0-315-01188-2

National Library of Canada | Bibliothèque nationale du Canada

Canadian Theses Division | Division des thèses canadiennes

Ottawa, Canada
K1A 0N4

49046

PERMISSION TO MICROFILM — AUTORISATION DE MICROFILMER

• Please print or type — Écrire en lettres moulées ou dactylographier

Full Name of Author — Nom complet de l'auteur

MICHELLE FRANCES MOTTOLA

Date of Birth — Date de naissance

SEPT. 1, 1955

Country of Birth — Lieu de naissance

CANADA

Permanent Address — Résidence fixe

6015 THERESA ST.
NIAGARA FALLS, ONT.
L2J 2A4

Title of Thesis — Titre de la thèse

THE EFFECTS OF DIET AND EXERCISE ON THE BODY COMPOSTION OF WOMEN

University — Université

UNIV. OF ALBERTA

Degree for which thesis was presented — Grade pour lequel cette thèse fut présentée

M.Sc.

Year this degree conferred — Année d'obtention de ce grade

1980

Name of Supervisor — Nom du directeur de thèse

Prof. Pat Conger

Permission is hereby granted to the NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

L'autorisation est, par la présente, accordée à la BIBLIOTHÈQUE NATIONALE DU CANADA de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

L'auteur se réserve les autres droits de publication; ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans l'autorisation écrite de l'auteur.

Date

Oct. 17/80.

Signature

Michelle F. Mottola.

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

THE UNIVERSITY OF ALBERTA

THE EFFECTS OF DIET AND EXERCISE ON THE BODY COMPOSITION OF WOMEN

by

© MICHELLE F. MOTTOLA

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

PHYSICAL EDUCATION

EDMONTON, ALBERTA

FALL 1980

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE EFFECTS OF DIET AND EXERCISE ON THE BODY COMPOSITION OF WOMEN submitted by MICHELLE F. MOTTOLA in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE.

Patricia E. Conger

Supervisor

E. G. Donald

[illegible]

Date Oct. 16, 1980

DEDICATION

'Life is like a waltz; it whirls and twirls, forever introducing new steps, quicks and slows, ups and downs, varying with the beat of the heart and the melody of an orchestra conducted by the soul.'

To Mom and Dad, who have always supported and encouraged me through the many 'ups and downs' of my life.

ABSTRACT

The purpose of the present study was to investigate the effects of a low-energy diet, an exercise program, and a combined program of the same diet and exercise on changes in body composition of sedentary women and to compare the effects of the three protocols to a control group.

The subjects were randomly placed into one of four groups: a control group (C), a low-energy diet group (D), an exercise group of three sessions per week (E), and a combination group with the same diet and exercise program (DE). The study was ten weeks in duration. Body weight, skinfolds, girths, and hydrostatic weight were estimated on each subject before and after the ten weeks.

The following hypothesis was tested for significance at the 0.05 level of probability:

> There is no difference in the effects of the experimental conditions on the body composition of sedentary women.

Results of the ten week study indicated that body weight measures did not reflect changes in body composition. Furthermore, skinfold measurements used alone were not an accurate assessment of changes in body fat. Percent body fat was significantly decreased by the regimen followed by the diet and diet and exercise groups when compared to the control group. There were no significant differences found in fat-free weight. Results also showed that the control group increased slightly on most of the mean skinfold values

($p>0.05$). The diet group showed a significant decrease in the tricep, subscapula, and umbilical skinfolds and a nonsignificant reduction in mean suprailiac, pubis, and front thigh measurements. Significance was found in the DE group on the pre and post values for front thigh and rear thigh skinfold thicknesses. The only decreases in mean skinfold thickness in the DE group was in the lower limb measurements, with the front thigh and rear thigh skinfolds significantly different from the other groups. The E group only showed a reduction in the front thigh skinfold ($p<0.05$). The D group showed a significant decrease in three of the five upper body measurements. Tricep, suprailiac, and umbilical mean post skinfolds were found to be significantly different in the D group compared to the other three groups.

Waist circumference was significantly different between the C group and the D group; the C group showed an increase in mean value and the D group a decrease in mean value. All the groups reduced in mean hip circumference with significance found between the C group and the D group, the D group and the E group, and the C group and the DE group. Significance was found between the C group and the D group, and the C group and the E group in thigh circumference. A difference was found between the C group and the D group, and the D group and the E group in the calf circumference measure. The D group decreased on all the mean circumference measurements with significance found on mean waist, hip, thigh, and calf measures. A significant increase on thigh

circumference occurred in the E group. The DE group showed a significant reduction on the calf circumference.

ACKNOWLEDGEMENTS

I wish to thank the following individuals:

Dr. Mike Yuhasz; who initiated my interest in this area of study during my fourth year at the University of Western Ontario.

Prof. Pat Conger; my chairperson, who accepted me into the program at the University of Alberta, and allowed me to pursue this interest.

Dr. Elizabeth Donald; one of my committee members, whose critical expertise and helpful insight kept me from going astray.

Dr. Art Quinney; my third committee member, who always offered useful information and advise when I needed it.

The friendly people at the Pulmonary Lab; whose patience and much appreciated assistance enabled me to learn the helium-dilution technique.

My fellow graduate students; who gave me encouragement and empathy through the good times and the bad.

Kathy Moore; whose knowledge and advice were greatly appreciated, especially during the final stages.

And last but certainly not least, I wish to thank Dan Rogers; who offered me companionship and support which gave me the strength and determination to strive for the best.

