CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

THE EFFECTS OF ISOKINETIC EXERCISES, JUMPING EXERCISES, AND VOLLEYBALL PRACTICE ON VERTICAL JUMPING ABILITY IN HIGHLY SKILLED VOLLEYBALL PLAYERS

A thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts in Physical Education

by

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ABSTRACT

THE EFFECTS OF ISOKINETIC EXERCISES, JUMPING EXERCISES, AND VOLLEYBALL PRACTICE ON VERTICAL JUMPING ABILITY IN HIGHLY SKILLED VOLLEYBALL PLAYERS

by

Walter Irwin Ker

Master of Arts in Physical Education

The purpose of this study was to investigate the effects of three different training techniques on the development of vertical jumping ability among highly skilled male and female volleyball players.

An additional purpose was to determine the validity of the Vertec jumping device (an instrument for measuring vertical jumping ability) by means of a cinematographical comparison.

Three hypotheses were tested: (1) there will be no significant differences between isokinetic exercise, jumping exercises, and volleyball practice, in developing
increased vertical jumping ability in highly skilled athletes; (2) there will be no significant difference between the mean heights recorded by the Vertec jumping device and the cinematographical assessment in measuring vertical jumping ability, and the relationship between these variables will exceed .90; and (3) there will be significant gains made in vertical jumping ability in each of the three training groups, as a result of their specific training three times per week for six weeks.

Thirty-three subjects volunteered from an advanced volleyball class at California State University, Northridge, in the spring of 1980. The subjects were assigned by matched triplets to three groups. All three groups participated in volleyball drills for one and one-half hours and an additional half-hour of specific training. Group A trained in maximum jumping, performing 60 repetitions. Group B trained isokinetically, using the "leaper," with each subject performing three sets of 20 repetitions, with a 10-minute rest between sets. Group C trained by playing doubles volleyball for the remaining half-hour. All three groups trained three times a week for six weeks.

A two-way analysis of variance revealed that there were no significant differences between any of the three
training techniques, and that there were no significant improvements in any of the three groups over the six-week period.

A t test was conducted between the mean heights as measured on the Vertec and by cinematography; and a correlation of .988 was found between these two variables.

It was concluded that within the limitations of this study none of the groups were effective in increasing vertical jumping ability in highly skilled subjects, and that the Vertec jumping device appears to be a valid means of measuring vertical jumping ability.
CHAPTER I

Introduction

Vertical jumping ability is one of the primary elements in the sport of volleyball, specifically in the area of spiking. The ability to jump has been the source of speculation for players, coaches, and researchers for many years. Many training techniques have been used in attempts toward increasing vertical jumping ability.

Many studies have been conducted in attempts to find which training regime would be most effective in increasing vertical jumping ability. Most of the studies conducted on vertical jumping ability have used non-skilled subjects. Relatively few studies have included highly conditioned athletes in their training. A large amount of research specific to vertical jumping has been done in the fields of isotonic and isokinetic exercise. Other studies have dealt with isometrics, ankle weights, height jumping, and depth jumping. In recent years, isokinetic exercise has moved to the forefront in strength training, and coaches as well as researchers are using isokinetics extensively for vertical jump improvement.
Specificity in movement training is another recent concept, currently being incorporated into training programs. This investigator has observed gains in vertical jumping ability in many highly skilled athletes through the use of specific jump training.

Lastly, most studies conducted on vertical jumping ability have used a control group which received no training. Since this investigator was concerned about the effects of training on highly skilled volleyball players, and whether the sport itself placed a large enough demand on the individual to increase vertical jumping ability, activity in the sport of volleyball was used as one of the training techniques.

Recently, a new training and measuring device for vertical jumping ability was marketed by Jim Perrine, a noted researcher in the area of isokinetics (1967, 1968). This device, called the Vertec, was used as the measuring instrument for this study. Since no research had been conducted on the Vertec, a second purpose for this study was to establish the validity of this instrument.

Statement of the Problem(s)

The problem which supports this study was the lack of knowledge related to which training technique would most effectively increase vertical jumping ability.
Statement of the Purpose(s)

The purpose of this study was to compare the effects of three different training programs on the development of vertical jumping ability among highly skilled male and female volleyball players.

An additional purpose was to determine the validity of the Vertec as an instrument for measuring vertical jumping ability, by means of a cinematographical comparison.

Hypotheses

The following hypotheses were tested:

Hypothesis 1: There will be no significant difference between isokinetic exercises, jumping exercises, and volleyball practice, in developing increased vertical jumping ability, in highly skilled athletes.

Hypothesis 2: There will be no significant difference between the mean heights recorded by the Vertec jumping device and the cinematographical assessment in measuring vertical jumping ability, and the correlation between the two measures will be above .90.

