AN ANALYSIS OF STRENGTH RETENTION DURING AN EIGHT-WEEK WALK/JOG TRAINING PROGRAM

THESIS

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The purpose of this study was to determine the effects of an eight-week walk/jog program upon strength retention. Twenty-four male executives from Dallas, Texas represented the sample size .

Following eight weeks of resistive training, all subjects were pretested for strength and endurance measures. After the eight-week walk/jog program, all subjects were then retested adhering to the same pretest protocol.

A two-way analysis of variance with repeated measures was used to test for mean group differences between pretest and posttest strength measures. A *t*-test for dependent means was utilized to ascertain differences in cardiovascular measurements. The alpha chosen to test the null hypotheses was the 0.05 level of significance.

Results indicated that muscular strength was retained during the eight-week walk/jog program. No change in upper or lower extremity strength occurred, but significant improvements in maximal oxygen consumption and treadmill time were evidenced.

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CHAPTER I

INTRODUCTION

Although the value of strength training has been recognized for many decades, it has only been in recent years that a critical analysis has been attempted to determine the effectiveness of this training in preparation for various sports. It has been documented that strength training programs will improve muscular strength (8), and speed of movement (9, 10). But a subject which has arisen recently is that of strength retention, the ability of an athlete to retain previously acquired strength during periods of inactivity of supplemental training. Coaches, athletic trainers, and athletes are asking themselves, "How long does newly acquired strength last once it has been developed?" Athletes are questioning the need for an off-season strength training program if the gains made are lost once the season begins.

Controversy exists over the amount of strength actually retained after a conditioning program stops. Jensen (5) reported that once a strength training program was terminated, much of the strength gained was lost at approximately one-third the rate it was gained. This means that strength gained rapidly is then lost rapidly when training is terminated. However, Darcus (3) claimed that tests performed on subjects twelve months after the end of training showed retention of strength in an amount double the pre-training value, although it had declined from the post-training level.

de Vries (4) reported that after a strength training program was terminated, the gains persisted for a long period of time. Berger (1) observed that isotonic strength was not reduced after six weeks following a three-week training program.

The research conducted on strength retention has been contradictory in findings and limited to weight training programs followed by varied periods of inactivity. Little research has been conducted to determine the retention of newly gained strength during prolonged periods of general conditioning, especially endurance training. Many coaches harbor thoughts that general conditioning which includes endurance training provides a foundation upon which strength related activities are built. This opinion has been neither confirmed nor disproven. Information gained in this area would contribute greatly to a better understanding of what training regimen should be adopted when setting up athletes' pre-season and in-season conditioning programs.

Statement of the Problem

The intent of this study was to examine the effects of a prescribed cardiovascular training program immediately following a resistive exercise program on upper and lower extremity strength of adult males.

Purpose of the Study

The purpose of this study was to determine if any significant changes occur in upper and lower extremity strength during an eight-week cardiovascular training program that was preceded by a resistive exercise program.

Hypotheses

This study investigated the following hypotheses:

1. There will be no changes in lower extremity isotonic or isokinetic strength during an eight-week walk/jog training program.

2. There will be significant decreases in upper extremity isotonic and isokinetic strength during an eight-week walk/jog training program.

3. There will be a significant increase in the subjects' cardiovascular fitness levels during an eight-week walk/jog training program.

The hypotheses advanced in this study were tested at the 0.05 level of significance.

Definition of Terms

Aerobics.-- Aerobics refers to a variety of exercises that stimulate heart and lung activity for a time period sufficiently long to produce beneficial changes in the body. Running, swimming, cycling, and jogging -- these are typical aerobic exercises (2).

Isokinetic exercise.-- A dynamic reciprocal form of resistive exercise performed by means of a variable speed control device that allows a constant velocity of motion (7).

Strength.-- The ability of the body or its segments to apply force (5).

Upper extremity strength.-- Operationally defined as muscular strength exhibited during a bench press exercise.

Lower extremity strength.-- Operationally defined as muscular strength exhibited during a leg press exercise.

Delimitations

The delimiting factors in the scope of the study were as follows:

1. The subjects were twenty-four male participants between the ages of twenty-two and thirty-five.

2. The strength measurements included two basic strength training exercises for determining upper and lower extremity strength.

3. Strength assessments were measured on isokinetic strength training equipment.

4. A test-retest situation was administered.

Limitations

The study was limited by the following factors:

1. The inability to control the subject's activity on non-scheduled workout days.

2. The inability to control the lifestyle of the subjects.

Assumptions

A number of basic assumptions were made in order to justifiably use various procedures in this study.

1. The subject samples did not differ significantly from the population from which they were taken.

2. The equipment used for measuring muscular strength were valid and reliable.

3. The data obtained were reproducible.

Significance of the Study

Strength training has been found to be an important part of both off-season and in-season conditioning programs. It would be beneficial for coaches and athletic trainers to determine what effect an endurance training program has on muscular strength which is necessary for successful participation in many sports. A better understanding could then be derived for establishing the best training regimen for off-season and in-season conditioning programs.

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CHAPTER II

REVIEW OF LITERATURE

Studies in strength retention have been limited. The majority of the completed research has dealt with the strength retention of isotonic and isometric exercises. Studies have shown that wide time lapses have existed between the end of training and the retention testing. The range in time of observation of retention extends from a few days to approximately one year.

The review of literature will serve as a means to produce relevant categories for pertinent background information. The background topics are as follows: (1) isotonic exercise, (2) isometric exercise, (3) isokinetic exercise, and (4) cardiovascular training.

Isotonic Exercise

Much of what has been attempted in the field of isotonic training is accredited to the work of De Lorme and Wilkins (7). They set up a protocol for strength training referred to as "progressive resistance exercises." This method involves three sets of exercises, each one based on ten maximum repetitions (10 RM). The following represents a sample of a "progressive resistance" workout:

One set of 10 repetitions with 1/2 (10 RM).

One set of 10 repetitions with 3/4 (10 RM).

One set of 10 repetitions near maximum (10 RM).

Today this method is still being used and is considered to be highly effective. However, recent studies by Berger (1, 2) found that strength increases most rapidly when somewhere between four and eight (RM's) are used with three sets.

A different procedure was compared to the usual 10 RM training technique by Berger and Hardage (3). One group was instructed to perform ten repetitions, but each repetition required a complete, maximum effort. The results of the study showed that the group training the traditional way (10 RM) and the group training the one repetition maximum (1 RM) made significant improvements in strength, but the (1 RM) group increased in strength faster. This finding suggests the importance of intensity during training.

Today there is a lack of agreement among experts as to which program is best for building strength. The following guidelines are generally agreed upon.

1. Exercises must be selected to work the specific muscles in which strength is to be developed, because significant strength gains result only in exercised muscles.

2. Muscles should be contracted regularly (3-4 times each week) against heavy resistance.

3. Near-maximum weight for few repetitions (4 to 8) should be used.

4. As strength increases the weight must be progressively increased to provide continual overloading of the muscles (14).

The effectiveness of isotonic training in causing the retention of muscular strength has been researched by McMorris and Elkins (15) The study utilized the De Lorme procedure and the Oxford technique (32). One year after the end of a twelve-week training period, subjects retained 45 percent of their gain in elbow flexion strength. This finding suggests that strength, once developed, subsides at a much slower rate than it is developed.