List of Figures

Table of Contents

I. INTRODUCTION

"O, that this too too solid flesh would melt,
Thaw and resolve itself into a dew!" [1]

In a society where more individuals are becoming increasingly conscious of weight control, fitness and health, an effective method for decreasing body fat is much in demand. People have been exposed to supposedly effortless ways to lose weight and shed pounds by fad diets and quackery, all completely guaranteed to change one's shape (94). Unfortunately, there is no magic metabolic formula that results in completely exertion-free weight loss (57).

The nonreality of a 'miracle' cure is evident from the prevalence of obesity in North America. One in every 4 women and 1 in every 5 men are sufficiently overfat to be predisposed to health problems (18;46). Body fat tends to increase with age. Approximately 50% of the North American populace is obese by middle age (18,63). However, it seems the main problem has been overlooked. Weight control is not the important issue but rather body composition changes and the proportion of total body fat (stored energy) and non-fat

---

[1] Shakespeare, W. *Hamlet, Prince of Denmark.* In *The Riverside Shakespeare. Vol VI. Tragedies.* Ed. by R.G. White. Boston: Houghton, Mifflin, p. 523, 1883.
Cited in Stuart, R. and Davis, B., 1975 (89).

components (fat-free weight) (18,48,94).

A state of energy equilibrium exists when energy input equals energy expenditure. There are three ways to create a negative energy balance which will induce physiological changes in body composition (53,108):

1) reduce energy intake by caloric restriction
2) increase energy expenditure through physical activity
3) combine energy intake restriction with increased activity level.

The change in energy stores (body fat) is equivalent to the energy input minus the energy output (33,34,89). Thirty-five hundred kcal of energy is needed to expend one pound of fat (58). Thus, a relatively large negative energy balance must be achieved over an extended period of time for changes in body composition to take place (18,28). It is important to prescribe appropriate reduction protocols which decrease total body fat without loss of the non-fat components. The physiological changes caused by specific diet and/or exercise programs must be included to meet this goal.

A. THE PROBLEM:

Physiological changes in body composition which result from exercise and diet regimens point to the possibility of using these two measures as preventative techniques and theraputic agents in the fight against adiposity in our society. To accomplish this goal, recognition of the appropriate energy restrictions and expenditures required to

produce body composition changes in specific populations is necessary. Few researchers have assessed the effects of a balanced low-energy diet on the body compostion of sedentary women. Many studies have examined the effects of physical training on the body composition of women (25,37,61,67,68,74,94,97), but few attempts have been made to compare dietary restriction and exercise as a means for reduction in body fat (108). The effect of energy restriction and increased physical activity on the body composition of inactive women has not been well-investigated. Therefore, the purpose of the present study was to examine the effects of a balanced low-energy diet, an exercise program, and a combined program of the same diet and exercise on changes in body composition of sedentary women and to compare these to a control group.

B. LIMITATIONS:

1) Temperature and humidity were not controlled in testing and/or the exercise areas.
2) The ten week time period included midterm exams and a mid-term break from classes (reading week) for those subjects who were students at the University of Alberta.
3) Initial fitness levels were not assessed.
4) The sample of subjects were volunteer.
5) The subjects were not in post-absorptive state nor were they required to empty their bladders before body weight measures were taken.

6) One-way analysis of covariance was used to analyse the results.

C. DELIMITATIONS:

1) Forty-seven female subjects from the university community, excluding the Faculties of Education, and Physical Education and Recreation, who ranged in age from seventeen to thirty-five years participated in a 10 week study.
2) One type of caloric restriction, the *Diabetic Exchange Diet* and one type of exercise program were examined.

D. NULL HYPOTHESIS:

The following hypothesis was tested for significance at the 0.05 level of probability:

If group 1 represents a control group with no restrictions, group 2 represents a diet group with a balanced low-energy restriction, group 3 represents an activity group with a moderate exercise program and group 4 represents a combined program of a balanced low-energy restricton and a moderate exercise program, then:

There is no difference in the effects of the experimental conditions on the body composition of sedentary women.

E. DEFINITION OF TERMS:

Sedentary:

a lifestyle involving no additional physical activity other than activity required in daily living.

Body composition:

proportions of skeletal tissue, musculature and fat of the human body (54).

Fat-free weight:

includes all the body tissues less the total body fat (3,8,33).

Percent body fat:

an estimate of the amount of fat present in the body indicated as a percentage of total body weight (105)

Low-energy dietary regimen:

an energy restricton (minimal level 1,000 kcal) which has 500 kcal less than the usual energy intake level with no more than 30% fat (89), no less than 14% protein and approximately 50% carbohydrate (49,63) for a ten week time period.

Exercise program:

refers to a period of supervised physical activity three times per week for ten weeks.

Preprogram:

refers to the seven days prior to the start of the 10 week treatment.

Postprogram:

the period immediately following the 10 week program,

not exceeding four days.

ANCV:

analysis of covariance.

Kilocalorie (kcal):

the amount of heat necessary to raise the temperature of 1 kilogram (kg) of water by 1°C (53).

II. REVIEW OF LITERATURE

Energy equilibrium becomes a state of negative energy balance in the body when energy output exceeds energy input, when energy input is less than energy output or, when a combination of energy restriction and increased energy output occurs. The various aspects of body composition alterations which result from this state of negative energy balance will be reviewed under the following headings: the effect of energy restriction on body composition; the effect of exercise on body composition; and the effect of diet and exercise on body composition.

A. THE EFFECT OF ENERGY RESTRICTION ON BODY COMPOSITION:

Much of the research in the area of diet pertains to obese individuals and the reduction of body weight. Studies relating to the changes in body composition of sedentary women are needed. This review will be subsequently concerned with reports of relatively sedentary young women.

