AN ABSTRACT OF THE THESIS OF

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Title: The Effects of Isotonic and Isokinetic Weight Training on Vertical Jump

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The general purpose of this study was to compare the efficacy of two weight training methods: isotonic and isokinetic. The sixty-two college students who were the subjects were randomly assigned to the isotonic group or the isokinetic group. There were thirty subjects in the isotonic group and thirty-two subjects in the isokinetic group. All subjects were pretested and then post-tested after a six week training program. A second post-test was conducted one week after the first post-test. The subjects were tested in four types of vertical jump: 1) standing two foot jump, 2) running two foot jump, 3) running left foot jump, 4) running right foot jump. The comparative difference of jumping

improvement for each jump was analyzed statistically. The statistical method used was the analysis of covariance at the .05 level of significance.

There was no significant difference in jumping improvement between the isotonic method and the isokinetic method. This study indicated, within its limitations, that these two methods for improving jumping ability are equal.

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THE EFFECTS OF ISOTONIC AND ISOKINETIC WEIGHT TRAINING ON VERTICAL JUMP

A Thesis

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Chapter 1

INTRODUCTION

This chapter has been devoted to information concerning the effectiveness of isotonic and isokinetic weight training in producing improvement of jumping ability with college athletes. The significance of the study, the specific statement of the problem, the purpose, the hypothesis, and the assumptions of the study have been discussed. The limitations and delimitations imposed on this study by uncontrolled variables, as well as terms identified as needing further clarification have been defined and included in this chapter.

Theoretical Formulation

The advantages of using isokinetic exercise have been documented by recent research (18, 32). The primary advantage is considered to be the consistency of the variable resistance that provides a maximum workload through the entire range of motion. A secondary advantage is the relative safety of using isokinetic machinery in comparison to using isotonic resistance, particularly free weights. Also, isokinetic weight training is thought to nearly eliminate muscle soreness that can accompany other types of weight training.

Isotonic resistance in the form of free weight lifting was examined in this study. Free weight exercise has the advantage of conditioning the supporting muscles used when executing an exercise (5, 12). Isokinetic exercise, since it is done on a fixed machine, does not condition the supporting musculature. It is possible that lifting free weights also has the advantage of providing greater motivation for the lifter as he attempts to overcome a definite resistance. The moving of a definite weight a specific number of times is a concrete goal for the lifter.

Isokinetic exercise, by contrast, actually pits the lifter against himself. The harder he/she exercises the more resistance the machine provides. The lifter's goal is to put forth a maximum effort. The only measurement of achievement available to the lifter is a gauge which is somewhat more removed from the physical aspect of lifting than the simple man against object of isotonic exercise. Isokinetic resistance, then, inherently contains more of a psychological element than does isotonic weight training.

Research that directly compares the benefits produced by these two types of exercise is needed. We must also attempt to pinpoint the positive and negative factors involved with each type of exercise.

The Problem

Weight training has become an integral part of the development of athletes for nearly every sport. The popularity of weight training has brought about a wide variety of program styles as well as several different techniques for providing the resistance. Reports regarding improvement that can be made in areas such as an athlete's strength and speed are abundant. Research that actually compares the improvement achieved by athletes engaging in different types of programs is much more rare.

An accurate understanding of the beneficial aspects of every type and style of lifting is necessary in developing the most effective weight training programs and equipment possible. Extensive research is the only means by which this information can be acquired. This study focuses on a comparison of the improvement in jumping ability achieved by athletes who engaged in a leg strength program using isokinetic resistance and the improvement in jumping ability achieved by athletes who engaged in a leg strength program using isotonic resistance.

Statement of the Problem

Is there a significant difference in the improvement of the jumping ability of college athletes who perform an isokinetic weight training program and those who perform an isotonic weight training program?

Statement of the Hypothesis (Null Form)

There is no significant difference in the improvement of the jumping ability of college athletes who perform an isokinetic weight training program as compared to those who perform an isotonic weight training program.

Stated symbolically, the null hypothesis was:

$$H_0: \mu_{it} = \mu_{ik}$$

while the alternate hypctheses were:

$$H_1: \mu_{it} > \mu_{ik}$$

$$H_2: \mu_{it} < \mu_{ik}$$

Assumptions of the Study

This study was designed to investigate the effects isokinetic weight training and isotonic weight training will have on the jumping ability of college athletes. It was assumed that the study's population, taken from a liberal arts college, was representative of all college athletes.

Another assumption of this study was related to the isokinetic weight training machine used in the study. It was assumed that the machine used was representative of all isokinetic squat machines. The results of this study were generalized to include isokinetic weight training in general rather than considering them to be applicable only to the specific machine upon which the isokinetic exercises were executed.

Purpose of the Study

It was the primary purpose of this study to determine the effects of two types of weight training, isotonic and isokinetic, on the development of jumping ability. Two groups of subjects performed identical exercises. The exercise was partial squats which were executed with the knee bent at a 110 degree angle at the bottom of the squat. Group 1 used an isotonic weight training program and Group 2 used an isokinetic weight training program.

A secondary purpose of this study was to determine if one type of exercise produced jumping increases that were not realized until the athlete had finished the program and had a chance to "stretch out". To judge this factor, two post tests were given, one immediately after completion of the programs and the other one week after completion of the programs.

Significance of the Study

Jumping ability has become an important physical attribute in the modern game of basketball. Jumping ability is equally important in the sport of volleyball and for particular positions in football such as the wide receiver and defensive back positions. Due to the relationship between this physical skill and individual and team success the best possible equipment and programs to increase jumping ability need to be determined. This study provides information that allows the development of intelligent and effective weight training programs that will improve jumping ability.

This study specifically indicates whether either isotonic or isokinetic weight training equipment is superior for the development of jumping ability. The new knowledge will be valuable to coaches and administrators who are considering the purchase of weight training equipment as well as to those who are developing a jumping program.

Definitions of Terms

The following definitions of terms apply in this study:

Isokinetic Weight Training

Makes use of machinery that provides a consistent workload for the muscle through the entire range of motion (variable resistance). The more pressure the exerciser puts on the machine the more resistance it provides. The muscle must work equally hard at each point in the exercise due to the machine's automatic adjustment of the workload.

Isotonic Weight Training

It involves dynamic contraction. This means that as the muscle contracts it either shortens or lengthens. Movement occurs in the joint associated with the muscle. In this study the type of isotonic weight training considered was free weight lifting.

Free Weight Lifting

Uses barbells or dumbbells. The lifter must control the position of the weight as he/she performs the exercise.

Jump Height

The value derived by subtracting the height of the reach of a subject from the height he/she touched when jumping.

Variable Resistance

Variation in the amount of resistance the muscle must overcome. The changes allow for the mechanical alterations that occur in a joint as movement takes place. The goal of this type of resistance is to provide a workload that taxes the muscle equally at each point in the range of motion.

Repetition Maximum (RM)

The heaviest weight that can be lifted successfully the number of times specified. For example, the ten RM for a lifter would be the heaviest weight that he/she could lift ten times.

Limitations of the Study

The primary limitation of this study was that the exercise programs of the subjects, aside from the leg strength programs, were uncontrolled. The subjects engaged in a wide variety of activities during the time of the study.

Such variation in exercise programs could conceivably affect the results of the study. Random sampling should, however, insure an accurate comparison between the isotonic and isokinetic resistance programs used in this study.

Chapter 2

REVIEW OF RELATED LITERATURE

Strength training has grown to become an integral part of athletic training programs. Due to the importance of strength development in the preparation process for athletic participation, a wealth of information relating to the area is available. There is, however, a relatively small quantity of material available that deals specifically with the effect of weight training on vertical jumping ability. There is even less research that actually compares isotonic and isokinetic weight training programs that are designed to improve jumping ability. This researcher has made the assumption that the information provided by research regarding general weight training techniques and programs does relate to the more specific problem dealt with in this study.

This chapter contains a historical review of the development of weight training. It also discusses research that relates to specific isometric, isotonic, and isokinetic weight training programs.

Historical Overview

The lifting of weights in the 1900's began not as a training technique but rather as a sport. Competitive weight lifting such as olympic weight lifting was an acceptable activity. By contrast, the lifting of weights as a part of training for athletic participation in other sports (weight training) was considered to be detrimental to the athlete.

Coaches and athletes alike feared a condition that was supposedly caused by weight training or weight lifting. This condition was called muscle boundness or muscle tightness. Muscle boundness is described by Wilkin (30) as a loss of coordination and speed of movement due to over-development of the musculature. No scientific evidence existed to substantiate such a claim regarding weight training. Nevertheless persons associated with athletics accepted it as truth and would not allow weight training to become a part of the conditioning program.

Even though coaches and athletes did not use weight training to develop strength they did realize the relationship between athletic prowess and strength. Educators developed tests that were designed to indicate the athletic ability of students. The criteria used to determine athletic ability was strength. Rogers (27) was the first to develop a battery of tests to evaluate the strength of students. The results of his tests were taken to indicate the student's athletic ability. Roger's test and variations from it were used by physical educators for twenty years.

As sport in the United States grew in popularity and technical sophistication, the efforts made to develop top quality participants grew proportionately. The desire of coaches and physical educators to improve the strength of their charges led them to question the long standing beliefs opposed to weight training.

Chui was one of the first researchers to question and subsequently test the belief that weight training was detrimental to the athlete. His study (9) was published in 1950. It evaluated the increase of the athletic power of college students who engaged in a weight training program and those who participated in physical education classes.

Group A, the experimental group, contained 23 subjects who were placed on a general isotonic weight training program. Group B, the control group, contained 22 subjects who participated in normal college physical education classes. The criterion used to determine athletic power was performance on six activities; Sargent Jump standing, Sargent Jump running, eight lb. shot put standing, 12 lb. shot put standing, and a 60 yard sprint.

The results of Chui's study showed that Group A had made consistent, significant improvement in all six activities. Group B did not show significant improvement. Since power is developed by speed and strength Chui concluded that Group A's improvement indicated their weight training had not caused muscle boundness.

A similar study to Chui's was published in 1950 by Capen (7). Group A contained 42 college students who enrolled in a weight training class. Group B contained 29 college students who enrolled in a conditioning class.

