Please make note of the expiration date indicated above. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved projects are subject to monitoring by the IRB. If you have questions about the IRB procedures or need any assistance from the Board, please contact Sharon Bacher, the Executive Secretary to the IRB, in 203 Whitehurst (phone: 405-744-5700, sbacher@okstate.edu).

Sincerely,

Carol Olson

Carol Olson, Chair
Institutional Review Board