A restriction of food intake may cause a negative energy balance in the body when energy input is less than energy output, and this change may affect body composition. Energy intake is directly related to the amount of food consumed (6 During the preliminary stages of energy restriction, depletion of the body's carbohydrate stores and enhanced fat catabolism leads to a substantial loss in body

water (41,53). Approximately one hundred grams of oxidized fat produces one hundred and twelve grams of water (8). Some women will retain fluid during their menstrual cycle regardless of dietary restriction (22,89,104). Several reports have shown that fat-free tissue in the form of protein is also reduced with energy restriction (12,29,41,42,69,78,108). After a week of restriction, protein catabolism appears minimal providing daily protein intake is at least 0.5 to 1 gm/Kg of body weight (8). Brozek, in 1961 investigated the effects of a 500 Kcal deficit from usual food intake levels. The results showed that over a period of 40-45 days, weight reduction consisted of 73-83% fat, 4-7% protein and 10-23% body fluid, determined by adipose tissue biopsy analysis. However, the composition of lost body tissue will vary with circumstance (12).

Severe diets of less than 800 Kcal/day cause little extra fat to be catabolized. Under these circumstances, an adaptation occurs which conserves energy; the type of mechanism which causes the adaptation is unknown (8,15). Restrictions of this kind may lead to loss of essential nutrients and malnutrition if followed for any length of time (18).

Several researchers indicate different methods of decreasing energy intake. The most prevalent diets include: fad diets, low carbohydrate diets, and balanced low-energy diets (8,18). Fad diets are the most popular because they

advertise an easy and fast way to shed pounds. The type of food may be bizarre and deficient in proper nutrition which may lead to health problems (89).

A diet low in carbohydrates will result in a relatively large loss in body weight. This is mainly due to loss of body water (89). For some individuals, the reduction of carbohydrate may lead to ketosis, fatigue, and fluid and electrolyte imbalance (53,89). A minimum of one hundred grams of carbohydrate ingested daily is strongly recommended (89). On the other hand, when carbohydrate consumption is decreased, fat intake may be voluntarily reduced because some people do not eat fat without carbohydrate. This may facilitate energy restriction (8).

Balanced, low-energy diets contain essential nutrients (9,89): no more than 30% fat (89), no less than 14% protein, and the remainder approximately 50% carbohydrate (49,63). The minimal energy level allowable for a well-balanced diet is 1,000 kcal a day (89). Energy restrictions of 1,000 kcal and 1,200 kcal per day are recommended most often for adult women (49). Daily energy deficits of 500-1,000 kcal from the usual intake level result in fat reduction of one to two pounds/week (22,25,53,63). Research has shown that restrictions of this type are more likely to be successful over an extended period of time (15,18,89).

To determine an energy baseline of food intake so that a kcal deficit may be imposed, a complete record of daily

ingestion of food and fluids is necessary. A diary of seven consecutive days is considered one of the best ways to assess dietary intake levels. The total energy intake for each of the seven days is added up and an average energy intake level established (53). A dietary regimen of the appropriate energy level which is the mean energy intake less 500 Kcal, is individualized to ensure a loss of approximately one pound/week (22,25,87).

Sloan and coworkers female subjects' kept food behaviour records as well as food intake diaries. These records were used to make the individual more aware of eating behaviours and food habits. An exchange system was utilized to control the energy level of the diet so that weight reducton would occur. The result of the twelve week program was weight loss ranging from 3.5 to 14.75 pounds with a mean of 8.5 pounds for the entire program or 2/3 of a pound lost/week (87).

Zuti and Golding, in 1976, instucted each of their female subjects to record total calories consumed for a 24 day period. The diet group decreased their usual calorie intake level by 500 kcal. Physical activity was maintained at a constant level. Body weight, skinfolds measured with the *Harpenden* caliper, circumference measurements and hydrostatic weight were taken before and after the 16 week treatment period. The mean weight loss was 11.7 pounds. Total body fat, as well as skinfold and girth measurements were reduced. Lean tissue was decreased even though average

protein intake was 71.3 grams/day which is more than adequate. The lean tissue loss could be attributable to insufficient replacement of protein caused by the diet. The reason for the reduction in lean tissue is not understood (108).

In summary, energy restriction enhances catabolism of body tissues to compensate for depleted metabolic requirements. Theoretically, a daily energy deficit of 500 Kcal from the usual dietary intake level may result in a reduction of approximately one pound of fat/week. Body fat is oxidized to supply a major source of energy. Carbohydrate and protein stores are utilized in the preliminary stages of energy restriction, and thus body water loss is substantial during the first week of dieting. As energy restricton continues, body water loss is minimal. Balanced low-energy diets are more likely to be successful over time with no potential danger to the individual's health. This is recommended most oftem in the literature (22,25,87,108).

B. THE EFFECT OF EXERCISE ON BODY COMPOSITION:

Energy expenditure is the summation of basal metabolic rate, heat loss due to the thermal effect of food (specific dynamic action), and physical activity (9,33,34,61). Basal metabolic requirements account for a large amount of total energy needs in sedentary individuals (61). Exercising after food intake can expend excess energy intake in the form of heat by almost doubling the thermic effect of a

meal (8,9,22). Exercise creates an increase in expended energy and consequently a resultant alteration of body composition (34).

Moody et al., in 1969, reported the effectiveness of a relatively low energy expenditure program on weight and adiposity reduction of young overweight women. The treatment was a walk-jog protocol, 6 days a week for 8 weeks. Skinfold technique assessed fat loss. Mean body weight and skinfold thickness decreased significantly. Total body fat was reduced while lean body mass increased. Since the equated loss of body fat from the skinfold determination was not the same as that expected from calculated energy expenditure, the authors concluded that the skinfold method alone was an inaccurate means of measuring body fat reduction (67).

