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## A Comparison of the Effects of Isotonic and Isokinetic Exercises on Leg Power

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A COMPARISON OF THE EFFECTS OF ISOTONIC  
AND ISOKINETIC EXERCISES  
ON LEG POWER

Thesis

Submitted to

APPROVED BY:

The School of Education of the  
UNIVERSITY OF DAYTON

*Louis R. Rice*  
In Partial Fulfillment of the Requirements for  
The Degree

Master of Science in Education  
*James D. L. L. L.*  
Faculty Reader

by

*John A. McGillivray*  
John A. McGillivray  
Faculty Reader

UNIVERSITY OF DAYTON

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Appreciation is also extended to Dr. Pamela L. Muhl for her help in supervising the training sessions and the collecting of the data.

The author is extremely grateful to Dr. J. Delores Morris for her guidance with the statistical analysis.

Gratitude is also extended to the members of the Delaware College student body who gave of their time and energy to be the subjects of the study.

The author is most thankful to his wife Bonnie and his five children for their patience and understanding during the time this study was being conducted.

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## Definition of Terms

Although some people use the terms *strength* and *power* interchangeably, there is a definite difference between them. *Strength*

<sup>1</sup>James Counsellman, "Strength and Power," *Athletic Journal* 22 (February 1972):28.

## CHAPTER I

### INTRODUCTION

#### Reasons for Interest

Since the author has been teaching physical education and coaching, he has been interested in improving the jumping ability of his students. He has used various training methods. Some of these methods have employed isotonic training techniques and others have been of an isokinetic nature, but he has never measured and compared the results to determine which method or methods are best. There are books and many articles written with contrasting viewpoints concerning the effects of isotonic and isokinetic exercises upon increasing muscular strength as it relates to athletic performance. According to Counsilman the isokinetic method is superior for strength development.<sup>1</sup> The author's interest lies in determining whether isotonics or isokinetics is better for increasing leg power as measured by the vertical jump. He is also interested in determining whether one method is superior to the other in the training of women as compared to the training of men.

#### Definition of Terms

Although some people use the terms strength and power interchangeably, there is a definite difference between them. "Strength

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<sup>1</sup>James Counsilman, "Isokinetic Exercise," Athletic Journal 52 (February 1972):58.



is defined as the capacity to exert force or as the ability to do work against a resistance."<sup>2</sup> Another definition of strength is "the force a muscle group can exert against a resistance in one maximum effort."<sup>3</sup> Strength is simply the maximum amount of force that a muscle can produce. Strength can be measured dynamically or statically. Since the vertical jump measures dynamic strength, the author is only concerned with the measurement and development of dynamic strength.

Power may be defined as the ability to release maximum force (strength) in the fastest possible time.<sup>4</sup> According to Hoffman, "Power is strength transformed into action."<sup>5</sup> How fast a muscle can move a joint as well as the amount of force it can exert must be measured in order to determine muscular power. Power is exemplified in the vertical jump, the broad jump, the shot put, and other movements against a resistance in a minimum amount of time.<sup>6</sup> Since strength is actually a component of power, the author is interested in determining whether isotonic or isokinetic develops strength better as it relates to power.

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<sup>2</sup>Daniel D. Arnheim and Carl E. Klafs, Modern Principles of Athletic Training (St. Louis: C. V. Mosby Co., 1973), p. 65.

<sup>3</sup>Edward L. Fox and Donald K. Mathews, The Physiological Basis of Physical Education and Athletics (Philadelphia: W. B. Saunders Co., 1971), p. 68.

<sup>4</sup>Barry L. Johnson and Jack K. Nelson, Practical Measurements for Evaluation in Physical Education (Minneapolis: Burgess Publishing Co., 1970), p. 80.

<sup>5</sup>Bob Hoffman, Weight Training for Athletes (New York: Ronald Press Co., 1961), p. 5.

<sup>6</sup>Johnson and Nelson, p. 80.

The three basic types of resistance training are isotonics, isometrics, and isokinetics. The theory of isotonic training states that it is moving any body part against an unchanging resistance.<sup>7</sup>

Weight training with loose weights and weight training with a weight machine are both examples of isotonic training. Isometric training is

a type of training where muscular force is applied to an immovable resistance.<sup>8</sup> The muscle, although contracting, remains at a fixed length throughout the contraction.<sup>9</sup> The newest form of resistance training is isokinetics. Isokinetic exercises are performed with a device that accommodates the force the exerciser applies against it so that a maximum force can be exerted throughout a full range of motion.<sup>10</sup> Isokinetics is a combination of isometrics and isotonics.

