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A COMPARATIVE STUDY OF CONVENTIONAL EXERCISE  
AND WEIGHT TRAINING OF COLLEGE WOMEN  
AT UTAH STATE UNIVERSITY

by

Virginia Gayle Oleksiak

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF SCIENCE

in

Health, Physical Education and Recreation

Approved:

UTAH STATE UNIVERSITY  
Logan, Utah

1974

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## ABSTRACT

A Comparative Study of Conventional Exercise  
and Weight Training of College Women

At Utah State University

by

Virginia Gayle Oleksiak, Master of Science

Utah State University, 1974

Major Professor: Dr. Janice Pearce  
Department: Health, Physical Education, and Recreation

Women are now making use of weight training for improving strength, flexibility and body contours. Most studies on weight training have used male subjects. This study compared the results of a conventional exercising program and a weight training program for reducing inches in the circumferences of the right upper arm, pectorals, waist, hips, and right thigh.

The subjects were twenty-nine female students in figure control classes at Utah State University. The control group of sixteen subjects exercised in the conventional manner, and the experimental group of thirteen subjects exercised on the weight training machine. Subjects were asked not to change dietary habits nor engage in physical activity outside the exercise period. The subjects participated in six weeks of exercise meeting two days per week.

The control group showed a decrease in the circumference of the right upper arm, the pectorals, the waist, and the right thigh, whereas the experimental group showed a decrease in the circumference of the right upper arm, the

pectorals, the waist, and the hips. The largest circumference lost for the experimental group was the right upper arm. A gain was shown by the experimental group in the right thigh.

Within the limits of this investigation it can be concluded that (a) circumference losses were attained by both the conventional and weight training methods; however, such losses were not sufficient to support one method over the other; (b) during regular exercising, a slight weight increase does not necessarily prevent a decrease in anthropometric measurements.

(73 pages)



## INTRODUCTION

American women have been very conscious about their physical appearance. In an effort to improve physical appearance women have resorted to a wide variety of methods and instruments that claim to reduce body measurements, or in some cases, to increase measurements.

Physical educators maintain that exercise along with controlled caloric intake are the most appropriate ways to achieve improved physical contours. In trying to relate such information, public school physical education programs have added to their curricula courses which are designed to improve body contours. Names such as "figure control" and "body conditioning" are examples of course titles. Some programs approach their goals through conventional exercising similar to the well-known calisthenics. A more recent approach for women has been through the use of a self-contained weight machine and also through the use of dumbbells and barbells.

It is important that students taking such "figure control" classes be well informed about what is required to improve anthropometrical measurements. Thus, when the individual is no longer in a school setting, it should be possible for that person to initiate a proper exercise program at home.

### Purpose of the Study

The purpose of this study was to compare the results of a conventional exercising program and a weight training program for the improvement of six anthropometrical measurements of selected college women at Utah State University.

### Hypothesis

The change in anthropometric measurements in the weight training group should be significantly greater than the change in the conventional exercise group.

### Basic Assumptions

The following were basic assumptions of this study:

1. The students involved in this study wanted to lose inches in the anthropometrical areas measured.
2. The students would not engage in any additional physical activity other than required by a normal daily routine.
3. The students would not change dietary habits during the course of this investigation.
4. Students would not miss any of the twelve exercise periods.
5. The amount of effort put forth when executing an exercise would be the same for each subject in the control group and for each subject in the exercise group.

## Definition of Terms

### Anthropometric

The measurements of the human body as an aid in the study of human variations.

### Circuit program

A method of exercising in which the exercises are numbered consecutively and which allows the subject to progress easily from one exercise to another, doing the prescribed amount of work at each exercise station until the entire circuit has been completed.

### Conventional exercise

The practice of executing exercises isototonically without equipment.

### Isotonic

"A term used to describe a muscular contraction in which the muscle shortens against a load or resistance, resulting in movement." (Wessel, 1970, p. 315)

### Repetition

"The performance of a single exercise from the start through its full range and back again to the starting point." (Sorani, 1966, p. 6)

### Set

A specified number of repetitions.

### Station

The location in the gym or on the weight machine where each exercise within the circuit was performed.

### Weight lifting

"The art or practice of lifting weights either for the purpose of exercise or for the pleasure of competition." (Massey et. al., 1959, p. 2)

### Weight training

"The practice of exercising systematically with weights for the purpose of benefitting from the exercise." (Massey et. al., 1959, p. 4)

### Delimitations

This study was delimited to twenty-nine female students from figure control classes at Utah State University; sixteen students used the conventional exercise approach and thirteen students used the weight training approach.

The study was six weeks in length, with the class meeting two times weekly. Each group was given specific exercises to perform, with no deviations from the specified exercises being allowed. Anthropometrical measurements taken were body weight, the right upper arm, pectorals, waist, hips, and the right thigh.

### Limitations

It was not possible to limit outside physical activity or dietary changes during this study.

Justification of the Study

The results of this study should contribute to the now lacking information available on the effects of weight training for women. ". . . nearly all of the research to date is focused on changes in men." (Wilmore, 1973) Research in physical education is required if the profession is to progress. Information obtained from this study should assist in the furthering of such progress. The findings should assist the investigator in becoming more knowledgeable about exercise, weight training, and possible results of each.

## REVIEW OF LITERATURE

The research pertaining to exercise has been concentrated and reviewed in the following areas: anthropometry, exercise, obesity, and weight training.

The information presented should be considered as fulfilling two purposes:

1) supportive material for methods used in this study; and, 2) general information regarding each topic.

### Anthropometry

Anthropometry is divided into four basic areas:

1. Somatometry: The measurement of the body in the living and in the cadaver.
2. Cephalometry: included in the somatometry, the measurement of the head and face in the living and in the cadaver and from x-ray films.
3. Osteometry: the measurement of the skeleton and its parts.
4. Craniometry: included in osteometry, the measurement of the skull. (Montagu, 1960, p. 4)

Montagu (1960) recommends that when making use of anthropometry, the investigator should measure only those parts of the body which will shed light upon the problem being studied. If there is no purpose to be served by taking a particular measurement, there is no need to take it.

It is desirable to make most measurements with the subject in the standing position.

Whenever possible all measurements should be made during the morning rather than the afternoon or evening, for the reason that individuals generally decrease in height from morning towards evening, and further because they tend to be more relaxed during the morning. (Montagu, 1960, p. 6)

Preferably, subjects should be nude when being measured. If clothed, samples of the clothing should be taken periodically. Any instrument used for measuring purposes should be used with a minimum amount of pressure.

Brozek (1956) states, "It is recommended that body weight be included in every anthropometric study of human nutriture" (p.8).

In the general population the differences in muscular development account for a lesser portion of variation in total body weight, at a given height, than does the size of the fat deposits. Nevertheless, quantitative characterization of musculature is of interest, especially to physical anthropologists concerned with the effects of exercise and physical work on man's physique. (Montagu, 1960, p. 88)

When making circumference measurements one should use a flexible steel measuring tape. The steel tape "should be applied lightly to the skin in order to avoid deforming the contour of the skin" (Montagu, 1960, p. 89).

#### Reliability of anthropometric measurements

Before 1930 there were very few studies published concerning the reliability of anthropometric measurements. In 1930, one of the first studies was conducted and published by Edward A. Lincoln (1930). In this study there were 97 subjects who were measured once at two different testing sessions under ordinary classroom conditions.

In every trait there were some very great differences between the two sets of measures. In practically every instance, there were maximum differences of at least two centimeters.

It was concluded that the use of more than one measurer would increase the reliability of the tests. A second series of measurements was administered

in which two anthropometrists took measurements on each subject. A third anthropometrist was used to take a third measurement in the event that the first two did not agree with half a centimeter.

The implications of these studies clearly show that measurements done by skilled anthropometrists using the best of instruments when taken on large numbers of subjects under ordinary school room conditions are highly unreliable. The improved techniques of the second study lowered the medium errors and decreased the number of excessively large errors; however, it did not result in perfect reliability (Lincoln, 1930).

Massey et. al. (1959) expressed a preference to "take each measure at least twice, and where a marked discrepancy exists between the first and second trials, a third should be recorded" (p. 150).