Hypothesis 3: There will be significant gains made in vertical jumping ability in each of the three training groups, as a result of their specific training three times per week for six weeks.
Definition of Unique Terms

**Spike approach.** A running approach consisting of from 3-5 steps with a two-foot gather and jump at the conclusion of the approach.

**Isokinetic exercise.** Isokinetic exercise occurs against a load which allows movement at a mechanically fixed rate of speed and offers resistance inherently proportional to the muscle's dynamic tension-developing capacity at every point in its shortening range and at some optimal shortening speed (Perrine, 1968).

**Isotonic exercise.** Isotonic exercise involves muscular contractions against a mechanical system which provides a constant load (Perrine, 1968).

Limitations of the Study

1. Data indicating each subject's prior and current level of training was not available.

2. Control of physical activities outside the training was not attempted.

3. Motivation to perform to the maximum during training periods varied among subjects.

4. Subjects received no training for one week after the fourth week because of the spring recess. Subjects resumed their final two weeks of training upon their return.
Importance of the Study

It is not clear in the area of jump training as to which training technique, if any, is superior. The question of whether training in addition to a volleyball practice will enhance vertical jumping ability needs to be answered. Most studies involving vertical jumping ability did not use highly skilled subjects. This study was designed to compare and determine which training technique, specific jump training, isokinetic exercise, or volleyball practice, would be most beneficial in improving vertical jumping ability in highly skilled athletes.

This study was also designed to determine through the use of a cinematographical comparison, whether or not the Vertec is a valid instrument for measuring vertical jumping ability.
CHAPTER II

Review of the Literature

The purpose of this study was to compare the effects of three different training programs on the development of vertical jumping ability among highly skilled volleyball players. An additional purpose was to determine the validity of the Vertec, as an instrument for measuring vertical jumping ability, by means of a cinematographical analysis.

This chapter contains a review of the literature related to vertical jumping ability. It is divided into studies relating to isotonic training, isokinetic training, isotonic and isokinetic training, and a summary of the reviewed literature.

Isotonic Training

Berger (1963) studied the effects of dynamic and static training to determine the effects of strength improvements on vertical jumping ability. Eighty-nine male college students trained three times weekly for seven weeks. It was found that only the subjects that were in the dynamic training group improved significantly in the vertical jump. The group that trained by jumping
decreased significantly in vertical jumping ability. Berger concluded that dynamic overload training is more effective for increasing vertical jumping ability than static overload training. Also, a significant increase in static strength does not guarantee an improvement in vertical jumping ability.

Laycoe and Marteniuk (1971) divided 45 subjects into three equal groups on the basis of a pre-test for static leg strength. No indication of gender was given; therefore, the subjects are assumed to be males based upon height values of 70.6 inches and weight values of 168.2 pounds. The two experimental groups then trained three days per week for six weeks on either a static or eccentric leg training program. Results indicated that both static (17.4%) and eccentric (17.0%) strength training produced significant gains in static leg strength. Laycoe and Marteniuk concluded that there are at least two factors responsible for increases in strength. One is the physiological changes in the muscle that occur through the inducement of tension, and the other is the development of neuromotor patterns which enable an individual to coordinate his muscles effectively to exert maximum tension.

In 1971, Shouman randomly assigned 39 male subjects to one of three groups. Each subject was tested at the beginning and end of an eight-week period. All subjects
received the same basic upper body weight training programs. The knee extension group, Group A, exercised on the knee extension apparatus of the Universal Gym machine. Each subject completed six sets of R. M. (one repetition of the maximum weight that can be lifted) during each class period for eight weeks. The bicycling group, Group B, performed knee extension work on the bicycle ergometers. Each subject completed three sets of thirty-second work intervals with a thirty-second rest between sets. The control group had no knee extension work of any kind. The results indicated that weight training proved to be significantly better than bicycling for the development of vertical jumping ability.

A study by Brown and Riley (1957) attempted to evaluate the effects of a systematic weight training program on leg strength and the vertical jump performance. The subjects consisted of forty college freshman male basketball players who were divided into two groups equated on the Rogers Physical Fitness Index. One group acted as a control while the other group participated in a three-day per week weight training program. The weight group trained for five weeks, with two sets of ten repetitions of the heel raise exercise and a third set of as many repetitions as possible. Both groups were pre- and post-tested using the following tests: (1) a modified Sargent jump test using chalked fingers, (2) the
Clarke tensiometer method of plantar flexion on each leg, and (3) the Rogers leg strength test with the belt. The experimental group gained in all three tests at the .01 level of confidence with an average gain of 7.3 centimeters in the jump reach. The control group made no significant increases with the exception in left plantar flexion.

The question of which muscles contribute the most when performing the vertical jump was investigated by Bangerter (1964). One control and four experimental groups from 100 college men at Brigham Young University were randomly assigned to varying muscle strengthening programs for 8 weeks. Group I exercised only the plantar flexion muscles; Group II exercised only the knee extension muscles; Group III exercised only the hip extension muscles; Group IV exercised plantar flexion, knee extension, and hip extension muscles; Group V was utilized as the control group and did not exercise. After training three times per week for eight weeks, all exercise groups except the plantar flexion group exhibited a significant increase in vertical jump. Each experimental group registered significant isotonic strength gains in the programmed muscle groups.

