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Thirty-two women students at The University of North Carolina at Greensboro participated in a study of the effect of two different exercise programs, one isometric and one stretching, on selected girth and skinfold thickness measurements. The subjects were randomly divided into two groups, both of which exercised daily for a four weeks period. All subjects were measured at the beginning and end of the study. Girth measurements were taken of the hips, waist, and right upper-arm. Skinfold thicknesses measured were triceps and subscapular.

Using Fisher's "t" test of significant difference between initial and final scores, the isometric exercise group showed a reduction of hip girth, upper arm girth and upper arm skinfold measurements significant at the five per cent level of confidence or better. There was no statistically significant difference in initial and final measurements of the waist girth and subscapular skinfold thickness.

The stretching exercise group showed a significant reduction of all measurements. These reductions were significant at better than the five per cent level of confidence.

There was a statistically significant difference between groups, as determined by an analysis of covariance, in only one of the five measurements. The subscapular skinfold thickness measurement of the stretching exercise group showed a reduction

greater than the isometric exercise group. This difference was significant at the one per cent level of confidence.

From the results of the study, the following conclusions were made:

(1) Either isometric or stretching exercises can be effective in reducing selected girth and skinfold thickness measurements of college women.

(2) According to this study, one exercise program (isometric) was not superior to the other (stretching) in reducing girth measurements of college women.

(3) Girth and skinfold thickness measurements can be reduced significantly in a four-weeks period, exercising daily.

THE EFFECT OF TWO DIFFERENT EXERCISE PROGRAMS ON COLLEGE WOMEN AS MEASURED BY GIRTH AND SKINFOLD THICKNESS

by

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APPROVAL SHEET

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CHAPTER I

INTRODUCTION

The role of exercise in weight and figure control has been considered primarily as one of reducing weight by burning up stored fat. However, since the publication of the energy costs of a variety of activities, the public seems resigned to the futility of exercising to lose weight. For example, one publication reads, ". . . it is necessary for certain individuals to walk 35 miles, or play 8 hours of squash, or wrestle for 5½ hours to lose a single pound of fat." (12, p. 23)

Weight can be lost by exercising, but it usually takes more time than most people want to invest. Burt and Blythe (12) say that regular exercise prevents "creeping overweight" or the gaining of weight over an extended period of time. This belief is in complete agreement with Mayer and Stare. (14) Burt and Blythe rephrase the above statistic so that it is more appealing to the public:

> On the contrary, if we walked one mile per day for a year, this would mean that we would walk enough to lose at least ten pounds in a year, or if we played a vigorous 30-minute game of squash each day, it would burn the caloric equivalent of sixteen pounds of fat in a year. (12, p. 24)

Weight loss is not the only contribution of exercise to weight control. Exercise strengthens the muscles involved.

Unfortunately, however, too many girls and women are not concerned with these facts. They are more concerned with having a body that meets ideal measurements - whatever they might be this year.

Although surveys show (5) that the majority of women do not conform to an "ideal" figure, their findings do not hinder members of the female population from trying to obtain it. Some women turn to dress to obtain the desired results, but more turn to dieting. There exist today hundreds of diets purported to build the female figure up or down. Usually, it is the quickest, easiest method, not necessarily the best one many women attempt. Nutritionists are continually warning society of the proven ill effects of fad diets such as the crash or the grapefruit diet. Although all women do not heed the warnings of the nutrition experts, the facts about fad diets exist in print and have been backed up by research. If a woman decides in favor of such a diet, she at least knows what she can expect from it.

The publicity given to isometric exercises, because of the small amount of time it takes to complete them, has opened a new door for the figure conscious female. So called "exercise specialists" are claiming, "Exercise your way to a perfect figure in only seconds a day." As nutritionists have investigated the effects of fad diets and printed the results, so should the researchers in exercise physiology investigate and print the results of such exercise programs on weight and figure control.

With the above points in mind, the following study was designed to investigate the effects of two different exercise programs on selected girth and skinfold thickness measurements. An isometric exercise program was chosen to investigate the claims made by Salls (31) and writers for popular women's magazines of tremendous changes in measurements in only seconds a day.

In reviewing various exercise programs, the author noted that stretching exercises were usually included. Stretching exercises are usually used to increase flexibility. The author was interested in determining what other effects they might have and, therefore, decided to investigate their effects on selected girth and skinfold thickness measurements.

The results of the two exercise programs were compared to determine if the effects of the two programs were similar or different.

CHAPTER II

STATEMENT OF PROBLEM AND DEFINITION OF TERMS

I. STATEMENT OF PROBLEM

It was the purpose of this study to determine the effects of an isometric exercise program and a stretching exercise program on girth and skinfold thickness measurements of two groups of college women.

The results of the two exercise programs as determined by the anthropometric measurements made were compared to determine how the effects of the two programs differed or were similar.

II. DEFINITION OF TERMS

The following terms used throughout the study are defined as follows:

Static stretching exercise. This is an exercise involving a held position with no movement, slow or fast, in which the body segments to be stretched are locked into a position of greatest possible length.

Ballistic stretching exercise. This exercise involves elongating the muscle to be stretched to its greatest length by a series of bouncing movements.

Isometric exercise. This is an exercise in which the muscles involved are placed in a state of as near maximum contraction as possible and held for a length of time.

Spot Reduction. Spot reduction is the process of reducing a specific area of the body in girth and skinfold thickness measurements by exercising that specific area.

LIMITATIONS OF STUDY

The following uncontrolled variables may have influenced the results of this study and are hereby listed as limitations of the study:

(1) No attempt was made prior to the study to determine the areas of greatest fat deposits for each subject, therefore the two experimental groups may have varied in this respect.

(2) In the isometric exercise group, it was assumed that the subjects performed the contractions maximally as directed; but the contractions may have been submaximal, depending on the individual subject's interpretation of a maximal effort.

(3) The size of groups may have been too limited. A larger sample of the population might have yielded different results.

(4) Although no students were enrolled in classes involving strenuous activities, it is possible that participation in golf, archery, and bowling might have been sufficient to influence the results obtained.

CHAPTER III

REVIEW OF LITERATURE

The review of literature for this study was undertaken to determine what is known about the effect of exercise on the human body. As exercise has a direct or an indirect effect on all parts of the body, the following topics were selected as being most pertinent to the study: muscle tonus, muscle girth, spot-reduction, isometric exercises, stretching exercises, and anthropometric measurements. Literature was reviewed on each of these topics.

Muscle Tonus

It has been generally accepted in the past that exercise increases the tonus of a muscle. However, physiologists are not in complete agreement as to what "muscle tonus" is, and how much or which part of the muscle is involved.