The results showed that Group A improved significantly more in muscular strength and power exercises after engaging in a general isotonic weight training program than did Group B after engaging in a general conditioning program. There was no significant difference in the endurance gains shown by the two groups. Capen, like Chui, interpreted these results to show that the weight training done by Group A did not produce muscle boundness or tightness.

Masley (21) published a study in 1953 that indicated the benefits of weight training may go beyond an increase in strength. Masley checked for improvement in speed of movement and coordination from weight training.

The study monitored three groups of college students. Group X (24 subjects) was a weight training class that participated in a general isotonic weight training program. Group CV (24 subjects) played volleyball in a class environment. Group CL (15 subjects) did not engage in any organized physical activity. The criteria used to determine speed of movement and coordination was the time it took the subject to complete 24 rotations of a crank that moved in the frontal plane.

The results showed that Group X did improve significantly more in performance of the test than did the other two groups. Masley, therefore, concluded that increased muscular strength seems to be associated with increased muscular speed of movement and coordination.

A study by Massey (22) in 1956 more specifically tested the effect of weight training on flexibility. Massey evaluated the changes in range-of-motion produced by weight training.

An experimental group (13 subjects) engaged in a general isotonic weight training program for six and a half months. A control group (13 subjects) participated in a variety of physical activities for the same period of time. The subject's range-of-motion in several joints was checked before and after the experimental period with the use of a flexometer.

The results of the study indicated that heavy resistance exercise does not result in an overall reduction in the range-of-motion of the joints throughout the body. Group A did not have a significant decrease in range-of-motion.

The studies above and others like them brought weight training out of the proverbial closet. The three decades that have passed since that time have shown a rapid expansion and evolution of weight training.

Nearly all of the weight training and weight lifting that took place up to the early 1950's used isotonic resistance. The only equipment involved was free weights--barbells and dumbells.

A new type of weight training came into vogue in the 1950's. The new technique was isometric exercise. Isotonic exercise involves dynamic contraction. When the muscle contracts it changes length and movement of the joint occurs. Isometric exercise involves static contraction. The muscle contracts but does not shorten. There is no movement of the joint. Isometric exercise brought with it the opportunity to gain the advantages of weight training without the equipment and facilities required by isotonic weight training. Almost no equipment or space is required in order to initiate and execute an isometric exercise program. It also requires very little time to execute a program.

Research soon indicated, however, that isometric exercise had definite limitations (16). The sports community, always searching for ways to elevate the abilities of athletes, continued to search for a weight training technique that was superior to the isotonic method. Isokinetic resistance offered hope for a new and better system.

Isokinetic weight training started its rise to popularity in the middle 1960's. It created infinitely adjustable variable resistance that automatically responded to the athlete as he/she performed an exercise. The workload remained constant throughout the range-of-motion. This factor--the automatic variable resistance--avoided what was considered to be the primary shortcoming of isotonic exercise: Since the workload in isotonic training remains constant, the muscle must put forth a maximum effort only at the angle of pull as which it is weakest. For this reason isokinetic exercise was expected by some to become the weight training method of the future (28).

Weight Training Programs

Weight training had become an established part of the developmental program for athletes. Researchers then turned to an inquiry into the type of resistance and the style of program that would produce the best results. This section contains a discussion of the research that examined the merits of particular weight training programs.

Isometric Exercise Programs

Physical educators and coaches were attracted to isometric exercise because of the extremely low equipment costs associated with it and the efficient use of time it made possible. Many individuals and institutions could not afford the weights, benches, and other apparatus needed to conduct isotonic weight training programs. Almost anyone could afford the minimal equipment needed for an isometric exercise program. In many cases a short length of rope and a doorway were all that were needed.

In some cases the amount of time it takes for a group of people to go through an isotonic weight training program is prohibitive. By contrast, Baley (1) was able to have a university physical education class perform 40 isometric exercises, a complete program, in a 30 minute class period. Baley was able to conduct a strength development program in a time span that would not accomodate the use of an isotonic weight training program. His experimental group showed a significant improvement in strength over a four-week period.

Wolbers and Sills (33) conducted one of the earliest studies of the effect of isometric exercise on strength development. Twenty high school boys were divided at random into two groups with ten subjects per group. The experimental group engaged in an eight-week isometric training program. The subjects performed the isometric program five days a week. Nine exercises were included in the program which worked the upper and lower body. Each exercise was done once each session. Each contraction was held for six seconds. The subjects were encouraged to give their maximum effort on every contraction. The control group did not engage in any organized exercise program.

The subjects were given a pretest and a post-test to determine their strength levels in the back lift, leg lift, right and left hand grip, and the Sargent Jump. The experimental group made statistically significant gains in strength in the back lift, leg lift, and a combined hand grip test score. There was no significant improvement by the experimental group in the Sargent Jump.

Chui (10) conducted a study comparing the effects of isometric exercise to isotonic weight training. Chui's study found no significant difference in strength and speed of movement improvement between the isometric group and two isotonic groups. Other research was, however, pointing out the shortcomings of isometric exercise.

A study by Berger (3) compared isometric exercise to a variety of isotonic exercise programs. Subjects engaged in isotonic programs with:

1. two sets, two repitition maximum (RM) per set
2. one set, six RM per set
3. two sets, six RM per set
4. one set, ten RM per set
5. two sets, ten RM per set
6. three sets, ten RM per set
7. three sets, six RM per set

Each of the above groups was compared to a group that participated in an isometric exercise program.

Berger's results showed that there was no significant difference between the effect produced by the isometric group and isotonic groups two, three, four, five, and six. The isometric group produced significantly better results than did isotonic group one. Isotonic group seven showed significantly more improvement than the isometric group and the other isotonic groups.

Continuing research into isometric exercise showed definite deficiencies. Gardner (16) found that isometric exercise techniques are not ideal for improving skill performances where strength is required through a considerable range-of-motion. Gardner concluded this was because isometrics develop strength only at the specific angle at which the contraction is done. Homola (17) states that while isotonic exercise can increase flexibility since it forces the joint through the full range-of-motion, isometrics may in fact reduce flexibility. A study by Larson (20) indicated that dynamic strength is nearly three times more accurate in predicting motor performance levels than is static strength. This suggested the importance of developing dynamic strength through isotonic or isokinetic exercise rather than developing static strength through isometric exercise.

In situations where definite time and/or monetary restrictions come into play isometric exercise may be the only viable alternative for a strength building program. Research has shown that the results produced by isometric exercise are not as beneficial to the participant as are the results from some other types of weight training.

Isotonic Weight Training Programs

As was stated earlier in this paper, the original lifting of weights was isotonic weight training. Free weights--barbells and dumbells--were used. Since that time another form of isotonic resistance has been developed. In response to the popularity of isokinetic weight training, machines were developed that used live weight for the resistive force and also provided variable resistance through a new lever system. This type of weight training, sometimes called dynamic variable resistance, does have some of the advantages of both isokinetic and traditional isotonic weight training.

It is not within the scope of this paper to discuss dynamic variable resistance. Free weight lifting is the only type of isotonic weight training that will be dealt with.

From the time that weight training established itself as a valuable type of training researchers have attempted to determine the number of sets, number of repetitions, and the workload that will produce the best results. A summary of their research is given below.

DeLorme developed a significant isotonic weight training program in the late 1940's. The system he devised was called progressive resistance. Capen (8) compared the results produced by the DeLorme method with a variation of that method. In DeLorme's system the athlete works with the following weights, sets, and repetitions:

First set - ten repetitions - ½ ten RM

Second set - ten repetitions - 3/4 ten RM

Third set - ten repetitions - ten RM

Although this system is still a popular one, Capen's study indicated that the same program using a five RM in place of the ten RM produced greater strength gains.

Capen's study, conducted in 1956, was one of the first of many studies which indicated that heavy weights lifted a relatively small number of times would provide the greatest gains in strength. A study by O'Shea (25) compared the results produced by three groups with ten subjects per group. All the subjects engaged in an isotonic weight training program that consisted of a deep knee bend exercise. All of the groups did three sets of each exercise but the number of repetitions per set varied. Group A performed two-three repetitions per set. Group B performed five-six repetitions per set. Group C performed nine-ten repetitions per set. The weight for each group was the appropriate repetition maximum for their group, i.e., Group A used a three RM. Improvement was judged by three criterion; muscle girth, dynamic strength, and static strength. Muscle girth was evaluated by measurement of the body part, dynamic strength was determined by the subject's one RM, and static strength was measured on a dynamometer.

The results showed that there was no significant difference between the groups in muscle girth. Group A showed the greatest improvement, 23.2 percent, in static strength. Group B showed more improvement, 15.5 percent, in static strength than did Group C. Dynamic strength increase proved to be more dramatic as Group B showed by far the most improvement with 26.7 percent. O'Shea concluded that Group B's program was superior to the other two because of the dynamic strength factor.

Several other studies support O'Shea's results. Berger (2) found that three sets with six repetitions per set with a six RM produced the greatest increase in strength in the bench press. Dintiman's (13) research showed that a workout of three sets with three-nine repetitions per set using a near maximum weight was the most effective program.

Another study by Berger (4) indicated that the optimum number of repetitions for a one set dynamic program was three-nine.

There is an abundance of research supporting the use of heavy weights and few repetitions. Some of the individuals who are primarily concerned with increasing lower body strength, however, disagree with this type of isotonic program.

Knauss (19) established an in-season isotonic weight training program for his 11 member boys high school basketball team. He had his athletes perform two sets with ten repetitions per set using low weights and quick repetitions. The workload was always increased for the second set. The exercises used were the inverted leg press, squat thrust, and tow raises. Knauss reported improvement in vertical jump from two-seven inches with a mean improvement of five inches.

Coker (11) has kept records on the 2,500 high school, junior college, college, and club athletes he has trained. His experience has led him to recommend 15-25 repetitions per set for three-four sets using 60 percent-70 percent of the athletes maximum workload when executing programs to develop leg strength. Blockovich (6) recommends a nearly identical program to Coker's for lower body lifting.

