CHANGES IN PHYSICAL PERFORMANCE AND BODY MEASUREMENTS ACCOMPANYING WEIGHT REDUCTION AND EXERCISE PROGRAMS AMONG UNIVERSITY WOMEN

by

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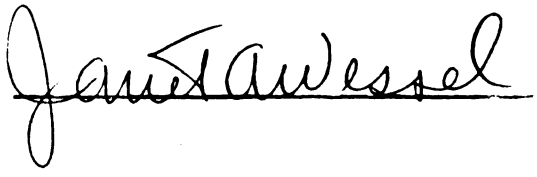
Approved 

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M.A.A.

ABSTRACT

CHANGES IN PHYSICAL PERFORMANCE AND BODY MEASUREMENTS ACCOMPANYING WEIGHT REDUCTION AND EXERCISE PROGRAMS AMONG UNIVERSITY WOMEN

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The purpose of this study was to:

1. Measure changes in physical performance and anthropometric measures among overweight university women who were undergoing diet, diet and exercise, and exercise programs;
2. Determine the significance of these changes in anthropometric and physical performance measures;
3. Investigate the relationships between changes in physical performance and anthropometric measures among overweight university women who were undergoing diet, diet and exercise, and exercise programs.

The procedure was as follows: Eighteen overweight university women were selected from the instructional physical education program at Michigan State University. Subjects were matched and divided into three groups. One group was placed on a program of reduced caloric intake diet; another group was placed on a supervised exercise program; the third group participated in both the diet and the exercise programs. Initial and final measurements were taken of the physical performance, skin-fold fat, girth, and body weight of each subject.

Conclusions from this study were that:

1. Improved physical performance accompanied participation in both the supervised exercise and the reduced caloric intake diet programs.
2. Subjects who participated in reduced caloric intake diet obtained greater weight reduction, decrease in skin-fold fat, and girth measurements than those who participated in the supervised exercise programs.
3. Subjects who participated in the supervised exercise program obtained greater decrease in girth measurements than in skin-fold fat.

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CHAPTER I

INTRODUCTION

Overweight is one of the most prevalent health problems in our society today. Excess weight impairs health. Studies show that individuals who are overweight are more likely to develop cardiovascular diseases, diabetes, and disorders of the gall-bladder and liver.[1]

Overweight individuals are handicapped physically by their excessive weight. Wear and tear on joints is hastened.[2] The performance of such strenuous activities as broad jump and dash events is hindered by excessive weight.[3]

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[1]Herbert H. Marks, "Influence of Obesity on Morbidity and Mortality," Symposium on Prevention of Obesity, Robert L. Craig, M.D., editor (Reprinted from Bulletin of the New York Academy of Medicine, 36:Nos. 5 and 6. New York: Charles C. Marchand Company, 1960), pp. 21-25.

[2]Ibid., p. 25.

[3]Aileen Carpenter, "An Analysis of the Relationships of the Factors of Velocity, Strength, and Dead Weight to Athletic Performance," Research Quarterly, 12:36,March,1941; R. P. Riendeau, et al., "Relationships of Body Fat to Motor Fitness Test Scores," Research Quarterly, 29:203, May, 1958; R. W. Kireilis, and T. K. Cureton, "The Relationships of External Fat to Physical Education Activities and Fitness Tests," Research Quarterly, 18:132, May, 1947; Frank D.Sills and Peter W. Everett, "The Relationship of Extreme Somatotypes to Performance in Motor and Strength Tests," Research Quarterly, 24:228, May, 1953.

The mortality rate for overweight individuals is greater than that for individuals who are not overweight.[4]

Problems accompanying overweight can be lessened by weight reduction. Beneficial results accompanying weight reduction have been shown in cases of diabetes,[5] blood pressure levels,[6] and glucose tolerance in diabetics.[7] Also, the mortality rate of individuals who had lost enough weight to improve their insurance rating was substantially less than that of overweight individuals.[8] Therefore, evidence shows that the problems accompanying overweight can be lessened by weight reduction.

The importance of exercise for improved physical performance and diet for decreasing girth measurements are

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[4]Marks, 17-20.

[5]L. H. Newburgh, "Control of the Hyperglycemia of Obese 'Diabetics' by Weight Reduction," Annals of Internal Medicine, 17:935-42, December, 1942.

[6]S. Lups and C. Franke, "Changes in Blood Pressure During Period of Starvation (September 1944 to May 1945) and After Liberation (May 1945 to September 1945) in Utrecht, Holland," Acta Medica Scandinavia, 126:449-58, Fasc. 6,1947.

[7]Newburgh.

[8]Marks, citing L. I. Dublin and H. H. Marks, "Mortality Among Insured Overweights in Recent Years," Trans. Assoc. Life Insur. med. Dir. Amer., 35:235-63, 1951.

well recognized. While stepped up physical activity has been minimized with respect to weight reduction in the past, recent research indicates that activity plays a significant part in weight control and weight reduction programs. The purposeful inclusion of optimum physical recreation in everyday living as a proper means of weight control is one of the major contributions of physical education to modern day living.

STATEMENT OF THE PROBLEM

The purpose of this study was three-fold:

1. To measure changes in anthropometric and physical performance measures among overweight college women who were undergoing diet, diet and exercise, and exercise programs.
2. To determine the significance of the changes in anthropometric and physical performance measures among overweight college women who were undergoing diet, diet and exercise, and exercise programs.
3. To investigate the relationships between the changes in anthropometric and physical performance measures among overweight college women who were undergoing diet, diet and exercise, and exercise programs.

NEED FOR THE STUDY

Means for evaluating changes which occur through different types of weight reduction techniques are necessary if the effectiveness of any type of program is to be determined. Diet and some form of exercise are among the most common techniques used in weight reduction programs.

There is a need for evaluating the effectiveness of specific exercises in changing selected body measurements. There is a need for evaluating the effects of diet in changing selected body measurements. There is need for comparing the changes in body measurements obtained by women undergoing exercise with those changes in the same body measurements obtained by women undergoing diet.

Also, little has been done to evaluate whether weight loss affects physical performance favorably or unfavorably. This points up a need for means of evaluating whether physical performance is affected favorably or unfavorably by weight loss.

DEFINITION OF THE TERMS

Overweight. Overweight is that weight in excess of the optimum weight for an individual as determined by a standard. The Helen B. Pryor Width-Weight Tables were used in this study to determine optimum weights on the basis of

sex, age, height, chest-width, and bi-iliac width measurements.[9]

Physical performance. Physical performance is a person's ability to use his body to perform in specified situations. Physical performance was measured by selected tests of flexibility, strength, agility, and endurance. The tests used to measure physical performance were grip-strength, push and pull strengths, back-extension, standing-flexion, sit-ups, shuttle-race, and chair-step.

Skin-fold fat. Skin-fold fat is that fat which lies immediately underneath the skin and which can be grasped or pinched between thumb and forefinger. Fat calipers were used to measure the thickness of skin-folds in the biceps, triceps, cheek, pectoral, bi-iliac crest, scapular, and lower ribs areas.

Girth. Girth refers to the distance around a particular area of the body. The specific girth measurements taken for this study were upper arm, bust, waist, abdomen, buttocks, thigh, and calf girths.

Diet. Diet is what a person usually eats. Unless otherwise specified, diet in this study shall refer to a carefully controlled reduced caloric intake diet of approximately 1500 calories per day.

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[9]Helen B. Pryor, Width-Weight Tables (Stanford, Calif.: Stanford University Press, 1940).

Exercise. Exercise is a regular series of movements designed for a specific purpose. Exercise as referred to in this study shall be specific movements of a calisthenic nature performed under supervision.

LIMITATIONS OF THE STUDY

This study was limited to certain physical changes which took place among overweight university women during a nine week period of controlled diet and exercise. The physical changes studied were: (1) body weight, (2) skinfold fat, (3) girth, and (4) physical performance.

The results of this study are reported in the light of the following limitations:

1. Limitations due to subjects and the control thereof;
2. Limitation of measurement procedures;
3. Limitations due to the duration of experimental period;
4. Limitations due to the selection of exercises;
5. Limitations due to the time of the testing;
6. Limitations due to the lack of energy cost data.

1. Limitations due to subjects and the control thereof. This study was definitely limited by the small number of subjects for whom complete data is available. Of the limited number of eligible women (based upon degree of overweight), even fewer desired to participate in the program. Although

the study was begun with 18 experimental subjects who were divided into equal groups, various circumstances permitted the compilation of complete data on only 8 subjects. One woman dropped out of school, another was dropped from the study for medical reasons, some were unable to stay on the diet, and others did not report for the full series of tests.

Motivation and attitude of the subjects affected this study in two ways: (1) Lack of motivation and self-discipline were partially responsible for situations in which subjects were not able to stay on the diet or who did not report for the full series of tests. Therefore complete data was not available for them and the total number of subjects was decreased accordingly. (2) Lack of motivation and self-discipline may have affected the scores of subjects in the physical performance tests and the performance of exercises in the exercise program. Subjects who felt that it took too much time attended exercise sessions less frequently. Those who felt it was too much work did not exert themselves as much as they could have, either in the exercise program or the physical performance tests and thereby possibly affected total changes.

It was exceedingly difficult to control whether the subjects on the diet program actually limited themselves only to the calories consumed under the diet program. Some "cheating" may have occurred which was not admitted to, thereby affecting the diet phase of the study. Each subject

was permitted to spend one weekend away from campus. During this time there were no dietary restrictions, some of the subjects ate excessively, and weight loss curves were affected.

Another limitation of the subjects and the control thereof was related to an attempt to estimate the daily extent of activity of each subject. When trying to account for all activities during a 24 hour day, sometimes subjects could account for only 12 hours, others might have a total of 30 hours. Control of, or a record of activity is an important aspect of this type of investigation and needs to be studied further.

Diet recall was used in an attempt to secure caloric intake information on the subjects in the exercise program. The ability of these subjects to recall accurately their food intake was not adequate for evaluation purposes. This is another very important aspect of this type of investigation.

2. Limitations of measurement procedures. A previous study on the same campus reported reliabilities for physical performance tests.[10] There were problems in administering the tests, which were unique to measuring overweight subjects

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[10]Janet A. Wessel, Richard Nelsen, and Eva Lou Dillon, "Frequency Distribution and Standards of Anthropometric and Physical Performance Measures for College Women," Research Quarterly, 31:523-533, October, 1960.

therefore, reliabilities should have been found for this specific group of subjects.

The frequency and time for obtaining body weights of the exercise subjects was not established definitely. In some cases, the time for the initial observed weight did not correspond exactly with the commencement of the exercise program, thereby providing an opportunity for discrepancy. Subjects on the exercise program were not required to weigh-in weekly, hence weight curves were not available.

3. Limitations due to the duration of the experimental period. The most serious limitation due to the duration of the experimental period was that the duration of the diet program was nine weeks, that of the exercise program only seven weeks. Some subjects began the diet program before all physical and body measurements were taken, therefore, initial measurements may have been affected by a certain amount of change due to the diet. It was difficult for subjects to hold to the diet without "cheating," especially in the latter weeks of the diet. Subjects in the exercise program had difficulty maintaining a high level of motivation in the exercise program when school pressures became greater towards the end of the term.

4. Limitations due to the selection of exercises. A limitation in the results of this study may lie in the selection of exercises. Although an all-out endurance activity was required, it can be questioned that this

required in all cases all-out effort. As subjects improved in swimming ability, so did their efficiency in the water improve, thereby perhaps actually decreasing caloric expenditure for a stated time or distance. To swim "as fast as one can for as long as one can" requires strong motivation. Also, subjects did not always respond favorably to the idea of getting wet, getting hair wet, etc. for a few minutes of effort.

Riding the bike often required greater exertion than swimming. A subject's total feeling of well-being any one day seemed to affect the rate and time she could maintain on the bike. The problem of waiting in line for use of the bike prevented some participation in this exercise. Subjects could not come in, perform all exercises in succession, and leave as originally planned.

Two exercises were changed when the purpose for which they were intended did not appear to be met, therefore, shorter durations of time were recorded for the exercises finally used.

5. Limitations due to the time of testing. As has been mentioned previously, the time of the administration of all tests did not always coincide with the beginning and end of the experimental period. Difficulties in getting all subjects together for testing, making arrangements for make-up, and retesting when necessary helped to contribute to this. In some cases, the duration of the experimental

period was cut down because time was needed to administer tests.

The placement of the initial tests immediately following Christmas vacation and the final tests at the end of a term may have affected test scores in a way not accounted for by the experimental variables. Following Christmas vacation, subjects were reasonably rested, ready to start a new term. Towards the end of the experimental period, when final tests were administered, pre-exam tensions, lack of sleep, and greater academic pressures may have affected physical performance test scores.

6. Limitations due to lack of energy cost data. No facilities were available for testing the actual energy cost of the subjects who were undergoing the supervised exercise program. Some activities may have caused a greater increase of energy expenditure than others for particular subjects. The activity recall used was too inaccurate to correlate with energy cost tables. This study could have been improved considerably with this information.

McKee, in studying the caloric expenditure of normal and obese subjects during a standard work test, actually found that "The energy expenditure of obese persons of both sexes was greater during both the basal period and the work period than that of the normal subjects."[2] When compared with basal expenditure, energy to perform work was no greater for obese subjects than for normal subjects. Greater expenditure during work was directly related to greater body surface area and basal expenditure of the obese subjects.[3]

Furthermore, according to Lauter,[4] Bruch,[5] and Newburgh,[6] the only factor of energy economy in obese people is decreased muscular activity, inactivity, diminished muscular exercise, or diminished outgo of energy.

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[2]W. D. McKee, R. E. Bolinger, "Caloric Expenditure of Normal and Obese Subjects During Standard Work Test," Journal of Applied Physiology, 15:197, March, 1960.

[3]Ibid., pp. 197-200.

[4]S. Lauter, "Zur Genese der Fettscucht," Deutches Arch. f. Klin. Med., 150:315, 1926, cited by Hilde Bruch, "Obesity in Childhood," American Journal of Diseases of Children, 60:1086, November, 1940.

[5]Hilde Bruch, "Obesity in Childhood IV: Energy Expenditure of Obese Children," American Journal of Diseases of Children, 60:1086, November, 1940.

[6]Newburgh, 720.

Bogert places inactivity second only to overeating in discussing the causes of overweight. He describes a vicious circle when a person performing only slight muscular activity uses less energy, deposits more fat, and desires less activity requiring even less energy outgo, hence develops more fat deposits. He mentions the necessity of taking either less food, more exercise, or both in order to keep the weight down. He also states that weight is almost certain to increase with age as a result of the tendency towards less activity and lower basal metabolism.[7]

Greene traced the beginning of obesity among 350 overweight adults to a sudden decrease in activity. Pregnancy, disease, long illness, and convalescence, rather than overall life activity were responsible for the onset of the inactive period. Greene further points out, however, the neglect in studying activity of patients during gain in body weight.[8]

Studies which were concerned with the activity of obese children report that inactivity is characteristic. Graham observed that obese children spent leisure time

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[7]L. Jean Bogert, "Food Value of Foods and Control of Body Weight," Nutrition and Physical Fitness (Philadelphia: W. B. Saunders, 1954), Chap. 5, p. 76.

[8]J. A. Greene, "Clinical Study of the Etiology of Obesity," Annals of Internal Medicine, 12:1797-1803, May, 1939.

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[8]J. A. Greene, "Clinical Study of the Etiology of Obesity," Annals of Internal Medicine, 12:1797-1803, May, 1939.

sitting down,[9] Bronstein reported that 335 obese children spent most leisure time in sedentary activities,[10] Bruch claims inactivity characteristic of 160 obese children studied,[11] and Mayer reported that a higher proportion of obese children than non-obese were labled as only moderately active or inactive.[12] When diet histories and over-all picture of physical activity of 28 obese and 28 normal high school girls were studied, Johnson, Burke, and Mayer found the intake of energy by obese girls to be significantly less than that of the normal girls, but the normal girls were significantly more active.[13]

Stunkard matched according to age and occupation 15 pairs of obese women with non-obese women. A pedometer was used to measure activity for one week. Obese women walked less than half as far as the non-obese controls. Also, the attitudes of obese women towards activity were less favorable

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[9]H. B. Graham, Medical Journal of Australia,2:649,1947.