Morehouse and Miller define tonus as, "A slight sustained contraction of a muscle." (6, p. 304) deVries reports that the

> . . . classic experiments of Sherrington on stretch reflexes resulted in the theory that muscle tonus was the result of a partial tetanus of muscle tissue in which there is a constant state of activity by a small portion of the muscle fibers . . . . Forbes speculated that this muscle tonus was brought about not by constant contraction of the same fibers but by a 'rotation of duty' among many different motor units. Thus it was considered that the skeletal muscles were never in a state of complete rest. (3, p. 190)

With the invention of electromyographic equipment and the discovery that muscles can be electrically silent, Basmajian says

> . . . the general tone of a muscle is determined both by the passive elasticity or turgor of muscular (and fibrous) tissues and by the active (though not continuous) contraction of muscle in response to the reaction of the nervous system to stimuli. Thus, at complete rest, a muscle has not lost its tone even though there is no neuromuscular activity in it. (3, p. 191)

Wells agrees with Basmajian's interpretation of muscle tonus and speculates further that the increased number of myofibrils and the enlargement of individual muscle fibers, both factors in the hypertrophy of a muscle, might also be factors in their firmness. (10, p. 165)

deVries concludes that, "Exercise is thought to improve resting muscle tonus, but experimental evidence to support this hypothesis is lacking at the present time." (3, p. 202)

Muscle Girth

The increase in the size of a muscle fiber is known as hypertrophy and according to deVries is brought about ". . . by subjecting a muscle to greater loads than those to which it is accustomed." (3, p. 303)

Steinhaus says that as early as 1897, Morpurgo showed that exercise makes a muscle increase in size and strength. (7, p. 366)

Edelstein (25) supports the findings of Morpurgo in a recent study using high school students. The students, divided

into two groups - one which exercised daily and the other on alternate days, exercised the muscles of their right upper arms with weights for a period of six weeks. The results showed no significant difference between the two groups but both groups gained significantly in strength and girth of the upper arm and showed a decrease in adipose tissue in that area.

However, a study by Bowers (23) using isometric exercises showed an increase in strength of the muscle exercised, but it did not show an increase in the girth of the muscles.

It seems that a certain degree of muscle tonus must be obtained initially before a muscle actually begins to hypertrophy. Day, in a study of the reduction of the waistline of women by maximum isometric contraction of the abdominal wall notes, "The average girl seems to lack degrees of muscle tonus in the abdominal muscle necessary to hold the abdominal wall in place." (24, p. vii) The subjects in Day's experimental isometric group decreased an average of 1.24 inches in the waistline over a six weeks period.

In a similar study by Mohr (15), thirty college women did six maximum isometric contractions daily for four weeks. Each contraction was held for six seconds. Significant evidence supported the hypothesis that isometric contractions can aid in reducing girth and skinfold thickness at the waistline and the umbilical level of the abdomen.

Vandine (27) compared the effects of two exercise programs, one isometric and one isotonic, on girth measurements of

the hips and thighs of college women. At the end of eight weeks, there was no significant difference between the two groups, but both groups had a significant reduction in their girth measurements in the hip and thigh areas.

Spot Reduction

Spot reduction is the process of reducing a specific area of the body in girth and skinfold thickness measurements by exercising that specific area. Spot reducing, as indicated by Mohr (15) in her study showing reduction of girth and skinfold thickness measurements of the waist, is a source of conflicting research.

According to Roby (17) in a study of the effects of exercise on regional subcutaneous fat accumulations, his findings did not support the postulate that subcutaneous fat is reduced in localities where muscles are active and in proportion to their activity.

There is general agreement in studies of the female configuration that fat tends to accumulate in the hip, thigh, and abdominal regions. While the trunk and arms may be involved also, the forearms and legs are usually not.

In a comparison of spot and generalized exercises, Schade (19) found evidence of reduction in body segments where fat accumulations had been most conspicuous, regardless of the type of exercise administered.

A special committee from the United States Department of Health, Education, and Welfare, appointed to investigate and report on the effects of obesity on health, reports,

> To a large extent the distribution of body fat is controlled genetically and hormonally. Except in treatable cases of endocrine abnormality, fat deposition patterns cannot be changed. Persons with abnormal fat deposits may be obese also, but as these people reduce, the abnormal fat deposits will still remain disproportionately large even though they do decrease.
>
> Therapeutic efforts should concentrate on bringing understanding to the patient and helping him to live with the situation. This is particularly true for young women, for whom esthetic considerations are so important, because their lack of understanding may lead to unwarranted anxiety or unnecessary dieting. (29, p. 12)

Isometric Exercises

Isometric is a Greek term meaning "same length." In an isometric contraction, the muscle involved is tensed while the length of the muscle remains constant.

Because of the recent emphasis on isometrics, many people have considered these exercises to be something new; but Steinhaus (7) says they are the same as exercises advocated by Svoboda and Atlas. Only the names were different. Svoboda called his exercises "conscious evolution" while Atlas called his "dynamic tension."

The first published research on isometric exercises was done by Hettinger and Muller. They were trying to determine the effect of varying amounts of overload on a muscle. Isometric exercises were chosen for use in their study because the amount of tension developed in a muscle can be measured more exactly when the muscle does not shorten. When their work was published in 1953, their findings indicated that one daily,

6-second contraction at two-thirds a person's maximum effort would yield a maximum training effect. (3, p. 307)

Since the publishing of Hettinger and Mueller's work, isometric exercises have been investigated by numerous researchers. The primary areas studied have been the optimum length of time each contraction should be held, the effect of repetitions or series of contractions as compared to one contraction daily, the optimum degree of contraction, and the effect of the contraction on strength and girth measurements.

Wallis and Logan (9) report the optimum length of time each contraction should be held to be ten seconds. The degree of contraction they recommend is a maximum contraction. Hislop (26) used a fifteen second contraction, while Wessel suggests starting with a three second contraction and working up to a six second one. Thompson (21) also used a progression but started with a three or four second contraction and progressed to an eight second maximum.

In a re-evaluation of isometric training methods and results, Royce (18) discusses the results of a more recent study by Mueller and Rohmert. This study indicated that the potential maximal strength plateau and the rate of strength increase become larger when the duration of the maximal static contraction is changed from one to five seconds. This study also indicated that repeating a short maximal contraction several times a day did not increase the training effect.

According to Vandine (27), Asa, Hislop, Rarick and Larsen all recommend a series of contractions daily for greater strength gains.

Most researchers agree that isometric exercises, when producing an overload on a muscle, will increase the strength of the muscle. There is some disagreement, however, as to the effect of these exercises on girth measurements. This point is discussed in the review of literature on the effects of exercise on girth measurements.

Stretching Exercises

A stretch may be defined as an extending or lengthening process. The stretching of a muscle would then be a lengthening of the muscle. There is a question, however, as to whether it is the muscle or muscle fibers that stretch or if it is the tendon involved which stretches.

Wells reports that there are three types of contractions: concentric, eccentric, and static. A concentric contraction is a shortening of the muscle; an eccentric contraction is a lengthening of the muscle; and in a static contraction the muscle remains the same. From these definitions it would seem that a stretch is an eccentric contraction. But Wells clarifies her definition by stating, "The term 'lengthening' is misleading, as in most instances the muscle does not actually lengthen. It merely returns from its shortened condition to its normal resting length." (10, p. 57)

A stretch then is not a contraction but, according to Steinhaus, it can invoke a contraction.