In theory, the energy required to metabolize one pound of body fat is 3,500 kcal. Some studies have found that the energy equivalent of the quantity of the exercise actually executed did not quite sum to the amount of activity required for the reported fat loss (5,33,34). One explanation offered was that a reduction in energy intake may occur with exercise and energy imbalance may result to the extent needed to elucidate the fat loss (5). Research has also shown that light to moderate exercise of approximately one hour/day may suppress the appetite (26,47,53,63).

A recommended exercise protocol should (94):

1) decrease body fat

2) not seriously alter lifestyle

3) be maintained all through life

4) be self-satisfying to the participant

The type or duration of exercise required to deplete energy stores is not precisely known (7). Generally, an exercise protocol of 3 sessions/week of approximately 45 minutes duration with a similar intensity to jogging causes a mean loss of 0.5 kg/month body weight on an ad libitum diet (7). From a theraputic viewpoint, the utilization of exercise as treatment for obesity may not be successful. This is because small amounts of weight loss/unit time of relatively difficult work may result, even when engaging large muscle groups (7,22,58). The exercise may also cause an increase in lean body weight because of muscular hypertrophy (5). Regularly performed submaximal exercise from 3 to 6 times/week may alter body composition by a rise in fat-free weight with an associated decrease in percent body fat (61). However, exercise periods of 6 to 10 weeks duration have shown no changes in body-weight (61).

Wallace, in 1975, reviewed the effect of cardiovascular training on body fat in college women. The daily exercise bout consisted of 5-7 minutes of warm-up, 10-20 minutes of aerobic exercise (walk-run), and 10-15 minutes warm-down. The intensity was 80% of maximum heart rate. Weight, girth and skinfold measures were taken. Percent body fat was assessed by the *Yuhasz* skinfold procedure using the *Harpenden* caliper (107). Results showed a significant

decrease in percent body fat after 4 months of the treatment. Body weight decreased slightly and girth measurements did not change. Wallace concluded that body weight is not a good indicator of changes occurring in body composition as a result of a training program. Because there is a gain in lean body mass, and because muscle weighs more than fat tissue, the actual loss in body fat is masked by muscle tissue gain. Thus, weight reduction programs should be guided by changes in percent body fat not body weight. It was also concluded that the individuals with the highest adiposity showed the greatest decrease of fat with the least amount of training (94).

Girandola (37) compared the effects of high and low intensity work bouts on the body composition of college women. The bicycle ergometer was used for training 3 times/week for 10 weeks. Body composition was assessed by hydrostatic weighing. Results indicated that the high intensity group had a slight increase in body weight, percent body fat and lean body mass. The low intensity group had a significant reduction of 1.1% body fat, a slight increase in lean body mass, and a small decrease in body weight. The nonsignificant changes in body weight supports the contention that physical activity does not singly decrease body weight. It was concluded that regular exercise of low intensity and long duration oxidized more fat. Several other authors are in agreement with this finding (7,31,74,94). In addition, this type of exercise

program may inhibit and reduce triglyceride blood concentrations (25).

There are several important factors which must be included in an exercise program. Exercises which stretch muscles and cause improvement of major muscle group tonus are some of the necessary components of training. In addition, cardiovascular exercises which enable large muscle groups to work for an extended period of time, and a cooling down phase which diminishes task intensity before exercise is ceased, are also important (2,25,80,91,105,106,107). Hockey, in his book on physical fitness, breaks down these components to include: cardiovascular endurance, muscular endurance, muscular strength, and flexibility (44). Several authors divide these sections into three segments: a 5-10 minute warm-up, a sustained 20-30 minute exercise series, and a 5-10 minute warm-down (25,44,56,89,97). Cooper believes that 'calisthenics' in combination with a good aerobic routine can provide fitness and body fat reduction (20,21).

A twelve week fitness program, of three-one hour sessions/week was designed to improve cardiovascular efficiency, muscular endurance, muscular strength, and flexibility in young women. Body density and percent body fat were estimated from skinfold measurements after the twelve week treatment. The women decreased mean body fat by 0.72% but showed no reduction in body weight (97).

In 1978, Noland and Kearney compared 10 weeks of a

localized exercise program to 10 weeks of a generalized exercise program by assessing pre and post values of skinfolds, girths, and percent body fat estimated by hydrostatic weighing. The 56 subjects were college women, mean age 19.21±1.02 years and mean weight of 59.91±6.58 kg. The group on localized activity performed exercise aimed at the abdominal, hip and thigh muscle groups. The generalized group utilized whole body movement or aerobic exercise. The 30 minute bouts occurred 3 times/week. Both groups performed a 5 minute warm-up with the remaining 25 minutes devoted to either localized or general activity. The results showed a significant reduction in both the suprailiac skinfold and girth at the iliac crest with a slight increase in the umbilicus skinfold measurement of both groups. There was also a decrease in body fat and an increase in lean body weight for both groups. It was concluded that no difference occurred between localized calisthenic-type exercise and general aerobic exercise. Both types of regimens when performed at a moderate intensity are effective in changing anthropometric characteristics of young women (74).

In the review of the literature presented it seems that activity of low intensity and long duration varying from 3 to 6 times/week has been shown to produce alterations in body composition which result in a reduction of percent body fat with a concomitant rise in fat-free weight. Short-term exercise treatments (6 to 10 weeks) frequently result in no change in body weight because of body composition changes.

From a theraputic point of view, use of exercise as treatment for obesity may not be successful because of the small amounts of weight loss/unit time of relatively difficult work loads.

Exercise programs should contain a 5-7 minute warm-up phase, some type of aerobic work for 10-20 minutes and a 10-15 minute cool-down phase. Flexibility, cardiovascular endurance, muscular strength and muscular endurance are important components of a work bout. It has not been established which combination of frequency, duration and intensity of the protocol are necessary to produce optimal changes, although low intensity and long duration appear to be the key.