In 1976, Silvester randomly assigned 70 male students to four groups as follows: Group C did squats with 80 percent of 1 R.M. The routine followed was to perform
three sets of six repetitions. Group N exercised on the Nautilus Compound leg machine. Group O did squats with 80 percent of the 1 R.M. Their exercise routine consisted of one set of six repetitions followed by one set of as many repetitions as possible. Group U exercised on the Universal Dynamic Variable Resistance leg press station. Significant differences were found and the following conclusions drawn: (1) all training systems caused significant strength gains in all strength measures, (2) Group C, O, and U improved significantly at the .01 level in vertical jumping ability, while Group N did not show a significant improvement in vertical jumping ability.

In summary, the section on isotonic training showed that vertical jumping ability can be significantly increased through isotonic training in non-skilled subjects. Significant increases can be achieved by doing exercises for plantar, knee, and hip extension, three times per week for a five to eight week period.

Isokinetic Training

In 1966, Perrine (1968) pioneered the first isokinetic exerciser called the Cybex Exerciser which is still used in hospitals and rehabilitation centers. Isokinetics is not a replacement for weight training but is another form of resistive exercise which retards the speed of movement and offers resistance inherently proportional to the muscle dynamic tension developing capacity. This
allows maximum muscle loading at every angle and with each repetition. Speed is controlled first, and then, secondly, resistance is developed by the user with the amount of effort he exerts.

Perrine makes this statement as a definition of isokinetic exercise:

Isokinetic exercise occurs against a load which allows movement at a mechanically-fixed rate of speed and offers resistance inherently proportional to the muscle's dynamic tension-developing capacity at every point in its shortening range and at some optimal shortening speed. (Perrine, 1968, p. 43)

According to Perrine, the advantages of isokinetic exercise over either isotonic or isometric are as follows: (1) greater strength gains, (2) freedom from muscular ache and lingering weaknesses, (3) greater cardiovascular fitness, (4) improved metabolic fitness, and (5) joint strengthening with safety.

One type of isokinetic training device is called the "leaper." The Mini-Gym isokinetic "leaper" is designed specifically for increasing the vertical jump. According to the public relations literature of Mini-Gym, Inc., gains of 5 to 14 inches have been realized by most athletes in a few weeks by isolating the leg and lower back muscles in the squat exercise. This is possible
through the use of the exclusive High Resistance at Fast Speed exercise program (Mini-Gym, Inc., 1978).

Hislop and Perrine (1967) reported that isokinetic exercise permits greater demands to be placed on muscular performance than have been possible through other forms of weight training. They claim that through loading the muscle to capacity throughout the full range of motion, isokinetic exercise offers a means of developing greater power and endurance over previous methods of training.

Counsilman (1972) stated that isokinetic exercises permit optimum strength-building stimuli throughout the entire range of movement. Counsilman (1971) used the example of Kris Berg, a weight lifter with nine years of AAU experiences, who achieved astonishing strength gains after ten weeks of isokinetic exercise. The benefits that were observed included: (1) a reduction of training time, (2) minimal warm-up, and (3) lack of pain and discomfort, in both the muscles and joints. Counsilman observed that research which compares isokinetic exercise with other methods of training has shown that strength gains are greater and less time-consuming with the use of isokinetic training. He concluded that this was due to maximal loading of the muscle throughout the entire range of motion.
A study by Pipes and Wilmore (1975) randomly assigned thirty-six men between twenty and thirty-eight years of age into one of four groups. The groups included: isotonic, isokinetic slow speed, isokinetic high speed, and control. The trained groups performed bent rowing, bench press, biceps curl, and leg press. The schedule of training was performed three days a week with an average duration of forty minutes per day for eight weeks. The isotonic group performed three sets of eight repetitions for each group of exercises.

A series of pre-tests were administered to assess various changes in muscular strength, body composition, anthropometric measurements, and selected motor performance tests.

For all movements, the isokinetic low and high speed group increases were significantly greater than those of either the isotonic or control groups. The increases for the isokinetic high speed group were significantly greater than those in the isokinetic slow speed group for the biceps curl, bench press, and bent rowing. Both of the isokinetically trained groups had significantly greater increases in strength than the isotonic group, and the isokinetic high speed group exhibited the greatest strength gains. The isokinetic training groups demonstrated significant improvements in the 40-yard dash, softball throw, and the vertical jump.
Hunter (1976) conducted a study dealing with isokinetic training and vertical jump performance of college varsity basketball players. Sixteen subjects were divided into three groups: high speed, high repetitions; low speed, low repetitions; and the control group. The period of training was eight weeks in duration. The results indicated that both training groups made statistically significant increases in vertical jump performance, while control group revealed no statistically significant increase in performance of vertical jump. The high speed, high repetition group displayed an increase in the mean of 4.00 inches which was significantly greater than the increase in the mean of 2.88 inches for the low speed, low repetition group in the performance of the vertical jump.