[10]I. P. Bronstein, et al., "Obesity in Childhood, Psychologic Studies," American Journal of Diseases of Children, 63:238, February, 1942.

[11]Bruch, 1082.

[12]Jean Mayer, "Exercise and Weight Control," Postgraduate Medicine, 25:331, February, 1959.

[13]M. L. Johnson, B. S. Burke, and J. Mayer, "Relative Importance of Inactivity and Overeating in the Energy Balance of Obese High School Girls," American Journal of Clincial Nutrition, 4:37-44, January-February, 1956.

TREATMENT OF OBESITY THROUGH PHYSICAL ACTIVITY

Although Rony says that "as an adjunct to the submaintenance diet, moderate exercise is not without value,. . ."[19] he credits muscular exercise with limited value in the practical treatment of obesity due to the relatively slight energy expenditure and resultant increase in appetite.[20]

On the other hand, Mayer:

> . . . is convinced that inactivity is the most important factor explaining the frequency of "creeping" overweight in modern Western societies [and that although] . . . strenuous exercise on an irregular basis is not advocated, . . . [one should] reorganize one's life to include regular exercise adapted to one's physical potentialities . . .[21]

RELATIONSHIPS BETWEEN BODY WEIGHT AND ANTHROPOMETRIC MEASUREMENTS

Anthropometric measurements have been used to estimate body weight and degree of overweight. Keys states that "body weight, even when evaluated with reference to the size of the skeleton, is a poor measure of fatness."[22] He claims

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[19]Hugo Rony, Obesity and Leanness (Philadelphia: Lea and Febiger, 1940), p. 266.

[20]Ibid., p. 265-66.

[21]Jean Mayer, "The Role of Exercise and Activity in Weight Control," Weight Control (Ames, Iowa: The Iowa State College Press, 1955), p. 203.

[22]Ancel Keys and Josef Brozek, "Body Fat in Adult Man," Physiological Reviews, 33:249, July, 1953.

that the measurement of body fat, itself, is more important, since the greatest variability in the animal body is in fat. This fat is measured by Keys with skin-fold calipers in a large number of sites. Keys has found the determination of body fat with skin calipers to correlate well with specific gravity.[23]

Hechter has used X-ray, selected girth, and selected bone diameter measurements to predict body weight and lean body weight in 31 adult males.[24] Behnke used skeletal, anthropometric, and X-ray measurements to estimate lean body weight. This was compared with body density and total body water determinations. Although Behnke attributed the largest source of error to variations in subcutaneous fat, the "size of the 'skeleton' appears to be a reliable reference standard in both health and disease to estimate lean body weight."[25]

RELATIONSHIPS BETWEEN ANTHROPOMETRIC MEASUREMENTS AND STRENGTH

Anthropometric measurements have been correlated to strength in several studies. In investigating factors

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[23] Ibid., pp. 249-60.

[24] H. Hechter, "The Relationship Between Weight and Some Anthropometric Measurements in Adult Males," Human Biology, 31:235-243, September, 1959.

[25] Albert R. Behnke, "The Estimation of Lean Body Weight from Skeletal Measurements," Human Biology, 31:295-315, December, 1959.

related to strength among women, Carpenter has found that relative size of arms and legs fails to indicate their strength.[26] Clarke correlated anthropometric measures with physical performance of men and reported significant correlations between body weight and trunk flexion, trunk lateral flexion, trunk rotation, and knee extension.[27] In predicting physical performance by somatotype in male college freshmen, Sills and Mitchem found that subjects with greater endomorphic components received lower test scores in sit-ups and pull-ups.[28]

RELATIONSHIPS BETWEEN BODY WEIGHT AND MOTOR PERFORMANCE

Motor performance among obese and normal female subjects was determined by standard exercise on a bicycle by Wang and his associates. Twenty-seven obese women, 9 normal, and 7 underweight women were the subjects of 57 experiments. Mechanical efficiency was found to vary inversely with per

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[26] Aileen Carpenter, "A Critical Study of the Factors Determining Effective Strength Tests for Women," Research Quarterly, 9:26, December, 1938.

[27] Harrison Clarke, "Relationships of Strength and Anthropometric Measures to Physical Performances Involving the Trunk and Legs," Research Quarterly, 28:226-228, October, 1957.

[28] Frank D. Sills and John Mitchem, "Prediction of Performances on Physical Fitness Tests by Means of Somatotype Ratings," Research Quarterly, 28:64-71, March, 1957.

CHAPTER II

REVIEW OF THE LITERATURE

There is little detailed information pertaining to controlled research of the relationship of muscular activity to obesity. The majority of the studies available have to do with the dietary aspect of overweight; those that substantiate the fact that obese people eat more than their energy outgo requires. This review shall present some of the more significant studies relating obesity and overweight to various aspects of physical activity, physical performance, and anthropometric measurements.

PHYSICAL ACTIVITY RELATED TO CAUSE AND ONSET OF OVERWEIGHT

There are claims that the energy outgo of obese people is less than that required for non-obese individuals. These are refuted by Newburgh when he says that:

> . . . obese persons . . . produce more heat in basal state, expend more energy to perform a measured amount of work, and . . . their total heat production is greater than that of normal persons of similar age, height, and sex under the same circumstances. Since they are unable to absorb more energy from their food, they must eat more than normal people simply to avoid loss of weight.[1]

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[1]L. H. Newburgh, Clinical Nutrition, Chapter 28, Norman Jollife, editor (New York: Paul B. Hoober, Inc., Med. Dept. of Harper and Bros., 1950), p. 707.

cent overweight; a gradual decrease in mechanical efficiency was found with an increase in obesity.[29]

Carpenter used 100 college women as subjects in investigating relationships between factors of velocity, strength, and dead weight and athletic performance. She states that "Dash and broad jump are both negative to weight and normal weight, yet the several variables involving strength are positive to weight in all cases."[30] Furthermore, Carpenter introduces the term "dead weight" as that weight not represented by contractile tissue and which acts as a load on muscular weight. She found the dead weight to be a handicap to dash and broad jump, and identifies it as "surplus baggage."[31]

Carpenter further clarifies the relationship between dead weight and strength by saying:

> [The] greater the dead weight is in proportion to total weight, the less will be the strength . . . , while the greater the strength factor in proportion to weight, the less will be the dead weight factor.[32]

Brady defined "dead weight" as "that part of the body weight which was a handicap in physical activity," in a

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[29]C. C. Wang, S. Strouse, and Z. Morton, "The Metabolism of Obesity," Archives of Internal Medicine, 45:727, May, 1930.

[30]Aileen Carpenter, "An Analysis of the Relationships of the Factors of Velocity, Strength, and Dead Weight to Athletic Performance," Research Quarterly, 12:34, March, 1941.

[31]Ibid., p. 36.

[32]Ibid., pp. 38-39.

study concerning the effect of excess weight upon motor skills.[33] Sills measured, tested, and somatotyped 158 male freshmen enrolled in freshmen physical education classes. He found that endomorphy (or overweight) bears a negative relationship to performance in sit-ups, pull-ups, squat-thrusts, squat-jumps, 100 yard pick-a-back-run, and 300 yard shuttle-run.[34] Sills also reported in a later study that in 12 fitness tests of strength, agility, speed, and endurance, no endomorph was able to complete the mile run. He concluded that "excess weight is a handicap to endomorphs . . . in the performance of physical tests."[35]

In relating body fat to motor fitness test scores, Riendeau and his associates concluded that "the motor fitness test items most affected by body fat were those which involve running and jumping."[36] Riendeau found that weight did not significantly affect the performance of any of the test

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[33]George F. Brady, "The Effect of Excess Weight Upon Motor Skills" (unpublished Ph.D. thesis, State University of Iowa, Iowa City, 1951), quoted by Frank D. Sills and Peter W. Everett, "The Relationship of Extreme Somatotypes to Performance in Motor and Strength Tests," Research Quarterly, 24:223, May, 1953.

[34]Ibid.

[35]Frank D. Sills and Peter W. Everett, "The Relationship of Extreme Somatotypes to Performance in Motor and Strength Tests," Research Quarterly, 24:223-228.

[36]R. P. Riendeau, et al., "Relationships of Body Fat to Motor Fitness Test Scores," Research Quarterly, 29:203, May, 1958.

items except the 220 yard dash.[37] Willgoose concluded that endomorphy was a limiting factor in physical fitness when he studied the relationship of somatotype to physical fitness.[38]

Kireilis claimed fat to be a real handicap in most strenuous exercises. During a 6 week period of treadmill running, external fat diminished among young male students as the number of miles accumulated. Little weight loss was noted, although loss of external fat from hips, rear thigh, and gluteals was observed. He then concluded that "weight is not a good guide to fat loss, possibly because fat loss is compensated for by increased muscular density due to the exercise."[39]

CHANGES IN BODY MEASUREMENTS ASSOCIATED WITH WEIGHT LOSS

There are few studies investigating the changes in body measurements which accompany weight loss. Carns and Glassow measured body volume changes which accompanied weight loss among 10 university women who underwent a 6 week diet program. The body volume was reduced to the greatest degree where the fat deposits were largest. Also, the

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[37] Ibid.

[38] Carl E. Willgoose and Millard L. Rogers," Relationship of Somatotype to Physical Fitness," Journal of Educational Research, 42:710, May, 1949.

[39] R. W. Kireilis and T. K. Cureton, "The Relationships of External Fat to Physical Education Activities and Fitness Tests," Research Quarterly, 18:123-134, May, 1947.

percentage loss of volume was twice that of percentage loss of weight.[40]

Ohlson and her associates reported decrease in body measurements accompanying weight loss among obese women. Most rapid change was noted in the girth of the upper arm.[41] Loss in scapula skin-fold thickness and upper arm circumference accompanying weight loss in college women were reported by Stefanik. In the same study, increase in the same measurements accompanied weight gain.[42]

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[40]Marie L. Carns and Ruth B. Glassow, "Changes in Body Volume Accompanying Weight Reduction in College Women," Human Biology, 29:305-14, December, 1957.

[41]Margaret A. Ohlson, et al., "Anthropometry and Nutritional Status of Adult Women," Human Biology, 28:195-98, May, 1956.

[42]Patricia A. Stefanik, et al., "Physical Performance, Skinfold Measurements, Activity Expenditures, and Food Consumption of College Women," Research Quarterly, 32:234-235, May, 1961.

CHAPTER III

DESIGN AND METHODOLOGY OF THE STUDY

Eighteen overweight university women were selected from the instructional physical education program at Michigan State University. Each subject was placed in one of three groups to participate in a nine week program of controlled diet, supervised exercise, or a combination of both controlled diet and supervised exercise. Initial and final measurements were taken of the physical performance, skin-fold fat, girth and body weight of each subject.

It was the purpose of this study to (1) measure changes in anthropometric and physical performance measures among overweight college women who were undergoing diet, diet and exercise, and exercise programs; (2) to determine the significance of the changes in anthropometric and physical performance measures; and (3) to investigate the relationships between the changes in anthropometric and physical performance measures among these university women.

SELECTION OF SUBJECTS AND GROUPS

The subjects were eighteen overweight women who were enrolled in the instructional physical education program at Michigan State University. Each subject had her parents' permission as well as a medical examination given by a

physician[1] of the University Health Service before participating in this experiment.

The Pryor Width-Weight Tables[2] were used to determine the optimum weight for each subject. The initial weight of each subject, her optimum weight, and initial kilograms overweight are presented in Table I. All observed weights were recorded in kilograms.

The subjects were matched according to mean kilograms overweight and divided into three groups. Group I was the diet group, Group II the diet and exercise group, and Group III the exercise group. Table II presents the means and ranges of kilograms overweight for the three groups.

The subjects in Group I were placed on the diet program for a period of nine weeks. A 24 hour Activity Recall was administered to each subject. This was used to estimate the extent of activity for requesting these subjects to continue their regular daily activities. These subjects did not enroll in physical education courses during the ten week period they were participating in this study.

Subjects in Group II participated in the diet program and were given a series of supervised exercises for a period of seven weeks.

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[1]Acknowledgment is made to Dr. O. Grant Reed for examining the subjects.

[2]Pryor.

TABLE I

INITIAL WEIGHTS, OPTIMUM WEIGHTS AND KILOGRAMS OVERWEIGHT FOR EXPERIMENTAL SUBJECTS

Subject No.	Initial Observed Weight Kg.	Optimum[a] Weight Kg.	Overweight Kg
11	87.18	72.0	15.2
12	80.36	68.0	12.4
13	59.88	52.1	7.8
14	80.94	63.5	17.4
15	82.22	64.4	17.8
16	74.36	61.2	13.2
21	79.62	69.4	10.2
22	74.26	63.0	7.7
23	76.56	61.2	15.4
24	72.50	67.5	5.0
25	85.90	70.4	15.5
26	92.70	69.4	23.3
31	73.56	66.6	7.0
32	64.31	63.0	1.3
33	68.42	56.2	12.2
34	78.36	59.9	18.5
35	83.22	59.9	23.3
36	61.16	54.4	6.8

[a]Optimum weight computed to kilograms from pounds based on Helen B. Pryor Optimum Weight Tables. The conversion factor was 0.45 kg. per pound.

Subjects in Group III participated in a series of supervised exercises for a period of seven weeks. A 24 hour Diet Recall was used to determine what the subjects ate. No other controls were used to insure that the subjects ate the same type and quantity of food that they were normally accustomed to eating at home or in the dormitory.

TABLE II

MEAN INITIAL KILOGRAMS OVERWEIGHT IN THE INITIAL GROUPS

	Group I Diet	Group II Diet and Exercise	Group III Exercise
Number of subjects	6	6	6
Kilograms overweight			
Range	7.8-17.8	5.0-23.3	1.3-23.3
Mean	14.0	13.6	11.5

THE DIET AND SUPERVISED EXERCISE PROGRAMS

Diet program. The subjects on the diet program ate all meals at a special diet table maintained by the Department of Foods and Nutrition where a low calorie diet of approximately 1500 calories per day was closely adhered to.[3]

[3]Acknowledgment is made to Evelyn Jones, Ph.D., who contributed this phase of the study.

Although the program was continued for nine weeks, each subject was permitted one weekend off during which she could go home, thereby being away from the close restrictions of the diet.

Control of activity was obtained by requesting each subject to continue her regular daily activity as estimated by the 24 hour Activity Recall. Subjects did not enroll in physical education activity courses for the duration of this experiment.

Supervised exercise program. Subjects on the supervised exercise program reported to the Women's Intramural Building five days per week, one to two hours per day, for a period of seven weeks. All exercises were under the supervision of one physical education instructor. Mats, a stationary bicycle, a stop watch, a timer, and record sheets for each subject were kept in the area for the duration of the program.

A daily record of activities in the supervised exercise program was kept by each girl with the help of the supervisor. Number of repititions was recorded for each exercise.

A description of the training procedure follows. Each subject performed all exercises at maximum rate for a specified time. Number of repititions was recorded and identified as the exercise level for that particular subject. This level of exercise was maintained for one week. At the

beginning of each succeeding week the level of exercise was increased. The method for increasing the level of exercise depended upon the exercise.

There were three series of exercises. Series I was designed to build up endurance. Run-in-place was used for the first seven days, but since the lack of motor skill in some of the subjects prevented the proper execution of the exercise, this was changed to rope-jump for the remainder of the exercise program.

Series II consisted of two types of toe-touching. Toe-touch I was changed when a swinging motion from the shoulder girdle was all that was being accomplished. In Toe-touch II the subject was required to stand erect before changing to the opposite side, therefore greater energy and greater abdominal muscular contraction were required.

Series III was continued for all 34 days and consisted of sit-ups, lift-push-point, and an all-out endurance activity. For the all-out endurance activity, each subject who could swim was instructed to swim as many lengths of the pool as she could to establish her exercise level. Time and number of lengths was recorded. In succeeding sessions, she was instructed to never go below her exercise level for that week. During the menstrual period, subjects changed to the bicycle for all-out endurance activity.

