A Study of Isometric and Isotonic Exercises on the Jumping Ability of College Basketball Players

David L. Hudssey

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A STUDY OF ISOMETRIC AND ISOTONIC EXERCISES
ON THE JUMPING ABILITY OF COLLEGE BASKETBALL PLAYERS

(TITLE)

BY

David L. Hussey

PLAN B PAPER

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Physical Education 475

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1963
YEAR

I HEREBY RECOMMEND THIS PLAN B PAPER BE ACCEPTED AS
FULFILLING THIS PART OF THE DEGREE, M.S. IN ED.
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CHAPTER I

INTRODUCTION

The desire to succeed and to excel at an activity seems to be inherent in all young athletes. However, it is apparent that all do not realize success nor ever reach a level of excellence. This could be the case of the many who fail to be chosen for the teams. Improved methods are constantly being employed by trainers of young athletes in an attempt to better equip them to compete with their peers.

The writer will explain a method of training that has been employed for some time by coaches dealing with young athletes. Strength seems to be a desireable asset in many athletic endeavors. John D. Lawther\textsuperscript{1} gives the following views regarding strength. (1). The majority of individuals are quite capable of attaining extensive development of strength. (2). The use of gradually increasing resistance exercises is the best means of obtaining strength. (3). The amount of work should increase rather than the length of time spent. (4). Weight training is described as a use of systematic exercises, with weights used merely as the means to increase resistance to muscle contractions.

The question arises as to whether weight training has been accepted as a valuable asset in training athletes. The article by John E. Nulton,\textsuperscript{2}


in the *Athletic Journal*, states that, "weight training has been recognized in physical education and athletics as an instrumental means in improving muscular fitness. Due to its variety, it has been useful in various types of training programs."

John Bunn,³ in the book, *Scientific Principles of Coaching*, expresses the following idea on strength and athletes.

The primary source of force is strength. The Implication . . . is so obvious it may be overlooked. Strength is derived from a muscle or combination of muscles, and is related directly to the cross sectional area of the muscle. Therefore, to have strength one must build muscle. And in athletics, in order to have a reserve to meet emergencies, it is desirable to acquire strength in excess of that required for the activity. This connotes a conditioning program more strenuous . . . than the activity itself, as a part of the training program.

J. A. Murray and Peter Karpovich,⁴ in the book, *Weight Training in Athletics*, mention the following incident pertaining to the principle of weight training.

The Greek wrestler, Milo of Croton, who won fame in ancient Olympic Games, is the first weight lifter of note in recorded history. The story has often been told of how young Milo, to strengthen himself for all out wrestling contests that frequently ended in death for the vanquished, practiced lifting a young bull and walking with it on his shoulders daily as it grew to its full size.


Milo's principle of gradual progression from a relatively light weight to a heavy poundage is the same one followed today to develop strength and improve physical condition by exercising with adjustable barbells and dumbbells.

It seems that weight training has established itself as a valuable asset to athletic endeavors. Recently, however, a new theory has become more and more evident. As Rex Lardner⁵ puts it:

"the most revolutionary advance in athletic training methods in recent years has been the increased use of isometric exercises that build up specific muscles by exerting them against an immovable object."

There are many opinions regarding the use of this type of exercise. In an article in Reader's Digest, Keith Monroe⁶ quotes:

What kind of exercise is more important than how much, says Dr. Arthur Steinhaus, dean and professor of physiology at George Williams College. In a German laboratory where I worked, it was discovered that muscle can grow at only a certain rate and a very small amount of the right exercise will start it growing at that rate. If you contract any one of your muscles to about 2/3 of its maximum power and hold it for six seconds once a day, the muscle will grow just as fast as it can grow.

Bob Hoffman,⁷ coach of the United States Olympic Weight

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Lifting Team, relates the following in relation to isometric training:

This method of training is moving so rapidly that it is difficult to find out just how many athletes are employing it, and how much each one is improving ... While this method has great value in the athletic field, we see even more value to the physical fitness program. We feel that functional isometric contractions offers the best way to promote physical fitness.

Such an authority as Peter Karpovich,\(^8\) suggests that muscle training had a long and successful history. However, there is considerable disagreement as to the best method for muscle training.

**Statement of the Problem**

The purpose of this study is to compare two types of exercise programs, namely isometric and isotonic.

**Definitions**

The word isometric is defined as, "the exertion of muscles against an immovable object."\(^9\) The word isotonic is defined as, "muscle work against resistance."\(^10\)

**Related Literature**

Previous research done in the area of isometric contractions is mentioned in the following paragraphs. Due to the aforementioned acceptability of weight training as a valuable asset in the field of

\(^8\)Hugh Thompson, "Weight Training vs. Isometric Training," *Scholastic Coach*, XXIV (October, 1962), pp. 42–47.

\(^9\)Ibid. 5, p. 41.