Houtz and associates (13) performed an early study training sixteen females on the quadricep extension and the right or left hand curl. The results indicated loss in muscular work capacity after a post-exercise period that exceeded in duration the initial period of training.

In summary, the literature on isotonic strength retention indicates that strength can be developed through an isotonic program. It was found that a percent of the initial strength gains were lost once a program was stopped. The amount of strength retained appeared to be dependent upon the length of detraining time.

Isometric Exercise

The studies supporting the use of a static muscular contraction for strength building were introduced by Hettinger and Muller (9). Their study involved isometric contractions of two-thirds maximum effort for six seconds. They found that maximum strength increased five percent per week from their original value. Little difference was seen when the tension level was pushed to 100 percent, or when exercises were held totaling forty-five seconds.

Research done by Royce (29) produced evidence that strength increases more rapidly with isometrics when: (1) the muscles contract at near maximum; and (2) five to ten repetitions are used. Royce also established the theory that strength will increase more evenly throughout the range of motion if the contractions are done at various positions within the range of motion.

Phillip J. Rasch (25) reviewed and analyzed studies pertaining to the benefits of isometric exercise. His conclusions were that isometric exercises: (1) increase muscular strength; (2) increase muscular endurance, but to a lesser degree than muscular strength; (3) do not affect muscular power; and (4) have no effect upon flexibility.

Few studies have dealt with strength retention following isometric training. Hislop (11) studied nineteen of ninety-one original subjects for one year following a forty-five day isometric training period. No drop-off in muscular strength was found. Muller (20), on the other hand, found the opposite to be true. The loss of strength after training by daily isometric contractions was at the rate at which it was gained, finding that inactivity lowered strength by about 30 percent per week. Working with both pre-pubescent and post-pubescent males, Rarick and Larsen (24) found that a significant loss in strength occurred four weeks after isometric training. The strength levels in most cases remained substantially higher than pretraining means.

Rasch and Morehouse (26) combined both isotonic and isometric training procedures and studied strength retention after a six-week layoff. Strength was assessed through arm elevation testing. Results indicate a significant increase in strength during training for both measures of strength. Strength was retained through the isotonic group, but there was a significant decrease in the isometric group strength.

Another combined study of isometric-isotonic muscle strength retention was performed by Ward and Risk (30). The muscle groups tested were the biceps and quadriceps, respectively. Increased muscular strength was attained through both training procedures, and the strength was retained through two and one-half months.

In summary the literature on isometric strength retention indicates that strength was developed by an isometric program. The amount of strength retained after the program was stopped varied considerably. One study reported no change in muscular strength following a year of detraining, while another study showed that inactivity lowered overall strength by 30 percent per week. These findings indicate that more research is needed in the area of isometric strength retention.

Isokinetic Exercise

A new development in the field of muscular strength and endurance development has been a system called isokinetic exercise. The basis for this type of exercise is accomodating resistance (12). Isokinetic contraction is similar to isotonic contraction, since the joint will move through a full range of motion. The difference is the speed and constant resistance of the movement. The rate of the limb through a range of motion can be preset; any encounter with a counteracting force will be applied as constant resistance through that range of motion.

Research on this topic has been limited to clinical use (4). The work done has primarily been on therapeutic exercise of knee related problems. An advantage of using an isokinetic device for muscular training of therapeutic exercise is the fact that the unit of measure is recorded in torque (foot-pounds). This feature makes it possible to obtain the functional capacity of the joint. The torque level produced represents the interaction between lever arm of the motion and the muscular force as it acts upon the joint (19). Torque measures allow for comparative inter-study when quantitating results of research. This is due to the fact that "torque values obtained are independent of where on the segment the measurements are taken (17)."

Results of work done at a controlled rate of motion has produced significant findings. Moffroid (17) reported on a study utilizing isotonic, isometric, and isokinetic work, testing the quadriceps and hamstring muscles. At the conclusion of the four-week study, increases in strength were found with all the three methods, but the isokinetic group was stronger through every angle in a full range of motion.

Moffroid (18) studied the speed of movement. She indicated that slow speeds on the isokinetic machines are directed toward the development of strength, while the faster speeds are designed to develop endurance. Rosentswieg, Hinson, and Ridgway (27) looked at the electromyographic results of an isokinetic bench press performed at three speeds. A significant difference was found in muscle action potential between fast and slow isokinetic contractions. Their results were supportive of those found by Moffroid.

From the research conducted to date, it is apparent that there are distinct advantages to isokinetic exercise. Some possible advantages are as follows:

1. Resistance is variable, allowing the development of maximal tension, thus increasing strength through the full range of motion.

2. The variance of training speed can change from 0 degrees to 200 degrees per second, which can accommodate for the speed of movement desired in a particular sport. This factor is important since the specificity of training concept has become so popular.

To date, studies on strength retention and isokinetic exercise have not been attempted. The reasons for this could be the relative newness associated with isokinetic training protocols and the limited amount of isokinetic equipment available to perform the research.

Cardiovascular Training

Cardiovascular training programs have been shown to increase maximum aerobic capacity (5, 21), decrease exercise and recovery heart rate response to a standard work task (22), and reduce resting heart rate (6, 8). If training is not continued, these improvements can be lost. Roskamm (28) found after training different groups of soldiers that working capacity decreased within two weeks following cessation of training. A second group maintained its efficiency by continuing to train every third day.

Michael and Gallon (16) followed the training of college basketball and soccer players, respectively, over a season. As long as the players were on a continuous training program, their efficiency increased; if detraining took place, a significant reduction of efficiency was found. Similar findings have been found by Williams and Edwards (31) who studied the effect of various training protocols on cardiovascular efficiency of young college men.

Frequency, duration, and intensity are factors that are important when producing cardiovascular improvements. People today have a tendency to "go through the motions" when participating in an exercise program. Hill (10) trained twenty-four men, twenty to forty-four years of age, at three or five days per week. At the end of eight weeks, both groups were re-evaluated. Both groups improved significantly in maximum oxygen consumption, but the group which trained five days per week improved significantly greater than the three days per week group. These findings suggest that the total work output was not equal even though both groups trained for the same number of weeks. Pollock, et al. (23) studied the changes which occurred in oxygen consumption during a two, three, and four day per week work-out regimens. The results showed that the four day per week program showed significantly more improvement than both the two and three day groups. There were no significant differences between the two and three day groups.

No investigations have studied retention of newly gained strength following a cardiovascular training program. In the past, strength and cardiovascular research studies have been studied independently. This viewpoint seems archaic, with such emphasis placed on both strength and endurance to improve performance.

Summary

The review of literature has indicated the commonly used procedures for strength and cardiovascular training. Studies showed that isotonic, isometric, and isokinetic testing systems do improve muscular strength. Controversy continues to exist as to which method is superior in developing muscular strength. Further studies are needed to quantify training protocols, with increased emphasis upon the new isokinetic methods.

Cardiovascular training was found to be more exact as to the known results obtained during a controlled workout. Maximal and resting heart rates were found to decrease, while oxygen consumption increased. The importance of the correct frequency, intensity, and duration of training was emphasized. These areas have been thoroughly researched.

Strength retention studies were limited. The research done has been primarily on isotonic and isometric exercise. Studies have varied as to the length of observation time in strength retention and have produced conflicting results. More research is needed to clarify the amount of strength retention existing under various isometric, isotonic, and isokinetic strength training programs. No research has been found in the literature which studied the interacting effects of endurance training upon strength retention. The effects of endurance training in the absence of strength training are not known. Research on the subject should materially improve understanding of the possible confounding effects of one training program upon another.