C. THE EFFECT OF DIET AND EXERCISE ON BODY COMPOSITION:

The reduction of body fat by exercise alone may be a difficult process for some people. Theoretically, in order to lose one pound of fat, while energy intake is held constant, 3,500 kcal/week must be expended. This may be accomplished by a 500 kcal increase in energy expenditure per day. Sedentary individuals who are not accustomed to this type of extra workload may be placed under an abnormal amount of stress. An energy intake deficit of 500 kcal/day from energy equilibrium may not seem as severe as an energy expenditure of that level but lean body tissue may deplete in addition to fat deposits. By combining these regimens, increased physical activity and a moderate energy

restriction, the stress of both need not be so severe and may be more easily tolerated (53,69). Exercise may contribute to the preservation of lean body mass by causing more of the fat stored as energy to be available for usage, especially when the individual is on a restricted energy level (55,69,78,79).

Zuti and Golding, in 1976, compared the effects of diet, exercise and a combinaton of the two regimens on the changes in body composition of young women. Body composition changes were determined by skinfold measures, girths, and hydrostatic weighing. The women in the diet group decreased their energy intake level by 500 kcal/day, the exercise group increased energy expenditure by 500 kcal/day, and the combination group reduced energy intake by 250 kcal and added 250 kcal of energy expenditure/day. The exercise protocol involved a supervised program for one hour/day, 5 days/week expending approximately 250 kcal/day. The exercise only group was prescribed an extra individualized walking program of 250 kcal to bring the total kcal expended to 500. There was no significant difference between the three groups for mean weight loss ($p>0.05$). Body density in all three groups increased significantly ($p<0.01$) with a concomitant reduction in body fat. The diet group showed a slight decrease in lean tissue whereas the women in the exercise groups had a slight gain. All three groups showed reduced skinfold and girth measurements but there were no significant differences. It was concluded that exercise

during weight loss may cause a greater loss of fat tissue while preserving lean body mass. A combination of reduced energy intake and a good fitness program were recommended for a weight reduction protocol.

Weltman and collegues in 1980, reported the effects of caloric restricton and/or mild exercise on the body composition of sedentary men. The restricted energy intake for the diet group was 500 Kcal/day less than usual consumption. The mild exercise program consisted of a brisk 15 minute walking program of approximately 3.5 mph, 4 times/week for 10 weeks. The combination group participated in both the diet and mild exercise regimens. The control group had no restrictions placed upon them. Body fat and lean body mass were estimated by hydrostatic weighing. The results showed that all groups, with the exception of the control group, obtained a significant reduction in percent body fat. The combination group lost a significantly greater amount of body fat, while the diet group had a greater reduction in body fat than the exercise group. The exercise group did not lose lean body weight. The diet only group lost significantly greater lean body mass tissue than the combination group. The authors concluded that the combination of 500 kcal energy intake restriction and exercise seem optimal for a program of body composition alteration (96).

Exercise and moderate energy restriction, should be incorporated into any program of adiposity management in

order to assist in the reduction of body fat and to act as a preventative health measure (16,89). Exercise preserves and possibly increases muscle tissue. Because protein stores are preserved, fat stored as energy may be available for usage especially when the individual is also restricting energy intake.

III. METHODOLOGY

A. SUBJECT SELECTION AND CRITERIA:

Sixty women volunteered to participate in a 10 week weight reduction program. The subjects were screened to meet the following criteria:

1) between 20 and 35% body fat as estimated by hydrostatic weighing.
2) free from any illness that would affect ability to reduce weight.
3) sedentary individual, involved in little or no regular physical activity.
4) between 17 and 35 years of age.

The subjects were randomly placed into four groups of 15 each. Attrition occurred during the course of the study and thirteen women were deleted from the final analysis. A total of 47 healthy sedentary women were the subjects in the final investigation.

B. FOOD BEHAVIOUR, DIETARY AND ACTIVITY RECORDS:

Before participating in the study, instructions were given to each subject on how to fill out *Food Behaviour* (9,30,50,53,60,71,89), *Dietary* (9,18,33,53,60,71,96,108), and *Activity* (9,33,71) record sheets for seven consecutive days before the treatment began. Calorie charts were also provided, with portion sizes stated in terms of standard measuring cups, spoons or ounces of food consumed (17,18)

(See Appendix A). The importance of an accurate diary was impressed upon the subjects. The written instructions for the *Food Behaviour* and *Dietary* record sheets are found in Appendix B. Each woman recorded her usual daily intake of food and fluids for the seven days, calculated the mean energy consumption/day and her mood and behaviour while eating (Refer to Appendix C for recording sheet). All calculations were checked for errors. The subjects also recorded extra-curricular activity, such as walking to or from school, jogging, cycling, swimming, etc. and estimated the duration and intensity of each activity for the week (See Appendix D).

C. GROUP DESCRIPTION:

GROUP 1 - CONTROL (C) N=12

There were no restrictions placed on energy intake or energy expenditure except for the maintenance of usual eating patterns and physical activity level.

GROUP 2 - DIET (D) N=12

The diet group was placed on the *Diabetic Exchange Diet* (17). The total exchanges allowed for each diet resulted in a 500 kcal/day deficit in energy intake for each subject. Energy expenditure was maintained at little or no regular physical activity.

GROUP 3 - EXERCISE (E) N=11

Subjects participated in fitness classes which were conducted three times per week by the experimenter. All the

exercises were timed and choreographed to taped music. Each subject's usual energy intake level was maintained for the 10 weeks.

GROUP 4 - DIET/EXERCISE (DE) N=12

Group 4 combined the 500 Kcal per day energy intake restriction with the same fitness classes three times/week.