\(^10\)Ibid. 8, p. 42.
strength development, the writer would like to mention some of the studies relating to isometric contractions as well as some of the studies showing a similar relationship to the present study being conducted.

The study found to be most related was done by M. L. Howell, R. Kimoto, and W. R. Morford,\(^\text{11}\) on the Effect of Isometric and Isotonic Exercise Programs Upon Muscular Endurance.

Three groups of eleven subjects enrolled in required physical education were equated on the basis of bicycling for two minutes at 14 kg. resistance. Group I did weight training, Group II used the Commander Set series of isometric contractions, and Group III participated in normal activities. At the conclusion of the eight week experimental period all subjects were retested on the bicycle ergometer under the original conditions. Both experimental groups showed statistically significant improvements in the bicycle ergometer test and there were no statistically significant differences between the means of the differences between the initial and final scores of the two experimental groups. It is hypothesized that increases in muscular endurance may be effected by certain programs of isometric contractions as well as by isotonic exercises.

The second study related to the present study is one done by J. D. Dennison, M. L. Howell, and W. R. Morford,\(^\text{12}\) again upon the Effect of Isometric and Isotonic Exercise Programs Upon Muscular Endurance.


Two groups of ten subjects, each enrolled in the required program, were equated on the basis of the scores on the Arm Strength Index. Group I participated in a weight training program, and Group II performed the thirteen exercises of the Commander Set, both groups meeting twice a week for eight weeks. Both groups showed statistically significant improvements in chinning and dipping ability and consequently in the Arm Strength Index. The difference between the means of improvement of the two groups was not statistically significant.

In Hugh Thompson's article,13 "Weight Training vs. Isometric Training," a survey of the literature on functional isometric contractions was conducted with the following conclusions:

(1) Both isotonic and isometric training against resistance causes a significant increase in strength development.

(2) Isotonic and isometric training programs have been compared in the development of strength with conflicting results. However, the majority of the studies indicate no significant difference between the two methods in total strength development.

(3) There appears to be no difference in the tension which can be exerted in a single maximum isometric contraction and the maximum weight which can be moved in a single isotonic contraction.

The delimitations of the problem include the following:

(1) The study involved males of four grade classifications. That is, freshmen, sophomore, junior, and senior.

(2) The study was conducted on the campus of Eastern Illinois University with all of the subjects being basketball players.

(3) The group consisted of only twenty-six men.

13 Ibid. 8, p. 47.
(4) Six of the subjects were not considered in the study due to injuries which prevented them from attending all of the sessions.

(5) No provision for a follow-up study has been made.

**Procedures Used In The Study**

The twenty-six members of the freshman and varsity basketball teams at Eastern Illinois University were used as subjects for the study. The individuals were randomly assigned to one of three groups. One group did weight training exercises, the second did isometric exercises, and the third was used as a control group.

Prior to the first exercise session, the vertical jumping ability of each individual was determined. This was found by finding the difference between his standing reach and vertical jump. This procedure was repeated at the conclusion of the study.

In an attempt to make a comparison of the two groups, the exercises assigned to each group were similar. A description of those exercises follows:

**Exercise Number 1**

**The Partial Deep Knee Bend**

The subject stands straight with feet approximately shoulder width apart. The bar is placed upon the shoulders behind the neck. Due to the weight used, partners are needed to help place the bar in position. In this exercise the body is lowered only from six inches to a foot, depending upon the weight of the bar being used and the subjects strength. The lowering is done slowly and the legs are straightened with a very quick movement. The exercise is repeated ten to twelve times.

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Exercise Number 2

Raise on Toes With Bar Bell

The weight is placed behind the neck as the subject stands in an erect position. His feet are together with the front third of the foot resting on a block one or two inches in thickness. From this position raise to tip toe position and then lower until the heels come below the toes. The exercise is repeated ten to twelve times.

The isometric group performed the same exercises under the following conditions. In each exercise the subject would assume a position similar to that of the weight lifter as he was about to make his lift. At this point an adjustable horizontal bar would be secured in position on the shoulders behind the neck. The subject would then attempt to lift this now immovable bar for a period of six seconds. In the case of the weight lifters, if the exercise could be repeated twelve times an additional weight was added at the next session.

The subjects performed the exercises twice per session. After a period of six weeks at three sessions per week, the vertical jumping ability of each individual was determined.

15 Ibid. 14, p. 8.
CHAPTER II

INTERPRETATION OF DATA

An attempt was made to determine whether there was any statistically significant difference between the means of the initial and find vertical jump within each group. These results are followed by a comparison of the means to determine whether there were any significant differences in the results between groups.

Comparison Within Groups\(^1\)

The difference between the means of the original and final test of the isotonic group was 1.46 inches.\(^2\) This difference was found to be statistically significant at the .02 level of confidence.

The difference between the means of the original and final test of the isometric group was 1.08 inches.\(^3\) This difference was found to be statistically significant at the .05 level of confidence.

