THE EFFECTS OF ISOKINETIC WEIGHT TRAINING AT TWO SPEEDS UPON THE VERTICAL JUMP

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Terry D. Somers

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ABSTRACT

THE EFFECTS OF ISOKINETIC WEIGHT TRAINING AT TWO SPEEDS UPON THE VERTICAL JUMP

Terry D. Somers

PURPOSE: It was the purpose of this study to determine if any advantage existed in altering the speed of repetition in a particular resistance exercise in order to improve skill performance scores.

PROBLEM: Will a slow speed of isokinetic training be more effective than a contrasting faster speed of similar training in significantly increasing vertical jumping performance scores of high school age males and females.

PROCEDURE: The sixty subjects used in this study were divided into three different groups: control group, slow speed training group and fast speed training group. Each group was pre-tested and then post-tested after a six week training period in the vertical jump. The comparative difference between initial and final test scores were statistically analyzed. The statistical method used was the analysis of variance and Dunnett's t-test at the .05 level of significance.

RESULTS: There was no significant difference in improvement of vertical jump performance scores.

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INTRODUCTION

The increasing competitiveness of athletics has led coaches and participants to pursue more deeply the training methods which will improve skills necessary to excell in sports. The improvement of performance is the criteria on which is based the necessity for better training methods or techniques. Strength has been one of the important areas of training in relationship to skill improvement.

Within the last decade, there have been several new training techniques to develop muscular strength and endurance. Isotonic weight training became prominent during the late 1940's as one form of weight training. In the early 1960's isometric training was utilized by athletic participants and coaches. It would seem natural for other techniques to be developed that would incorporate the dynamic and the isometric elements of weight training.

Isokinetic weight training has become prominent recently for use in physical education activities, athletics, and physical rehabilitation centers as a means of improving strength. The training concept, utilizing both isotonic and isometric elements, is based upon the principle that a maximal contraction of a muscle or muscle group through a

full range of motion at a controlled rate of speed increases muscle strength.

Mini-Gym Incorporated of Independence, Missouri has developed an isokinetic unit which can be adjusted to create rates of speed. Since this is a relatively new concept, the basis for this study arose from the question "Is there an advantage to changing the speed of the resistance exercise?"

THE PROBLEM

Hellebrandt found that "the amount of work done is not as important as the rate at which it is done." (16:319) According to this principle, if resistance exercises were performed at faster speeds greater strength gains would be created.

Moffroid and Whipple later upheld Hellebrandt's principle and stated further that speed was found to be specific for increases in muscular force at and below the exercise speed (21). This is to say that resistance training performed at a specific speed will graphically show increased strength at any exercise speed equal to and slower than the training speed. Therefore, if a skill could be improved through strength gains, and assuming that strength gains were possible through isokinetic weight training, then the faster speed of performing the resistance exercise would produce an improvement in a skill as long as the training is directly related to the skill.

Statement of the Problem

Will a slow speed of isokinetic exercise training be more effective than a contrasting faster speed of similar training in significantly increasing vertical jumping performance of high school age males and females?

Statement of the Hypothesis

There is no significant difference in vertical jump performance after training at a slower isokinetic exercise speed as compared to a faster exercise speed.

Assumptions of the Study

1. There was a gain in strength resulting from the resistance exercises.
2. The work by all subjects in the study was equal.

Purpose of the Study

The purpose of this study was to compare the effects of two isokinetic weight training speeds upon the vertical jumping performance of male and female high school physical education students. More specifically, the intent was to determine if any advantage existed in altering the speed of repetition in a particular resistance exercise in order to improve skill performance scores.

Significance of the Study

The area of physical education and athletics is consistently faced with new ideas concerning training and skill improvement. One such idea, isokinetic weight

training, is quite new and many questions have been asked concerning this new concept in resistance exercise.

It was hoped that through this study added insight might be gained concerning the isokinetic concept of weight training. Since isokinetic weight training is new, the desire was that immediate application of the findings might be used in developing new programs relating to strength and skill improvement.

With the limited budgets in today's schools and the pressures of winning, physical educators and coaches need to know more about an idea before investing large sums of money on equipment. Further, inadequate knowledge concerning the application of a concept could mean that very little progress will be achieved toward a certain goal, injuries to participants could occur along with a general lack of interest in various programs.

DEFINITION OF TERMS

The following definition of terms apply to this study.

Accommodating Resistance

A principle of exercise which is achieved by the use of an automatic braking mechanism which permits resistance to be held in direct ratio to the force applied by the performer. (31:282)

Fast Speed Training

The training of subjects in the quadracep extension exercise which took approximately one second to complete one repetition.

Gastrocnemias

The large muscle located in the posterior portion of the lower leg. Its function is extension of the foot.

Isokinetic Contraction

A type of dynamic contraction in which the resistance is in direct relation to the force applied.

Isometric Contraction

A contraction in which there is no joint movement and the resistance is in direct relation to the force applied.

Jump Board

A slate board, commonly used as a chalk board, which was mounted on the wall in the gymnasium. Marks made after the subjects put chalk dust on their hands provided for ease in taking measurements on the vertical jump.

Quadracep Muscle Group

The muscle group located in the anterior aspect of the thigh. The vastus medialis, vastus lateralis, vastus intermedius and the rectus femoris.

Repetition

The given number of times an exercise is performed in succession.

Set

The number of repetitions of a particular movement or exercise repeated.

Seventy Degree Angle at the Knee

An angle of flexion between the upper and lower leg determined by adjusting the chair of the sitting leg press forward or backward, after the subject had placed his feet on the resistance platforms, to match a cardboard cut equal to seventy degrees. The cardboard device, made with the use of a protractor, was placed on the lateral portion of the leg to determine the correct angle of flexion desired in the study.

Sitting Leg Press

One of several machines manufactured by Mini-Gym, Incorporated in Independence, Missouri which utilized the isokinetic principle. The machine allows for maximal extension of the legs by means of a ballistic movement.

Slow Speed Training

The training of subjects in the quadracep extension exercise which took approximately four seconds to complete one repetition.

Strength

The ability to exert force against resistance.

LIMITATIONS OF THE STUDY

The study had the following limitations:

1. The subjects were limited to male and female physical education students at Inman High School.

2. The training was limited to the development of the muscles of the leg, specifically the quadracep muscle group and the gastrocnemius.

3. Training sessions were conducted three days a week for only six weeks. The subjects performed one set of ten repetitions each training session.

4. Increases in skill performance were confined to measurement of the vertical jump.

Chapter 2

REVIEW OF RELATED LITERATURE

The review of literature for this study appears in four parts. The first section deals with the nature of the vertical jump. The second section reviews the validity and reliability of vertical jump testing. The third section covers the effects of various weight training programs on vertical jump performance. The fourth section includes literature related to the isokinetic principle of exercise and isokinetic training.

LITERATURE RELATING TO THE VERTICAL JUMP

The Sargent jump test, or a modified form of this test, has been frequently used for purposes of classifying students in physical education or, in combination with other measures to predict athletic ability for high level performance. Researchers have studied the nature of the jump with respect to form and variations which have contributed to its effectiveness as a feasible measurement tool.

The original Sargent jump was presented by Sargent as an effective test for measuring physical ability. In experimenting with the formula devised for determining an efficiency index for each individual, Sargent used girls as subjects. The devised test, believed to take into

consideration an individual's strength, speed, energy and dexterity combined was, in Sargent's opinion, a true test of a man's physical potential. (27)

Start, Gray, Glencross and Walsh used in their study sixty-three college men to provide nineteen measures of the lower limb. There were seven measures of isometric strength: total leg strength through use of a dynomometer, plantar flexion, knee extension, hip extension using the tensiometer; four of power: results in the power jump, the Sargent jump, the squat jump, and the standing broad jump; seven anthropometric estimates: weight height, total length of the lower leg, length of foot and distance of the malleolus to the heel; and one measure of speed on the bicycle ergometer. The authors found by varimax analysis that power was linked with speed and very little to strength. (30)

Berger experimented to determine whether there were differences in the amount of force able to be exerted at leg angles of approximately 105 degrees, 120 degrees, and 140 degrees. Eighteen college males were tested for maximum leg extension on the inverted leg press. Muscular force was measured by the amount of weight on a barbell the subject could raise vertically as the leg was extended from the various angles to be tested. The subjects were tested at one position every other day. Through an analysis of variance and an F-score of 28.66 significant to the .001 level, indications were that leg extension force is

increased as the angle of the leg increases from 105 to 140 degrees in the inverted leg press position. (4)

Smith, in his study of the relationship between explosive leg strength and performance in the vertical jump, measured in a position designed to involve the power thrust of the major muscle groups used in the vertical jump. The subjects then performed a modified Sargent jump that used no arm snap. Although the reliability of all measures was high, individual differences in the ratio of tested strength to body mass showed only a low and nonsignificant correlation with jumping performance. The results were interpreted to support the hypothesis that strength exerted against a dynamometer involves a different neuromotor pattern than strength exerted by the muscle during a movement. (28)

Glencross investigated the jump reach test and standing broad jump as tests of muscle power. This investigator related the two jumps by means of a power lever and measured four major movements on the level: preferred shoulder flexion, non-preferred shoulder flexion, preferred leg extension, and non-preferred leg extension. The subjects, eighty-five college students, were tested by taking results in the vertical jump which was a form of the standing vertical jump, standing broad jump, body weight and the power lever.