The all-out endurance activity for subjects who could not swim was that of riding the stationary bicycle. The

first day, each subject was instructed to go as long as she could, maintaining a minimum speed of 10 miles per hour. The subject's time and miles per hour were recorded and established as the exercise level for that particular subject. Each subject was then requested to maintain this level for one week. At the beginning of the second week, the subject increased her exercise level. This greater level was then performed for one week. This procedure was continued throughout the training period.

Specific exercises of all three series are described in detail in the Appendix.

MEASUREMENT AND TESTING PROCEDURES

Body weight. The subjects in Group I and Group II were weighed weekly. The subjects in Group III were weighed at the beginning and at the end of the supervised exercise program. Subjects were no outer clothing nor shoes. Body weights were recorded to the nearest hundredth of a kilogram.

Physical performance tests. The physical performance tests were administered to all subjects before the beginning of the supervised exercise program. The tests were again given to all subjects at the completion of both the diet and the supervised exercise program. All physical performance tests were administered in the Women's Intramural Building by instructors in physical education.

A description of individual testing procedures can be found in the Appendix.

Skin-fold fat measurements. Skin-fold fat measurements were taken of all subjects before the beginning of the supervised exercise program and at the completion of both the supervised exercise and the diet programs. Fat calipers such as those developed at the laboratory of Ancel Keyes were used for all skin-fold tests. One instructor with experience in the use of the fat calipers took all skin-fold measurements.

A description of procedures for administering the skin-fold measurements can be found in the Appendix.

Girth measurements. Girth measurements were taken of all subjects before the beginning of the supervised exercise program and at the completion of both the supervised exercise and the diet programs. All measurements were taken by a physical education instructor experienced in this type of work. A steel tape measure calibrated in centimeters was used for all girth measurements.

Procedures for taking all girth measurements are to be found in the Appendix.

Height and width measurements. Height and width measurements of all subjects were taken at the beginning of the supervised exercise program and the diet program at the same time as the skin-fold fat and the girth measurements.

STATISTICAL METHODS EMPLOYED

Initial and final measurements for each subject were used to determine the changes in body weight, physical performance, skin-fold fat, and girth. Group means were compared. Analysis of variance was employed to determine the significance of the differences in mean changes among the three groups. Changes in physical performance, skin-fold fat, and girth were plotted against weight change.

CHAPTER IV

ANALYSIS AND PRESENTATION OF DATA

The purpose of this study was to (1) measure changes in anthropometric and physical performance measures among overweight college women who were undergoing diet, diet and exercise, and exercise programs; (2) to determine the significance of the changes in anthropometric and physical performance measures; and (3) to investigate the relationships between the changes in anthropometric and physical performance measures among these university women.

SUBJECTS USED IN FINAL ANALYSIS

Of the 18 subjects who began this study, complete data is available for only 8. Three subjects from Group I were dropped from the experiment because they did not hold to the rigid diet. Of the five Group II subjects who were dropped from the study, one dropped out of school, one was dropped for medical reasons, and three were known to have "cheated" on the diet. Two Group III subjects did not report for the full battery of tests.

Table III presents the range and mean kilograms overweight for each of the groups used in the final analyses of this study. The total range of kilograms overweight is 1.3 kg. to 18.5 kg. The means for Group I, II, and III are 11.8, 10.2, and 13.0 kg., respectively.

TABLE III

MEAN INITIAL KILOGRAMS OVERWEIGHT FOR THE GROUPS USED IN THIS STUDY

	Group I Diet	Group II Diet and Exercise	Group III Exercise
Number of subjects	3	1[a]	4
Kilograms overweight			
Range	7.8-15.2	10.2	1.3-18.5
Mean	11.8	10.2	13.0

[a]Weight based upon single subject.

FREQUENCY OF PARTICIPATION IN SUPERVISED EXERCISE PROGRAM

The supervised exercise program was offered for a total of 34 days over a period of seven weeks. Table IV presents the frequency of participation in this program. No subjects participated fewer than 3 times per week, and the average participation for both Group II and Group III was 4.7 times per week. Attendance was required. The supervisor was informed of any absence to be incurred other than for illness. Each subject made up the activity in an equivalent of exercise at home or in the dormitory any day she missed an exercise session.

TABLE IV

FREQUENCY OF PARTICIPATION IN SUPERVISED EXERCISE PROGRAM

	Group II Diet and Exercise	Group III Exercise
Number of subjects	1[a]	4
Frequency per week		
Mean (days)	4.9	4.6
Range (days)	4-5	3-5
Total participation in seven weeks		
Mean (days)	33	31.5
Range (days)	33	29-34

[a]Mean based upon single subject.

The mean daily performance of activities in the supervised exercise program as shown in Table V depicts the extent that the subjects were participating in regular physical activity beyond the requirements of their daily routine. Furthermore, the daily performance of certain exercises required the exertion of specific parts of the body which would not normally be used. Examples of these are the toe-touch which required a sideward bending and accompanying stretch of the hamstrings; sit-ups which required a greater extent of abdominal contraction than the subjects would normally perform in a day, and lift-push-point which required back-extension, gluteal contraction, and controlled lowering of the body from a push-up position.

TABLE V

MEAN DAILY PERFORMANCE OF ACTIVITIES IN SUPERVISED EXERCISE PROGRAM FOR 34 DAYS

Subject Number	Group	Series I		Series II	
		1st 7 days	Next 27 days	1st 8 days	Next 26 days
		Exercise		Exercise	
		Run in Place	Rope Jump	Toe-Touch I	Toe-Touch II
21	II, Diet and exercise	57.1	73.9	83.5	32.9
31	III, Exercise	55.7	105.6	96.0	45.7
32	III, Exercise	66.3	125.0	100.0	48.5
33	III, Exercise	55.1	83.0	115.1	80.0
34	III, Exercise	26.0	76.5	106.3	33.1

TABLE V (Continued)

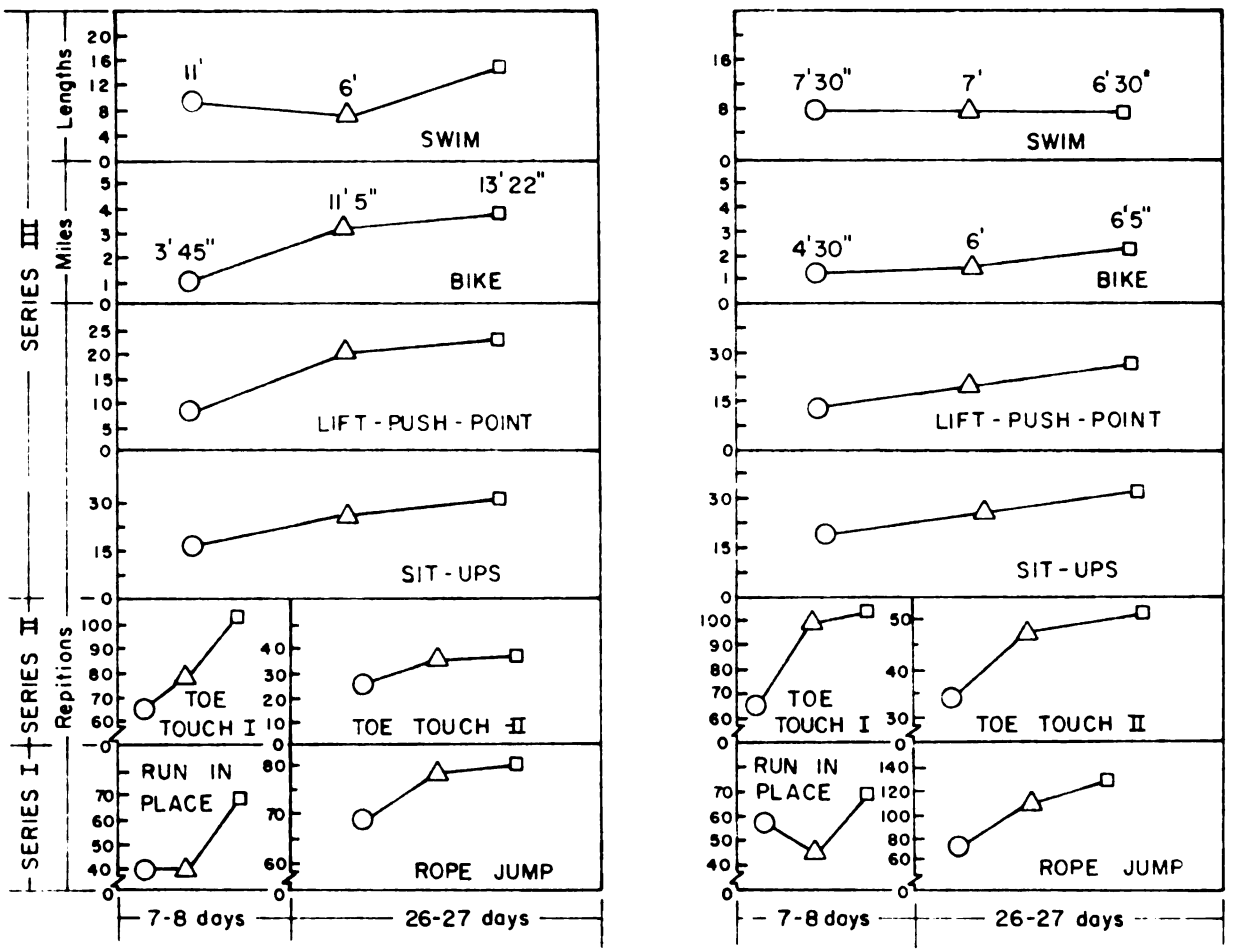
Subject Number	Group	Exercise		Bike			Swim		
		Sit-Ups	Lift-Push Point	Days	Miles	Time	Days	Lengths	Time
21	II, Diet and exercise	25.6	17.9	28	2.6	10 min. 6 sec.	5	10.4	10 min. 15 sec.
31	III, Exercise	24.6	19.0	15	1.8	6 min. 5 sec.	15	6.5	5 min.
32	III, Exercise	23.4	20.0	29	2.8	10 min.	--	--	--
33	III, Exercise	18.2	16.7	22	2.0	8 min.	5	6.6	16 min.
34	III, Exercise	31.9	14.7	28	2.2	8 min. 6 sec.	--	--	--

On the basis of the Activity Recall, the subjects did not ordinarily exert themselves physically in a normal day. Since this point was reached during the supervised exercise session, particulary during the rope jump and riding the bike, it can be concluded that this activity was beyond the requirements of the normal daily routine of the subjects.

IMPROVEMENT OF PERFORMANCE IN SUPERVISED EXERCISE PROGRAM

Improvement in performance of activities in the supervised exercise program is illustrated in Figure 1. Representative days from the beginning, the middle, and the end were selected from the supervised exercise program daily records. There were two possible ways of increasing the exercise level: (1) by increasing the rate or speed at which the exercise was performed, and (2) by increasing the number of repititions. Thus, either faster rate, or increased number of repititions increased the exercise level.

The final performance of each exercise for each individual was in all cases greater than the initial performance. There was a tendency to increase at a more rapid rate from the initial to the middle period than from the middle period to the final. Similar findings are found in most physical training programs. In all exercises performance was improved from the middle to the end with the exception of the swimming or riding the bike.

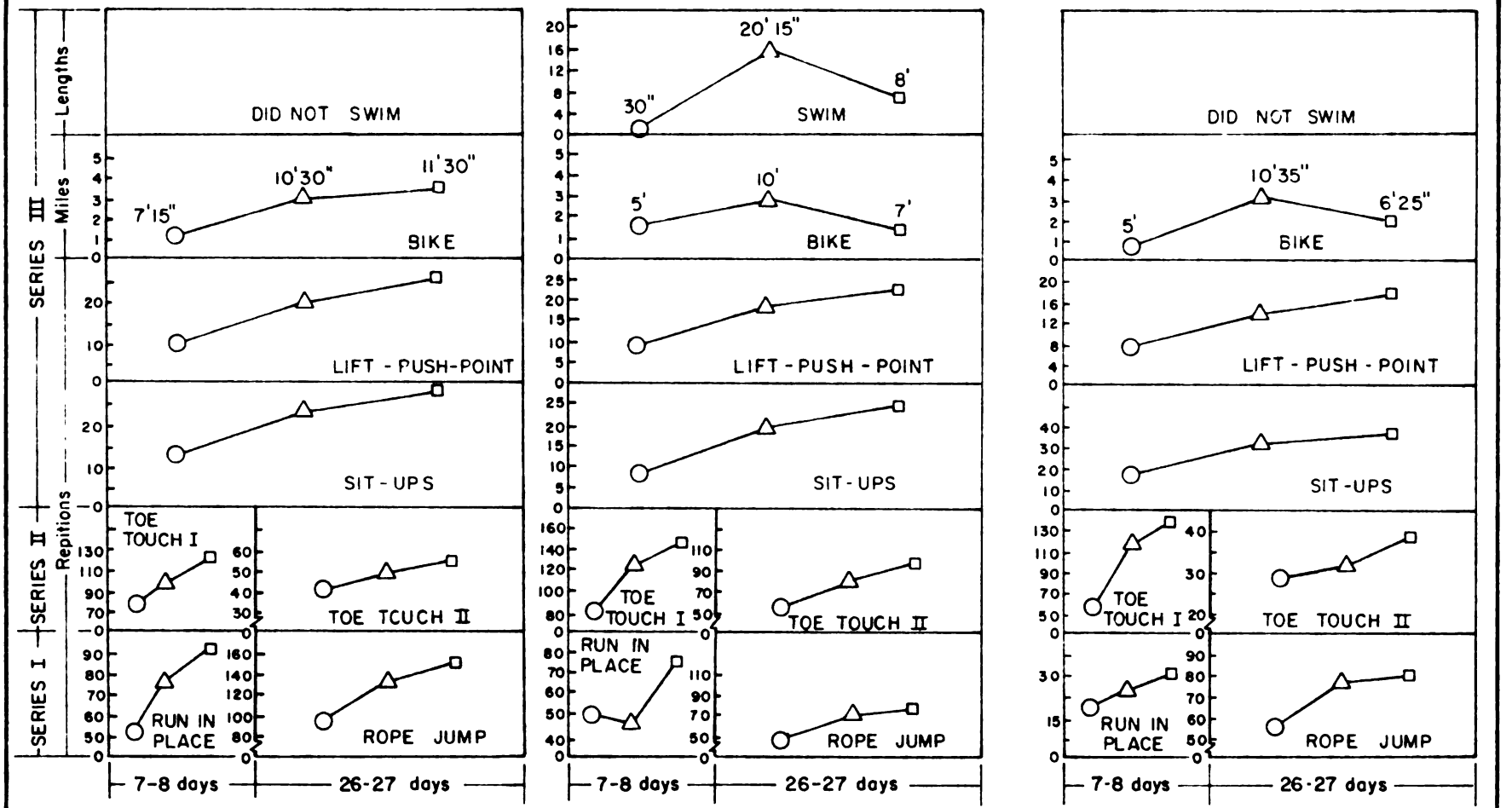


Subject #21
Group III (Diet and Exercise)

Subject #31
Group III (Exercise)

Fig. 1. Improvement in Performance of Activities in Supervised Exercise Program

○ INITIAL △ MIDDLE □ FINAL



Subject #32
Group III (Exercise)

Subject #33
Group III (Exercise)

Subject #34
Group III (Exercise)

○ INITIAL △ MIDDLE □ FINAL

Fig. 1. -- continued

The three instances in which final performance was less than middle performances were investigated further by looking at the daily records for subjects numbered 33 and 34. There is an apparent over-all decrease in the swim time and rate for subject number 33. However, her daily record shows that she actually swam only five times altogether, the first time only one length. At the end of almost two weeks of participating in the supervised exercise program, she swam for the third time, this time swimming 16 lengths. Previous to that day she had been riding the bike regularly for her all-out endurance activity.