Not all isotonic weight training programs are as similar to each other as the ones just mentioned. O'Conner (24) claims to effectively build both strength and endurance with an unusual program. He calls it the "gut work-out". The athlete executes the first set with a heavy weight that will allow a maximum of approximately three reptitions. In the following sets the workload is reduced and the number of repetitions is increased. The lifter always does as many repetitions as possible with each weight. He/she is allowed very little rest between sets. An example of O'Conner's program is given below.

First set - 60 lbs., three repetitions

Second set - 50 lbs., 12 repetitions

Third set - 40 lbs., 27 repetitions

Fourth set - 30 lbs., 70 repetitions

Fifth set - 20 lbs., 90 repetitions

While isokinetic weight training continues to develop there are still trainers and coaches who believe that isotonic weight training with free weights is the best kind of lifting method available. Dienhart (12) developed a program for basketball players that used the competitive weight lifting events to develop strength, quickness, co-ordination, and flexibility. Blazek (5) recommends the use of free weights because of their economy and the demands they place on supporting musculature. Pepin (26) reports excellent results from the use of free weights for track jumpers. These individuals and others continue to attempt to refine and develop isotonic weight training with free weights.

Isokinetic Weight Training Programs

The weight training technique of the future, as isokinetics have been called, has gained much support in the last 15 years. The popularity of isokinetic weight training has continued to grow.

Wilson (32) explained the advantages he believes isokinetic weight training has. They are given below.

1. It allows for efficient time usage since there are no weights to change.
2. It prevents sore muscles.
3. There are very few injuries.
4. It gives the muscle a maximum workload throughout the range-of-motion.
5. It adjusts the workload from one repetition to the next.
6. It requires only limited space.

Wilson developed an isokinetic weight training program for high school athletes. The eight-week program emphasized total body development. To execute the program each athlete assumed his position at one of the eight stations and prepared to exercise. At the whistle each man performed the exercises for his particular station as rapidly as possible for 30 seconds. The athletes then had 15 seconds to prepare for the next exercise. With this procedure the entire program took six minutes for eight athletes to complete. The program was done on Monday, Wednesday, and Friday. Wilson reports tremendous success with the program.

Divitto (14) conducted one of the few studies that compared the effects of an isotonic weight training program to the effects of an isokinetic weight training program on lower body strength development. His research involved 60 college student volunteers from college physical education classes. The subjects were divided equally into three groups. Group I was designated the isotonic group, Group II the isokinetic group, and Group III was a control group. Group III did not engage in a strength development program.

The pretest and post-test evaluated the static strength of the quadriceps muscle group. The non-dominant leg only was tested. A tensiometer attached to a cable was used for the evaluation. Tests were made with the knee bent at a 90 degree angle, a 135 degree angle, and a 170 degree angle. Measurements were taken at the three different knee angles in order to determine if either of the two weight training programs would produce varying degrees of improvement in strength at specific points in the knee extension.

Both groups participated in their respective programs for six weeks. Group I, the isotonic group, performed three sets of knee extensions on an extension table. The starting weight was 50 pounds for every subject. Seven repetitions were done for each set. Whenever the exerciser could do ten repetitions in the third set the workload was increased ten pounds.

The isokinetic group, Group II, also executed three sets of knee extensions with seven repetitions per set. Exercisers were told to perform the repetitions as quickly as possible and to give their maximum effort.

Divitto reported that the results indicated a significant improvement at all three knee angles in both experimental groups when compared to the control group. There was no significant difference in the strength gains made by the isotonic group as compared to the isokinetic group at the 135 degree or 170 degree knee angles. The isotonic group showed significantly greater improvement than the isokinetic group at the 90 degree knee angle.

Several studies that examined isokinetic weight training were reported by Jensen and Jensen (18). In that report research done by Thistle and Pipes and Wilmore was described as showing that isokinetic training was clearly superior to isotonic and isometric training. Sheeran (28) agrees with this point of view stating that isokinetic weight training is the most effective means by which to attain the end of increased muscular development.

A major advantage of isokinetic weight training, according to its proponents, is the fact that it is possible to vary the exerciser's speed of movement as he/she performs an exercise. Isotonic weight training does not allow for similar adjustment of the rate of exercise.

A study done by Moffroid and Whipple (23) examined the effects of the rate of exercise in isokinetic weight training programs on leg strength development. The two experimental groups performed reciprocal knee extensions and flexions on an isokinetic device. The ten subjects in Group I exercised at a rate of six revolutions (six extensions and flexions) per minute for two minutes. They performed three sets of exercises. The ten subjects in Group II exercised at a rate of 18 revolutions per minute for two minutes. They also performed three sets of exercises. The isokinetic device was adjusted so that the rate of exercise for both groups required continuous, maximum effort. In other words, the isokinetic device forced the subjects in Group I to exercise at a very low rate of speed while the device allowed the subjects in Group II to exercise at a high rate of speed.

The results from this six-week study led Moffroid and Whipple to conclude that low speed isokinetic weight training increases leg strength only for low speed exercises. High speed isokinetic weight training, by contrast, produces increases in leg strength at all speeds of contraction both at and below the training speed.

A review of research relating to isokinetic weight training by Wilmore (31) led him to a conclusion in agreement with Moffroid and Whipple. He stated that athletes need to execute weight training programs at a relatively high rate of speed in order to achieve maximum strength gains. Research done by Somers (29) with high school age subjects also supports the above statement. Fox (15), following his own review of isokinetic research, takes the idea of speed of exercise a step farther. He recommends a rate of exercise as fast as or faster than the actual activity being trained for.

Summary

The literature relating to this topic clearly shows that all three types of resistance, particularly isotonic and isokinetic, will produce increased muscular strength. No conclusion can be drawn, however, as to whether isotonic or isokinetic resistance is most effective. Neither does the literature make documented statements regarding the specific advantages and disadvantages of the two systems. New research is needed to provide answers to these questions.

Chapter 3

METHODS AND PROCEDURES

This study involves a comparison of the effectiveness of isotonic and isokinetic weight training programs in improving vertical jumpint ability. Volunteers from the population of athletes at a four-year liberal arts college in the Midwest were used as subjects.

Population and Sampling

Both men and women athletes from Tabor College in Hillsboro, Kansas were used in this study. Tabor College is a four-year liberal arts college sponsored by the Mennonite Brethren Church. The enrollment is approximately 500 students.

All of the subjects were volunteers from the larger population of athletes at Tabor College. Every varsity sport at Tabor College was represented by the group of volunteers. Men's varsity sports were football, soccer, basketball, golf, tennis, and baseball. Women's varsity sports were tennis, volleyball, basketball, and softball.

The number of individuals who initially signed up to participate in the program and subsequently took part in the pretest was 82. Of this group, 20 were women and 62 were men. Due to injuries, a shortage of time, and other reasons

20 of the subjects, six women and 14 men, failed to complete the program. Therefore, the number of subjects used in this study was 62, 14 women and 48 men.

The isotonic exercise group (I) and the isokinetic exercise group (II) were formed by random sampling of the original 82 subjects prior to the pretest. The name of each subject was written on a four inch by two inch piece of white paper. The papers were folded and placed in a hat. An assistant then drew the papers from the hat one at a time. The first name drawn was placed in the isotonic group and the second name drawn was placed in the isokinetic group. This alternating pattern was continued until all 82 subjects had been assigned to a group.

Initially Groups I and II each contained 41 subjects. Eleven subjects dropped out of Group I leaving a final number of 30 subjects, six women and 24 men. Nine subjects dropped out of Group II leaving a final number of 32 subjects, eight women and 24 men.

The type of exercise each subject engaged in outside of the leg strengthening program was not controlled. Every subject was, however, instructed not to participate in any activities that were designed to strengthen the quadriceps muscle group or the gastrocnemius.

Materials and Instrumentation

The testing for the study was conducted in the gymnasium at Tabor College. The leg strengthening programs were carried out in the weight room at Tabor College.

The subjects in the isotonic group, as was stated earlier, used free weights for their lifting program. An olympic bar, weights, and locking collars were used. The squats were performed on a power rack (Appendix F). The power rack allows sufficient freedom of movement of the weights to place the maximum possible stress on the supporting musculature. At the same time it will not allow the weights to fall on the lifter should he/she lose control of the weights. The power rack has a series of holes in the main supports. Pins were placed through the holes at the appropriate height for each subject so that the exerciser could not squat below the prescribed level and injure his/her knees. A power rack is a necessary piece of safety equipment when doing squats with heavy weights.

The isokinetic group performed their lifting program on an Isokinetic Jumper (Appendix G). Mounted on it was a speedometer that indicated the power developed by the exerciser. The speedometer gave the exerciser an indication of his work output. The Jumper provides resistance through the use of a large fan blade that is mounted inside the machine. As the lifter begins to exercise the fan blade begins to turn. Resistance is created by the movement of the fan blade through the air. When the lifter applies more force to the Jumper the fan blade moves more rapidly, a larger volume of air is moved, and more resistance is given to the lifter.

The Jumper can be adjusted to six different speeds of exercise. This is accomplished by changing the length of the fan blades. When the Jumper is set for fast speed of exercise the fan blades are short. The short axis of the fan blade creates a small amount of resistance and allows the exerciser to move rapidly through the range-of-motion. When the Jumper is set for slow speed of exercise the fan blades are longer. This creates more resistance and thereby slows the movement of the exerciser.

Other equipment used in the study was as follows: 1) a board with feet and inches markings attached to a wall for measuring the reach heights of the subjects (Appendix H); 2) a square basketball backboard with feet and inches markings for measuring the heights touched by the subjects on their jumps (Appendix I); 3) a board with feet and inches markings attached to the bottom of a square basketball backboard for measuring the heights touched on the jumps by the subjects who could not reach the bottom of the backboard (Appendix J); 4) a knee angle board with a 110 degree angle cut into it to aid the subjects in finding their proper squat position (Appendix K).

Design of the Study

This study evaluated the effects of an isotonic weight training program and an isokinetic weight training program on the vertical jumping ability of men and women college athletes. The exercise performed by all the subjects was partial squats with a toe raiser at the end of each squat. The subjects participated in the program for six weeks.