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CHAPTER III

PROCEDURE

The procedures followed in this study were divided into five major areas: selection of subjects; facilities and equipment; testing procedures, experimental design; and data analysis.

Selection of Subjects

Twenty-four male volunteers made up the sample size. The subjects consisted primarily of junior executives from various corporations and businesses throughout Dallas, Texas.

1. Health: Participants were free from coronary heart disease or other serious health problems that would contra-indicate endurance training. This information was obtained by having all participants fill out a medical questionnaire prior to the training sessions.

2. Age: Participants ranged in age from twenty-two to thirty-five years.

3. Availability: Participants were available for eight consecutive weeks of training, plus two weeks for strength evaluations prior to and following the training periods.

4. Vacations: No vacations were scheduled during the eight week project.

5. Lifestyle: Participants were instructed not to change general living habits during the project.

6. Other physical activities during project: Participants were instructed not to engage in physical activities other than the training project.

The mean age of the subjects were twenty-nine years with the range between twenty-four and thirty-five years of age. The range in weight was from 151.9 pounds to 205.6 pounds, with a mean weight of 178.6 pounds. Height of the subjects ranged from sixty-five inches to seventy-four inches, with a mean height of sixty-nine inches.

All subjects had trained for eight weeks of resistive exercises prior to the beginning of the study. Cardiovascular fitness levels were low because of the inactive lifestyle followed by the subjects.

Facilities and Equipment

The strength and cardiovascular testing for this study was conducted at the Institute for Aerobics Research, Dallas, Texas. The training sessions were held at the Aerobics Activity Center, Dallas, Texas.

A physician's scale (Health-O-Meter, Continental Scale, Chicago, Illinois) was used to measure height. An object of known height was used for instrument calibration.

Body weight was measured in kilograms by the use of a seated scale (Detecto Scales, Inc., Brooklyn, New York). Calibration of the scale was performed by checking the balance at the zero level, and measuring a known weight object.

A Universal Gym (Gladiator model, University Athletic Sales, Fresno, California) was used to test maximum isotonic strength. The calibration methods used followed those indicated in the manufacturer's instructions (Instruction Manual Universal Gym).

Strength was also assessed through isokinetic testing machines. The Cybex (Lumex, Inc., Bay Shore, New York) testing systems were used. A Cybex recorder was used to achieve permanent recordings on each test, plus analyzing total work in foot-pounds of each exercise performed. (See Appendix A).

The endurance testing was conducted on a Quinton (Model 24-72) treadmill. The accuracy of the speed and grade was calibrated according to specifications established by the manufacturer (Instruction Manual, Quinton Instruments).

Maximal oxygen intake was analyzed for O_2 and CO_2 content on Beckman OM-11 polarographic O_2 and LB_{-2} infra-red CO_2 gas analyzers. Calibration gases and analyzers were checked by a modified Lloyd Haldane gas analyzer.

During the jogging training phase, each subject used a stopwatch (Meylan Company, New York, New York) to obtain individual pace time and total time. A physician's stethoscope (Littman Company, Medical Products Division, 3M Company, St. Paul, Minnesota) was used to attain mid- and end-heart rates for the exercise.

Testing Procedures

Each subject was scheduled for testing individually. When the subject reported to the testing area, certain procedures were followed:

1. No eating, drinking (except water), or smoking at least fourteen hours prior to an appointment. No alcohol should have been consumed the day prior to testing.

2. No physical activity should have occurred the day prior to testing.

3. A Medical History Questionnaire was completed before the first appointment.

Upon entering the laboratory, each subject was given verbal instructions concerning procedures involved in testing.

The subjects were requested to undress, eliminate all waste and return in the nude. Height and weight measurements were taken to the nearest pound and quarter-inch, respectively.

Strength Assessment

Two assessments for strength levels were taken. Before the tests were performed, the total number of subjects were randomly divided into two groups of twelve subjects. One group was tested first on the Universal Gym, while the other group was tested first on the isokinetic equipment. This method prevented any "sequence effects" which could influence the data, and randomized the treatment effects of the testing.

Isotonic Strength

Two isotonic assessments were performed on the Universal Gym. De Lorme and Watkins (4) claim that before any conditioning program begins, an individual's present status must be measured. The best method for measuring strength is felt to be a "maximum overload." This method was applied to test maximum isotonic strength. Two basic isotonic exercises were tested: the bench press, which represented the upper extremity strength measure; and, the leg press for the lower extremity strength measure. The procedure used to obtain testing poundages followed those established by O'Shea (7). On completion of each maximum repetition, the weight was increased ten pounds until failure to perform the movements. The weight last completed was accepted as the maximum poundage for that exercise. A one-minute rest period existed between exercises (7). All weight measurements were measured and recorded in pounds.

Isokinetic Strength

Isokinetic strength testing was assessed also. A twenty-four hour time period existed between the two strength assessments. The bench press and leg press were again used to represent upper and lower extremity strength values. The testing procedures followed were those established by Coplin (3). A period of one minute intervened the strength assessments. All isokinetic measurements were obtained and recorded in foot pounds.

Muscular strength values were obtained by the maximum torque achieved through a full range of motion. Moffroid (6) and Pipes (8) discovered that the speed of exercise is specific to the desired movement. They found when testing for maximal strength on isokinetic machine, a slow speed setting produced the most reliable measurement of total strength of a given movement.

The testing protocol for the isokinetic bench press and leg press was as follows:

1. A slow speed setting of two (thirty degrees per second) was used on the two isokinetic machines.

2. The subject then performed two "practice" sub-maximal contractions in order to get acclimated to the machine and testing speed.

3. The subject then performed three maximum contractions, with one minute rest between each contraction.

4. The highest measure of torque achieved (in foot-pounds) was used.

Each repetition was monitored through a recorder so peak torque levels could be evaluated and kept for comparative measures. The isotonic and isokinetic strength assessments therefore provided for bench press and leg press measures on all twenty-four subjects.

Endurance Testing

To determine cardiovascular fitness a modified Astrand (1) running test was used. Starting work loads were individualized as to the subject's ability. A five minute warm up walk at 3.5 m.p.h., 2.5 percent grade was followed by a continuous, multi-stage progression of walking to running until exhaustion. The speed of the run was adjusted to exhaust each subject in seven to ten minutes. Each subject was encouraged to run to their subjective limits while under medical observation. Termination of the test was determined when the subject verbally stated he could go no further, or by order from the physician. Treadmill time was measured and recorded as was the maximum oxygen consumption. The metabolic techniques and procedures outlined by Consolazio, Johnson, and Pecora (2) were followed.

Upon completion of all tests the subjects began an eight-week walk/jog program. The training sessions were held from 5:30 to 8:30 a.m. and from 5:00 to 7:00 p.m. Mondays, Wednesdays, and Fridays. All training sessions were performed on a quarter and half mile tracks at the Aerobics Activity Center, Dallas, Texas. Each session began with a short warm-up, emphasizing the stretching of major muscle groups involved in jogging (See Appendix B). During the initial phase of training a pace time was established for each subject. The first week's training consisted of slowly jogging segments of 330 yards intervened with a walk of 110 yards for a total distance of two miles (See Appendix C). Each week the distance of jogging was gradually increased. Subjects were taught to determine training heart rates by the palpation technique (9). This technique involved the subjects placing their middle two fingers on either the carotid or apical pulse, and counting the heart beats for ten seconds. The instructors periodically checked heart rate values with a stethoscope to insure testing validity. Heart rates were taken during the middle and end of all training sessions. Percent of maximum heart rates were determined by using Karvonen's method (3). Training heart rates were between 70 to 85 percent of each subject's predicted maximal heart rate. The workouts lasted approximately forty-five minutes. After each workout the subjects recorded all data on a computer card. (See Appendix G).