Subject number 33 evidently felt like exercising the day she swam the 16 lengths, since she also increased the repititions of lift-push-point by 5, the repititions for Toe-touch I by 35, swam 16 lengths, and also increased her activitity on the bike by going 1 mile further in 4 minutes greater time than her previous day's effort. The greatest increase previous to that day was 1/2 mile further in 3 minutes greater time. It should be pointed out that the all-out endurance activity for any one exercise session was normally either riding the bike or swimming; it was the exception for a subject to do both.

The final swim record for subject number 33 was on a day when in the other exercises she just maintained the level achieved the previous day. This subject did not ride the bike at this session. Subject number 33 also shows a

decrease in the number of miles and the time on the bike for the final session. Again going back to her daily record, the middle level was maintained for almost 2 weeks. Then a definite drop-off is seen for the remaining 4 days. Declining of interest, lack of motivation, and perhaps exam worries may provide the explanation for this decline in work output.

Subject number 34 also showed a decline in both time and miles from the middle to the final sessions. This subject was definitely expending more energy during the middle of the program than at the end. For a one week period she was riding the bike over 10 minutes at the rate of 15 miles per hour, whereas in the last two weeks, she had increased the rate to 18 miles per hour, but maintained this rate for only 6-1/2 minutes.

Improvement in performance on the bicycle and swimming was dependent not only on distance, but also on time and rate. It was difficult to graphically portray improvement in performance from the data available. For instance, in the case of subject number 31, the distance swum each time was 8 lengths of the pool, but it can be seen that the time it took to swim those 8 lengths decreased one minute between the initial and final performances. This would indicate improvement in performance which does not readily appear in Figure 1.

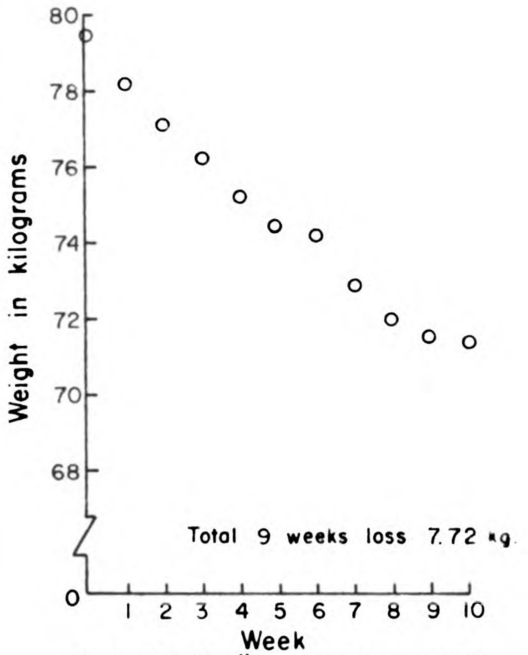
In summary, performance of all exercises by all subjects in the supervised exercise program was improved from beginning to the middle of the program, and with three exceptions, from the middle to the end. The exceptions were due to a definite decline in the final weeks of the program in two cases, to a single spurt of activity one day in the other case. There was generally progressively greater performance of the activities in the supervised exercise program during the 34 days.

CHANGES IN BODY WEIGHT

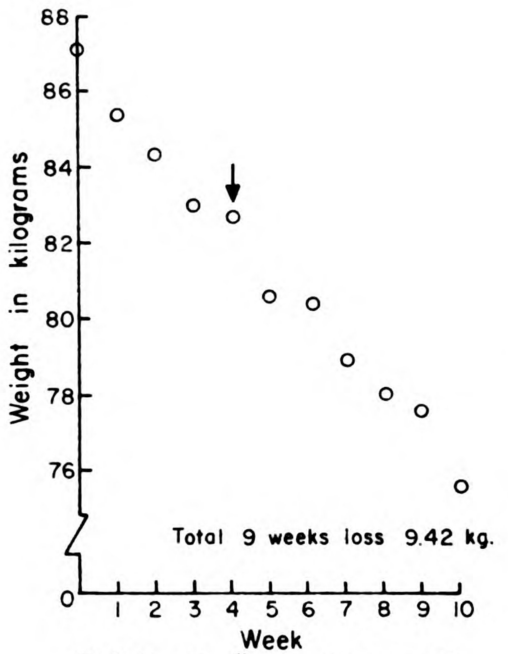
Weight loss curves for each subject in Group I and Group II are depicted in Figure 2. Regular loss of weight can readily be seen in all cases, with substantial decrease from the beginning to the end. Body weights were recorded weekly.

Each subject in Group I showed a slight gain or less rapid rate of loss after the fifth week of the diet. This can be attributed to the fact that previous to that particular weighing, each subject had taken her weekend off during which there had been no dietary restrictions.

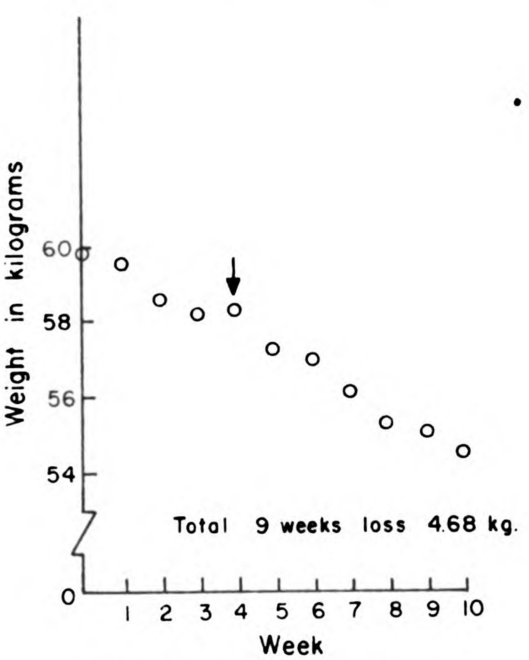
The mean group changes in body weight over a nine week period are presented in Table VI. Group I and II, both participating in the reduced calorie diet, showed a mean loss of 7.23 kg. and 7.72 kg., respectively. Group III, the exercise group which was in caloric balance, showed no



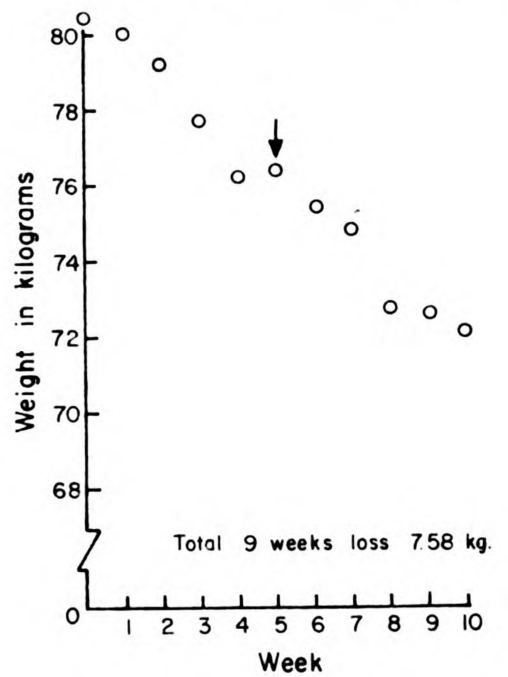
Subject #21 Group II



Subject #11 Group I



Subject #13 Group I



Subject #12 Group I

Fig. 2. Weight Loss Curves for Subject on Diet Program

↓ Indicates 1st weight following week-end off

appreciable change in weight. Weight loss curves are not available for the subjects in Group III, since initial and final weights only were taken.

TABLE VI

MEAN CHANGES IN BODY WEIGHT OVER A NINE WEEK PERIOD

Group	Initial kg.	Final kg.	Change kg.
Group I (Diet)	75.81	65.58	-7.23
N 3			
Group II[a] (Diet and exercise)	79.62	71.90	-7.72
N 1			
Group III (Exercise)	71.16	71.19	0.03
N 4			

[a]Weight based upon single subject.

Substantial weight loss was incurred through reduced caloric intake. No weight change was shown to result from the exercise program alone when the diet was allowed to remain constant.

CHANGES IN PHYSICAL PERFORMANCE

Mean changes in physical performance levels are presented in Table VII. Group means are based on the three subjects in Group I, four subjects in Group III, and on a single subject in Group II. The reasons for smaller group

sizes than presented in the original plan have been previously discussed.

No change in physical performance was found to be statistically significant. Two factors contributed to the difficulty of achieving statistical significance in this study: (1) The extreme differences among the groups were often greater than the differences between the groups, and (2) the small number of subjects with correspondingly small degrees of freedom made the F ratio necessary for significance extremely high.

All groups showed improvement in cardiac efficiency as determined by a decrease in pulse rate following a standard amount of activity, an increase in the number of sit-ups which could be done in 30 seconds, and improvement in performance of the back extension.

The decrease in pulse rate for Groups I and III was approximately the same, whereas the decrease in pulse rate for the subject in Group II was nearly twice that of the means for Groups I and III. The improvement for subjects in Group III could be due to improvement of cardiac efficiency brought about through regular participation in physical activity. The improvement for subjects in Group I may be explained by the fact that each subject had lost a considerable amount of weight, therefore the heart did not have to work as hard as during the initial test when the subject was heavier. Accordingly, the subject in Group II

TABLE VII

MEAN CHANGES IN PHYSICAL PERFORMANCE MEASURES

	Grip Strength Dominant lbs.			Grip Strength Other lbs.			Push lbs.			Pull lbs.		
Group	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
I (Diet) N=3	96.0	82.0	-14.0	73.0	58.7	-14.3	41.3	40.0	- 1.3	48.7	40.0	- 8.7
II (Diet and Exercise) N=1	93	94	+1	100	100	0	58	56	-2	75	74	-1
III (Exercise) N=4	94.5	85.0	- 9.5	84.5	75.5	- 9.0	63.5	62.5	- 1.0	50.0	61.0	+11.0
	Shuttle sec.			Sit-Ups Number in 30 sec.			Deep-Knee Bends Number in 30 secs.			Standing Flexion inches		
I (Diet) N=3	13.2	13.3	+ 0.1	12.3	14.7	+ 2.3	19.7	21.0	+ 1.3	+ 3.8	+ 3.0	- 0.8
II (Diet and Exercise) N = 1	12.0	12.1	+ 0.1	15	17	+ 2	19	19	0	+ 1.5	+ 3.0	+ 1.5
III (Exercise) N=4	12.9	12.6	- 0.3	17.3	19.0	+ 1.8	22.5	22.5	0	+ 3.5	+ 3.8	+ 0.3

TABLE VII (continued)

Group	Back Extension inches			Standing Broad Jump feet-inches			Chair Step 30 sec. pulse		
	Before	After	Change	Before	After	Change	Before	After	Change
I (Diet) N=3	14.8	15.7	+ 0.9	3'9"	4'2"	+5"	65.3	56.7	-8.7
II (Diet and Exercise) N=1	9	15	+ 6	5'4"	5'3"	-1"	65	46	-19
III (Exercise) N=4	10.8	12.3	+ 1.5	4'3"	4'6"	+3"	68.3	58.7	-9.7

benefitted from both factors: she had less weight to move, and she had been exercising regularly. The decrease in pulse rate for this subject was great enough for this to be a possibility.

This was investigated further. The mean for Group III is unrealistic, since one subject showed a pulse rate decrease of 22, data is not available for one subject, and the other subjects showed pulse rate decreases of only 3 and 4. The decrease of 22 obtained by the subject in Group III is greater than the decrease of 19 obtained by the subject in Group II. Therefore it is inaccurate to conclude that the diet and exercise program produced the greatest change in cardiac efficiency.

All groups showed slight improvement in performance of sit-ups and back-extension. There was little difference between the groups in improvement in the number of sit-ups. The subject in Group II increased the back-extension by six inches, whereas only slight improvement was obtained by subjects in Groups I and III.

A very slight decrease in performance levels of push-strength was observed in all groups. This decrease was in no way significant.

When the physical performance levels of each group were analyzed, Group I showed greater improvement of performance than any other group in sit-ups, deep-knee-bends, and standing-broad-jump. These are all activities which require

APPENDIX B

RAW DATA

APPENDIX A

DESCRIPTION OF PROCEDURES

APPENDIX

the lifting or moving of body weight. Since body weight was decreased considerably between initial and final testing, the greater improvement by these subjects may be due to the fact that they had less mass to lift or move. Sills, Brady, Willgoose, Riendeau, and Kireilis all report excess fat to be a handicap in most strenuous exercise, particularly running and jumping.[1] The improvement in performance of sit-ups, deep-knee-bends, and standing-broad-jump accompanying weight loss in this study seems to substantiate the theory that excess weight is a handicap in physical performance.

Group I subjects showed the greatest decrease in physical performance levels in the grip-strength and the pull-strength. It is possible that some loss of strength accompanied the reduced caloric intake diet. Another possibility is that a decrease in strength which often occurs from the beginning to the end of a term accounts for the decrease in grip-strength. Since Group III also showed a decrease in grip-strength, no conclusion was drawn concerning the reason for loss of strength.

Group III showed greater improvement of performance than was observed in the other two groups in pull-strength

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[1]Sills, Research Quarterly, 28:64-71; Brady; Sills, Research Quarterly, 21:432; Sills, Research Quarterly, 24:223-228; Riendeau; Willgoose; and Kireilis.

and the shuttle-race. An increase in pull-strength was achieved by all subjects in Group III. It is difficult to explain this, since no one exercise of the supervised exercise program would seem to affect strength across the shoulder blades. There is a possibility that the lift-push-point exercise affected the physical performance level of Group III in the pull-strength, but if this were the case, the subject in Group II should also have showed an increase in this particular measurement. A negligible loss of one pound was recorded in the pull-strength for the subject in Group II.

The improvement of performance in the shuttle-run by Group III may even be more notable than the mean would indicate. Although one subject in Group III ran the shuttle-run 0.9 seconds slower than initially, the other three subjects ran the shuttle-run 0.7, 0.5, and 0.8 seconds faster following the supervised exercise program. In observing the subjects during the supervised exercise program, the supervisor noted increased skill and coordination in the performance of physical activities. In other words, learning seemed to have taken place. The greater speed in the shuttle-run by subjects in Group III may be attributed to this factor.

When comparing the mean changes in physical performance levels for Group II with the mean changes in physical performance levels for the other two groups, it appeared

that the greatest improvements in grip-strength, standing-flexion, back-extension, and pulse-rate were found in Group II. Also, the greatest decreases in push-strength and standing broad-jump were found in Group II. But the Group II means were actually the scores of a single subject, therefore not true means. When treated as a single score and compared with the single scores achieved by subjects in the other two groups, greater changes by other subjects were found in all tests but the back-extension.

To summarize, mean changes in physical performance following diet, supervised exercise, and diet and supervised exercise programs were analyzed. Although no differences between groups were statistically significant, the following results were noted:

1. Improved performance was obtained by all groups in pulse-rate following a standard amount of activity, number of sit-ups in 30 seconds, and back-extension.
2. Slightly decreased grip-strength was observed in all groups.
3. Greater improvement in sit-ups, deep-knee-bends, and standing-broad-jump was obtained by Group I than any other group.
4. Greater improvement of pull-strength and shuttle-run was obtained by Group III than by any other group.

CORRELATIONS BETWEEN PHYSICAL PERFORMANCE AND WEIGHT LOSS

The changes in physical performance were plotted against weight loss as shown in Figure 3. Improved performance by all subjects regardless of weight loss was observed only in the decreased pulse-rate following a standard activity. Loss of weight appeared to be a greater factor in the decreased pulse-rate than did exercise, but a subject who had little change in weight achieved greatest decrease in pulse-rate.

Although the group means indicated that improved performance in physical performance tests of sit-ups and back-extension was obtained by all groups, individual records show that slightly decreased performance was obtained by a subject in Group I and little or no change was observed for three out of four members of Group III.

The decreased grip-strength in all groups noted in the discussion of mean changes in physical performance is evident in the plot of grip-strength versus weight-loss. The exception was that a subject in Group III showed slight improvement in grip-strength with little weight change.