The pretest for this study was conducted in a single day. On the same day, immediately following the subject's completion of the pretest, verbal instructions and written materials were given to the subjects. Following this session the subjects were prepared to begin their six week leg strength programs.

Immediately following completion of the pretest the subjects were given a brief verbal introduction to their respective programs by the researcher or his assistant. A handout with a comprehensive description of the isotonic leg strength program was given to the subjects in Group I (Appendix A). A similar descriptive handout of the isokinetic leg strength program was given to the members of Group II (Appendix B). A progress report sheet was also given to each subject. They were instructed to keep an accurate record of the progress of their programs. The report sheets were to be returned to the researcher upon completion of the program (Appendixes C and D).

At this time each subject was also given a demonstration of the proper use of the knee angle board (Appendix K). This device was used to determine the proper amount of knee bend to be used while performing the exercises. The subjects were instructed to use the knee angle board at the start of their first lifting session.

The demonstration of the use of the knee angle board consisted of the following procedure. One of the subjects was placed in the proper exercising position. He/she was then told to move into a squat position while the researcher or the researcher's assistant held the knee angle board in position at the subject's knee. Movement downward into the squat position was stopped when the angle created by the knee joint matched the 110 degree angle of the board.

Following this demonstration subjects in Group I were told how to adjust the power rack in order to insure that they performed the exercises with the 110 degree knee angle. The subjects in Group II were told how to read the gauge that had been placed on the Jumper in order to insure that they also exercised at a 110 degree knee angle.

Members of the isotonic group were told to get into position to exercise on the power rack as described in the handout. The olympic weight lifting bar without any weights on it was to be placed on their shoulders. The exerciser was then to move into the squat position while a partner used the knee angle board to determine when the knee was bent at a 110 degree angle (Appendix L). While the exerciser held the proper position the partner placed the pins in the appropriate holes in the power rack so that the pins would support the bar. The pin placement that was identified in this manner was to be used by the exerciser for the entire program. The holes in the power rack were labeled numerically to allow for easy identification.

The procedure described above was given to the subjects in the isokinetic group with the following changes. The subjects were to assume the proper position to exercise on the Jumper (Appendix M). A gauge mounted on the Jumper (Appendix N) was used as the indicator for the proper squat position. The isokinetic group subjects were instructed to move to the proper squat position on each repetition as indicated by the mark on the gauge that corresponded with their 110 degree knee angle.

The weight training programs began the day after the pretest was given. The isotonic program and the isokinetic program were as similar as possible except for the type of resistance used. Both programs were six weeks long and involved three sets of partial squats with 20 repetitions per set. The subjects in both groups lifted three times per week for six weeks. Both programs also included a complete lower body flexibility program. The following exercises were done before the lifting session, after the lifting session, and between each set:

1. hurdler's stretch leaning forward and lying back
2. calf stretch on an incline board

3. standing quadriceps stretch
4. standing groin stretch

   (for a more complete description see Appendixes A and B).

The subjects carried out the programs on their own time as their schedules allowed. The two weight training programs are described in more detail below.

Group I, the isotonic group, used a progressive resistance weight training program. The first set was to be done with 60 percent of the exerciser's maximum weight, the second set with 75 percent of the maximum, and the third set with 90 percent of the maximum. The subjects who had no idea of what their maximum weight was were given the following program to use as a starting point.

	MEN		WOMEN	
	Weight	Repetitions	Weight	Repetitions
First Set:	180 lbs.	20	90 lbs.	20
Second Set:	225 lbs.	20	115 lbs.	20
Third Set:	270 lbs.	20	135 lbs.	20

If this suggested program was too difficult the subjects were instructed to reduce the weight in each set to a manageable level. Whenever the subject could accomplish the 20 repetitions in each set with the weights he/she was using, the men were to add ten pounds to the weight for each set and the women were to add five pounds to the weight for each set. The subjects were told to rest three to four minutes between sets. The time between sets was to be used executing the flexibility exercises.

The progress report sheet referred to earlier included areas for the isotonic group to record the weight and repetitions for each of the three sets. This information was recorded for every workout.

Group II, the isokinetic group, performed partial squats on the Jumper. This program also used a type of increased progressive resistance. The rate of exercise adjustment on the Jumper was set at four on the first set, five on the second set, and six on the third set. The number one setting on the Jumper allows for the greatest speed of movement while exercising. The number six setting is the slowest rate of exercise setting. Therefore, the subjects executed the partial squats at the three most difficult (slowest) settings on the Jumper. Also, the exercises became more difficult from set one to set two and then from set two to set three because of the slower exercise speed.

The subjects in Group II were instructed to start the program with a relatively comfortable number of repetitions per set in order to avoid undue muscle soreness. The rest time between sets and the flexibility program used by Group II was identical to that used by Group I.

The progress report sheet included areas for the isokinetic group to record the speed (on the speedometer) they were able to maintain throughout each set and the number minutes between sets. The time between sets was to be used executing the flexibility exercises.

The progress report sheet referred to earlier included areas for the isotonic group to record the weight and repetitions for each of the three sets. This information was recorded for every workout.

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The progress report sheet included areas for the isokinetic group to record the speed (on the speedometer) they were able to maintain throughout each set and the number of repetitions performed on each set. This information was recorded for every workout.

To provide motivation, notes were sent to the subjects three different times during the program. In the notes the subjects were asked to visit with the researcher if any problems had developed and also encouraged the subjects to diligently engage in the weight training program. The researcher also visited the weight room on many occasions while the subjects were lifting to answer questions and provide encouragement.

At the end of the six week training period the subjects discontinued their weight training programs. The first post-test was given the day after the weight training programs were completed.

Data Collection

Four different types of jumps were evaluated in the pretest. The four jumps were: 1) standing jump off of two feet (no foot movement was allowed to develop momentum for the jump); 2) two foot jump with a running approach; 3) left foot jump with a running approach; 4) right foot jump with a running approach. The subjects were given three attempts on each type of jump. The best effort for each type of jump was used for statistical analyses.

On the day of the pretest the researcher and his assistant were available in the gymnasium to carry out the evaluation from 11:00 a.m. to 12:15 p.m. and from 2:30 p.m. to 5:30 p.m. The subjects had been notified of the times for the testing. They came to the gymnasium whenever their class and work schedules allowed.

Upon entering the gymnasium the subject(s) was told to begin by running five laps around the gymnasium. Following this warm-up the subject(s) was told to do the same four flexibility exercises that were to be used during the weight training programs. Requiring the same exercises that were to be used later gave the researcher the opportunity to demonstrate the flexibility exercises to every subject.

With the warm-up completed the subject's reach was determined. Reach was checked with the subject standing flat-footed with his/her side against the wall board (Appendix H). The dominant hand, which was turned to the wall, was extended as high as possible. The point touched was recorded as that subject's reach height.

The next step in the testing procedure was the jumping itself. The subjects executed three of each of the four types of jumps with rest periods between jumps. All three jumps of one type were executed before moving on to the next type of jump. The researcher was positioned on a ladder a few feet from the basketball backboard where the jumping took place (Appendix O). This position enabled the researcher to accurately assess the height touched by each subject. Although only the best effort on each type of jump was used for statistical analysis all jump heights were recorded on a permanent record sheet (Appendix E).

When the jumping tests were completed the subject was told which was his/her group. The appropriate materials were handed out and the introduction to the weight training program described earlier was given. The subject was told that he/she should start the program the next day.

The first post-test was administered the day after the weight training program was to be completed, or six weeks and one day after the weight training program began. The procedure used for this test was identical to the procedure used for the pretest.

The second post-test was administered one week after the first post-test. The subjects had at this point a one week rest following the completion of the weight training program. The procedure used for this test was identical to the earlier procedures with one exception. The reach heights of the subjects were not checked and recorded in this test.

Data Analysis

In this study there were pre- and post-test measures found on the same individuals from two separate groups. For that reason it was determined that the analysis of covariance (ANOCOV) would be most appropriate to make specific comparisons. The ANOCOV is a blending of regression and the analysis of variance and permits statistical control of variables. Whenever two measures are correlated, e.g., pre- and post-tests, one measure can then be used to predict scores on the other. In essence, a proportion of the variance of the criterion (dependent) variable existed prior to the experiment and is subsequently eliminated in the final analysis. Error variance is substantially reduced. The obtained F-ratio is found as follows:

$$F = \frac{MS'_{by}}{MS'_{my}}, \text{ with df} = (k-1), (N-k-1)$$

MS'_{by} = adjusted mean square between-groups from post-test

MS'_{my} = adjusted mean square within-groups from post-test

df = degrees of freedom

k = number of groups

N = sample size or total number of subjects

Chapter 4

ANALYSIS OF DATA

The area of concern in this study was to determine whether there would be a significant difference in jumping improvement produced by two different weight training programs. Group I participated in an isotonic program while Group II participated in an isokinetic program.

There were 62 subjects that completed the program. They had been divided into the two groups with 30 subjects in Group I and 32 subjects in Group II. Both groups were pre-tested once and post-tested twice. The first post-test was given the day after the six week program was completed. The second post-test was given one week after the first post-test.

The comparative differences of jumping improvement between the pre-test and the post-tests for each of the four types of jumps were analyzed statistically. The statistical method used was the analysis of covariance.

Treatment of Data

The null hypothesis was used in this study. Thus it was hypothesized that no significant differences would exist between the two groups. In the case that statistically significant differences were found the null hypothesis would be rejected. If no statistically significant differences were found the null hypothesis would be retained.

Analysis of Covariance

An analysis of covariance was done for each of the four types of jumps. A separate analysis was done to compare the pretest to post-test 1 and then to compare the pretest to post-test 2. For this analysis of covariance it was necessary to have an equal number of subjects in each group. The scores of two randomly selected subjects in the isokinetic group were withdrawn from the data to create equal group sizes.

Each analysis of covariance is given a separate section. A table indicates the procedure for establishing F-ratios which were computed at one and 57 degrees of freedom. There is also a comparison of the pretest and post-test means, the mean differences, and the adjusted means for the two groups. A statement is then made regarding the presence or absence of a significant difference between the adjusted means at the .05 level of significance.