Differing from other studies, the investigation revealed that, although the jumps are similar, about half of the variance of each test is specific. Muscle power

appeared to be only one component of the common variance, and jumping ability seemed to be the most important component. Glencross concluded that the jump reach test and the standing broad jump have limited application as measures of muscle power using the power lever as a criteria. (7)

Bangerter devised a study to determine the amount of contribution the plantar-flexor muscles, knee-extensor muscles, and the hip-extensors had on the vertical jump following progressive weight training. Five randomly assigned groups from 112 college men made up four test groups and one non-test or control group. All subjects met three days per week for eight weeks using progressive resistance training at eight to twelve repetitions maximum method. Group I exercised the plantar-flexors by use of a heel raise exercise; group II exercised the knee-extensors while seated at an exercise table; group III exercised the hip-extensors while being strapped face down on an exercise table; group IV performed all the exercises while group V did not participate in the training. All five groups took a pre-test and post-test in the vertical jump reach test and cable tension measurements for the muscle groups to be tested. (2)

The experimental results indicate that the plantar-flexors did not significantly contribute to the vertical jump at the .05 level with an F-score of .667. However, the knee extensors (F-score of 3.03), the hip extensors (F-score of 2.07), and a combination of the two extension exercises

(F-score of 2.64) were significant to the .05 level of significance.

The author concluded that exercises strengthening the knee extensors, or hip extensors, or a combination of the two contribute to the vertical jump. (2)

Eckert selected eighteen men and eleven women basketball team members for a study comparing the joint action of the knee, hip, and ankle during the standing broad jump and the vertical jump as measured in terms of maximal angular velocity and range of movement and isometric extensor strength. The subjects were selected because they were in good physical condition and participated in basketball which involves a certain amount of jumping. Isometric strength was measured according to the Clarke cable tension technique at the ankle, hip and knee extensors. Three trials were recorded for all strength measures.

The experimenter made cinematographic records of one vertical jump and one standing broad jump of each subject. A syncronous watch making one revolution in .76 seconds was in the jump records as a timing device. Stick figures were made of the trunk, thigh, lower leg, and foot from each frame in the records. The angles of the knee, hip and ankle were measured with a protractor from the position of deepest flexion to maximal extension. The range of motion was calculated as the difference between the two positions.

Eckert concluded that no general relationship or pattern of relationships was found between isometric extensor

strength and maximal angular velocity of the hip, knee or ankle joint action for either the vertical jump or the standing broad jump. (12)

In another study by Eckert using seventeen male varsity basketball players the purpose was to determine the effect of added weight on the joint actions in the vertical jump. Using the same method described in the previously cited study, Eckert took cinematographical records of four vertical jumps by each subject in the following order: no weight, a six-pound weight, a twelve-pound weight and an eighteen-pound weight. The weight was attached around the waist by means of a diving belt. Five minutes rest between each jump was allowed. Eckert concluded that decreases in maximal angular velocity while increases in range of motion and time occurred with increasing weight. (13)

Using thirty male volunteers, Martin and Stull studied various combinations of knee angles and lateral-anterior-posterior foot spacings on performance in the vertical jump. The subjects performed the vertical jump at knee angles of sixty-five, ninety, and one hundred fifteen degrees while using lateral and anterior posterior foot spacings of zero, five, ten, and fifteen inches. A goniometer was used to regulate the knee angles, and strips of tape forming a grid regulated the foot spacings below the jump board. The preliminary position was held momentarily before jumping and each subject jumped three times at each position for a total of forty-eight positions. The average

of the three jumps for each position was considered the subjects score.

The results in Martin and Stull's study reveal that anterior-posterior foot spacing of between five and ten inches was optimal for vertical jumping. It was also found that a one hundred fifteen degree angle at the knee joint resulted in better vertical jumping scores. (18)

On a similar investigation Willson studied the relative effects of various lateral and anterior-posterior foot spacings on the vertical jumping ability performance by junior high school boys. A total of one hundred sixty subjects were used, requiring that each subject be a volunteer and be free of any physical defects of the arms, legs and hands. Each subject performed three jumps at sixteen foot spacings, ranging in five intervals of zero, five, ten, and fifteen inches laterally and anterior-posteriorly. The best of the three jumps at each foot spacing was recorded.

Analysis of the F-ratio indicated that no significant difference existed between the zero, five and ten inch lateral foot spacings, but the means of these positions were significantly greater than the fifteen inch spacing. Significant differences occurred in jumps as anterior-posterior spacings were changed, with poorer results as the spacings were increased. (35)

The analysis of how horizontal momentum is transferred to a vertical jump was the concern of a study by

Couper; ten secondary school girls were selected on the basis of their jumping ability as subjects. After recording each girl's reaching height and standing height, the subjects were instructed to vertical jump three times. The subjects were allowed to approach the target horizontally at any speed. Thirty seconds were required between jumps.

The second and third jumps were recorded on film. Data gained from the film included the best jump of each subject, the velocity of approach and projection, the height achieved, the degrees of flexion and extension at various stages of the jump, and the relative timing on the jump.

Couper found horizontal approaches yielded significant differences between skilled and nonskilled jumpers in that the skilled performers had greater arm hyperextension in approach, later initiation of arm swing in approach, more erect trunk at the low point of the crouch, more vertical projecting legs, greater angle of projection, greater vertical velocity of projection and a backward inclination of the trunk at the high point of the jump. Couper also found no significant difference in the velocity of approach, amount of horizontal momentum developed, length of stride, flexion at the ankle, knee, and hip joints, and the relative timing of the phases of the jump before take-off. (9)

LITERATURE ON RELIABILITY OF VERTICAL JUMP TESTING

McCloy did several studies concerned with the Sargent jump and tried to correlate the jump to various track and field events. According to McCloy, the Sargent jump was equated to any other athletic skill such as the high jumping or shooting a basketball. The author stated that if the jump was to be correlated against other activities it should be practiced until the skill was constant as in athletics.

The experimenter claimed that the Sargent jump was affected by (1) the skill, ability or coordination necessary to perform the jump, and (2) the ability to do one's potential best at any given time. Utilizing various groups of subjects ranging from college physical education majors to grade school age youth, McCloy compared the Sargent jump to the 100-yard dash, high jump, standing broad jump and the eight-pound shot put, by using the reliability scores of the events. After each event was practiced until the skills were mechanically acceptable a reliability of .890 was found for the track events and a .980 for the Sargent jump. McCloy instructed each of the subjects to perform the Sargent jump by pausing in a crouch position with approximately a ninety degree knee bend and to swing the arms downward and backward. Following the pause they were to jump as high as possible while swinging the arms vigorously forward and upward. Just prior to attainment of maximum height in the jump, the arms

were to be whipped downward. The experimenter also approved of the use of the chalk jump.

After a great amount of study with the Sargent jump McCloy concluded that the jump was an excellent test of the body's ability to develop power and do work. (20)

The purpose of Van Dalen's study was to clarify and validate the various types of jumps in general use under optimum conditions and statistically point out their deficiencies. The Sargent jump was defined as a test of the ability of the body to develop power relative to the weight and size of the individual. Power was defined as force times velocity. Hence, the jump is a measure of the way in which force can combine with the highest possible contraction velocity of the muscle so as to project the body upward to a maximum height. Van Dalen used four track and field events (the six-second run, running high jump, shot put, and standing broad jump) to test this item of muscular contraction. One hundred six senior high boys were used for the study. Van Dalen taught them the correct form of seven types of jumps: the Sargent jump, the Sargent weight jump, the chalk jump, the jump and reach, the wall jump, and the belt jump.

The results indicated that the Sargent jump when standardized, practiced, and correctly administered is undoubtedly a valuable test for predicting the ability of the body to develop power. The arm swing of the Sargent jump is exceedingly important to the successful execution of

the jump. Several deficiencies exist in the chalk and wall jumps as to their administration and execution that may prohibit accurate measurement of this jump and a warning is issued against their use. (32)

Using eighty college male students as subjects, Gray, Start, and Glencross (15), by examining simpler forms of the vertical jump, wanted to determine if a measure other than an absolute measure of leg power exclusive of the time factor would be precise enough to be used as a substitute.