Comparison of the mean changes in physical performance indicated that greater improvement in sit-ups, deep-knee-bends, and standing-broad-jump was obtained by Group I than by any other group. In the case of sit-ups and deep-knee-bends, the plots of change versus weight-loss do not point

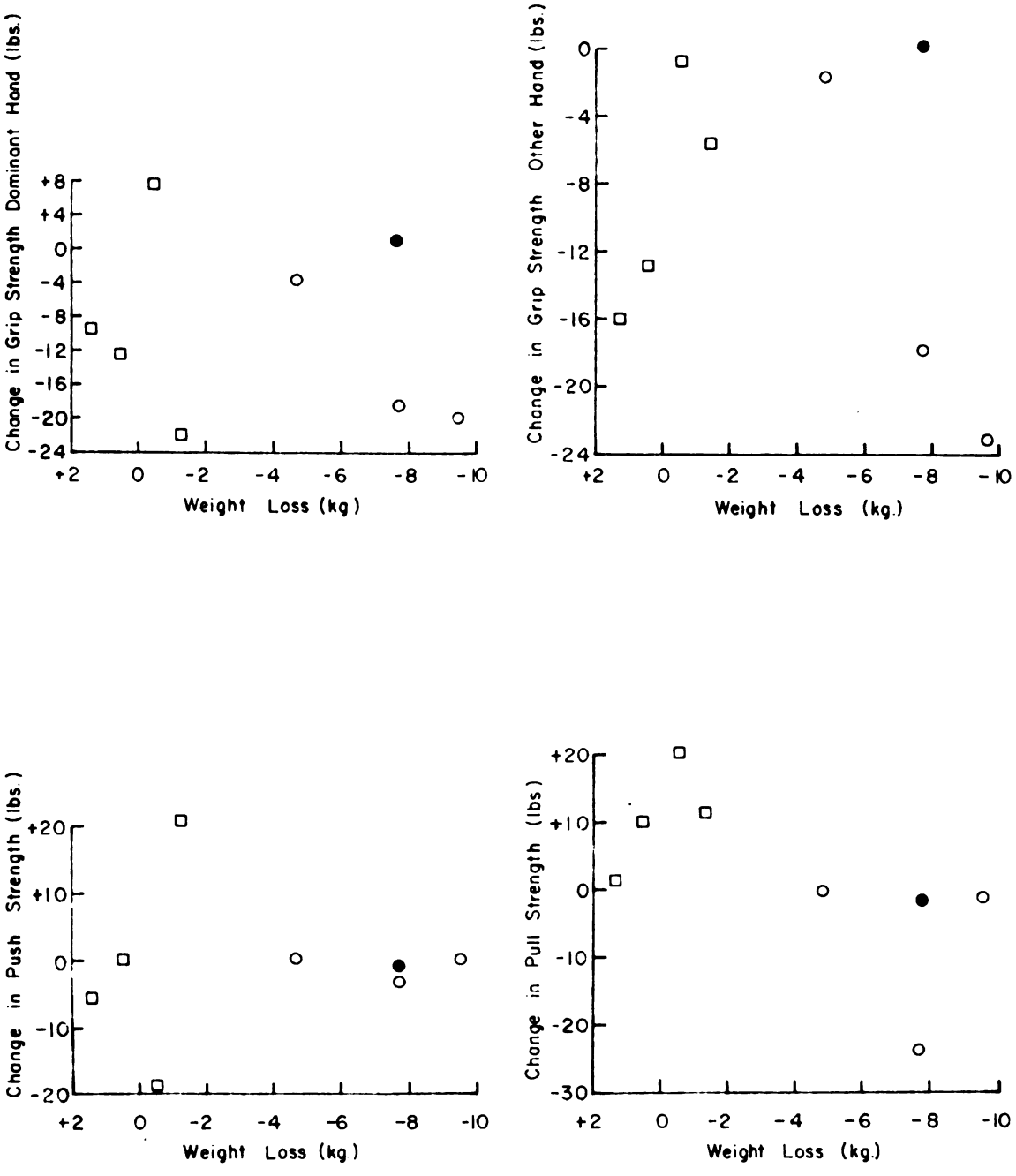


Fig. 3. Relationship Between Physical Performance Measures (Grip, Push, and Pull Strengths) and Changes in Body Weight

○Diet □ Exercise ● Diet and exercise

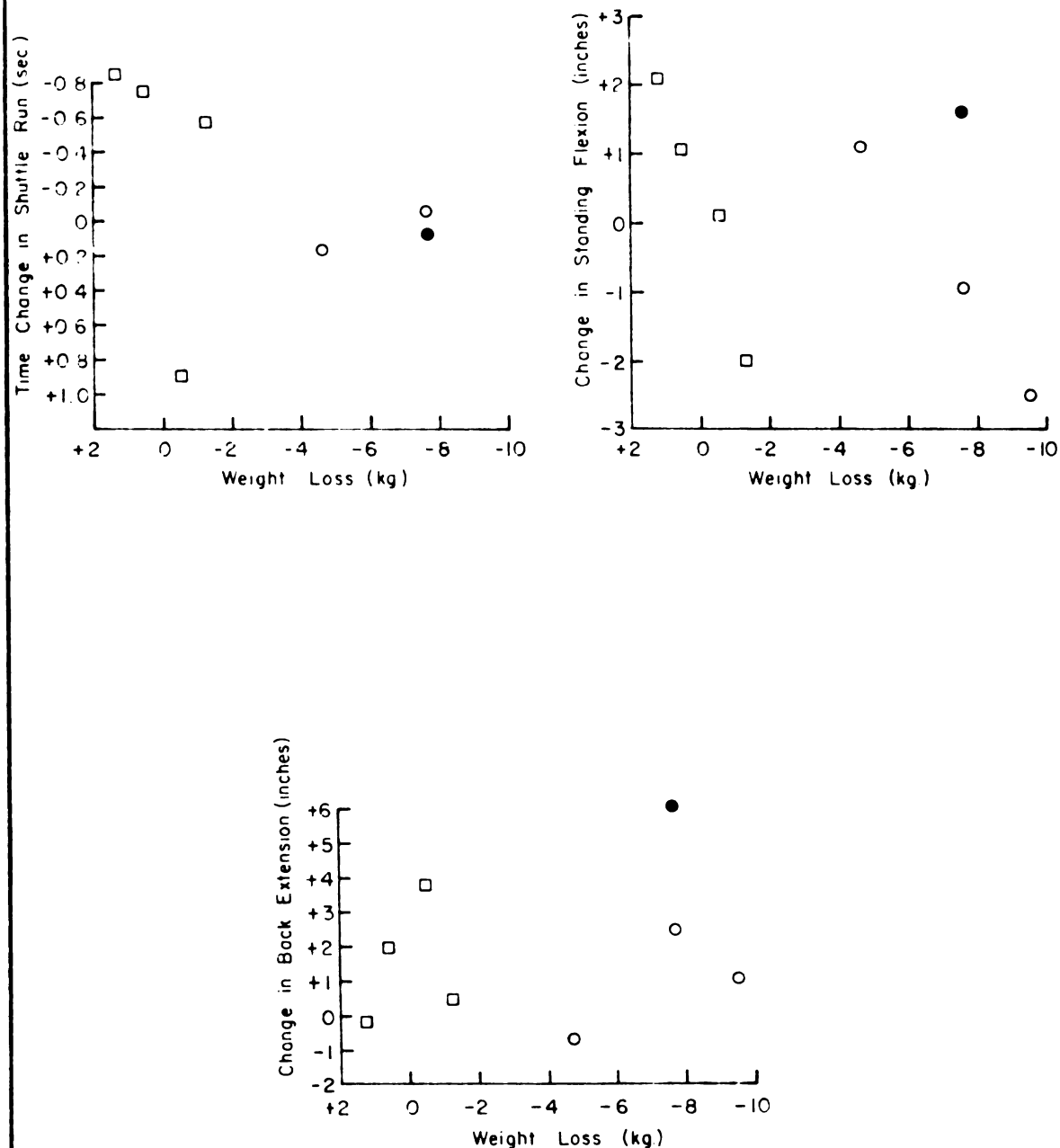


Fig. 3 -- continued
Relationship Between Physical Performance Measures (Shuttle Run, Standing Flexion, Back Extension) and Changes in Body Weight

○ Diet □ Exercise ● Diet and exercise

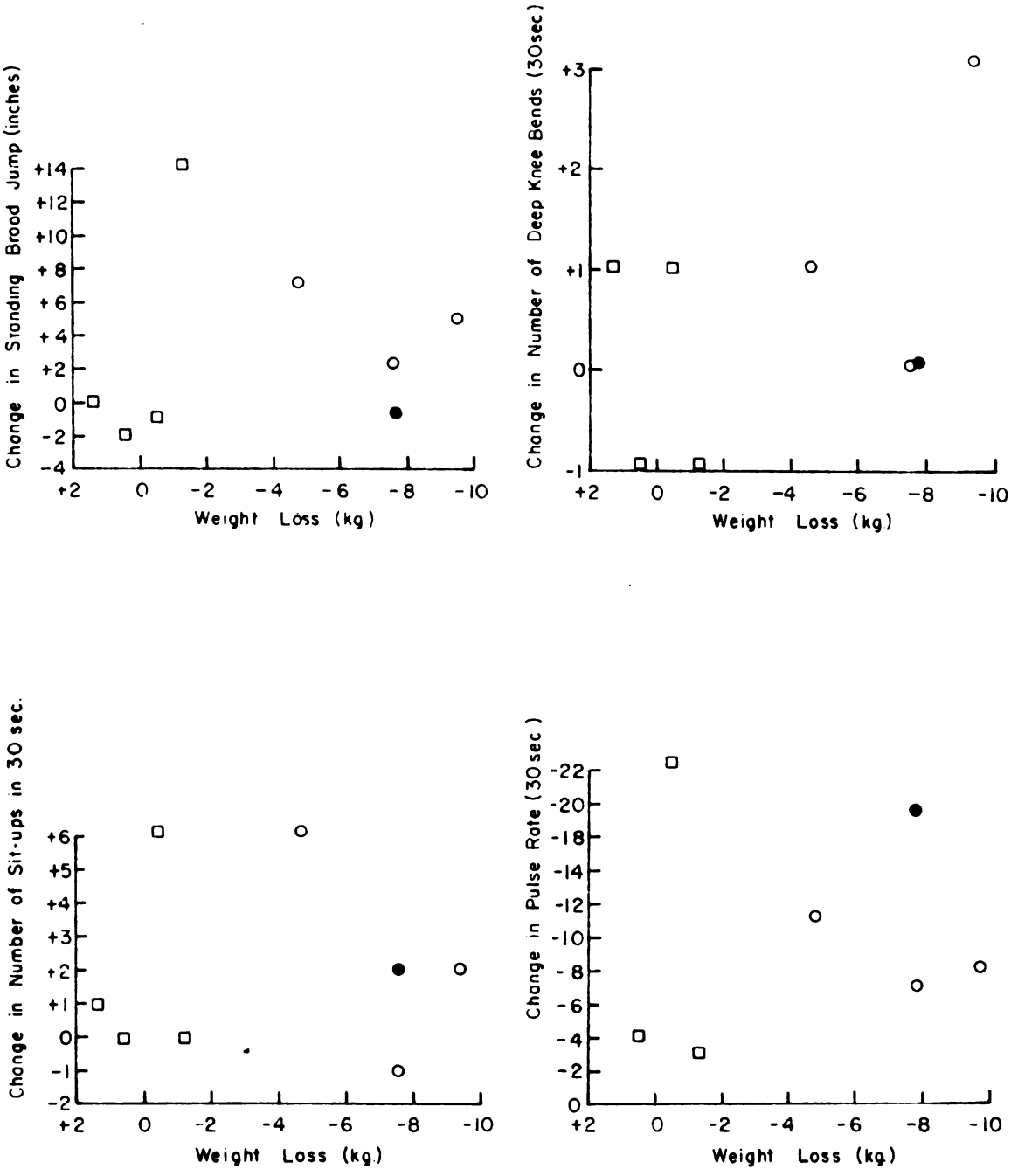


Fig. 3 -- continued
Relationship Between Physical Performance Measures (Standing Broad Jump, Deep Knee Bends, Sit-ups in 30 Sec., Pulse Rate) and Changes in Body Weight

○ Diet □ Exercise ● Diet and exercise

to a strong relationship between weight-loss and improvement of performance in these tests. Weight loss did appear to be more closely associated with improvement in performance in standing-broad-jump than did exercise.

Greater improvement in performance in the pull-strength and shuttle-run tests was found in Group III than in Groups I and II. The plots of changes in physical performance in pull-strength and shuttle-run tests versus weight-loss indicate that performance of pull-strength and shuttle-run did not improve with weight loss.

In further analyzing the changes in physical performance by correlating them with weight loss, the following relationships appeared to exist:

1. Loss of weight appeared to be a greater factor in decreased pulse-rate than did exercise.
2. Improved performance in sit-ups and back-extension as indicated by comparing mean group changes did not appear to exist when individual performances were studied.
3. A slight decrease in grip-strength was evident in all groups.
4. Weight loss appeared to be more closely associated with improvement in performance in standing-broad-jump than did exercise.
5. Performance in pull-strength and shuttle-run improved among the subjects who participated in the supervised exercise program.

CHANGES IN SKIN-FOLD MEASUREMENTS

A comparison of means of changes in skin-fold measurement is presented in Table VIII. Loss or no change of skin-fold fat as measured by fat calipers was obtained by all groups in all regions measured, with the exception of the lower ribs in Group III. When analysis of variance was used, the difference between groups was statistically significant at the 1% level for the triceps measurement. The scapular, lower-ribs, and pectoral measurements and sum of all losses were significant at the 5% level. The decrease of skin-fold thickness was much greater in Groups I and II than in Group III.

The correlation plots of the changes in skin-fold fat against weight loss as illustrated in Figure 4 indicate that a strong relationship exists between loss of weight and decrease in skin-fold fat. In the plots of the sum, scapular, lower-ribs, and triceps measurements versus weight loss, decrease in skin-fold thickness always accompanied weight loss. A slight decrease in the sum of skin-fold fat measurements was obtained by all subjects who participated in the supervised exercise program.