> . . . the sense-endings in muscle and tendon are stimulated by stretching. Sherrington found that when he pulled on a muscle it responded with marked shortening. This is called the stretch reflex. (7, p. 113)

This leads to a questioning of the effects of stretching exercises. Steinhaus states,

> . . . I immediately questioned the value of stretching muscles to lengthen them. Perhaps if the muscle were first consciously relaxed (all tonus inhibited) a bit of stretching would be good for the connective tissue in the muscle. . . . at best there is danger of stimulating the sense-endings and thus invoking the contraction of the stretch reflex. (7, p. 113)

Wells discussed the stretch reflex in more detail,

> In its simplest form the stretch reflex is a local response to stretch. For example, a muscle is subjected to stretch. The muscle spindles pick up the stretch stimulus and transmit it by way of the afferent neuron to the spinal cord. There the central terminal branches of the sensory neuron synapse directly with the dendrites of the motor neuron which innervates the same muscle fibers that were stretched. These fibers then contract. (10, p. 163)

Gardner, according to Wells, classifies stretch reflexes as phasic and static types. The phasic type is extremely rapid and the contraction brief. The static type is slow and the muscle contraction more sustained. (10, p. 164)

The phasic and static stretch reflexes defined by Gardner bear some similarity to deVries' definitions of ballistic and static stretching. According to deVries, ballistic stretching

requires short, jerky movements while lengthening the muscles involved. Static stretching on the other hand is a held stretch with the muscle in a position of its greatest length.

deVries conducted a study to determine the effect of ballistic (moving) and static (held) stretching exercises on flexibility of college students. There was no significant difference between the two groups in the amount of flexibility achieved, but both groups increased in flexibility at the .01 level of significance. deVries noted, however, that the ballistic stretch group reported soreness from their exercises whereas the static stretch group did not. (13, p. 24)

The review of literature in this area of stretching exercises seems to imply that stretching exercises can cause a contracting of the muscles involved instead of a lengthening and if any substances are actually lengthened by these exercises, they are most likely the tendons involved. However, since most studies of stretching exercises are done in terms of flexibility and posture, the above implications must remain simply implications until specific research is conducted to verify them. As of this time, the author could find no such research.

Anthropometric Measurements

Anthropometric measurements consist of objective measurements of structures and of functions of the body. (5, p. 345) These measurements include measures of girth, height, weight,

body fat and strength. Since the work done by Hitchcock at Amherst in 1861 using anthropometric measurements, the techniques have been refined. Researchers are attempting to standardize the techniques used so studies can be more readily analyzed and compared.

Brozek (2) has compiled a book which lists the most acceptable techniques for making these measurements. He recommends that a pilot study be performed before engaging in a mass survey. This way the researcher can establish a consistent technique thereby producing more reliable measurements.

Although not as precise as some techniques, anthropometric measurements serve as reliable measures of change in the human body. There is some expressed concern that these measures are outdated, but Metheny and Cureton say, "The idea should be dispelled that anthropometry is an outmoded subject." (1, p. 20) In mass surveys, it is more functional than more involved techniques.

It is recommended by Brozek (2) that girth measures be made with a steel tape to eliminate possible stretching of the tape.

The use of the skinfold thickness caliper has proven to be the most functional and reliable technique for measuring subcutaneous fat deposits. The body density test, although slightly more accurate, is more involved to administer and requires special, expensive equipment.

The technique recommended by Brozek in making a skinfold measurement is as follows:

> The skin should be lifted by grasping firmly a fold between the thumb and forefinger at about a distance of one centimeter from the site at which the skinfold is to be measured. (2, p. 10)

Young (22) lists the following possible skinfold sites: (1) the chin under the mandible, (2) below the tip of the scapula, (3) the chest, midaxillary border of the pectoralis major and at the xyphoid level on the midaxillary line, (4) the lateral aspect of the thorax over the lower rib midway between the axilla and the iliac crest, (5) the waist, on the midaxillary line, halfway between the lower rib and the iliac crest, (6) the abdomen, just to the right of the unbilicus and also halfway between the unbilicus and the pubis on the midline, (7) the suprailium on the midaxillary line, (8) the upper arm, over the triceps midway between the tip of the acromial process of the scapulas and the tip of the elbow, (9) the thigh, halfway down over the rectus femoris muscle, (10) and the knee, over the patella.

Brozek (2) recommends measuring the upper arm skinfold or triceps skinfold and the subscapula skinfold. In studies involving subscutaneous fat deposits, Sloan, Burt and Blythe (20) recommend the vertical skinfold thickness over the iliac crest.

It is possible to estimate the amount of body fat in an individual by inserting skinfold thickness measurements into a specific gravity equation and then in turn into an equation

designed by Rathbun-Pace (16) to convert specific gravity into per cent body fat.

Estimation of body fat, however, was not used in this study as the only equation of specific gravity for women was one formulated by Young (22) and involved measuring skinfolds on the midabdominal line halfway between the umblicus and pubis. This skinfold site is difficult to measure consistently as the skin on the abdomen can be tensed or relaxed simply by the subject's inhaling or exhaling.

Summary

In general, the review of literature for this study indicates that most researchers believe exercise improves muscle tone. However, this point has not been scientifically established.

The effect of exercise on girth, according to the literature reviewed, varies depending on the initial condition of the muscles involved. A poorly conditioned muscle, when subjected to overload, will tend to decrease in girth. Once a basic state of tonus is acquired, the muscle will begin to hypertrophy or increase in size.

While there is agreement in studies as to the location of fat deposits on women, there is disagreement as to the effect of exercise on these locations. Some research indicates that fat deposits can be reduced by exercising the area involved; other research indicates that fat is removed from the area in which it was most recently deposited, regardless of the area exercised.

Although researchers disagree on the number of repetitions, length of contraction, intensity, and effect on girth of isometric exercises they agree that isometric exercises increase the strength of the muscles involved.

The literature on stretching exercises implies that a stretch can initiate a contraction ("stretch reflex") and could conceivably affect the girth and strength of the muscles involved. However, the author found no research to this effect.

With these facts in mind, the following study was conducted.

CHAPTER IV

PROCEDURE

This study was designed (1) to investigate the effects of an isometric exercise program on selected girth and skinfold thickness measurements of college women, (2) to investigate the effects of a stretching exercise program on selected girth and skinfold thickness measurements of college women, (3) to compare the effects of the two exercise programs and to determine if the results were similar or different.

Initially, it was hypothesized that (1) neither isometric exercises nor stretching exercises would have an effect on the girth and skinfold thickness measurements of college women, and (2) there would be no significant difference between the effects of the two exercise programs.

Selection of Subjects

Subjects for this study were college women volunteers. Notices requesting participants for the study were placed in all women's residence halls on the campus of The University of North Carolina at Greensboro in the spring of 1967. (See Appendix for copy of notice.)

Thirty-two women students responded to the notice and met for an organizational meeting at 6:30 p.m. on Monday, April 10 in

the Rosenthal Gymnasium. The purpose of the study was explained to those present. Those persons who were interested and eligible signed up for an initial measuring date and time. To be an eligible participant, a person had to be a female student at The University of North Carolina at Greensboro who was not scheduled for vigorous, physical activity for the four-week testing period. Students enrolled in golf, archery, bowling, and recreational sports classes were considered eligible as these activities were not classified as vigorous activities. All thirty-two women present signed up to be measured.

A second meeting was held Thursday, April 13 at 6:30 p. m. in the Rosenthal Gymnasium to designate exercise groups and to explain and demonstrate the exercises. The subjects were randomly assigned to an exercise group by drawing their names from a hat. Each subject then received a sheet which described her exercises and an individual score card for recording the days she exercised. (See Appendix for explanation of exercises and copy of individual score card) These cards, designed for a one week exercise period, were issued and collected weekly by the author. This procedure gave the author an opportunity, once a week, to check on each subject and see how she was progressing with her exercise program. A general information card (see Appendix for a copy) giving the name, age, address, state of health, and regular physical activities of the subjects was also filled out at this time.