The subjects performed four modifications of the vertical jump: the modified vertical power jump, the jump-reach test, the standing broad jump and the squat jump. Each test was scored in inches jumped and work done. The subjects performed all four jumps. In order to do this, the students were randomly divided into four groups and each group was assigned to one of the four orders of jumps. Each participant performed three jumps with one minute recovery time allowed between each jump. After completing three jumps of a type, the subjects went to the next jump and followed the same procedure until all jumps were completed.

By using the test-retest method for reliability and a t-test to determine if the differences between the correlation was significant, the conclusion indicated that the modified vertical power was acceptable as a test of leg power in certain areas of testing. However, the authors believed that it should not be used where precise measures were necessary.

Gray, Start and Glencross developed a study to test the reliability of the vertical jump as a determinant of leg power. They defined leg power from the Sargent jump to the physical science definition in terms of work/time. The formula used was:

$$\text{Power} = \frac{w\ (h_1 + h_2)}{h}\ \sqrt{\frac{gh}{2}} \quad \text{horse power.}$$

The sample consisted of eighty male college students ranging in age from seventeen to twenty-two. Each subject was weighed and the position of his center of gravity was determined. A mark signifying the center of gravity was placed on the subject in pencil. Each subject was given one minute of stationary running as a warm-up.

The value of h_1 was determined as the difference between the height of the center of gravity in a crouched position and the height of the center of gravity while standing on tip toes. The difference in height of the center of gravity in the tip toe position and at the peak of the vertical jump was used as a value of h_2. The value h also equated to the distance between the upper limits of the fingers in the tip toe and the peak of the jump position.

Each subject had six attempts at the vertical power jump consisting of two rounds of three trials. The second round was considered the retest trial and the best performance each round was recorded as the score. One minute of rest was allowed between jumps with twenty to thirty minutes between rounds.

The objectivity of the test was determined by comparing the scores recorded by two experienced and two non-experienced observers. The non-experienced observers had no prior experience with recording jump and reach tests.

The experiment concluded, with a test-retest reliability of 0.985 and a coefficient of objectivity of 0.981, that the vertical power jump is a valid test of leg power. (19)

LITERATURE CONCERNING THE EFFECTS OF WEIGHT TRAINING PROGRAMS ON VERTICAL JUMP PERFORMANCE

Pacheo set up two experiments to study the effect of preliminary exercise upon the performance of the vertical jump. One experiment involved ten experienced subjects performing more than ninety vertical jumps preceded by exercises such as stretching for the hip and legs, running in place and deep knee bends. A control condition consisted of no preliminary exercise prior to performing the vertical jump.

In a second experiment fifty men were used in a test in which half of the subjects jumped five times with no preliminary exercise and the other half jumped after performing deep knee bends. One week later the groups reversed the procedure.

Both experiments showed improvement which was statistically significant in the vertical jump performances after preliminary exercise. The vertical jump performances were poorer when tested without preliminary exercise. (23)

Ball, Rich and Wallis experimented with sixty-three college men who were divided into two equated groups on the basis of their initial ability to exert isometric force upward against shoulder pads of a specially constructed device. Measurements were made and the apparatus adjusted to fit each subject so that the knees were flexed to the angle at which a vertical jump is usually initiated. All subjects were precisely measured in the vertical jump at the beginning and at the conclusion of the six-week training period. The experimental group trained on the apparatus three times per week for six weeks. The control group was not trained. One ten-second bout of maximum effort was made on each training day. The experimental group increased in strength with a mean gain of 17.3 percent, significant at the .01 level of confidence. However, they concluded that there was not a significant increase in jumping ability. (1)

In a study by McClements (19), the purpose was to compare the power of the body, as measured by the product of jumping heights and body weight, with the strength of leg and thigh flexor muscles. Secondly, he compared the effect on power of strength development of agonistic and antagonistic muscle groups. Eighty-six college men, enrolled in eight physical conditioning classes, met twice a week for sixteen weeks. After an initial testing period, four treatment groups were formed and randomly assigned to an extensor program, a flexor program, a flexor-extensor program or the normal conditioning program. The training lasted nineteen class

periods. McClements concluded that equal effective gains in power of the leg and thigh muscles used in the vertical jump were found resulting from the four training programs. Further, McClements concludes that strength is related to power although gains in strength are not related to gains in power.

Using fifty-five college males as subjects, Chui devised a study to determine some of the facts concerning the effects of systematic weight training on athletic power. One group of twenty-three subjects performed sixteen weight training exercises for one hour, two to three times a week, from eight to twelve repetitions. The control group of twenty-two subjects received no weight training but participated in a required college physical education program. The subjects were tested in seven events: body weight, standing Sargent jump, running Sargent jump, standing broad jump, eight pound shot put, twelve pound shot put, and the sixty yard dash. The tests were performed before and after the training period with the best attempt recorded in each category as the score. The experiment resulted in significant increases in performances which seemed to indicate that athletic power increases could be attained through systematic weight training. (6)

Thirty-eight college freshmen basketball candidates were subjects of a test to learn if a systematic weight training program would increase an athlete's leg strength and vertical jump. The subjects were divided into two equal

groups using the Robert's Physical Fitness Index. Group A participated in weight training, while group B, the control group, received no training.

The tests included the Sargent jump, the leg-lift strength test, and the ankle-plantar flexion strength test. The subjects in group A were tested prior to and every Friday during the weight training program.

Group A performed the heel raise exercise three days a week for five weeks. The training consisted of two sets of ten repetitions and a third set of as many repetitions as possible. A one minute rest between sets was required. The weight to be lifted on the first day was determined by totaling the test scores for the right and left legs in the plantar-flexion test. Weight was added at five pounds per day plus one pound for every repetition over ten during the third set.

The results showed that the weight training program produced significant increases in leg strength and vertical jumping scores. (5)

The purpose of a study by Williams was to determine which of the following weight training programs would produce the greatest increases in vertical jumping ability:

1. Weight training program with exercises limited to strengthening the arms and shoulders.

2. Weight training program with exercises limited to strengthening the legs.

3. Weight training program using a combination of the exercises used in the two weight training programs.

Twenty-seven male college students served as subject for the study. The vertical jumping ability of each subject was measured by a jump reach variation of the Sargent jump at the beginning and conclusion of a six week training period. All subjects performed exercises three days a week. The participants were randomly divided into three groups: group A performed curls and presses; group B performed toe-raises and half squats.

The vertical jump test consisted of five trials for each individual in both the pre-test and post-test. The arithmetic mean of the trials was considered the score.

An analysis of covariance technique yielded a significant difference between groups. A t-test was then used to determine where the mean differences were. The t-test showed that a significant difference existed between group A and group B, and group A and group C. No significant difference existed between group B and group C.

The conclusions according to this study, were that arm and shoulder weight training exercises will not increase vertical jumping ability and weight training on the legs will increase the jumping ability. However, a combination of exercises for both legs and arms will increase vertical jumping ability. (34)

Roberts (25) compared the effects of a program of jumping exercises and a weight training program upon the jumping ability of basketball players. Twenty-one freshmen varsity basketball players were used as subjects. The

college age subjects were divided randomly into three groups with group I assigned to be the control group. Group II took part in the jumping program while group III participated in the weight training program.

For the pre-test and post-tests, after a degree of fatigue imposed on each subject by pedaling an ergometer for five minutes, ten vertical jumps were executed with one hop or step prior to take off. Each subject jumped five times reaching with the left hand. All ten jumps were recorded.

The jumping program consisted of jumping, as in the pre-test, ten times reaching with the right hand and ten jumps reaching with the left hand. Each week thereafter, five jumps were added while reaching with the right hand and five more while reaching with the left hand. The weight training program consisted of the forward raise, lateral raise, walking squat, press, curl, and heel raise. Training lasted for eight weeks and was performed three days a week.

Roberts concluded that neither program aided in increasing the jumping ability of basketball players. Results were indicated that the values varied on all statistical computations and were attributed to random variations.

Ness and Sharos proposed a study to analyze and determine the effects of systematic weight training upon leg strength and the vertical jump. They used thirty varsity basketball players in their study equating them into two groups using the scores of the Sargent jump. Group A was subjected to a weight training program while group B participated in no formal program.

The testing consisted of measurements taken for the Sargent jump test, the leg lift test and the ankle-plantar flexion strength test. Group A was tested prior to and every Friday of the training period. Group B was tested prior to and during the fourth week of the conditioning program. The training period lasted four weeks.

Results from this study indicated that the exercise group had an increase of 3.23 inches while the control group dropped .27 inches in the Sargent jump. The increase gave a t-score of 5.37 which was significant at the .01 level. In the leg lift, the training group increased 25.34 pounds significant to the .01 level of confidence with a t value of 7.31. The plantar-flexion strength was increased by both groups, with exercise groups attaining a t value of 12.92 which was significant at the .01 level.