<sup>7</sup>Universal's New Centurion: The Scientific Approach to Conditioning (Fresno, Calif.: Universal Athletic Sales, 1975), p. 3.

<sup>8</sup>Ibid., p. 6.

<sup>9</sup>H. A. DeVries, Physiology of Exercise for Physical Education and Athletics (Dubuque, Iowa: Wm. C. Brown Co., 1974), p. 24.

<sup>10</sup>Counsilman, p. 58.

<sup>1</sup>Edward L. Fox and Donald H. Matney, The Psychological Basis of Physical Education and Athletics (Philadelphia: W. B. Brown Co., 1971), p. 66.

<sup>2</sup>P. V. Karpovich and Gary E. Slonick, Physiology of Human Activity (Philadelphia: W. B. Saunders Co., 1971), p. 13.

<sup>3</sup>H. A. DeVries, Physiology of Exercise for Physical Education and Athletics (Dubuque, Iowa: Wm. C. Brown Co., 1974), p. 13.

## CHAPTER II

### REVIEW OF RELATED LITERATURE

#### Physiological Basis of Muscular Strength

"Muscular strength may be defined as the force a muscle group can exert against a resistance in one maximal effort."<sup>1</sup> The amount of force exerted is determined by the number of motor units stimulated and by the size of the individual muscle fibers. A motor unit is made up of a muscle fiber and a motor neuron (nerve). The amount of force generated by a muscle is dependent upon the summation of the contractions of many motor units.<sup>2</sup> The more units contracting, the more force exerted; however, there is no variability of the force exerted by a single contracting motor unit. The "All or None Law" states that if a muscle fiber is stimulated by a single impulse, it responds by a contraction that is maximal for any given set of conditions.<sup>3</sup> A muscle fiber will either contract maximally or it will not contract at all.

"It is known that the development of strength in any one individual is the result of increasing the size of the muscle fibers

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<sup>1</sup>Edward L. Fox and Donald K. Mathews, The Physiological Basis of Physical Education and Athletics (Philadelphia: W. B. Brown Co., 1971), p. 68.

<sup>2</sup>P. V. Karpovich and Wayne E. Sinning, Physiology of Muscular Activity (Philadelphia: W. B. Saunders Co., 1971), p. 15.

<sup>3</sup>H. A. DeVries, Physiology of Exercise for Physical Education and Athletics (Dubuque, Iowa: Wm. C. Brown Co., 1974), p. 19.



involved."<sup>4</sup> An increase in fiber size and the resulting increase in strength are brought about by subjecting the muscle to greater loads than it is accustomed to moving. This is known as the "Overload Principle."<sup>5</sup> According to Karpovich, "The only way by which the strength of muscles can be developed is by exercising them against gradually increasing resistance."<sup>6</sup> This means that as a muscle becomes stronger it must be subjected to even greater overloads in order to continue to become stronger. The amount of strength development varies among individuals because each person has a different number of muscle fibers.<sup>7</sup> Obviously an individual with more muscle fibers possesses the potential for greater strength development than an individual with less muscle fibers. A muscle cannot continue to get larger and stronger indefinitely; there is a limit to its increase in size and strength.<sup>8</sup>

#### Mechanical Advantage

Even though all of the muscle fibers of a particular muscle may be stimulated, there is a difference between the amount of force exerted by a muscle at one point during contraction when compared to its contracting force at another point during the same contraction.

<sup>4</sup>Ibid., p. 367.

<sup>5</sup>Ibid.

<sup>6</sup>P. V. Karpovich, Physiology of Muscular Activity (Philadelphia: W. B. Saunders Co., 1966), p. 26.

<sup>7</sup>Robert O'Connor, "Scientific Weight Training," Scholastic Coach 34 (September 1964):54.

<sup>8</sup>H. H. Clarke, Muscular Strength and Endurance in Man (London: Wood Cl. Fox and Mathews, The Physiological Basis of Physical Education and Athletics, p. 71.

Bob Sprackman, "A New Approach to Strength Building," Athletic Journal 51 (January 1971):29.

