A Comparison of Two Isotonic Resistance Training Routines for Individuals with Above Average Strength

Craig L. Kruse
Eastern Illinois University

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A COMPARISON OF TWO ISOTONIC RESISTANCE
TRAINING ROUTINES FOR INDIVIDUALS WITH
(Title)
ABOVE AVERAGE STRENGTH

BY
Craig L. Kruse

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

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IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1995

YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED ABOVE

May 2, 1995

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ABSTRACT

A Comparison of Two Isotonic Resistance Training Routines for Individuals with Above Average Strength

Craig L. Kruse

The purpose of this study was to determine if individuals, possessing above average strength in the bench press exercise, would improve their 1RM more by using an experimental resistance training program as compared to a program of a more traditional nature.

Seventeen male subjects between the age 18 and 26 years, mean age 21.8 years, who were considered to have an above average strength level in the bench press exercise (a bench press strength to body weight ratio, S/BW, greater than 1.00) participated in this study. The subjects had an average S/BW of 1.17. All the subjects trained three alternate days per week performing the bench press, dumbbell military press, lat pulldown, bicep curl, tricep curl, and leg press exercises for three sets of six repetitions. The eight subjects in the traditional training group (Group T) used a load intensity of their 6RM for all three sets, all three days. The nine subjects in the experimental training group (Group E) used their 6RM on day one (the heavy day) and 75 percent of their 6RM on days two and three (the light days). Prior to the seven week training cycle, the subjects were tested on their
1RM in the bench press exercise and measured on several girths and skin fold sites. After the training period, the subjects were re-tested on their 1RM and measurements to determine a training effect.

Independent t-tests were performed to identify the significant difference (p < .05) between Groups T and E in the changes in 1RM and specific anthropometric measurement, following training. After the seven wee training period, Group E gained significantly more on their 1RM on the bench press test than did Group T. Non-significant changes in the anthropometric measurements were observed. It was concluded that training using the experimental training program can produce greater strength gains for the strong individual than the traditional training program.
ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

Conditioning and training are very important aspects for today's athlete. Because of this, exercise physiologists have performed research on the various aspects of an athlete's training in an effort to make him/her a better athlete.

Muscular strength is a characteristic athletes attempt to develop when trying to improve their current level of performance. With higher levels of muscular strength, many aspects of performance can be improved. With all other factors being equal, a stronger athlete can run faster, jump higher, and throw farther than his weaker counterpart (Jones et al., 1986). For this reason, it is beneficial for the athlete to be constantly improving his strength.

In addition to the performance enhancing effects, an increase in muscular strength can decrease the chance of an injury occurring during athletic competition or a practice session. When muscles are weak, the joints that those muscles act upon are susceptible to injury (Arnheim, 1991). By increasing the strength level of muscles that surround a joint, tendon and ligament strength increases and the joint becomes more stable. This increase in joint stability decreases the chance of injury (Fisher, 1990).

A tried and proven method of building one's muscular
strength is resistance training. Resistance training is working the body’s musculature against an opposing force, which can come in the form of a barbell, dumbbell, weight machine, training partner, or even an immovable object such as a wall (Fleck and Kraemer, 1987).

Strength gains through resistance training occur as a result of actual physiological responses to training, two of which are hypertrophy and neuromuscular adaptations.

Hypertrophy, the growth in muscle fiber size, is a known response of a muscle to resistance training (Fleet and Kraemer, 1987). During the training session, the muscle is actually injured as a result of the resistance placed on the muscle. Through a repair process, the muscle can rebuild to a larger size. This increase in muscular size is known to bring about an increase in muscular strength (Fox et al., 1989).

Strength can also be gained through a process of neuromuscular adaptation to the resistance training. As the muscles are trained against resistance they are forced to adapt to the new workload by learning to activate an increased number of motor units which are also taught to fire in a synchronous manner. A greater force can be produced by the increased number of motor units contracting at the same time (Fox et al., 1989).

Resistance training is a complicated process where many variables have an effect upon successful training programs.
proper frequency of training, number of sets and repetitions, and load intensity must be followed for strength to be increased at an optimal rate.

Justification for the Study

Many researchers have studied the frequency of training sessions per week, number of sets and repetitions, and the proper level of load intensity to be used to produce the maximal strength gains. While some researchers are uncertain, others have suggested that there is indeed a proper manner to train with weights.

The programs that are most widely accepted typically prescribe three alternate days of resistance training performing three sets of six repetitions using the 6RM.

Most of the past studies on resistance training have involved subjects enrolled in beginning weight training classes, and not athletes. The majority of subjects had average or below average strength levels, while most athletes have above average strength levels. Therefore, their results can not necessarily be generalized to athletes.

More research needs to be done using subjects who have above average strength levels to compare the strength gains from resistance training programs of non-athletes to the gains made by athletes using these programs.