At the end of the eight-week training sessions, all subjects were re-tested. The procedures followed were identical to those of the pretest. All posttesting was accomplished within two days of completion of training to avoid any detraining effects. If a subject missed four or more workouts during the training period he was eliminated from the study.

Experimental Design

Two experimental designs were employed in this study: (1) a factorial design with repeated measures; and (2) a single group design with repeated measures.

The factorial design employed in the study was utilized separately for isotonic and isokinetic strength, thus two separate two-by-two factorial designs were evidenced. The independent variables were fixed in that upper and lower extremity strength were measured before and after the treatment period; however, the dependent variables were different in that isotonic strength was measured in pounds and isokinetic strength was measured in foot-pounds. On the following page is a paradigm.

1. Isotonic:

	Pretest	Posttest
Bench Press		
Leg Press		

dependent variable = pounds

2. Isokinetic:

	Pretest	Posttest
Bench Press		
Leg Press		

dependent variable = foot pounds

The single group design with repeated measures was employed separately for the treadmill times and maximal oxygen uptake, both being measures of cardiovascular endurance. Thus, two separate one group designs for each independent variable were evidenced. The following is a paradigm.

1. Treadmill Test:

	Pretest	Posttest
Duration		

dependent variable = seconds

2. Maximal Oxygen Uptake:

	Pretest	Posttest
$\dot{V}_{O_2}$		

dependent variable = ml/kg/min

Data Analysis

The intent of the experiment was to test the hypotheses advanced and resulted in two types of data analysis techniques.

The factorial designs required a two way analysis of variance with repeated measures to be computed upon the collected data. These computations were performed by the computer system at the Institute for Aerobics Research, Dallas, Texas.

The single group designs required a *t*-test for dependent means to be computed. These computations were also computed at the Institute for Aerobics Research.

Decision making regarding the hypothesis testing was performed at the 0.05 level of significance.

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CHAPTER IV

ANALYSIS OF DATA

In analyzing the data collected, an attempt was made to determine what effects an eight week jogging program had upon upper and lower body isotonic and isokinetic strength. Statistical analysis of the data was used to compare these effects on twenty-four male volunteers.

A two-by-two factorial design with repeated measures was deemed appropriate for accepting or rejecting two null hypotheses. This experimental design made it possible to evaluate pretest and posttest values, while utilizing two testing measurements for strength.

A single group design with repeated measures was deemed appropriate for accepting or rejecting the third null hypothesis. This experimental design made it possible to evaluate pretest and posttest values while utilizing two separate measures of cardiovascular endurance.

The data analysis included mean and standard deviation calculations for all strength and endurance measures. The two-way analysis of variance (ANOVA) with repeated measures yielded F ratios and the *t*-test for dependent means yielded t ratios. All F and t ratios were treated at the 0.05 level of significance.

Sample Statistics

The subjects represented a random sample from various corporations within Dallas, Texas. The ages ranged between twenty-four and thirty-five years with a mean age of twenty-nine and a standard deviation of 3.1. The height measurements ranged between 65.7 and 74.2 inches with a mean height of 69.8 inches and a standard deviation of 2.6. Weight measurements were between 151.9 and 205.6 pounds with a mean weight of 178.6 pounds and a standard deviation of 15.6. The descriptive data for the subjects may be found in Table I.

TABLE I.

RANGES, MEANS AND STANDARD DEVIATIONS
FOR AGE, HEIGHT AND WEIGHT MEASUREMENTS

Variable	Range	Mean	Standard Deviation
Age (yr.)	24 - 35	29.0	3.1
Height (in.)	65.7 - 74.2	69.8	2.6
Weight (lbs.)	151.9 - 205.6	178.6	15.6

Isotonic Strength Measurements

Isotonic strength values were obtained by taking the best single maximum repetition performed on the Universal Gym. The pretest leg press mean was 362.89 pounds with a standard deviation of 84.05. The posttest leg press mean was 350.78 pounds with a standard deviation of 83.17.

The pretest bench press mean was 152.1 pounds with a standard deviation of 23.29. The posttest bench press mean was 144.7 pounds with a standard deviation of 22.75.

The descriptive statistics for isotonic strength measurements for pretest and posttest are summarized in Table II.

TABLE II

MEANS AND STANDARD DEVIATIONS FOR ISOTONIC STRENGTH PRETEST AND POSTTEST

Mode	Pretest		Posttest	
	Mean	Standard Deviation	Mean	Standard Deviation
Leg Press (lbs.)	362.89	84.05	350.78	83.17
Bench Press (lbs.)	152.1	23.29	144.7	22.75

A two-way analysis of variance with repeated measures was utilized to determine if there was any mean group differences between the pretest and posttest scores. A summary table for the two-way analysis of variance for isotonic strength is presented in Table III.

TABLE III

SUMMARY TABLE FOR ANALYSIS OF VARIANCE ON ISOTONIC PRETEST AND POSTTEST SCORES

Scource	DF	SS	MS	F
Total	75	1098023.68		
Rows	1	825347.36	825347.36	219.46
Columns	1	1801.31	1801.31	0.479
RXC	1	106.57	106.57	0.028
Error	72	270768.42	3760.67	

An *F* ratio of 3.98 is required for significance at the 0.05 level.

The results of the data analysis of isotonic strength scores suggest there is a difference in upper and lower extremity strength. This finding was expected as the literature available is complete with supportive findings.

It is interesting to note that no significant difference was found in the isotonic strength scores from pretesting to posttesting. This would suggest that eight weeks of walking and jogging neither improves or diminishes isotonic strength. Further, since no interaction of the main effects was evidenced in the data analysis, it may be assumed that the absence of isotonic strength changes are true for both the upper and lower extremity.

Isokinetic Strength Measurements

The values were obtained from both the pretest and posttest evaluations. Isokinetic strength was monitored by a Cybex recorder which measures peak torque levels. These values were then compared to the measurements obtained from the pretest.

The pretest mean for the isokinetic leg press was 841.84 foot pounds with a standard deviation of 158.97. The posttest mean was 835.78 foot pounds with a standard deviation of 147.71.

The pretest mean for the isokinetic bench press was 217.26 foot pounds with a standard deviation of 24.45. The posttest mean was 197.15 foot pounds with a standard deviation of 25.94. The descriptive statistics are presented in Table IV.

TABLE IV

MEANS AND STANDARD DEVIATIONS FOR ISOKINETIC STRENGTH PRETEST AND POSTTEST SCORES

Mode	Mean	Standard Deviation	Mean	Standard Deviation
Leg Press (ft. lbs.)	841.84	158.97	835.78	147.71
Bench Press (ft. lbs.)	217.16	24.45	197.15	25.94

A two-way analysis of variance with repeated measures was utilized to determine any mean group changes from pretest to posttest. The summary table of the two-way analysis of variance for isokinetic strength measures is presented in Table V.