It has been shown that a muscle has the ability to contract with more force when it is longer. "A muscle is in a position to exert its greatest force when it is somewhat stretched."<sup>9</sup> According to Clarke:

The amount of strength that can be applied by muscles when the body is in different positions and when tested throughout their range of motion provides objective evidence for the following statements. (a) Other things being equal, a muscle exerts its greatest force when it functions at its greatest length. (b) The angle at which the muscle pulls is of importance, but usually not of as great an importance as its length. (c) The mechanical arrangement of levers sometimes interferes with the full application of strength, even though the muscle may be at its greatest length. (d) There probably is an optimum position at which each muscle functions best in the application of strength, and this position may be one in which the tension is optimal (not necessarily maximum) and in which the angle of pull provides for the greatest rotary force.<sup>10</sup>

Although a muscle may contract with its greatest force when it is at its greatest length, it cannot move as great a resistance as it can move at some other point due to an increase in mechanical advantage as the muscle moves a joint through its range of motion. Due to skeletal leverage in most range of motion movements, the middle one-third of the range is usually twice as strong as the weakest third of the range.<sup>11</sup> This means that the maximum resistance a muscle can move must be limited to the maximum amount which can be moved at the weakest point along the range of motion. According to Universal's New Centurion, "The variation in muscular force results from the biomechanical advantages and disadvantages occurring in the human lever

<sup>9</sup>P. J. Rasch, Weight Training (Dubuque, Iowa: Wm. C. Brown Co., 1966), p. 6.

<sup>10</sup>H. H. Clarke, Muscular Strength and Endurance in Man (Englewood Cliffs, N.J.: Prentice-Hall Inc., 1966), p. 190.

<sup>11</sup>Bob Sprackman, "A New Approach to Strength Building," Athletic Journal 51 (January 1971):39.



system."<sup>12</sup> Since there are changes in leverage during the range of motion, the number of muscle fibers needed to move a constant resistance decreases as the muscle comes closer to completing its range of motion. These changes in leverage which occur naturally during all movements are primarily responsible for the different levels of muscular involvement.<sup>13</sup> Figure 1 shows changes in the amount of muscular effort needed to move a constant resistance throughout a range of motion.

### Speed and Strength

It is a well established fact that speed and strength are related, but there is some difference of opinion as to their exact relationship. As the strength of a muscle increases, the speed at which it will be able to contract also increases. According to one study: "Increased strength gained through training with weights was apparently associated with increased muscular coordination and speed of movement."<sup>14</sup> In another study conducted with the speed of arm movement, the following conclusion was drawn. "There is no good basis to argue that greater strength gives greater speed in the arm movement test, though there is probably some point below which a lack of

<sup>12</sup>Universal's New Centurion: The Scientific Approach to Conditioning (Fresno, Calif.: Universal Athletic Sales, 1975), p. 2.

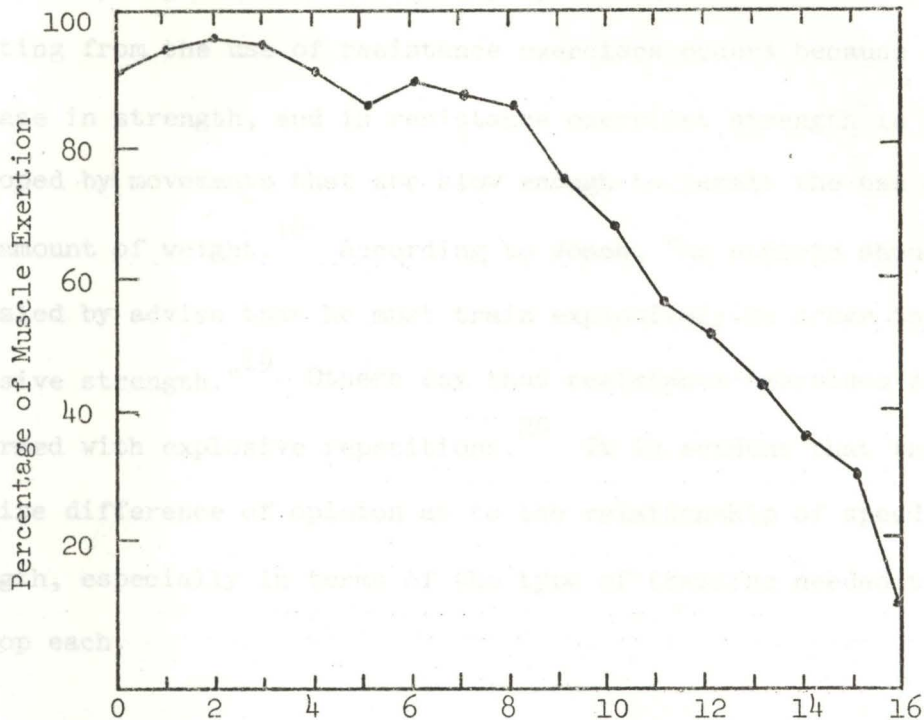
<sup>13</sup>Ibid.