Standing Two Foot Jump Pretest to Post-test 1. The mean of the pretest for Group I on the standing vertical jump was 22.933. The corresponding post-test mean for Group I was 23.217. The mean difference was 0.284. Group II showed more improvement than Group I. The pretest mean for Group II was 21.917 and the post-test mean was 22.450, resulting in a mean difference of 0.533 (Table 1).

Table 1

Summary Table for Analysis of Covariance
Standing Two Foot Jump
Pretest to Post-test 1

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	15.50	11.69	8.82	1	0.30	0.30	0.303*
Within	58	769.41	688.81	673.52	57	56.87	1.00	
Total	59	784.91	700.50	682.34	58	57.17		

* Not significant at the .05 level

The adjusted mean for Group I on the standing vertical jump was 22.762. The corresponding mean for Group II was 22.905 yielding an F-ratio of 0.303. An F-value greater than or equal to 4.08 ($F \geq 4.08$) was needed to reject the null hypothesis at the .05 level of significance (df = 1,57). Since this F-ratio was less than 4.08 the null hypothesis was retained. The difference between the adjusted means of these two groups on the standing jump was not significant.

Standing Two Foot Jump Pretest to Post-test 2. The pretest means were, of course, the same as those in the above analysis. The pretest mean of 22.933 for Group I was subtracted from the post-test mean of 23.583 to produce a mean difference of 0.65. The pretest mean of 21.917 for Group II was subtracted from the post-test mean of 22.767 to produce a mean difference of 0.85 (Table 2).

The adjusted mean for Group I on this measure was 23.124 as compared to the adjusted mean for Group II of 23.226. These means produced an F-ratio of 0.117. In order to reject the null hypothesis at the .05 level of significance (df = 1,57) an F-value greater than or equal to 4.08 ($F \geq 4.08$) was needed. The null hypothesis was retained since this F-ratio was less than 4.08. There was no significant difference between the adjusted means of these two groups.

Running Two Foot Jump Pretest to Post-test 1. Group I developed a pretest mean of 26.45 and a post-test mean of

Table 2

Summary Table for Analysis of Covariance
Standing Two Foot Jump
Pretest to Post-test 2

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	15.50	12.45	10.00	1	0.15	0.15	0.117*
Within	58	769.41	694.58	700.41	57	73.37	1.29	
Total	59	784.91	707.03	710.41	58	73.52		

* Not significant at the .05 level

26.933 for a mean difference of 0.483 on this measure. Group II's corresponding means were 24.9 and 25.583 for a mean difference of 0.683 (Table 3).

Group I had an adjusted mean of 26.192 on this measure. The adjusted mean for Group II was 26.325. The F-ratio obtained from these means of 0.137 caused the null hypothesis to be retained at the .05 level of significance (df = 1,57). An F-value greater than or equal to 4.08 ($F \geq 4.08$) was needed to reject the null hypothesis. Therefore, the difference between the adjusted means of these two groups on this measure was not significant.

Running Two Foot Jump Pretest to Post-test 2. The pretest mean of 26.45 and the post-test mean of 27.25 for Group I yielded a mean difference of 0.8. A pretest mean of 24.9 and a post-test mean of 25.867 for Group II yielded a mean difference of 0.967 (Table 4).

An adjusted mean of 26.541 was computed for Group I. Computations indicated an adjusted mean of 26.576 for Group II. The null hypothesis was retained since these means developed an F-ratio of 0.007. This F-value was less than the 4.08 which was required to reject the null hypothesis ($F \geq 4.08$) at the .05 level of significance (df = 1,57). This measure did not show a significant difference between the adjusted means of these two groups.

Running Left Foot Jump Pretest to Post-test 1. A mean difference of 0.433 was produced by Group I from a

Table 3

Summary Table for Analysis of Covariance
Running Two Foot Jump
Pretest to Post-test 1

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	36.04	31.39	27.34	1	0.26	0.26	0.137*
Within	58	1,288.87	1,232.90	1,285.91	57	106.55	1.87	
Total	59	1,324.91	1,264.29	1,313.25	58	106.81		

* Not significant at the .05 level

Table 4

Summary Table for Analysis of Covariance
Running Two Foot Jump
Pretest to Post-test 2

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	36.04	32.16	28.70	1	0.02	0.02	0.007*
Within	58	1,288.87	1,179.73	1,237.34	57	157.52	2.76	
Total	59	1,324.91	1,211.89	1,266.04	58	157.54		

* Not significant at the .05 level

pretest mean of 27.017 and a post-test mean of 27.45. The mean difference for Group II was 0.583 from corresponding means of 26.15 and 26.733 (Table 5).

The adjusted mean for Group I on the running left foot vertical jump was 27.079. The corresponding mean for Group II was 27.104 yielding an F-ratio of 0.003. An F-value greater than or equal to 4.08 ($F \geq 4.08$) was needed to reject the null hypothesis at the .05 level of significance (df = 1,57). Since this F-ratio was less than 4.08 the null hypothesis was retained. The difference between the adjusted means of these two groups on the left foot jump was not significant.

<u>Running Left Foot Jump Pretest to Post-test 2</u>. The pretest means were the same as those in the immediately preceeding analysis. The pretest mean of 27.017 and the post-test mean of 28.15 for Group I yielded a mean difference of 1.133. The pretest mean of 26.15 and the post-test mean of 27.233 gave a mean difference of 1.083 for Group II (Table 6).

The adjusted mean for Group I on this measure was 27.798 as compared to the adjusted mean for Group II of 27.585. These means produced an F-ratio of 0.203. In order to reject the null hypothesis at the .05 level of significance (df = 1,57) an F-value greater than or equal to 4.08 ($F \geq 4.08$) was needed. The null hypothesis was retained since this F-ratio was less than 4.08. There was no

Table 5

Summary Table for Analysis of Covariance
Running Left Foot Jump
Pretest to Post-test 1

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	11.27	9.32	7.70	1	0.01	0.01	0.003*
Within	58	1,693.82	1,450.47	1,434.04	57	191.95	3.37	
Total	59	1,705.09	1,459.79	1,441.74	58	191.96		

* Not significant at the .05 level

Table 6

Summary Table for Analysis of Covariance
Running Left Foot Jump
Pretest to Post-test 2

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	11.27	11.92	12.60	1	0.68	0.68	0.203*
Within	58	1,693.82	1,375.12	1,305.94	57	189.55	3.33	
Total	59	1,705.09	1,387.04	1,318.54	58	190.23		

* Not significant at the .05 level

significant difference between the adjusted means of these two groups.

<u>Running Right Foot Jump Pretest to Post-test 1</u>. Group I developed a pretest mean of 24.55 and a post-test mean of 25.617 for a mean difference of 1.67 on this measure. The corresponding means for Group II were 23.617 and 24.65 for a mean difference of 1.03 (Table 7).

Group I had an adjusted mean of 25.23 on this measure. The adjusted mean for Group II was 25.036. The F-ratio of 0.248 which was obtained from these means caused the null hypothesis to be retained at the .05 level of significance (df = 1,57). An F-value greater than or equal to 4.08 ($F \geq 4.08$) was needed to reject the null hypothesis. Therefore, the difference between the adjusted means of these two groups on this measure was not significant.

<u>Running Right Foot Jump Pretest to Post-test 2</u>. The pretest mean for Group I on the vertical jump off the right foot was 24.55. The post-test mean was 26.133 which produced a mean difference of 1.58. The mean difference for Group II on the vertical jump off the right foot was 1.63 which was produced by a pretest mean of 23.617 and a post-test mean of 25.25 (Table 8).

An adjusted mean of 25.755 was computed for Group I. Computations indicated an adjusted mean of 25.628 for Group II. The null hypothesis was retained since these means developed an F-ratio of 0.099. This F-value was less than

Table 7

Summary Table for Analysis of Covariance
Running Right Foot Jump
Pretest to Post-test 1

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	13.07	13.53	14.02	1	0.56	0.56	0.248*
Within	58	1,643.02	1,360.05	1,254.42	57	128.60	2.26	
Total	59	1,656.09	1,373.58	1,268.44	58	129.16		

* Not significant at the .05 level

Table 8

Summary Table for Analysis of Covariance
Running Right Foot Jump
Pretest to Post-test 2

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y	F
Between	1	13.07	12.37	11.70	1	0.24	0.24	0.099*
Within	58	1,643.02	1,330.67	1,216.84	57	139.13	2.44	
Total	59	1,656.09	1,343.04	1,228.54	58	139.37		

* Not significant at the .05 level

the 4.08 which was required to reject the null hypothesis ($F \geq 4.08$) at the .05 level of significance (df = 1,57). This measure did not show a significant difference between the adjusted means of these two groups.

Discussion of Results

The statistical analysis showed that Group II, the isokinetic group, had a higher mean difference and adjusted mean than did Group I, the isotonic group, on the following types of vertical jumps: 1) standing jump pretest to post-test 1, 2) standing jump pretest to post-test 2, 3) running two foot jump pretest to post-test 1, 4) running two foot jump pretest to post-test 2, 5) running left foot jump pretest to post-test 1. The statistical analysis showed that Group I had a higher mean difference and adjusted mean on the following types of vertical jumps: 1) running left foot jump pretest to post-test 2, 2) running right foot jump pretest to post-test 1, 3) running right foot jump pretest to post-test 2.

To make a generalization, Group II developed greater mean differences and adjusted means than did Group I on the two-footed vertical jumps. Group I developed greater mean differences and adjusted means on the one footed jumps than did Group II. The differences between groups were, however, very small. There were no statistically significant differences between groups at the .05 level of significance. Therefore, the null hypothesis was retained for every measure.

The second post-test was given to determine whether or not one of the groups would demonstrate more of a delayed response (jumping improvement) to the weight training program than would the other group. The only measure where the adjusted mean was noticeably changed between post-tests was the running left foot jump. Group I had a lower mean difference and adjusted mean on the pretest to post-test 1 than did Group II. These two means were then higher for Group I than for Group II on the pretest to post-test 2. These differences were, however, very small. The results, therefore, indicated that the two groups showed virtually the same reaction to the one week layoff between the two post-tests.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter contains a summary of the study and conclusions drawn from the statistical data. It also contains recommendations for further research.