In determining the reliability coefficient of weight, Rogers (1932) conducted a study and ascertained the reliability coefficient to be ".999 when measurements were made within a few minutes apart. The reliability of weight when taken nine months apart was reduced to .944" (p. 17).

Another study on weight reliability was conducted by Gaito and Gifford (1958) who investigated a study of eleven morphological features. Fourteen subjects were measured three times per week by three examiners. A coefficient of 99.68 for weight was obtained.

Other experimental evidence concerning the reliability of anthropometric measurements was presented by Meredith (1936). Fifteen measurements were taken on twenty-five eight- and nine-year-old white male subjects with a reliability of .986 for arm girth, .977 for chest circumference, and .978 for the girth of the thigh.



When Tanner (1952) conducted a study on weight training effects he reports taking

Two complete measuring sessions a few days apart . . . before the training began in order to establish the errors of measurement, and this has enabled the changes observed in each individual to be assessed statistically as to whether each was likely to be ascribable merely to such errors or not. (p. 428)

Contrary to Lincoln's (1930) study using numerous measurers, Gavan (1950) concludes that ". . . consistency decreases as the number of technicians increases" (p. 424).

Gagan (1950) further states

Its (a good measurement) quality is determined by many things; primarily by the use which is made of it. A low consistency measurement would be good if it were the only one which would give data for the solution of any given problem. However, the interpretation of such data should be colored by the expected consistency of the measurements used. (p. 426)

### Girth measurements

Girth measurements have been one of the best means for measuring the body in order to study body form and proportions and functions. Such measurements are relatively easy to take.

Initially, the gains in girth are quite rapid; later, changes occur much more slowly. It is suggested that in beginning classes, girth measurements be taken at the end of the third week, after eight weeks and at the end of the semester. (Massey et. al., 1959, p. 154)

Patricia White (1966) recommends that "measurements be taken at five or six week intervals" (p. 3). Tanner (1952), in his weight-training study, followed changes in the physique of his subjects by "taking some twenty anthropometric measurements approximately every three weeks" (p. 428).

In a study by Clarke, Geser, and Kundson (1956), aspects of the upper left arm that easily could be differentiated by roentgenogram and anthropometric measures were undertaken. A high correlation of 0.95 was obtained between girth by tape and width by roentgenogram. This correlation was high enough to justify the use of either for testing purposes.

Anthropometry, including girth, has been important in determining the body build and the changes of physical measurements of men and women over a period of years. Hoffman (1939) presented a study comparing anthropometric measurements of two groups of University of Michigan male students. The students of the 1938 era were decidedly younger, taller, and heavier than their predecessors of 1900.

One of the most important uses of girth measurements has been that of aiding in the determination of body build. A three-fold investigation was conducted by Jorgensen and Hallestad (1940) which included: (1) an evaluation of a number of anthropometric indices most frequently used in determining body build; (2) a determination of those anthropometric measurements which best indicated the body build of any given individual, and (3) a determination of any separate and distinct categories of body builds in men and women students which might exist. The findings seemed to indicate a continuous distribution of body builds varying from an extreme lateral build to an extreme linear build. Among the indices which proved to be highly valid for both men and women were the chest/girth height and leg length/chest girth measurements.

A standard of comparison is needed for interpreting the measurement obtained. Two standards are customarily used; the scores of other individuals and the performance of the trainee himself from

one time to the next. The comparison of the individual's measurements with his own previous measurements is the most practicable method in weight training. (Massey et. al., 1959, p. 151)

Anthropometrical measurement was one of the first areas of research in the field of physical education. Physical educators have for many years attempted to determine the structural status and the functional changes of the human body attributable to exercise. (Mitchem and Arsenault, 1966, p. 438)

Mitchem and Arsenault (1966) reviewed the anthropometrical studies which had appeared in The Research Quarterly from 1940-1960; it was found that there was not any degree of similarity in the methods used for taking anthropometrical measurements. Two of three recommendations made by these authors were that:

1. A single anthropometric methodology be established by some professional group association with the AAHPER.
2. Regional workshops should be held to demonstrate the technique to be used in collecting anthropometric data. (p. 438)

During Fall Semester of 1966 and the Spring Semester of 1967, San Diego State College conducted an Anthropometric Training Project which was funded by the United States Department of Health, Education and Welfare. It was "aimed at providing a training program for select students to develop research competency in an area relating body type, composition, anthropometric assessment, and physical performance measures" (Mitchem and Arsenault, 1966, p. 438).

Students participating in this project received instruction in anthropometric research methodology, resolution of data, physique and body type, body composition, anthropometric procedures and practice, and selected performance parameters. Each participant was also required to conduct studies in areas of their choosing related to the project. To date, details of material presented

during this project have not been published in a professional journal so that others could have the benefit of such information.

### Exercise

Americans have shown an increasing interest in physical activity. "Slightly more than half of the nation's adults--55 per cent--engage in some form of physical activity as a form of exercise" ("Why 60 Million Americans are on a 'Fitness Kick,'" 1974, p. 26). The activities range from jogging to walking, bicycling, tennis, swimming, yoga, and even belly dancing.

### Benefits of exercise

Exercise is not the remedy for all ills, but it will certainly assist in the delaying, if not the preventing, of many of man's physical complaints. Studies have shown that physical activity can help the body resist infectious diseases as well as postpone the degenerative changes of the aging process (Health and Fitness in the Modern World, 1961).

Incidents of heart disease are common. Recent findings have indicated physical activity to be a preventive measure as well as a recovery method for heart disease. Lumberjacks, who are considered to be very physically active individuals, show less evidence of coronary heart disease. A study conducted in Finland showed that "within the age range of 40-49 years the men doing heavy work had a significantly lower cholesterol level than those in lighter occupations" (Health and Fitness in the Modern World, 1961).

The American Heart Association and the National Heart Institute concur that the lack of physical activity is one of the factors causing atherosclerosis.

This disease was felt to be responsible for the majority of coronary cases and heart attacks (Health and Fitness in the Modern World, 1961).

Exercise should not be limited to only the so-called "well" individual. Ex-cardiac patients, for example, do not have to exclude physical activities from daily routines. Properly controlled amounts of physical activity should prove to be more of a help than a hindrance in rehabilitating such individuals. A reconditioning program for coronary patients has been conducted in Israel for three years. Upon completing a one-year training program, many patients are in better condition than before the heart attack. Being able to perform physically in this program gives the patients confidence that it is possible to perform the physical tasks required of daily living (Brunner, 1968).

Athletes are proof of an improved cardiovascular system through physical activity. An athlete, compared to a sedentary individual, has a "slower pulse rate, prolonged diastole with resulting better utilization of oxygen, lowering of systolic blood pressure, shortened recovery period following exercise" (Health and Fitness in the Modern World, 1961, p. 78).

Through exercise the heart is able to develop better circulation. Improved circulation implies a more efficiently operating heart. The heart is now able to do more work with less effort. This is made evident through a decrease in heart rate (Wessel, 1970). After participating in a ten-week jogging program three days a week, twenty-one middle-aged men had a reduction in their heart rate at rest, during submaximal exercise, and during the recovery period (Wallen and Schendel, 1969).

Yeager and Brynteson (1970) conducted a study using eighteen college women. The subjects exercised three days per week for six weeks on a bicycle ergometer. The subjects were divided into three groups with one group exercising for ten minutes a day, one for twenty minutes and the third for thirty minutes a day. All three groups showed significant improvement in cardiovascular efficiency, but the thirty minute group showed a more consistent increase.

A prime end result of physical exercise is the effect it has on the tone of the muscles. This is especially important when one has been losing weight. The combination of diet and exercise will bring about a much better appearance (Davis et. al., 1965). Fifteen overweight college women were involved in a strenuous exercise program for four days a week for one semester. The activities included calisthenics, circuit training, badminton, basketball, hiking, jogging, and bicycling. Weight and body fat were reduced significantly. There was considerable decrease in the girth measurements of the upper arm, chest, waist, thighs, and calves (Tufts, 1969).