<sup>14</sup>John W. Mosley, Ara Hairbedian, and Donald N. Donaldson, "Weight Training in Relation to Strength, Speed, and Coordination," Research Quarterly 24 (March 1953):315.

FIGURE 1

MUSCULAR FORCE CURVE  
FOR ISOTONIC LEG PRESS

Total Range of Muscular Performance



SOURCE: Universal's New Centurion: The Scientific Approach to Conditioning. Fresno, Calif.: Universal Athletic Sales, 1975. p. 5.

strength definitely would limit speed of movement."<sup>15</sup>

"Recent neurological research has demonstrated that the brain performs differently depending upon whether the desired motion is slow or fast."<sup>16</sup> This seems to indicate that to develop speed one would have to train with less weight since training for strength requires

<sup>15</sup>Bruce M. Wilkin, "Effect of Weight Training on Speed of Movement," Research Quarterly 23 (December 1952):367.

<sup>16</sup>Gideon B. Ariel, "Locomotor Principles Underlying Athletic Performances," Universal's New Centurion: The Scientific Approach to Conditioning (Fresno, Calif.: Universal Athletic Sales, 1975), p. 8.

the use of heavy weights which cannot be moved as fast as lighter weights. Strength seems to be developed best by low repetitions with a high amount of weight.<sup>17</sup> It is not necessary to perform a resistance exercise rapidly in order to develop speed. An increase in speed resulting from the use of resistance exercises occurs because of an increase in strength, and in resistance exercises strength is best developed by movements that are slow enough to permit the use of a maximum amount of weight.<sup>18</sup> According to Jones, "An athlete should not be misled by advice that he must train explosively in order to build explosive strength."<sup>19</sup> Others say that resistance exercises should be performed with explosive repetitions.<sup>20</sup> It is evident that there is a definite difference of opinion as to the relationship of speed and strength, especially in terms of the type of training needed to develop each.

### Isotonics

Isotonics is a type of resistance training where the resistance remains constant throughout the range of motion.<sup>21</sup> The muscle must also continue to shorten as it contracts for the movement to be

<sup>17</sup>O'Connor, p. 52.

<sup>18</sup>Samuel Homola, Muscle Training for Athletes (West Nyack, N.Y.: Parker Publishing Co., 1971), p. 17.

<sup>19</sup>Arthur Jones, "Improving Functional Ability in Any Sport," Athletic Journal 55 (March 1975):78.

<sup>20</sup>Gordon B. Ariel, "Principles of Ballistics Motion in Resistive Exercise Training," Scholastic Coach 43 (May 1974):80.

<sup>21</sup>Karpovich, p. 11.



considered isotonic.<sup>22</sup> Weight training is the most common form of isotonic exercise.

Isotonics are used chiefly for the development of strength.<sup>23</sup>

Due to the nature of unchanging resistance, isotonic exercises do not provide for maximum overloading of the muscle at all points throughout the full range of movement.<sup>24</sup> (See Figure 1.) Since the resistance

remains constant throughout the motion, the muscular force needed to move the resistance is not constant because of the modifying effects of the skeletal lever system.<sup>25</sup> For this reason the muscle only works

at or near maximum effort for a very small part of the entire range of movement. According to Sprackman, "Weights are always limited to the maximum resistance at the exact point in the range where the lever is at its greatest mechanical disadvantage."<sup>26</sup> This point is usually at

or near the start of a movement when a muscle is its longest. Due to the change in mechanical advantage it is impossible to load muscles to their maximum through a full range of motion with isotonic exercises.

Strength seems to be developed best by maximum overloading of a muscle. Tests for strength indicate that a group trained with maximum or near maximum loads gained in strength more than another group

<sup>22</sup> DeVries, p. 24.

<sup>23</sup> Alfred E. Scholz and Robert E. Johnson, Body Conditioning for College Men (Philadelphia: W. B. Saunders Co., 1969), p. 57.

<sup>24</sup> Sprackman, p. 69.

<sup>25</sup> Universal's New Centurion, p. 4.

<sup>26</sup> Sprackman, p. 39.

that did each repetition with the same amount of weight.<sup>27</sup> It seems that isotonic exercises are an effective way to increase strength despite the fact that isotonics do not provide for maximum overloading throughout the full range of movement.

