COMPARISON OF 30 AND 60 SECOND REST PERIODS BETWEEN SETS OF A RESISTANCE TRAINING PROGRAM

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CHAPTER I

INTRODUCTION

The concept of resistance training has been around for quite some time, but it was not until the early studies of DeLorme and Watkins (1948) that weight training for strength purposes had really been researched. Many of the early studies dealt primarily with males and the effect of resistance exercise training on their strength. The long and short-term effects of training in men are well documented, but the effects on the female physique are less familiar (Oyster, 1979). Comparisons of training effects between the sexes have for the most part been reported in studies dealing exclusively with men or women (Masicotte, Avon & Corriveau, 1979). In most cases the frequency, intensity, and type of training differed from one another. How women respond to physical training compared to males is important considering the rise of women in jobs that require considerable physical exertion (Knapik, Wright, Kowal & Vogel, 1980). By better preparing individuals to handle the demands of daily living, reaching greater levels of muscular fitness can have a critical impact on quality of life (Peterson, Bryant & Peterson, 1995). More women have accepted strength training as an essential component of any functional conditioning program (Peterson et al., 1995).

Since women have a tendency not to engage in physical activities that involve the upper body, they are unlikely to develop their maximal strength potential (Sidney & Jette, 1992). Women have a lower level of muscular strength especially in the upper body (Laubach, 1976).

There has been little research in the way of effectiveness of rest periods in strength-training. Reed-Hardison (1998) conducted a study involving both men and women comparing rest periods of 30 and 90 seconds. In this study, it was found that rest periods less that 90 seconds would be better for strength development. Due to this insight and that there is less research on women than men, it is apparent that there is a need for further research and information on the effectiveness of rest periods between sets in strength training on women.

Statement of the Problem

The purpose of this study was to investigate the effect of two different rest periods between sets in strength training on muscular strength of upper body, lower body, and percent body fat, among women 25-35 years of age participating in a 12 week resistance training program.

Hypotheses

The hypotheses for this study are as follows:

1) There will be no significant group, time, or group by time upper body strength differences for participants in this study.
2) There will be no significant group, time, or group by time leg strength differences for participants in this study.
3) There will be no significant group, time, or group by time body fat percentage differences for participants in this study.

Limitations

The following limitations apply:

1) Subjects were not chosen randomly
2) There were only to be 16 females in this study.
3) Computerized equipment was not available to test strength.

Delimitations

The following delimitations apply:

1) Other than verbal instructions not to alter their diet, no attempt was made to control subjects' diets.
2) Other than verbal instruction not to engage in exercise/activity that could enhance muscular strength, no attempt was made to control subjects' extracurricular activities involving exercise.
3) Only two (30 and 60 second) rest periods between sets were examined in this study.
4) Strengths were measured using 1 RM testing.
5) Subjects were not tested for ergogenic aids.

Assumptions

The following assumptions were made:

1) Individuals did not participate in any extracurricular physical activity, which affected training or training results.
2) Subjects did not ingest any drugs or other ergogenic aids that affected the outcome of this study.

3) All subjects gave maximal efforts in response to the strength tests.

Definitions

Agonist – the muscle most directly involved in bringing about a movement.

Antagonist – a muscle that can slow down or stop the movement.

Anthropometry – the measurements of the size including height, weight, and proportions (including overall girth and limb girths) of the human body.

Body Fat Percentage (Body Composition) – refers to the relative proportions by weight of body fat and lean mass.

Body Mass Index – the number of kilograms of body weight per unit of surface area.

Concentric Muscle Action – when the total tension developed in all the cross-bridges of a muscle is sufficient to overcome any resistance to shortening.

Delimitation – refers to the scope of the study. Delimitations spell out the population studied and include those things the researcher can control.

Eccentric Muscle Action – when the total tension developed in the cross-bridges is less than the resistance, and the muscle lengthens.

Intensity – the power output of an exercise.

Limitation – refers to the weaknesses of the study. Limitations are things the researcher could not control, but may have influenced the results of the study.

Muscular Strength – the maximal force that a muscle or muscle group can generate at a specified velocity.

One Repetition Maximum (1RM) – the maximum amount of weight a person can lift one time.

Overtraining Syndrome –sometimes referred to as "staleness". Can, but does not always include a plateau or decrease in performance.

Periodization -- the gradual cycling of specificity, intensity, and volume of training to achieve peak levels of fitness.

Ponderal Index – a table used to determine the third component of somatotype. The Ponderal Index = Ht. / $\sqrt[3]{\text{Wt.}}$

Repetitions – the number of times a specific movement is repeated.

Resistance Training – uses of activity intervals and rest periods to develop the body's energy systems for repeated and high-power output demands.

Set – a particular number of repetitions.

Skinfold – a fold of skin measured with calipers at various body sites. By measuring a skinfold thickness, the total percentage of body fat can be calculated.

Somatotype –the body type or physical classification of the body. The terms endomorph, mesomorph, and ectomorph are used to describe a person in terms of his or her somatotype.

Endomorph – rounder and more pear-shaped.

Endomorphic mesomorph – the second component is greater than the third component.

Mesomorph – muscular, broad shoulders, a thick chest, and a narrow waist.

Ectomorph – slender, tall, and more angular.

Two-Way Analysis of Variance (ANOVA) – a statistical method for examining data. It is used to test several hypotheses about differences between means in the factorial design.

CHAPTER II

LITERATURE REVIEW

Introduction

DeLorme and Watkins' (1948) research contradicted initial publications concerning resistance training where 70 to 100 repetitions were suggested for muscular strength gains. Their knowledge showed these figures to be too high, and instead a total of 20 to 30 repetitions broken down into three sets showed better response. DeLorme and Watkins (1948) demonstrated that fewer repetitions with less resistance produced greater strength gains, where higher repetitions with less resistance showed greater endurance gains.

Very little information concerning the length of rest periods between sets and its influence in strength or endurance response is published. Studies showing the utilization of rest periods such as 30 and 90 seconds were considered (Gettman, Ayres, Pollock & Jackson, 1978, Rooney, Herbert & Balnave, 1994). There is limited experimental evidence that show the length of rest periods that would optimize strength responses. Combined information using similar variables playing important roles in resistance training was considered.

Rest Periods Between Sets

Fleck and Kraemer (1987) state that recovery between sets of exercises and sessions are important factors in weight training. Rest periods between sets of exercise are in large part decided by the goals of the training program. If a program's goal is to increase the ability to produce maximal strength, relatively long rest periods and heavy

resistance should be utilized. When the goal is to increase the performance of high-intensity exercises, rest periods between sets should be less than one minute. If improvement of long-term endurance is the goal, the shorter rest periods and lighter resistance is prescribed (Fleck & Kraemer, 1987). In their Super Pump System, 15 seconds rest between sets of five to six repetitions appears to create greater muscular hypertrophy. Reed-Hardison (1998) compared 30- and 90-second rest periods. This study found that less than 90 seconds rest would be better for strength development.

Newby-Fraser and Mora (1995) stated that resting for 30 seconds to 1 minute between sets is fine, but if one is performing a particularly intense workout, a 2- to 4-minute rest period between sets may be needed. During a circuit training exercise session, little or no rest should be taken between exercise stations being that there is one set per station (Peterson et al., 1995).

Rest Periods Between Repetitions

Fleck and Kraemer's (1987) book Designing Resistance Training Programs included the only information directly relating to rest periods in weight training. They state in the Rest-Pause System that using near-maximal resistance for multiple repetitions with 10-15 seconds rest between repetitions will create the greatest possible strength gains.

Rooney, Herbert and Balnave (1994) conducted a study that showed subjects who trained by repeatedly lifting the set training weight without resting experienced significantly greater increases in strength than those subjects who trained with rest between lifts did. The data in this study states that the strength increases associated with the short-term strength-training program is greater if subjects have no rest between

contractions. This shows that processes associated with fatigue add to the stimulus by which training increases muscular strength.