It does take large amounts of activity to have any effect in the burning of calories, but if one were to exert a portion of this extensive activity each day, results would be evident over a period of time. Wessel (1970) states:

In order to burn (lose) one pound of body fat, you have to do 4,000 push-ups, walk to the top of the Washington Monument 45 times, play hockey for 4 hours, or ride a horse for 40 hours. This seems to be a tremendous program. Think of it in terms of six months or a year. Just one-half hour a day of some kind of exercise you like will result in a loss of 15 pounds over a twelve-month period--and that is without dieting. (p. 170)

Larson (1973) emphasizes also the importance of doing some vigorous physical activity each day for approximately half an hour. He stresses vigorous, endurance-type activities as being most effective in reducing weight. No one part of the body should be exempted from exercise or physical activity. Overall exercise will strengthen the abdominal wall, promote better posture, and balance the weight throughout the body.

Exercise alone can be employed to bring about a reduction in weight. Sedentary middle-aged males who exercised for a two-year period were able to reduce weight and increase their fitness. A matched nonexercising group, showed weight gains during this same period ("Exercise for Sedentary Males," 1970). Thus, for the individual finding it difficult to restrict caloric intake severely in order to reduce weight, an increase of calories expended (physical activity) and a moderate decrease of calories consumed should make weight reduction more palatable (Stuart and Davis, 1972).

#### Types of exercise

There are two basic classifications of exercise: isometric and isotonic.

Isometric exercises are defined as:

. . . a muscular contraction in which the muscle remains the same length while tension is developed. No movement is produced by this type of contraction . . . (Wessel, 1970, p. 315)

The advantage of using isometric exercises is that a large area is not needed to perform such exercises. Thus, any person confined to a small space, such as an apartment dweller, or a person confined for prolonged periods of time, such as astronauts, are able to use the body muscles so that the muscles do not atrophy.

A study conducted using isometric abdominal contractions with women found that in a six week period a decrease of over an inch was reduced from the waistline. Upon cessation of this exercise, however, the inch returned to the subjects' waist within about six weeks (Davis et. al., 1965).

An area neglected by isometric exercising is the cardiovascular system. As indicated by the definition, there is no movement of the body; thus, without movement, it is impossible to sufficiently stimulate the heart and lungs.

Isometric exercises are most effective in developing strength and firmness of the muscles. This form of exercise can be performed even in public places without passersby being aware the individual is exercising; therefore, it would be possible to do some exercising in spite of a busy schedule. A disadvantage of this type of exercise is that a loss of motivation or interest might take place. Noble (1972) conducted a study to compare the effects of isometric and isotonic exercise programs. It was found that several subjects were not always exerting maximum effort in the isometric program. This was considered to be a disadvantage of this type of program.

Isotonic exercises are defined as:

. . . a muscular contraction in which the muscle shortens against a load or resistance, resulting in movement . . . (Wessel, 1970, p. 315)

Examples of isotonic exercises are calisthenics, weight lifting, tennis, jogging, etc. Any time there is muscle contraction plus movement of all or part of the body through space, that movement is isotonic.

For all-round development of the body, isotonic exercises should be selected as such exercises develop not only strength and muscle tone, but also



can develop the cardiovascular system. An extension of isotonic exercise is called aerobics. Dr. Kenneth H. Cooper (1970) defines aerobics as:

. . . a variety of exercises that stimulate heart and lung activity for a time period sufficiently long to produce beneficial changes in the body. (p. 15)

The type, intensity, and duration of exercise will have varying effects as to the end results of calories expended and conditioning of the body. Anytime a machine is doing the work for the body--passive exercise--the calorie expenditure will be low. Isometric exercises would be considered passive as such exercises do not expend many calories; the primary purpose of isometrics is to strengthen and develop individual muscles. Exercises causing the entire body to do considerable movement of its muscles will consume considerable amounts of energy and use up calories at a greater rate than will passive exercise (Stuart and Davis, 1972).

The first week or two of exercising should not be overdone. The person unaccustomed to exercising should expect to have sore muscles. Sore muscles will not disappear rapidly with inactivity; rather, it takes activity to relieve sore muscles. Wessel (1970) suggests that the sore muscle be placed in the greatest possible stretch position and held there for two two-minute periods with a one minute rest between the two periods. This is to be done three times a day.

The first six to ten weeks will show much improvement in what can be accomplished. Once a higher level of skill is attained, improvement will come less rapidly. Due to individuality it is difficult to place an exact time as to when improvement will decrease. Once the high skill level is attained, it is necessary

to maintain that level. Thus, consistency is most important to preserve the level of competency.

In order for improvement to take place, there must be a regular repetition of a suitable physical activity. The number of repetitions should be kept low yet should be at a level that places demands on the body. Frequent exercise periods of a short duration are more advantageous than longer, infrequent periods. With the frequent exercise periods, one should not feel as fatigued nor as stiff; the rate of improvement exhibits itself sooner, and with this improvement, one's motivation is augmented (Wessel, 1970).

There are some exercises which should be avoided because of the possible injury to the body if done incorrectly. If full deep knee bends are done many times with a bouncing motion, rotation of the femur cannot take place, and this leads to serious knee damage. All bouncing squat movements should be eliminated from an exercise program. Straight leg sit-ups usually find the person placing a strain on the back; thus, a bent knee position is best when doing sit-ups. Leg lifts in the supine position works the hip flexors more than the stomach muscles and also can put some strain on the back. Heel raises are excellent to strengthen the calves, but as the muscles raise the back part of the leg, it usually depresses the front, and this action weakens the arch (Rasch and Allman, 1972).

#### Obesity

It has been estimated that fifty-eight per cent of all American adults suffer from obesity to some degree (Wyden, 1965). Affluence in the United States

has brought about this alarming rate of obesity. With affluence, people have begun to expend less energy in every day living. It is well-known that the major cause of obesity is an intake in excess of caloric expenditure.

Lack of physical activity is something which most people might be able to change. However, the human mind is much more complicated than to merely decide to become more physically active. The environment in which the individual was raised plays a definite role as a cause of obesity. The child who is rewarded with food for something well-done will most likely carry this reward system into his adult life. Mayer (1968) found through interviews with obese children that if one parent was obese, chances are the child will also be obese. If both parents are obese, the child has even more likelihood of being obese also.

The psychological aspects of obesity cannot be overlooked. Making oneself feel better by having food is common. This pattern starts very early with most children as mothers so often will quiet a crying baby with a bottle. As the child grows, food is the pacifier for pain as might be experienced by falling. Such pain can also be emotional. When feelings are hurt, the cure-all is, once again, food.

Food, by itself, is not that detrimental. It is the kind of food that creates the obesity problem. When reaching for food, for whatever reason, most people reach for foods that taste good. Usually, such foods are high caloric. Stunkard (1968) found that when subjects were presented with poorly flavored ice cream, not as much was eaten compared to the amount of good tasting ice cream eaten.

Obesity can also be brought about by an individual's body type. According to Selzter (1964),

. . . obese adolescent girls appear to be more endomorphic, somewhat more mesomorphic, and considerably less ectomorphic than the nonobese girls . . . (p. 180)

There are some causes of obesity which are congenital. Such cases are not nearly as common as many obese individuals would like to think. Mayer (1968) describes two types of congenital obesities as metabolic and regulatory. The former is obesity caused by fat formation by the body in spite of no over-eating; the later involves a malfunction of the central nervous system that normally tells one when to stop eating.

The typical obese person is between forty to sixty years old and female. This individual engages in little physical activity, and, by this age, has usually developed numerous health problems due to the obesity. Obese individuals frequently develop respiratory difficulties, impaired cardiovascular systems, increased blood pressure, heart disorders, and hyperglycemia. Obesity is also a hindrance to arthritics (Mayer, 1968; Bigsby, 1965; Heald, 1966). The lower socioeconomic individual has shown a prevalence toward obesity. Stunkard (1968) found that obesity in the lower class was six times that found in the upper class.