Subjects were cautioned not to try to gain or lose weight. They were told their diet should remain constant. The loss or gain of over five pounds would result in a subject being dropped from the study.

At this second meeting, each subject selected a partner for the duration of the study whose responsibility was to encourage and remind her to do her exercises daily. After dividing into their respective groups, the subjects performed the exercises under the observation and direction of the author. This meeting was considered as the first day of the exercise program.

Selection of Measurements

Each subject was measured twice during the study, once prior to the start of the exercise program and again at the conclusion of the four-week exercise period. All measurements were made by the author. Prior to beginning the study, practice sessions enabled the author to establish consistency in the measuring techniques.

All subjects were measured while clothed only in their underclothing. The subjects stood on a stadiometer for all measurements except the weight measurement. The following measurements, made according to the recommendations of Brozek (2), were taken:

Height. This measurement was recorded to the nearest quarter of an inch. It was made to insure similar posture during the initial and final measurements. Each subject was

instructed to focus her eyes on a spot on the wall, hold her chin horizontal to the floor, and align her head, shoulders, hips and heels with the height indicator on the stadiometer.

Weight. Subjects were weighed on a balanced set of scales and weight was recorded to the nearest pound. The scales were checked at the beginning and end of the study with an eleven pound weight to check their consistency.

Girth. A steel tape was used for all girth measurements. Three girth measurements were taken and each was recorded to the nearest quarter of an inch. The first was taken at the hips measuring the largest part as determined visually with the aid of a mirror. The second measurement, the waist was measured at the subject's natural waistline. The third girth measurement was of the subject's right, upper arm. In order to determine the point at which this measurement was to be made, the distance between the tip of the elbow and the acromium process of the scapula was measured. This was done with the subject's arm flexed at a 90^{o} angle. At a point one-half the above determined distance, the upper arm girth measurement was taken with the subject's arm relaxed at her side.

Skinfold. A skinfold thickness caliper designed by First Lieutenant William R. Best of the Medical Nutrition Laboratory, United States Army, was used for all skinfold measurements. The caliper was checked and calibrated prior to the study by an exercise physiologist at The University of North Carolina at Greensboro according to the specifications of Lieutenant Best.

The two skinfold sites used were the triceps and subscapula. All measurements were recorded to the nearest millimeter.

The triceps skinfold measurement was taken at a point one-half the distance between the tip of the elbow and the acromium process of the scapula on the subject's right arm. This measurement was taken with the subject's arm relaxed at her side. Three measurements were recorded and an average taken to insure accuracy of the measurement.

The subscapula skinfold thickness measurement was taken at a point just below the lower tip of the right scapula. Three measurements were recorded and an average taken.

Exercise Programs

The thirty-two subjects were randomly assigned to one of two exercise groups, isometric or stretching. Sixteen women were assigned to the isometric exercise group and sixteen to the stretching exercise group. Both groups exercised daily, on a volunteer basis, for a period of four weeks.

The isometric exercises consisted of nine exercises designed by Wallis and Logan (30) plus one designed by Mohr (15). (See Appendix for explanation of these exercises.) Each exercise was held for ten seconds once a day. The approximate length of the daily exercise period for this group was three minutes.

The ten stretching exercises consisted of nine static-stretch exercises taken from a study by deVries (13) and one

designed by the author. The first day of the program, each exercise was held for thirty seconds, the second day for 40 seconds, the third day for 50 seconds, and the fourth day for one minute. For the remainder of the study, each exercise was held for one minute. The approximate length of the daily exercise period for the stretch group was ten minutes.

Treatment of Data

Five measurements were recorded for each of the subjects in the study: (1) hip girth measurement, (2) waist girth measurement, (3) upper arm girth measurement, (4) upper arm skinfold thickness measurement, (5) subscapula skinfold thickness measurement.

To determine if there was a significant change in the initial and final measurements within each group, Fisher's "t" test of significance for small, correlated samples was computed. The following formula given by Van Dalen (8, p. 383) was used:

$$\text{"t"} = \frac{\overline{D}}{\sqrt{\frac{d^2}{N\ (N-1)}}}$$

A two-tailed test of significant difference was used as the direction of the scores was pertinent.

An analysis of co-variance as described by Ferguson (4, pp. 326-340) was used to determine if there was a significant difference between the isometric and stretching groups at the end of the study. This statistical technique makes adjustments in the data for uncontrollable variables and enables a researcher

to work with data which has such variables in it. The variable in this study was the fact that the two groups, isometric and stretching, were not equated with respect to all measures at the beginning of the study.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA

This study, conducted at The University of North Carolina at Greensboro during the second semester of the 1966-67 academic year, was designed to investigate the effects of two exercise programs as follows:

(1) to determine the effect of an isometric exercise program on girth and skinfold thickness measurements of college women.

(2) to determine the effect of a stretching exercise program on girth and skinfold thickness measurements of college women.

(3) to compare the effects of an isometric exercise program with the effects of a stretching exercise program and to determine if the effects were similar or different in relation to anthropometric measurements.

Presentation of Findings

Thirty-two subjects who volunteered to participate in the study were measured initially as to hip girth, waist girth, upper arm girth, upper arm skinfold thickness, and subscapula skinfold

thickness according to techniques described by Brozek (2). The subjects were then randomly assigned to an exercise program, isometric or stretching, by drawing their names from a hat. The groups were not equated on the basis of any measurements.

Both groups exercised daily using either isometric or stretching exercises for a four-weeks period. By the end of the four weeks, six subjects had been dropped from the study for continually failing to do the exercises. The remaining twenty-six subjects, twelve in the isometric group and fourteen in the stretching group, were re-measured to determine whether changes in girth and/or subcutaneous fat had occurred.

Tests of Significance

Fisher's "t" test of significance of difference between means for correlated groups (8) was used to determine if there was a significant change in the measurements of the subjects within each group. A two-tailed test for significant difference was used as the study was not limited to one direction of change. It was originally hypothesized that the measurements would not change.

As shown in Table I, in the test of significant difference in the measurements of the isometric exercise group, the hip girth and upper arm skinfold thickness measurements decreased sufficiently to be considered significant at the one per cent level of confidence. The upper arm girth measurement decreased an amount which was statistically significant at the five per cent

TABLE I

WITHIN GROUP "t" TESTS OF DIFFERENCES BETWEEN MEANS OF INITIAL AND FINAL MEASUREMENTS OF GROUP I (ISOMETRIC) AND GROUP II (STRETCHING)

Groups	"t's"				
	Hip Girth	Waist Girth	Upper Arm Girth	Upper Arm Skinfold	Subscapula Skinfold
Group I	*-4.82	-.76	**-2.60	*-3.37	-1.79
Group II	*-3.37	**-2.55	*-2.94	*-4.32	*-3.10

*Significant at the one per cent level of confidence.
**Significant at the five per cent level of confidence.

level of confidence. However, the waist girth and subscapula skinfold thickness measurements showed no significant change.

In the stretching exercise group, the hip girth, upper arm girth, upper arm skinfold thickness, and subscapula skinfold thickness measurements all decreased. This reduction was statistically significant at the one per cent level of confidence. The waist girth measurement also showed a change which was statistically significant at the five per cent level. (See Table I.)