Summary

The purpose of this study was to compare the amount of improvement in vertical jumping ability gained from an isotonic weight training program to the improvement gained from an isokinetic weight training program. It was thought that this knowledge would be valuable to physical educators who were considering the purchase of weight training equipment. It would also be helpful to coaches who were interested in developing weight training programs.

The hypothesis was that there would be no significant difference in jumping improvement between the isotonic and isokinetic groups. In order to test this hypothesis 62 college athletes from Tabor College were randomly assigned to either an isotonic group or an isokinetic group. All of the subjects were pretested and post-tested in four types of vertical jumps: 1) standing two foot jump, 2) running two foot jump, 3) running left foot jump, 4) running right foot jump. Each subject was given three attempts on each type of jump. The subject's reach height was then subtracted from his/her best effort on each type of jump to generate a jump height for each type of jump.

All of the subjects engaged in a six week weight training program which consisted of three sets of partial squats. The programs were executed three times a week. The isotonic group (Group I) exercised with free weights on a power rack. The isokinetic group (Group II used the Isokinetic Jumper machine.

An analysis of covariance was used to compare the improvement in vertical jumping ability achieved by the two groups. No significant difference was found between the adjusted means of the two groups at the .05 level of significance. The null hypothesis was retained for every measure evaluated in this study.

The results of this study indicate that isotonic weight training and isokinetic weight training are equally effective in improving jumping ability. Neither group produced significantly greater improvement than the other.

Conclusions

Within the limitations of this study, the following conclusion appears to be justified:

There is no significant difference in the amount of vertical jumping improvement achieved through the use of isotonic weight training program and the improvement achieved through the use of an isokinetic weight training program.

Recommendations

This section offers suggestions for the direction of further research that relates to the area of interest in this study. Some factors that became items of concern during this study are also given.

One of the areas of concern with this study dealt with the analysis of covariance (ANOCOV) as the statistical tool. ANOCOV was used because of its complete analysis of both between-groups and within-groups variance. Included in the process of calculating the adjusted means for a measure, however, is a factor that compensates for differences that exist between the overall mean for the measure and the group pretest means. In other words, if Group I has a higher pretest mean than does Group II, which was the case in this study, there is a factor in ANOCOV that statistically lowers the adjusted mean of Group I and statistically raises the adjusted mean of Group II.

This compensating factor is necessary in most studies for an accurate analysis of data produced by groups that have different pretest means. It is this researcher's opinion that this factor is inappropriate for analyzing data from a study relating to jumping improvement. Due to the natural law's of gravity the percentage of increase in force needed to improve a subject's jumping ability from 24 to 26 inches is greater than that needed to improve a subject's jumping ability from 12 to 14 inches. Therefore, any compensation of adjusted means should in fact favor the group with the higher pretest mean rather than vice versa. Improvement will be more difficult for the group with the higher pretest mean than it will be for the group with the lower pretest mean.

Another area of concern related to the lack of control of the subjects' exercise programs, other than the weight training program, that existed in this study. This researcher suggests that future studies of this type include, if possible, control of the subject's entire exercise programs.

While conducting this study this researcher saw a need for a more complete understanding of the jumping movement itself. The relative importance of each joint and muscle involved in the jumping movement needs to be determined. This knowledge would hopefully lead to the ability to diagnose the mechanical deficiencies of an athlete's jumping form and prescribe alterations that would improve his/her jumping ability. This knowledge could then also enable a coach/physical educator to determine which muscle or muscles an athlete most needed to strengthen to improve his/her jumping.

Future research should also be aimed at determining the training techniques, particularly strength and flexibility training techniques, that will best increase the effectiveness of each specific muscle as it is involved in the jumping motion. The training technique that works best for one muscle group will not necessarily be the best technique for a different muscle group.

If all of the above knowledge was available athletes could first of all improve their mechanical efficiency. They could then strengthen the appropriate muscles by using the best equipment and training techniques for that particular muscle or muscle group.

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APPENDIX A

ISOTONIC LEG STRENGTH PROGRAM HANDOUT

ISOTONIC LEG STRENGTH PROGRAM HANDOUT

Objective of the Program

It is the goal of this weight lifting program to improve your leg strength. The exercise you will do to accomplish this goal is squats on the power rack.

We will be evaluating your improvement by testing your jumping ability. However, increasing your leg strength will also increase your speed, quickness, and power for any athletic event.

General Guidelines

1. Always warm up--jog 5 laps in the gym, jump rope, etc.--before starting to lift.

2. Use the foam pads provided to minimize the stress caused by the pressure on your shoulders.

3. Your feet should be slightly less than shoulder width apart. Your toes should be pointed straight ahead.

4. Always use a back support belt. It must be adjusted so that it is very snug.

5. Keep your head and chest up throughout the exercise. Avoid straining your lower back by keeping your hips in line with your shoulders. (Figure 1)

6. You can move to stand up quickly in the exercise, but move slowly back down into the squat position until the bar touches the pins. Control the weight as you descend.

7. Do a fully extended toe raiser at the end of each repetition.

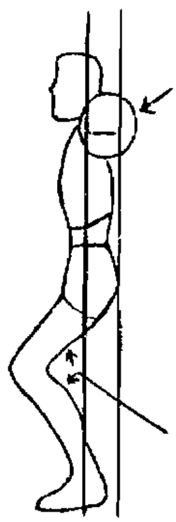


Figure 1

8. When beginning the program (the first 2 or 3 lifting sessions) do not work your muscles to the point of extreme fatigue in order to avoid excessive soreness.

How to Begin the Leg-Weight Program

You will execute the squats on the "Power Rack" in the Tabor Fitness Center. The first step for starting your program is to determine how deep you should squat when performing the exercise. Position yourself in the power rack using a bar with no weights on it. With a partner to help you, move down into the squat position until your knees are bent at a 110° angle. (Figure 1)

Use the boards indicating the correct knee angle that are in the fitness center to help you find the correct position. (Figure 2) When you are in the squat position with your knees bent at a 110° angle, place the pins through the holes in the power rack that will support the bar.

Every squat you perform should be done from the position you just established. Always make sure the pins are properly placed.

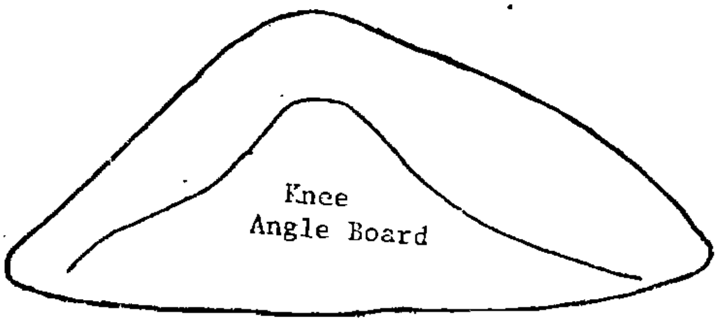


Figure 2

Flexibility

It is essential that you work to improve your flexibility as well as your strength while you are on this program. Do the following stretching exercises after your warmup but before your first set, between each set, and after completing the program.

Hurdlers Stretch

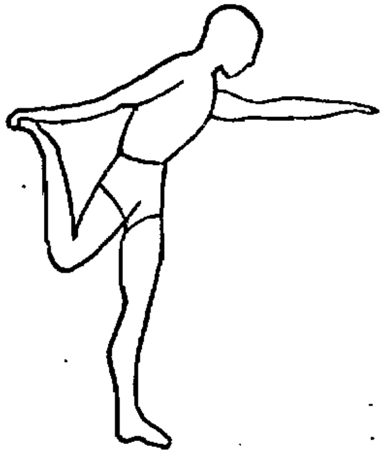
Leaning forward and laying back

Calf Stretch

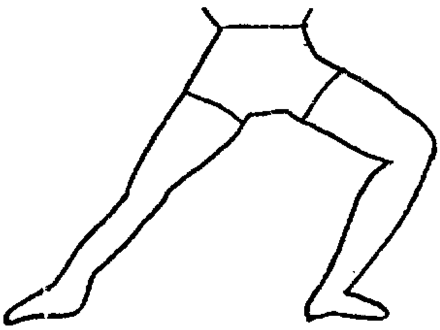
Stand on an
incline board
or L-sit and
pull back
on the
toes

Standing Quadriceps Stretch

Pull the knee up and
attempt to arch your
back



Standing Groin Stretch



Lower yourself to the
side on one knee
while putting pressure
on your hip with your
hand.

The Program

1. The program involves doing 3 sets of squats.

2. You will do the program 3 times a week, but never 2 days in a row.

3. The program will last for 6 weeks, ending May 7.

4. You will be retested after completion of the program on May 8 and again on May 15.

	Weight	Repetitions
Set #1	60% of your maximum	20
Set #2	75% of your maximum	20
Set #3	90% of your maximum	20

5. The period of rest between sets should be 3-4 minutes.

6. When you can do 20 repetitions in all 3 sets with the weight you are using:
   Men - add 10 lbs. to the weight used for each set.
   Women - add 5 lbs. to the weight used for each set.

7. Remember - start slow and work your way up (see guidelines 1).

   If you have no idea what the maximum weight you can squat is, use the following program as a starting point:

Men:	Weight	Repetitions	Women:	Weight	Repetitions
Set #1	180 lbs.	20	Set #1	90 lbs.	20
Set #2	225 lbs.	20	Set #2	115 lbs.	20
Set #3	270 lbs.	20	Set #3	135 lbs.	20

8. If you can complete the above program increase the amount of weight used for each set.

9. If the above program seems to strenuous decrease the amount of weight used for each set.

APPENDIX B

ISOKINETIC LEG STRENGTH PROGRAM HANDOUT

ISOKINETIC LEG STRENGTH PROGRAM HANDOUT

Objective of the Program

It is the goal of this weight lifting program to improve your leg strength. The exercise you will do to accomplish this goal is squats on the Jumper.

We will be evaluating your improvement by testing your jumping ability. However, increasing your leg strength will also increase your speed, quickness, and power for any athletic event.