The experimenters concluded that weight training for four weeks will significantly increase leg strength and vertical jumping ability. (22)

In a study by Berger to determine the effects of strength improvement upon vertical jumping ability of college males, eighty-nine college male students were enrolled in four activities classes. Group I training by performing deep knee bends with a barbell resting on the shoulders for ten repetitions. Group II's training consisted of jumping squats with a barbell for five to six repetitions. Group III trained statically at ninety degrees and 135 degrees of knee flexion for the contraction lasting eight seconds each.

Group IV performed the vertical jump ten times each session to determine if specificity of training was a factor. After a vertical jump reach pre-test, the subjects trained for seven weeks and three days a week. A post-test followed the training phase of the experiment. The study concluded that dynamic training was significant and more effective than static training for increasing the vertical jump performance. (3)

Coppoc in his study investigated the effects of a supplementary bout of isometrics upon the vertical jump performance of junior high school boys and girls. Coppoc used ninety-four seventh, eighth, and ninth grade boys and girls in his study. The subjects were placed into equated groups on the basis of their initial vertical jumps. The subjects in group I performed an isometric half squat exercise which was held for an eight second count during each of the physical education class periods for six weeks. The subjects in group II, or the control group, did not have the supplementary isometric exercise program.

Coppoc found in his study the following things: (1) Group I and group II both made highly significant improvement at the .01 level of significance on the vertical jump test. (2) The difference between the final mean vertical jump scores of the two groups was no significant. (3) The subjects in the seventh grade of group I and group II did not improve their vertical jump performance significantly. (4) The subjects in the eighth grade of group I and group II

significantly improved their vertical jumping performance at the .01 level of significance. 5) The females of both groups made significant improvement in vertical jump performance at the .01 level of significance. (7)

Crane studied the effects of two programs of weight training upon the vertical jump performance of college males. Specifically this study investigated the effect of training with the Exer-Genie, and an isometric training program upon the vertical jump performance of forty-seven college males, and the comparative effects of the two programs of exercise. Forty-seven male students enrolled in a required physical fitness course were randomly divided into two groups. Group I was the Exer-Genie group and group II was the isometric group. Both groups met for fifty minutes a day and performed three comparable exercises four times a week for five weeks.

The findings in Crane's study were 1) the isometric training program over a five week period did result in a significant improvement in vertical jump performance at the .05 confidence level. 2) The Exer-Genie weight training program over a five week period did not result in a significant improvement in vertical jump performance. 3) No significant difference in vertical jump performance was found when the two weight training programs were compared. (10)

LITERATURE ON ISOKINETICS

Until recently two basic possibilities in exercise mechanics have been generally accepted, the isotonic and the isometric exercise. Isokinetic exercise, a new approach to muscle training, has now been recognized and implemented as a third basic method of muscular exercise.

Isokinetic exercise is performed with the aid of a special machine or isokinetic exerciser which allows a muscle group to develop maximum dynamic tension throughout the range of movement at a mechanically fixed rate of speed. The load against which a muscle or muscle group contracts offers resistance inherently proportional to the muscle's dynamic tension developing capacity at every point in its shortening range. (24)

Resistance is a force applied. Instead of controlling resistance or distance moved, the isokinetic device controls the speed at which the user can move throughout a full range of motion. The user applies maximum effort and an isokinetic device automatically controls the speed one may exert. As the muscle's tension capacity and skeletal advantage varies through the range of movement, the resistance caused by the speed-governing action of the device fluctuates accordingly and naturally accommodates to the muscle's force transmitting capacity at every point in the range. (29)

In a pilot study by Thistle an accommodating resistance exercise was compared with progressive resistance

exercise and isometric exercise as methods of increasing strength. Sixty normal subjects were divided into three exercise groups and one non-exercise control group. The three exercise groups exercised four days a week and on the fifth day each subject in all four groups was tested with the isokinetic apparatus and torque curves were recorded. This testing was done each week for eight weeks. For the final analysis of results, comparisons were made between the better scores for total work and for maximal force exerted in the final two weeks and in the first two weeks. After these scores were calculated and analyzed it was reported that after the eight week period of exercise, the experimental group using isokinetic exercises showed an improvement of 35.4 percent in total work ability, while the group using the isotonic method improved only 27.5 percent and the group using the isometric contractions improved 9.2 percent. The results in peak force ability were even more remarkable with the isokinetic group improving 47.2 percent, the weight lifting group 28.6 percent, and the isometric group 12.1 percent. (30)

Delateur and others compared the effectiveness of isokinetic and isotonic exercise for quadraceps strengthening. The isokinetic program was performed on a Cybex isokinetic exerciser. Subjects who performed isotonic exercise trained with weights.

The two types of exercise were made comparable for purposes of comparison through a pilot study where subjects

were instructed to perform to fatigue on the Cybex machine. Sixty-five college age women who were not participants in any type of exercise program performed ten maximal kicks daily for a total of five sessions. Following determination of the work output for the last three sessions, forty-four subjects whose work output fell within plus or minus 1 standard deviation of the mean were selected for participation in the study. These subjects were randomly divided into four equal groups. Group I trained on weights, group II trained on the Cybex, group III shifted from weights to the Cybex after eighteen sessions and group IV shifted from the Cybex to weights after eighteen sessions. All groups completed a total of twenty-six sessions.

On the Cybex machine subjects were asked to perform to fatigue, designated as the occurrence of two repetitions which fell 2 standard deviations below the common mean. Subjects in the weight training program lifted forty pounds of weight until a transverse bar which measured full leg extension could no longer be lifted. The amount of weight to be lifted was mathematically determined according to findings of the pre-test. Both groups exercised at the rate of twenty-nine repetitions per minute through a seventy degree range of motion. All subjects were motivated by payment for each repetition. Though each group of subjects performed slightly better in the type of exercise for which they initially trained, differences were not statistically significant. Results indicated that the two types of training were

equally effective, with immediate feedback being an advantage of the Cybex and inexpensive construction being an advantage in weight training. (11)

Rosentswieg and Hisson conducted a study in an effort to determine differences in muscle action potential at various angles of elbow flexion for maximum isometric, isotonic, and isokinetic contractions with joint angle and time period held constant. Subjects consisted of thirteen women between the ages of twenty-two and thirty-six who were familiar with all three testing techniques. With the dominant arm each subject performed a maximal isometric contraction at each of four degrees of elbow flexion as well as maximal isokinetic and isotonic contractions through the full range of movement.

Electromyographic measures were recorded as each contraction was simultaneously filmed with a Bell and Howell Camera set at sixty-four frames per second. Additional instruments utilized included a goniometer and cable tensiometer for isometric conteactions, a Super Mini-Gym machine with a controlled velocity of 8.1 feet per minute for isokinetic contractions and a standard dumb bell and weight discs for isotonic contractions. Analysis of variance and application of the Scheffe test of mean differences indicated that at the .10 significance level, muscle action potential was significantly greater for isokinetic contractions than for either isotonic or isometric contractions. Isometric and isokinetic contractions exhibited no significant differences in muscle action potential as the forearm moved through

various angles of flexion, but in the isotonic work a significantly smaller muscle action potential was elicited during the final phase of elbow flexion as compared to the angles which were considered. (26)

By training subjects at two different speeds Moffroid and Whipple evaluated the specific effects of contrasting speeds on muscular endurance and no muscular force. Thirty subjects were randomly divided into a control group and two experimental groups; one of which trained with slow maximal exercise, termed low power, and the other of which trained at a rapid maximum, termed high power. Training occurred three days per week for six weeks for two minute continuous training sessions of alternate extension and flexion at the knee joint. Subjects in the slow speed group performed approximately twenty repetitions per training session while subjects in the fast speed group performed approximately sixty repetitions during the two minute period.

Pre-test and post-test measurements for peak torque for the best out of five maximal repetitions were taken at sixty-five degrees of knee extention for the quadraceps and at forty-five degrees of knee flexion for the hamstrings. Both degree positions were recommended as those joint angles where the muscle groups could produce the greatest amount of torque. Recordings for each group on the pre-test and post-test were taken with the electronic speed control setting of the exercise device at velocities of contraction which required three, six, nine, twelve, fifteen, and eighteen

revolutions per minute. Actual training for the low power group occurred at six revolutions per minute while the high power group exercised at eighteen revolutions per minute.