### Isokinetics

The word isokinetic simply refers to the maintenance of the same (iso) force in a muscle throughout a complete joint movement.<sup>28</sup> This is accomplished by varying the resistance so the muscle that is contracting can exert a maximum amount of force throughout the range of motion. The isokinetic method attempts to overcome the limitations of both the isometric and isotonic methods by allowing the total range of motion with control over the speed of the movement in an attempt to insure that maximum volitional muscular involvement occurs at each point along the continuum of movement.<sup>29</sup>

When the amount of electrical activity present in the biceps brachii muscle was measured and compared during maximum isometric, isotonic, and isokinetic contractions, it was found that the greatest electrical activity was present during the isokinetic contraction.<sup>30</sup> From this experiment, it seems that maximum isokinetic contractions

<sup>27</sup>R. A. Berger and Bill Hardage, "Work with Maximum Overloading," Scholastic Coach 41 (April 1972):126.

<sup>28</sup>Universal's New Centurion, p. 7.

<sup>29</sup>Marilyn Hinson and Joel Rosensweig, "Comparative Electromyographic Values of Isometric, Isotonic, and Isokinetic Contraction," Research Quarterly 44 (March 1973):71.

<sup>30</sup>Marilyn Hinson and Joel Rosensweig, "Comparing the Three Best Ways of Developing Strength," Scholastic Coach 41 (March 1972):43. (April 1973):39.

overload a muscle more than isometric or isotonic contractions and thus should produce a greater strength gain. According to Counsilman, at the present time all research which compares the strength gains made by the use of older methods of strength training with gains made by the use of isokinetic training has shown that strength gains are greater and are made faster with isokinetics than with any other method tested.<sup>31</sup>

The mechanical technique of controlling the speed of movement enables greater development of muscular strength and endurance.<sup>32</sup> According to Sprackman, "Isokinetics constantly loads the muscles with each repetition of the exercise and without overstressing or understressing the muscles at any point."<sup>33</sup> Muscles need to be worked to the point of fatigue in order to gain strength. Exercise performed for the purpose of increasing strength should be of a very high intensity so as to cause momentary muscular failure.<sup>34</sup> According to Wilson, "Isokinetics overloads the muscle through the full range of motion, therefore fatigue is achieved quicker and more effectively."<sup>35</sup>

It seems that isokinetics is a superior method for developing strength, but how is the strength it develops related to actual performance? Counsilman believes, "Physiologically isokinetic exercises

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<sup>31</sup>James Counsilman, "Isokinetic Exercise," Athletic Journal 52 (February 1972):58.

<sup>32</sup>Universal's New Centurion, p. 7.

<sup>33</sup>Sprackman, p. 69.

<sup>34</sup>Jones, p. 77.

<sup>35</sup>Jim Wilson, "Isokinetic Maxi-Programs," Athletic Journal 53 (April 1973):39.



are so sound that they have to be considered the best method of building strength."<sup>36</sup> The fixed rate of movement with an isotonic device eliminates the dissipation of muscular force or energy that normally occurs when there is acceleration in movement.<sup>37</sup> The fixed rate of movement, however, results in a major alteration of the natural ballistic characteristics of motion.<sup>38</sup> Since most athletic events are ballistic movements and since neural control of these patterns differs from slow controlled movements, it is essential that training routines employ fast motions.<sup>39</sup> It seems that although isokinetics may be a superior method in strength development, isokinetics may not be best for developing explosive movements where the speed of the movement is of prime concern.

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<sup>36</sup>James Counsilman, "New Approach to Strength Building," Scholastic Coach 40 (March 1971):52.

<sup>37</sup>Universal's New Centurion, p. 7.

<sup>38</sup>Ibid.

<sup>39</sup>Ariel, "Locomotor Principles Underlying Athletic Performances," p. 8.

<sup>1</sup>Barry L. Johnson and Jere E. Nelson, Practical Procedures for Evaluation in Physical Education (Champaign: Human Kinetics Co., 1970), p. 91.

### CHAPTER III

#### METHODS AND PROCEDURES

##### Preliminary Procedures

Eighteen male and fifteen female students at Cedarville College volunteered to be in the study were the subjects. Both male and female subjects were used in the study so that the effects of different training procedures could be compared between sexes as well as within each sex.

Since the study involved the effects of training methods on leg power, the "vertical power jump" test was used because according to Johnson and Nelson it is one of the most practical ways to measure leg power.<sup>1</sup> The vertical power jump was used to measure leg power as determined by the jumping ability of the subjects in centimeters before training and after a five-week training period.