TABLE V

SUMMARY TABLE FOR ANALYSIS OF VARIANCE ON ISOKINETIC PRETEST AND POSTTEST SCORES FOR MIDDLE-AGED MALES

Source	DF	SS	MS	F
Total	75	8454322.98		
Rows	1	7579578.96	7579578.96	626.87*
Columns	1	3250.11	3250.11	0.26
RXC	1	938.01	938.01	0.07
Error	72	870555.89	12091.0541	

*An $\underline{F}$ ratio of 3.98 was required for significance at the 0.05 level.

The results indicate that there was a significant difference between overall leg press strength and bench press strength. There were no significant differences between pretest and posttest.

The results of the data analysis of isokinetic strength scores suggests that there is a difference in upper and lower extremity strength. These findings are comparable to those found with the isotonic score. Again, these findings are expected and are supported by the literature.

No significant differences were found in the isokinetic scores from pretesting to posttesting. This would suggest that eight weeks of walking and jogging neither improves nor diminishes isokinetic strength. Since no interaction of the main effects occurred in the data analysis it would further suggest that the absence of isokinetic strength changes were true for both the upper and lower extremity.

Cardiovascular Measurements

Means and standard deviations were obtained for treadmill times, and maximum oxygen consumptions. The pretest mean time for the Astrand treadmill test was 7.4 minutes with a standard deviation of 1.03. The posttest mean time was 9.2 minutes with a standard deviation of 1.10.

The pretest mean for maximal oxygen consumption was 43.22 ml/kg/min with a standard deviation of 3.40. The posttest mean was 46.68 ml/kg/min with a standard deviation of 3.55. The summary scores for both treadmill time and maximal oxygen consumption are recorded in Table VI.

TABLE VI

MEANS AND STANDARD DEVIATIONS FOR TREADMILL TIME AND MAXIMIM OXYGEN CONSUMPTION PRETEST AND POSTTEST SCORES

	Pretest		Posttest	
	Mean	Standard Deviation	Mean	Standard Deviation
Treadmill Time (min.)	7.4	1.03	9.2	1.10
$\dot{V}_{O_2}$ (ml/kg/min.)	43.22	3.40	46.68	3.55

A _t_ test for dependent means was utilized to determine the significant difference at the 0.05 level from pretest to posttest. The findings are summarized in Table VII.

TABLE VII

SUMMARY TABLE FOR THE _t_ TEST FOR DEPENDENT MEANS OF PRETEST AND POSTTEST SCORES OF TREADMILL TIME AND MAXIMAL OXYGEN UPTAKE SCORES

Variable	_t_ Statistic
Treadmill Time	5.26*
$\dot{V}_{O_2}$	3.00*

*A _t_ test ratio of 2.069 is required for significance at the 0.05 level

Examination of the results indicated that there was a significant improvement in the subjects cardiovascular fitness levels. The increase for treadmill time between pretest and posttest was 24 percent. The maximum oxygen consumption showed an 8.0 percent improvement. These findings are comparable with the literature and suggest that a walk/jog program is an excellent means for improving cardiovascular fitness levels.

Summary of Findings

The results of the analysis indicates the following findings.

1. Upper and lower body strength levels measured by isotonic and isokinetic means were retained during an eight week walk/jog program.

2. Cardiovascualr fitness levels improved significantly with the eight-week walk/jog program.

Discussion of the Findings

The results obtained from this investigation indicated that initial strength levels obtained by eight weeks of resistive training were retained following an eight-week walk/jog training program. These findings are similar to those found by Waldman and Stull (7). They reported that initial strength levels were retained after fifty-four male university students engaged in an eight-week isotonic program followed by an eight-week period of inactivity. Another study which further supports these findings was conducted by Egolinski (3). He reported that gains in muscular endurance are retained for a considerable period of time following the cessation of training.

It was hypothesized that upper body strength would decrease while lower body strength would not change during the eight-week walk/jog program. These findings were not apparent. An explanation for this could be as follows:

1. The intensity and duration of the daily workouts were too low to show significant changes in muscular strength.

2. The duration of the training program was not long enough to show signs of strength changes.

Cardiovascular levels improved significantly following the eight-week training session. Both treadmill times and maximal oxygen consumption values increased. These findings have been supported numerous times by studies on endurance training (2, 4, 5, 6). Cureton and Phillips (1) found that utilizing an eight-week period of slow jogging showed significant increases in aerobic capacity.

To summarize the findings of the study, it would seem to indicate that a walk/jog training program had no effect upon overall strength. Significant gains in cardiovascular efficiency were found but no change was evident in upper or lower body strength. Initial strength levels were retained during the eight-week cardiovascular phase.

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CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the effects of an eight-week walk/jog program upon the retention of upper and lower extremity strength. Twenty-four middle-aged male executives from Dallas, Texas with a mean age of 29.0 years, a mean height of 69.0 inches and a mean weight of 178.6 pounds represented the sample size.

Following eight weeks of resistive training, all subjects were pretested for strength and endurance measures. The subjects then engaged in an eight-week walk/jog program working between 70 and 85 percent of maximum heart rate. After the training period, all subjects were then retested on all strength and endurance measures.

A two-way analysis of variance with repeated measures was used to test for mean group differences between pretest and posttest strength measures. A *t*-test for dependent means was utilized to ascertain differences in cardiovascular measurements. The alpha chosen to test the null hypotheses was the 0.05 level of significance.

Results indicated that muscular strength was retained during the eight-week walk/jog program. No change in upper or lower extremity strength occurred, but significant improvements in maximal oxygen consumption and treadmill time were evidenced.

Conclusions

The findings would seem to warrant the following conclusions:

1. Strength levels achieved in a resistive exercise program can be maintained during an eight-week walk/jog training program.

2. An eight-week endurance program of walking and jogging does not cause changes in upper or lower extremity isotonic or isokinetic strength following a resistive exercise program.

Recommendations

The following recommendations are made as a result of this investigation:

1. It is recommended that a similar study be repeated with subjects who had not trained previously.

2. It is recommended that a similar study be done with a longer cardiovascular training phase.

3. It is recommended that a similar study be undertaken with a control group.

4. It is recommended that a similar study be done to investigate upper and lower extremity muscular endurance.

5. It is recommended that a study be done utilizing more exercises to represent upper and lower extremity strength.

6. It is recommended that a similar study be performed using another aerobic exercise during the cardiovascular training period.

7. It is recommended that a study be done utilizing other methods of measuring maximal strength.

8. It is recommended that a similar study take place to incorporate anthropometric measurements.

APPENDIX

APPENDIX A

CYBEX CALIBRATION

Recorder Scale Selector	Lever Arm Inches*	Weight Pounds	Calib. Torque Input Foot Pounds	Graph Recording Peak
360	30	70	180	5 Major Divisions
180	31	32.5	90	5 Major Divisions
30	33	5	20	20 Minor Divisions

CALIBRATION POINTS (Mid-Scale)

360 Scale *30"	70 lbs on arm yields 180 ft lbs	(5 Major Divisions)
180 Scale *31"	32.5 lbs on arm yields 90 ft lbs	(5 Major Divisions)
30 Scale *33"	5 lbs on arm yields 20 ft. lbs	(20 Minor Divisions)

*Distance from center of CYBEX input shaft to center of T tube (lever arm length).