A two-way analysis of variance indicated that no gains in peak torque occurred for any of the three groups at zero velocity. Significant increases occurred at three and six revolutions per minute for the low power group, and it was further noted that at the exercise speed for the experimental groups, numerical increase in newton meters was 47.1 for the low power groups at six revolutions per minute and 15.6 new ton meters for the high power group at eighteen revolutions per minute. It was concluded that the study further delineated that exercise is speed specific in the following ways:

> 1. Low power (low speed, high load) exercise produces greater increases in muscular force only at slow speeds.
>
> 2. High power (high speed, low load) exercise produces increases in muscular force at all speeds by contraction at and below the training speed.
>
> 3. High power exercise increases muscular endurance at high speeds more than does low power exercise increase muscular endurance at slow speeds. (21:1699)

In a study to determine the effects of isokinetic training on leg strength and vertical jumping ability of college women, Van Octeghen used forty-eight varsity and B-team power volleyball team members as subjects. Specifically Van Octeghen wanted to learn 1) if isokinetic exercise training programs conducted at either a slow or fast speed would significantly increase leg strength; 2) if leg

strength occurred, would this improve vertical jumping performance; and 3) would either the slow or fast speed of training significantly improve vertical jumping performance.

The subjects were randomly selected from the team rosters of our mid-west universities. After being selected as a participant, the subjects were randomly assigned to either a fast speed training group, a slow speed training group or a control group.

In order to measure strength gains, each subject performed five repetitions of leg extension exercises on an isokinetic compensator Leg Press machine made by Mini-Gym, Incorporated. A dial on the machine recorded in units the maximum output of each repetition. An overall average of the five repetitions was recorded at the initial day of the investigation before the training routine began and every two weeks thereafter through the eight week experimental period.

Performance in the vertical jump was recorded at the initial session and four other times during the experimental period. The vertical jump was tested by having each individual perform the jump reach test six times with twenty seconds between trials. Using the first two trials for warm-up, an average of trials three through six was recorded.

Training consisted of the fast speed group's performing three sets of ten repetitions of the leg extension on the Leg Press machine at a speed of approximately two seconds per repetition. The slow speed group performed the

same training routine except the speed per repetition was set at four seconds per repetition. Two minutes were allowed between sets. The control group performed no training.

Analysis of the data, through a two way analysis of variance with repeated measures on one factor for the vertical jump scores, slow speed strength scores, and fast speed scores, showed that at the .05 level of significance a significant difference existed between groups in the vertical jump. The difference was found to exist between the control group and the training groups. There was no significant difference between the fast speed training group and the slow speed training group.

Results concerning strength, showed that a significant difference occurred between the slow speed group and the control group with an F-value of 8.63 at the .05 level of significance. The fast speed group did not significantly improve in strength over the control group, recording on a 3.55 F-value which required a 4.30 F-value to be significant.

Van Octeghen concluded that increases in leg strength will not necessarily increase vertical jumping ability and that differences in speed training had no effect on vertical jump performance. (33)

SUMMARY

Individual studies in the various related fields showed varying results and conclusions. In the literature

relating to the vertical jump, Sargent (27) felt that the vertical jump was a true test of the physical ability of man. Start, Gray and Glencross (30) found that power was linked with speed and very little to strength. Berger (4) indicated that leg extension force increased at the angle of the leg increased from 105 to 140 degrees. Smith (25) in his study of explosive leg strength found that strength exerted against a dynomometer gave a different result than strength exerted by muscles during movement. Glencross (7) found that the vertical jump had limited use as measures of leg power. Bangerter (2) determined that strengthening the knee extensor, or his extensors, or a combination of the two contributed to increased vertical jump performance. Eckert (12, 13) in studies regarding joint actions of the vertical jump concluded that no relationship existed between isometric strength and maximal angular velocity of the hip, knee, or ankle, however with weight angular velocity decreased as range of motion increased. Martin and Stull (18) and Willson (35) studying foot spacings in relation to vertical jump performance found that anterior-posterior foot spacings of five to ten inches resulted in better vertical jumping performances. Couper (9) in a study of horizontal momentum as it applies to vertical jumping ability found that no significant difference existed in the velocity of approach, amount of horizontal momentum, length of stride, flexion of the ankle, knee and hip joints and the relative timing of the phases of the jump in jumping ability.

In the area of reliability of the vertical jump as a valid test of power and ability, McCloy (20) indicated that when the vertical jump was standardized, practiced, and correctly administered it is undoubtedly a valuable test of the ability of the body to develop power. Gray, Start and Glencross (14, 15) and McClements (6) determined that the vertical jump was a valid test of leg power.

The effects of weight training programs of the vertical jump showed varying results and conclusions. Pacheo (23) 1) found that preliminary warm-up resulted in improved vertical jumping performances. Ball, Rich and Wallis (1), Coppoc (7), and Crame (10) found that isometric weight training did not increase vertical jumping ability. Chui (6) Brown and Riley (5), Williams (34), Ness and Sharos (22), Berger (3) concluded that systematic dynamic weight training on the legs improved vertical jumping ability. Roberts (25) in a comparison of jumping exercises and isotonic weight training, found no increase in vertical jumping performance.

In the area of isokinetics, Thistle (31) determined that remarkable gains in strength using isokinetic weight training resulted in comparison to isotonic weight training. Delateur and others (11) in comparing isokinetic and isotonic weight training found equally effective strength gains between the two training methods. Rosentswieg and Hinson (26) in comparing isotonic, isometric, and isokinetic contractions to muscle action potential concluded that

significantly greater potential existed as the forearm moved through the various angles of flexion during isokinetic and isometric contractions that during the latter phase of the isotonic contract. Moffroid and Whipple (21) determined that exercise was speed specific. Van Octeghen (33) in studying the effects of two speeds of isokinetic weight training upon the vertical jump of college-age women found that increases in leg strength will not necessarily increase vertical jumping ability and that speed training had no effect upon vertical jumping performance.

Chapter 3

METHODS AND PROCEDURES

This study was concerned with the effectiveness of isokinetic weight training of different exercise speeds upon the performance of the vertical jump of high school physical education students.

The sixty subjects were freshmen, sophomore, and junior boys and girls in the Inman High School at Inman, Kansas during the spring semester of the 1973-74 school year. The subjects enrolled in physical education were randomly divided into three groups. Group I trained at the slow exercise speed of approximately four seconds per repetition; group II trained at the fast exercise speed of approximately one and one-half seconds per repetition; and group III received no training. All three groups met for fifty-five minutes a day in a required physical education class. Groups I and II performed ten repetitions three times a week for six weeks.

The initial testing of vertical jumping ability was completed during the first week. The following six weeks the training program was administered during the physical education class period. The eighth week was used for administering the post-test.

NATURE OF THE PHYSICAL EDUCATION PROGRAM

All students at the Inman High School are required to take a minimum of one year in physical education activity classes. The classes include one boys class, two girls classes and one coeducational class, all meeting five days a week for the full semester. This physical education program was established to meet the requirements of the State of Kansas and the school board of Unified School District 448 for graduation from high school. The purpose of this program is to promote physical fitness and provide activities of carry-over value.

All class periods were fifty-five minutes in length. The physical education classes consisted of a calesthenic period plus an activity period. The first five minutes were spent in dressing and roll taking. Ten minutes were devoted to calesthenics such as side straddle hops, push-ups, sit-ups, stretching exercises and leg raises. The activity period covered forty minutes and was used for instruction in such activities as archery, badminton, basketball, gymnastics, soccer, and tennis. The final ten minutes were used for showering and dressing.

The second hour physical education class, consisting of freshmen, sophomore, and junior girls, met daily from 9:25 am. until 10:20 am. A similarly structured class met from 10:25 am. until 11:20 am. At 11:25 am. until 12:20 pm. a coeducational class consisting of sophomore and junior male and female students met for recreational activities.

In the afternoons a class of freshmen convened daily from 1:50 pm. until 2:45 pm. These four sections were the classes utilized for the investigation concerning vertical jump improvement.

SUBJECTS

The subjects were students enrolled in physical education activity classes during the fourth nine weeks of the school term in the spring of 1974. The number enrolled totaled sixty-four students and consisted of forty girls and twenty-four boys. Due to three fractured humerous bones and a knee injury suffered by students enrolled during the selected sections only sixty students consisting of thirty-nine girls and twenty-one boys were able to be part of the final testing of the study.

The male subjects were required to wear a white T-shirt, gym shorts, athletic supporter, white socks and tennis shoes. The female subjects were required to wear a white blouse, shorts, white socks and tennis shoes.

For a valid random grouping of these subjects the names of the students in each of the previously mentioned selected physical education classes were placed on a two-inch long and two-inch wide piece of plain white paper referred to as name cards. The name cards were shuffled thoroughly. As each name card was drawn the subjects were placed into group I, group II, and group III.