Decrease in the iliac-crest skin-fold measurement was obtained by all subjects in all groups. Greatest decrease of 1.9 cm was obtained by the subject who lost the most weight. A subject who showed slight weight gain, but who

TABLE VIII

MEAN CHANGES OF SKIN-FOLD MEASUREMENTS

Group	Biceps (cm.)			Triceps (cm.)			Cheek (cm.)			Pectoral (cm.)		
	Initial M	Final M	Change M	Initial M	Final M	Change M	Initial M	Final M	Change M	Initial M	Final M	Change M
Diet N=3	1.7	1.4	-0.3	2.5	1.9	-0.6	1.7	1.5	-0.2	1.3	0.8	-0.5
Diet and exercise N=1	1.1	0.6	-0.5	2.4	1.7	-0.7	1.4	---	---	0.8	0.8	0
Exercise N=4	1.2	1.1	-0.1	2.3	2.2	-0.1	1.6	1.6	0	1.1	1.0	-0.1

Group	Iliac-crest (cm.)			Scapular (cm.)			Lower-ribs (cm.)			Sum of All Changes (cm.)		
	Initial M	Final M	Change M	Initial M	Final M	Change M	Initial M	Final M	Change M	Initial M	Final M	Change M
Diet N=3	5.6	2.8	-0.8	2.4	1.8	-0.6	5.1	2.8	-0.4	16.4	13.0	-3.4
Diet and exercise N=1	4.0	3.7	-0.3	1.6	1.2	-0.4	2.4	2.1	-0.3	13.7	11.5	-2.2
Exercise N=4	3.5	2.6	-0.6	2.3	2.3	0	2.4	2.5	+0.1	14.4	13.6	-0.8

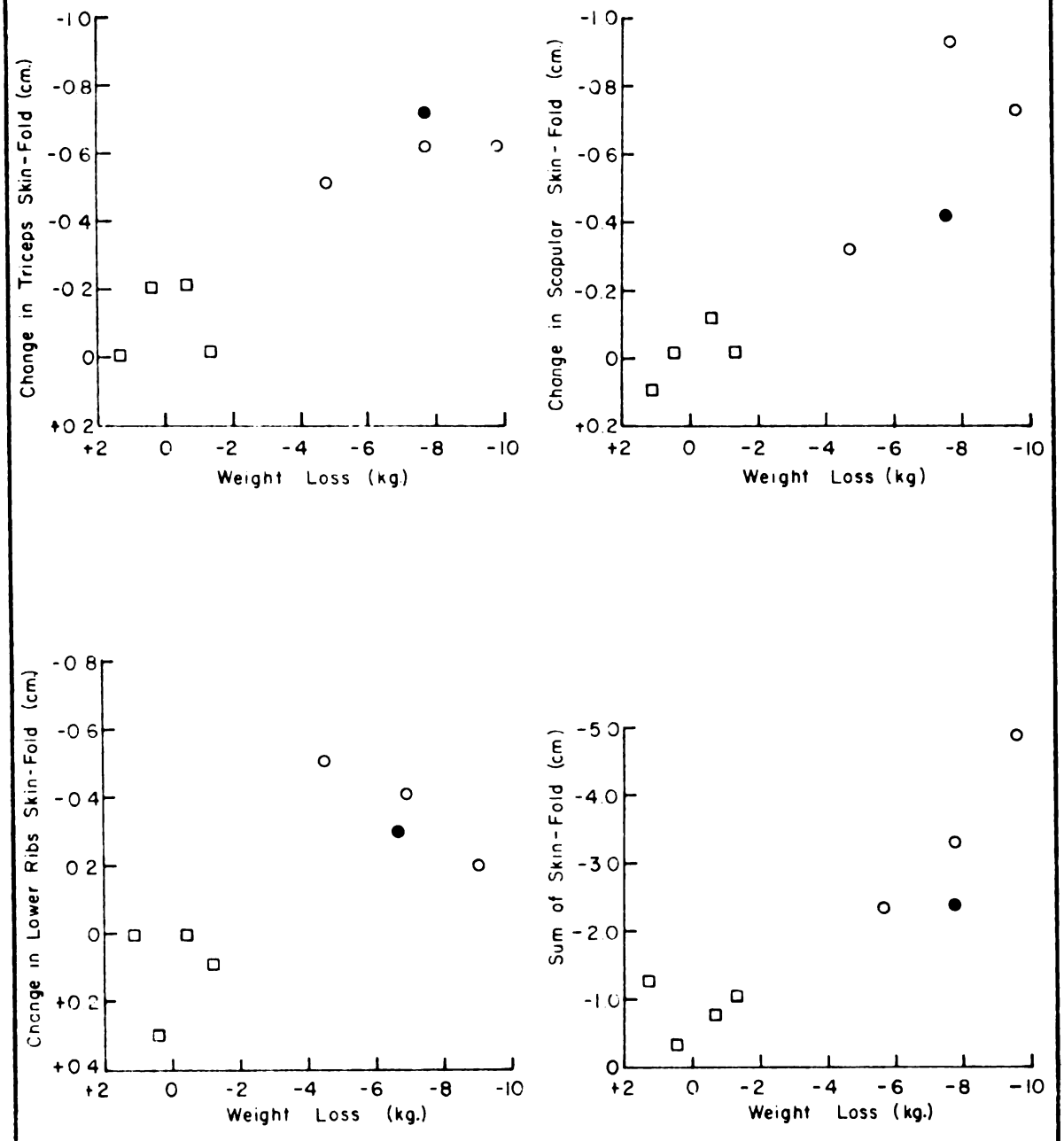
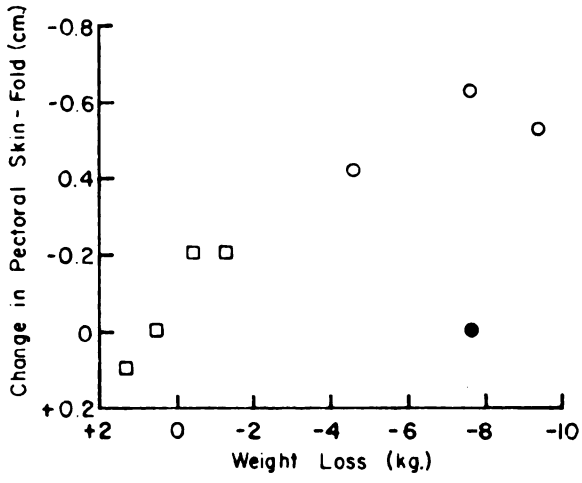


Fig. 4. Relationship Between Changes in Skin-Fold Measurements (Triceps, Scapular, Lower Ribs, Sum) and Changes in Body Weight

○ Diet □ Exercise ● Diet and exercise



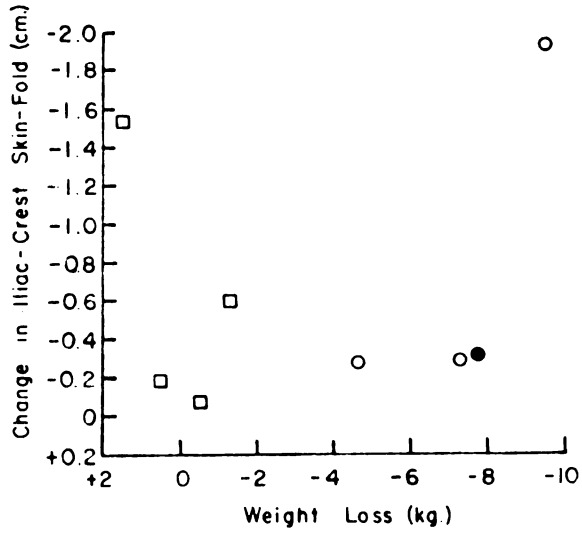


Fig. 4 -- continued
Relationship Between Changes in Skin-Fold Measurements (Pectoral, Iliac-Crest) and Changes in Body Weight

○ Diet □ Exercise ● Diet and exercise

participated in the supervised exercise program showed a decrease of 1.7 cm.

Changes in skin-fold measurements accompanying diet, diet and exercise, and supervised exercise programs were evaluated. Results are as follows:

1. With one exception, loss or no change of skin-fold fat was obtained by all groups in all regions. The mean of the measurement of the lower-ribs in the exercise group showed a slight increase.
2. The decrease in skin-fold fat obtained by the diet, and diet and exercise groups was greater than the decrease obtained by the exercise group in the triceps, lower-ribs, pectoral, and sum of all losses. These differences were significant at the 1% level for triceps; at the 5% level for lower-ribs, pectoral, and sum of all losses.
3. Correlation plots of change in skin-fold versus weight loss indicated a strong relationship between loss of body weight and loss of skin-fold fat.
4. Subjects who participated in the supervised exercise program obtained a slight decrease in the sum of skin-fold fat measurements.

CHANGES IN GIRTH MEASUREMENTS

An over-all loss of girth is shown in Table IX. All groups, whether or not there was a loss in body weight, obtained a decrease in girth measurements. When totaled, the loss by Group I and II is more than double that of Group III.

Although there was no appreciable weight change in the exercise group, losses in girth are seen in the upper-arm, waist, abdomen, buttocks, thigh, and calf measurements. Greatest losses were in the abdomen (3.1 cm.), thigh (2.9 cm.), waist (1.5 cm.), and buttocks (1.4 cm.).

Group I showed greatest loss in the abdomen (6.3 cm.), waist (4.4 cm.), buttocks (4.1 cm.), thigh (3.7 cm.), and bust (2.7 cm.). Mean weight loss of 7.23 kg. accompanied the decrease in girth measurements.

Greatest decrease in girth measurements for the subject in Group II was in the bust (8.2 cm.). The other losses were abdomen (5.3 cm), buttocks (4.6 cm), thigh (3.5 cm.), waist (2.2 cm.), and upper arm (1.7 cm.). This subject showed a much greater decrease in bust measurement than did the other subjects in the diet program; although she showed less decrease in waist and abdominal girth. This subject's loss of body weight was 7.72 kg.

Correlations between changes in girth measurements and changes in body weight were plotted in Figure 5. A

TABLE IX

MEAN CHANGES OF GIRTH MEASUREMENTS

Group	Upper Arm			Bust			Waist			Abdomen		
	Before M	After M	Change M	Before M	After M	Change M	Before M	After M	Change M	Before M	After M	Change M
Diet N=3	27.9	27.2	-0.6	93.2	90.5	-2.7	73.1	68.7	-4.4	97.3	91.1	-6.3
Diet and exercise[a] N=1	29.2	27.5	-1.7	94.7	86.5	-8.2	73.0	70.8	-2.2	96.0	90.7	-5.3
Exercise N=4	28.9	28.4	-0.5	93.0	93.0	0	74.1	72.6	-1.5	97.0	93.9	-3.1
	Buttocks			Thigh			Calf			Total		
Diet N=3	103.5	99.4	-4.1	61.0	57.3	-3.7	37.1	36.5	-0.6	493.1	470.7	22.4
Diet and exercise[a] N=1	104.0	99.4	-4.6	60.3	56.8	-3.5	39.3	38.6	-0.7	496.5	470.3	26.2
Exercise N=4	104.1	102.7	-1.4	62.8	59.9	-2.9	37.5	36.8	-0.7	497.4	487.3	10.1

[a]Mean based on single measurements. All measurements recorded in cm.

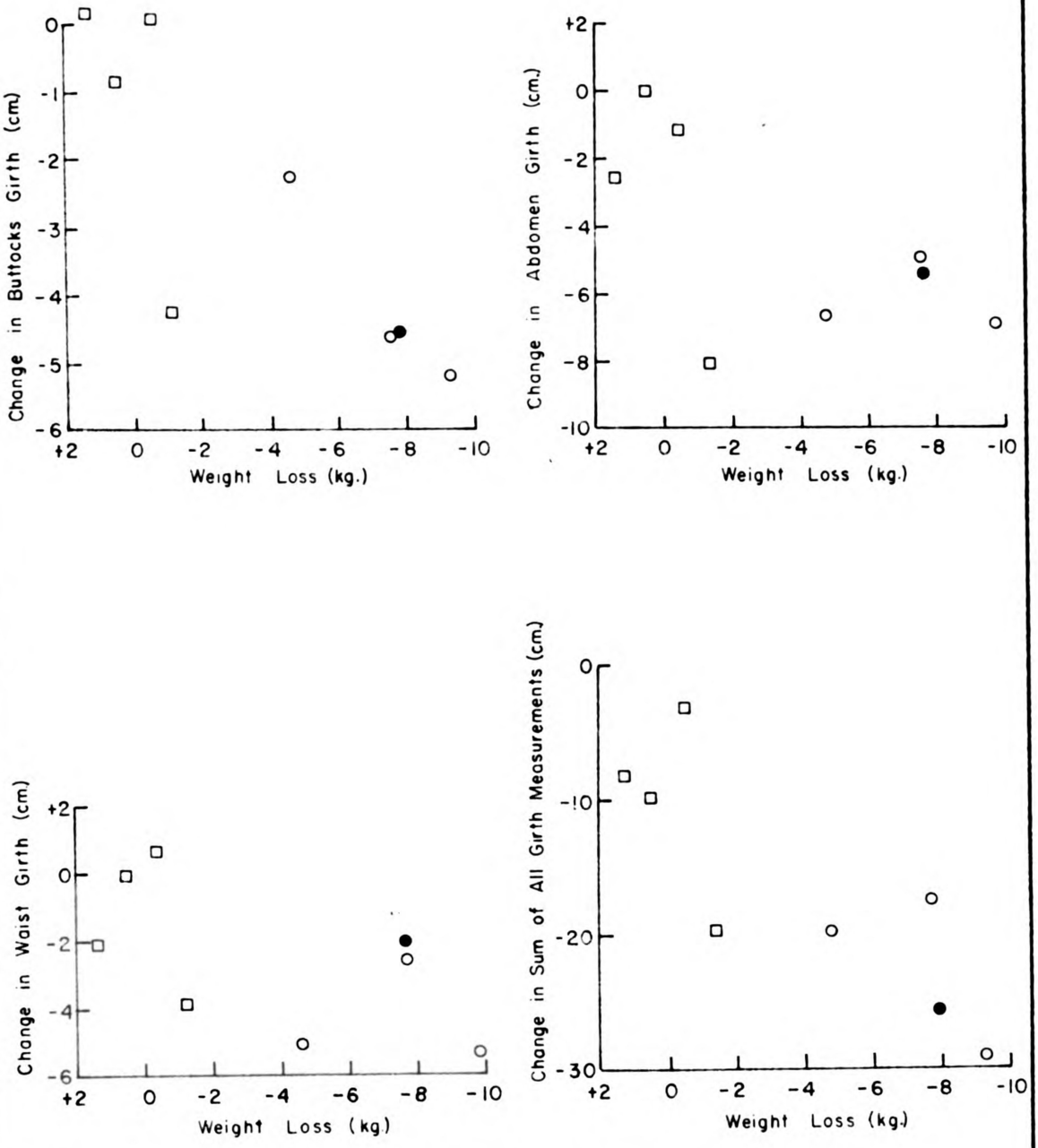


Fig. 5. Relationship Between Changes in Girth Measurements (Buttocks, Abdomen, Waist, Sum) and Changes in Body Weight

○ Diet □ Exercise ● Diet and exercise

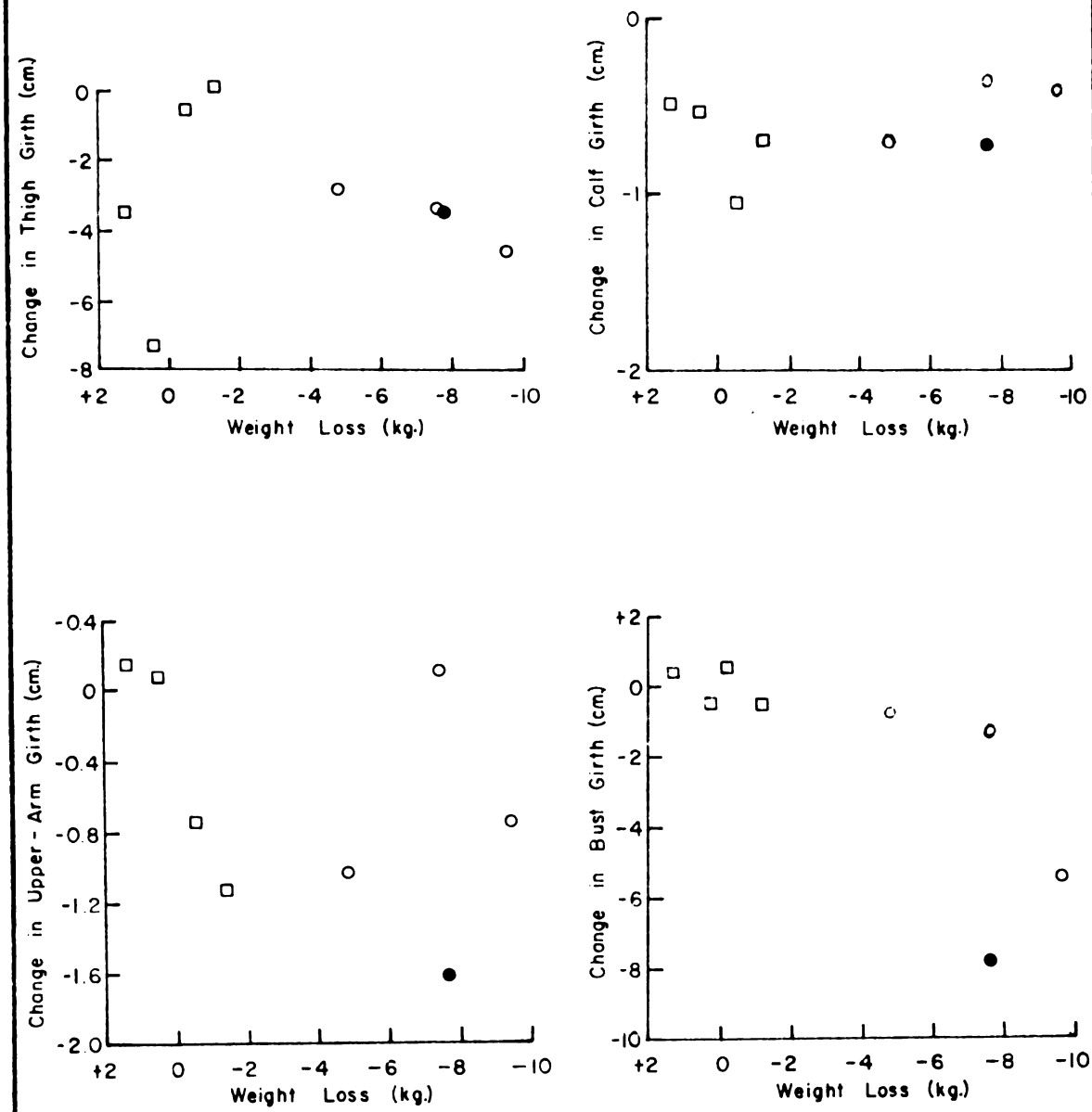


Fig. 5. -- continued
Relationship Between Changes in Girth Measurements (Thigh, Calf, Upper-Arm, Bust) and Changes in Body Weight

○ Diet □ Exercise ● Diet and exercise

relationship seems to exist between weight loss and decreases in buttocks, abdomen, thigh, and waist girths, and the sum of all girth measurements. Decrease in these girth measurements accompanied loss of body weight in all cases. Greatest loss in the sum of all girth measurements was obtained by the subject who lost most body weight.