The difference between the means of the original and final test of the control group was .65 inches.\(^4\) This difference showed no statistical significance.

Comparison Between Groups\(^5\)

In comparing the means between the initial and final scores of any combination of two of the three groups, no statistically significant differences were found.

\(^{1}\)See formula #2, p. 11.
\(^{2}\)See table 1, p. 10.
\(^{3}\)See table 2, p. 10.
\(^{4}\)See table 3, p. 10.
\(^{5}\)See formula #1, p. 11.
TABLE 1
Isotonic Group

<table>
<thead>
<tr>
<th>Subject</th>
<th>Initial Jump in Inches (X)</th>
<th>Final Jump in Inches (Y)</th>
<th>Difference in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>30.25</td>
<td>31.75</td>
<td>+1.5</td>
</tr>
<tr>
<td>(2)</td>
<td>26</td>
<td>28.5</td>
<td>+2.5</td>
</tr>
<tr>
<td>(3)</td>
<td>23.25</td>
<td>23.25</td>
<td>0</td>
</tr>
<tr>
<td>(4)</td>
<td>26.5</td>
<td>27.5</td>
<td>+1</td>
</tr>
<tr>
<td>(5)</td>
<td>30.5</td>
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</tr>
<tr>
<td>(6)</td>
<td>21.25</td>
<td>23</td>
<td>+1.75</td>
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Mean of (X) = 26.32
Mean of (Y) = 27.78
Difference of Means = 1.46 inches

TABLE 2
Isometric Group

<table>
<thead>
<tr>
<th>Subject</th>
<th>Initial Jump in Inches (X)</th>
<th>Final Jump in Inches (Y)</th>
<th>Difference in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>25.25</td>
<td>27.25</td>
<td>+2</td>
</tr>
<tr>
<td>(2)</td>
<td>25.75</td>
<td>25.75</td>
<td>+2</td>
</tr>
<tr>
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<td>+1</td>
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<tr>
<td>(7)</td>
<td>29.25</td>
<td>29.25</td>
<td>0</td>
</tr>
</tbody>
</table>

Mean of (X) = 25.91
Mean of (Y) = 26.99
Difference of Means = 1.08 inches

TABLE 3
Control Group

<table>
<thead>
<tr>
<th>Subject</th>
<th>Initial Jump in Inches (X)</th>
<th>Final Jump in Inches (Y)</th>
<th>Difference in Inches</th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
<td>27</td>
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<tr>
<td>(2)</td>
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<tr>
<td>(6)</td>
<td>24</td>
<td>24.5</td>
<td>+ .5</td>
</tr>
<tr>
<td>(7)</td>
<td>25</td>
<td>25</td>
<td>0</td>
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</tbody>
</table>

Mean of (X) = 25.71
Mean of (Y) = 26.36
Difference of Means = .65 inches
Formula #1.\(^{20}\)
\[
\begin{align*}
t &= \frac{(\bar{x} - \bar{y})}{\sqrt{\frac{n_x s_x^2 + n_y s_y^2}{n_x + n_y}}} \cdot \sqrt{\frac{n_x n_y (n_x + n_y - 2)}{n_x + n_y}}
\end{align*}
\]

\(\bar{x}\) = mean of group x  
\(\bar{y}\) = mean of group y  
\(n_x\) = number of subjects in group x  
\(n_y\) = number of subjects in group y  
\(s_x^2 = \frac{\sum (x - \bar{x})^2}{n_x}\)  
\(s_y^2 = \frac{\sum (y - \bar{y})^2}{n_y}\)

Formula #2.\(^{21}\)
\[
\begin{align*}
\sigma_x^2 &= m_x^2 - (m_x)^2 \quad \sigma_y^2 = m_y^2 - (m_y)^2 \\
r &= \frac{m_{xy} - m_x m_y}{\sigma_{x'y}} \\
\frac{\sigma_x^2}{n-1} &= \sigma_{x^2} \\
\frac{\sigma_y^2}{n-1} &= \sigma_{y^2} \\
S.E.D. &= \sigma_{x^2} + \sigma_{y^2} - 2r \sigma_{x} \sigma_{y} \\
t &= \frac{m_x - m_y}{S.E.D.}
\end{align*}
\]


The purpose of the study was to compare two types of exercise programs. The two types of programs compared were isometric contractions and isotonic exercises.

To be able to make a comparison, the writer attempted to keep the two programs as similar as possible. It was for this reason that the specific exercise in each group had its counterpart in the other group. The number of times the subject repeated each exercise was equal in each group.

**Conclusions**

(1) It would appear both types of exercise programs improve jumping ability.

(2) It would seem that the area of isometric contractions compared to isotonic exercises needs further study.

**Recommendations**

(1) A further study involving the use of isometric exercises daily is suggested due to the fact the isometric exercises required no recovery period.

(2) A study involving subjects not involved in a varsity sport at the time would be desirable.
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Books


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