A STUDY OF THE EFFECT OF ONE ISOMETRIC EXERCISE ON VERTICAL JUMP PERFORMANCE OF JUNIOR HIGH SCHOOL BOYS AND GIRLS

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CHAPTER I

INTRODUCTION

For some time, coaches have wanted to have ways of increasing the strength of performers. Recently coaches have turned to isometrics as a means of developing strength for improved athletic performance.[1]

Isometric exercises are now widely used for conditioning and also as an addition to athletic training. Karpovich states, "The only way by which the strength of the muscle can be developed is by exercising them against gradually increasing resistance."[2]

In an early test of isometric exercise, E. A. Muller in Germany concluded that the best results in gaining strength will be obtained by a single daily isometric contraction continued for six seconds and utilizing only two-thirds of maximum strength. At this amount of tension, oxygen supply becomes inadequate because the capillaries of the muscles are compressed. This oxygen deficit is an important factor in acquiring muscular strength.[3]

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[1]Bill Morgan, "Endurance via Isometric Exercise," Athletic Journal, XLIV (November, 1963), 18, 62-63.

[2]Peter V. Karpovich, Physiology of Muscular Activity (sixth edition; Philadelphia: W. B. Saunders Company, 1964), pp. 26-27.

[3]Ibid.

The inability of a person to gain height in the vertical jump may affect a performer's ability in such sports as basketball and track. This inability in the vertical jump may be due to weakened muscles. These muscles include the soleus, the gastrocnemius, and all of the extensors of the lower extremity. The use of isometrics on these muscle groups may aid in increasing the vertical jump height.[4]

I. STATEMENT OF THE PROBLEM

This study investigated the effects of a supplementary isometric contraction upon the vertical jump performance of junior high school boys and girls.

Specifically insight was gained into the following questions: (1) Will a physical education activity program plus a calesthenics program bring about a significant amount of improvement in the vertical jump performance of junior high school boys and girls? (2) Will a physical education activity program plus a calesthenics program with the addition of one isometric contraction bring about a significant amount of improvement in the vertical jump performance of junior high school boys and girls? (3) Will the addition of an isometric program to the routine of the subjects show a

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[4]Jay A. Bender, Harold M. Kaplan, and Alex J. Johnson, "Isometric Strength Needs in Athletic Skills," Journal of Health, Physical Education, and Recreation, XXXIV (September, 1963), 36-37, 57.

significant difference from the subjects without the isometric program on the vertical jump improvement?

The study will help physical educators and coaches to increase the explosive power as demonstrated by vertical jump performance of a student. The study will give further information into whether an isometric program included in the physical education activity and calesthenics program will give better results than no isometric program in the physical education activity and calesthenics program upon increasing vertical jumping performance.

II. DEFINITIONS OF TERMS USED

Vertical jump. Vertical jump is a measure of the height that a person can jump off the floor from a standing position.

Isometric exercise. Isometric exercise consists of contractions in which no movement takes place. The muscle does not shorten.[5]

Half squat isometric exercise. This exercise starts with the subject standing with his feet shoulder width apart and his toes even with each other. The subject then flexes

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[5]Elwood Craig Davis and Gene A. Logan, Biophysical Values of Muscular Activity (Dubuque, Iowa: Wm. C. Brown Company, 1961), p. 134.

at the knees so that the legs are at a 135-degree angle. The subject remains in this position for eight seconds, exerting maximum force in an upward motion on the immovable bar.

CHAPTER II

REVIEW OF THE LITERATURE

The chapter on review of the literature will be divided into sections on a general survey of strength and isometrics, a comparison of the isotonic to isometric exercise programs, literature on isometric exercise as a means of strength gain, literature on vertical jump performance as a measure of explosive power, and a summary of the review.

I. GENERAL SURVEY OF STRENGTH AND ISOMETRICS

Bender, Kaplan, and Johnson define muscular strength as "the ability to accomplish an activity at peak performance without injury." Bender, Kaplan, and Johnson go on to say that strength is "the ability to work against a specified resistance."[6]

Bender, Kaplan, and Johnson state that many skill failures are caused by lack of strength. They feel that much time is wasted trying to teach a skill when the basic need in the development of enough strength to perform the

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[6]Jay A. Bender, Harold M. Kaplan, and Alex J. Johnson, "Isometrics--A Critique of Faddism versus Facts," Journal of Health, Physical Education, and Recreation, XXXIV (May, 1963), pp. 21-22, 66.

skill. They feel that isometrics are unexcelled in developing the muscular strength defined previously.[7]

Wagner defines isometric exercise by a comparison with weight training. He states, "An isometric exercise might be compared to a weight training exercise in which the weight is increased until it can't be moved at all. It's a strain by a particular muscle group against an immovable resistance." From his study of college men, working in pairs with the resistance being the partner or oneself, Wagner found that isometrics will only build strength. They do not necessarily increase endurance or coordination.[8]

Bender and Kaplan explain the difference between dynamic and isometric force by defining them both. They define dynamic force as the "equivalent of the amount of mass an individual can move through a specific joint range of motion in a controlled manner." Isometric force is defined as "that amount of force an individual can exert at a given point in a range of motion when joint movement is sharply limited or not allowed to occur." Chinning was the measurable task that Bender and Kaplan used in their

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[7]Jay A. Bender, Harold M. Kaplan, and Alex J. Johnson, "Isometric Strength Needs in Athletic Skills," Journal of Health, Physical Education, and Recreation, XXXIV (September, 1963), 36-37, 57.

[8]Berny Wagner, "Simple Isometrics," Scholastic Coach, XXXII (December, 1962), 22-23.

experiment. The subjects used a bar that could be adjusted for any point in the chinning range of motion. Bender and Kaplan named three points for strength measurements to be done isometrically. The subjects were tested dynamically on a regular chinning bar. The subjects in the experimental group of Phase 1 were 123 males aged ten through eighteen. The experimental group of Phase 2 had thirty-one similar students who could not chin. Bender and Kaplan found that the strength necessary in performing a dynamic movement can be measured by isometric techniques. Bender and Kaplan conclude that failure in a given movement may be caused by a lack of strength only at one specific region in the range of movement. Some external assistance in passing through that region can result in success.[9]

Pierson and Rasch tested fifteen subjects for isometric strength with and without the knowledge of their results. The subjects were paid volunteer upper class students at the California College of Medicine. The testing apparatus was a short bar connected by an airplane cable and adjustable link chain to a Baldwin-Lima SR-4 load cell. The area tested was the forearm at a ninety-degree angle to the pendant humeri. The maximum pull was measured twice a day.