Since the two exercise groups were not equated prior to the study, any comparison between the two groups from the above scores would be invalid. In order to compare the results of the two programs, the analysis of covariance method (4) was used. An analysis of covariance is a statistical technique which takes into consideration uncontrollable variables, such as groups not being equated, and allows the researcher to make a valid judgment from the data collected.

When an analysis of covariance was figured between the isometric and stretching exercise groups (see Tables II, III, IV and V), there was no significant difference noted between four of the five measurements: hip girth, waist girth, upper arm girth, and upper arm skinfold thickness. These data indicate that one of the exercise programs, designed for use in this study, is not superior to the other in reducing girth and skinfold thickness measurements in these areas for the subjects who participated in this study.

TABLE II

ANALYSIS OF COVARIANCE FOR HIP GIRTH MEASUREMENTS
BETWEEN GROUP I AND GROUP II

Source of Variance	Sum of Squares: Y	Sum of Squares: X	Sum of Products	df	Adjusted Sum of Squares: X	df Adj. Sum of Sqs.	Variance Estimates	F
Between Groups	.55	1.04	.76	1	1.07	1	1.07	.38
Within Groups	61.98	67.46	97.72	24	64.97	23	2.82	
Total	62.53	68.50	98.48	25	66.04	24		

TABLE III

ANALYSIS OF COVARIANCE FOR WAIST GIRTH MEASUREMENTS
BETWEEN GROUP I AND GROUP II

Source of Variance	Sum of Squares: Y	Sum of Squares: X	Sum of Products	df	Adjusted Sum of Squares: X	df Adj. Sum of Sqs.	Variance Estimates	F
Between Groups	4.90	1.59	2.81	1	1.62	1	1.62	.47
Within Groups	88.75	79.63	79.58	24	78.83	23	3.43	
Total	93.65	81.22	82.39	25	80.45	24		

TABLE IV

ANALYSIS OF COVARIANCE FOR UPPER ARM GIRTH MEASUREMENTS
BETWEEN GROUP I AND GROUP II

Source of Variance	Sum of Squares: Y	Sum of Squares: X	Sum of Products	df	Adjusted Sum of Squares: X	df Adj. Sum of Sqs.	Variance Estimates	F
Between Groups	.62	.61	.62	1	.61	1	.61	.88
Within Groups	18.89	16.66	17.44	24	15.81	23	.69	
Total	19.51	17.27	18.06	25	16.42	24		

TABLE V

ANALYSIS OF COVARIANCE FOR UPPER ARM SKINFOLD MEASUREMENTS BETWEEN GROUP I AND GROUP II

Source of Variance	Sum of Squares: Y	Sum of Squares: X	Sum of Products	df	Adjusted Sum of Squares: X	df Adj. Sum of Sqs.	Variance Estimates	F
Between Groups	.50	.05	.16	1	.12	1	.12	1.09
Within Groups	3.78	3.11	2.78	24	2.56	23	.11	
Total	4.28	3.16	2.95	25	2.68	24		

However, the analysis of covariance for the subscapula skinfold thickness measurements between the isometric and stretching exercise groups, as is indicated in Table VI, produced an F which was significant at the one per cent level of confidence.

In order to determine which group reduced significantly more than the other in the subscapula skinfold thickness measurement, the adjusted means for both groups were computed. (See Table VII.)

Before adjustment, the mean of the initial measurements for the isometric exercise group was 1.38 and the mean for the final measurements was 1.24. The adjusted final mean was 1.38.

For the stretching group, the initial measurement mean was 1.79 and the final measurement mean was 1.57. The adjusted final mean was 1.45.

According to the adjusted final means, there was a difference between the two means which was statistically significant. This difference was in favor of the stretching group.

Interpretation of Findings

In the comparison of the means of the initial and final measurements of the isometric exercise group, three of the five measurements indicated a significant difference. The three significant measurement changes were hip girth, upper arm skinfold thickness and upper arm girth.

The hip girth and upper arm skinfold measurement changes indicated a reduction significant at the one per cent level of

TABLE VI

ANALYSIS OF COVARIANCE FOR SUBSCAPULA SKINFOLD MEASUREMENTS BETWEEN GROUP I AND GROUP II

Source of Variance	Sum of Squares: Y	Sum of Squares: X	Sum of Products	df	Adjusted Sum of Squares: X	df Adj. Sum of Sqs.	Variance Estimates	F
Between Groups	1.08	.70	.87	1	.66	1	.66	5.67*
Within Groups	4.55	3.88	2.87	24	3.48	23	.15	
Total	5.63	4.58	3.74	25	4.14	24		

*Significant at the one per cent level of confidence.

TABLE VII

ADJUSTED MEANS OF GROUP I AND GROUP II
FOR SUBSCAPULA SKINFOLD THICKNESS MEASUREMENTS

Group	N	Means		
		Initial Mean	Final Mean	Adjusted Mean
Isometric Group	12	1.38	1.24	1.38
Stretching Group	14	1.79	1.57	1.45

confidence. The upper arm girth change was significant at the five per cent level of confidence. The difference in the level of significance of the reduction in the upper arm girth and upper arm skinfold thickness measurements would appear to indicate that the isometric exercises increased the tone of the muscle while decreasing the subscutaneous fat deposit. These results support further the findings of Edelstein (25) and other researchers who have reported cases of spot reduction.

The two measurements that showed no significant change after four weeks of isometric exercises were the waist girth and subscapula skinfold measurements. The lack of reduction in waist girth is in direct opposition with the findings of Mohr (15) who reported a significant reduction in waist girth using an isometric exercise designed specifically for this purpose. As the author used Mohr's exercise in this study, the difference in results may be attributed to the degree of original tonus in the abdominal muscles of the subjects involved. If the original tonus of the muscles for the subjects in this study was high, the muscle would hypertrophy thus increasing girth instead of decreasing it.

The stretching group had a significant reduction in all five measurements. The level of significance of difference between means of the initial and final measurements was at the one per cent level of confidence for hip girth, upper arm girth, upper arm skinfold and subscapula skinfold thickness measurements. The waist girth reduction was significant at the five per cent level of

confidence. As indicated in the review of literature on stretching exercises, the author found no research testing the effects of stretching exercises on girth and skinfold thickness measurements. The above findings would appear to indicate that stretching exercises can be significantly effective in reducing girth and skinfold thickness measurements. The author suggests that stretching exercises be investigated further as a method of reducing selected measurements, girth and skinfold thickness.

The between group comparison of the two exercise programs' results using the analysis of covariance technique showed no significant difference with respect to the hip girth, waist girth, upper arm girth, and upper arm skinfold thickness measurements. These findings would seem to indicate that one exercise program was not superior to the other in reducing girth and skinfold thickness measurements of college women. However, the subscapula skinfold thickness measurement was significantly different in results when a between group comparison was made. The final skinfold measurement for the stretching group was significantly different from that of the isometric group. The difference could not be attributed to initial differences between the two groups on this measure. The degree of significance was at the one per cent level of confidence.

The difference between groups on the reduction of the subscapula skinfold measurement might possibly be attributed to the number of exercises involving the back muscles in each program.

The isometric exercise group had four of ten exercises (see exercises 2, 3, 6, and 10 in Appendix) which directly involved the back muscles around the subscapula region, whereas the stretching exercise program had seven out of ten (see exercises 1, 4, 5, 6, 7, 9, and 10 in Appendix).