Another confounding factor is the amount of recovery time allowed following training. When an individual’s
strength level increases, his ability to recover from the training session does not increase proportionately. During the early phases of a weight training program, recovery requires 24 to 48 hours to be completed. When an individual gains strength, this recovery time must be increased to allow time for the additional motor units to be repaired (Darden, 1977). Generally, a training stimulus will not produce an increase in strength if the muscle is not given an opportunity to recover before the next training session.

**Statement of the Problem**

The purpose of this study was to determine whether college men with above average strength would gain a greater amount of strength using a routine that included both maximal and submaximal training as opposed to a routine using only maximal training. Strength gain was determined by the subjects' increase in one repetition maximum on a bench press test.

**The Research Hypothesis**

Individuals with above average strength will gain a greater amount of strength using a routine that includes both maximal and submaximal strength training as opposed to a traditional routine that uses only a maximal stimulus.
Definitions

Hypertrophy - an increase in muscle fiber size

Motor Unit - the motor neuron and the muscle fibers it stimulates. The fundamental unit of skeletal muscle

Muscular Strength - the force or tension a muscle can exert against a resistance in one maximal effort

Overload Principle - as a muscle becomes stronger it must continually be forced to work against a progressively greater resistance to continue to achieve gains in strength

Repetition Maximum (RM) - the maximal load that a muscle can lift a given number of repetitions before fatiguing

Resistance training - training the body's muscles against an opposing force

Set - the number of repetitions performed consecutively without resting

Limitations

1) This study was limited to seventeen male volunteers who were students at Eastern Illinois University.

2) The subjects had to have a bench press strength to body weight ratio greater than 1.00 to be admitted into the study.

3) Though the investigator made periodic visits with the subjects, they were not monitored during every
training session. They were trusted to complete each week of training on their own and turn in the log sheets.

4) The training cycle was limited to seven weeks in length.
CHAPTER II

REVIEW OF LITERATURE

This chapter reviews literature related to the physiological processes involved in the development of strength, different types of resistance training, and the optimal frequency, load intensity, set, and repetition range for maximal strength gains. The majority of these studies on resistance training have dealt primarily with beginning weight trainers and not individuals with above average strength levels.

The Development of Strength

While resistance training will produce strength gains, the exact process is quite complicated. For example, the increases in strength may be due to hypertrophy of the muscle tissue and/or neuromuscular adaptations.

Muscle Hypertrophy

Through resistance training, a muscle increases in size and this increase in size has been shown to result in a corresponding increase in strength (Fox et al., 1989). Studies indicate that hypertrophy, an increase in muscle fiber diameter, leads to an increased functional capacity.
because the muscle fiber can generate greater tension (Goldberg et al., 1975).

Increases in muscular size with strength training can be viewed as a biological adaptation to an increased workload (McArdle et al., 1981). The process of muscular hypertrophy is actually a repair process. During resistance training, the muscle cells are damaged due to the excess stress being forced upon them. As a result of this damage, protein synthesis is enhanced in an effort to repair the damaged muscle cells (Goldberg et al., 1975). As a muscle cell is repaired it increases its myofibril cross sectional area significantly and grows in size. The muscle diameter increases to compensate for the increased physiological demand placed upon it by resistance training. The greater the muscular activity and tension, the greater the rate of protein synthesis and amino acid transport (Goldberg et al., 1975).

The repair process of a muscle requires an appropriate amount of time to be completed. Typically the repair process can be successfully completed within 24-72 hours after the training session (Tiidus, et al., 1983). If the muscle is not given an adequate amount of recovery time, strength levels may actually decline (Jones et al., 1986).
Neurological Adaptations

Increases in cross-sectional area of a muscle cell only partially account for the increase in muscular strength that accompanies resistance training. Strength training also causes changes to occur within the nervous system that allow a trainee to activate an increased number of motor units with each contraction, thereby producing more force (Sale, 1988). Resistance training also enhances motor unit synchronization. When an increased number of motor units fire at the same time, the muscle is able to generate a greater amount of force (Sale, 1988). When heavier loads are placed upon a muscle, these two neural responses result in a stronger muscular contraction. These adaptations by the central nervous system allow an individual to better coordinate the activation of a muscle to increase its net force production (Jones et al., 1986).

Strength training causes another adaptation of the nervous system. Weight trained subjects are better able to fully activate prime movers and to better coordinate the activation of all synergists in specific movements thereby generating a greater net force (Sale, 1988).

Types of Resistance Training

There are several types of resistance training used for developing strength. Some of the methods are based on
different types of muscular contraction.

**Isometric Training**

Isometric training requires the muscles to exert a force against a resistance at a specific joint angle. The muscle does not shorten or lengthen, but remains at a specific length throughout the entire contraction. The resistance used during isometric training is typically an immovable object such as a wall and is equal to the force produced by the muscle.

Isometric training was popularized by Hettinger and Muller in 1953 when they stated that maximal strength could be developed as a result of one daily isometric contraction lasting six seconds at two-thirds maximal effort (Atha, 1981). A drawback of isometric training is that it only develops strength at the specific joint angle of the exercise (Fox, et al., 1989).