Bradley and Gedney (1976) studied the effects of various speeds and repetitions performed isokinetically on the development of strength of the quadriceps muscle group. Forty-two male college students were randomly assigned to one of the six groups: one repetition fast speed, four repetitions fast speed, seven repetitions fast speed, one repetition slow speed, four repetitions slow speed, and seven repetitions slow speed. The fast speed was two feet per second, while the slow speed was one foot per second. All subjects trained three days per week on the Mini-Gym leaper for a duration of seven weeks.
The parallel-squat was the exercise employed in this study. Subjects were given pre-tests and post-tests on the vertical jump and the running 40-yard dash. Results revealed that only those subjects who trained at seven fast and four slow repetitions produced statistically significant gains in the mean of vertical jump. Only those subjects who trained at seven fast and seven slow repetitions produced statistically significant increases in the 40-yard dash. The seven fast group showed a gain of 1.84 inches in the vertical jump and the four slow group displayed a gain of 1.83 inches in the vertical jump while the seven fast group displayed a gain of .18 seconds in the 40-yard dash; and the seven slow group displayed a gain of .11 seconds in the 40-yard dash.

In 1977, Kehl conducted a study to determine the effects of three different numbers of repetitions of parallel-squat exercises performed isokinetically on the performance of the vertical jump. Forty-eight male, non-athlete, non-physical education majors at Western Illinois University were randomly assigned to one of four groups. All three training groups met three times a week for six weeks. The following conclusions were reached: (1) the group that trained at two sets of 10 repetitions increased significantly in vertical jumping ability with a gain of 1.3 inches, (2) the group that trained at two sets of 20 repetitions increased significantly in vertical jumping
ability with a gain of 1.59 inches, (3) the group that trained at two sets of 30 repetitions increased significantly in vertical jumping ability with a gain of 2.18 inches, (4) the control group gained 1.1 inches in vertical jumping ability which was not significant, and (5) the difference between the mean gains in vertical jumping ability were not significant.

Lesmes et. al (1978) investigated muscle strength and power changes during maximal isokinetic training. Five male subjects trained four times per week for seven weeks. Two consecutive days of training were followed by a day of rest until the four workouts were completed. Each training bout consisted of maximal extensions and flexions of the knee at a constant velocity of $180^\circ$/sec. One leg was trained with a six second (6s) work bout repeated 10 times, with 114 seconds of relief between each work bout. The other leg was trained with thirty-second (30s) work bouts, with 20 minutes of relief between each bout.

The results of this study are as follows: (1) neither program produced significant changes in thigh volumes, girth measures, or skinfold thickness, (2) a significant increase in peak torque occurred during a single knee extension after training in both the 6s and 30s trained legs, (3) no significant differences in strength were found, (4) the mean work output of both
the 6s and 30s trained legs increased significantly, and (5) both training programs produced approximately similar gains in strength at angular velocities equal to or slower than the training velocity; at relatively high velocities no significant changes were observed. These findings imply that strength training benefits, in part, are limited to the angular velocities of training and/or at slower rates. As a practical consideration to the athlete, it was suggested that the athlete should train at speeds approximately or exceeding those used during his or her actual sport.

A study by Blattner and Noble (1976) used 48 male subjects in one of three groups. Group I trained with isokinetic exercise, Group II trained with plyometric exercises, and Group III was the control. Subjects in the training groups trained three times per week for eight weeks. The isokinetic group performed three sets of 10 repetitions per set of leg presses each training session. The plyometric group performed three sets of repetitions per set of depth jumps from a height of 34 inches, with added resistance beginning with weeks 3, 5, and 7 of 10, 15, and 20 pounds respectively. Prior to and at the end of the training period, all subjects were given a vertical jump and reach test. Mean gains of 1.94 and 2.05 inches resulted from the isokinetic and plyometric programs, respectively. Although neither training
program was more effective than the other in improving vertical jump performance, both programs resulted in significant improvement of vertical jumping ability.

Testone (1972) showed in his study that ability in the vertical jump and strength can be improved through isokinetic training at four times a week for a period of six weeks. Forty male non-major physical education subjects were used and randomly assigned to either a training or a control group. The trained group executed one set of fifteen leg extensions on the isokinetic Mini-Gym leaper four times per week. The findings revealed that gains in the means from the pre-test of 209.72 pounds in strength, and of 1.21 inches in the vertical jump of the trained group were statistically significant at the .05 level. No statistically significant gains for the control group concerning the vertical jump were identified.