Procedure

1. Select Recorder Range Scale (0-30, 0-180, 0-360).

2. With Speed Selector ON at 5 RPM and Recorder ON but no torque applied to input shaft:

(a) Select #4 position on Damping control.

(b) Select slow chart speed (2mm/sec).

(c) Align stylus with baseline of chart paper grid using Zero Adjust control.

(d) Check to see baseline does not shift when range scale is changed. Plus or minus one small division of change on the 30 scale is acceptable. Baseline shift can be corrected by adjusting with a small screwdriver the potentiometer behind the cap marked ZERO on the front vertical panel of the recorder case.

3. Attach proper amount of disc weights to T bar as per above calibration. Check accuracy of weights first as a 25 pound weight may be off as much as one half pound from its indicated value. A two and one half pound weight may be off one quarter pound. Use correct weight value.

4. Dynamic calibration is done by manually lifting weighted T bar to vertical position above dynamometer, then allowing it to swing down until weights contact the floor. As weighted arm passes the horizontal, it is applying the specified torque. The graph recording will show this value as the maximum point on the curve. If this point is above or below the correct torque value, adjust the recorder and make it read the correct value by turning the appropriate (30, 180, 360) potentiometer behind the plug on the front case of the recorder using a small screwdriver. Turning the potentiometer clockwise will decrease the reading and counter-clockwise will increase it.

PROCEDURE FOR CALIBRATING CYBEX DIGITAL WORK INTEGRATOR

1. Set CYBEX recorder to have 0 volts on AUX OUTPUT when 0 torque or force is applied to CYBEX input arm.

   (a) Adjust voltage by turning potentiometer behind ZERO hole on front panel of Recorder with small slotted screw driver.

   (b) NOTE: CYBEX Speed Selector should be ON but no torque applied to dynamometer. Set Speed Selector to 10 RPM.

   (c) A side benefit of setting 0 volts is that the three range scales (30, 180, 360) will have baseline alignment.

   (d) When using a CYBEX Channel Selector with the Recorder (so as to read out as many as four signal sources) each channel can be zeroed in a similar fashion to above via ZERO potentiometer on each channel of the Selector.

2. Select proper machine input on Integrator selector knob (FITRON, Bench Press, Leg Press, ORTHOTRON or CYBEX).

3. Turn Isokinetic Velocity selector knob on Integrator counterclockwise to zero degrees/second.

4. Connect Integrator to recorder with signal cable provided.

5. Turn Integrator ON.

6. Select X 1/10 METER SCALE.

7. Select HOLD function.

8. Adjust R8 potentiometer inside back panel of Integrator such that digital readout shows + or - 0.00 HOLD function.

9. Turn Isokinetic Velocity selector knob clockwise to 200 degress/second.

10. Adjust R7 potentiometer inside back panel of Integrator such that digital readout does not change or drift from 0.00. This cannot be done to absolute zero drift but it should not add or subtract .01 more frequently than every ten seconds. NOTE: The system is now set up for a work integration calibration.

11. The basic procedure involved putting a known amount of work into the system and insuring that the Digital Integrator indicates the correct answer. If the digital readout is greater or less than the correct amount, R6 will be adjusted to make it read correctly.

Proceed as follows:

(a) If the recorder has not been calibrated for proper torque or force readout, this must be done prior to calibrating the Integrator.

(b) Assuming that the recorder <u>is</u> not calibrated, place the input arm of the CYBEX or other machine at a horizontal position and set the velocity of that machine to zero (isometric). Apply sufficient weight to the arm of the CYBEX (or Bench Press or whatever) such that a torque of 180 foot pounds is created and so indicated on the recorder. This means that the Integrator will see a torque signal of 180 foot pounds for as long as it is switched to the INTEGRATE position.

(c) Select 100 degrees/second on Isokinetic Velocity knob of Integrator. Thus, the Integrator will sum up torque under the deliberately false assumption that said torque is moving at a controlled velocity of 100 degrees/second. Since the mechanical position of the weight of the CYBEX does not really move at all, this is simply a way of providing a known torque for a measured period of time at an assumed velocity.

(d) Using a good stopwatch or sweep second hand, switch the Integrator to INTEGRATE for 30 seconds and then to HOLD to observe total work. It should read <u>9.42</u>. When adjusted with R6, the unit will reproduce values with ± 1% of the indicated value.

(e) This simulated work value is arrived at by computation using the following formula.

Work = 2 pi X torque X angular distance traveled (radians)

$$W = 2 \text{ pi} \times T \times \frac{\text{angular distance in degrees}}{360 \text{ degrees}}$$

$$W = 2 \text{ pi} \times T \times \frac{\text{angular velocity} \times \text{time}}{360}$$

$$W = 6.28 \times 180 \times \frac{100 \text{ degrees/second} \times 30 \text{ seconds}}{360 \text{ degrees}}$$

W = 6.28 X 180 x 8.33

W = 9.416 foot pounds in 30 seconds

(f) The Integrator can be checked at other simulated velocities and other actual torques by varying one or both of these inputs (one simulated, one real in terms of torque applied).

CALIBRATION OF CYBEX EXERCISE UNITS

1. Power Leg press

    (a) On 360 range scale of recorder:

    Each minor division = 50 pounds of force on footplates

    Each major division = 150 pounds

    Therefore, full scale = 1500 pounds

    (b) On 180 range scale of recorder:

    Each minor division = 25 pounds of force on footplates

    Each major division = 75 pounds

    Therefore, full scale = 750 pounds

    (c) Calibrate using 115 pounds weight on Bench Press arms (24 inch lever arm) which is equivalent to 200 pounds on the 15" leg press lever arm. Use higher weights and/or known body weight for higher calibration. Convert, however, to effective force at footplate radius. Bench press arms alone have an effective weight of ten pounds at 24" lever arm length.

2. Power Bench Press

    (a) On 360 range scale of recorder:

    Each minor division = 15 pounds force on handles

    Each major division = 45 pounds

    Therefore, full scale = 450 pounds

(b) On 180 range scale of recorder:

Each minor division = 7.5 pounds force on handles

Each major division = 22.5 pounds

Therefore, full scale = 225 pounds

(c) Calibrate using 95 pounds on Bench Press Arms which is a 105 pound input force and should read 7 small divisions on 360 scale. Use more weights and/or body weight to check other calibration points.