FACILITIES AND EQUIPMENT

The facilities used in this study were the Inman High School gymnasium and a weight training room adjacent to the gymnasium. The gymnasium has a playing area approximately seventy feet wide and ninety feet long and seats approximately eight hundred people on stationary bleachers on the north and south side. The weight room is approximately twenty-five feet long and twenty feet wide.

The weight training equipment used was the sitting leg press station of a multi-station weight machine manufactured by Mini-Gym, Incorporated of Independence, Missouri. A model 180 Super Mini-Gym Isokinetic unit, which is an adjustable speed unit, was used as the resistance device. The station has a facsimile of a chair with an adjustable canvas back which slides up and down on supporting poles to the correct position. By pulling a pin the chair can be moved forward or backward on parallel supporting bars and locked into place. The isokinetic unit is connected by a rope through a pulley system to the base of a platform for the subject's feet. The platform is attached to a pendulum. When the subject placed his feet upon the platform and extended the legs, resistance occurred.

The Super-Mini Gym has a dial in full view of the participant while performing the set of ten repetitions. The dial has two hands. The smallest hand indicates resistance applied on each repetition. The large hand retains the

maximum resistance attained throughout the set of ten repetitions. Fifty unit intervals measure resistance.

The Model 180 unit has a knob on it which is calibrated from zero to nine representing varying speeds per repetition. The experimenter, prior to the investigation period, determined the settings to be used in the study. With the use of a stop watch, the experimenter performed leg extensions and timed each setting. The four second setting was found to be at position zero and the one and one-half setting was found to be at position eight. The settings were checked weekly to be sure of accuracy. The calibrated knob was then set prior to each group's training session.

The vertical jump tests were measured on a chalk board made of slate and green in color. The board was three-eighths inch thick, four feet long and three feet wide. The jump board was secured on the wall and held in place by slotted boards which were mounted to the wall by one-fourth inch toggle bolts. The slotted boards extended the testing surface of the jump board from the wall one and one-half inches. The bottom of the jump board was five and three-fourths feet above the floor. The board was scaled off in one inch graduations in pencil to aid the experimenter in accuracy of measurement.

TRAINING PROCEDURES

The experiment began in the spring of 1974 on the twenty-eighth week of school and continued through the

thirty-sixth week of school. On Wednesday of the initial week a demonstration of the skill to be performed, the procedures of the weight training phase and a general explanation of the complete project was presented to the selected physical education classes. The initial testing of the vertical jump was conducted on Thursday and Friday during the first week of the eight week experimental period. The second through the seventh weeks were used in actual training. The final testing of the vertical jump was on Thursday and Friday of the eighth week.

The subjects trained three days a week on Monday, Wednesday, and Friday. If, because of interruption due to school activities or individual absences, training was not possible on the designated days the routine was moved to Tuesday or Thursday. This was done to insure training for three days a week. On training days, after five minutes of dressing and roll call groups I and II were taken in sequence to the weight room to perform their training procedures. The groups not in the weight room were supervised as they sat on the bleachers in the gymnasium until called. Each training group went en masse to the weight room. The subjects each took their turn at performing the training exercise. The procedure for each subject was to sit on the chair of the machine and place his feet on the platforms provided. The sitting space was adjusted forward or backward so that the angle at the knee was approximately seventy degrees as predetermined. The canvas back was adjusted to be even at the

bottom with the tip of the coccyx. After the adjustments were completed the subject folded his arms across his chest to isolate the muscles of the legs and proceeded to perform ten repetitions of the exercise at the designated speed of training.

The training exercise was leg extension against resistance. The subjects were instructed to extend the legs until the knees locked, then follow through until the foot was completely extended. The exercise offered resistance to the quadracep muscle group and the gastrocneumius. This exercise was similar to the leg movement in the vertical jump.

Group I was designated as the slow speed training group. The calibrated knob was adjusted to position zero causing each subject to perform the leg extension at a speed of approximately four seconds per repetition for a total of ten repetitions. After each subject had completed the training Group I went to the gymnasium to sit on the bleachers and Group II was taken to the weight room.

The training procedures were identical to those used for Group I. However the knob was set at position eight to allow a leg extension to be completed in approximately one and one-half seconds. When all subjects in Group II had completed the training procedure they returned to the gymnasium.

The control group was designated as Group III. This group received no training. However, each day of the study

they were taken into the weight room as a unit and returned to the gymnasium to sit on the bleachers.

Upon completion of the training on the designated days, the class joined together for the remainder of the period for activity and instructions.

TESTING PROCEDURES

The testing of all vertical jump performances was conducted on Thursday and Friday of the first and eighth week of the investigation period. All jumps took place during the physical education class period.

For testing the subject's vertical jump ability the vertical jump board was utilized. After powdering the dominant hand with chalk dust, each subject faced parallel to the center of the jump board and stood approximately six inches out from it with the dominant side located nearest the board. The arm of the dominant hand was extended fully upward and chalk from the powdered hand marked the height of the subject's reach as the extended fingers touched the jump board. The subject was then instructed to take one step backwards and assume a standing position with the feet shoulder width apart, toes parallel and even with each other, and arms relaxed at his sides. From this position, the subject took one step forward with the dominant foot and jumped, touching the board at the height of his jump with his fingertips. The marks were measured from the top of the lowest mark to the top of the highest mark, recorded and

erased. The subject had three trials on the testing days for a total of six jumps for the test. The arithmetic average of the six trials was used as the score. The same procedure was followed in the final testing as was used in the initial testing.

STATISTICAL ANALYSIS

The experimental data in this study was collected to compare gains in vertical jumping performance resulting from two isokinetic weight training programs. The first step in the treatment of the data was to determine the significant difference between the pre-test and post-test of each group in vertical jumping performance. In order to test the hypothesis of equal means, the analysis of variance was computed to see if any significant difference occurred between the two tests at the .05 level of significance. The F-ratio was calculated as follows:

$$F = \frac{MS_b}{MS_w} \quad \text{, with df = k-1, N-k.}$$

The second step in the treatment of the data was identical to step one except the significant differences between the pre-test and post-test were calculated for the male subjects and the female subjects for each group.

The third step utilized was to compare the control group to the test groups after the analysis of variance resulted in a significant difference for one of the groups. The Dunnet t-test was calculated to determine where the

significance rested in relation to a control group.

Dunnet's test is calculated as follows:

$$\underline{t} = \frac{M_1 - M_2}{MS_n \left(\frac{1}{n_1} + \frac{1}{n_2}\right)} \qquad \text{with df} = N - k$$

Chapter 4

ANALYSIS OF DATA

The purpose of this study was to compare the effects of two isokinetic weight training speeds upon the vertical jumping performance of male and female high school physical education students.

RESPONSE ANALYSIS

The study was comprised of sixty male and female high school students enrolled in physical education activity classes. The subjects were classified as freshmen, sophomore and junior students at Inman High School.

The subjects consisted of thirty-nine girls and twenty-one boys ranging in age from fourteen to seventeen. Group I had one female and two males aged seventeen; six females aged sixteen; three females and five males aged fifteen; and three females and one male aged fourteen. Group II was comprised of two females aged seventeen; eight males aged sixteen; three females and seven males aged fifteen; and two females aged fourteen. Group III was comprised of one female aged seventeen; two females aged sixteen; nine females and four males aged fifteen; and one male aged fourteen.

STATISTICAL ANALYSIS

An analysis of variance was used to test the null hypothesis that there was no significant difference between the means of the three groups in vertical jump performance.

All Subjects, Three Groups, Pre-test

Using the means of 16.08 (Group I), 16.64 (Group II) and 14.46 (Group III), Table 1 compares the arithmetical average of the six trials of the vertical jump which made up the pre-test. The table shows the value of the sum of squares between groups was 55.19 and the value of the sum of squares within groups was 538.03. The mean squares between groups was 27.592 and the mean squares within groups was 9.439. With 2 and 57 degrees of freedom, an F-score was calculated at 2.923.

Table 1

Analysis of Variance of Arithmetic Average of Pre-test Scores in the Vertical Jump of All Subjects

Source of variation	Sum of squares	Degrees of freedom	Mean squares	F	P
Between	55.19	2	27.592	2.923	--
Within	538.03	57	9.439		
Total	539.26	59			

The obtained F-ratio of 2.923 was less than the tabled value of 3.23 ($F_{2,57} \geq 3.23$) at the .05 level of significance. Since the obtained F-value of 2.923 did not fall within the critical region the null hypothesis was

retained. There was no significant difference between the three sample means.

All Subjects, Three Groups, Post-test

In comparing the arithmetic average of the post-test of all subjects in the vertical jump the mean values of 16.84 (Group I), 17.19 (Group II) and 15.03 (Group III) were utilized. A sum of squares between groups was 46.466 while the sum of squares within groups was 491.228. The mean squares between groups was found to be 23.333 and the mean squares within groups was 8.618. Again with 2 and 57 degrees of freedom an F-score of 2.695 was obtained.