Van Oteghen (1975) conducted a study concerning the isokinetic training of females. Forty-eight subjects were randomly assigned to three groups: a control, a fast speed (two seconds per repetition); and a slow speed (four seconds per repetition). The vertical jump was used as a criterion measure. The experimental groups trained three days a week for eight weeks. Both groups performed three sets of ten leg press repetitions on an isokinetic leg press apparatus each session of training.
Results indicated that the slow and fast speed isokinetic groups were significantly superior to the control group on vertical jump performance and that the slow speed isokinetic group improved significantly more on strength than did the control group. There was no significant difference between the two experimental groups with respect to the vertical jump.

In 1976, McKenzie studied the effects of isokinetic training on vertical jump performance. Twenty-four female volleyball players were divided into two groups; a control group, and a trained group. The trained group executed one set of 25 parallel squats at high speed on the Mini-Gym leaper three times per week. The program of training was six weeks in duration. The control group did not participate in any program of training. The findings revealed a gain in the mean of the vertical jump of 1.31 inches for the trained group which was statistically significant at the .01 level of confidence. There was no significant difference in the gains in the means of strength between the trained and the control group.

Escutia (1971) studied the effects of two separate forms of training on the performance of the vertical jump as it related to volleyball. Fifty-three male non-physical education majors from two volleyball classes were divided into three groups: one set of 25 repetitive jumps of
maximal effort against no resistance; one set of 10 isokinetic leg extensions from a parallel-squat position on the Mini-Gym leaper; and a control group. All subjects were tested on the vertical jump prior to the onset of the study, and again at the conclusion of the study. The trained groups performed two days per week for seven weeks. Escutia concluded that performance of the vertical jump was not significantly improved statistically through the use of isokinetic training two times per week over a seven week period.

A summary of the section on isokinetic exercise shows that vertical jumping ability can be significantly increased by training on the Mini-Gym leaper. Although the results from the studies varied slightly, it appeared that training at the high speed with 20 to 30 repetitions and two to three sets, over a six week to eight week period produced the greatest results.

Isotonic and Isokinetic Training

Thistle et al. (1967) studied the effect of isometric, isotonic, and isokinetic exercise programs on the development of strength in the quadriceps muscle. Fifty-one "normal" subjects were randomly assigned to three experimental groups and a control group. The experimental groups exercised four days per week for eight weeks and were tested on the fifth day of each week. The control group was also tested on the fifth day.
Results of the study indicated that the isometric group increased 9.2 percent in the total work ability; the isotonic group increased 27.5 percent; the isokinetic group increased 35.4 percent; and the control group decreased 9.4 percent. Maximum force gains were even more remarkable. The isometric group improved 12.1 percent; the isotonic group improved 28.6 percent; the isokinetic group improved 47.2 percent; and the control group decreased 6.0 percent.

Tanner (1971) compared isotonic and isokinetic weight training of the lower extremities on vertical jumping ability. Twenty-seven college male subjects--12 volunteers and 15 basketball players--completed the study. Training exercises were performed for six weeks, three times per week. Group A was the control group and did not participate in any training program. Group B had an isotonic progressive weight training program. Group B had an isotonic progressive weight training program for the lower extremities. Subjects performed three sets of the half squat and the heel raise. The first two sets consisted of eight repetitions, and the third set consisted of a maximum number of repetitions that could be performed. Group C had an isokinetic training program for the lower extremities using the Mini-Gym leaper.

The subjects in groups B(isotonic) and C(isokinetic) increased significantly in vertical jumping ability at
the .05 level (mean increase of 1.05 and 1.32 inches, respectively). However, when the isotonic group was compared to the isokinetic group, no significant difference in vertical jumping ability was found.

In 1975, Haun conducted an investigation of the relative effects of isotonic and isokinetic weight training on increasing leg power as measured by the modified vertical power jump test. Sixty college male subjects were randomly assigned to one of the three groups--control, isokinetic, and isotonic. The subjects participated in three training sessions per week for twelve weeks. The isotonic group performed 5 training exercises which included the leg press, toe raises, squat thrust, double leg extension, and double leg curl. For each exercise, one set of 20 to 35 repetitions was performed against the clock (45 seconds) at the Universal Gym machine. The isokinetic group utilized the following isokinetic units; (1) the Mini-Gym isokinetic squat thrust, (2) the Mini-Gym isokinetic sitting leg press, and (3) the Mini-Gym isokinetic hamstring and quad exerciser. The isokinetic group performed the same 5 exercises as the isotonic group. One set of 35 repetitions was performed at the various stations against time (45 seconds). The findings of this study lead to the following conclusions: (1) the isokinetic group did significantly increase leg power as measured by the modified vertical power jump test,
(2) the isotonic group did significantly increase leg power as measured by the modified vertical power jump test, and (3) there was no significant difference between the isokinetic and isotonic groups with respect to leg power as measured by the modified vertical power jump test.