D. DIETARY REGIMEN:

At the beginning of the first week of the treatment, subjects in the D and DE groups were given individualized *Diabetic Exchange* diets (17,35). The calculated decrease in energy intake was based on each subject's mean food consumption (19,24,60,71,81,92,93,96). The energy restriction of each subject was approximately 500 Kcal less than her usual dietary intake (30,49,71,89,108). This resulted in the subjects being placed on one of the following energy intake levels: 1,500 Kcal, 1,200 Kcal, and 1,000 Kcal.

Energy restricted diets of 1,500 Kcal, 1,200 Kcal and 1,000 Kcal each contained exchanges from the six different food lists thus providing a well-balanced diet. Table 1 presents the break down of the food exchange lists in terms of grams (gm) of carbohydrate (CHO), protein and fat and an example or equivalent in portions of food (17). The number of exchanges allowed for each of the three levels of energy restriction are found in Table 2 (17). The complete exchange lists are shown in Appendix E.

TABLE 1
FOOD EXCHANGE LISTS

LIST NUMBER	FOOD EXCHANGE	AMOUNT OF CHO gm	PROTEIN gm	FAT gm	EXAMPLE OR EQUIVALENT
1	Milk	6	4	4	1/2c (4 oz) whole milk
2 Group A	Vegetable	7	2		1/2c cooked carrots
2 Group B	Vegetable				4 stalks celery
3	Fruit	10			1/2 medium raw apple
4	Bread	15	2		1 slice of bread
5	Meat		7	5	1 oz, 30 gm meat or equivalent
6	Fat			5	1 tsp, 1 pat butter or margerine
A	Calorie-Free	No	Food	Value	clear tea or coffee
B	Calorie-Poor	Little	Food	Value	1 tsp catsup

Recording sheets were given to each of the subjects in the D and DE groups in order to list the exchanges eaten each day for the 10 weeks (See Appendix F). The dietary intake records were reviewed once a week, to ensure adherence to the diet plan and to maintain accuracy in recording.

TABLE 2
THE NUMBER OF FOOD EXCHANGES ALLOWED
FOR EACH LEVEL OF ENERGY RESTRICTION

FOOD EXCHANGES	ENERGY RESTRICTION 1,000 kcal	1,200 kcal	1,500 kcal
List 1 - Milk	4	4	4
List 2 - Vegetable Group A	1	2	2
List 2 - Vegetable Group B	2	2	2
List 3 - Fruit	3	3	3
List 4 - Bread	4.5	5	6
List 5 - Meat	4	5	7
List [illegible]	2.5	3	4.5
Fre[illegible]	unlimited	unlimited	unlimited
Calo[illegible] - B	2	2	2

E. EXE[illegible]SE PROTOCOL:

Du[illegible]ng the second week of the treatment, the E and DE groups [illegible]egan the fitness program. The exercise plan had been delayed for one week to eliminate differences between the two diet groups and to allow them to become accustomed to new eating habits and restricted energy intake levels. A brief description of the program is presented in Table 3 - Week 1 to 5, and Table 4 - Week 5 to 10 (2,21,25,44,71,74,80,91,106,107). Week four of the 10 week treatment was reading week for those subjects who were students at the University of Alberta. A written exercise program w[illegible] given to those subjects who were not able to attend [illegible] fitness classes for that week (Refer to

TABLE 3
FITNESS PROGRAM UNDERTAKEN BY THE EXERCISE GROUPS
WEEK 1 TO 5

TYPE OF EXERCISE	DESCRIPTION	NUMBER OF REPETITIONS	TIME MIN:SEC
flexibility	range of joint motion	5-6	16:45
muscular strength	static dynamic	4-5 10	5:09
C-V endurance	continuous activity of large muscle groups to increase HR and body temp.		5:00
warm-down	stretching and relaxation	4-5	1:55

HR - heart rate, temp. - temperature .TOTAL DURATION = 28:09

Appendix G).

F. TESTING PROCEDURES:

During the seven consecutive days prior to week one of the program, anthropometric data was collected for each subject. The procedure will be described under the following headings: height and weight, subcutaneous fat measurements, circumference measurements, and hydrostatic weighing. Measurements were taken by a trained investigator. Reliability of the investigator was measured on all of the procedures. Each subject was measured in a two-piece swim suit or underwear. Subcutaneous caliper and circumference measurements were taken three consecutive times and the mean

TABLE 4
FITNESS PROGRAM UNDERTAKEN BY THE EXERCISE GROUPS
WEEK 5 TO 10

TYPE OF EXERCISE	DESCRIPTION	NUMBER OF REPETITIONS	TIME MIN:SEC
flexibility	range of joint motion	5-6	19:19
muscular strength	static dynamic	8 15	8:02
C-V endurance	continuous activity of large muscle groups to increase HR and body temp.		10:31
warm-down	stretching and relaxation	5-6	10:00

HR - heart rate, temp. - temperature .TOTAL DURATION = 47:46

of the three trials was taken as the actual reading. The three measures were within ten mm (skinfolds) and one cm (circumferences) of each other. The same procedure was repeated to collect the anthropometric data immediately following the end of the 10 weeks.

HEIGHT AND WEIGHT:

Height was recorded in inches using a tape measure which was secured to the wall. Dry body weight was measured on a balance scale to the nearest 10th of a kilogram (kg). All subjects were weighed once/week and the weight charted for the duration of the ten week program. A graph showing the average weekly weights for each group is found in Appendix H.

SUBCUTANEOUS FAT MEASUREMENTS:

The *Harpenden* caliper (90) was used to measure the eight skinfolds according to the technique of *M.S. Yuhasz* (107). Measurements were taken on the right side of the body except for the *SUBSCAPULA* and the *UMBILICAL* skinfolds.