Table 2

Analysis of Variance of Arithmetic Average of Post-test Scores in the Vertical Jump of All Subjects

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	P
Between	46.466	2	23.233	2.695	--
Within	491.228	57	8.618		
Total	537.694	59			

The F-value of 2.695 was less than the tabled value of 3.23 ($F_{2,57} \geq 3.23$) at the .05 level of significance. Since the F-value of 2.695 did not fall within the critical region the null hypothesis was retained.

Since no significant difference existed between vertical jump scores of all subjects in all groups an analysis of variance was conducted to determine if any

difference existed between the girls average scores on their pre- and post-tests.

All Females, Three Groups, Pre- and Post-test

In Tables 3 and 4 the results of a comparison of the average of the six trials of the vertical jump pre-test and post-test scores are shown. The sum of squares between groups shows values of 17.246 and 4.406 and the sum of squares within groups shows a value of 108.884 and 86.41. The mean squares was 3.02 and 2.40. With 2 and 36 degrees of freedom an F-score was figured at 2.85 for the pre-test and 0.92 for the post-test.

The mean score value for Group I females was 13.90. Group II had a mean score of 15.12 while the value of the mean score for Group III was 13.60.

Table 3

Analysis of Variance of Arithmetic Average of Pre-test Scores in the Vertical Jump of All Female Subjects

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	P
Between	17.25	2	8.63	2.85	--
Within	108.88	36	3.02		
Total	226.13	38			

The mean score value for the post-test of Group I females was 14.75. The females of Group II had a mean score of 15.30 and Group III scored a 14.50 for the mean.

Table 4

Analysis of Variance of Arithmetic Average of Post-test Scores in the Vertical Jump of All Female Subjects

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	P
Between	4.41	2	82.20	0.92	--
Within	86.41	36	2.40		
Total	90.82	38			

The F-score yielded at 2.8509 and 0.92 were less than the necessary tabled value of 3.23 ($F_{2,36} \geq 3.23$) at the .05 level of significance. Since the obtained F-value of 2.85 and 0.92 did not fall within the critical region the null hypothesis was retained in both instances.

All Boys, Three Groups, Pre- and Post-test

Table 5 shows a comparison made to determine if any difference existed between groups of the male population studied in the pre-test average scores in the vertical jump. Comparing the means of the male subjects pre-test scores, Group I had a mean score of 19.61, Group II had a value of 19.58, and Group III produced a mean score of 16.51. The results show a sum of squares value between groups of 39.32 and value within groups of 124.92. The mean squares between groups has a value of 19.66 and a value within groups of 6.94. With 2 and 18 degrees of freedom, an F-score was obtained of 2.83.

Table 5

Analysis of Variance of Arithmetic Average of Pre-test Scores in the Vertical Jump of All Male Subjects

Source of variation	Sum of squares	Degrees of freedom	Mean squares	F	P
Between	39.32	2	19.66	2.83	--
Within	124.92	18	6.94		
Total	164.25	20			

The obtained F-score value of 2.83 was less than the necessary value of 3.55 ($F_{2,18} \geq 3.55$) at the .05 level of significance. Since the obtained value of 2.83 did not fall within the critical region the null hypothesis was retained.

The results of an analysis of variance for the boys post-test average scores are shown in Table 6. A value of 57.0 was determined for the sum of squares between groups while a value of 107.72 was attained for the sum of squares within group. These results were obtained by comparing the post-test means of 20.21 for Group I, 20.46 for Group II and 16.48 for Group III. The mean squares values were 28.50 between groups and 5.98 within groups. With 2 and 18 degrees of freedom an F-score of 4.76 was attained.

The obtained F-ratio of 4.76 was greater than the tabled value of 3.55 ($F_{2,18} \geq 3.55$) at the .05 level of significance. Since the obtained F-value of 4.76 did fall within the critical region the null hypothesis was rejected.

Table 6

Analysis of Variance of Arithmetic Average of Post-test Scores on the Vertical Jump of All Male Subjects

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	P
Between	57.0	2	28.50	4.76	.05
Within	107.72	18	5.98		
Total	164.72	20			

Table 7 shows the initial and final mean scores of the male and female subjects, the mean improvement for each sex, and the t value as determined by the Dunnet test. As indicated in the table, Group I females had an initial mean of 13.90 and a final mean of 14.75 for a mean improvement of .85. The females of Group II had an initial mean of 15.12, and a final mean of 15.30 for a mean improvement of .18. The initial mean of the females in Group III yielded a 13.60, a final mean of 14.50 for an improvement of .90.

The male subjects in Group I obtained an initial mean of 19.61, a final mean of 20.46 for an improvement mean of .88. The males in Group III obtained an initial mean of 16.57, a final mean of 16.48 for a mean decrease in improvement of .03.

In comparing the control group (Group III) to Group I of each sex, a t-value of .25 was obtained for the females which was non-significant. The male subjects in this comparison yielded a 2.66 for the t which was significant at the .05 level of significance. A value of 1.97 was necessary for significance at the .05 level.

Table 7

The Significance of the Difference Between Initial and Final Vertical Jump Test Scores For All Groups

Group	N	Initial mean	Final mean	Mean diff.	t*	P
Group I						
Males	8	19.61	20.21	.80	2.66*	.05
Females	13	13.90	14.75	.85	0.25	--
Group II						
Males	8	19.58	20.46	.88	2.84*	.01
Females	14	15.12	15.30	.18	0.84	--
Group III						
Males	5	16.51	16.48	-.03	--	--
Females	12	13.60	14.50	.90	--	--

*The obtained t-value compared means of Groups I or II to control group (Group III). A t-value of 1.97 at the .05 level of significance and 2.68 at the .01 level of significance was required with 58 degrees of freedom.

The comparison of Group III females to Group II females yielded a non-significant t-value of .84. For the male subjects an obtained value of 2.84 proved to be significant to the .01 level of significance being greater than the necessary value of 2.68.

Chapter 5

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter contains a summary of the study, conclusions drawn from statistical data, and recommendations for further studies. The findings of the study were also included.

SUMMARY

It was the purpose of this study to compare the effects of two isokinetic weight training speeds upon the vertical jumping performance of male and female high school physical education students.

The study was conducted with sixty students enrolled in physical education activity classes. The subjects were classified as freshmen, sophomore, and junior students at Inman High School and ranged in age from fourteen to seventeen years. The students were randomly divided into three groups for the study. All groups met for fifty-five minutes a day and trained three days a week for six weeks.

Testing procedures included one week of pre-testing, demonstration, and explanation of the study, six weeks of training, and a post-test during the eighth week. The scores obtained in the pre-test and post-test were arithmetic averages of six vertical jumps over a two day testing period.

The statistical procedure computed for this study was the analysis of variance to determine whether differences existed between the pre-test and post-test scores of the three groups in vertical jumping performance. The analysis of variance was first calculated to determine if any differences existed between the scores of the females in the three groups, followed by the differences of the males' scores. The Dunnett's t-test was used to compare the training groups to the control groups and to determine the significance of the existing differences in the means.

FINDINGS

The findings of this study show that for all groups, all subjects Group I (slow speed training) had an initial mean of 16.08 and a final mean of 16.84 for a mean difference of 16.64, a final mean of 17.19 and a difference of .55. The scores of Group III (control group) resulted in an initial mean of 14.46 and a final mean of 15.03 for a mean difference of .57. At the .05 level of significance, the improvement in vertical jumping performance was non-significant for both the slow speed and fast speed training.

In comparing the groups by sex the scores of the female subjects of Group I (slow speed training) resulted in an initial mean of 13.90, a final mean of 14.75 and a difference between the means of .85. The results of the scores for the female subjects in Group II (fast speed training) produced an initial mean of 15.12, a final mean of 15.30 and

a mean difference of .18. The female scores of Group III (control group) produced an initial mean of 13.60 and a final mean of 14.50 for a difference between the means of .90. The results were non-significant at the .05 level of significance.

However, for the male subjects, Group I (slow speed training) had an initial mean of 19.61, a final mean of 20.21 for a mean difference of .80. This was significant at the .05 level of significance. Group III (fast speed training) resulted in an initial mean of 19.58 and a final mean of 20.46. The mean difference of .88 was significant at the .01 level of significance. Group III (control group) resulted in a mean difference of -.03 with an initial mean of 16.51 and a final mean of 16.48.

CONCLUSIONS

Within the limitations of this study the following conclusions were made:

1. The vertical jumping performance of freshmen, sophomore and junior girls will not be improved through the use of isokinetic weight training performing quadracep extensions.

2. The vertical jumping performance of freshmen, sophomore and junior boys will be improved through isokinetic weight training performing quadracep extensions.