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[9]Jay A. Bender and Harold M. Kaplan, "Determination of Success or Failure in Dynamic (Isotonic) Movement by Isometric Methods," The Research Quarterly, XXXVII (March, 1966), 3-8.

Once the dial was visible and once it was hidden. This test continued five days a week for two weeks. There was five-minute rest between the tests. Pierson and Rasch found that isometric strength scores are greater when the subject has knowledge of the results than when he does not. The day of the week is not an important variable in isometric strength scores, as indicated by this experiment.[10]

II. A COMPARISON OF THE ISOTONIC TO ISOMETRIC EXERCISE PROGRAMS

Many studies have been conducted to investigate the effects of isometric exercise as a means of strength gain. The first to be discussed will be those involving a comparison of the results of isotonic contraction and isometric contraction methods.

Morgan drew conclusions from experimental evidence that he had studied on the comparative effects of isometric and isotonic exercises. Experiments conducted by Nagle and Irwin; Swegan; Meadows; Dennison, Howell, and Morford; and Howell and others showed no significant difference between the effects of the two types of exercise in such area as arm dipping on the parallel bars and endurance. Marley was

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[10]William R. Pierson and Philip J. Rasch, "Effect of Knowledge of Results on Isometric Strength Scores," The Research Quarterly, XXXV (October, 1964), Part 1, 313-315.

the only investigator quoted who found that isotonic exercises were better for endurance in an athletic situation. Morgan concluded that isometric exercise is the most economical method of developing muscular strength. His research also indicated that isometric exercises will improve athletic performance and muscular endurance.[11]

Thompson, in his findings on a survey of literature on weight training and isometric training, states that both isotonic training and isometric training against resistance cause a significant increase in the development of strength. However, he found that there is no significant difference between the two methods on total strength development.[12]

Bergeron compared the effectiveness of strength training using weight training as compared to short periods of static contractions. The isometric contractions were against maximum resistance for six seconds once per training period. Bergeron used two groups of male college students. The weight training program, for forty-five minutes per period three times a week for ten weeks, used the supine press on leg flexion and leg extension. The two groups both increased significantly in the development of strength

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[11]Bill Morgan, "Endurance via Isometric Exercise," Athletic Journal, XLIV (November, 1963), 18, 62-63.

[12]Hugh Thompson, "Weight Training vs Isometric Training," Scholastic Coach, XXXII (October, 1962), 42-47.

and muscle girth. The weight training program had a greater mean of gains in development of strength, as measured by the supine press, in all five exercises: upper arm, upper thigh, lower thigh, isotonic strength measurement, isometric strength measurement. The supine press measurement showed a difference between the two groups' means of gains at the .05 level of confidence. The group using maximum static contractions had a greater mean of gains in development of strength on the same five exercises as measured by the Drury-Broussard Torque Table. However, this difference between the two groups did not meet the test of significance at the .01 level of confidence.[13]

Burnham attempted to determine the relative effectiveness of isotonic exercise and isometric exercise on the development of muscular strength in individuals with different levels of strength. He used 148 college men in a ten-week exercise program three days a week. The subjects were divided into four exercise groups: isotonic exercises for ten weeks, isotonic exercises for five weeks followed by five weeks of isometric exercises, isometric exercises for ten weeks, isometric exercises for five weeks followed by five weeks of isotonic exercises. The aircraft cable tensiometer was used to measure strength in four strength

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[13]Philip C. Bergeron and F. A. Drury, "Muscle Size and Isometric Contraction Exercise" (Mimeographed.)

tests: arm flexion and forearm extension, arm extension and forearm flexion, thigh and leg extension, trunk flexion. Burnham found no significant differences between isometric and isotonic contractions in the development of muscular strength either for the group as a whole or for the different strength levels. Burnham found that during the first five weeks of training, more individuals gained strength through isometric exercises than through the isotonic program. Most individuals who gained strength during the first five weeks also gained when they stayed in the same program during the final five weeks.[14]

A study of the influence of three different experimental training programs on the strength and speed of limb movement was conducted by Whitley and Smith. They divided 104 male college students into four groups for a ten-week program. The subjects participated in strength training exercises to increase the strength of muscles involved in providing the force necessary for moving a limb through the specific speed test movement. Group A did isometric-isotonic exercises two times a week. The subjects in Group A did six-second static work at each point in the movement and also did general dynamic weight training. Group B did

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[14]Stanley Burnham, "A Comparison of Isotonic and Isometric Exercises in the Development of Muscular Strength for Individuals with Different Levels of Strength" (Austin: The University of Texas, Mimeographed abstract).

dynamic-overload exercises. The subjects in Group B used a vertically suspended weighted box apparatus. The subjects moved it six times through the test range of movement, exercising two times a week. A third group swung their arms freely six times per period. A fourth group was the control group. The horizontal flexion strength test measured the adduction strength of the right arm at six equidistant points of a sixty-degree arc. The dynamometer was used in the measurement. Groups A and B had significant increases in the speed of arm movement. The difference of the speed gain of the two groups was not significant. Both Groups A and B had significant increases in strength, with Group A strength increases significantly greater than Group B increases. The results showed that, regardless of the type of exercise, increasing the strength of muscles involved in a specific movement makes it possible for an individual to execute a faster limb movement.[15]

Chui compared the effects of isometric and dynamic weight training exercises on strength and speed of selected movements. He used ninety-six men between the ages of eighteen and twenty-four years that were enrolled in physical education skills classes at college. The experimental

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[15] Jim D. Whitley and Leon E. Smith, "Influence of Three Different Training Programs on Strength and Speed of a Limb Movement," The Research Quarterly, XXXVII (March, 1966), 132-142.