Also, loss of body weight seemed to affect the decreases in girth measurements more than participation in the exercise program. Subjects in the exercise program did show decrease in girth in calf, abdomen, thigh, and the sum of all girth measurements. These decreases were not as great as those obtained by subjects who lost a considerable amount of body weight. However, one exception was found. One subject on the exercise program showed a weight loss of 1.3 kg. This subject obtained a greater decrease in girth than any other subject, regardless of amount of weight loss, in the abdominal, calf, and thigh measurements. This subject showed equally as great a decrease in girth in the waist, buttocks, and sum of all girth measurements, as the subjects who showed a substantial weight loss.

Greatest decreases in upper-arm girth and bust-girth were obtained by the subject who participated in the diet and exercise program.

Changes in girth measurements of university women who underwent diet, diet and exercise, and supervised exercise programs were studied. The findings were as follows:

1. All groups obtained decreases in girth measurements in the abdomen, thigh, waist, buttocks, calf, upper-arm, and total of all measurements.
2. Greater decreases in girth measurements were found among the subjects who participated in the diet and diet and exercise programs than in the exercise program.
3. The greater decreases in girth measurements among the subjects on the diet programs were accompanied by weight loss.
4. Decreases in girth measurements obtained by the group on the exercise program were accompanied by weight loss in only one instance.

CHAPTER V

SUMMARY AND CONCLUSIONS

Changes in anthropometric and physical performance measures which took place in overweight women during diet and exercise programs were studied. Subjects were divided into three groups. One group was placed on a reduced caloric intake diet, another group participated in a supervised exercise program, and the third group participated in both the reduced caloric intake diet and the supervised exercise program.

The following results were found:

Changes in body weight.

1. Weight loss was achieved by all subjects who participated in the diet program. Subjects in the supervised exercise program alone showed no appreciable change in body weight.

Changes in skin-fold fat measurements.

1. Decrease in skin-fold fat was obtained by all groups in triceps, iliac-crest, and biceps measurements and in the sum of all changes.
2. The decrease in skin-fold fat obtained by the diet, and diet and exercise groups was greater than the decrease obtained by the exercise group in the triceps, lower-ribs, pectoral, and sum of all losses. These differences were significant at the

1% level for triceps; at the 5% level for lower-ribs, pectoral, and sum of all losses.

3. All subjects who participated in the supervised exercise program obtained a slight decrease in the sum of skin-fold fat measurements.

Changes in girth measurements.

1. All groups obtained decreases in girth measurements in the abdomen, thigh, waist, buttocks, calf, upper-arm, and total of all measurements.
2. Greater decreases in girth measurements were found among the subjects who participated in diet and diet and exercise programs than in the exercise programs.
3. The greater decreases in girth measurements among the subjects on the diet programs were accompanied by weight loss.
4. Decreases in girth measurements obtained by the group on the exercise program were accompanied by weight loss in only one instance.

Changes in physical performance.

1. Improved performance was obtained by all groups in pulse-rate following a standard amount of activity, number of sit-ups in 30 seconds, and back-extension.
2. Improvement in performance of sit-ups, deep-knee bends, and standing-broad-jump was obtained by

1% level for triceps; at the 5% level for lower-ribs, pectoral, and sum of all losses.

3. All subjects who participated in the supervised exercise program obtained a slight decrease in the sum of skin-fold fat measurements.

Changes in girth measurements.

1. All groups obtained decreases in girth measurements in the abdomen, thigh, waist, buttocks, calf, upper-arm, and total of all measurements.
2. Greater decreases in girth measurements were found among the subjects who participated in diet and diet and exercise programs than in the exercise programs.
3. The greater decreases in girth measurements among the subjects on the diet programs were accompanied by weight loss.
4. Decreases in girth measurements obtained by the group on the exercise program were accompanied by weight loss in only one instance.

Changes in physical performance.

1. Improved performance was obtained by all groups in pulse-rate following a standard amount of activity, number of sit-ups in 30 seconds, and back-extension.
2. Improvement in performance of sit-ups, deep-knee bends, and standing-broad-jump was obtained by

subjects who lost a substantial amount of body weight.

3. The improvement in performance of sit-ups, deep-knee-bends, and standing-broad-jump was greater for subjects who lost weight than for subjects who participated in the supervised exercise program.
4. Greater improvement in performance of pull-strength and shuttle-run was obtained by the group which participated in supervised exercise than by the group which participated in the diet program.
5. Slightly decreased grip-strength was observed in all groups.

In conclusion, it may be stated that:

1. Improved physical performance accompanied participation in both the supervised exercise and the reduced caloric intake diet programs.
2. Subjects who participated in reduced caloric intake diet obtained greater weight reduction, decrease in skin-fold fat, and girth measurements than those who participated in the supervised exercise program.
3. Subjects who participated in the supervised exercise program obtained greater decrease in girth measurements than in skin-fold fat.

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DESCRIPTION OF EXERCISES IN SUPERVISED EXERCISE PROGRAM

Series I

A. Run-in-place. Subject placed both hands on mat, arms extended, weight supported by arms and legs, one knee bent, other leg extended. She then alternated the leg position as many time as she could in 40 seconds. The total number of times as well as the number of seconds was recorded.

B. Rope-jump. Rope-jumping was done with a minimum of arm movement and a single bounce each time the rope passed under the feet. Initially the number of jumps in one minute was recorded. Afterwards, this number was used as the exercise level. Subjects were instructed to increase the number of times, maintain for a week, then increase again at the beginning of the following week. This procedure was repeated each week.

Series II

A. Toe-touch. Standing, legs 16-18 inches apart, subject bent over, knees straight, and alternated touching left toes with right hand, right toes with left hand, keeping body in bent position.

B. Toe-touch. Same as A except that the subject rose to standing position before bending to touch opposite foot.

Series III

Swing-sit-ups. Subject lay on back on mat, arms extended overhead, legs extended. On signal, she swung arms towards feet simultaneously bending knees and drawing legs towards chest. Knees were brought to one side, hands touched floor on opposite side. At touch, she swung back to starting position and repeated on opposite side. The number in 40 seconds was recorded. Exercise level was increased weekly.

Lift-push-point. Subject lay on stomach, palms of hands on floor directly underneath shoulders. The four movements are as follows: (1) head and shoulders were raised; (2) arms were extended, body raised and held straight in a long push-up; (3) one leg was forcefully extended upwards; and (4) whole body was lowered as in a push-up. up. Number per 40 seconds was recorded. Exercise level was increased each week.

Swimming. Each subject who could swim was instructed to swim as many lengths in the pool as she could. The time and number of lengths was recorded daily. Subject was instructed to maintain or exceed exercise level previously established.

Bike-riding. Subjects riding the bike were instructed to ride at a minimum of 15 mph for 10 minutes or as long as they could. Time and miles were recorded. Subjects rode the bike until they reached minimum time. At this point,

rate was increased. The amount of rate increase varied with each subject.

PROCEDURES FOR ADMINISTRATION OF PHYSICAL PERFORMANCE TESTS

Grip-strength. A hand dynamometer was used in the following manner. The instrument was placed in subject's hand by test administrator so that the dial was against the palm of the subject's hand. Subject was told to squeeze just as hard as she could without permitting additional force by another part of her body. Test administrator read score which was recorded by recorder. Two readings were taken for each hand. Dominant hand was designated by asterisk.

Push-strength. The adaptation device for the grip dynamometer was used to permit the recording of push-strength. The subject was instructed to push as hard as she could without permitting the instrument to bump against her. Subjects were instructed to keep shoulders and fore-arms directly in line at shoulder height. A single attempt was made and the score recorded.

Pull-strength. A dynamometer was used in the same manner as described in push-strength, but subject was instructed to pull, permitting only a horizontal line of force. The score of a single attempt was recorded.

Shuttle-run. The subject lay on her stomach with her hands and chin on a two inch line which was parallel to

another two inch line thirty feet away. On the signal she got up, ran to the far line, stepped on it, reversed direction, and ran back to the first line, ran again to the far line and back to the starting point. Timer stopped watch as subject crossed starting line the last time. Best of two trials was recorded. A short period of rest was allowed between trials.

Sit-ups. Subject lay on back with hands on shoulders, knees bent so that feet were flat on floor. Partner sat or knelt at subject's feet, placed hands on top of subject's feet to give slight support. At signal subject touched elbows to knees as many times as she could in 30 seconds. The number of touches per 1/2 minute was recorded.

Deep-knee-bends. Subject stood with feet about 10 inches apart, right toe in line with left heel. What was done with arms and hands was optional. Upon signal subject lowered herself until buttocks touched heels, then immediately extended her legs. Number of deep-knee-bends in 1/2 minute was recorded.

Standing-flexion. A bench with a ruler attached perpendicular to the top of the bench was used. Subject stood in bare feet or stocking feet on bench, feet together, toes even with edge. She then bent at waist, keeping knees straight, and reached down as far as she could below the level of her toes. Three bounces were allowed and score was read as girl held the fourth bounce. A plus score

indicated that the subject was unable to reach down as far as her toes, a minus score indicated that she could reach below her toes.

Back-extension. Subject lay on stomach on a mat with hands linked behind neck. Partner sat on subject's thighs, placing hands on buttocks to give support. Subject raised upper part of body as far from mat as possible. Test administrator held string between both hands, placing thumb of one hand at hollow of neck of subject, other thumb on floor so that string was taut and perpendicular to floor. Both hands with string stretched between them were placed against yardstick and the score was read to the nearest quarter of an inch. Score was recorded as the perpendicular distance from the floor that the subject was able to raise herself as measured from the hollow of the neck.

Standing-broad-jump. Mats marked off in feet and inches were used. Subject stood on beat board, jumped as far as she could from standing position. Score was read to nearest inch by test administrator. Score was determined by that part of the body which was closest to the starting point, whether it be heel or hand. Best of three trials was recorded.

PROCEDURES FOR ADMINISTRATION OF SKIN-FOLD FAT MEASUREMENTS

General procedure. Subject was instructed to stand at ease with weight evenly distributed on both feet. The

administrator grasped a skin-fold of the area to be measured between the thumb and forefinger of the left hand. The fat calipers were then placed on the skin-fold. The mouth of the calipers was closed against the skin until the two lines on the movable gauge met. The measurement was read to the closest millimeter. The caliper was withdrawn from the flesh and two more measurements were taken immediately. A minimum of 3 measurements within ±1 millimeter were taken.

Scapular. Thumb and forefinger were held vertically to obtain a fold in a horizontal line over tip of scapula. Calipers were held vertically to obtain the reading.

Lower-ribs. Thumb and forefinger were held in a vertical line. One fold of skin lying over lower rib just to side of mid-line was obtained. Calipers were held in vertical position as they were read.

Triceps. Subject held upper arm straight out from shoulder at side, forearm held straight up, biceps relaxed. A skin-fold running parallel to humerus was grasped and calipers held perpendicular to arm to obtain measurement.

Pectoral. Skin was grasped at intersection of upper-arm and chest. Caliper was held at the best angle to facilitate reading.

Iliac-crest. Vertical position of thumb and fore-finger was used to obtain a skin-fold passing over iliac-crest. Calipers were held in approximately vertical position to be read.

Biceps. Subject's arm was hanging relaxed at side. Thumb and forefinger were in horizontal plane to secure this skin-fold. Calipers were held in horizontal plane to obtain reading.

Cheek. Forefinger was placed on cheek directly above thumb. A fold of skin was secured and the calipers held in a vertical position to obtain the reading.

PROCEDURES FOR ADMINISTRATION OF GIRTH MEASUREMENTS

General procedure. The subject stood with weight evenly distributed on both feet. Arms hung relaxed in a position approximately 68 degrees from body with the elbows slightly flexed. All measurements were read to the nearest millimeter and taken a minimum of three times within ±1 millimeter. The tape was withdrawn and replaced between each reading. The girth measurements were taken at the point of greatest or least circumference as described in the following.

Upper-arm. Measurement was taken at point of greatest circumference.

Bust. Measurement was taken from side at point of greatest circumference. Subjects wore bras.

Waist. Measurement was taken from side at point of least circumference.

Abdomen. Measurement was taken from side at point of greatest curvature.

Buttocks. Measurement was taken from side at point of greatest curvature.

Thigh. Measurement was taken in front at point of greatest curvature.

Calf. Measurement was taken from side at point of greatest curvature.

PROCEDURES FOR ADMINISTRATION OF HEIGHT AND BODY WIDTH MEASUREMENTS

Height. Subject stood barefoot with heels, buttocks, upper part of back, and head touching the stadiometer. Each subject was instructed to hole herself erect, head straight and eyes looking horizontally forward. The horizontal bar was read to the nearest tenth of a centimeter.

Width. Chest and bi-iliac widths were taken using wooden calipers calibrated in centimeters. Each score was read to the nearest tenth of a centimeter. A minimum of three readings was made, withdrawing the caliper from the body between each reading.

Chest-width (transverse diameter). Calipers were applied to the chest directly at line of the fourth costo-sternal articulation. The fixed branch was pressed against right side of thorax until it met resistance of ribs. The movable branch was applied repeatedly to opposite side with equal pressure during inspiration and expiration until mean between the two was found. The instrument was held so that its plane was at right angles to the vertical plane or axis

of the thorax. The subject stood in a natural, easy, erect position with forearms flexed slightly and arms lifted forward to about 65 degrees outward from the body.

Bi-iliac-crest. To obtain the bi-iliac crest width measurement, the calipers were held in a horizontal plane with the movable and fixed branches perpendicular to the vertical plane or axis of the spine. The fixed branch was pressed against the right side of the superior iliac-crest until resistance was met. The movable branch was applied to the opposite side with equal pressure to obtain the reading. The subject stood in a natural, easy, erect position.

TWENTY-FOUR HOUR ACTIVITY RECALL

Name _____ No. _____ Group _____ Age _____ (Year - month) Hgt. _____ Wgt. _____ (kg.)

Date _____

Activity Morning to Noon Lunch	Min.	Hr.	Afternoon to Dinner	Min	Hr.	Dinner Through Night Sleep	Min.	Hr.
Dressing			Lunch			Dinner		
Bathing-washing			Daytime rest			Daytime rest		
Care of hair-nails			Personal necessities			Undressing		
Laundry-ironing-sweing			(list)1._____			Care of hair-nails		
Clean room			2._____			Laundry-ironing-sewing		
Walk			3._____			Clean room		
Stand			4._____			Walk		
Getting to & from class			Getting to & from class			Stand		
In class (type_____)			In class (type ____)					
Sit			Sit					
Stand			Stand					
Walk			Walk					
Studying			Studying			Studying		
Sit__Stand__Walk__			Sit__Stand__Walk__			Sit__Stand__Walk__		
Work (type____)			Work (type ____)			Work (type ____)		
Sit__Stand__Walk__			Sit__Stand__Walk__			Sit__Stand__Walk__		
Extracurric.(Type____)			Extracurric.(Type ____)			Extracurric.(Type ____)		
Sit__Stand__Walk__			Sit__Stand__Walk__			Sit__Stand__Walk__		
Recreational & off Work			Recreational & Off Work			Recreational & Off Work		
Sit__Stand__Walk__			Sit__Stand__Walk__			Sit__Stand__Walk__		
Daytime rest						Sleep		
Midmorning snack			Midafternoon snack			Evening snack		
Exercise (Type)			Other Activities			Other Activities		
Other Activities								

LETTER TO SUBJECTS PREVIOUS TO PARTICIPATION IN THIS STUDY

Dear Miss

Since you have indicated a desire to lose weight, I'm sending you the details about the Foods and Nutrition Department Weight Reduction Study during winter quarter, 1959.