**Isokinetic Training**

Isokinetic resistance training is defined as training the muscles through their entire range of motion, while keeping the speed of contraction constant throughout the exercise. Kousakin (cited in Atha, 1981) stated that isokinetic training is a more effective method of strength training than other currently known methods. He stated that isokinetic training activates more muscle fibers for longer periods of time.
Isotonic Training

During isotonic resistance training, the workload is kept constant throughout the entire range of motion of the exercise. The force generated by the muscle is greater than the resistance against it. The resistance supplied during isotonic training comes in the form of a barbell, dumbbell, a weight training machine (Fox, et al., 1989).

Resistance Training Methods

When it became apparent that isotonic resistance training could produce dramatic strength gains, researchers began to seek out the most appropriate load intensity, set, repetition, and frequency ranges for maximal strength gains in hope of finding the optimal method of resistance training.

Load Intensity

A crucial aspect of resistance training for the purpose of strength development is the load intensity. Load intensity is the percentage of one's 1RM used in a given exercise.

Filanovsky and Palameev (cited in Atha, 1981) studied the load intensity of Russian weightlifters in 1968. They observed the optimal intensity for strength development to be between 75 percent and 85 percent of the lifter's 1RM.

Berger (1965) studied seventy-nine college age males enrolled in weight training classes. He assigned the subjects to one of seven different training groups. They used training
load intensities of 66 percent, 80 percent, 90 percent, and 100 percent of their 1RM. The groups used a one set by one repetition training routine either once, twice, or three times per week. He evaluated their strength development in the squat exercise each week. A significant difference was noted between the groups using 80, 90, and 100 percent of their 1RM. No significant differences were seen between the 80, 90 and 100 percent groups. A significant difference was observed between the groups who trained two or three times weekly and the group that trained only once a week. It was concluded that increases in strength would result from training with loads greater than 66 percent of 1RM and must be done two to three times per week.

Dons (1979) studied the structural effects of load intensities of 50 percent and 80 percent subjects 1RM in the squat exercise. It was found that the group training with 80 percent of maximum gained the most strength (Dons, 1979).

Number of Sets and Repetitions

Of the many resistance training variables, the area of proper set and repetition range has received much attention by numerous researchers. The load intensity has also been included in many of these studies.

One of the first routines popularized for resistance training was developed by DeLorme and Watkins (1948). The program consisted of three days of weight training per week.
The training sessions consisted of three sets of ten repetitions. Each set had an increasing load intensity of 50 percent, 75 percent, and 100 percent of the subjects' 10RM. This routine became known as the DeLorme method.

O'Shea (1966) studied thirty beginning weight trainers divided into three groups. The three different groups each trained three days per week using the squat exercise. The groups used repetitions ranges of two to three, five to six, and nine to ten respectively for three sets. After the six week training period, O'Shea found that the group performing three sets of 5 to 6 repetitions gained the greatest amount of strength, although the difference in strength development was not great enough to be statistically significant to determine the optimal repetition range.

Capen (1956) also studied the set-repetition scheme for eight groups of university freshmen students. He was unable to find a program of specific set-repetition ranges that produced statistically significant differences in strength development. However, it was concluded that a routine of three sets of five repetitions produced the greatest strength gains.

Studying 55 male freshmen enrolled in weight training classes at Washington State University, Withers (1970) had the students training three days per week using the bench press, squat, and biceps curl exercises. The subjects were divided into three groups. The various groups used three sets of
seven repetitions at 7RM, four sets of five repetitions at 5RM, or five sets of three repetitions at 3RM respectively. The group using four sets of five repetitions at 5RM recorded the greatest improvement in strength, although the difference from the other groups was not statistically significant.

At the University of Kentucky, Anderson and Kearney (1982) studied 43 college age males. The subjects were divided into three groups. They performed either three sets of six to eight repetitions using their 6RM, two sets of 30 to 40 repetitions using their 30RM, or one set of 100 to 150 repetitions using their 100RM. Each group trained with the bench press exercise three times per week for a period of nine weeks. The group using three sets of six repetitions at their 6RM showed statistically significantly greater strength gains.

During the 1960's, Berger performed several studies dealing with effects of various weight training programs on strength development of college aged males enrolled in weight training classes.

In one study, he studied 177 freshmen and sophomore male students in nine weight training classes at the University of Illinois. Each weight training class was assigned a specific weight training routine. The program differed in number of sets (one, two, or three) and number of repetitions (two, six, or ten). Each group trained three days per week for twelve weeks on the bench press exercise. At the conclusion of the training cycle, strength gains between the
different groups were compared. There were statistically significant differences between the groups. He concluded that maximum development of strength gain resulted from a routine of three sets of six repetitions (Berger, 1962a).