Women and Weight Training

Resistance training programs are widely studied and researched on the effects of muscle mass in the male physique, but less is known for the female physique. Peak fitness is growing in popularity, particularly among women, which is why there is a need for up-to-date and specific fitness information for women (Newby-Fraser & Mora, 1995).

Nieman (1990) states that men and women experience similar relative strength gains when training with the same program, but there appears to be less muscle hypertrophy and associated strength among women. A study performed by Pardee and Eisenmann (1988) studied college-age women in a resistive exercise program determined that although a significant gain in muscular strength in the lower extremities was found, there was not a significant gain in upper body strength. Oyster (1979) also conducted a heavy resistance-training program using college female athletes. This study resulted in significant gains in leg and shoulder strength, but not in elbow extensions and flexion strength.

Newby-Fraser and Mora(1995) says how strength and increasing the energy output and efficiency of the muscles will help one achieve peak fitness and reach true potential. Laubach (1976) reviewed nine reports comparing the absolute muscle strength of men and women. In the combined data from these studies, he found that the upper extremity strength of females was estimated to be 56%, lower extremity strength 72%, and trunk strength 64% that of males. Knapik, Wright, Kowal and Vogel (1980) performed a study comparing the muscular strength of men and women before and after

completing U.S. Army Basic Initial Training. The above values in this study before basic training were 57%, 65%, and 66% respectively. They found that following basic training; the above values changed to 60%, 67%, and 72% respectively. This shows that basic training brought the strength of the females closer to that of the males.

Although strength can be derived from a balanced cross-training program, performing aerobic training exclusively yields limited results. Cross-training in different cardiovascular activities can produce sufficient muscular strength, it is difficult to attain good balance using a completely multi-sport approach (Newby-Fraser & Mora, 1995).

The practical benefits of strength training are not limited to athletes or competitors. Improving muscle strength can make lifting or carrying heavy materials at home or on the job less strenuous (Peterson et al., 1995). Also, resistance training can act as an important role in enabling women of all ages to preserve a physically active and relatively challenging lifestyle.

Circuit Training

The goal of circuit training is to simultaneously improve aerobic fitness as well as muscular strength and endurance (Peterson et al., 1995). It is stated by Peterson, Bryant and Peterson (1995) that circuit training programs have an average of 6 to 15 strength training station per circuit and the circuit is repeated 2 or 3 times. Generally, the stations are arranged to exercise different muscle groups in successive stations, allowing each muscle group time to recover (Gettman et al., 1978). The stations also are arranged close to one another so one can work from one station to the next in an orderly manner.

Nieman (1990) states that during a circuit program one must perform a series of resistance training exercises one after the other with a rest of 15-30 seconds between

exercises. Also that approximately 10-15 repetitions per exercise are performed each circuit at a resistance of 40-60% RM. This type of program is time efficient when training large groups of people or when one does not have a lot of training time (Fleck & Kraemer, 1987).

A study performed by Kauranen, Siira and Vanharanta (1998) utilized a 10-week circuit-training program with free weights as resistance. This program was directed at increasing the strength of the muscles of the upper extremities. The subjects performed three sets per training station with 30 seconds rest between sets. The results of muscle strength tests showed that all measured isometric muscle strengths were increased during the training period. The mean amplitude of m biceps increased by 19% and the m triceps increased by 29%.

Periodization

Periodization can be defined as systematic changes in the resistance, number of sets, and/or number of repetitions performed during a continuous weight-training program (DeVries & Housh, 1994). What this means is that it is beneficial to vary the weight training protocol periodically for optimal strength gains, in part by minimizing boredom and enhancing program adherence (National Strength and Conditioning Association [NSCA], 1990). The National Strength and Conditioning Association states that the basic pattern of periodization involves starting with a low-intensity (resistance) and high-volume (number of sets *x* repetitions *x* resistance) training during the preparation phase early in the season and then shifting to a high-intensity and low-volume training during the competition phase late in the season.

Fleck and Kraemer (1987) describe the cycles of periodization. The longest period of time is the macrocycle (about 1 year), which is broken down into three or four periods called the mesocycles (3 to 4 months), which can be broken down even further into a microcycle (usually about 1 to 4 weeks). Each training phase has a particular goal and is an essential part of the training program.

The concept of periodization can minimize the possibility of overtraining syndrome by appropriately manipulating the training variables of volume, intensity, and exercise selection (Stone, 1981). Studies and reviews suggest that high force, high velocity, movement-specific training, properly integrated into a training program, is necessary to produce superior gains in strength/power performance-oriented sports (Deschenes, 1989, Sale, 1988).

Super Sets

Super setting involves alternating agonist and antagonist muscles of a joint with minimal rest between exercises, with examples of bicep curls and tricep extensions, and leg extensions and leg curls (Baechle, 1994).

Fleck and Kraemer (1987) use two different types of super setting programs. One program uses several sets of agonist and antagonist muscles for one body part, for example bicep curls and tricep extensions. The other consists of using one set of several exercises in rapid succession for the same muscle group or body part, for example one set of each of lat. pulldowns, seated rows, and bent-over rows. Both types utilize 8-10 repetitions with little or no rest between sets and exercises. They also state that super setting appears to increase both muscular hypertrophy and local muscular endurance.

One study shows that a training program that couples concentric and eccentric muscle actions of the same submaximal force results in a greater or no different gain in strength than training with concentric muscle actions (O' Hagan, Sale, MacDougall & Garner, 1995). Also the greater effectiveness of coupled eccentric and concentric training has been attributed to greater muscle hypertrophy.

Body Mass Indices

Wilmore (1974) conducted a study involving 73 men and women participating in a 10-week weight-training program. Anthropometric measurements were taken at the beginning and at the end of the study. Harpendon skinfold calipers were used to measure body composition, an anthropometer for diameters, and a Gulick cloth tape for girths. Significant gains were found both in the diameters and girths.

Pardee and Eisenmann (1988) conducted a study where 40 university female students performed a resistance training program four days a week alternating weight training and interval work consisting of jumping and sprinting intervals. The subjects underwent somatotyping using the Heath-Carter method and skinfold analysis. The results showed significant decreases in skinfolds with training.

Summary

Recovery between sets during a resistance-training program are determined by the goals of the program (Fleck & Kraemer, 1987, Newby-Fraser & Mora, 1995, Rooney at al., 1994). The literature states that higher intensity strength workouts should yield longer rest periods, and endurance building programs should yield shorter rest periods (Fleck & Kraemer, 1987, Newby-Fraser & Mora, 1995). The components that make up a

training program are largely dependent upon the goals of the program. The benefits of strength training are not limited to athletes or competitors, the general population can benefit from resistance training programs for stress relief, percent body fat loss, mobility, and/or increase in flexibility (Peterson et al., 1995, Pardee & Eisenmann, 1988).

There is a substantial need for further investigation on the effectiveness and length of rest periods between sets in resistance training. Several variables including rest periods between sets, rest between contractions, women and weight training, circuit training, periodization training, super setting, and somatotype studies were researched to combine data.

In addition, other studies were noted in order to obtain information concerning the length if the training program and what other factors to gather – body composition, somatotype, and strength measurements. Other components implemented were the two-week pretest conditioning period, the frequency of the weight training sessions, and which exercises were to be completed during each session.

Finally, studies on women and weight training were also examined to view the strength gains that can be achieved during an exercise training program. Because of structural and hormonal differences between the sexes, it is doubtful that females can ever reach the same level of absolute strength as the males.

This study will attempt to add to the existing body of knowledge of rest periods between sets in resistance training and their effect in strength of women in the 25- to 35-year-old age group.

CHAPTER III

METHODS AND PROCEDURES

The purpose of this study was to investigate the effect of two different rest periods between sets on muscular strength and selected body mass indices among women ages 25-35 participating in a 12-week resistance training program. Each subject reviewed and signed an informed consent form. In order for this study to be completed fairly, all 16 test were administered as identically as possible to insure the best possible test validity. The Oklahoma State University Institutional Review Board has reviewed and approved this study (Appendix H).