CHAPTER VI

SUMMARY AND CONCLUSIONS

Consideration of the role of exercise in weight control has been concerned predominantly with weight reduction. Weight loss as a result of exercise is a long, tedious process. Since many people are more concerned with how they look and not particularly with what the scales read, the author decided to investigate the effects of exercise on girth and skinfold thickness measurements.

The study was designed with the following purposes in mind:

(1) to determine the effect of an isometric exercise program on girth and skinfold thickness measurements of college women.

(2) to determine the effect of a stretching exercise program on girth and skinfold thickness measurements of college women.

(3) to compare the effects of an isometric exercise program with the effects of a stretching exercise program and to determine if the effects were similar or different in relation to anthropometric measurements.

Thirty-two women students at The University of North Carolina at Greensboro volunteered to participate in the study during the Spring semester of 1967. They were randomly assigned to an exercise program, isometric or stretching, by drawing their names from a hat. The subjects were measured at the beginning of the study as follows: (1) hip girth, (2) waist girth, (3) upper arm girth, (4) upper arm skinfold thickness, (5) subscapula skinfold thickness.

The subjects exercised daily for a four weeks period. During the course of the study, six subjects were dropped from the roll for continually failing to do their exercises. The remaining twenty-six subjects, twelve in the isometric group and fourteen in the stretching group, were re-measured at the end of the four weeks to determine if there were any changes in girth and skinfold thickness measurements.

In tests of significant difference using Fisher's "t" for correlated groups, the isometric group showed a reduction in hip girth and upper arm skinfold thickness significant at the one per cent level of confidence, a reduction in upper arm girth significant at the five per cent level of confidence and no significant reduction in waist girth and subscapula skinfold thickness.

The stretching exercise group showed a reduction in four of the five measurements, significant at the one per cent level of confidence: hip girth, upper arm girth, upper arm skinfold thickness and subscapula skinfold thickness. The waist girth

measurement for this group showed a reduction which was significant at the five per cent level of confidence.

The results of the two groups were compared using the analysis of covariance technique. There was no significant difference between the results of the two exercise programs in hip girth, waist girth, upper arm girth and upper arm skinfold thickness measurements. However, the subscapula skinfold thickness measurements between the isometric and stretching groups when analyzed using the covariance technique indicated a difference between the results of the two groups which was statistically significant at the one per cent level of confidence. In reviewing the adjusted means of both groups, it was found that the stretching group had decreased significantly more than the isometric group. This difference may possibly be attributed to a greater number of exercises involving the back muscles in the stretching exercise program than in the isometric exercise program.

As a result of the above findings, the following conclusions have been drawn:

(1) Either isometric or stretching exercise can be effective in reducing selected girth and skinfold thickness measurements of college women.

(2) According to this study, one exercise program (isometric) was not superior

to the other (stretching) in reducing girth measurements of college women.

(4) Girth and skinfold thickness measurements can be reduced significantly in a four-weeks period, exercising daily.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

1. American Association of Health, Physical Education and Recreation. Measurement and Evaluation Materials in Health, Physical Education and Recreation. Washington, D. C.: N. E. A. Publications, 1950.

2. Brozek, J. (editor). Body Measurements and Human Nutrition. Detroit: Wayne University Press, 1956.

3. deVries, Herbert A. Physiology of Exercise for Physical Education and Athletics. Dubuque, Iowa: Wm. C. Brown Company, Pub., 1966.

4. Ferguson, George A. Statistical Analysis in Psychology and Education. Second edition. New York: McGraw-Hill Book Company, 1966.

5. McCloy, Charles H., and Norma D. Young. Tests and Measurement in Health and Physical Education. Third edition. New York: Appleton-Century-Crofts, Inc., 1954.

6. Morehouse, Laurence E., and Augustus T. Miller, Jr. Physiology of Exercise. Fourth edition. Saint Louis: C. V. Mosby Company, 1963.

7. Steinhaus, Arthur H. Toward an Understanding of Health and Physical Education. Dubuque, Iowa: Wm. C. Brown Company, 1963.

8. Van Dalen, Deobold B., and William J. Meyer. Understanding Educational Research. New York: McGraw-Hill Book Company, 1962.

9. Wallis, Earl L., and Gene Logan. Isometric Exercises for Figure Improvement. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964.

10. Wells, Katharine F. Kinesiology. Fourth edition. Philadelphia: W. B. Saunders Company, 1966.

11. Wessel, Janet. Movement Fundamentals. Second edition. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1961.

B. PERIODICALS

12. Burt, J. J., and Carl S. Blythe. "The Role of Exercise in Weight Control," Journal of Health, Physical Education and Recreation, 32:23-24, January, 1961.

13. deVries, Herbert A. "Evaluation of Static Stretching Procedures for Improvement of Flexibility," Research Quarterly, 33:222-29, May, 1962.

14. Mayer, J., and F. J. Stare. "Exercise and Weight Control: Frequent Misconceptions," Journal of American Dietetic Association, 29:340-343, April, 1953.

15. Mohr, Dorothy R. "Changes in Waistline, Abdominal Girth and Subcutaneous Fat Following Isometric Exercises," Research Quarterly, 36:168-173, May, 1965.

16. Rathbun, E. N., and N. Pace. "Studies on Body Composition: The Determination of Total Body Fat by Means of the Body Specific Gravity," Journal of Biological Chemistry, 158:557, May, 1945.

17. Roby, F. E., Jr. "The Effect of Exercise on Regional Subcutaneous Fat Accumulations," Research Quarterly, 33:273-278, May, 1962.

18. Royce, Joseph. "Re-evaluation of Isometric Training Methods and Results," Research Quarterly, 35:215-216, May, 1964.

19. Schade, Maja, F. A. Hellebrandt, Joan C. Waterland, and Marie L. Carns. "Spot Reducing in Overweight College Women: Its Influence on Fat Distribution as Determined by Photography," Research Quarterly, 33:461-471, October, 1962.

20. Sloan, A. W., J. J. Burt, and C. S. Blythe. "Estimation of Body Fat in Young Women," Journal of Applied Physiology, 17:967-970, June, 1962.

21. Thompson, Clem W. "Some Physiologic Effects of Isometric Work in Man," Research Quarterly, 25:476, December, 1954.

22. Young, Charlotte M. "Predicting Body Fatness of Young Women on the Basis of Skinfolds," New York State Journal of Medicine, 62:1667-1673, June, 1962.

C. UNPUBLISHED MATERIALS

23. Bowers, Louis A. "An Investigation of the Effects of Autosuggested Muscle Contraction on Muscular Strength and Size." Unpublished Doctoral dissertation, Louisiana State University, Baton Rouge, 1964.

24. Day, I. June. "A Study of The Reduction of The Waistline of Women by Maximum Isometric Contraction of The Abdominal Wall." Unpublished Master's thesis, Louisiana State University, Baton Rouge, 1957. (Microcard.)

25. Edelstein, Elliott S. "Changes in Strength, Girth, and Adipose Tissue of The Upper Arm Resulting from Daily and Alternate Day Progressive Weight Training." Unpublished Master's thesis, Temple University, Philadelphia, 1954.

26. Hislop, Helen J. "Quantitive Changes in Human Muscular Strength During Isometric Exercises." Unpublished Ph. D. dissertation, State University of Iowa, Iowa City, 1960.

27. Vandine, Dora. "A Comparison of The Effects of Isometric and Isotonic Exercises on Reduction of Girth of The Glutei and Thigh Muscles." Unpublished Master's thesis, State University of Iowa, Iowa City, 1964.