Adult obesity is the most common, yet juvenile obesity should not be overlooked. There are two age categories when juvenile obesity is likely to be seen; ages zero to four years and seven to eleven years. Most obese juveniles do not outgrow their obesity; such children continue to be obese into adulthood. An individual who is obese from childhood through adulthood tends to be the severely obese, and because he has lived with this excess weight for so long, is generally more resistant than the nonobese individual to receiving any help to reduce (Heald, 1966).

Studies have been conducted in an attempt to see which weight reduction approach yields the best results. Since each obese individual presents a different reason for the cause of obesity, it is most difficult to find one approach that works best for all.

One study used twelve matched super-obese patients. Each day the twelve exercise subjects would engage in a thirty-minute program of physical exercises designed to include all muscle groups and to produce a pulse rate of 120 to 140 beats per minute. Initially, all subjects worked hard and weight reduction occurred. As the study continued, each subject, at some time, performed less even though weight loss was continuing. The motivation of each person varied considerably. The effect of the exercise subjects seeing the non-exercisers also losing weight was not conducive as a motivating factor to continue with the exercising. The researchers did find that by keeping the exercise subjects busy throughout the day when not exercising was helpful in keeping the subjects interested in exercising (Kenrick, 1972).

Dudleston and Bennion (1970) divided twelve obese college women into four groups: 1) diet and exercise; 2) diet only; 3) exercise only; 4) no diet or exercise. The diet and exercise group lost the most weight with slightly less weight lost by the diet only group.

The notion that physical activity brings about an increase in appetite was studied by Mayer (1968). Rats which exercised one or two hours daily did not eat more than did unexercised rats; indeed, they ate somewhat less. When the rats exercised beyond two hours, but not to a point of fatigue, the food intake increased. When the animals became exhausted, they ate less, and lost weight.

The lack of inactivity is considered to be the prime reason for obesity. Motion pictures were taken of obese and nonobese girls swimming, playing volleyball and tennis. The obese were participating, but to a much lesser extent than the nonobese girls (Bullen, 1964).

Obese and nonobese high school girls of similar height, age, and grade were compared in the areas of physical maturation, food intake, and activity. Both groups were found to be inactive, but the obese girls were significantly more so. Inactivity played an important role in these girls' lives for their caloric intake was considerably lower than the nonobese, yet without sufficient activity, the obese were still unable to burn the calories consumed (Johnson et. al., 1956).

Bigsby (1965) points out, however, that depending on the cause of the obesity, some patients have found that strenuous physical exertion did not cause weight loss. If this occurs, the obesity is undoubtedly related to muscular development rather than fatty deposits.

Care must be taken with the severely obese in implementing an exercise program. This individual should begin with a mild exercise program and gradually progress to the more strenuous. The increased burden upon the cardiovascular, renal and respiratory systems might present a real danger to such a person (Bigsby, 1965).

The easy access to food is a serious problem for the obese. When sandwiches were placed on a table where the subjects were sitting, the obese ate considerably more than did their normal weight controls. When one sandwich was placed on the table, and the subjects were told that more were available in

the refrigerator, the obese ate less than the normal subjects. Therefore, by placing an obstacle between the person and food, the subjects were restrained from additional eating (Stunkard, 1968).

Being aware of established times for eating meals also strongly affects the obese. Subjects were given some tests that lasted into or near the evening meal time. In actuality, the tests finished well before the meal time. When subjects thought it was 6:05 p. m. , they ate almost twice as much as when they thought it was only 5:20 p. m. (Stunkard, 1968).

### Weight Training

Weight training is a physical activity which can be enjoyed by both men and women. One usually thinks that anyone using weights has as a goal to develop his or her muscular build. This is not necessarily true. The competitive aspect of weight lifting is but one facet of weight lifting. Hoffman (1939) stresses that weight lifting is beneficial for men and women in not only improving body proportions, enlarging or decreasing the body measurements, but also for the improvement of the inner workings of the body. Weight training will strengthen the organs and glands which brings a greater chance for long life as well as reduces the possibility of contracting diseases as the body functions more efficiently.

Weight training for women is primarily used for firming up flabby muscles and improving one's strength, tone, and muscular endurance. MacIntyre (1967) has conducted one of the few studies using female subjects for a weight training program. A group of college women using a traditional isotonic exercise program was compared with a like group using a progressive weight training program.

The subjects exercised for nine weeks, two times a week. The isotonic group lost some inches in the arms; the least amount of loss took place in the waist. The weight training group showed considerable loss in the hips, arms, and thighs; again, the least amount of loss took place in the waist.

Weight lifting will not produce bulging muscles in women. Recent study into this topic was done by Wilmore (1973). He states:

. . . muscular hypertrophy is predominantly the result of testosterone levels. Since testosterone levels in males are considerably higher than they are in females, you will get substantially greater hypertrophy of muscles in the male. (p. 1)

Also to be considered when discussing muscle hypertrophy in women is the body structure of women compared to men. Men, generally have larger muscles due to their larger body structure; therefore, men have the potential for developing larger muscles through weight training. A final factor contributing to hypertrophied muscles is the manner in which one engages in any physical activity. The woman wishing to improve the figure would not use sufficient resistance to enlarge the muscle whereas a man would engage in a heavy resistance program as he usually works towards an increase in strength and muscular development (Leighton, 1961).

Contrary to popular belief, weight training does not impair flexibility, make one muscle-bound, or cause a slowness of movements. Such thoughts are usually directed toward the person working towards an overly-developed physique. Women do not generally make use of weight lifting so extensively for the above beliefs to be even remotely possible. Such beliefs are erroneous. Weight training does not cause inflexibility. Extremely well-developed weight lifters were tested for flexibility and found to be more flexible than the average sixteen



year-old boy (Leighton, 1961). Muscle-boundness and slowness of movements are thought of as being synonymous. Yet, this concept of weight training is also incorrect. When weightlifters were compared with nonweightlifters in arm movement speed, the weightlifters had faster arm movements (Darden, 1972).

One particular area of some controversy regarding the benefits of weight training is that of cardiovascular improvement. Massey et al., (1959) very emphatically says that weight lifting will not improve the cardiovascular system; Darden (1972) cites evidence to the contrary. In a study he conducted at Florida State University, findings indicated that weight training can develop cardiac endurance.

No matter in what condition a person might be, there is a poundage that can be used when first beginning. As the individual's strength increases, the weights can progressively be increased. As the weights become heavier, less amount of time is needed for results. Wetzel (1970) reported women students feeling good after exercising with weights as well as having a feeling of accomplishment due to performing strenuous physical work.

It is possible that an individual would lose inches via weight training yet maintain or slightly gain weight. When lifting weights the loss of fat is replaced by muscle weight due to the increased muscle size (Massey, 1959).

The most immediately noticeable result of weight training is the increased strength of the individual. The method employed in developing strength is through the overload principle. The muscle must contract against a resistance that calls for effort. As the muscle increases in size and strength, it is necessary for the load to be progressively greater and greater (Massey, 1959). The load should be

one of relative ease and comfort--not to a point of straining. Each exercise should be repeated at a specific weight for ten repetitions (Wallis and Logan, 1964). Once the ten repetitions become easy and additional repetitions would be possible, it is time for an increase in the weight to the next poundage. To improve strength in the most efficient manner, research shows that the minimum number of repetitions at any one time should be two and the maximum should be no more than twenty (Berger, 1962, 1963, 1968; O'Shea, 1966; Withers, 1970).

A set consists of a specified number of repetitions. The number of sets to be completed at any one exercise period should be at least one with the possibility of completing several sets. Berger (1962, 1963) reported that completing more than three sets during any one exercise session was not any more effective for improving strength than when completing less than three sets. When completing more than one set per workout, five to ten repetitions should be performed in each set (Berger, 1962). It is recommended that weight lifting be done three times a week on an alternate day basis; the days when not lifting weights should be devoted to some form of physical activity not using weights (Wessel, 1970; Massey, 1959; Leighton, 1961; Hoffman, 1939). There is no advantage to exercising more than once in any given day. Hettinger (1961) reports that more than one training session on one day did not prove to be advantageous in gaining strength; training sessions held every other day showed an increase in strength of eighty per cent; two times per week showed an increase of sixty per cent in strength; and one training session per week showed a forty per cent strength increase.