groups consisted of seventy-two subjects in the weight training activity sections of the class. Some used isometric contraction. Others used rapid contraction. A third group used slow contraction. The control group consisted of twenty-four students in other activity sections. The control group used no weight training of any sort. The cable tensiometer was used as a measure of strength for eight different strength measures. The experimental groups did six exercises three days a week for nine weeks using barbells and plate weights. The group using isometric contraction held the weights in a static position six seconds at the mid-point of the exercise. Each exercise was done in three bouts. Chui found that significant gains in limb strength were accompanied by significant gains in speed in the same movement. Chui concluded that gains in strength made by the isometric exercise are not greater than the gains made by the use of the dynamic methods in weight training exercises.[16]

Berger is another researcher who compared the effects of both types of exercise. He used eighty-nine male college students in four groups: two dynamically trained groups, a group that trained statically, and a group that trained by

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[16]Edward Chui, "Effects of Isometric and Dynamic Weight-Training Exercises upon Strength and Speed of Movement," The Research Quarterly, XXXV (October, 1964), Part 1, 246-257.

jumping vertically. The statically trained group trained at two positions of knee flexion: upper legs parallel to the ground and legs flexed at approximately 135 degrees. The maximum contraction was held for six to eight seconds. Both of the dynamically trained groups did the deep knee bend exercise with a barbell resting on the shoulders and behind the neck. The second of the two dynamically trained groups used fifty to sixty per cent of the load that the first dynamically trained group had used. The dynamically trained groups increased their vertical jump significantly more than the statically trained group. Berger concluded that a significant increase in static strength does not always mean an improvement in vertical jump ability.[17]

III. LITERATURE ON ISOMETRIC EXERCISE AS A MEANS OF STRENGTH GAIN

Several investigators have studied the effects of isometric exercise on strength gain.

Scheuermann conducted a study to determine the overall gains in muscular strength made by high school boys in the eleventh grade. The subjects did isometric contraction exercises for fifteen minutes per day before regularly scheduled physical education classes. Both the experimental

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

and the control groups made significant gains in all areas tested: leg, back, arm, and shoulder strength. However, the gains of the experimental group were significantly greater than those made by the control group.[18]

Bowers investigated the effects of autosuggested muscular contraction on muscle strength and size as compared to the effects of isometric and static contractions. He divided his sixty-one male subjects into four groups. The subjects in the experimental groups did five contractions of the elbow flexor muscles three days a week for a six-week period. The conclusions were that either isometric, static, or autosuggested muscular contractions will significantly increase muscle strength over a six-week period. However, the contractions will not increase muscle size. The isometric exercise was found to be significantly more effective than either static or autosuggestion exercises in developing muscle strength.[19]

Ball, Rich, and Wallis divided sixty-three college men into two groups on the basis of their initial ability

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[18]Francis Scheuermann, "A Study of the Overall Gains in Muscular Strength Made by High School Boys Who Participated in an Isometric Exercise Program for Six Weeks" (Mimeographed abstract.)

[19]Louis A. Bowers, "An Investigation of the Effects of Autosuggested Muscle Contraction on Muscular Strength and Size" (University of Southwestern Louisiana, 1964, Mimeographed).

to exert isometric force upward against shoulder pads of a special device. The apparatus was adjusted to fit the subject so that the knees were flexed at the angle at which the vertical jump is usually initiated. During the six-week training program, the experimental group was trained on the apparatus three times per week. The subjects in the experimental group did one ten-second bout of maximum effort each time. The control group was not trained. The experimental group increased significantly in strength at the .01 level of confidence. The mean increase was seventy-eight, or 17.3 per cent. The gain in strength shown by the experimental group was not, however, accompanied by a corresponding increase in the ability to perform the vertical jump. In this experiment, the gains in ability to exert isometric force were not accompanied by an increase in vertical jumping ability.[20]

Lindeburg, Edwards, and Heath studied the effect of isometric exercise on standing broad jumping ability. Seventy-six male eighth-grade junior high school students were paired according to their broad jumping ability into two groups. The experimental group participated in a fifteen-second maximum contraction in an inverted leg press

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[20]Jerry R. Ball, George A. Rich, and Earl L. Wallis, "Effects of Isometric Training on Vertical Jumping," The Research Quarterly, XXXV (October, 1964), Part 1, 231-235.

once a day, five days a week, for six weeks. The experimenters found that neither of the two groups improved significantly in standing broad jumping ability.[21]

Davis and Logan feel that more strength would be gained at the one angle in the range of motion since isometric contraction involves overcoming resistance at that one angle.[22]

Gardner investigated the specificity of strength changes of the exercised and nonexercised limb following isometric training. Sixty subjects were assigned to one of four groups on the basis of strength scores obtained against a cable tensiometer. The first group was the control group. Group II exercised the preferred limb at 115 degrees of knee extension. Group III exercised the preferred limb at 135 degrees of knee extension. Group IV exercised the preferred limb at 155 degrees of knee extension. The exercises were done three times a week for six weeks for six seconds per bout at two-thirds of their maximum tension loads. Gardner concluded from his results that strength increases are quite specific according to the

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[21]Franklin A. Lindeburg, Donald K. Edwards, and William D. Heath, "Effect of Isometric Exercise on Standing Broad Jump Ability," The Research Quarterly, XXXIV (December, 1963), 478-483.

[22]Elwood Craig Davis, and Gene A. Logan, Biophysical Values of Muscular Activity (Dubuque, Iowa: Wm. C. Brown Company, 1961), p. 116.

position at which a limb is exercised. Gardner found also that cross transfer of either a specific or nonspecific variety should not be expected following isometric exercise.[23]

Wolbers and Sills attempted to determine the effect of static muscle contractions upon the strength of high school boys as measured by four strength tests: leg lift, back lift, left and right grips combined, and vertical jump. Twenty eleventh and twelfth grade volunteers were placed into one of the two groups: experimental and control. The eight-week training period consisted of the six-second contraction done five days a week with the resistance being a partner. The experimental group, doing the static muscle contractions, showed significantly greater gains in leg lift, back lift, and combined hand grip. Wolbers and Sills concluded that isometric muscle contractions of six seconds' duration would cause significant gains in strength. However, the increases in leg strength made by the subjects in the experimental group were not proportionately great enough to produce a statistically significant gain in vertical jump.[24]

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[23]Gerald W. Gardner, "Specificity of Strength Changes of the Exercised and Nonexercised Limb Following Isometric Training," The Research Quarterly, XXXIV (March, 1963), 98-101.