In the same year, Berger performed another study utilizing 199 freshmen and sophomore males in six weight lifting classes at the University of Illinois. He divided the classes into nine groups and had them train three times per week on the bench press exercise. The groups differed in the number of repetitions they were to perform. The effects of two, four, six, eight, ten, and twelve repetitions for one set were studied. At the conclusion of the twelve week training period, statistically significant greater strength gains were made by the subjects who had utilized four, six, or eight repetitions rather than two, ten, or twelve repetitions. Berger concluded that the optimal number of repetitions for strength development is between three and nine repetitions (Berger, 1962b).

Of the controlled experiments performed in the area of optimal set and repetition range for strength development, the studies that revealed statistically significant differences between groups found the optimal set range to be 3 to 4 and the optimal repetition range to be 3 to 9. Berger’s routine of three sets of six repetitions at 6RM is generally accepted as the best method of developing strength (Stone, O’Bryant, and Garhammer, 1981).
Frequency of Training

The final variable of resistance training to be considered is the frequency of training. The reason the frequency of training is of crucial importance is the fact that during resistance training, the muscle is damaged (Jones et al., 1986, Tiidus and Ianuzzp, 1983) and it must be given proper time to recover in order to grow in size and strength (Wescott, 1987).

Immediately following a training session, a muscle's strength level is decreased. During the recovery process, the muscles repair themselves and reach new levels of strength development (Fleck and Kraemer, 1987). If the training sessions are too frequent, the muscle will be unable to rebuild itself to its previous level of strength and thus may experience a decrease in strength. Too frequent training sessions prevent complete protein synthesis and repair of the muscle cells and retards progress in neuromuscular adaptations. This same effect can be seen not only from too frequent training sessions but from training sessions that are too intense (Atha, 1981). There is a direct relationship between the load intensity and the amount of muscular damage (Tiidus and Ianuzzp, 1983). When a heavy stimulus is used for resistance training, more motor units are called on to help move the resistance and therefore more recovery time is required.

It has been found that maximal strength gains are made
when 24 to 72 hours of rest and recovery time is allowed between maximal training sessions. When this time is cut short, strength gains are not made and strength levels can actually decrease (Jones et al., 1986).

The previously mentioned investigation by Berger (1965) discovered the optimal training frequency to be three days per week. This study observed the differences between one, two, and three days per week and thus did not determine if more frequent training would be beneficial.

Gilliam (1981) studied the effects of varied training frequency on the bench press exercise. He used 68 high school males enrolled in physical education classes as subjects. The students had no prior weight training experience and they were divided into five groups each using the bench press exercise. The subjects performed 18 sets using their 1RM each training session. The five different groups trained either one, two, three, four, or five times each week for nine weeks. Gilliam found that training five days per week produced larger gains in strength than training fewer times per week.

Fry studied the effects of overtraining on strength development of college age males at the University of Memphis. Initially all subjects were capable of performing the squat exercise with at least 1.5 times their body weight. The 17 weight trained subjects were divided into two groups. One group trained daily using their 1RM for ten sets of one in the squat exercise. The other group trained one day per week
using 50 percent of their 1RM squat for three sets of five repetitions. It was found that the group training daily actually decreased in strength (Fry et al., 1994).

Summary

From the reported resistance training studies, it has generally been accepted that the proper method to train for strength development consists of training three days per week performing three sets of six repetitions using the 6RM. The majority of studies on resistance training methods were performed using subjects in weight training classes and not experienced lifters or individuals with above average strength levels. More research needs to be done with this population to determine the optimal methods of resistance training for them.
CHAPTER III

METHODS AND PROCEDURES

The following chapter describes the subjects that participated in this training study. The procedure used for the pre and post-training tests and the actually training cycles are also presented.

Subjects

Seventeen adult male students at Eastern Illinois University between the ages of 18 and 26 years completed the seven week resistance training study. The mean age was 21.8 years. Body weights ranged from 135 to 210 pounds with a mean body weight of 174.3 pounds.

All of the subjects were self-reported experienced weight lifters with an average of six years of resistance training experience. The subjects had also been on a weight training routine for at least two consecutive months prior to the initiation of this training study.

All of the subjects had a strength to body weight ratio (S/BW) of 1.00 or greater for the bench press exercise. The average strength to weight ratio was 1.17.
Procedures

Preliminary Information

Anthropometric and physiological data were gathered in the Human Performance Laboratory at Eastern Illinois University. The height (to the nearest half inch) and body weight (to the nearest pound) were measured. Skin fold measurements were taken at the triceps, biceps, chest, subscapular, abdominal, and thigh sites. Then body fat percentages were determined via the Jackson and Pollock method (Pollock, 1990). Girth measurements (to the nearest .1cm) were also obtained from the chest, right arm, right thigh, and abdominal region. The subjects were asked various questions about weight training experience and current status. Answers were written on a data collection sheet (Appendix A). The subjects' blood pressure was also measured to determine if they could safely participate in the study. All these data are presented in Appendices B through E.