Spielman (1978) investigated the influence of isotonic and isokinetic weight training on vertical jumping proficiency. Forty-two male subjects from South Dakota State University weight training classes were randomly assigned to either an isotonic, isokinetic, or a control group. Circuit training for the isotonic group was performed on the Universal weight machine. Training stations included leg presses, toe raises, double leg extensions, and double leg curls. The isokinetic group utilized the leaper to perform 6 sets of 35 repetitions in 30 seconds. The subjects participated in three training sessions per week for six weeks. Both experimental groups improved significantly in vertical jumping proficiency. Although there was no significant difference between mean performances of the two experimental groups, the isokinetic groups experienced a higher level of improvement (8.7%) than did the isotonic group (7.3%).

A review of studies that compared the effects of isotonic and isokinetic training reveals that Tanner, Haun, and Spielman all found no significant differences
in the two training methods. This seems to indicate that both strength programs increased vertical jumping ability in the non-trained individual.

Summary

This chapter reviewed studies that have been undertaken in attempts to increase vertical jumping ability through isotonic, isokinetic, isotonic and isokinetic, and jump training. In the late 1950's and 1960's, isotonic training was used frequently by athletes to enhance athletic skills. Many studies were conducted during this time to determine if isotonic training did, in fact, improve vertical jumping ability. A summary of the findings shows that vertical jumping ability can be significantly improved through isotonic training.

In the late 1960's, isokinetics were introduced and became a very common method of training for athletes during the 1970's. Many studies were conducted on the Mini-Gym "leaper" to determine if, in fact, isokinetics did significantly improve vertical jumping ability. A summary of the findings shows that in every study except one, vertical jumping ability was significantly increased through isokinetic exercise.

During the same time period, many studies were conducted to determine which method (isokinetic exercise or isotonic exercise) was superior for increasing vertical
jumping ability. Although the isokinetically trained
groups generally performed better than the isotonic
groups, no significant differences between the two groups
were found.

Only one study in the review dealt with jump
training. Escutia trained one group with 25 maximum
jumps. No significant gains were reported. However, the
group only trained twice a week. Recently, much has
been said about the theory of specificity as it related
to training. In Volleyball Magazine, Doya reports large
gains in vertical jumping ability by maximum jumping
toward a goal. This investigator, after several weeks
of personally training in this fashion, introduced this
mode of training to the men's volleyball team at California
State University, Northridge. Large gains were again
observed, and this technique of training was included
in the study in an attempt to gain scientific evidence
to substantiate these observations.
Chapter III

Method

Pilot Studies

A pilot study was conducted to determine the reliability of the vertec jumping device. Twenty college age students, members of the men's volleyball and women's basketball teams, were tested on their vertical jumping ability. After warming up, each subject was given three practice trials using a running approach and two-foot take-off. The subjects were then recorded for five attempts on the Vertec machine. The same process was repeated two days later. The arithmetic mean of the five jumps recorded for each day were compared and a test re-test reliability coefficient of .99 was found.

Selection of Subjects

The original subjects for this study were 11 male and 22 female students registered in an advanced volleyball class at C.S.U.N. in the spring semester of 1980. The students were informed from the outset that this class would be used for research purposes. All the students had extensive experience in volleyball. Twenty of the 22 female subjects had at least one year of interscholastic
or intercollegiate experience. All 11 males had at least one semester of advanced volleyball at C.S.U.N. One male and two females did not complete this study, reducing the final total N to 30.

Subjects were assigned to groups by means of the matched triplets technique according to their vertical jumping ability recorded on the pre-test. All three groups trained for 1½ hours in volleyball drills. Included in these drills were spiking, blocking, digging, serving, underhand passing, and overhead passing. The 1½ hour block of time was spent in the same fashion as a normal varsity team practice. Efforts were made to keep the subjects active and motivated throughout the entire 1½ hours. Following the 1½ hour practice, ½ hour was devoted to specific training sessions.

Group A trained in maximum jumping, performing 60 repetitions. Each subject was given a card which had been constructed specifically for the individual. Each card was stapled to a piece of wood doweling which could be fastened into the bleachers in the gymnasium. This allowed the cards to hang down in a manner so as to allow the subjects a full spike approach without obstruction. Each subject's card was originally positioned at a height .5 inch lower than their maximum jump on the pre-test. Subjects attempted to jump and touch the card with a spike approach. As the subjects' jumping ability increased
through the six-week period, the cards were shortened appropriately. This was done in an effort to constantly challenge subjects to perform maximum jumps.

Group B trained isokinetically, using the mini-gym "leaper." Each subject performed 3 sets of 20 repetitions at the high-speed, low-resistance setting. The subjects rested 10 minutes between each set. Maximum repetitions were recorded for each set by means of the dial on the front of the leaper. Subjects were informed before training as to their previous best score in pounds of resistance. The subjects were then given a new maximum goal to work toward. This was done in an effort to constantly challenge subjects to work to their maximum.