The determination of the starting weight is a trial and error situation. As each person has a different capacity, a different goal, and therefore, a

different number of repetitions for each exercise, it is difficult to determine the weight by some predetermined formula (Massey, 1970). If the exercise can be performed properly ten times, keep that weight. If the last three of the ten were a struggle and not performed properly, decrease the weight by five pounds. If ten repetitions were done properly and did not cause any strain, increase the starting weight by five pounds (Wetzel, 1970).

It is most important that weighted exercises be executed properly. Failure to do so could cause injury to the individual. When doing any lifting, pushing, or pulling movement involving the legs and back, the back should be straight and at an angle of approximately forty-five degrees to the floor; the legs, at the knee joint, should be close to right angles, but not fully flexed. When pushing, lean in the direction of the movement that is to take place. To pull, lean away from the object and in the line of direction in which the movement is to take place. When lifting, the object should be near the center of gravity of the person doing the lifting (Leighton, 1961).

Normal breathing should take place while lifting weights. Breathe between each repetition; do not hold a breath for several repetitions. Exhale through the mouth. When lifting excessively heavy weights, inhale before lifting, then exhale upon completing the lift. The breathing helps to develop a rhythm when exercising as well as to allow blood circulation to continue (Cooker, 1971; Wessel, 1970).

Another aspect to be considered in the determination of the starting weight is the goal of the individual doing the lifting. To increase inches, heavy weights should be lifted as a muscle will grow in size when exercised strenuously. Due to

the weight, the pace of the lift will be slow. To reduce inches, then, exercises should be done with light weights, which in turn, will allow the pace to be quickened (White, 1970).

When selecting exercises, muscles throughout the body should be worked. Once the entire body has been exercised, then return to areas needing additional emphasis. By moving from one part of the body to another, there is less chance of fatigue setting in early, thus not requiring a rest period before continuing. A rest will make for a longer exercise period (Massey, 1959).

To avoid boredom, two exercise routines should be alternated throughout the training period. Such a change of pace will also involve the same muscles, but in different movements (Massey, 1959).

Warm-up before lifting weights is essential. Warm-ups should include two types of movements: rhythmical movements to increase circulation and stretching exercises to stretch the joints. The amount of time spent warming-up should be at least five minutes (Massey, 1959).

### Summary

Exercise has been found to change anthropometric measurements. To observe such changes a comparison should be made between the pre and post anthropometric measurements. The taking of these measurements should follow certain guidelines.

Exercise also plays a role in keeping the body fit in that it improves the circulatory capabilities of the heart and improves muscle tone. Weight training

is one form exercise which is well suited for women. Women generally use weight training for firming up flabby muscles and improving one's strength, tone, and muscular endurance.

## METHODS OF PROCEDURE

The subjects were twenty-nine women students enrolled in two figure control classes during Winter Quarter, 1974, at Utah State University. The subjects ranged in age from 18 to 25, their weight varied from 105.50 to 149.25 pounds, and their height ranged from 60.50 to 68.00 inches. The sixteen control subjects ranged in age from 18 to 23, their weight varied from 112.75 to 144.25 pounds, and their height ranged from 61.25 to 68.00 inches. The thirteen experimental subjects ranged in ages from 18 to 25, their weight varied from 105.50 to 149.25 pounds, and their height ranged from 60.50 to 68.00 inches.

Assignment to each group was done at the beginning of Winter Quarter. Since each group met at a different time and on different days of the week, students were assigned to the group which was workable with their overall class schedule.

The control group met Tuesday and Thursday at 2:30 p. m. , while the experimental group met Monday and Wednesday at 10:30 a. m. The study was conducted for six weeks beginning January 14, 1974, and ending February 21, 1974. The two groups were given seven exercises to perform as illustrated later in this chapter. One set of each exercise was completed the first three weeks of the experiment, and two sets were completed the last three weeks. Each subject performed her exercises on the "circuit program" basis rather than working on one exercise as a group. This was necessary in making use of the weight machine, and therefore, was used as well with the control group. A

chart depicting each exercise and the order in which each was to be done was displayed during the exercise period for each group.

Subjects in the experimental group reported to each class period on a staggered schedule within the designated hour. This was done since only three stations were used on the weight machine and subjects would have had a long delay between each exercise if all had arrived at the same time. The control group subjects would begin exercising upon arriving; therefore, there was somewhat of a staggered schedule for this group also.

The anthropometric measurements of the twenty-nine subjects were taken and recorded at the beginning of the six-week experiment which was Wednesday, January 9, 1974, 10:30 a. m. for the experimental group and Thursday, January 10, 1974, 2:30 p. m. for the control group. All subjects were re-measured and the results recorded again at the completion of the six-weeks which was February 22, 1974, Friday, between 9 a. m. and 12 p. m. The second measurement was compared to the first measurement to determine any change which occurred by the end of the six weeks.

#### Anthropometric Measurements

All subjects had their body measurements taken in the Human Performance Laboratory in the Physical Education Building at Utah State University. Body measurements were taken with a flexible steel tape measure. This measurement was recorded in inches to the nearest one-fourth of an inch. Extreme caution was exercised at all times to measure as accurately as possible and to avoid errors in recording. Each measurement was taken twice by the investigator.

The methods used in measuring each subject were as follows:

Clothing: Each subject was dressed in leotards and tights.

Measurement stance: Figure I illustrates the stance which each subject assumed by facing the measurer with feet approximately six inches apart and arms hanging by the side, except for the right arm measurement when the arms were extended to the side at shoulder level. The head was held erect and the eyes focused straight forward. Body weight was equally balanced between both legs. The tape did not indent the skin, yet was fit firmly. The subject was instructed not to hold her breath.

Right arm circumference: Subject assumed the measurement stance. The circumference of the right upper arm was taken by placing the tape around the uppermost part of the arm.

Pectoral circumference: Using the measurement stance, the circumference of the waist was taken by placing the tape around the waist and meeting directly above the naval.

Hip circumference: Standing in the measurement stance with the right side of the body toward the measurer, the tape was placed around the body at the top of the pubic hair line.

Right thigh circumference: Using the measurement stance, the right thigh was measured on the upper leg at a point nine inches from the crest of ilium.

#### Exercise Program

Each group completed one set of the exercise program during the first three weeks of the experiments; two sets of the program were completed the



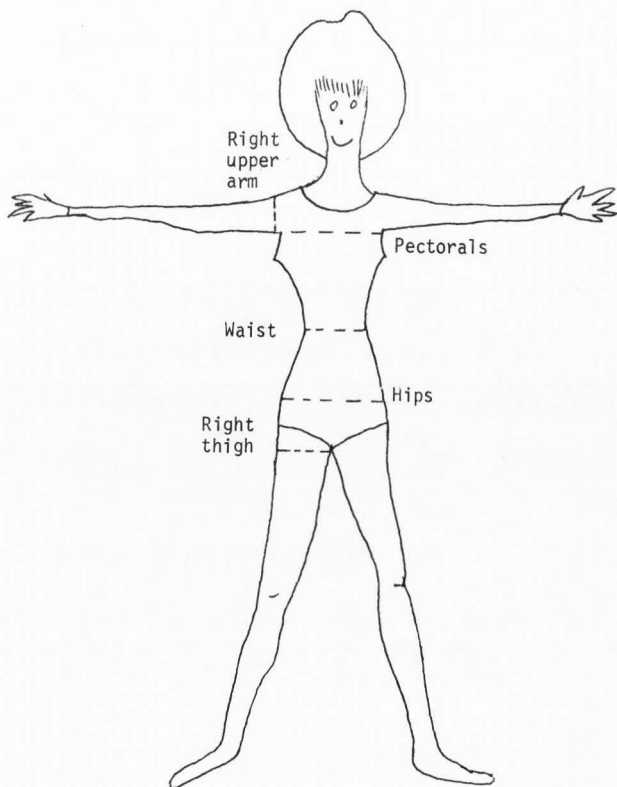


Figure 1. Measurement stance.

last three weeks. The number of repetitions completed per set for each control group exercise was determined on the basis of what a regular figure control class would do. The number of repetitions completed per set for each experimental group exercise was based on recommendations of weight training experts as cited in the review of literature.