The equipment used in the training of the subjects consisted of a Super Mini-Gym model 180-A for isokinetic training and a Universal Gym leg press station for isotonic training. The subjects that trained on the Super Mini-Gym did standing squats and those that trained on the Universal Gym did leg presses. The first phase of standing squats consisted of starting from a standing position and bending at the ankles,

<sup>1</sup>Barry L. Johnson and Jack K. Nelson, Practical Measurements for Evaluation in Physical Education (Minneapolis: Burgess Publishing Co., 1970), p. 91.

<sup>2</sup>Gordon S. Ariel, "Principles of Pedagogical Motion in Pedagogical Exercise Training," Scholarship 14

knees, and hips until the angle of the knee joint was a maximum of ninety degrees. The second phase (the lifting phase) consisted of standing up as quickly as possible, while keeping the back perpendicular to the floor, until the legs were fully extended. Leg presses were done the same way as the standing squats except that the legs were extended horizontally while the upper body remained in a vertical position. The standing squat and leg press were chosen because they more closely resemble the motion of jumping than any other exercise that can be done on these particular machines. For exercises to be successful in improving performance they must simulate as nearly as possible the pattern of the activity itself.<sup>2</sup>

The pre-test was administered from 3:00 P.M. to 5:00 P.M. on a Friday. Before the subjects were tested they were told to warm up for five to ten minutes using a warm-up procedure of their own choosing. All of the subjects were weighed and their weights recorded before jumping. The clothing worn for the weigh-in was exactly the same as used when jumping. The clothing consisted of tennis shoes, shorts, and whatever else the subjects chose to wear.

The testing procedures were as follows: first, each subject stood with his feet flat on the floor with one arm behind his back and reached up as high as possible with the other hand and touched the jump and reach board. The distance each subject reached was recorded. The jump and reach board used in this study was a board about four feet long and eighteen inches wide, black in color with numbered white

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<sup>2</sup>Gordon B. Ariel, "Principles of Ballistic Motion in Resistive Exercise Training," Scholastic Coach 43 (May 1974):80.



lines one centimeter apart running across the width of it. The board was clamped to a basketball backboard to eliminate any fear the subjects might have of bumping into something when they jumped. Following the reach measurements the subjects placed white chalk on the ends of their middle fingers. The subjects were then instructed to keep one arm behind the back, one arm fully extended, and the upper body erect while attempting to jump as high as possible and touch the board at the peak of their jumps. Each subject was given three trials with the best effort being determined from the highest white mark on the board. The distance to the nearest centimeter was recorded for each subject. A ladder was used to facilitate the reading of the marks and the wiping clean of the board between subjects. When subjects did not jump as they were instructed, they were told of their errors and given substitute trials so that each subject was given three legitimate attempts. By subtracting the number of centimeters each subject reached on the jump and reach board from the number of centimeters each one had jumped, the leg power in centimeters of each person was determined.

The male subjects were divided into two groups such that the mean jumping ability in centimeters was exactly the same for both groups. The same procedure was followed with the female subjects. This was done so that the mean jumping ability in centimeters of each of the experimental groups would be as nearly as possible the same before training. The groups of men and women that trained isototonically were called group A and those that trained isokinetically were called group B.

### Training Procedures

Both of the groups trained on Mondays, Wednesdays and Fridays during the same time of day in the same location. The days were alternated because the body requires time for rebuilding after strenuous exercise.<sup>3</sup> All training sessions were supervised by the author or a Cedarville College colleague or both. Each group did three sets of eight repetitions of its particular exercise. Three sets of eight to twelve repetitions is a standard weight training program.<sup>4</sup> The rest interval between sets was two minutes. The only differences in training procedures between the groups were what was created by the machines themselves and the isokinetic group's warm-up procedure. The warm-up consisted of doing one set of ten repetitions with fifty percent of the workout weight prior to each training session. Warm-up was not needed for the isokinetic group.<sup>5</sup> The training period started on Monday after the pre-test and continued for five weeks. The last training session was Monday of the sixth week. Both groups were urged to start lifting from a position where the angle formed by the upper and lower leg was no more than ninety degrees and to extend the legs completely on each repetition.

The isotonic group was given a maximum strength test on the leg press station the first day of training to establish a workout weight

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<sup>3</sup>Don C. Seaton et al., Physical Education Handbook (Englewood Cliffs, N.J.: Prentice-Hall Inc., 1974), p. 392.