Group C trained by playing doubles volleyball for the remaining 1/2 hour. All three groups trained Monday, Wednesday, and Friday for six weeks.

**Instrumentation**

The Vertec jumping device is an instrument which was designed to train and record vertical jumping ability. An adjustable metal vertical rod extends upward from a weighted metal base. This rod supports 25 plastic slats which extend horizontally from the vertical rod. Each slat is .5 inch apart and is color coded for quick and easy recording. The vertical rod adjusts to record heights from 6' to 12'. The plastic slats are easily
pushed aside as each subject jumps and reaches to their maximum height (see Figure 1).

**Procedures**

In order to determine the validity of the Vertec jumping device both the pre-test and the post-test were filmed. A Canon Auto Zoom 814 camera, filming at 24 frames per second, was placed on a tri-pod 17 feet from the take-off area for each jump.

Each subject's vertical jumping ability was measured two ways: One, by means of the Vertec jumping device, and secondly, by means of cinematography.

To record jumps on the Vertec device, each subject was first measured for their standing reach against a wall. A yardstick had been taped to the wall and calibrated at the 6 foot mark by means of the Vertec to assure consistency. Each subject was instructed to stand with both toes against the wall, their heels down on the ground, and stretch with their dominant hand to their maximum reach. The investigator recorded these marks.

A standing mark was also recorded cinematographically by affixing a landmark to each subject at the ridge of their lateral iliac crest. After warming up by running, stretching, and jumping, each subject was provided three practice trials with the Vertec machine. Following the practice jumps, subjects' scores were recorded for 5
Figure I. Picture of the Vertec Jumping Device
trials on the Vertec machine. Each of the trials were also recorded on film.

To determine the subjects' vertical jump cinemographically, the distance measured from the ground to the standing landmark was subtracted from the distance from the ground to the landmark at the apex of each jump as recorded on film. The subjects lined up in groups of approximately six or seven, performed one jump and returned to the end of the line. This provided each subject with approximately 45 seconds of rest between each of the 5 trials. This procedure was repeated until the testing was complete.

Statistical Analysis

A two-way analysis of variance technique was used to determine if there were significant differences among the groups by trials or training effect. A t-test between the mean vertical distance of the jump as measured by the Vertec and the camera was used to determine if significant differences existed between these measures, and Pearson's correlation technique was applied to determine the relationship between the two variables.
Chapter IV

Analysis of Data

This chapter contains a presentation and analysis of the experimental data from this investigation.

Data

The experimental data was collected from thirty male and female students (10 male, 20 female), who enrolled in an advanced volleyball class at California State University, Northridge. Data was collected by administration of a pre, mid, and post test. Each subject performed 5 jumps during each test. Data was obtained in terms of how high each subject could touch on the Vertec, and how high the iliac landmark reached when viewed cinematically.

Analysis of Data

The means and standard deviations of each group were computed for each test (see Table 1 and Figure 2). A two-way analysis of variance was computed in order to determine any significant differences among groups by trials and training. Table 1 shows the results of the two-way analysis of variance for the pre-test and post-test mean scores using the results obtained from the Vertec jumping device.
Figure II. Graphed Results of a Two-Way Analysis of Variance for the Pre-Test and Post-Test Mean Scores
Table 1
Results of a Two-Way Analysis of Variance for the Pre-Test and Post-Test Mean Scores

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum Squares</th>
<th>DF</th>
<th>Mean Squares</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows (training effect)</td>
<td>.57</td>
<td>2</td>
<td>.256</td>
<td>1.59</td>
</tr>
<tr>
<td>Columns (trials effect)</td>
<td>.05</td>
<td>2</td>
<td>.025</td>
<td>.155</td>
</tr>
<tr>
<td>Interaction</td>
<td>.02</td>
<td>4</td>
<td>.005</td>
<td>.033</td>
</tr>
<tr>
<td>Error</td>
<td>12.99</td>
<td>81</td>
<td>.160</td>
<td></td>
</tr>
</tbody>
</table>

By examination of the resultant F ratios (1.59 for training effect and .155 for trials effect), it was found that there was no significant difference among any of the groups at the .05 level of confidence on either the pre or post tests.

Vertec Validation

In order to examine whether there was a significant relationship between vertical jumping ability scores recorded cinematographically and vertical jumping ability scores recorded on the Vertec device, a correlation coefficient was used. The pre-test scores recorded on the Vertec and film correlated .988 (P < .001), and the post-test result was .982 (P < .001). This result indicated that there was a very high relationship between the scores
recorded for a given subject when measured by the Vertec device or the film.