TRICEP:

This measurement was taken at the back of the upper arm, at the midpoint between the shoulder and the elbow. The arm was relaxed loosely at the side, while the skin was lifted parallel to the long axis.

SUBSCAPULA:

The site was located below the tip of the scapula. The thumb was placed on the tip of the shoulder blade and rotated clockwise, vertically lifting the skinfold between the thumb and forefinger.

SUPRAILIAC:

The skinfold was located above the crest of the ilium. The thumb was placed on the iliac crest, with the forefinger lifting the fold along a slight vertical angle, coinciding with the normal fold line.

UMBILICAL:

This site was slightly below and adjacent to the left side of the navel. Measurements were taken by lifting the skinfold parallel to the long axis of the body.

PUBIS:

A vertical skinfold was lifted at the site located mid-way between the symphysis pubis and umbilicus.

FRONT THIGH:

This skinfold was located on the upper thigh mid-way beween the hip and the patella, parallel to the long axis of the leg. The foot was elevated six inches in order to slightly flex the knee and relax the quadriceps muscle.

REAR THIGH:

The measurement was taken with the leg in the same position as previously described for the *FRONT THIGH.* The skinfold was located mid-way between the knee and the curve of the buttocks on the back of the upper leg, parallel to the long axis of the leg.

CALF:

In order to relax the calf muscle, the leg was bent with the knee resting on a stool which was twelve inches high. The skinfold was lifted parallel to the long axis of the leg at the greatest circumference of the rear calf.

CIRCUMFERENCE MEASUREMENTS:

Subjects stood with the feet together. An anthropometric steel tape was used to measure girth to the nearest mm (5,9,12,53,71,74,76,85,95,100,107,108).

UPPER ARM:

The arm was held laterally at a right angle to the

body. The tape measure was placed around the prominence of the flexed and contracted bicep muscle.

BUST:

The measurement was taken at the fullest part of the bust.

WAIST:

The tape measure was placed at the narrowest circumference of the trunk.

GLUTEAL:

Measurements were taken at the maximum circumference of the hip at the gluteal prominence.

THIGH:

With toes flexed to contract the muscles of the thigh, the tape was placed around the circumference of the thigh located just below the curve of the gluteal muscle.

CALF:

With toes flexed to contract the calf muscles, the maximum circumference of the calf was measured.

HYDROSTATIC WEIGHING:

INTRODUCTION:

A rectangular densitometry tank 5 feet wide, 10 feet in length and 6 feet deep was used for hydrostatic weighing. A suspended aluminum chair was attached to a strain gauge which was connected to a *Sargent Recorder (model SRG)*. The recorder was calibrated prior to each test.

The subject entered the densitometry tank and dislodged air bubbles from the swim suit and hair. The subject then sat in the suspended metal chair immersed to the neck-shoulder level and an 8.22 kg weight belt was draped across the lap. The water temperature was recorded. Room temperature was not controlled but remained between 28°C and 30°C.

LUNG VOLUME DETERMINATION:

A volume of room air was added to the spirometer *Godart Pulmotest - Model NV)* approximating the 3 1/2 litre mark on the kymograph. About half a litre of helium gas was put into the system and the helium analyser *(Godart Pulmo Analyser - Model NV)* allowed to settle. When stable, the first helium concentration reading and the temperature of the spirometer were recorded.

Nose clips were secured about the nose. The mouthpiece was placed into the subject's mouth ensuring a tight seal. The closed-circuit helium dilution technique began with the introduction of the subject into the system by the turn of the mouth piece stopcock at the end of a normal expiration. Carbon dioxide was removed from the system by a sodalime absorbent, and oxygen was fed into the circuit by the oxygen stabilizer at the rate oxygen was consumed. Equilibration of helium throughout the system and the lung occurred after a suitable time span of approximately 3-5 minutes. This

registered on the helium analyser and the second helium concentration reading was recorded. The later reading was lower than the initial concentration reading, in proportion to the functional residual capacity (FRC) of the lungs (64,65,66,72).

The subject then inhaled as deeply as possible, followed immediately by a maximal expiration. The procedure was then reversed; maximal expiration followed immediately by a maximal inspiration. The largest volume was measured as the vital capacity (VC) reading (71,72,80A,107). The subject was then removed from the apparatus.

Expiratory reserve volume (ERV) was measured from the vital capacity reading. Residual volume (RV) was calculated from the formula:

$$RV = FRC - ERV$$

Detailed instructions for the complete closed-circuit helium dilution technique and lung volume formulas are presented in Appendix I.

PROCEDURE:

Any remaining air bubbles were again removed from the hair. The subject, wearing secured nose clips, took a slow maximal inspiration through the mouth, ensuring the intake was audible (107). The breath was retained while the subject slowly leaned forward from the waist

until total submersion occurred. The position was held until the recording was taken, always within 5 seconds. The subject was signalled to resurface by a knock against the side of the tank. Two or three trials were taken to enable familiarization of the hydrostatic weighing procedure to occur. Three subsequent readings were then registered on the *Sargent Recorder* (73).

The format for calculations of body density and fat-free weight are found in Appendix J. Percent body fat was estimated according to the method of Brozek et.al., 1963 (13).

G. PROGRAM SCHEDULE:

PREPROGRAM:

The preprogram consisted of the seven consecutive days prior to the 10 week treatment. During this time the subjects kept *Food Behaviour*, *Dietary*, and *Activity* records. All of the anthropometric measurements and hydrostatic weighings were taken.

WEEK 1:

The women in the D and DE groups were placed on their appropriate energy restriction.

WEEK 2:

The E and DE groups began the fitness program.