<sup>4</sup>R. T. Withers, "Effects of Varied Weight Training Loads on Strength of University Freshmen," Research Quarterly 41 (March 1970): 113.

<sup>5</sup>Jim Wilson, "Isokinetic Maxi-Programs," Athletic Journal 53 (April 1973):39.



for each of the subjects. The maximum amount of weight that could be lifted by each subject was determined by starting the subjects lifting at one hundred pounds and adding twenty pounds until a weight was reached that could not be lifted. The amount of weight twenty pounds less than that which was not lifted was determined to be the maximum for that subject. The starting workout weights for the subjects were determined by taking eighty percent of their maximums. According to Rasch, "To permit repetitions the resistance must be sufficiently large enough to demand a greater than normal effort but small enough to require a less than maximal effort."<sup>6</sup> Every Monday the workout weight of each subject in group A was increased by twenty pounds unless on the first set of repetitions the subject was unable to lift it eight times in which case the weight was reduced to the amount used the previous week. This occurred with only one individual during the five-week training period.

The isokinetic machine was placed near a smooth wall. As the subjects got into the shoulder harness and stood on the machine, the distance between it and the wall was adjusted so that the subjects could lean against the wall. This was done so that the subjects could more easily keep their backs perpendicular to the floor. The subjects were instructed to keep their backs straight and lift with as much force as possible throughout the complete range of motion. A dial on the machine indicated approximately how much they were lifting on each repetition. It was emphasized that they would only get out of the

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<sup>6</sup>P. J. Rasch, Weight Training (Dubuque, Iowa: Wm. C. Brown Co., 1966), p. 7.

exercises what they put into them. The speed of the machine used in the study was fixed at a constant rate approximately equal to the speed at which the weights were being lifted on the leg press device.

The post-test was administered following exactly the same procedures that were used for the pre-test. The post-test was given on Wednesday following the Monday of the last training session.

For the purpose of statistical treatment it was hypothesized that no differences would exist between the effects of isotonic and isokinetic training methods on leg power between men and women. The data acquired from the vertical power jump test, which consisted of the difference of scores between the pre-test and post-test, were analyzed using the two by two analysis of variance with randomized blocks. The .05 level of significance for F-ratios was established for the rejection of the null hypothesis. The results of these analyses are summarized in Table 1. The mean number of new degrees of improvement for each of the groups and the standard deviation for each are listed in Table 1.

TABLE 1

LEG POWER MEAN SCORES AND STANDARD DEVIATIONS			
	N	Mean	S.D.
Men (isotonic)	8	2.50	2.26
Women (isotonic)	8	2.00	2.32
Men (isokinetic)	9	1.78	2.63
Women (isokinetic)	7	.75	2.53

There was no significance at the .05 level for any of the variables or combinations of variables. The total combination of treatments had an F-ratio of 1.37 with 7.54 needed for significance.

## CHAPTER IV

### ANALYSIS AND INTERPRETATION OF DATA

For the purpose of statistical treatment it was hypothesized that no differences would exist between the effects of isotonic and isokinetic training methods on leg power between men and women. The data acquired from the vertical power jump test, which consisted of the difference of scores between the pre-test and post-test, were analyzed using the two by two analysis of variance with randomized blocks. The .05 level of significance for F-ratios was established for the rejection of the null hypothesis. The results of these analyses are summarized in Table 2. The mean number of centimeters of improvement for each of the groups and the standard deviations for each are listed in Table 1.

TABLE 1

LEG POWER MEAN SCORES AND STANDARD DEVIATIONS			
	N	Mean	S.D.
Men (isotonic)	8	2.50	2.26
Women (isotonic)	8	4.00	2.82
Men (isokinetic)	9	1.78	2.63
Women (isokinetic)	7	.70	2.53

There was no significance at the .05 level for any of the variables or combinations of variables. The total combination of treatments had an F-ratio of 1.899 with 2.98 needed for significance.

Training modes were close to significance with an F-ratio of 4.363 where 4.75 was needed. The sex variable did not even come close to significance with an F-ratio of less than one. The F-ratio was 1.577 for the combination of sex and training mode, but 4.75 was needed for significance.