Subject Selection

A total of 16 women volunteered to participate in this study. All subjects read and signed a PAR-Q Form (Appendix A). Subjects were between the ages of 25 and 35 years of age at the time of testing, and all subjects were apparently healthy.

Test Protocol/Data Collection

The subjects were tested at Exercise Specialist of Tulsa in Tulsa, Oklahoma. The subjects were divided into two experimental groups by somatotype. One group rested for 30 seconds between sets and the other group rested for 60 seconds between sets. The groups were divided equally according to strength and somatotype. Endomorph, mesomorph, and ectomorph were the terms describing the subject in terms of her somatotype. Sheldon (1954) describes each classification.

Endomorphy

Rounder, softer, and more pear-shaped bodies typically characterize the endomorph. Features of this type are predominance of the abdomen over the thorax, high square shoulders, and a shorter neck.

To determine this variable, the somatotype rating form is used (Appendix B). See Appendix C for instructions on how to determine this component.

Mesomorphy

The mesomorph is typically characterized by muscular, broad-shoulders, a thick chest, and a narrow waist. The bones are large and covered with thick muscle. Prominent characteristic of this type are forearm thickness, heavy wrists, hands, and fingers. The thorax is large and the waist is relatively slender. Many athletes have a large degree of this component.

The somatotype rating form is used in this variable as well. See Appendix D to determine this variable.

Ectomorphy

The ectomorph is described as slender, tall, and more angular. The bones are small and the muscles thin. Shoulder droop is seen consistently in the ectomorph. The limbs are relatively long and the trunk short. The abdomen and the lumbar curve are flat. The shoulders are mostly narrow and lacking in muscle relief. There is no bulging of muscle at any point in the physique.

Computing the Ponderal Index, which is stated in Appendices E and F attains this final variable.

As stated by Sheldon (1954) a pure type does not exist, each person is made up of all three components. Sheldon's research involved men mostly, but Heath and Carter (1967) contributed to the area of somatotyping for males and females by creating a method to calculate each variable.

Body Weight

To determine body weight, subjects were weighed on a Health-O-Meter physician's balance scale. The subjects wore a tee shirt, shorts, and socks.

Body Composition

Body Composition was taken at the beginning and at the end of the study using the Jackson and Pollock (1985) seven-site method.

Training Program

The subjects began the program with a two-week pre-conditioning period as suggested by O'Shea and Wegner (1981). These training sessions were performed on Mondays, Wednesdays, and Fridays. This preconditioning program consisted of their given workout, but with a light resistance to learn and insure proper form. This time was used to familiarize subjects with the testing and training procedures followed during the experimental period. Subjects were also instructed on correct lifting techniques and how to maximally apply force prior to being tested. As stated in the International Powerlifting Federation Rules Book (1979), the correct technique for bench press requires the lifter to lower the bar from an arms extended position to the chest, and with a slight pause and no heave, return the bar to the starting position. The squat begins at a standing position. The lifter then slowly bends the knees and lowers to a position where the tops of the thighs are parallel with the floor. The lifter then pauses briefly and drives the hip

extensors and thigh back to starting position. In this study, the leg press was used instead of the squat for safety measures, but the same technique was applied.

During this two-week preconditioning phase, the training intensity was moderate, and the repetitions were set between ten and twelve for three sets per exercise. Once the subject felt comfortable with 10 repetitions at a set weight, the repetitions were then increased to twelve before increasing the weight and decreasing the repetitions back to ten per set. The subjects worked out three times per week, and were closely supervised at all times. Correct lifting was emphasized. No one was permitted to attempt a one-repetition maximum lift at any time during this phase.

Strength tests were measured on all subjects on the first Monday following the two-week pre-conditioning phase and again at the end of the training period.

Training Period

For the ten weeks following the pre-conditioning period, the experimental subjects participated in a strength-training program three times per week under supervision at St. John Siegfried Health Club. The training format for the two experimental groups was identical. After five minutes of warm-up exercises, each subject completed three sets of the following exercises: horizontal leg press, leg extension, leg curl, bench press, incline chest press, front lat pulldown, rear row adduction, tricep extension, and bicep curls (Figures 1, 2, 3, 4, 5, 6, 7, 8, and 9). All exercises except the bench press and incline chest press were performed on weight stack machines. The bench press was performed using the standard 45-pound bar and rack. The incline chest press was performed using dumbbells. These exercises consisted of 10-12 repetitions per set. The subject was instructed to add weight as necessary to limit 12

repetitions per set with effort. Once the subject could perform 12 repetitions, the general rule was to add 5 pounds per upper body exercise and 10 pounds per lower body exercise and proceed to drop the number of repetitions back to ten. Each subject was encouraged to put maximal effort into each set. Subjects kept records of each training period throughout the ten-week training period, which included the exercises, sets, weight lifted, and number of repetitions completed (Appendix G).

The subjects were instructed not to do resistance training outside the given program. The subjects were also instructed to allow at least one and no more than two full days of rest between exercise bouts. Other than the preceding verbal instructions, subjects were not monitored for diet or extracurricular activities.

The training period of this study ran from April 1999 to July 1999.

Pre and Post Strength Measures

After the two-week pre-conditioning period, the subjects were tested for strength on the bench press and leg press by a one repetition maximum lift on the first Monday following the two-week period. In a study by O'Shea and Wegner (1981), the predicted 1 RM was determined by adding 25% to the weight each subject could lift for eight to ten repetitions. This basis allowed a projected 1 RM in both lifts for each subject.

Using this number as a guide, the subjects warmed up by performing eight repetitions with 60% of their target lift, three repetitions with 75%, one repetition with 90%, and then the target 1 RM was attempted. When the subject successfully lifted the target 1 RM, the load was then increased by 5 pounds for the bench press and 10 pounds for the leg press, and then another attempt was made. No subject had more than three 1 RM attempts.

Analysis of Data

All experimental variables were analyzed for group, time, and group by time interaction using a two-way analysis of variance (ANOVA) with .05 as the significance level. The reason for using the two-way ANOVA was to compare mean score from the groups in a factorial design in order to decide whether the differences between the means were due to chance levels of one variable paired with certain levels of other variables.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

A total of 16 volunteer female subjects with a mean age of 28.6 years were tested on a 1 RM bench and leg press and percent body fat. There were eight subjects in the 30-second rest group and eight subjects in the 60-second rest group. The subjects were divided by somatotype to insure, as closely as possible, an equal dispersion of numbers, body somatotype, and beginning strength, by group. The 30-second group contained two endomorphic-mesomorphic subjects and six mesomorphic subjects. The 60-second rest group contained two endomorphic-mesomorphic subjects and six mesomorphic subjects as well.

Results

Descriptive Statistics

The 30-second experimental group consisted of women with an average height of 65.3 inches, average weight of 136.4 pounds, and average body fat percentage of 22.54%. This group contained 2 endo-mesomorphs and 6 mesomorphs.

The 60-second experimental group consisted of women with an average height of 65.5 inches, average weight of 148 pounds, and average body fat percentage of 22.75%. This group also contained 2 endo-mesomorphs and 6 mesomorphs.

Descriptive statistic results for subjects are contained in Table 1.

Inferential Statistics

Results were analyzed using a 2 x 2 ANOVA. The priori alpha of significance was set at .05.

Inferential statistic results for subjects are contained in Tables 3-5. Results are presented below.

Upper Body Strength. There were no significant differences ($p < .05$) in the group and group by time interactions in the 1 RM bench press results among the groups. There were, however, differences in time interactions. The differences in time were that the ending 1 RM bench press results were greater than the beginning scores (Table 2).

Leg Strength. There were no differences in the group and group by time interactions in the 1 RM leg press results among the groups. There were differences in time interactions. The differences in time were that the ending 1 RM leg press results were greater than the beginning scores (Table 3).

Percent Body Fat. There were no significant differences ($p < .05$) in the group and group by time interactions in the percent body fat results among the groups. There were differences in time interactions. The differences in time were that the ending percent body fat was less than the beginning (Table 4).