D. GOVERNMENT PUBLICATIONS

28. Best, William R., 1st L.T., M. C. "An Improved Caliper for Measurement of Skinfold Thickness." Report No. 113, Project No. 6-60-11-017. August 31, 1953. Chicago: Medical Nutrition Laboratory, United States Army, 1953.

29. U. S. Department of Health, Education, and Welfare - U. S. Public Health Service. Obesity and Health. Washington: Printing Office, 1966.

E. POPULAR LITERATURE CITED

30. Wallis, Earl L., and Gene Logan. Isometric Exercises for Figure Improvement and Body Conditioning. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964. (Booklet.)

31. Salls, Donald J. XSXIM, Ten Static Exercises in One Minute. Dr. Donald J. Salls Foundation, Inc., Box 392, Anniston, Alabama. (Booklet.)

APPENDIX

NOTICE!!

For Girls Only!

Do you look like  or  instead of  ?

Then note--

Wanted: Volunteers for graduate research study on exercise. If you are a UNC-G coed not registered for a physical education activity course this spring, you are eligible. (Exception--students in golf, archery, or recreational sports classes are eligible.)

If you are interested, come to the organizational meeting:

Where: Rosenthal Gym

When: Monday, April 10, 1967
7:00 P.M.

Attending the meeting does not obligate you to participate, so come see what it is all about.

Study conducted by
Miss Pat Sylvester
Graduate Student-P.E.
Phone Ext. - 317

If you are interested in being a subject but cannot come to the organizational meeting, please contact Miss Sylvester on or before April 10.

INDIVIDUAL SCORE CARD - Front

INDIVIDUAL'S CARD

Name _____ Date _____

Exercise Group _____ Exercise time _____

Name of Partner _____ Dorm _____ Rm. #___

WEEKLY CALENDAR

Th	Fri	Sat	Sun	Mon	Tues	Wed

MEASURING DATES

Where?	Date	Day	Time	
Graduate dressing rm. Rosenthal Gym				1st measurement
				2nd measurement

INDIVIDUAL SCORE CARD - Back

Calendar: Check off days as you exercise. If you miss a day leave it blank. If you participate in strenuous exercise on a certain day, write it in on that day plus the approximate number of hours.

Example: April 21
Swimming
2 hrs.

Important! Cards will be picked up every Thurs. evening. Please leave them at your dorm's main desk. Bring the 4th card with you on the final measuring date.

Note: If you have questions or an emergency arises, call -

Miss Pat Sylvester
Graduate Student
N. Spencer Annex
Rm. 239, Phone ext. 317

ISOMETRIC EXERCISES

Instructions: Do each of the following exercises once daily. Hold each position in a maximum contraction for 10 seconds.

Exercise 1.

Starting position: Lie on back on floor, legs straight, arms at your side. Abdomen relaxed.
Exercise: Breathe in deeply, pushing the abdomen out as far as possible. Hold one second. Then exhale fully, pulling abdomen in as tight as possible. Hold for ten seconds. (No illustration of this exercise.)

Exercise 2.

Starting position: Lie on back, legs extended, arms straight at sides, palms down.
Exercise: Press down with hands. At same time, raise pelvis off floor. Hands, heels, and head should bear all the weight. Hold for 10 seconds.

ISOMETRIC EXERCISES

Instructions: Do each of the following exercises once daily. Hold each position in a maximum contraction for 10 seconds.

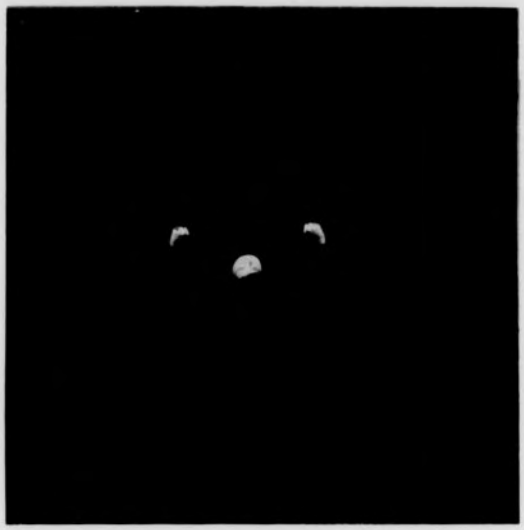
Exercise 1.

Starting position: Lie on back on floor, legs straight, arms at your side. Abdomen relaxed.
Exercise: Breathe in deeply, pushing the abdomen out as far as possible. Hold one second. Then exhale fully, pulling abdomen in as tight as possible. Hold for ten seconds. (No illustration of this exercise.)

Exercise 2.

Starting position: Lie on back, legs extended, arms straight at sides, palms down.
Exercise: Press down with hands. At same time, raise pelvis off floor. Hands, heels, and head should bear all the weight. Hold for 10 seconds.

ISOMETRIC EXERCISES



Exercise 3.

Starting position: Lie on back on floor. Draw heels up to hips. Arms placed outward, perpendicular to body, elbows against floor. Arms bent upward at elbow.
Exercise: Force elbows against floor in maximum effort for 10 seconds.

ISOMETRIC EXERCISES

Exercise 3.

Starting position: Lie on back on floor. Draw heels up to hips. Arms placed outward, perpendicular to body, elbows against floor. Arms bent upward at elbow.
Exercise: Force elbows against floor in maximum effort for 10 seconds.

ISOMETRIC EXERCISES

Exercise 4.

Starting position: Lie face down on floor, toes and ankles flexed. Place arms at side, palms down. Face floor, weight on chin. Draw hands up to hips

Exercise: Press hands downward attempting to flex arms. You will feel pull on your biceps. Hold for 10 seconds.

ISOMETRIC EXERCISES

Exercise 4.

Starting position: Lie face down on floor, toes and ankles flexed. Place arms at side, palms down. Face floor, weight on chin. Draw hands up to hips

Exercise: Press hands downward attempting to flex arms. You will feel pull on your biceps. Hold for 10 seconds.

ISOMETRIC EXERCISES

Exercise 5.

Starting position: Lie on back on floor in doorway so elbows are against door facing when arms are raised outward perpendicular to the body. Make fists and place them on door jam pushing away from body.

Exercise: Force hands outward from body pushing against door jam. Hold for ten seconds. (This exercise was illustrated using heavy boxes, but a doorway is recommended.)

ISOMETRIC EXERCISES

Exercise 5.

Starting position: Lie on back on floor in doorway so elbows are against door facing when arms are raised outward perpendicular to the body. Make fists and place them on door jam pushing away from body.

Exercise: Force hands outward from body pushing against door jam. Hold for ten seconds. (This exercise was illustrated using heavy boxes, but a doorway is recommended.)

ISOMETRIC EXERCISES

Exercise 6.

Starting position: Sit on floor in doorway, legs extended so that shoulders are even with door facing.
Exercise: Keeping back erect, exert maximum force against door facing with palms (a) on base of facing for 10 seconds, (b) shoulder level on facing for 10 seconds, (c) straight overhead on facing for 10 seconds.

ISOMETRIC EXERCISES

Exercise 6.

Starting position: Sit on floor in doorway, legs extended so that shoulders are even with door facing.
Exercise: Keeping back erect, exert maximum force against door facing with palms (a) on base of facing for 10 seconds, (b) shoulder level on facing for 10 seconds, (c) straight overhead on facing for 10 seconds.