After this preliminary information was recorded, the subjects were taken individually into the athletic weight training room or the Student Recreation Center in the Lantz Building. They were then informed as to the testing procedures on the bench press and signed an informed consent form (Appendix F).
The Bench Press Test

The investigator explained the proper form to be used during the bench press testing. The subject was allowed to warm up using approximately 50 percent of this body weight for ten repetitions on the bench press exercise before being tested for his 1RM.

The subject assumed the supine position on the bench in preparation for the test. He began by using a load intensity equal to his body weight. He removed the barbell from the standards and then lowered it to his chest in a controlled manner and paused before pressing the barbell to his fully extended arms length.

At the completion of each successful attempt, the subject was required to rest two minutes while the barbell was loaded with an additional ten pounds. This procedure continued until the subject’s 1RM was determined for the bench press test.

The same procedures described above were employed during the post-training tests at the completion of the seven week training cycle.

The Training Cycle

After the subject’s 1RM was determined for the bench press test, he was alternately assigned, based on bench press administration order, to one of two training groups.
The Traditional Training Group (Group T)

The subjects assigned to Group T used the training method prescribed by Berger in the 1960's. They were to train three alternate days per week. The subjects trained the entire body every training session. The primary exercise for this study was the bench press. Secondary exercise included dumbbell military press, lat pulldown, bicep curl, lying tricep extension, and leg press.

The training program required the subjects to attempt three sets of six repetitions using their 6RM for all three sets every training session. When they could successfully complete all six repetitions of all three sets, they were required to add an additional five pounds for the next training session. They were to train in this manner of progression for all six exercises for the entire seven week training cycle.

The Experimental Training Group (Group E)

The subjects assigned to Group E were also required to train three alternate days per week. They used the same exercises as Group T. On day one, the heavy day, each subject attempted three sets of six repetitions using his 6RM of all three sets. When he was able to successfully complete all six repetitions in all three sets, he was required to put an additional five pounds on the barbell for his next heavy workout, which was exactly one week later. During days two
and three of each training week, the light days, the subject was to attempt three sets of six repetitions using 75 percent of the weight used on the heavy day. The subjects in Group E trained in this manner for all six exercises for the entire seven week cycle.

**Analysis of Data**

An independent t-test was performed to determine if there was any statistically significant difference between the average seven week change in 1RM found for the traditional versus the experimental group on the bench press test.

Though the major thrust of this investigation was to look at the absolute change in the 1RM in the bench press test, other comparisons (body weight, bench press strength to body weight ratio, girth measurements, and body fat percentages) were performed to compare the two groups.

The .05 level of confidence was used to denote statistical significance for this study.
The purpose of this study was to see if college age males, with above average strength in the bench press exercise, would see greater strength gains after training using an experimental training program rather than a more traditional training program. Seventeen male students volunteered to be subjects.

The traditional training group (Group T) consisted of eight subjects. They performed a weight training routine three alternate days per week for a period of seven weeks. The primary exercises in this study was the bench press. Secondary exercises included the dumbbell military press, lat pulldown, bicep curl, lying tricep extension, and leg press. For each exercise, the subjects in Group T were to attempt three sets of six repetitions at their 6RM. When the subject could successfully complete all three sets of six, five additional pounds were added for the next training session.

The experimental training group (Group E) consisted of nine subjects. The days per week and exercises were exactly the same as for Group T. However, on day one, the heavy day, each subject attempted three sets of six repetitions at his 6RM. When all three sets of six could be completed, five pounds were added for the next heavy day, one week later. On
days two and three, the light days, each subject performed three sets of six repetitions at 75 percent of the weight used on the heavy day.

The raw scores obtained during the pre and post-training tests, for each group, are presented in Appendices B through E.

Using dependent and independent group t tests and a .05 level of confidence, several comparisons were made within and between groups.

Pre-Training Comparisons

Though subjects were assigned to groups in a randomized manner, it seemed important to establish that the groups were similar in their body weight and 1RM in the bench press test scores at the pre-training test period. In addition, several other pre-training comparisons were made between the groups.

Table 1 reveals the average scores for a variety of parameters. It also indicates the t and probability (p) values for each comparison.

By far of greatest interest in this study was the 1RM bench press score and the bench press strength/body weight (S/BW) ratio values. Though Group E was slightly heavier (7.56 pounds) and bench pressed slightly more (2.99 pounds) than Group T, and Group T had a S/BW ratio that was slightly above (.03 units) those recorded by Group E, none of the
differences were statistically significant at the .05 level of confidence. In other words, the groups were similar to each other during the pre-test period for these variables. Though both groups were similar, it is important to note that their S/BW ratios were above 1.00, a necessary admission criteria for the subjects in this study.