Discussion

Since there were significant differences observed in the time interaction for the upper body strength, this suggests that a 12-week resistance-training program will have a positive effect on upper body strength whether the subjects rest 30 seconds or 60 seconds between sets. The fact that neither comparison of groups or groups by time interactions

were not significant indicates that one will gain strength in the upper body whether one rests 30 or 60 seconds between sets of exercise.

Both experimental groups experienced an increase in leg strength in pre and post testing over the course of the 12-week resistance regimen. Neither group, however, experienced any significant gains between the 30- and 60-second group comparison nor the combination of the groups compared with the time factor. This indicates that one will increase leg strength over the course of a 12-week strength-training program, regardless if one rests either 30 or 60 seconds between sets of exercise.

Both groups from pre to post test lost a significant amount of body fat over the course of the 12-week strength-training program. There was not enough loss in body fat percentage from pre to post testing to be significant between the 30- and 60-second experimental groups or in the comparison of the groups by time component. This suggests that a 12-week training program will result in loss of body fat percentage despite whether one rests 30 or 60 seconds between sets.

Fleck and Kraemer (1987) state that if the goal of the program is to increase strength, longer rest periods and heavier resistances should be utilized. They also state that in order to create greater muscular hypertrophy, the rest periods should be about 15 seconds in length. Rooney, Herbert and Balnave(1994) performed a study that proved strength increases would be greater if subjects had no rest between contractions during a short-term strength-training program. This could show why both experimental groups increased in upper and lower body strength. The results of this study agreed with the literature in that a rest period under 90 seconds would show an increase in strength (Reed-Hardison, 1998, Kauranen et al., 1998).

Pardee and Eisenmann (1988) stated in their study of 40 university female students performing a resistance training program alternating weight training and interval work resulted in significant decreases of skinfold analysis. This study showed a loss in percent body fat over the 12-week resistance-training period in both experimental groups.

In summary, the findings of this study show that with a 12-week strength-training program, subjects in the 30- and 60-second experimental groups increased in strength from pre to post testing. The subjects also had a significant percent body fat loss over the course of the twelve-week period.

CHAPTER V

SUMMARIES, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The statistical analyses of the data used in this study indicated that there were no significant differences in strength gain between the 30- and 60-second rest period experimental groups. This information could be beneficial to those population groups that would prefer to rest longer between sets during a strength-training routine. Some of these populations would include, but are not limited to older adults, beginning participants in resistance training and some physically limited individuals. The 60-second rest period would give these populations an opportunity to recover and feel more comfortable in their training programs than the 30-second rest period would.

Findings

Upper Body Strength

Although no significant differences ($p < .05$) were found in the 1 RM bench press results among groups, differences ($p < .05$) were found in time interaction. This means that upper body strength was gained in a 12-week resistance-training program, although these rest periods had no effect on the amount of gains made.

Leg Strength

No significant differences ($p < .05$) were found in the 1 RM leg press results among groups, but there were differences ($p < .05$) found in time interactions. This means

that leg strength was gained in a 12-week resistance-training program, although these rest periods had no effect on the amount of gains made.

Percent Body Fat

As stated previously, there were no significant differences ($p < .05$) in percent body fat. Differences ($p < .05$) were seen though in the time effect. The ending percent body fat was less than in the beginning.

Conclusions

The purpose of this study was to investigate the effect of two different rest periods between sets on muscular strength of upper and lower body and percent body fat, among women ages 25-35 years of age participating in a 12-week resistance training program. The results of the two-way ANOVA using .05 as the significance level permit the following findings to be stated:

1. The first hypothesis stated that there would be no significant group, time, or group by time upper body strength differences for participants was partly accepted and partly rejected. The sections dealing with group and group by time were accepted, while the sections dealing with time was rejected.
2. The second hypothesis states that there would be no significant group, time, or group by time leg strength differences for participants was partly accepted and partly rejected. The sections dealing with group and group by time were accepted, while the section dealing with time was rejected.
3. The third hypothesis stated that there would be no significant group, time, and group by time body fat percentage differences for participants was partly accepted

and partly rejected. The sections dealing with group and group by time were accepted and the section dealing with time was rejected.

Recommendations and Limitations

1. It is recommended to further investigate effectiveness of rest periods between sets in resistance training by utilizing various age groups and explore differences between the groups.
2. It is recommended to use a larger sample size and explore the differences between male and female groups using the variables of somatotype, percent body fat, strength, and work.
3. It is recommended to recognize different upper and lower body strength tests and compare results with this investigation for the same sex and age range.
4. It is recommended to identify other variables that would perhaps be affected by a training program and examine its effects under the rest period investigation.

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Table 1

DESCRIPTIVE STATISTIC RESULTS FOR SUBJECTS

Test	30 Second Rest Group Means	SD	60 Second Rest Group Means	SD
Age, years	27.9	3.9	29.3	5.75
Height, inches	65.3	1.5	65.5	2.94
Weight, pounds	136.38	20.3	148	27.7
Bench Pretest	86.9	26.58	87.5	14.14
Bench Posttest	100.6	22.75	95.6	12.37
Leg Pretest	196.3	51.18	184.4	53.55
Leg Posttest	213.3	56.93	213.8	53.7
Body Fat Pretest	23.1	4.92	22.7	6.61
Body Fat Posttest	21.7	4.97	21.3	6.01

Table 2

ANALYSIS OF VARIANCE RESULTS FOR 1 RM BENCH PRESS

Source	SS	df	MS	F	Sig of F
Error	10,598.44	14	757.03		
Group	38.28	1	38.28	0.05	0.825
Time	957.03	1	957.03	30.3	0
Group x Time	63.28	1	63.28	2	0.179
Total	1,058.59		1,058.59	30.55	

Table 3

ANALYSIS OF VARIANCE RESULTS FOR 1 RM LEG PRESS

Source	SS	df	MS	F	Sig of F
Error	79,698.44	14	5,962.75		
Group	1,725.78	1	1,725.78	0.3	0.591
Time	8,288.28	1	8,288.28	73.17	0
Group x Time	63.28	1	63.28	0.56	0.467
Total	10,077.34		10,077.34	74.03	

Table 4

ANALYSIS OF VARIANCE RESULTS FOR PERCENT BODY FAT

Source	SS	df	MS	F	Sig of F
Error	893.66	14	63.83		
Group	1.49	1	1.49	0.02	0.881
Time	15.26	1	15.26	29.59	0
Group x Time	0	1	0	0	0.981
Total	910.41		80.58	29.61	