[24]Charles P. Wolbers and Frank D. Sills, "Development of Strength in High School Boys by Static Muscle Contractions," The Research Quarterly, XXVII (December, 1956), 446-450.

Rarick and Larsen compared the effectiveness of a single daily six-second exercise bout using two-thirds maximum tension with an exercise program involving more frequent exercise bouts at 80 per cent maximum tension. Rarick and Larsen divided thirty post-pubescent boys into two experimental groups and one control group. The two experimental groups both did isometric exercises of the wrist for four weeks. These two groups differed only in frequency of the exercise bouts and the levels of static muscular tension employed. Rarick and Larsen found that tension levels greater than two-thirds maximum with more frequent exercise bouts were not superior to the single daily six-second bout in building isometric strength. The greater tension exerted more frequently is somewhat more effective in maintaining strength once it is developed than is a six-second bout once a day at two-thirds maximum tension.[25]

Muller and Hettinger concluded that repetition of contractions is not more effective than a single contraction. However, Asa found different results in testing the abductor of the little finger, using one hand as the experimental and the other hand as the control. Through this experiment, Asa concluded that isometric contractions

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[25]Lawrence G. Rarick and Gene L. Larsen, "Observations on Frequency and Intensity of Isometric Muscular Effort in Developing Static Muscular Strength in Post-Pubescent Males," The Research Quarterly, XXIX (October, 1958), 333-341.

repeated twenty times gave better results than a single contraction.[26]

IV. LITERATURE ON VERTICAL JUMP PERFORMANCE AS A MEASURE OF EXPLOSIVE POWER

Most basketball coaches agree that an athlete's vertical jumping ability is directly proportional to the explosive power of his legs.[27] In tests of physical fitness, the vertical jump is used as a test of explosive strength.[28]

In physical fitness tests, explosive strength emphasizes the ability to exert maximum energy in one explosive act. This factor is different from other strength factors in requiring one short burst of effort, rather than continuous stress or repeated exertion.[29]

Berger investigated whether static or dynamic strength was more highly related to leg power. He used as subjects male college students. For the static strength

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[26]Peter V. Karpovich, Physiology of Muscular Activity (sixth edition; Philadelphia: W. B. Saunders Company, 1965), p. 27.

[27]Bill Morgan, "Static Exercise Program," Scholastic Coach, XXXII (March, 1963), 34, 36, 38, 40.

[28]Edwin A. Fleishman, The Structure and Measurement of Physical Fitness (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), p. 29.

[29]Ibid.

test, Berger used the standard leg dynamometer after the subject had warmed up by doing twelve squats without weights. The dynamic strength test was conducted to get the subject's maximum lifting performance by adding increments to a barbell and having the subject lift it from a squatting position to a standing position. The leg power test was conducted by measuring the power of the legs exerted in the vertical jump. The vertical jump power measurement equaled work divided by time. Berger found that both the dynamic and the static leg strength related to leg power as measured by the vertical jump power test. The correlation between static leg strength and leg power was .64, which is significant at the .01 level. The correlation between dynamic leg strength and leg power was .71, which is significant at the .01 level. Neither the static nor dynamic strength was more highly related to leg power than the other, however, because the two coefficients were not significantly different.[30]

McClements compared the power of the body, as measured by jumping height times body weight, with the strength of leg and thigh flexor muscles and strength of leg and thigh extensor muscles. McClements used eighty-six college

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[30]Richard A. Berger and Joe A. Henderson, "Relationship of Power to Static and Dynamic Strength," The Research Quarterly, XXXVII (March, 1966), 9-13.

men in his study. The subjects met two times a week for sixteen weeks. For measuring jumping height, McClements used the vertical jump test. For measuring strength, McClements used the cable-tension technique to measure the force exerted in isometric contraction of the following muscle groups: leg-flexion, leg extension, thigh-flexion, thigh-extension. McClements assigned two physical-conditioning classes to concentrate on improving the strength of each of the following: extensor program, flexor program, flexor-extensor program, normal program for fitness of the whole body. McClements found that the four training programs were equally effective in causing increases in power of the leg and thigh muscles used in the vertical jump. However, McClements did not find that gains in strength were related to gains in power.[31]

Glencross attempted to answer the question "What do tests of muscle power measure?" He measured muscle power on a pulley device that measures the average horsepower developed in a variety of single explosive movements. The movements were preferred and nonpreferred shoulder flexion and preferred and nonpreferred leg extension. The standing vertical jump test was given in the jump-reach form to

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

eighty-five male college students. The test-retest technique was used as the reliability device. Glencross found that the jump-reach test and the standing broad jump test have limited application as valid measures of muscle power as measured by the power lever.[32]

Smith studied the relationship between explosive leg strength and performance in the vertical jump. The leg strength of the seventy college men subjects was measured at an angle designed to involve the power thrust of the major muscle groups used in the vertical jump. The modified vertical jump without arm snap was used in this experiment. Findings showed that individual differences in vertical jumping performance have little or no relationship to explosive leg strength or to the ratio of leg strength to body mass. Smith concluded that strength exerted against a dynamometer involved a different neuromotor pattern or program from that controlling the muscles during a movement.[33]

V. SUMMARY OF THE REVIEW

Individual studies in the field of isometrics differ in results and conclusions. In the area of the comparison

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[32]D. J. Glencross, "The Nature of the Vertical Jump Test and the Standing Broad Jump," The Research Quarterly, XXXVII (October, 1966), 353-358.