General Guidelines

A. Always warm up--jog 5 laps in the gym, jump rope, etc.--before starting to lift.

B. Use the foam pads provided to minimize the stress caused by the bar resting on your shoulders.

C. Your feet should be slightly less than shoulder width apart. Your toes should be pointed straight ahead.

D. Place your feet toward the front of the platform to help you keep your back straight. (Figure 1)

E. Always use a back support belt. It must be adjusted so that it is very snug.

F. Keep your head and chest up throughout the exercise. Avoid straining your lower back by keeping your hips in line with your shoulders. (Figure 1)

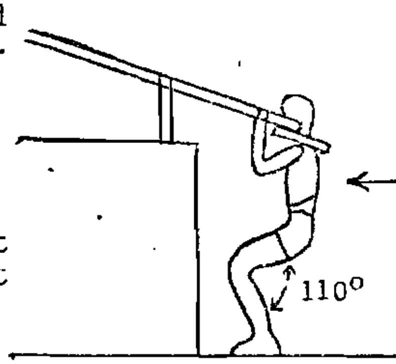


Figure 1

G. You must give your maximum effort on every repetition. Keep the speedometer registering as high a rate of speed as possible.

H. Do a fully extended toe-raiser at the end of each repetition.

I. When beginning the program (the first 2 or 3 lifting sessions) do not work your muscles to the point of extreme fatigue in order to avoid excessive soreness.

How to Begin the Leg-Weight Program

You will execute the squats on the "Jumper" in the Tabor Fitness Center. The first step for starting your program is to determine how deep you should squat when performing the exercise. With a partner to help you, position yourself on the Jumper and move down into the squat position until your knees are bent at a 110° angle. (Figure 1) Use the boards indicating the correct knee angle that are in the fitness center to help you find the correct position. (Figure 2) When you are in the squat position with your knees bent at a 110° angle, note the mark indicated on the front of the Jumper. (Figure 3)

Every squat you perform should be done from the position you just established. Use the marker on the front of the Jumper as the guide to help you get into the correct position on each squat.

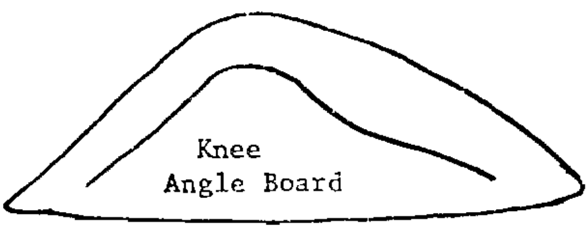


Figure 2

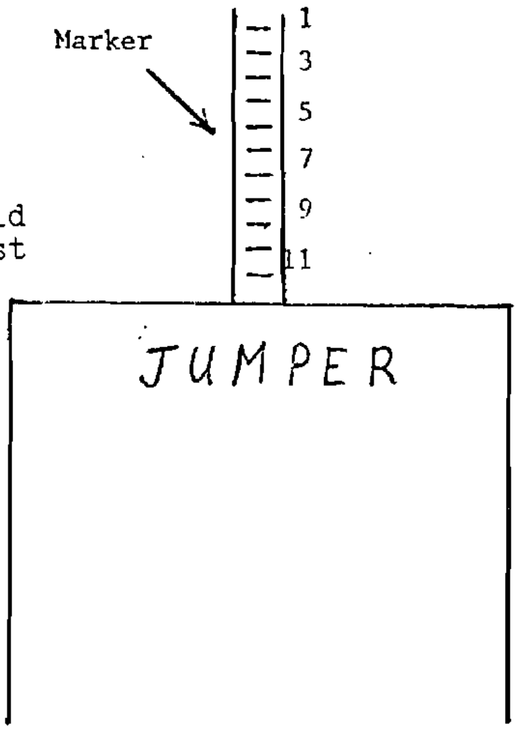


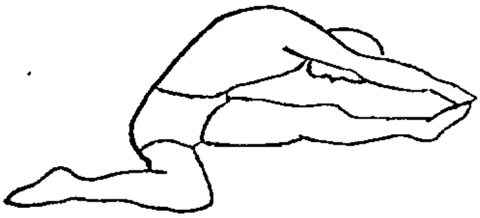
Figure 3

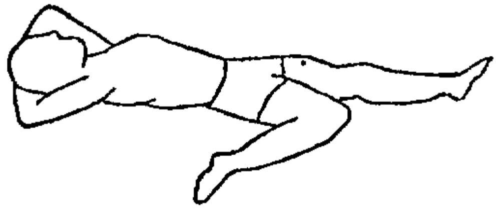
Flexibility

It is essential that you work to improve your flexibility as well as your strength while you are on this program. Do the following stretching exercises after your warmup but before your first set, between each set, and after completing the program.

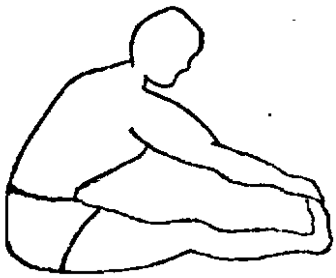
Hurdlers Stretch

Leaning forward and laying back



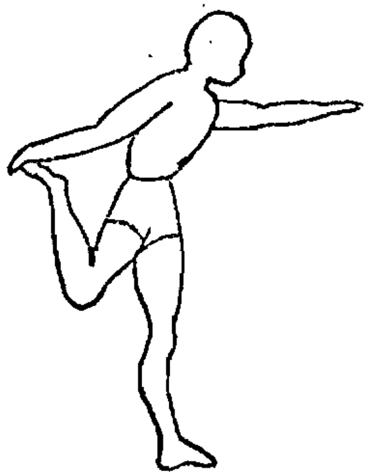


Calf Stretch Stand on an incline board or L-sit and pull back on the toes (below)



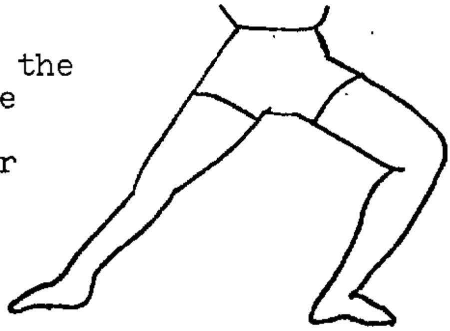
Standing Quadriceps Stretch

Pull the knee up and attempt to arch your back.



Standing Groin Stretch

Lower yourself to the side on one knee while putting pressure on your hip with your hand.



The Program

1. The program involves doing 3 sets of squats.

2. You will do the program 3 times a week, but never 2 days in a row.

3. The program will last for 6 weeks, ending May 7.

4. You will be retested after completion of the program on May 8 and again on May 15.

	Jumper Resistance Setting	Repetitions
Set #1	#4	20
Set #2	#5	20
Set #3	#6	20

5. The period of rest between sets should be 3-4 minutes.

6. Do not attempt to do 20 repetitions per set during the first few lifting sessions. (See Guideline I) Start slow and work your way up.

7. However, give your maximum effort on each repetition.

APPENDIX C

ISOTONIC WORKOUT REPORT SHEET

ISOTONIC WORKOUT REPORT SHEET

Isotonic Leg Strength Program

Name ______________________________

	Set No. 1		Set No. 2		Set No. 3	
	Weight	Number of reps.	Weight	Number of reps.	Weight	Number of reps.
Session Number 1						
Session Number 2						
Session Number 3						
Session Number 4						
Session Number 5						
Session Number 6						
Session Number 7						
Session Number 8						
Session Number 9						

Isotonic Leg Strength
Program

Name ______________________

	Set No. 1		Set No. 2		Set No. 3	
	Weight	Number of reps.	Weight	Number of reps.	Weight	Number of reps.
Session Number 10						
Session Number 11						
Session Number 12						
Session Number 13						
Session Number 14						
Session Number 15						
Session Number 16						
Session Number 17						
Session Number 18						

APPENDIX D

ISOKINETIC WORKOUT REPORT SHEET

ISOKINETIC WORKOUT REPORT SHEET

Isokinetic Leg Strength Program

Name ____________________

	Set No. 1		Set No. 2		Set No. 3	
	Minimum Speed Maintained	Number of reps.	Minimum Speed Maintained	Number of reps.	Minimum Speed Maintained	Number of reps.
Session Number 1						
Session Number 2						
Session Number 3						
Session Number 4						
Session Number 5						
Session Number 6						
Session Number 7						
Session Number 8						
Session Number 9						

Isokinetic Leg Strength Program

Name____________________________

	Set No. 1		Set No. 2		Set No. 3	
	Minimum Speed Maintained	Number of reps.	Minimum Speed Maintained	Number of reps.	Minimum Speed Maintained	Number of reps.
Session Number 10						
Session Number 11						
Session Number 12						
Session Number 13						
Session Number 14						
Session Number 15						
Session Number 16						
Session Number 17						
Session Number 18						