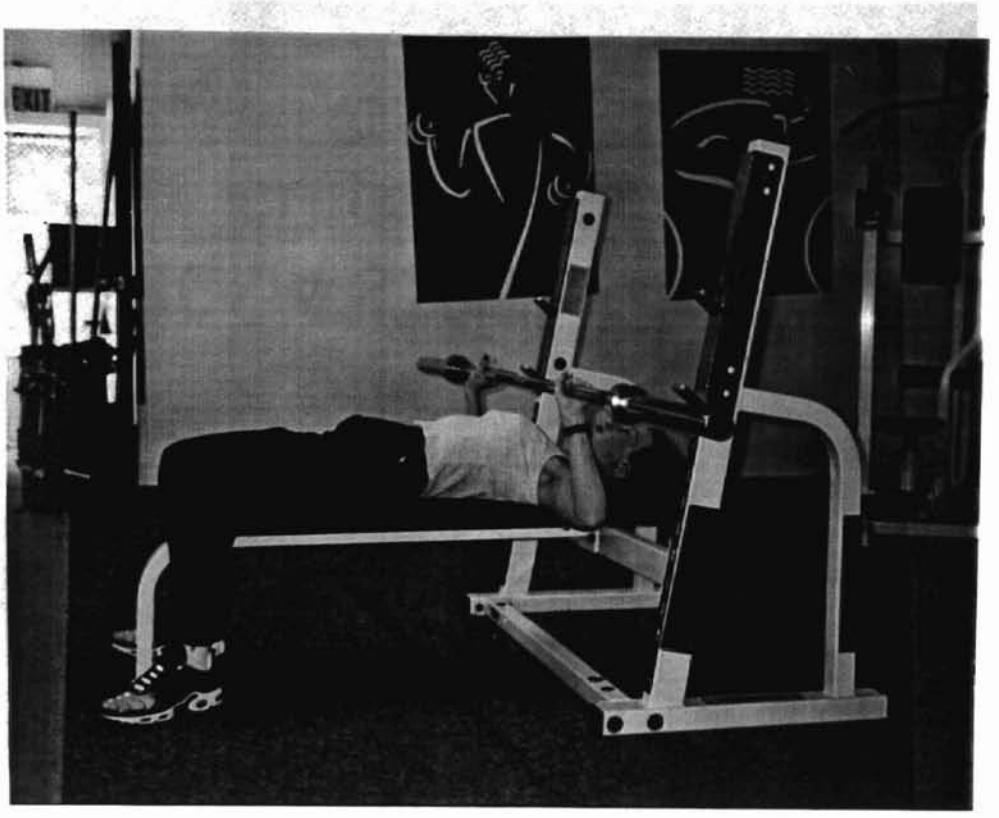


Figure 1. Bench Press

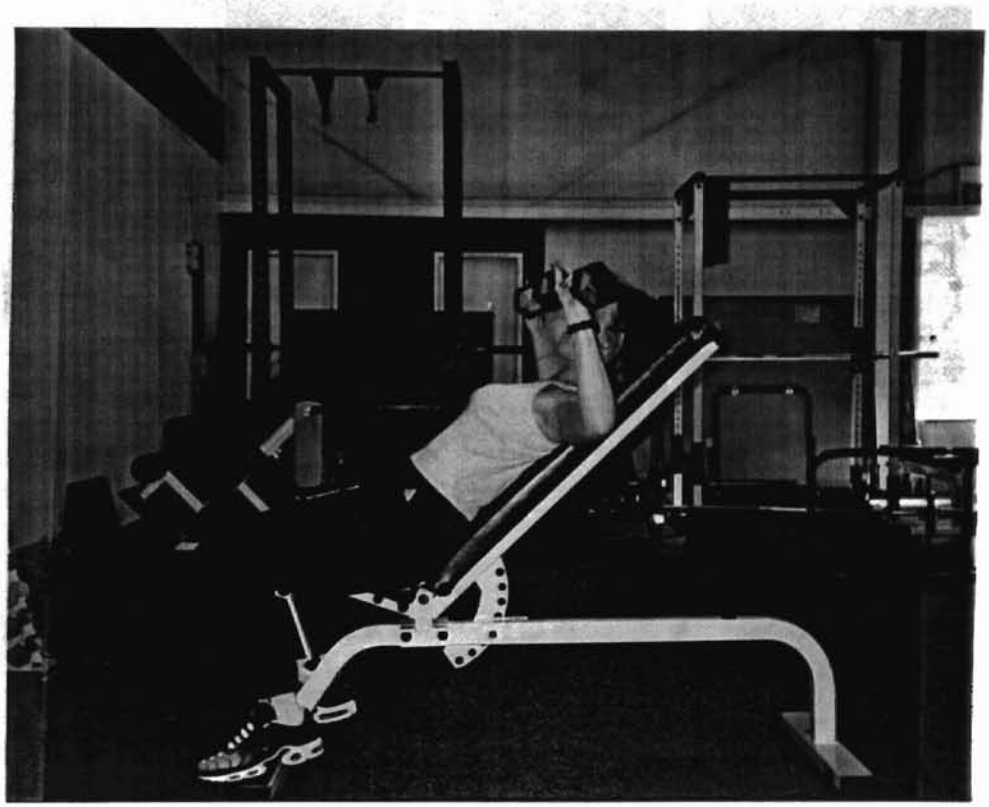


Figure 2. Incline Chest Press

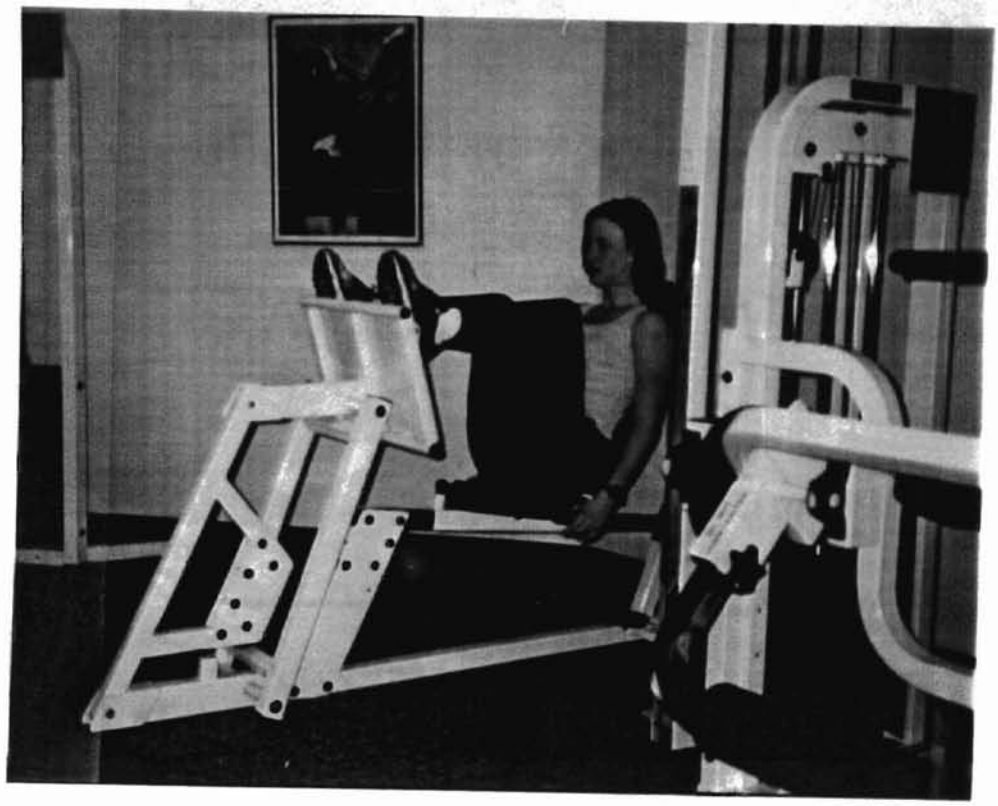


Figure 3. Leg Press

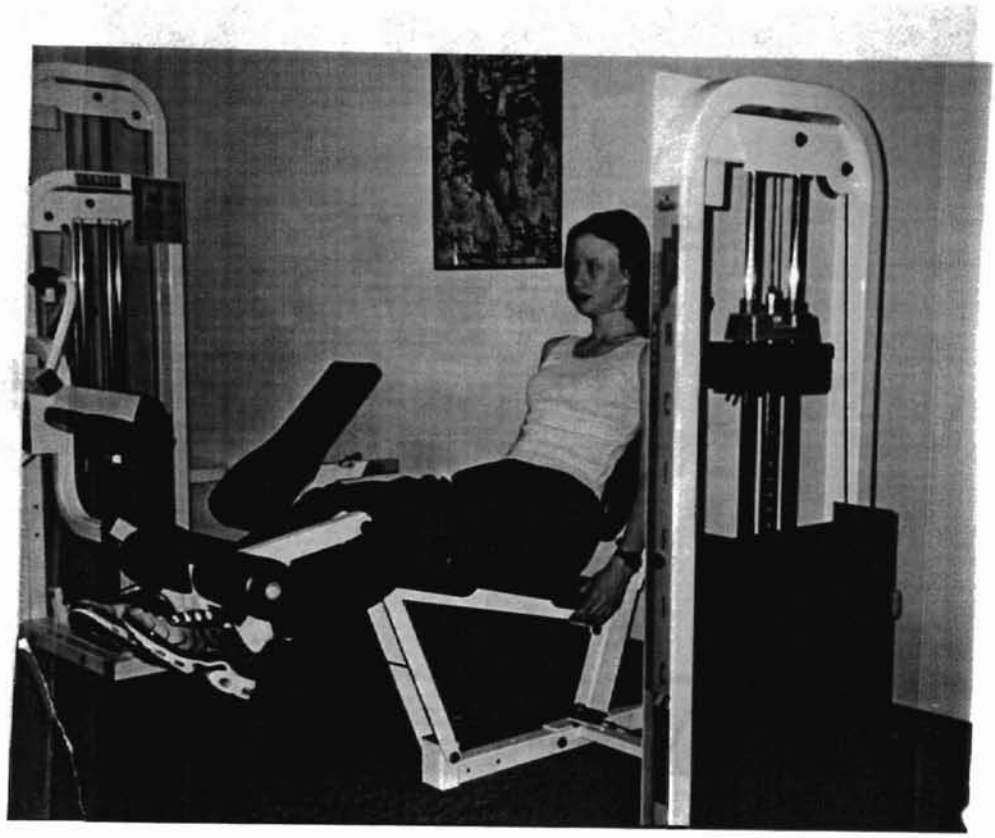


Figure 4. Leg Extension

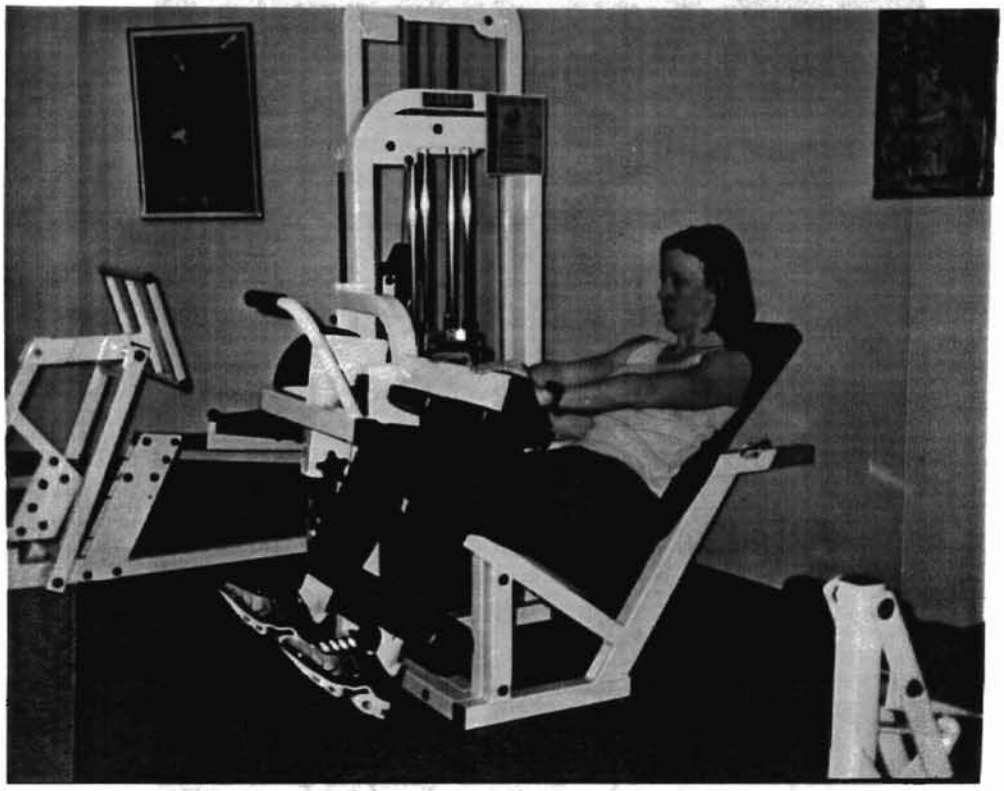


Figure 5. Leg Curl

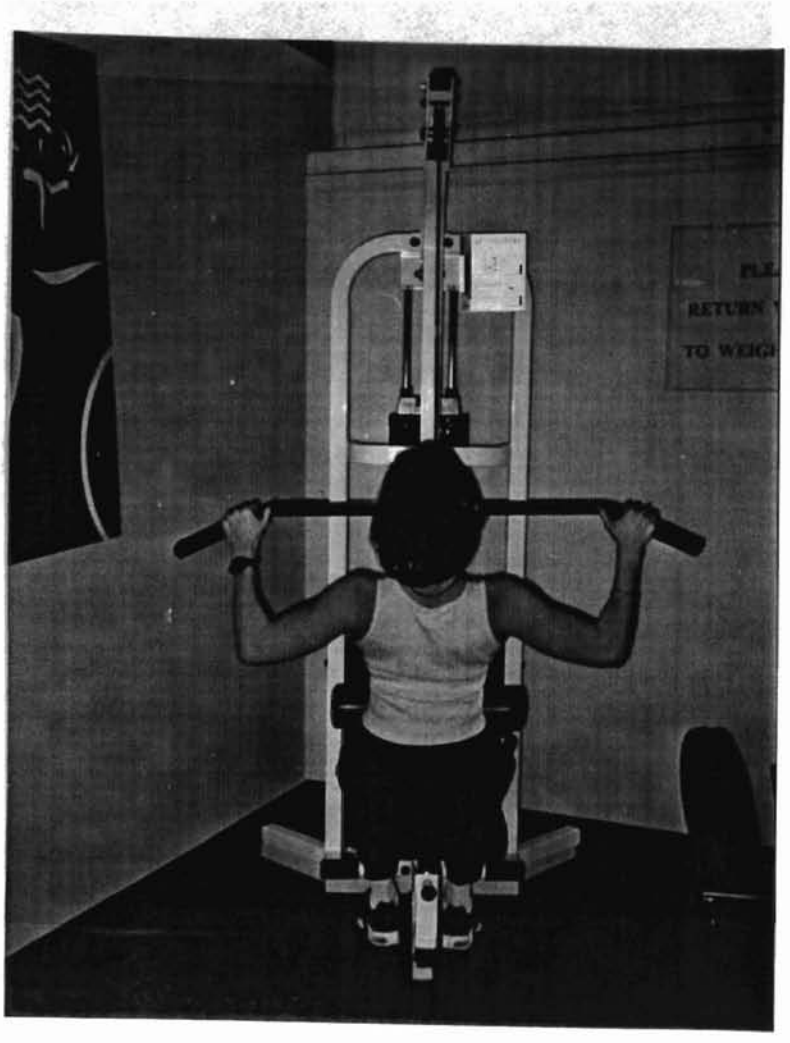


Figure 6. Front Lat Pulldown

Figure 7. Seated Row

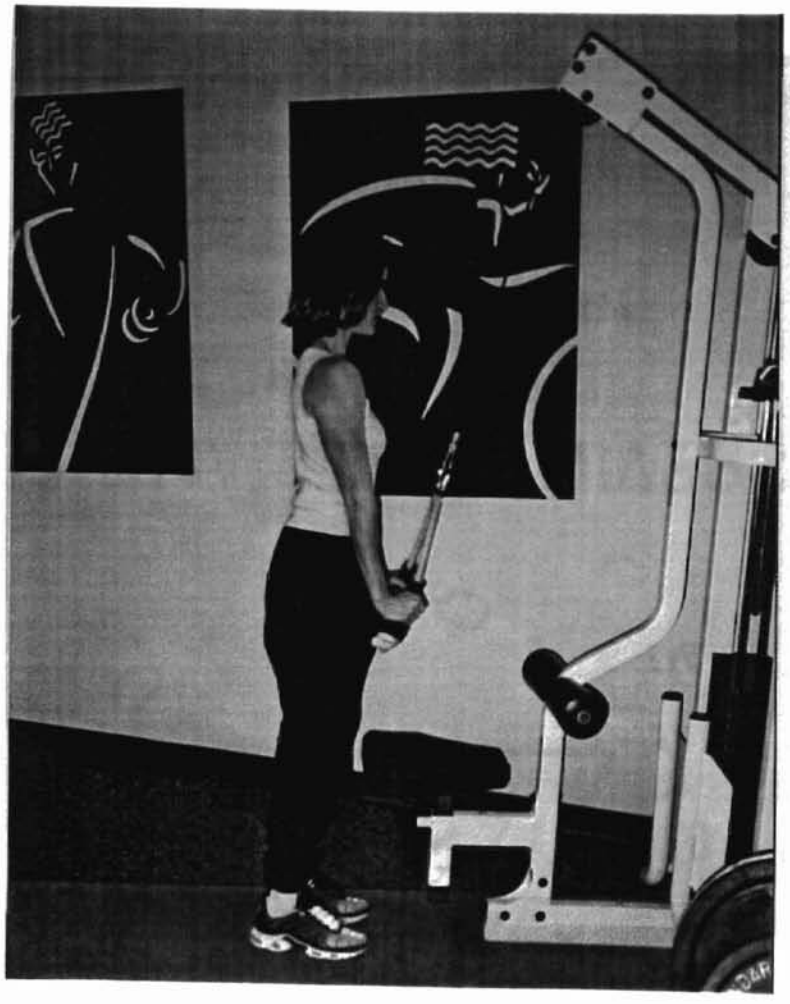


Figure 8. Tricep Extension

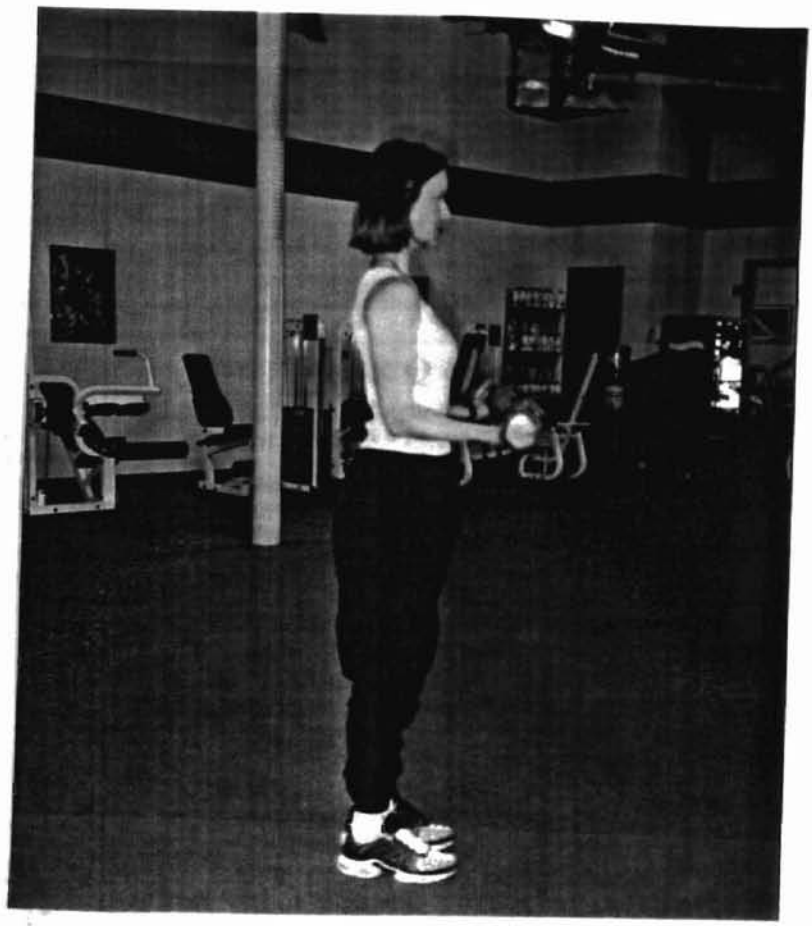


Figure 9. Bicep Curl

Appendix A. PAR-Q Form

NAME _____ Date of Birth _____

CURRENT ADDRESS _____

In case of emergency, name and telephone of person to contact

Name _____ Telephone _____

In case of emergency, what vital information should be related to medical personnel (such as allergies, current medication, etc.)_____

PAR Q & You

PAR-Q is designed to help you help yourself. Many health benefits are associated with regular exercise, and the completion of PAR-Q is a sensible first step to take if you are planning to increase the amount of physical activity in your life.