Following are written explanations and pictorial illustrations of the exercises performed by each group. The top pictures on each page demonstrate the exercises performed by the control group, and the bottom pictures demonstrate the corresponding exercises performed by the experimental group.

#### Treatment of Data

An analysis of variance for each measurement variable was computed to determine if a significant difference occurred between the control and experimental groups' pre and post measurements. A simple correlation was completed separately for the control group and the experimental group on each of the six variables to determine the relationships among the variables. As the primary objective of this study was to compare the two groups, no attempt was made to statistically determine the significance of results achieved within either group.

Control Group  
Arm Raises



- a) Arms at sides, stand erect.
- b) Extend arms backward and upward with palms up.  
Repeat 30 times.

Experimental Group  
Arm Lifts



- a) With palms down, grasp upper pulleys and move arms to sides.
- b) Extend arms backward and upward.  
Repeat 10 times.

Figure 2. Upper arm exercises.

Control Group  
Push-ups



- a) In prone position on mat, place hands on the floor close to shoulders; extend legs with toes gripping mat.
- b) Push torso off floor until body is in a straight line from head to foot; keeping body rigid, bend elbows and slowly lower the body until returned to position a.  
Repeat 10 times.

Experimental Group  
Chest Press



- a) Lie in supine position on bench, grasp bar with palms up (bar should be even with shoulders); knees bent and soles of feet and head on bench.
- b) Push up with arms making sure arms are straight. Return to starting position.  
Repeat 10 times.

Figure 3. Pectoral exercise.

Control Group  
Side Bends



- a) Stand erect, feet slightly apart, right arm at side, left arm extended above head.
- b) Stretch left arm toward ceiling; bend to right side while sliding right arm down side of right leg to the knee; hips face forward. Repeat for left side. Repeat 30 times per side.

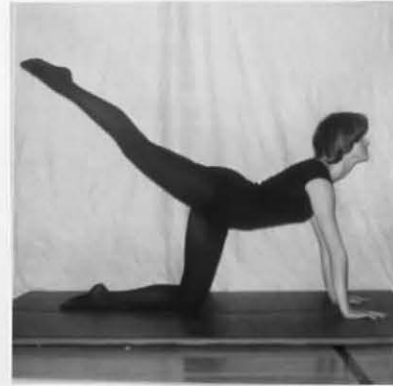
Experimental Group  
Side Lifts



- a) Stand close to handle of chest press machine with right side; grasp handle with right hand, keeping arm straight; left arm is by left side.
- b) Lift weight with right arm, keeping right arm straight; bend at waist and slide left arm down left side to the left knee. Repeat for right side. Repeat 10 times each side.

Figure 4. Waist exercise

Control Group  
Knee-Nose Stretch



- a) On all fours, bring the right knee close to nose.  
 b) Stretch leg back and up; at same time raise head, keeping arms straight.  
 Repeat 30 times per leg.

Experimental Group  
Sprinters Back Kick



- a) Place shoulders on padded area; grasp bar in front of shoulders, head down; place ball of left foot on left pedal with knee bent; right foot is on right pedal with right leg fully extended back.  
 b) Alternate legs so that one leg is bent and forward, while the other leg is straight and extended back.  
 Repeat 10 times each leg.

Figure 5. Hip exercise.

Control Group  
Back Leg Extensions



- a) Stand erect, grasp stool with straight arms.
- b) Extend leg back and up; lead with heel.  
Repeat 30 times per leg.

Experimental Group  
Back Leg Extensions



- a) Place foot strap on ankle; stand erect, grasp machine for balance, arms straight.
- b) Extend leg back and up, lead with heel; keep arms straight.  
Repeat 10 times per leg.

Figure 6. Hip and hamstring exercise.

Control Group  
Inner Thigh Lift



- a) Stand erect, cross left leg over right leg with arms at side.
- b) Lift crossed leg sideways to the right and up; lead with instep of foot.  
Repeat 30 times per leg.

Experimental Group  
Inner Thigh Pull



- a) Stand erect; place ankle strap on left ankle and cross left leg over right leg.
- b) Lift crossed leg sideways to right and up; lead with instep of foot.  
Repeat 10 times per leg.

Figure 7. Inner thigh exercise.



Control Group  
Outer Thigh Lift



- a) Stand erect, feet together.  
 b) Extend right leg sideways and up, keeping leg straight.  
 Repeat 30 times per leg.

Experimental Group  
Outer Thigh Pull



- a) Stand erect, feet together; ankle strap on right ankle.  
 b) Extend right leg sideways and up, keeping leg straight.  
 Repeat 10 times per leg.

Figure 8. Outer thigh exercise

## ANALYSIS OF DATA

Data for this study were obtained from twenty-nine women enrolled in two figure control classes at Utah State University during Winter Quarter, 1974. Six anthropometrical measurements were taken before and at the conclusion of the six-week study and included weight, right arm circumference, pectoral circumference, waist circumference, hip circumference, and right thigh circumference. An analysis of variance for each measurement variable was computed to determine if a significant difference occurred between the control and experimental groups' pre and post measurements. A simple correlation was completed separately for the control group and the experimental group on each of the six variables to determine the relationships among the variables.

### Characteristics of Subjects

The control group performed the specified exercise program in the conventional manner. The sixteen subjects in this group ranged in age from 18-23 years with a mean age of 19.06; their height varied from 61.25 to 68.00 inches with a mean height of 64.75 inches; their weight ranged from 112.75 to 144.00 pounds with a mean weight of 128.83 pounds.

The experimental group performed the specified exercise program on a weight training machine. The thirteen subjects ranged in age from 18-25 years with a mean age of 19.36; their height varied from 60.50 to 68.00 inches with a

mean height of 64.87 inches; their weight ranged from 105.50 to 149.25 pounds with a mean weight of 128.59 pounds.

#### Analysis of Variance

Analyses of variance were computed to determine if the differences in the anthropometric measurements which occurred over the six week period between the control and experimental groups were statistically significant. The results are shown in Table 1 which contains the mean differences between the control and experimental groups on each variable, the standard deviations, and the resultant F scores.

The control group showed a mean weight gain of 1.38 pounds and a mean circumference gain of .14 inches in the hips. There was a mean circumference loss of .45 inches in the waist; .13 inches in the right thigh; .11 inches in the pectorals; and, .05 inches in the right upper arm. The largest mean circumference loss was in the waist measurement. The right thigh loss of .13 inches was significant at the .01 level when compared with the results achieved by the experimental group.

The experimental group showed a mean weight gain of .98 pounds and a mean circumference gain of .35 inches in the right thigh. There was a mean circumference loss of .37 inches in the right upper arm; .35 inches in the waist; .19 inches in the pectorals; and, .14 inches in the hips. The largest mean circumference loss of .37 inches was in the right upper arm measurement. This mean loss was significant at the .01 level when compared with the results achieved by the control group.

Table 1. Analysis of variance of the six anthropometric measurements of the experimental and control groups based on inches lost

Variable	Group	MS	SD	F
Weight	A	1.384	1.98	.152
	B	.984	3.23	
Arm	A	- .05	- .05	4.51 *
	B	- .37	.51	
Pectorals	A	- .11	.40	.22
	B	- .19	.56	
Waist	A	- .45	.53	.17
	B	- .35	.87	
Hips	A	.14	.47	1.76
	B	- .14	.65	
Thigh	A	- .13	.59	4.5
	B	.35	.61	

\* - .01 level of significance

A - Control Group

B - Experimental Group

The results indicated that circumference changes were significant at the .01 level of confidence in the control group for only the right thigh, while a significant difference of .01 was demonstrated in the experimental group for only the right upper arm. Both groups showed a decrease in four of the six anthropometrical measurements. The control group had a gain in the hips, while the experimental group had a gain in the thigh.

### Weight

A slight increase in body weight occurred for both groups, but the largest gain occurred for the control group. The difference yielded an F score of .15 which was not of sufficient size for significance at the .01 or .05 per cent level of confidence. The hypothesis was rejected and the change was attributed to chance factors.