Table 1

Pre-Training Comparisons between Group T and Group E

<table>
<thead>
<tr>
<th>Parameter (mean)</th>
<th>Group T</th>
<th>Group E</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press (lbs)</td>
<td>203.12 ±45.7</td>
<td>206.11 ±36.5</td>
<td>-.15</td>
<td>.44</td>
</tr>
<tr>
<td>Body Weight (lbs)</td>
<td>170.00 ±19.5</td>
<td>177.56 ±18.6</td>
<td>-.83</td>
<td>.21</td>
</tr>
<tr>
<td>S/BW (ratio units)</td>
<td>1.19 ± 0.2</td>
<td>1.16 ± 0.1</td>
<td>.41</td>
<td>.34</td>
</tr>
<tr>
<td>Chest Girth (cm)</td>
<td>94.10 ± 5.0</td>
<td>97.10 ± 3.5</td>
<td>-1.43</td>
<td>.17</td>
</tr>
<tr>
<td>Upper Arm Girth (cm)</td>
<td>35.00 ± 2.9</td>
<td>34.80 ± 2.0</td>
<td>.03</td>
<td>.97</td>
</tr>
<tr>
<td>Body Fat Percentage</td>
<td>12.00 ± 2.0</td>
<td>10.80 ± 3.0</td>
<td>.93</td>
<td>.37</td>
</tr>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>125.25 ± 7.1</td>
<td>127.56 ±10.6</td>
<td>-.52</td>
<td>.61</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>83.25 ± 3.9</td>
<td>81.11 ± 4.9</td>
<td>.99</td>
<td>.34</td>
</tr>
</tbody>
</table>

Table 1 also illustrates that there were no statistically significant differences between the other parameters measured during the pre-training testing. The body fat percentage, girths, and blood pressures were all within an acceptable range for weight training college age males.
Post-Training Comparisons

Having established that the groups were initially similar, the next question to be answered relates to what changes may have taken place during the seven week (21 session) training cycle.

Within Groups Comparison - Group T

Looking Table 2, one can see that Group T remained almost unchanged in all parameters following the seven week training cycle. The difference between pre and post-training test scores were not statistically significant at the .05 level of confidence, in any of the parameters. Although a statistically significantly difference was not found in pre and post-training 1RM bench press test scores, the subjects did increase by an average value of 4.38 pounds. Also, the arm girth measurement did increase. These two differences were close to being statistically significant (.0875 and .0687). A possible reason for the lack of statistical significance is the relatively low subject number.
Table 2

**Group T: Pre and Post-Training Comparison**

<table>
<thead>
<tr>
<th>Parameter (mean)</th>
<th>Pre-training</th>
<th>Post-training</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press (lbs)</td>
<td>203.12 ± 45.7</td>
<td>207.50 ± 46.7</td>
<td>1.99</td>
<td>.09</td>
</tr>
<tr>
<td>Body Weight (lbs)</td>
<td>170.00 ± 19.5</td>
<td>169.80 ± 19.4</td>
<td>-.13</td>
<td>.90</td>
</tr>
<tr>
<td>S/BW (ratio units)</td>
<td>1.19 ± .2</td>
<td>1.22 ± .2</td>
<td>1.72</td>
<td>.13</td>
</tr>
<tr>
<td>Chest Girth (cm)</td>
<td>94.10 ± 5.0</td>
<td>94.60 ± 4.4</td>
<td>1.27</td>
<td>.25</td>
</tr>
<tr>
<td>Upper Arm Girth (cm)</td>
<td>35.00 ± 2.9</td>
<td>35.40 ± 2.4</td>
<td>2.15</td>
<td>.07</td>
</tr>
<tr>
<td>Body Fat Percentage</td>
<td>12.00 ± 2.0</td>
<td>12.00 ± 3.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>125.25 ± 7.1</td>
<td>125.25 ± 6.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>83.25 ± 3.9</td>
<td>81.00 ± 1.9</td>
<td>-2.25</td>
<td>.18</td>
</tr>
</tbody>
</table>

**Within Group Comparison - Group E**

Table 3 reveals similar results for pre and post-training comparisons for Group E as were found for Group T, except for the comparisons made between pre and post-training 1RM on the bench press test and the S/BW ratio. The 1RM increased 13.89 pounds and the S/BW ratio increased .1 ratio units. These differences were found to be statistically significant at the .05 level of confidence. The changes in the other parameters were not found to be statistically significant although the change in arm girth was close to being significant (.0727), this could be due to the relatively low subject number.
Table 3