For most people physical activity should not pose any problem or hazard. PAR-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of activity most suitable for them.

Common sense is your best guide in answering these few questions. Please read them carefully and check the correct answer opposite the question if it applies to you.

Yes	No		
☐	☐	1	Has your doctor ever said you have heart trouble?
☐	☐	2	Do you frequently have pains in your heart and chest?
☐	☐	3	Do you often feel faint or have spells of severe dizziness?
☐	☐	4	Has a doctor ever said your blood pressure was too high?
☐	☐	5	Has your doctor ever told you that you have a bone or joint problem such as arthritis that has been aggravated by exercise or might be made worse with exercise?
☐	☐	6	Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to?
☐	☐	7	Are you over age 65 and not accustomed to vigorous exercise?

If you answered

Yes to one or more questions

If you have not recently done so, consult with your personal physician by telephone or in person before increasing your physical activity and/or taking a fitness appraisal. Tell your physician what questions you answered "yes" to on PAR-Q or present your PAR-Q copy.

Postpone

After medical evaluation, seek advice from your physician as to your suitability for

- unrestricted physical activity starting off easily and progressing gradually, and
- restricted or supervised activity to meet your specific needs at least on an initial basis. Check in your community for special programs or services.

No to all questions

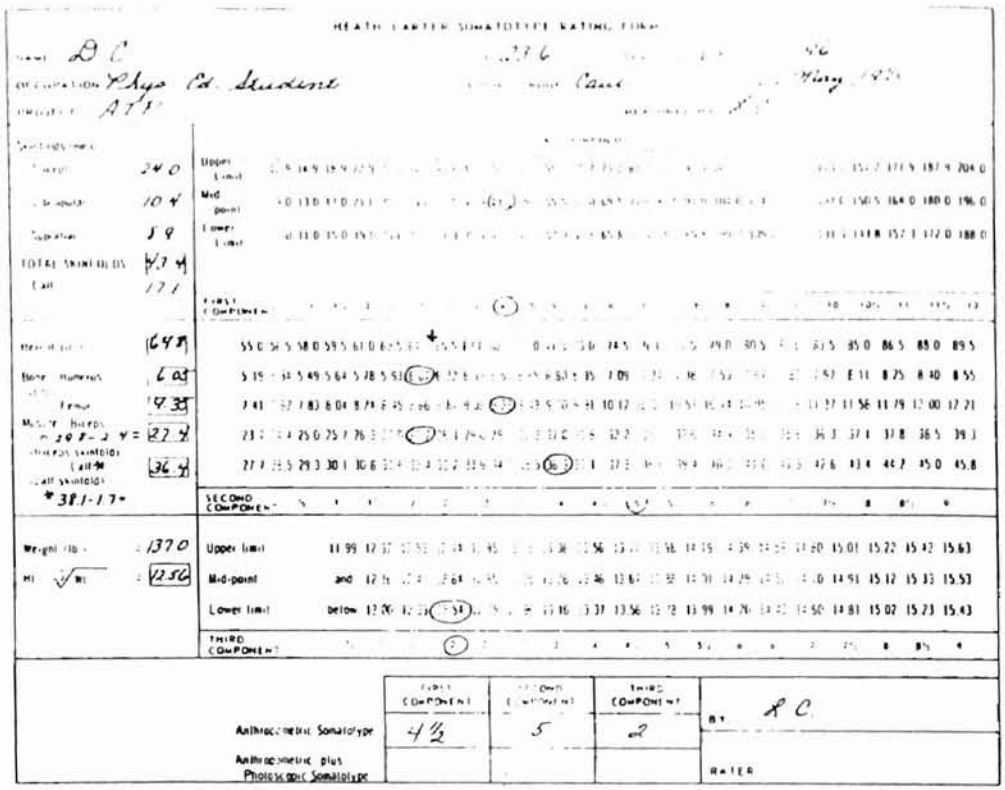
If you answered PAR-Q accurately, you have reasonable assurance of your present suitability for

- a graduated exercise program—a gradual increase in proper exercise promotes good fitness development while minimizing or eliminating discomfort—and
- a fitness appraisal—the Canadian Standardized Test of Fitness (CSTF)

Postpone

If you have a temporary minor illness, such as a common cold

Appendix B. Somatotype Rating Form



Heath-Carter Somatotype Rating Form

Appendix C.