[33]Leon E. Smith, "Relationship between Explosive Leg Strength and Performance in the Vertical Jump," The Research Quarterly, XXXII (October, 1961), 405-408.

of isometric versus isotonic exercise programs, Bergeron; Burnham; Whitley and Smith; and Chui all found no significant difference between the two types of exercise. Berger, however, found the increase in vertical jumping performance was more significant for the groups that trained dynamically than for the group that trained statically. Bowers; Ball, Rich, and Wallis; Wolbers and Sills; and Scheurermann found that isometrics have a positive effect on strength gain. Lindeburg, Edwards, and Heath found no significant improvement in standing broad jump ability after isometric training.

In the area of power, Berger found that the correlations between both static leg strength and leg power and dynamic leg strength and leg power were significant. On the other hand, McClements found that gains in strength are not related to gains in power. Smith and Glencross state that the vertical jump performance has little relationship to strength and power. Gardner found static strength increases to be specific. Rarick and Larsen concluded that a single bout is as effective as increased frequency in building isometric strength.

CHAPTER III

PROCEDURES

This study investigated the effects an isometric exercise program would have on the vertical jump performance of junior high school boys and girls.

The ninety-four subjects were seventh, eighth, and ninth grade boys and girls in the Central Heights Junior High School at Princeton, Kansas. On the basis of their initial vertical jump, the subjects were placed into equated groups. The subjects in the experimental group, or Group I, performed an isometric half squat exercise, which was held for an eight-second count, during the physical education class periods for six weeks. The control group, or Group II, did not have the supplementary isometric exercise program. Both groups participated in fifteen minutes of calesthenics and twenty-five minutes of physical education activities each class period for six weeks.

The initial testing of vertical jumping ability was completed during the first week. The following six weeks the treatment or conditioning program was administered during the physical education class. The eighth week the final testing of vertical jumping ability was again administered.

I. NATURE OF THE PHYSICAL EDUCATION PROGRAM

All students at Central Heights Junior High School are required to enroll in physical education each semester for three years. This physical education program was set up to meet the requirements of the State of Kansas for graduation from junior high school into senior high school. In setting up this program, certain objectives were considered: each student must grow physically as well as mentally; each student must learn how to get along with his fellow men; each student must learn skills that will help him to make better use of his leisure time.

The class periods were sixty minutes in length. The physical education classes consisted of a calesthenics period plus an activity program. The first five minutes and last five minutes of each class period were spent in dressing and showering. After roll call, fifteen minutes were spent doing calesthenics such as side straddle hops, push ups, sit ups, and leg rises. The remaining thirty-five minutes of the class period were used for such activities as tumbling and basketball.

Each grade level met at a different hour. The seventh grade class consisted of both male and female students. The forty-one seventh graders met on Monday, Wednesday, and Friday from 9:30 until 10:30. The eighth grade

class also consisted of both male and female students. The thirty eighth graders met on Tuesday and Thursday from 9:30 until 10:30. The nineteen ninth grade female students met separately from the ninth grade male students on Monday, Wednesday, and Friday from 11:10 until 12:10. The twelve ninth grade male students met separately from the ninth grade female students on Tuesday and Thursday from 11:10 until 12:10.

II. THE SUBJECTS

During the last part of the first semester and the first part of the second semester, 102 students were enrolled in Central Heights Junior High School for physical education activity class. Of these 102 students, ninety-four male and female students were used as subjects for this study.

The subjects ranged in age from eleven to fifteen. The weight range was 65 pounds to 172 pounds. In height the subjects ranged from fifty-four inches to seventy inches. Forty-five male students and forty-nine female students were involved in this study. Thirty-six subjects were enrolled in grade seven. Twenty-eight subjects were enrolled in grade eight. Thirty subjects were enrolled in grade nine. Table I shows the division of subjects by group, grade, and sex. Table II shows the mean age, weight, and height of the groups and their subdivisions.

TABLE I

DIVISION OF SUBJECTS BY GROUP, GRADE, AND SEX

	G R O U P I			G R O U P II		
GRADE	Total number	Male	Female	Total number	Male	Female
7	17	8	9	19	10	9
8	13	7	6	15	8	7
9	15	6	9	15	6	9
TOTALS	45	21	24	49	24	25

TABLE II

MEAN AGE, WEIGHT, AND HEIGHT OF THE GROUPS AND THEIR SUBDIVISIONS

Group	Number of subjects	Mean age	Mean weight	Mean height
Total Subjects	94	12.94	107.54	62.00
Total Group I	45	12.91	109.51	62.34
Total Group II	49	12.97	105.73	61.70
Group I Male	21	12.85	105.76	62.50
Group I Female	24	12.95	112.79	62.20
Group I Grade 7	17	11.94	94.76	60.26
Group I Grade 8	13	12.92	109.30	62.57
Group I Grade 9	15	14.00	126.40	64.50
Group II Male	24	12.83	102.16	62.39
Group II Female	25	13.12	109.16	61.04
Group II Grade 7	19	12.05	93.42	59.36
Group II Grade 8	15	13.06	111.26	63.26
Group II Grade 9	15	14.06	115.80	63.10

The male and female subjects were required to wear socks and tennis shoes on their feet. The male and female subjects wore shorts of various lengths above the knee. The female subjects wore blouses or sweatshirts, and the male subjects wore white T-shirts.

III. FACILITIES AND EQUIPMENT

The facilities employed in the experiment were the Central Heights Junior High School gymnasium. This gymnasium has a playing area approximately forty-five feet wide and sixty feet long and seats approximately three hundred persons on portable bleachers on the east and west sides. A stage is located at the south end of the gymnasium. The basketball goals are located at the north and south ends of the playing area.

The isometric exercise equipment consisted of a wooden bar five feet in length and one and one-half inches in diameter. A nylon rope approximately twenty feet in length was attached to the middle of the wooden bar. At the other end of the nylon rope was a wooden handle fourteen inches in length and one inch in diameter. Before the wooden handle was attached to the rope, the rope was threaded through a hook and eye that was connected to the floor plate. The wooden floor plate was eighteen inches long and twelve inches wide and two inches thick. A visual

description of the exercise equipment is on page 56 of the appendix. (See Figure 1.)

A stop watch with two sweep hands was used to time the subjects as they did the program.