3. Significantly greater gains in vertical jumping performance of males will be produced by performing quadracep

extensions at a speed of approximately one and one-half seconds than at a speed of four seconds.

RECOMMENDATIONS

The recommendations for further study based on the findings of the present study follow:

1. A replication of this study should be conducted utilizing three sets of six repetitions instead of one set of ten repetitions to provide for more maximal loading of the muscle group for a greater length of time.

2. A replication of this study using a motivational device while performing the resistance exercises. Such devices as verbal encouragement while performing the repetitions or a sum of money for each repetition which exceeded a specific level of resistance as recorded on the dial.

3. A similar study using another type of exercise such as Mini-Gym's station called the Driver but developing the same muscle groups as exercised in this study.

4. A replication of this study using a combination of fast and slow speeds of training in one test group in comparison to a fast speed training group and/or a slow speed training group.

5. A similar study using a different skill other than the vertical jump as the criterion such as velocity of throwing a baseball or the starting skill in track.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Ball, Jerry R., George Q. Rich, and Earl L. Wallis. "Effects of Isometric Training on Vertical Jumping," Research Quarterly, XXXV, 3, October (1964), 231-235.

2. Bangerter, Blauer L. "Contributive Components in the Vertical Jump," Research Quarterly, XXXIX, 3, October (1968), 432-436.

3. Berger, Richard A. "Effects of Dynamic and Static Training on Vertical Jumping Ability," Research Quarterly, XXXIV, 4, December (1963), 419-424.

4. _____. "Leg Extension Force at Three Different Angles," Research Quarterly, XXXVII, 4, December (1966), 560-562.

5. Brown, Robert J. and Douglas R. Riley. "Effect of Weight Training on Leg Strength and Vertical Jump," Research Quarterly, XXVII, 4, December (1957), 44.

6. Chui, Edward F. "The Effects of Systematic Weight Training on Athletic Power," Research Quarterly, XXI, 3, October (1950), 188-194.

7. Coppoc, James Nelson. "A Study of the Effect of One Isometric Exercise on Vertical Jump Performance of Junior High School Boys and Girls," Unpublished Master Thesis, Kansas State Teachers College, 1967.

8. Counsilman, James. "Isokinetic Exercise," Athletic Journal, Vol. 52, No. 6, February (1972), 58.

9. Couper, Margaret Elena. "An Analysis of the Transfer of Horizontal Momentum to a Vertical Jump," Unpublished Master's Thesis, Smith College, 1965.

10. Crane, Neil Eugene. "A Comparison of Two Programs of Weight Training Upon Vertical Jump Performance of College Males," Unpublished Master's Thesis, Kansas State Teachers College, 1967.

11. DeLateur, Barbara and others. "Comparison of Effectiveness of Isokinetic and Isotonic Exercise in

Quadraceps Strengthening," Archives of Physical Medicine and Rehabilitation, Vol. 53, No. 2, February (1972), 60-64.

12. Eckert, Helen M. "Angular Velocity and Range of Motion in the Vertical and Standing Broad Jump," Research Quarterly, XXXIX, 4, December (1968), 937-942.

13. _____. "The Effect of Added Weights on Joint Actions in the Vertical Jump," Research Quarterly, XXXIX, 4, December (1968), 943-947.

14. Gray, R. K., K. B. Start and D. J. Glencross. "A Test of Leg Power," Research Quarterly, XXXIII, 1, March (1962), 44-50.

15. _____. "A Useful Modification of the Vertical Power Jump," Research Quarterly, XXXIII, 2, May (1962), 230-233.

16. Hellebrandt, F. A. "Methods of Muscle Training: Influence of Pacing," Physical Therapy Review, Vol. 38, April (1958), 319-326.

17. Henry, Franklin. "The Practice and Fatigue Effects in the Sargent Test," Research Quarterly, XIII, 1, March (1942), 16-23.

18. Martin, Thomas P. and G. Alan Stull. "Effects of Various Knee Angle and Foot Spacing Combinations in the Vertical Jump," Research Quarterly, XL, 2, May (1969), 324-331.

19. McClements, Lawrence E. "Power Relative to Strength of Leg and Thigh Muscles," Research Quarterly, XXXVII, 1, March (1966), 71-78.

20. McCloy, C. H. "Recent Studies in the Sargent Jump," Research Quarterly, III, 2, May (1932), 235-242.

21. Moffroid, Mary T. and Robert H. Whipple. "Specificity of Speed of Exercise," Physical Therapy, Vol. 50, December (1970), 1692-1697.

22. Ness, Philip E. and Charles L. Sharos. "The Effect of Weight Training on Leg Strength and the Vertical Jump," Unpublished Master's Thesis, Smith College, 1956.

23. Pacheo, Betty. "Improvement in Jumping Performance Due to Preliminary Exercise," Research Quarterly, XXVIII, 1, March (1957), 55-57.

24. Perrine, James J. "Isokinetic Exercise and the Energy Potentials of Muscle," Journal of Health, Physical Education and Recreation, Vol. 35, No. 5, May (1968), 40-44.

25. Roberts, John A. "A Comparison of the Effectiveness of Two Methods of Training Upon the Jumping Ability of Basketball Players," Unpublished Master's Thesis, Iowa State University, 1956.

26. Rosentswieg, Joel and Marilyn M. Hinson. "Comparison of Isometric, Isotonic, and Isokinetic Exercises by Electromyography," Archives of Physical Medicine and Rehabilitation, Vol. 53, No. 6, June (1972), 249-252.

27. Sargent, Dr. D. A. "The Physical Test of Man," American Physical Education Review, Vol. 21, April (1921), 194.

28. Smith, Leon. "Relationship Between Explosive Leg Strength and Performance in the Vertical Jump," Research Quarterly, XXXII, 4, December (1961), 405-409.

29. Spackman, Robert. "A New Approach to Strength Building," Athletic Journal, Vol. 51, No. 5, January (1971), 87-89.

30. Start, K. B. and others. "A Factorial Investigation of Power, Speed, Isometric Strength, and Anthropometric Measures in the Lower Limb," Research Quarterly, XXXVII, 4, December (1966), 553-559.

31. Thistle, Howard G. and others. "Isokinetic Contraction: A New Concept in Resistance Exercise," Archives of Physical Medicine and Rehabilitation, Vol. 48, No. 6, June (1967), 281-285.

32. Van Dalen, Deobold. "New Studies in the Vertical Jump," Research Quarterly, XI, 2, May (1940), 112-115.

33. Van Octeghan, Sharon Lea. "Two Speed of Isokinetic Exercise as Related to the Vertical Jump Performance of Women," Unpublished Doctoral Dissertation, Eastern Illinois University, 1973.

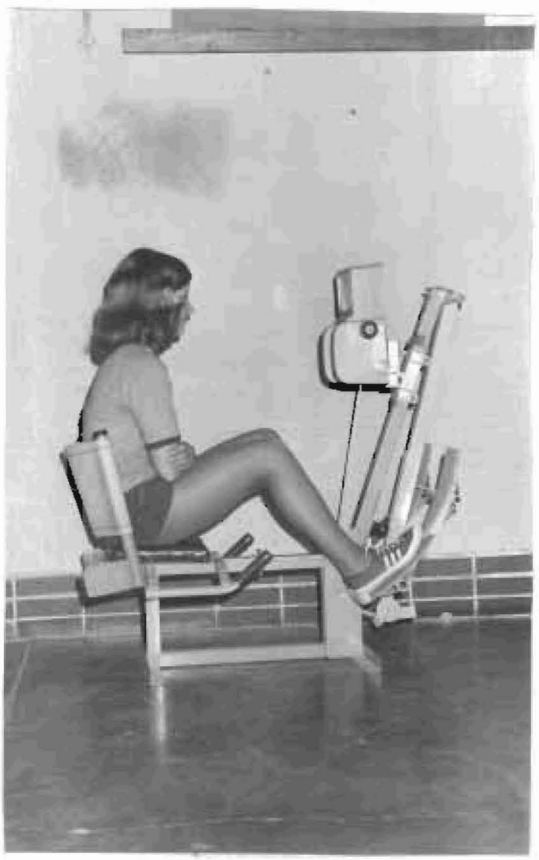
34. Williams, Clayton. "The Effect of Weight Training Upon Vertical Jumping Ability," Unpublished Master's Thesis, Fort Hays Kansas State College, 1965.

35. Willson, Kent R. "The Relative Effects of Various Foot Spacings on Performance in the Vertical Jump," Unpublished Master's Thesis, Penn State University, 1965.

APPENDIX

APPENDIX A

INITIAL POSITION OF QUADRACEP EXTENSION EXERCISE



APPENDIX B

FINAL POSITION OF QUADRACEP EXTENSION EXERCISE