ISOMETRIC EXERCISES

Exercise 7.

Starting position: Stand with back against wall, feet 10 inches from wall, hands hanging loosely at sides.
Exercise: Slide back down wall till you are in sitting position. At the same time, go up on your toes. Hold this position for ten seconds.

ISOMETRIC EXERCISES

Exercise 7.

Starting position: Stand with back against wall, feet 10 inches from wall, hands hanging loosely at sides.
Exercise: Slide back down wall till you are in sitting position. At the same time, go up on your toes. Hold this position for ten seconds.

ISOMETRIC EXERCISES

Exercise 8.

Starting position: Standing or sitting with head tilted to side, place palm against forehead between temple and eyebrow.
Exercise: Press head against hand and vice-versa. Hold for 10 seconds. Do this exercise once with the right hand and once with the left.

ISOMETRIC EXERCISES

Exercise 8.

Starting position: Standing or sitting with head tilted to side, place palm against forehead between temple and eyebrow.
Exercise: Press head against hand and vice-versa. Hold for 10 seconds. Do this exercise once with the right hand and once with the left.

ISOMETRIC EXERCISES

Exercise 9.

Starting position: Clench teeth, tilt head back slightly. Smile, pulling sides of mouth as far back as possible.
Exercise: Hold the above position for 10 seconds.

ISOMETRIC EXERCISES

Exercise 9.

Starting position: Clench teeth, tilt head back slightly. Smile, pulling sides of mouth as far back as possible.
Exercise: Hold the above position for 10 seconds.

ISOMETRIC EXERCISES

Exercise 10.

Starting position: Sit in a chair in doorway. Shoulders should be even with door jam.
Exercise: Place palms against door jams and exert maximum positions: (a) hands straight down, (b) hands shoulder level, (c) hands overhead.

ISOMETRIC EXERCISES

Exercise 10.

Starting position: Sit in a chair in doorway. Shoulders should be even with door jam.
Exercise: Place palms against door jams and exert maximum positions: (a) hands straight down, (b) hands shoulder level, (c) hands overhead.

STRETCHING EXERCISES

Instructions: Do each of the following exercises once daily. Hold them for 30 seconds the first day, 40 seconds the second day, 50 seconds the third day, and one minute for the remainder of the four weeks.

Exercise 1.

Stand straight with hands extended overhead. Stretch as tall as you can, (as if picking an apple off a tree), keeping feet flat on floor.

STRETCHING EXERCISES

Instructions: Do each of the following exercises once daily. Hold them for 30 seconds the first day, 40 seconds the second day, 50 seconds the third day, and one minute for the remainder of the four weeks.

Exercise 1.

Stand straight with hands extended overhead. Stretch as tall as you can, (as if picking an apple off a tree), keeping feet flat on floor.

STRETCHING EXERCISES

Exercise 2.

Lie face down on floor, legs straight, hands palms down placed at shoulder level. Fingers facing forward. Push up with arms, keeping hips on floor. Stretch up as high as you can still keeping hips on floor.

STRETCHING EXERCISES

Exercise 2.

Lie face down on floor, legs straight, hands palms down placed at shoulder level. Fingers facing forward. Push up with arms, keeping hips on floor. Stretch up as high as you can still keeping hips on floor.

STRETCHING EXERCISES

Exercise 3.

Lie flat on floor on stomach. Reach back with hands, grasp ankles, and pull feet toward head.

STRETCHING EXERCISES

Exercise 3.

Lie flat on floor on stomach. Reach back with hands, grasp ankles, and pull feet toward head.

STRETCHING EXERCISES

Exercise 4.

Sit on floor, legs straight and together. Reach down with hands, grasp outer borders of feet and pull head downward. Hold for 1 minute. If unable to reach feet, grasp ankles and pull. Each time you do this exercise, you should strive to be able to grasp outer borders of feet.

STRETCHING EXERCISES

Exercise 4.

Sit on floor, legs straight and together. Reach down with hands, grasp outer borders of feet and pull head downward. Hold for 1 minute. If unable to reach feet, grasp ankles and pull. Each time you do this exercise, you should strive to be able to grasp outer borders of feet.

STRETCHING EXERCISES

Exercise 5.

Lie on back on floor, legs straight, hands at sides. Lift legs over head. Rest extended toes on floor. Keep hands and arms flat on floor.

STRETCHING EXERCISES

Exercise 5.

Lie on back on floor, legs straight, hands at sides. Lift legs over head. Rest extended toes on floor. Keep hands and arms flat on floor.

STRETCHING EXERCISES

Exercise 6.

Sit on floor, right knee pulled to body. Left leg tucked under right leg. Twist trunk as far as you can to right. Hold. Caution: Do not use bouncing motion. Twist as far as you can and hold.

Exercise 7.

Repeat Exercise 6 to the left side. (No illustration of this exercise.)

STRETCHING EXERCISES

Exercise 6.

Sit on floor, right knee pulled to body. Left leg tucked under right leg. Twist trunk as far as you can to right. Hold. Caution: Do not use bouncing motion. Twist as far as you can and hold.

Exercise 7.

Repeat Exercise 6 to the left side. (No illustration of this exercise.)

STRETCHING EXERCISES

Exercise 8.

Stand facing wall, feet 3 to 4 feet from wall. Keeping body straight, place hands on wall. Keep feet parallel and heels on floor. Hold for one minute.

STRETCHING EXERCISES

Exercise 8.

Stand facing wall, feet 3 to 4 feet from wall. Keeping body straight, place hands on wall. Keep feet parallel and heels on floor. Hold for one minute.

STRETCHING EXERCISES

Exercise 9.

Bring right hand over right shoulder. Bring left hand under left shoulder and hook fingers of two hands together. Hold. If unable to reach this position, stretch as far as you can and hold this position.

Exercise 10.

Repeat Exercise 9 to the left side. (No illustration of this exercise.)

STRETCHING EXERCISES

Exercise 9.

Bring right hand over right shoulder. Bring left hand under left shoulder and hook fingers of two hands together. Hold. If unable to reach this position, stretch as far as you can and hold this position.

Exercise 10.

Repeat Exercise 9 to the left side. (No illustration of this exercise.)

GENERAL INFORMATION CARD - Front

RESEARCHER'S CARD

Name _____, _____ _____ Age_____ Date_____
Last First Middle

School Address: Dorm_____ Room #_____ Phone ext. _____ Box #_____

Home Address: _____ Phone #_____

Do you have any medical restrictions? ___Yes ___No. If yes, list restrictions below:

_____ List any scheduled physical activities you have for the Spring semester: _____.

Measuring times & dates

Date	Day	Time	
			1st measurement
			2nd measurement

Exercise Group: Isometric

Stretching

Name of Partner: _____

Dorm _____ Rm. _____

Researcher's Comments:

GENERAL INFORMATION CARD - Back

(Back)

Name _____, _____ _____ Age _____
Last First Middle

Calendar

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														

(Circle days Missed)

MEASUREMENTS

	Height (inches)		Weight (lbs.)		Girth (inches)	
	Head	Hips		Hips	Waist	Upper Arm
1st.						
2nd.						
diff.						

Skinfold

	Upper Arm (mm)				Subscapula							
	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
1st.												
2nd.												
diff.												