All food will be served in the Home Economics Building with the exception of a take-home breakfast and supper on Sunday. Tentative menus are attached.

If you participate in the study, you should enroll in HPR 196, MW, 2-3, where special attention will be given to helpful activities.

You will have a physical at the Health Service at the beginning of the study. Parents of minors will be notified.

You will pay the dorm for room rent only. Pay Foods and Nutrition approximately one-half of what the dorm charges for board. This can be done any time during winter quarter.

Participation in certain tests for Foods and Nutrition Department will be required:

1. Nitrogen balance studies.(This involves total collection of urine and feces during two one-week periods.
2. Measurement of energy expenditures while resting and walking on a treadmill.
3. Blood samples.

At the time of your final exam, please let your instructor know whether or not you are interested. Leave address where you may be reached over holidays. Further details will be sent to you if you express an interest in this study.

Call Extension 2034 if you have questions.

MENUS

SUNDAY

Orange Slices Corn Flakes Skim Milk	Pot Roast Beef Potatoes,Lettuce, Carrots Sherbert Skim Milk	Turkey Sandwich Devilled Egg, Dill Pickles, Celery Sticks Pineapple Skim Milk

MONDAY	TUESDAY
Orange-Grapefruit Juice Eggs Toast, Butter Skim Milk Banana,Peach,Pineapple and Cottage Cheese Salad Rye-Krisp Skim Milk Pork Cutlet Carrots Cabbage Salad Sweet Cherries Skim Milk	Tomato Juice Eggs Toast, Butter Skim Milk Grilled Cheese Sandwich Lettuce & Tomato Salad Orange Slices Skim Milk Roast Veal Baked Potato Spinach Pineapple Skim Milk
WEDNESDAY	**THURSDAY**
Pineapple Juice Eggs Toast, Butter Skim Milk Tuna,Celery & Lettuce Salad w/Salad Dressing Green Beans Prune Plums Skim Milk Beef Pattie Peas Lettuce & Tomato Salad (French Dressing) Cherry Cobbler Skim Milk	Orange Juice Eggs Toast, Butter Skim Milk Hamburger Peas Carrots,Celery Peaches Skim Milk Round Steak w/Tomato Brussel Sprouts Lettuce Apricots Skim Milk
FRIDAY	**SATURDAY**
Prunes Eggs Toast,Butter Skim Milk Shrimp w/Cocktail Sauce Lettuce Green Beans Muffin Orange & Grapefruit Sections Skim Milk Roast Pork Stewed Tomatoes Carrots Celery Sticks Pears Skim Milk	Orange Juice Eggs Toast,Butter Skim Milk Hot Dog Peas Celery Sticks Applesauce Skim Milk Turkey Mashed Potatoes Mixed Vegs. Lettuce Orange Slices Skim Milk

TABLE X

RAW SCORES OF BODY WEIGHTS

Subject	Group	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Total Change
		kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.
11	I Diet	87.18	85.52	84.36	83.08	82.92*	80.94	80.72	79.10	78.06	77.76	-9.42
12	I Diet	80.36	80.01	79.36	77.78	76.22	76.42*	75.48	74.98	72.86	72.78	-7.58
13	I Diet	59.88	59.72	58.58	58.08	58.30	57.18	57.02	56.21	55.28	55.20	-4.68
14	I Diet	80.94	77.30	76.30	75.38	74.16	72.80	74.92	73.52	72.44	73.00	-7.94
15	I Diet	82.22	79.90	79.62	78.20	79.40	76.99	76.16	75.66	75.28	74.00	-12.22
16	I Diet	74.36	72.40	71.62	71.08	70.52	69.20	68.24	67.20	66.18	66.56*	-7.80
21	II Diet & Exercise	79.62	78.42	77.28	76.42	75.28	74.64	74.40	73.06	72.06	71.90	-7.72
22	II Diet & Exercise	74.26	73.22	71.84	70.54	70.48	70.18	69.62	68.60	67.92*	70.72	-3.54
23	II Diet & Exercise	76.56	74.36	73.34	73.28	72.68	71.24	71.14	73.08*	72.63	72.60	-3.96
24	II Diet & Exercise	72.50										
25	II Diet & Exercise	85.90	85.24	83.46	82.68	82.58	81.92	80.62	--	--	--	-5.28
26	II Diet & Exercise	94.50										
31	III Exercise			73.56			73.46				74.04	+0.48
32	III Exercise				64.31	64.86	64.60	65.32	64.05		63.78	-0.53
33	III Exercise					68.42				67.30	67.26	-1.16
34	III Exercise			78.36	79.03	79.12		79.24	78.70		79.68	+1.32
35	III Exercise			83.02	83.24		83.10	83.44			--	--
36	III Exercise				59.26						60.78	+1.52

TABLE XI

IMPROVEMENT IN PERFORMANCE OF ACTIVITIES IN SUPERVISED EXERCISE PROGRAM

Subject Number	Group		Series I		Series II	
			1st 7 days	Next 27 days	1st 8 days	Next 26 Days
			Exercise		Exercise	
			Run in Place	Rope Jump	Toe-Touch I	Toe-Touch II
21	II Diet and Exercise	Initial	40	68	65	27
		Middle	40	79	78	35
		Final	68	80	104	36
31	III Exercise	Initial	58	75	64	34
		Middle	45	110	99	47
		Final	70	130	104	51
32	III Exercise	Initial	51	98	75	41
		Middle	77	130	102	49
		Final	93	150	127	56
33	III Exercise	Initial	50	50	81	53
		Middle	47	95	124	80
		Final	75	107	157	104
34	III Exercise	Initial	18	57	58	28
		Middle	24	78	119	32
		Final	31	82	139	38

TABLE XI (Continued)

Subject Number	Group		Series III All 34 Days					
			Exercise		Bike		Swim	
			Sit-Ups	Lift-Push Point	Miles	Time	Lengths	Time
21	II Diet and Exercise	Initial	16	8	1.0	3'45"	9	11'
		Middle	25	21	3.0	11'5"	6	6'
		Final	31	23	3.6	13'22"	15	--
31	III Exercise	Initial	19	14	1.1	4'30"	8	7'30
		Middle	25	20	1.5	6'	8	7
		Final	31	26	2.3	6'5"	8	6'30"
32	III Exercise	Initial	13	10	1.2	7'15"	--	--
		Middle	23	20	3.0	10'30"	--	--
		Final	29	26	3.5	11'30"	--	--
33	III Exercise	Initial	8	9	1.8	5'	1	30"
		Middle	18	18	2.8	10'	16	20'15"
		Final	24	23	1.7	7'	7	8'
34	III Exercise	Initial	17	8	0.8	5'	--	--
		Middle	32	14	3.0	10'35"	--	--
		Final	38	18	2.0	6'25"	--	--

TABLE XII

RAW SCORES OF PHYSICAL PERFORMANCE MEASURES

Group	Grip Strength Dominant Hand lbs.			Grip Strength Other Hand lbs.			Push Strength lbs.			Pull Strength lbs.		
	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
11 (Diet)	112	92	-20	95	72	-23	44	44	0	48	46	-2
12 (Diet)	110	92	-18	92	74	-18	58	54	-4	78	54	-24
13 (Diet)	66	62	- 4	32	30	- 2	22	22	0	20	20	0
21 (Diet & Exercise)	93	94	+1	100	100	0	58	56	-2	75	74	-1
31 (Exercise)	105	92	-13	99	86	-13	70	70	0	72	82	+10
32 (Exercise)	63	70	+7	69	68	-1	60	42	-18	40	60	+20
33 (Exercise)	100	78	-22	80	74	-6	60	80	+20	30	42	+12
34 (Exercise)	110	100	-10	90	74	-16	64	58	-6	58	60	+2

TABLE XII (Continued)

Group	Shuttle Race sec.			Sit-Ups Number in 30 sec.			Deep Knee Bends Number in 30 sec.			Standing Flexion inches		
	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
11 (Diet)	--	13.1	--	8	10	+ 2	19	22	+ 3	+ 0.5	-2.0	-2.5
12 (Diet)	12.3	12.3	0	15	14	- 1	22	22	0	+ 7.0	+6.0	-1.0
13 (Diet)	14.0	14.2	+0.2	14	20	+ 6	18	19	+ 1	+ 4.0	+5.0	+1.0
21 (Diet & Exercise)	12.0	12.1	+0.1	15	17	+ 2	19	19	0	+ 1.5	+3.0	+1.5
31 (Exercise)	12.5	11.8	-0.7	18	18	0	20	19	- 1	+ 4.0	+5.0	+1.0
32 (Exercise)	13.1	14.0	+0.9	11	17	+ 6	22	23	+ 1	+ 3.5	+3.8	+0.3
33 (Exercise)	12.3	11.8	-0.5	17	17	0	24	23	- 1	+ 4.0	+2.0	-2.0
34 (Exercise)	13.6	12.8	-0.8	23	24	+ 1	24	25	+ 1	+ 2.5	+4.5	+2.0

TABLE XII (Continued)

Group	Back Extension inches			Standing Broad Jump feet-inches			Chair Step 30 sec. pulse		
	Before	After	Change	Before	After	Change	Before	After	Change
11 (Diet)	15.5	16.5	+1.0	3'7"	4'0"	+5"	64	56	-8
12 (Diet)	17.0	19.5	+2.5	4'9"	4'11"	+2"	69	62	-7
13 (Diet)	11.8	11.0	-0.8	3'0"	3'7"	+7"	63	52	-11
21 (Diet and Exercise)	9	15.0	+6.0	5'4"	5'3"	-1"	65	46	-19
31 (Exercise)	11.5	13.5	+2.0	4'2"	4'0"	-2.0"	60	56	-4
32 (Exercise)	8.5	12.3	+3.8	3'11"	3'10"	-1.0	68	46	-22
33 (Exercise)	11.8	12.3	+0.5	4'7"	5'9"	+14.0"	77	74	-3
34 (Exercise)	11.3	11.0	-0.3	4'5"	4'5"	0	72	--	--

TABLE XIII

RAW SCORES OF GIRTH MEASUREMENTS

Group	Upper Arm			Bust			Waist			Abdomen		
	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
11(Diet)	27.2	26.4	-0.8	100.4	94.6	-5.8	80.3	74.9	-5.4	105.2	98.2	-7.0
12(Diet)	28.7	28.7	0	98.1	96.5	-1.6	75.3	72.5	-2.8	100.5	95.5	-5.0
13(Diet)	27.7	26.6	-1.1	81.2	80.4	-0.8	63.8	58.7	-5.1	86.3	79.5	-6.3
21(Diet & Exercise)	29.2	27.5	-1.7	94.7	86.5	-8.2	73.0	70.8	-2.2	96.0	90.7	-5.3
31(Exercise)	29.4	29.4	0	101.0	100.8	-0.2	76.5	76.3	-0.2	96.8	96.4	-0.4
32(Exercise)	27.2	26.4	-0.8	89.6	89.8	+0.2	69.5	70.0	+0.5	93.5	92.1	-1.4
33(Exercise)	28.2	27.0	-1.2	88.0	87.5	-0.5	70.2	66.2	-4.0	94.8	86.6	-8.2
34(Exercise)	30.8	30.9	+0.1	93.3	93.8	+0.5	80.2	78.0	-2.2	103.0	100.4	-2.6

Group	Buttocks			Thigh			Calf			Total		
	Before	After	Change	Before	After	Change	Before	After	Change	Initial	Final	Change
11(Diet)	109.0	103.7	-5.3	63.8	59.0	-4.8	38.2	37.7	-0.5	524.1	494.5	-29.6
12(Diet)	106.6	102.0	-4.6	63.8	60.5	-3.3	36.3	35.9	-0.4	509.3	491.6	-17.7
13(Diet)	94.8	92.4	-2.4	55.5	52.5	-3.0	36.7	36.0	-0.7	446.0	426.1	-19.9
21(Diet & Exercise)	104.0	99.4	-4.6	60.3	56.8	-3.5	39.3	38.6	-0.7	496.5	470.3	-26.2
31(Exercise)	100.7	99.7	-1.0	64.6	57.3	-7.3	37.0	36.4	-0.6	506.0	496.3	- 9.7
32(Exercise)	95.7	95.6	-0.1	56.0	55.3	-0.7	36.5	35.5	-1.1	468.0	464.7	- 3.3
33(Exercise)	108.8	104.5	-4.3	61.4	61.3	-0.1	34.1	33.4	-0.7	485.5	466.5	-19.0
34(Exercise)	111.1	111.1	0	69.3	65.6	-3.7	42.5	42.0	-0.5	530.2	521.8	- 8.4

TABLE XIV

RAW SCORES OF SKIN-FOLD MEASUREMENTS

Group	Biceps			Triceps			Cheek			Pectoral		
	Initial	Final	Change	Initial	Final	Change	Initial	Final	Change	Initial	Final	Change
11(Diet)	2.1	1.7	-0.4	2.5	1.9	-0.6	1.7	1.3	-0.4	1.3	0.8	-0.5
12(Diet)	1.8	1.4	-0.4	2.2	1.6	-0.6	1.9	1.8	-0.1	1.4	0.8	-0.6
13(Diet)	1.3	1.1	-0.4	2.7	2.2	-0.5	1.5	1.5	0	1.3	0.9	-0.4
21(Deit & Exercise)	1.1	0.6	-0.5	2.4	1.7	-0.7	1.4	--	--	0.8	0.8	0
31(Exercise)	1.1	0.9	-0.2	2.4	2.2	-0.2	1.7	1.7	0	1.3	1.3	0
32(Exercise)	1.3	1.1	-0.2	1.8	1.6	-0.2	1.5	1.5	0	1.1	0.9	-0.2
33(Exercise)	0.9	0.7	-0.2	1.5	1.5	0	1.5	1.4	-0.1	1.0	0.8	-0.2
34(Exercise)	1.6	1.7	+0.1	3.5	3.5	0	1.7	1.7	0	1.1	1.2	+0.1

Group	Scapula			Lower-Rib			Bi-iliac-Crest			Sum of All Measurements		
	Initial	Final	Change	Initial	Final	Change	Initial	Final	Change	Initial	Final	Change
11(Diet)	3.2	2.5	-0.7	3.6	3.4	-0.2	4.3	2.4	-1.9	18.7	14.0	-4.7
12(Diet)	2.5	1.6	-0.9	3.3	2.9	-0.4	3.8	3.5	-0.3	16.9	13.6	-3.3
13(Diet)	1.5	1.2	-0.3	2.5	2.0	-0.5	2.8	2.5	-0.3	13.6	11.4	-2.2
21(Diet & Exercise)	1.6	1.2	-0.4	2.4	2.1	-0.3	4.0	3.7	-0.3	13.7	11.5	-2.2
31(Exercise)	2.5	2.5	0	2.4	2.7	+0.3	3.5	3.3	-0.2	14.9	14.6	-0.3
32(Exercise)	2.5	2.4	-0.1	2.2	2.2	0	3.3	3.2	-0.1	13.7	12.9	-0.8
33(Exercise)	2.1	2.1	0	2.3	2.4	+0.1	2.6	2.0	-0.6	11.9	10.9	-1.0
34(Exercise)	2.0	2.1	+0.1	2.8	2.8	0	4.5	3.0	-1.5	17.2	16.0	-1.2

All measurements in centimeters.