### Right upper arm circumference

Both groups experienced a decrease in the circumference of the right upper arm. The mean decrease for the control group was .05 compared with .37 for the experimental group. The difference of .32 inches yielded an F score of 4.51. Since this score was of sufficient size for significance at the .01 per cent level of confidence, the difference was statistically significant. Thus, the hypothesis could be accepted, and the difference attributed to the experimental treatment.

### Pectorals

Both groups showed a decrease in the pectoral measurement. The decrease was .11 for the control group compared with .19 inches for the experimental group. This difference of .08 inches resulted in an F score of .22. Since this F score was not of sufficient size to meet the criteria for either the .01 per cent or .05 per cent level of confidence, the hypothesis could not be accepted. The difference could be attributed to chance factors.

### Waist

Both groups showed considerable decrease in the waist measurement. The decrease for the control group was .45 compared with .35 for the experimental group. This difference of .10 inches yielded an F score of .07, which was not significant at the .01 or .05 per cent level of confidence. Therefore, the differences could be attributed to chance.

### Hips

The control group showed an increase of .14 in the hips, while the experimental group showed a loss of .14 in the hips. The difference resulted in an F score of 1.76 which was not adequate to meet the criteria for a .01 or .05 per cent level of confidence. Consequently, the differences could be ascribed to chance factors.

### Right thigh

There was a decrease in the circumference of the right thigh of .13 inches for the control group. The experimental group, however, experienced a mean increase of .35 inches. The difference resulted in an F score of 4.50, which met

the criteria for significance at the .01 per cent level of confidence. Thus, the differences were attributed to the experimental treatment.

#### Correlations for Control Group

Correlations were computed to show the relationships that existed in the mean changes that occurred for each anthropometric measurement. These data are shown in Table 2. The circumference changes in the control group correlated with the weight change as follows: .08 for the right upper arm; .23 for the pectorals; .31 for the waist; .28 for the hips; and .04 for the right thigh. A correlation of .49 was required for the .05 per cent level of confidence. Thus, the changes in body circumference were independent of the weight gain.

Correlations between the mean changes that occurred in the various areas with the mean change in the right upper arm circumference were as follows: .24 for the pectorals; -.34 for the waist; -.19 for the hips; and .13 for the right thigh. Since these were not sufficient to qualify for the .01 or .05 level of probability, these changes were independent of the changes that occurred in the right arm circumference.

Correlations of the mean changes that occurred in the various areas with the mean change in the pectorals circumference were as follows: .26 for the waist; .29 for the hips; and .34 for the right thigh. These did not meet the criteria for the .01 or .05 level of probability. Therefore, these changes were independent of the changes that occurred in the pectorals.

Correlations of the mean changes that occurred in the various areas with the mean change in the waist circumference were as follows: .05 in the hips and

Table 2. Correlation table of six anthropometric measurements--control group based on inches lost

	Weight	Arm	Pectorals	Waist	Hips	Thigh
1. Weight	1.00	.083	.232	.312	.276	.043
2. Arm		1.00	.240	-.337	-.193	.134
3. Pectorals			1.00	.265	.291	.349
4. Waist				1.00	.056	-.331
5. Hips					1.00	.007
6. Thigh						1.00

.497 = .05

.623 = .01



-.33 in the right thigh. The changes were independent of the changes that occurred in the waist circumference as these were not adequate to qualify for the .01 or .05 level of probability.

Correlations of the mean change that occurred in the right thigh with the mean change in the hips circumference was .00. This did not meet the criteria for the .01 or .05 per cent level of probability. Thus, the change was independent of the change that occurred in the hips.

#### Correlations for Experimental Group

Table 3 shows the relationships that existed in the mean changes that occurred for each anthropometric measurement in the experimental group. The circumference changes correlated with the weight change were as follows: .69 for the right upper arm; .24 for the pectorals; .81 for the waist; .41 for the hips; and, .38 for the right thigh. The arm and waist met the criteria for the .01 per cent level of probability. The changes in these two measurements were related to the change that took place in the body weight.

The circumference changes correlated with the right upper arm were as follows: .48 in the pectorals; .70 in the waist; .54 in the hips; and .20 in the right thigh. The right upper arm correlated with the waist at the .01 per cent level of probability. Thus, the change in the right upper arm was inclined to take place along with a change in the waist.

The circumference changes correlated with the pectorals were as follows: .57 in the waist; .43 in the hips; and, -.29 in the right thigh. The pectoral-waist

Table 3. Correlation table of six anthropometric measurements--experimental group based on inches lost

	Weight	Arm	Pectorals	Waist	Hips	Thighs
1. Weight	1.00	.690*	.240	.817*	.418	.389
2. Arm		1.00	.484	.706*	.549	.208
3. Pectorals			1.00	.578**	.437	-.292
4. Waist				1.00	.518	.225
5. Hips					1.00	.324
6. Thighs						1.00

.553 = .05\*

.684 = .01\*\*

correlation was sufficient for the .01 per cent level of probability. Therefore, there was a strong tendency for a pectoral change to be accompanied by a waist change.

The circumference changes correlated with the waist were as follows: .51 in the hips and .22 in the right thigh. These were not sufficient to qualify for the .01 or .05 per cent level of probability. Thus, such changes were independent of the change in the waist.

The circumference change in the hips correlated with the right thigh at .32. This did not meet the criteria for the .01 or .05 per cent level of probability. Such a change was, therefore, independent of the change in the hips.

#### Percentage of Losses

Within the control group, 68.70 per cent of the subjects lost inches in the waist; 43.70 per cent lost inches in the pectorals and hips; 31.25 per cent lost inches in the right upper arm and the right thigh. Within the experimental group, 76.90 per cent of the subjects lost inches in the right upper arm; 61.50 per cent lost inches in the waist; 53.80 per cent lost inches in the pectorals; 38.50 per cent lost inches in the hips; and, 23.10 per cent lost inches in the thigh.

#### Percentage of Gains

Within the control group, 43.75 per cent of the subjects gained inches in the hips; 25.00 per cent gained inches in the pectorals and the right thigh; 12.50 per cent gained inches in the right arm; and, 6.25 per cent gained inches in the waist. Within the experimental group, 61.54 per cent of the subjects gained

inches in the right thigh; 30.77 per cent gained inches in the pectorals and hips; and, 15.38 per cent gained inches in the right arm and the waist.

### Discussion

A most surprising finding was the increase in the right thigh circumference shown by the experimental group, while a decrease in circumference resulted in all other areas measured. In addition, while the experimental group experienced an increase in the thigh circumference, the control group experienced a decrease in the thigh circumference. This finding did not appear to be consistent with the theories on which exercise for figure control are based. No determining causal factor could be isolated. Consideration was given to the possibility that the increase was due to a gain in body weight. However, there was not a statistically significant relationship between weight gain and the circumference increase in the right thigh in the experimental group. A possibility that would have to receive consideration was that a sufficient increase in the size of the muscle fibers caused an increase in the circumference. This, however, would not seem likely since it has been pointed out by White (1970) that ten repetitions of an exercise with moderate weight would not increase circumference. At any rate, this finding does suggest that a different approach might be used when using the weight training machine for reducing thigh circumference. Another consideration would be the use of a different exercise for this part of the body, though still using the weight training machine.

The weight gain for the control group was unusual as this was not considered to be a logical result when exercising in the conventional manner.

However, Massey (1959) stated that a slight weight gain is not uncommon when exercising with weights. Because the weight gain did not average even one pound, it seemed logical that the subjects were still able to lose inches in the measurements taken.

Subjects in both groups were quite anxious to proceed with the task of exercising in order to decrease body measurements. The motivation to exercise appeared high throughout the study, but there was concern as to how long the high motivation would continue with the subjects on a highly structured and limited exercise program. This concern was a determining factor in selecting a six week time period for the experiment. A further consideration for subjects being willing to participate in a study of this type for an extended period was the request for subjects to limit physical activity to class time only. Most of the subjects wanted to see immediate results in decreased body measurements and were eager to participate in additional physical activity.