The vertical jump test performances were measured on white plaster board eighteen inches wide by sixty-two inches in length. The plaster board was nailed to a two-inch by six-inch board seven feet in length. The plaster board was scaled in half-inch graduations. On the plaster board, the foot marks were made by a blue-tipped felt marker. The inch marks were made by a green-tipped felt marker. The half-inch marks were made by a yellow-tipped felt marker. A hook at the top end of the two-inch by six-inch board held the portable jumping board in place at the front part of a basketball rim. The front part of the rim is five feet from the open stage. The measurement at the top of the plaster board when attached to the basketball rim was ten feet. The measurement at the bottom of the plaster board when hung was four feet, ten inches from the gymnasium floor. The markings on the plaster board, therefore, began at four feet, ten inches and ended at ten feet. A visual description of the portable jumping board is on page 56 of the appendix. (See Figure 2.)

IV. TRAINING PROCEDURES

According to their initial vertical jump performances, the subjects were placed in either the experimental group or the control group. In order to have equated groups, the subject having the highest vertical jump in his grade level and sex division was placed in the experimental group, Group I. Then the subject having the second highest jump was placed in the control group, Group II. From this point on, the subjects were placed into groups evenly. For example, the third subject was placed into Group I. The fourth subject was placed into Group II, and so forth.

As shown in Table I, page 28, forty-five subjects were in Group I. Twenty-one were males; twenty-four were females. There were seventeen seventh graders, thirteen eighth graders, and fifteen ninth graders in Group I. Group II included forty-nine subjects. Twenty-four were males; twenty-five were females. There were nineteen seventh graders, fifteen eighth graders, and fifteen ninth graders in Group II.

The experiment began on January 3, 1967, and ended on February 25, 1967. The first week of the eight-week period was used for the initial test of vertical jump performance, which will be referred to as Vertical Jump I. The second week through the seventh week was used in the actual training program. During this six-week period, each subject

in Group I did the isometric half squat exercise for one eight-second bout each time his physical education class met. As stated previously, the seventh grade class and the ninth grade boys met twice per week. The eighth week was used for final testing of vertical jump performance.

After five minutes for dressing and roll call, each subject in Group I did the isometric half squat exercise. This activity lasted about ten minutes. The subjects in Group I lined up haphazardly to take their turns in doing the isometric exercise. Each subject in Group I, as his turn came, held the five-foot wooden bar behind his head on his shoulders. At least four other students, not in Group I, held the other end of the rope so that the bar was immovable. A pictorial description is on page 57 of the appendix. (See Figure 3.) The subject placed his feet shoulder width apart and his toes even with each other. The subject flexed the knees so that the legs were at a 135-degree angle. The experimenter, by visually noting the angle, told each subject when the legs were at the 135-degree angle. The subject remained for eight seconds in this position, exerting maximum force in an upward motion on the immovable bar. The experimenter or a student, not in Group I, used the stop watch to time the eight-second bouts. At the end of the bout, another subject in Group I moved into position.

While the subjects in Group I were doing the isometric half squat exercise, the subjects in Group II either helped in conducting the experiment or sat on the benches in the gymnasium. Those in Group II who helped to conduct the experiment provided the resistance by holding the long end of the rope; put a mark by the name of the subject in Group I who did the exercise; or timed the bouts on the stop watch. After all subjects in Group I had completed the exercise, both groups joined together for fifteen minutes of calesthenics and twenty-five minutes of activities such as tumbling and basketball.

As a motivational factor, both groups were given the vertical jump tests during the last physical education period of each week of actual training during the six-week period. During the eighth week, the final vertical jump test, which will be referred to as Vertical Jump II, was administered to all subjects. This test showed the increase or decrease in vertical jumping performance of each participating subject.

V. TESTING PROCEDURES

The testing of all vertical jump performances took place during the physical education period. Vertical jump tests were administered at the last physical education period of each of the six weeks of actual training, as a motivational factor.

For testing of vertical jump performances, a vertical jump board was utilized. Approximately six inches distance from the vertical jump board, a subject took a position with his feet shoulder width apart and his toes parallel and even with each other, with the preferred side to the board. The subject's legs were flexed at a 135-degree angle, as visually determined by the experimenter. A pictorial description is on page 57 of the appendix. (See Figure 4.) From this position, the subject, with arms moving in an upward swing, jumped and touched the vertical jump board with his fingertips at the height of the jump. After each trial, the subject regained the jumping position. Each subject had three jumping trials in succession. The height of each of the three jumps was visually noted by the experimenter. The best of the three jumps was recorded.

During the first week of the experiment, the standing reach of each subject was recorded. To determine the standing reach of each subject, the experimenter directed the subject to stand flat footed beside the vertical jump board. The subject stood with his preferred side to the board. The subject extended the preferred arm up the board until reaching the maximum height with his fingertips. This height was noted visually by the experimenter and then recorded as the subject's standing reach.

VI. STATISTICS

Data for this study was gathered on the following information for each subject: name and number, grade, group, sex, age, weight, and height.

For the purpose of ascertaining the effectiveness of the isometric exercise upon vertical jump performance, data was collected on the standing reach and the height of the vertical jump performance of the initial and final test, referred to as Vertical Jump I and Vertical Jump II.

The data from age, weight, height, standing reach, Vertical Jump I, Vertical Jump II, and the difference between Vertical Jump I and Vertical Jump II was correlated for significance.

The variables were correlated separately for these divisions: Group I total, Group I male, Group I female, Group I grade 7, Group I grade 8, Group I grade 9, Group II total, Group II male, Group II female, Group II grade 7, Group II grade 8, Group II grade 9, and Groups I and II together.

The *t* test for significance was computed upon the gains made by each group and upon the difference between the gains of Group I and the gains of Group II. The *t* test was also computed in comparison of the gains made by Group I male versus Group II male, Group I female versus Group II female, Group I grade 7 versus Group II grade 7, Group I

grade 8 versus Group II grade 8, Group I grade 9 versus Group II grade 9.

CHAPTER IV

PRESENTATION OF DATA

I. INTRODUCTION

There were two statistical computations used in this study to determine the effects of training upon the vertical jump performance of junior high school boys and girls. The t test for significance was computed for gains made on vertical jump for each group and was also computed for significant difference between the groups for mean gain. Also determined by the t test was the significance of the mean gain for both groups by grade and by sex.