APPENDIX E

PERMANENT RECORD SHEET FOR JUMPS

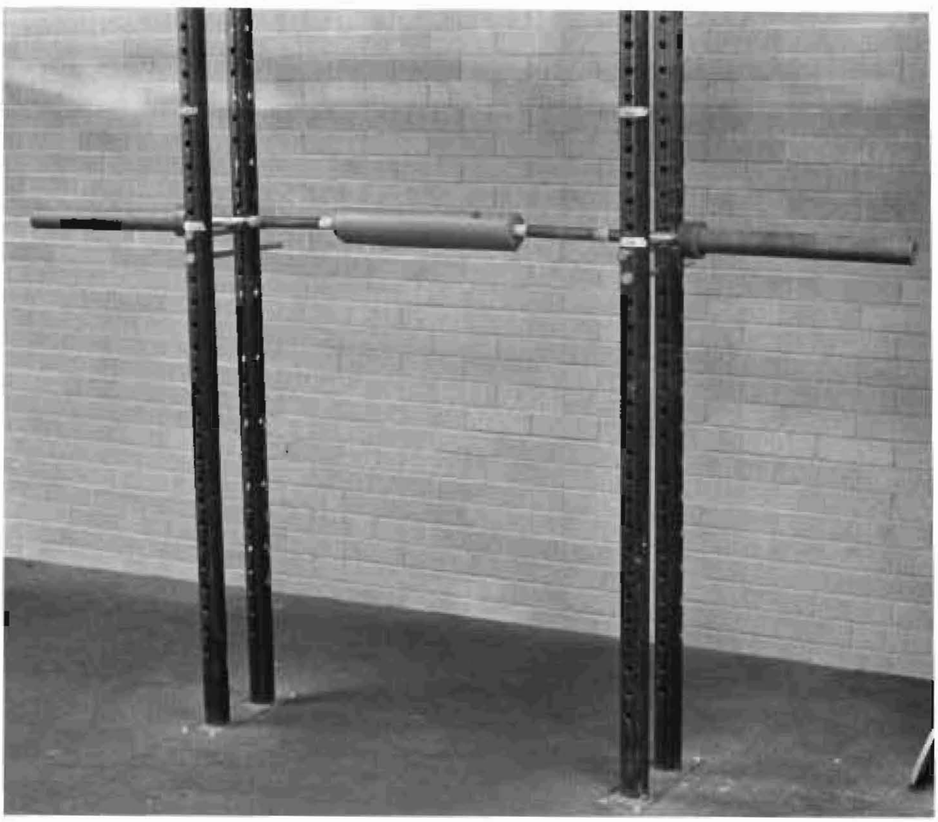
PERMANENT RECORD SHEET FOR JUMPS

Name Reach Hgt.	2 feet - Standing			2 feet - Running Approach			Left foot - Running Approach			Right foot - Running Approach		

APPENDIX F

POWER RACK

POWER RACK



APPENDIX G

ISOKINETIC JUMPER

ISOKINETIC JUMPER

APPENDIX H

REACH HEIGHT BOARD

REACH HEIGHT BOARD

APPENDIX I

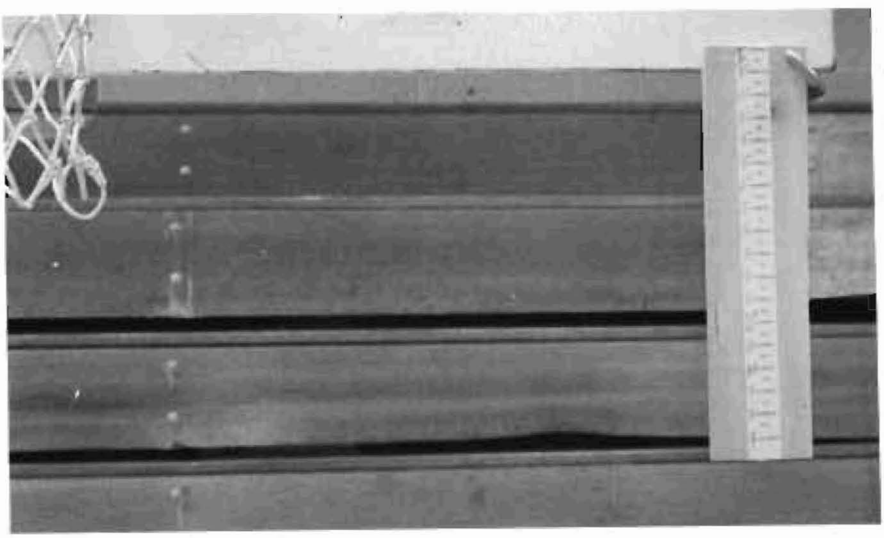
BASKETBALL BACKBOARD WITH MEASURING TAPE

BASKETBALL BACKBOARD WITH MEASURING TAPE

APPENDIX J

LOW JUMP REACH BOARD

LOW JUMP REACH BOARD



APPENDIX K

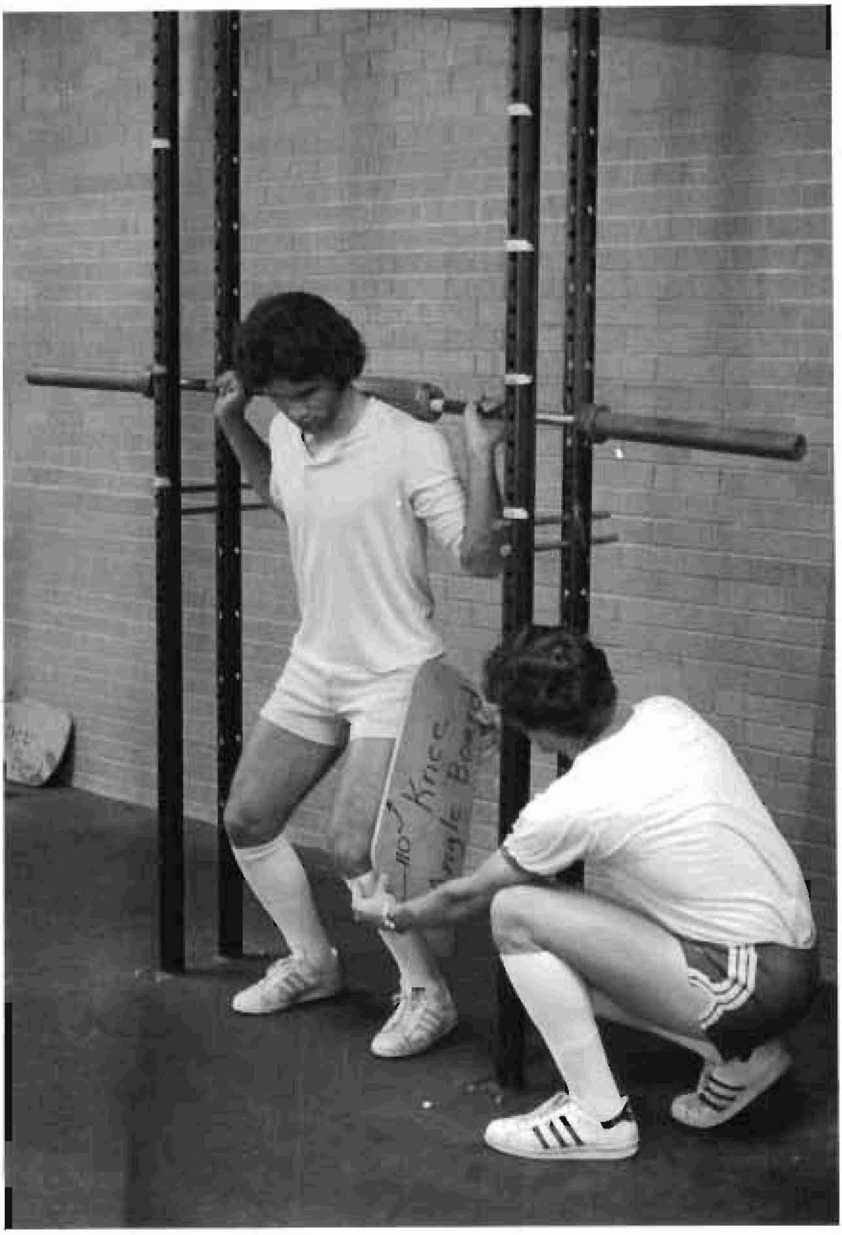
KNEE ANGLE BOARD

KNEE ANGLE BOARD

APPENDIX L

KNEE ANGLE BOARD BEING USED ON THE POWER RACK

KNEE ANGLE BOARD BEING USED ON THE POWER RACK



APPENDIX M

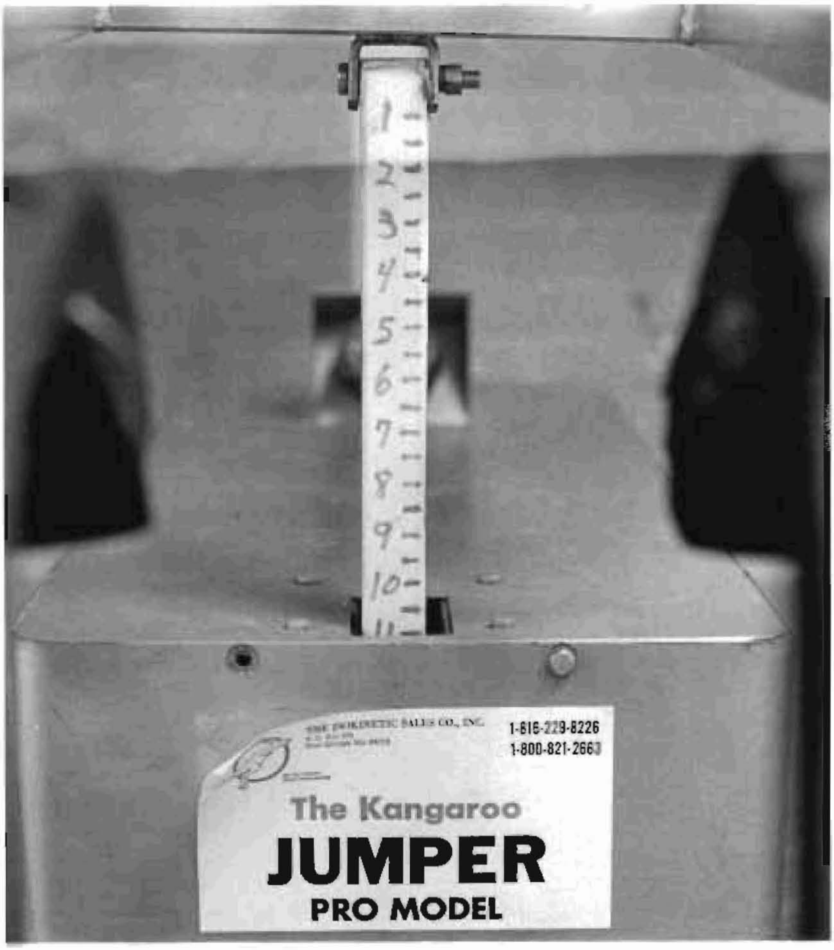
KNEE ANGLE BOARD BEING USED ON THE JUMPER

KNEE ANGLE BOARD BEING USED ON THE JUMPER

APPENDIX N

JUMPER GAUGE

JUMPER GAUGE



APPENDIX O

RESEARCHER IN POSITION TO RECORD JUMPS

RESEARCHER IN POSITION TO RECORD JUMPS