Changes in body circumference did occur over the six week experimental period, although the changes could be considered to be minimal. There was, therefore, the implicit suggestion that further changes could be effected with an extended experimental period.

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### Summary

The purpose of this study was to compare the results of conventional exercising and weight training for the improvement of anthropometrical measurements of college women at Utah State University. The data were accumulated from twenty-nine women students who were enrolled in two figure control classes. The control group of sixteen subjects exercised in the conventional manner, while the experimental group of thirteen subjects exercised on a weight training machine. The subjects participated in six weeks of exercise meeting two days per week.

Changes in body weight, right arm circumference, pectoral circumference, waist circumference, hip circumference, and right thigh circumference of the control and experimental subjects were analyzed by analysis of variance. In addition, a simple correlation among the six anthropometric variables was completed for each group.

### Findings

1. The control group showed a mean circumference loss of .13 inches in the right thigh whereas the experimental group showed a mean circumference gain of .35 inches in the right thigh. The difference between the groups was determined to be statistically significant at the .01 per cent level of confidence.

2. The control group showed a mean circumference loss of .05 inches in the right upper arm whereas the experimental group showed a mean circumference loss of .37 inches in the right upper arm. The difference between the groups was determined to be statistically significant at the .01 per cent level of confidence.

3. The control group revealed a mean gain of 1.38 pounds in body weight while the experimental group revealed a mean gain of .98 pounds. The difference between the groups was not significant at either the .01 or .05 per cent level of confidence.

4. The control group demonstrated a mean circumference loss of .11 inches in the pectorals whereas the experimental group demonstrated a mean circumference loss of .19 inches. The difference between the groups was not significant at either the .01 or .05 per cent level of confidence.

5. The control group showed a mean circumference loss of .45 inches in the waist while the experimental group showed a mean circumference loss of .35 inches in the waist. The difference between the groups was not significant at either the .01 or .05 per cent level of confidence.

6. The control groups showed a mean circumference gain of .14 inches in the hips while the experimental group showed a mean loss of .14 inches in the hips. The difference between the groups was not significant at either the .01 or .05 per cent level of confidence.

#### Conclusions

Within the limits of this investigation it can be concluded that: (a) circumference losses were attained by both the conventional and weight training methods;

however, such losses were not sufficient to support one method over the other; (b) during regular exercising, a slight weight increase did not necessarily prevent a decrease in anthropometric measurements.

### Recommendations

On the basis of the findings from this investigation, the following recommendations have been made:

1. A similar study should be conducted with the subjects exercising three times per week rather than two times a week.
2. The length of a similar study should be extended to a minimum of nine weeks, with measurements taken at the mid-point as well as the beginning and end of the period.
3. An additional measurement for each subject should be the pre and post determination of body fat percentage by hydrostatic weighing and/or skinfolds.
4. An investigation should be conducted to establish a workload equivalency for work accomplished on a weight training machine versus work accomplished in a conventional exercise program.
5. An investigation should be conducted to ascertain the relationship of thigh circumference increase to weight training exercises and/or conventional exercise.



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## APPENDIX

Table 4. Physical characteristics of control subjects

Subject	Height*	Pre and Post Measurements												Age*
		Weight		Arm		Pectorals		Waist		Hips		Thigh		
1	61.25	119.25	118.75	11.25	12	32	32.25	25	24.75	36.5	36.25	21.5	21.5	19
2	61.5	119.5	120	12	12	33.5	33.25	29.25	28.5	36.5	36.75	18.75	18.75	23
3	63	136	137.75	11	11	32	32	26.75	26.5	39.25	39	23.5	23.5	18
4	63	112.75	110	11	11	31	31	25	24	35.25	35	20	19.25	18
5	63.25	126.25	131.75	12.5	12.5	33.25	33.25	28.5	28	36	36.75	21.5	21.75	18
6	64	125	121.25	11	10.75	29.75	30	25	25	37.5	38.5	21.5	21	18
7	64	144	149.5	13.5	13.25	33	33.5	27.5	28	39	39.5	23.75	23.5	18
8	64.25	131.5	130	12	12	33	32.5	27.25	26.5	38	37.5	21.25	21.5	18
9	64.75	123.25	121.5	11.75	11.5	32	31.5	25.25	25	36	35.75	20.25	20.25	20
10	65.6	126	129.5	11.5	11	30.5	30.25	25	25	36.25	36	20.5	20.25	21
11	66	126.5	129.5	11.5	11	31.25	31	25.5	25.25	35.5	36	21	21	19
12	66.5	139	137	12.5	12.5	33.25	33.25	28.5	27	38.5	38.5	21.5	22.5	19
13	67	124.25	129	11	11	32	32	25.75	25.75	37.75	37.5	20.5	20.5	18
14	67.5	128	128	12	12	31.5	31	26	24.75	36.5	37.25	21.5	21.25	21
15	68	140.75	143.75	11.5	11.5	34.25	33.25	27.5	27	39.5	39.5	23.25	21.5	18
16	68	135.5	141.25	11.75	12	33	33.5	28.5	27.75	37.5	28	22	22.25	19

\*Height and Age remained constant

Table 5. Physical characteristics of experimental subjects

Subject	Height*	Pre and Post Measurements												Age*
		Weight		Arm		Pectorals		Waist		Hips		Thigh		
1	60.5	105.5	107.5	11	10.5	30.5	30	24.5	24	36.5	36.5	20.5	20.75	25
2	61.5	110.25	110.75	12	11.5	31.5	31	25	25	34.5	34.5	19	19.75	18
3	63.75	129.25	128.25	11.75	11.5	32.75	32.25	26.5	25.5	38	38	21	21.25	23
4	64	115.75	118	11.5	11.25	31	31	25	25	36	35.25	19.5	20	18
5	64.5	138	139.25	11.5	11.5	34	33.5	27.5	27	40	40.25	23.5	24	22
6	65	128.25	131.25	12.5	11.5	33	32	26.5	25	36.5	37.25	20.5	21.75	18
7	65.25	118.5	121.25	11.75	11.25	32	32	25	24.75	36	35.75	21.25	21	18
8	65.25	134	133.25	12	12	33.25	32.5	27	26	37.5	37.5	22.5	22.5	18
9	65.25	149.25	151.75	12.75	12.75	35.25	35	29.5	29.5	41.5	40.5	23.25	23.25	18
10	65.5	145	142	13	13	34	33	29	26.75	39.5	38.25	22.5	22	19
11	65.75	130.5	131.5	11.5	11.5	32.5	31.5	28.5	29	36	36	22.25	21.5	19
12	68	145.5	151.25	12.5	12.5	33.25	33.5	26	27.5	38.5	38.5	22	23	18
13	68	125	125	12.25	12.25	31.5	31.75	25	24.5	37.5	37.5	19.25	20.5	18

\*Height and Age remained constant

Table 6. Pre- and post-measurement ranges

Range	Control		Experimental	
	Pre	Post	Pre	Post
Age	18-23	18-23	18-25	18-25
Weight	112.75-144	110-149.5	105.5-149.25	107.5-151.75
Arm	11-13.5	10.75-13.25	11-13	10.5-13
Pectorals	29.75-34.25	30-33.5	30.5-35.25	30-35
Waist	24.75-29.25	24-28.5	24.5-29.5	24-29.5
Hips	35.5-39.5	35-39.5	34.5-41.5	34.5-40.5
Thigh	18.75-23.75	18.75-23.5	19-23.5	19.75-24



Table 7. Pre- and post-means of six anthropometric measurements

	Control				Experimental			
	Pre		Post		Pre		Post	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Weight	128.83	3.594	130.07	5.418	128.59	6.554	129.57	6.553
Arm	12	3.04	11.68	1.866	11.73	1.171	11.68	1.1
Pectorals	32.65	1.723	32.23	1.414	32.20	1.836	32.12	2.1
Waist	26.53	3.53	26.19	2.175	26.64	3.55	26.17	2.82
Hips	37.44	1.964	37.32	1.87	37.21	3.158	37.35	1.96
Thigh	21.30	1.54	21.63	1.41	21.39	4.0	21.26	2.785

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