3. CYBEX Channel Selector Assignments

Aerobics Activities Center

Channel 1	1 BP757	2 BP753	3 LP673	4 LP11

APPENDIX B

WARM-UP: STRETCHING

1.	Arm Circles	- 20 REPS
2.	Trunk Twist	- 20 REPS
3.	Trunk Rotation	- 10 REPS
4.	Side Stretch	- 10 REPS
5.	Toe Touch	- 3 REPS - 10 Second Count
6.	Calf Stretch	- 3 REPS - 10 Second Count
7.	Front Leg Stretch	- 3 REPS - 10 Second Count

APPENDIX C

WEEKS TWO AND THREE

2.5 MILES

WALK 110
RUN 440
WALK 110
RUN 440
WALK 110
RUN 440
WALK 110
RUN 440 ______ TAKE HEART RATE (1.25 Miles)

8 WALKS OF 110

8 RUNS of 440

REPEAT ABOVE FOR SECOND HALF OF WORKOUT

PACE/100 YD	TOTAL TIME
30	24:00
31	24:32
32	25:04
33	25:36
34	26:08
35	26:40

APPENDIX D

AGE, HEIGHT, AND WEIGHT RAW DATA

Subject	Age (yrs)	Height (in)	Weight (lbs)
Black	30	69.00	188.1
Caughey	30	67.25	156.9
Coffman	29	71.50	197.8
Crump	29	71.25	183.2
Denning	26	72.00	204.6
Herzfeld	29	69.25	183.3
Johnson	32	74.26	181.1
Kenney	24	70.75	163.1
Kidd	28	69.25	184.8
Kobik	34	73.75	182.9
Laudicino	26	66.50	160.3
Luterman	31	67.50	205.6
Malhoit	31	70.75	171.2
McMundie	31	65.75	151.9
Newman	33	71.75	184.5
Rose	28	70.00	178.5
Taylor	35	70.75	189.3
Womer	26	64.25	168.5
Whitten	35	72.00	158.7

APPENDIX E

ISOTONIC AND ISOKINETIC RAW SCORES

Subject	Isotonic (lbs)		Isokinetic (ft lbs)	
	T_1 T_2	T_1 T_2	T_1 T_2	T_1 T_2
Black	160-150	420-380	244-240	1100-1030
Caughey	140-125	280-300	224-188	640- 700
Coffman	155-145	380-380	240-190	1110- 925
Crump	135-125	260-250	188-187	800- 840
Denning	155-145	400-360	210-185	790- 830
Herzfeld	175-165	360-360	240-210	930- 940
Johnson	135-135	260-230	240-210	750- 615
Kenney	225-220	400-380	256-240	800- 925
Kidd	155-150	325-280	210-195	740- 755
Kobik	150-145	360-335	225-180	1015- 940
Laudicino	150-125	320-340	226-210	690- 685
Luterman	155-155	380-380	212-210	910- 825
Malhoit	140-130	440-400	229-210	950-1050
McMundie	120-120	280-280	178-132	560- 450
Newman	140-135	320-320	200-170	990- 900
Rose	145-140	360-360	196-192	965- 955
Taylor	140-140	400-380	205-187	750- 800
Womer	185-170	630-630	240-240	880- 910
Whitten	130-130	320-320	165-195	625- 805

APPENDIX F

CARDIOVASCULAR RAW SCORES

Subject	Treadmill Times (min)		$\dot{V}O_2$ (ml/kg/min)	
	T_1	T_2	T_1	T_2
Black	7:30	9:30	39.9	45.5
Caughey	8:00	10:00	44.1	48.7
Coffman	6:15	7:30	44.6	46.8
Crump	8:15	9:00	43.9	49.4
Denning	7:15	8:45	42.2	45.9
Herzfeld	7:30	10:00	43.0	46.0
Johnson	4:35	7:15	41.8	42.8
Kenney	9:00	10:00	48.4	50.1
Kidd	7:15	8:15	45.0	49.9
Kobik	8:30	9:45	45.2	45.1
Laudicino	7:45	10:00	44.8	45.4
Luterman	7:15	8:30	40.9	41.8
Malhoit	7:00	9:00	36.0	44.0
McMundie	7:00	9:15	46.8	56.1
Newman	9:00	10:45	43.1	41.3
Rose	7:00	8:30	40.0	45.1
Taylor	7:30	11:00	38.3	44.9
Womer	8:00	11:00	42.3	47.3
Whitten	8:30	9:00	50.3	50.8

APPENDIX G

INSTITUTE FOR AEROBICS RESEARCH

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Caughey Chuck — NAME (LAST, FIRST)   Cybex — PROJECT   AGE   HEIGHT   SEX   MONTH   YEAR   GROUP   NUMBER

DEFINITION OF CODES

MODE:
TRK = Track or field
TML = Treadmill
BIK = Stationary cycling

WEEK:
Week number in training study

WO:
Workout number in current week (e.g. 1, 2, 3, 4, 5)

INT:
Intensity of workout interval
H = High (e.g. jog/run)
L = Low (e.g. walk/jog)

DISTANCE:
For Track: distance of one interval
For Treadmill: speed of treadmill in miles/hour
For Bike: load in kilogram-meters/min. (e.g. 300, 600, etc.)

PACE:
Time for one interval

REPS:
Number of repetitions of an interval

TIME:
For Track: leave blank
For Treadmill or Bike: total time at pace

HR:
Ten second heart rate times six taken at the middle and end of workout

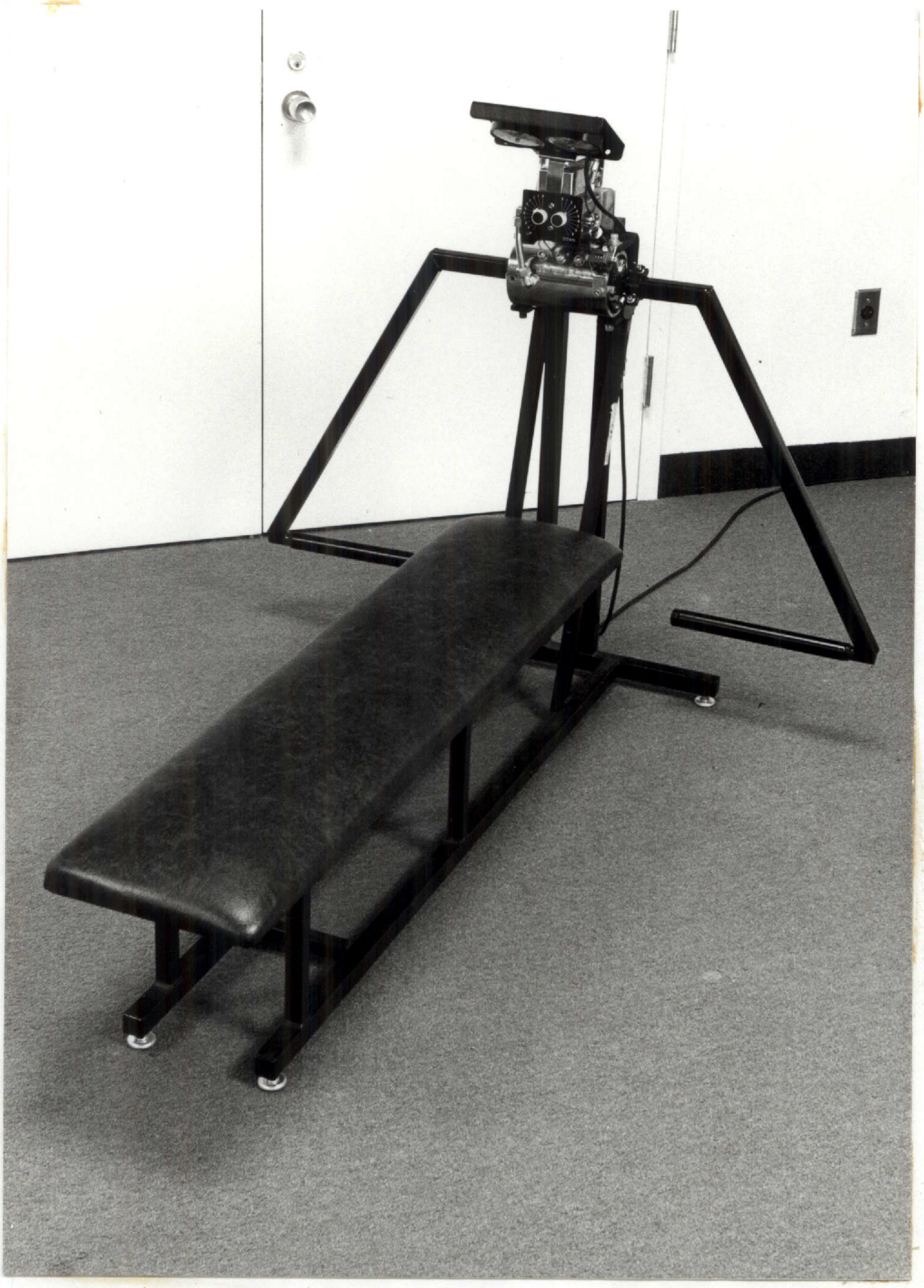
WEIGHT:
Body weight to nearest ½ pound prior to workout