TABLE 2

## SUMMARY: ANALYSIS OF VARIANCE

Source	SS	df	MS	F-ratio
Treatments	41.496	3	13.822	1.899*
Training Modes	30.0	1	30.0	4.363**
Sex	0.648	1	0.648	<1.0 **
Training Modes x Sex	10.847	1	10.847	1.577**
Error	189.304	26	7.280	
Blocks	106.8	14	7.628	
Blocks x Treatment	82.504	12	6.875	
Total	230.8	29		

\* F.05 (3,26)  $\approx$  2.98

\*\* F.05 (1,12)  $\approx$  4.75

### Conclusions

The data from this study suggests the following conclusions with regard to a population of college students such as those studied.

1. Isotonic and isokinetic training affects speed and accuracy



## CHAPTER V

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

#### Summary

The purpose of this study was to determine if there was a significant difference between the effects of isotonic and isokinetic exercises on leg power. A second purpose of the study was to determine if one method of training would have a significantly greater effect upon men than upon women.

Thirty-three subjects were involved in either isotonic or isokinetic training for a five-week period. The subjects trained three days per week. Data was gathered from the vertical power jump test which was administered both before and after the five-week training period to determine the effects of training.

The statistical analysis of the data in this study indicated that there was no significant difference between the effects of isotonic and isokinetic training methods upon each sex. The effects of the two training methods bordered on being significant, but were not.

#### Conclusions

The data from this study suggests the following conclusions with regard to a population of college students such as those studied.

1. Isotonic and isokinetic training methods have the same

- effect on leg power: an increase in leg power as measured by the vertical power jump test.
2. Isotonic and isokinetic training have the same effect upon leg power of men.
  3. Isotonic training has a greater effect upon leg power of women than isokinetic training, but not a significantly greater effect.
  4. Isokinetic training affects men more than women, but not significantly more.
  5. Isotonic training affects women more than men, but not significantly more.

#### Recommendations

The author suggests the following recommendations in order to provide further information about the effects of isotonic and isokinetic exercises on leg power.

1. A similar study be done with more subjects using the analysis of covariance statistical technique.
2. A similar study be done using a more durable isokinetic machine.
3. Since some of the subjects showed negative results when the pre- and post-test scores were compared, it is recommended that the subjects be both pre- and post-tested on several different days.
4. A study be done with younger subjects.
5. Studies be done comparing different isokinetic training

methods; the variable might include frequency of training sessions, speed of training, number of repetitions, number of sets, and motivational techniques.

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It was the purpose of this study to determine if there is a difference between the effects of isotonic and isokinetic exercises on the leg power of men and women.

PROCEDURE. Thirty-seven Dubuque College students participated three days per week for five weeks in a training program for the development of leg power. The subjects were given the Vertical Power Jump test to assess their jumping abilities prior to training. On the basis of the pre-test scores and sex the subjects were divided into four groups. One group of men and one group of women trained on a Universal Gym leg press station. The other two groups trained on a Super Mini-Gym isokinetic device. Each group did three sets of eight repetitions each training session. After the five-week training period the subjects were given the Vertical Power Jump test to determine the amount of change in leg power.



## ABSTRACT

### A COMPARISON OF THE EFFECTS OF ISOTONIC AND ISOKINETIC EXERCISES ON LEG POWER

John Arthur McGillivray, M.S.  
University of Dayton, 1976

Major Professor: Dr. Doris A. Drees

**PROBLEM.** The author has been interested in improving the jumping ability of the students and athletes with whom he has worked. Current literature reflects conflicting viewpoints concerning isokinetic training as a superior method to isotonic training for power development. It was the purpose of this study to determine if there is a difference between the effects of isotonic and isokinetic exercises on the leg power of men and women.

**PROCEDURE.** Thirty-three Cedarville College students participated three days per week for five weeks in a training program for the development of leg power. The subjects were given the Vertical Power Jump test to assess their jumping abilities prior to training. On the bases of the pre-test scores and sex the subjects were divided into four groups. One group of men and one group of women trained on a Universal Gym leg press station. The other two groups trained on a Super Mini-Gym isokinetic device. Both groups did three sets of eight repetitions each training session. After the five-week training period the subjects were given the Vertical Power Jump test to determine the amount of change in leg power.

FINDINGS. There were no significant differences in the amounts of change of the four groups. Gains in leg power were made by all of the groups. The biggest gain was made by the women's isotonic group and the least gain was made by the women's isokinetic group.

CONCLUSIONS AND RECOMMENDATIONS. Isotonic and isokinetic exercises both caused improvement in the leg power of men and women over a five-week training period. There was no significant difference between the types of training used.

The author recommends that a similar study be done with more subjects. He also suggests that a study be done comparing different types of isokinetic training programs with the number of repetitions, number of sets, frequency of training, and speed of the device as possible variables.