However, the very high correlation between the Vertec and film scores could exist simultaneously with a significant difference in mean scores. Therefore, a paired t-test was performed on the pre-test mean jump scores as measured by the Vertec and the film. The results as indicated by Table II revealed no significant differences between the two groups.

| Table II |
| Paired t-test on Pre-Test |
| Vertec vs. Film |

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>m</th>
<th>r</th>
<th>d</th>
<th>t</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Vertec</td>
<td>1.875</td>
<td>.401</td>
<td>.074</td>
<td>.988</td>
<td>.011</td>
<td>-.24</td>
</tr>
<tr>
<td>Pre-Film</td>
<td>1.878</td>
<td>.391</td>
<td>.073</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Chapter V

Summary, Conclusions, Discussions, Recommendations

Summary

The purpose of this study was to compare the effects of three different training programs on the development of vertical jumping ability among highly skilled male and female volleyball players. An additional purpose was to determine the validity of the Vertec as an instrument for measuring jumping ability, by means of a cinemagraphical comparison. In an attempt to solve these problems, 33 male and female subjects volunteered from a physical education class at California State University, Northridge during the Spring semester of 1980, which 30 completed the study.

The subjects were assigned to three different groups by means of matched triplets, according to their scores recorded on the pre-test. Group A (jumping) participated in volleyball drills for $1\frac{1}{2}$ hours and for an additional $\frac{1}{2}$ hour trained by performing 60 repetitions of the maximum jump. Group B (leaper) participated in volleyball drills for $1\frac{1}{2}$ hours and for an additional $\frac{1}{2}$ hour trained isokinetically on the leaper machine, performing 3 sets of
20 repetitions. Group C (volleyball) participated in volleyball drills for 1\(\frac{1}{2}\) hours and played doubles volleyball for the remaining \(\frac{1}{2}\) hour. All subjects trained Monday, Wednesday, and Friday for six weeks.

The subjects were given a pre-test, a mid-test, and a post-test. Each subject was allowed three practice jumps on the Vertec prior to recording any data. During the testing phase, a landmark was affixed to the iliac crest and each subject attempted five jumps. During each of the five jumps, scores were recorded both cinematically and by means of the Vertec jumping device.

In analyzing the experimental data, a two-way analysis of variance was used to determine significant differences between training techniques on the pre, mid, and post scores. A correlation coefficient and a paired t-test were used to determine the relationship between the Vertec scores and scores recorded by cinematography.

**Major Findings**

From the two-way analysis of variance among the 3 groups for the pre, mid, and post tests for jumping ability, it was determined that there was no significant difference in the effect of the three programs on vertical jumping ability.

The correlation coefficient showed an extremely high relationship (.99) between scores obtained on the vertical jump by cinematography and by means of the Vertec jumping device.
In addition, a paired t-test revealed no significant difference between the means of the two groups.

Conclusions

Hypothesis number one was accepted: There is no significant difference between the isokinetic exercise group, the jumping exercise group, and the volleyball practice group in developing vertical jumping ability in the highly skilled athletes.

Hypothesis number two was also accepted: There is no significant difference between the Vertec jumping device and the cinematographical assessment in measuring vertical jumping ability, and the correlation between the two measures was above .99.

Within the limitations of this study, the major findings may be summarized as follows: (1) All three groups showed small but insignificant improvements in vertical jumping ability; isokinetic group (.05 inch), volleyball group (.05 inch), and jumping group (1.00 inch). However, it would appear that highly trained and conditioned volleyball players do not need extra practice training in either jumping techniques of isokinetic exercises. (2) The Vertec jumping device appears to be a very accurate and functional means of measuring vertical jumping ability.
Discussion

After six weeks of training, three times per week, no significant improvements in vertical jumping ability were achieved in either the isotonic group, the isokinetic group, or the volleyball group. Because the subjects used in this study were highly skilled athletes, already near the top of the learning curve, and because of observations made during the training period, this investigator feels it would be interesting to continue this study over a longer period of time. It can be noted that the jumping group improved at almost a two-to-one ratio over the other groups. Although statistically the differences were not significant, and are probably due to a chance occurrence, to the volleyball coach who trains his player on a long-term basis, a two-to-one ratio over six weeks time may be quite important. The key would be whether or not the trend would continue.

This investigator has also observed difficulties in continuing to motivate subjects to work to their maximum over a long period of time, and particularly after a rigorous practice session. Since the coach of a volleyball player will be working with a subject at the top of the learning curve, it is suggested that a variety of training techniques be used over a long period of time, in order to continually motivate the players to work to their maximum.
Recommendations for Further Research

From the results of this investigation, it may be recommended that further research in this area might deal with the following problems: (1) Since this investigation utilized highly skilled athletes, who are near the top of their learning curve, it is suggested that a longer period of time be used to test significant differences in training programs. (2) Because of the incidence of injury in training and differences in personal motivation, it is suggested that a similar study be conducted with a much larger N. (3) Because of the lack of scientific evidence in the literature, it is suggested that other studies involving comparisons of different jump training techniques or different combinations of jump training techniques be conducted.
References