TOTAL TIME:
Total time of entire workout

	MODE	WEEK	WO	INT	DISTANCE	PACE	REPS	TIME	INT	DISTANCE	PACE	REPS	TIME	MID-HR	END-HR	WEIGHT	TOTAL TIME
22	TRK	01	2	L	110	1:00	8	8:00	H	330	1:39	8	12:00	182	198	155.00	20:00
24	TRK	01	3	L	110	1:00	8	8:00	H	330	1:30	8	12:00	195	199	155.00	20:00
26	TRK	01	1	L	110	1:00	9	9:00	H	330	1:33	9	16:00	185	190	155.00	25:00
29	TRK	02	2	L	110	1:00	9	9:00	H	330	1:30	9	14:00	191	196	155.00	23:00
31	TRK	02	3	L	110	1:00	9	9:00	H	330	2:30	9	14:00	183	190	154.00	23:00
1	TRK	03	1	L	110	1:00	8	8:00	H	550	2:35	8	21:00	186	180	154.00	29:00
3	TRK	03	2	L	110	1:00	8	8:00	H	550	2:30	8	22:00	188	184	154.00	30:00
5	BIK	08	3	L	300	1:00	8	8:00	H	900	3:00	8	20:00	160	155	154.00	28:00
7	BIK	04	1	L	300	1:00	6	6:00	H	900	3:00	7	21:00	164	160	154.00	27:00
8	BIK	04	2	L	300	1:00	6	6:00	H	900	3:00	7	21:00	168	180	154.00	27:00
9	BIK	04	3	L	300	1:00	6	6:00	H	1200	3:00	7	32:00	150	194	154.00	27:00
10	BIK	05	1	L	300	1:00	6	6:00	H	1200	3:00	6	18:00	167	174	154.00	24:00
12	BIK	05	2	L	300	1:00	6	6:00	H	1200	3:00	6	18:00	152	174	154.00	24:00
13	BIK	05	3	L	300	1:00	6	6:00	H	1200	3:00	6	18:00	152	166	154.00	24:00
14	BIK	06	1	L	300	1:00	6	6:00	H	1200	3:00	6	21:00	152	166	154.00	24:00
16	BIK	06	2	L	300	1:00	6	6:00	H	1200	3:00	7	21:00	156	162	154.00	27:00
19	BIK	06	3	L	600	1:00	8	8:00	H	1200	3:00	8	24:00		180	154.00	32:00

(continue on back side)

APPENDIX H

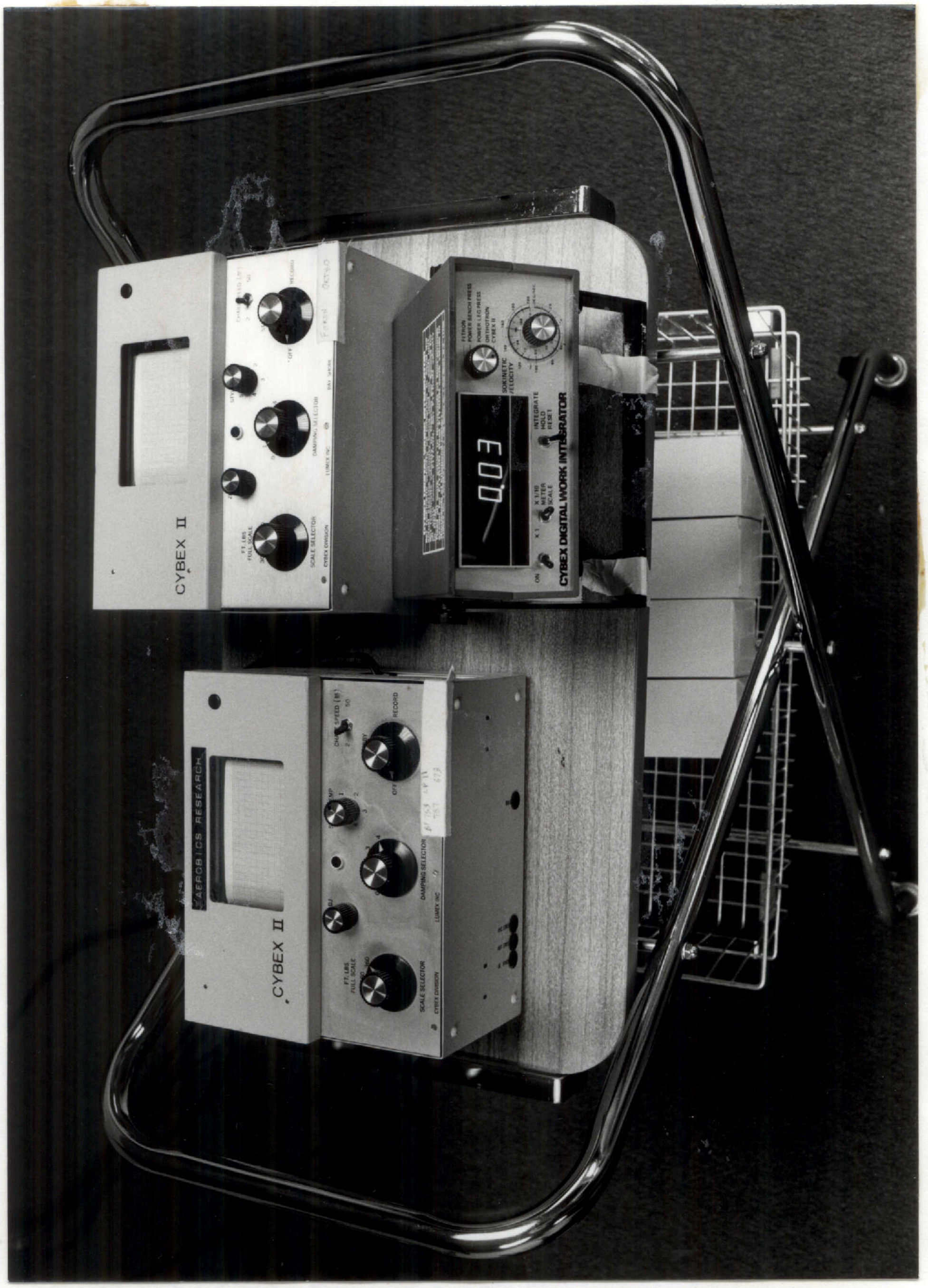


Isokinetic Bench Press Machine

APPENDIX I

Isokinetic Leg Press Machine

APPENDIX J



Isokinetic Work Integrators

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