II. THE SIGNIFICANCE OF THE MEAN GAIN FOR EACH GROUP ON THE VERTICAL JUMP TEST

To establish significance for both groups on the gains made on the vertical jump test, differences were compared between the initial and final vertical jump tests. As can be noted on Table III, Group I and Group II made significant improvement at the .01 level of confidence on the vertical jump test.

Group I had an initial mean of 94.60 and a final mean of 96.73, which yielded a mean difference of 2.13. The SE difference was .22, which yielded a t of 9.68. For significance with forty-four degrees of freedom, a t of 2.02 at the

.05 level of confidence was required, while a 2.69 was required at the .01 level. The t of 9.68 was, therefore, very highly significant at the .01 level of confidence.

Group II, or the control group, had an initial mean of 93.22 and a final mean of 95.41, which yielded a mean difference of 2.19. The SE difference was .51, which yielded a t of 4.31. For significance with forty-eight degrees of freedom, a t of 2.01 at the .05 level of confidence was required, while a 2.68 was required at the .01 level. The t of 4.31 was highly significant at the .01 level of confidence. This significance indicates the control group did make significant gain or improvement brought about by the program of activity and maturation.

TABLE III

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE INITIAL AND FINAL VERTICAL JUMP TEST SCORES FOR THE TWO GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	P
Group I Isometric	45	94.60	96.73	2.13	.22	9.68	.01
Group II Control	49	93.22	95.41	2.19	.51	4.31	.01

t necessary with 44 degrees of freedom at .01 level = 2.69

t necessary with 48 degrees of freedom at .01 level = 2.68

III. THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE FINAL MEAN SCORE ON THE VERTICAL JUMP OF THE TWO GROUPS

The major concern of this study was to ascertain if a significant improvement in the vertical jump test could be obtained through one isometric exercise and cause a significant difference between the groups. To accomplish this objective, the significance of the difference between uncorrelated means was computed between the two groups.

The critical ratio, or t, was found to be a .54, as can be noted in Table IV. For significance at the .05 level of confidence, a 1.98 was required, with ninety-three degrees of freedom. With the nonsignificant return of .54, the null hypothesis must be retained.

TABLE IV

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE FINAL MEAN SCORE ON THE VERTICAL JUMP FOR BOTH GROUPS

Group	N	Final Mean	Difference	t	P
Group I Isometric	45	96.73	1.32	.54	--
Group II Control	49	95.41			

t necessary with 93 degrees of freedom at .05 level of probability is 1.98, at .01 level of probability is 2.63.

IV. SIGNIFICANCE OF THE MEAN GAIN FOR BOTH GROUPS BY GRADE

To establish the significance of the mean gain for both groups by grade, the mean difference for each group by grade was compared between the initial and final vertical jump tests.

As can be noted in Table V, neither Group I nor Group II of the seventh grade made significant improvement at the .05 level. For significance with sixteen degrees of freedom, a t of 2.12 at the .05 level of confidence was required. For significance with eighteen degrees of freedom, a t of 2.10 at the .05 level of confidence was required.

The seventh grade of Group I, or the isometric group, had a t of 1.49, which is not significant. The seventh grade of Group II, or the control group, had a t of 1.56, which is not significant.

As can be noted in Table VI, both Group I and Group II of the eighth grade made significant improvement at the .01 level of confidence. For significance with twelve degrees of freedom, a t of 2.18 at the .05 level of confidence was required, while a 3.06 was required at the .01 level. For significance with fourteen degrees of freedom, a t of 2.14 at the .05 level of confidence was required, while a 2.98 was required at the .01 level.

The eighth grade of Group I, or the isometric group, had a t of 5.73, which is significant at the .01 level of

confidence. The eighth grade of Group II, or the control group, had a *t* of 5.67, which is significant at the .01 level.

As can be noted in Table VII, both Group I and Group II of the ninth grade made significant improvement at the .01 level of confidence. For significance with fourteen degrees of freedom, a *t* of 2.14 at the .05 level of confidence was required, while a *t* of 2.98 was required at the .01 level.

The ninth grade of Group I, or the experimental group, had a *t* of 8.65, which is significant at the .01 level of confidence. The ninth grade of Group II, or the control group, had a *t* of 6.43, which is significant at the .01 level.

TABLE V

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE INITIAL AND FINAL VERTICAL JUMP TEST SCORES OF THE SEVENTH GRADE OF BOTH GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	*t*	P
Group I Isometric	17	91.06	93.21	2.15	.96	1.49	--
Group II Control	19	88.89	91.45	2.56	.56	1.56	--

t necessary with 18 degrees of freedom at .05 level = 2.10

t necessary with 18 degrees of freedom at .01 level = 2.88

TABLE VI

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE INITIAL AND FINAL VERTICAL JUMP TEST SCORES OF THE EIGHTH GRADE OF BOTH GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	P
Group I Isometric	13	95.46	98.04	2.58	.93	5.73	.01
Group II Control	15	95.8	97.9	2.1	.94	5.67	.01

t necessary with 14 degrees of freedom at .01 level = 2.98

TABLE VII

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE INITIAL AND FINAL VERTICAL JUMP TEST SCORES OF THE NINTH GRADE OF BOTH GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	P
Group I Isometric	15	97.87	99.6	1.73	.99	8.65	.01
Group II Control	15	96.1	97.9	1.8	.98	6.43	.01

t necessary with 14 degrees of freedom at .01 level = 2.98

V. SIGNIFICANCE OF THE MEAN GAIN FOR BOTH GROUPS BY SEX

To establish the significance of the mean gain for both groups by sex, the mean difference for each group by sex was compared between the initial and final vertical jump tests.

As can be noted in Table VIII, both Group I and Group II males made significant improvement at the .01 level of confidence. For significance with twenty degrees of freedom, a *t* of 2.08 at the .05 level of confidence was required, while a *t* of 2.83 was required at the .01 level. For significance with twenty-three degrees of freedom, a *t* of 2.07 at the .05 level of confidence was required, while a *t* of 2.81 was required at the .01 level.