Determining the Endomorphic Component

The following are the steps to determine the endomorphic variable:

1) Sum the values obtained from the following skinfold measurements: triceps, subscapular, and suprailiac.

2) Find the closest value on the total skinfold scale and circle it. Then circle the first component for that column.

Appendix D.

Determining the Mesomorphic Component

The following are the steps to determine the mesomorphic variable:

1) Place an arrow above the column containing the subject's height (or closest approximation).

2) For the two bone measurements (humerus and femur breadth), circle the closest figure in the appropriate row. If there is a decision to be made to circle a higher or lower number, circle the one which is closer to the height column (noted by arrow).

3) Subtract the triceps skinfold from the biceps circumference. To do this, first convert the triceps to centimeters by moving the decimal point to one place to the left.

4) Now subtract the calf skinfold from the calf circumference. Again, change the calf skinfold to centimeters by moving the decimal point one place to the left.

5) Circle these two corrected measurements (Steps 3 and 4) in their proper rows.

6) Using the arrow marked in the height row as a starting column, count the number of columns each other circled value deviates from this starting point (each column equals ½ unit). If the measurements are immediately next to the arrow column, they are considered to deviate zero units. The average deviation of these measurements equals the total divided by four. This represents the average deviation from the height column.

7) Take the average deviation from the height column and add 4. This value gives the obtained final value for the second component.

Appendix E.

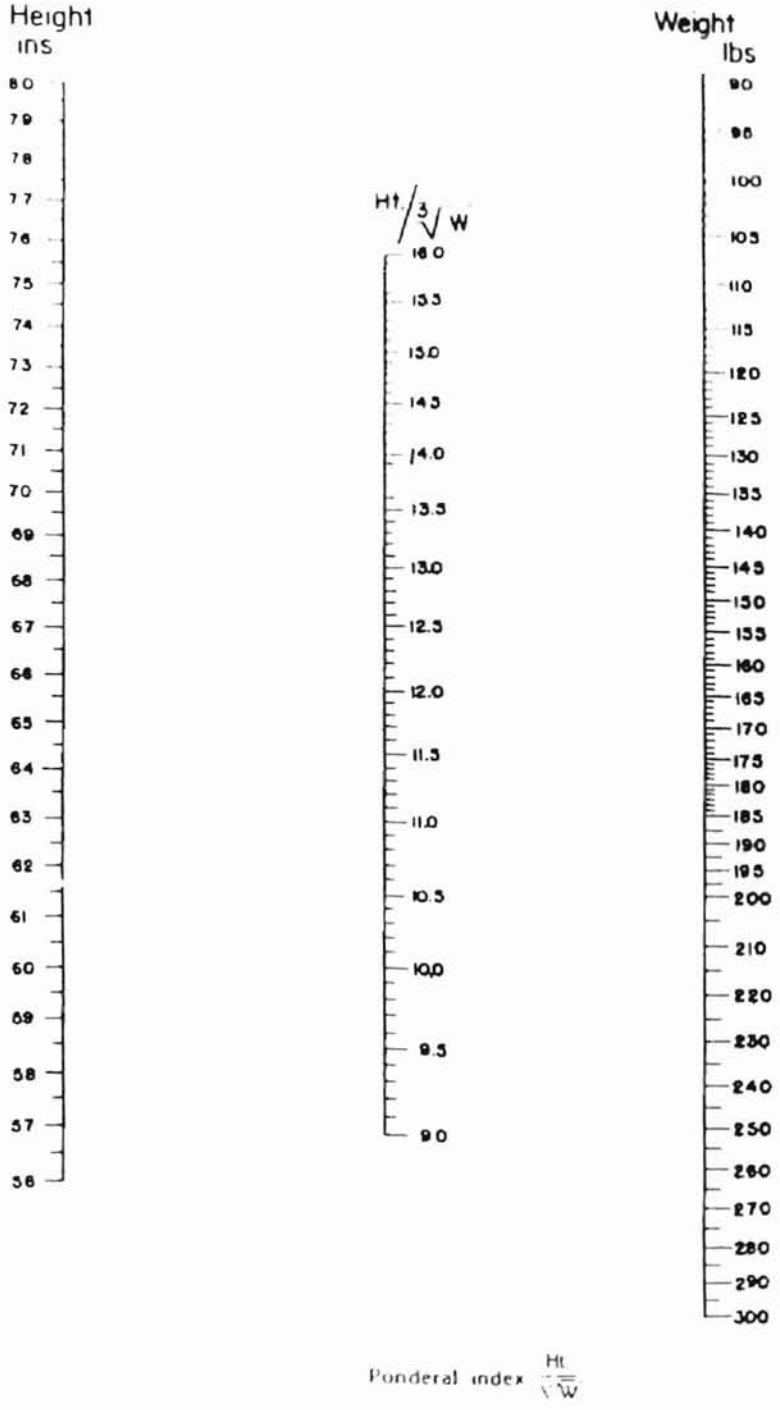
Determining the Ectomorphic Variable

The following are the steps to determine the ectomorphic variable:

1) Compute the ponderal index, which is the height divided by the cube root of the weight, and record this value.

2) On the somatotype rating form, circle the closest value and note the somatotype in the third component row under the column.

Appendix F. Ponderal Index



Appendix G. Training Program Workout Card

NAME	Week 3			Week 4			Week 5			Week 6			Week 7			Week 8			Week 9			Week 10			Week 11			Week 12		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Bench Press																														
Incline Press																														
Lat Pulldown																														
Seated Row																														
Leg Press																														
Leg Curl																														
Leg Ext.																														
Bicep Curls																														
Tricep Plldn																														
Bench Press																														
Incline Press																														
Lat Pulldown																														
Seated Row																														
Leg Press																														
Leg Curl																														
Leg Ext.																														
Bicep Curls																														
Tricep Plldn																														
Bench Press																														
Incline Press																														
Lat Pulldown																														
Seated Row																														
Leg Press																														
Leg Curl																														
Leg Ext.																														
Bicep Curls																														
Tricep Plldn																														

Appendix H. Oklahoma State University Institutional Review Board Approval Form

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Date:	November 30, 1999	IRB #:	AS-00-102
Proposal Title:	"COMPARISON OF 30 AND 60 SECOND REST PERIODS BETWEEN SETS OF A RESISTANCE TRAINING PROGRAM INVOLVING YOUNG WOMEN"		
Principal Investigator(s):	Frank Kulling Jenifer Cassetty		
Reviewed and Processed as:	Exempt		

Approval Status Recommended by Reviewer(s): Approved

Signature:

Carol Olson, Director of University Research Compliance

November 30, 1999
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

Jennifer L. Cassetty

Candidate for the Degree of

Master of Science

Thesis: COMPARISON OF 30 AND 60 SECOND REST PERIODS BETWEEN SETS OF A RESISTANCE TRAINING PROGRAM

Major Field: Health, Physical Education, and Leisure

Biographical:

Personal Data: Born in Atlanta, Georgia, on November 12, 1974, the daughter of Bill and Linda Cassetty.

Education: Graduated from Broken Arrow High School, Broken Arrow, Oklahoma in May 1993; received a Bachelor of Science degree in Health Promotion from Oklahoma State University in May 1997. Completed the requirements for the Master of Science degree with a major in Exercise Science at Oklahoma State University in December 1999.

Experience: Currently employed at the Tulsa Community College Northeast Campus Fitness Center as a Paraprofessional and Adjunct Instructor in Tulsa, Oklahoma. Previously employed at St. John Siegfried Health Club as a Fitness Instructor.

Professional Memberships: American College of Sports Medicine (Certified Health/Fitness Instructor), National Strength and Conditioning Association, American Heart Association Community Site Committee.