Group E: Pre and Post-Training Comparisons

<table>
<thead>
<tr>
<th>Parameters (mean)</th>
<th>Pre-Training</th>
<th>Post-Training</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press (lbs)</td>
<td>206.11 ±36.5</td>
<td>220.00 ±34.2</td>
<td>10.00</td>
<td>.0001</td>
</tr>
<tr>
<td>Body Weight (lbs)</td>
<td>177.56 ±18.6</td>
<td>174.60 ±17.0</td>
<td>1.97</td>
<td>.0844</td>
</tr>
<tr>
<td>S/BW (ratio units)</td>
<td>1.16 ± .1</td>
<td>1.26 ± .1</td>
<td>12.66</td>
<td>.0001</td>
</tr>
<tr>
<td>Chest Girth (cm)</td>
<td>97.10 ± 3.5</td>
<td>97.20 ± 2.8</td>
<td>.28</td>
<td>.7840</td>
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<tr>
<td>Upper Arm Girth (cm)</td>
<td>34.80 ± 2.0</td>
<td>35.20 ± 2.2</td>
<td>2.07</td>
<td>.0727</td>
</tr>
<tr>
<td>Body Fat Percentage</td>
<td>10.80 ± .0</td>
<td>10.80 ± .0</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Systolic BP (mm Hg)</td>
<td>127.56 ±10.6</td>
<td>126.67 ± 9.5</td>
<td>-1.00</td>
<td>.3466</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>81.11 ± 4.9</td>
<td>81.11 ± 5.5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Between Groups Comparisons - Group T vs. Group E

Since both groups were initially similar for all of the parameters investigated, it is interesting to observe if the groups differed in their responses to their respective training cycles. Table 4 reveals the gain or losses for Group T compared to Group E.

The major focus of this study was the change in 1RM on the bench press test for groups T and E. Table 4 shows that Group E gained significantly more strength during the seven week training cycle than did Group T. The significance of this finding is that experimental training program appears to be more beneficial, to individuals with above average strength, than the traditional program.
Table 4

Pre and Post-Training Differences Between Groups T and E

<table>
<thead>
<tr>
<th>Parameter (mean)</th>
<th>Group T</th>
<th>Group E</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press (lbs)</td>
<td>4.38 ±6.2</td>
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<td>Body Weight (lbs)</td>
<td>-20 ±2.7</td>
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<td>1.54</td>
<td>.145</td>
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<tr>
<td>S/BW (ratio units)</td>
<td>.03 ± .05</td>
<td>.10 ± .02</td>
<td>3.06</td>
<td>.001</td>
</tr>
<tr>
<td>Chest Girth (cm)</td>
<td>.50 ±1.2</td>
<td>.10 ±1.1</td>
<td>.80</td>
<td>.436</td>
</tr>
<tr>
<td>Upper Arm Girth (cm)</td>
<td>.40 ± .6</td>
<td>.40 ± .4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Body Fat Percentage</td>
<td>0.00 ± .01</td>
<td>0.00 ± .0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>0.00 ±1.9</td>
<td>-.89 ±2.7</td>
<td>.79</td>
<td>.443</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>2.25 ±3.5</td>
<td>0.00 ±3.2</td>
<td>-1.40</td>
<td>.181</td>
</tr>
</tbody>
</table>

It is also interesting to view the other parameters of the study. The change in body weights, girth measurements, and body fat percentages were not statistically different between the groups. It would appear from these scores that the two training programs did not affect these parameters differently.

Discussion of Findings

After the seven week training program, a statistically significant difference was seen in change in 1RM on the bench press test. Group E gained an average of 13.89 pounds, while
Group T gained only an average of 4.38 pounds. This finding allows the research hypothesis to be accepted. Training with the experimental training program did indeed produce greater strength gains than did the more traditional training program.

Accepting the research hypothesis indicates that individuals with above average strength need to train differently than the traditional methods of resistance training, in order to produce maximal strength gains. Research has been done on the optimal set/repetition range for the beginning weight trainer. The results of this study would appear to indicate that individuals who have above average strength levels should train differently than the beginning weight lifter. The decreased number of heavy lifting may allow the subjects to more fully recover between heavy training sessions and therefore gain more strength.

It is puzzling to observe the insignificant changes in body weight, girth measurements, and body fat percentage. Research has shown that most of the strength gains found later in training programs are the result of muscle hypertrophy and not neural adaptations. With no significant increase in these three parameters, it might be inferred that there was no muscle mass gain. This may have been due to the relatively short training cycle or the low number of subjects involved in the study. Another possible cause in the strength gains could be the result of another adaptation of the body to resistance training. This adaptation could be one of the many
neuromuscular adaptations produced by resistance training.

Of late, researchers have raised questions about the blood pressure response to resistance training. Results of this study showed no statistically significant change in resting blood pressure for previously trained subjects following seven weeks of resistance training.
CHAPTER V

SUMMARY

The purpose of this study was to determine if college age males with above average strength in the bench press exercise (S/BW > 1.0) would improve their 1RM more by resistance training using an experimental training program than a program of a more traditional nature. The seventeen male volunteers followed a resistance training program for seven weeks.

The subjects were alternately assigned to either the traditional training group (Group T) or the experimental training group (Group E). Both groups trained three alternate days per week using the bench press, dumbbell military press, lat pulldown, bicep curl, lying tricep curl, and leg press exercises each training session. Group T performed three sets of six repetitions at their 6RM for all six exercises every session. Group E performed one heavy day and two light days. On their heavy day, Group E performed three sets of six repetitions at their 6RM. On the two light days, they performed three sets of six repetitions using 75 percent of the weight used on the heavy day. Both groups were required to add five pounds to the barbell when they could successfully complete all three sets of six using their 6RM.