The males of Group I, or the isometric group, had a *t* of 13.64, which is significant at the .01 level of confidence. The males of Group II, or the control group, had a *t* of 5.00, which is significant at the .01 level.

As can be noted in Table IX, both Group I and Group II females also made significant improvement at the .01 level of confidence. For significance with twenty-three degrees of freedom, a *t* of 2.07 at the .05 level of confidence was required, while a *t* of 2.81 was required at the .01 level. For significance with twenty-four degrees of freedom, a *t* of 2.06 at the .05 level of confidence

was required, while a *t* of 2.80 was required at the .01 level.

The females of Group I, or the isometric group, had a *t* of 6.82, which is significant at the .01 level of confidence. The females of Group II, or the control group, had a *t* of 5.62, which is significant at the .01 level.

TABLE VIII

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE INITIAL AND FINAL VERTICAL JUMP TEST SCORES OF THE MALES OF BOTH GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	P
Group I Isometric	21	95.8	98.8	3.0	.98	13.64	.01
Group II Control	24	94.8	97.4	2.6	.94	5.00	.01

t necessary with 20 degrees of freedom at .01 level = 2.84

t necessary with 23 degrees of freedom at .01 level = 2.81

TABLE IX

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE INITIAL AND FINAL VERTICAL JUMP TEST SCORES OF THE FEMALES OF BOTH GROUPS

Group	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	P
Group I Isometric	24	93.5	95.0	1.5	.98	6.82	.01
Group II Control	25	91.7	93.5	1.8	.93	5.62	.01

t necessary with 23 degrees of freedom at .01 level = 2.81

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

This study investigated the effects of a supplementary bout of isometrics upon the vertical jump performance of junior high school boys and girls.

Ninety-four seventh, eighth, and ninth grade boys and girls in the Central Heights Junior High School were subjects in this study. The subjects were placed into equated groups on the basis of their initial vertical jumps. The subjects in Group I, or the experimental group, 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. Groups I and II participated in fifteen minutes of calesthenics and twenty-five minutes of physical education activities each class period during the six weeks of training.

The initial testing of vertical jumping ability was completed the first week. The following six weeks the conditioning program was administered during the physical education class. The final testing of vertical jumping ability was administered the eighth week.

II. FINDINGS

The findings of the study are as follows:

1. Group I and Group II both made highly significant improvement at the .01 level of confidence on the vertical jump test.
2. The difference between the final mean vertical jump scores of the two groups was not 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 jump performance at the .01 level of confidence.
5. The subjects in the ninth grade of Group I and Group II significantly improved their vertical jump performance at the .01 level of confidence.
6. The males of both groups made significant improvement in vertical jump performance at the .01 level of confidence.
7. The females of both groups made significant improvement in vertical jump performance at the .01 level of confidence.

III. CONCLUSIONS

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

1. Generally speaking, boys and girls in the seventh, eighth, and ninth grades will improve in vertical jump performance.
2. As the grade increases, vertical jump performance improves regardless of training.

IV. DISCUSSION

Ball, Rich, and Wallis found that, although the isometrically trained group increased significantly in strength, the gain in strength was not accompanied by a corresponding increase in the ability to perform the vertical jump.[34] Contrary to the study by Ball, Rich, and Wallis, this investigator found a significant gain in ability to perform the vertical jump by the group that trained isometrically, or Group I.

However, the control group, or Group II, also made a significant gain in vertical jumping performance. The difference between the final mean scores of the two groups was not, however, significant.

V. RECOMMENDATIONS FOR FURTHER STUDY

As a result of the findings in this study, the following recommendations are suggested for further study:

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[34]Jerry R. Ball, George A. Rich, and Earl L. Wallis, "Effects of Isometric Training on Vertical Jumping," The Research Quarterly, XXXV (October, 1964), Part I, 231-235.

1. What effect would one bout of isometric exercise per day, five days per week, have on vertical jumping performance?
2. What effect would the conditioning done in this study have on tenth, eleventh, and twelfth grade boys and girls?
3. What effect would the isometric half squat exercise have on the high jumping performance in track of males and females?

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APPENDIX

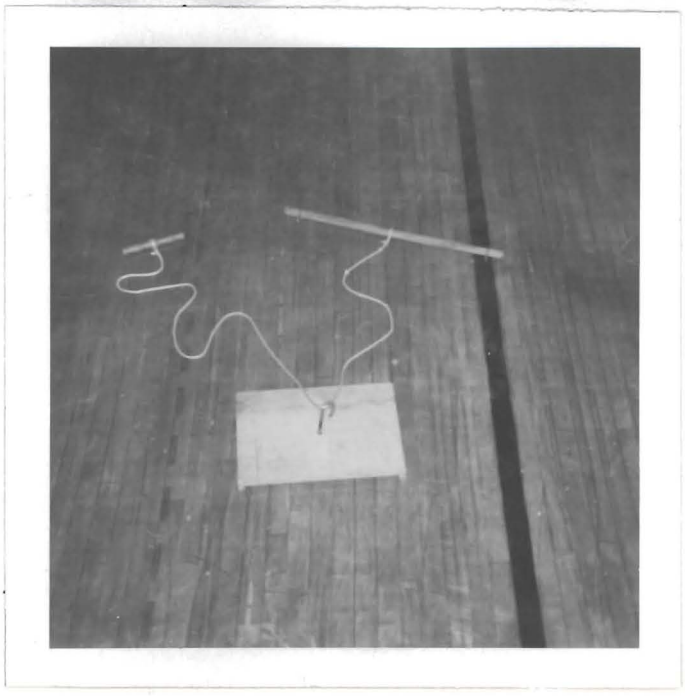

FIGURE 1

ISOMETRIC HALF SQUAT EXERCISE EQUIPMENT

FIGURE 2

VERTICAL JUMP BOARD

FIGURE 3

SUBJECT PERFORMING ISOMETRIC HALF SQUAT EXERCISE

FIGURE 4

SUBJECT IN POSITION TO PERFORM THE VERTICAL JUMP