Prior to the seven weeks of training, and directly after these seven weeks, the subjects were tested in the Human
Performance Laboratory at Eastern Illinois University. The pre and post-training tests consisted of measuring the body weight, 1RM on the bench press test, strength to body weight ratio, selected girth measurements, body fat percentage, and blood pressure of the subjects' changes (increase or decrease). The differences in the six variables, between Group T and Group E, were calculated after the post-training tests were completed. Independent t tests were used to determine if the differences between the changes for the two groups were significant. The level of confidence was set at .05.

There was a statistically significant difference in the range in 1RM on the bench press test and the S/BW between Group E and Group T. The gains made by Group E were significantly greater than the ones made by Group T. There was no significant change in any of the other variables for either group.

Conclusion

This study reveals that individuals with above average strength, will benefit by deviating from the traditional program of resistance training. The improvements in bench press 1RM and S/BW can be accounted for by the increased amount of time between maximal training sessions, thus giving the muscles additional time to recover and adapt to the new loads.
Recommendations for Further Study

As the review of literature reveals, there is little research on resistance training methods for the individual with above average strength or the experienced weight lifter. Therefore, this population warrants further study. Also, the experimental training program suggested in this study needs to be investigated more thoroughly. The following recommendations are based on the results and experiences gained from this study.

1) A similar study should be conducted for a longer period of time and with more subjects.
2) A similar study should be conducted in which all of the training sessions were monitored to ensure exact subject compliance.
3) A study should be conducted using different percentages of the subjects 6RM for the light days to determine the optimal load intensity for the submaximal training.
4) Further study must be done on the exact process of repair and recovery after a resistance training session to discover exactly how long the process takes to be completed.
REFERENCES


APPENDIX A

Data Collection Sheet

Name

Age ______  Height (in) ______  Weight (lbs) ______

Skin Folds (mm)

<table>
<thead>
<tr>
<th>Triceps</th>
<th>Biceps</th>
<th>Chest</th>
<th>Subscapular</th>
</tr>
</thead>
<tbody>
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<td>______</td>
<td>______</td>
<td></td>
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<table>
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<tr>
<th>Abdominal</th>
<th>Thigh</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td>______</td>
</tr>
</tbody>
</table>

Resting Blood Pressure (mm Hg) ______

Girth Measurements (cm)

| Chest R. Arm R. Thigh Abdominal |
|---|---|---|---|
| ______ | ______ | ______ | ______|

Past Weight Training Experience

Years of weight training experience ______

Age started weight training ______

Do you feel you are an experienced weight lifter?  Y  N

Current Weight Training Experience

Are you currently involved in a weight training routine?  Y  N

How many consecutive weeks have you been weight training ______

How many days per week are you lifting? ______

Bench Press Testing

<table>
<thead>
<tr>
<th>hand spacing (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
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<table>
<thead>
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<tbody>
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<table>
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<table>
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<th>Trial 4</th>
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</thead>
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APPENDIX B

Pre and Post-Training Skinfold Measurements (nearest mm)

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<th>Subject</th>
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<th>Chest</th>
<th>Subscap</th>
<th>Ab</th>
<th>Thigh</th>
</tr>
</thead>
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<td>5</td>
<td>5</td>
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**APPENDIX C**

**Pre and Post-Training Girth Measurements (nearest .1 cm)**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Group</th>
<th>Chest (cm)</th>
<th>Arm (cm)</th>
<th>Thigh (cm)</th>
<th>Ab (cm)</th>
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<td>55.3</td>
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</table>
## APPENDIX D

**Pre and Post-Training Body Fat % and Blood Pressure**

<table>
<thead>
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<th>Group</th>
<th>Body Fat %</th>
<th>Blood Pressure</th>
</tr>
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</tr>
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### APPENDIX E

**Pre and Post-Training Body Weight, Bench Press 1RM and S/BW**

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APPENDIX F

Informed Consent

The study that you have volunteered to take part in involves weight training. The training cycle will involve weight training three days per week for seven weeks. The entire body will be exercised each training session. Each training session will require approximately 45 minutes.

Prior to the training cycle, you will be tested on your maximum bench press. You will also be tested at the end of the training cycle.

Weight training also has a few risks. These include a temporary increase in blood pressure and potential muscle/tendon injuries.

You, as a subject, are a volunteer. This means that if you at any time you want to stop participating in the study you can. This is your right and privilege.

Also I will be available at any time to answer any questions that might arise during your training program. My telephone number is 348-1871.

By signing this consent form, you are stating that you have read the above information and understand the risks, benefits, and general procedures of this study. You also agree to abide all the stipulations of the study.