POST PROGRAM:

Immediately following the end of the 10 weeks, the same procedure for anthropmetric analysis and hydrostatic

weighing was used on all of the subjects.

WEEKLY WEIGH-INS:

During the 10 weeks, all of the subjects were weighed-in once per week and the weights recorded. The post program weight was taken as the weight for week 10.

H. STATISTICAL ANALYSIS:

Due to the unequal pretest means of the groups, a 2 X 4, 1-way analysis of covariance (ANCV 10 - XDER computer program) was utilized for statistical assessment. The covariate was the mean pre-program measurements for each group. The variates or the dependent variables consisted of the post program mean measurements of dry body weight, eight subcutaneous skinfolds, six circumferences, fat-free weight, body density, and total percent body fat of the four groups. Post-hoc determination, where appropriate, incorporated the *Scheffe* (39,84) method for determining significance between the pre and post means. Significant results were accepted at the $p<0.05$ level, where p is the probability that no difference occurred between the covariate and variate means.

I. EXPERIMENTAL DESIGN:

The experimental design for the treatment effects on the dependent variables was a 2 X 4 design with a pooling of the variate means, which allowed for the unequal pretest group means among the four groups. A representation of the design is presented in Table 5.

TABLE 5
EXPERIMENTAL DESIGN

	PREPROGRAM ANALYSIS 18 COVARIATES	10 WEEK TREATMENT	POST ANALYSIS 18 VARIATES
GROUP-1 (Control)	X	no restrictions	X
GROUP-2 (Diet)	X	500 kcal energy intake restriction	X
GROUP-3 (Exercise)	X	fitness program 3 times/week	X
GROUP-4 (Diet and Exercise)	X	500 kcal energy intake restriction fitness program 3 times/week	X

IV. RESULTS AND DISCUSSION

Preprogram data were collected seven days prior to the 10 week treatment protocol. The characteristics of the forty-seven women are described in Table 6. Significant differences were found between the preprogram means for body weight at the $p<0.05$ level. No difference was found for age and height. However, the four groups were within the ranges of height and weight for healthy women in this age group (4,5,67,71,74,85,97,99,104,108).

A one-way analysis of covariance (ANCV) was performed on the variables to compensate for the unequal nature of the groups. Weltman and coworkers in 1980 used an ANCV to minimize the effects of unequal mean in the sample. The 58 sedentary male subjects enrolled in one of four groups: diet, a mild exercise program, a combined regimen of diet and exercise, and a control group. The subjects in the mild exercise only group had a lower initial mean body weight value than the rest of the groups (96).

The discussion and presentation of the results will be presented under the following headings: 1) Body weight, 2) Skinfold measurements, 3) Circumference measurements, 4) Fat-free weight, Body density, Percent body fat. A summary will follow each section.

TABLE 6
SUBJECT CHARACTERISTICS

		GROUPS			
		C	D	E	DE
HEIGHT inches	MEAN	65.2	64.1	63.9	64.9
	±sd	2.58	3.04	2.08	2.08
	RANGE	60.8-69.5	59.5-69.5	59.5-66.8	61.3-69.5
WEIGHT kg	MEAN	62.5	60.9	58.2	59.6
	±sd	5.66	4.71	6.79	6.87
	RANGE	49.8-70.8	54.6-70.0	48.6-69.9	47.0-69.9
AGE years	MEAN	21	25	21	20
	±	3.91	8.11	3.96	1.49
	RANGE	18-32	18-35	17-32	18-23

A. BODY WEIGHT:

Mean pre and post body weight values are presented in Table 7. The ANCV table and the Scheffe contrasts are found in Appendix K-1. The ANCV analysis revealed that the mean body weight in the D group and the DE group decreased significantly from the control group. The D group showed a reduction of mean body weight from 60.9 kg to 58.3 kg, a difference of 2.6 kg ($p<0.05$). The DE group decreased from 59.6 kg to 59.1 kg, a mean change of .5 kg. The C group showed an increase in mean body weight ($p>0.05$), 62.5 kg to 63.3 kg which is a gain of .8 kg. The E group increased from 58.2 kg to 58.7 kg ($p>0.05$), a difference of .5 kg. The D group and the DE group differed from the E group ($p<0.05$) and the D group was also significantly different from the DE

TABLE 7
EFFECT OF 10 WEEK PROGRAM ON BODY WEIGHT *
AND SKINFOLD * MEASUREMENTS

	GROUPS							
	C		D		E		DE	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
BODY WEIGHT kg	62.5	63.3	60.9	58.3	58.2	58.7	59.6	59.1
±	5.66	6.41	4.71	4.81	6.79	6.14	6.87	6.52
TRICEP mm	21.4	23.4	20.8	19.8	17.8	19.6	18.3	18.3
±	4.23	6.64	5.87	5.77	6.12	5.83	4.31	3.65
SUBSCAPULA mm	14.4	14.6	16.3	14.1	13.7	14.4	12.5	13.4
±	3.42	3.64	6.00	5.10	4.42	4.00	3.80	4.23
SUPRAILIAC mm	14.8	14.7	13.7	11.9	11.6	13.2	10.3	10.3
±	2.96	3.46	5.83	5.76	4.16	3.91	4.15	4.58
UMBILICAL mm	20.0	22.8	22.2	17.8	19.1	21.4	16.3	16.4
±	4.12	4.75	6.99	7.16	7.38	6.79	6.18	6.96
PUBIS mm	29.6	29.3	29.3	25.5	28.7	29.9	23.9	24.2
±	4.40	5.23	5.27	6.02	6.51	6.29	6.24	7.71
FRONT THIGH mm	40.8	41.2	40.7	37.8	38.9	37.5	38.0	33.5
±	6.88	5.21	7.37	3.64	5.42	6.02	5.98	8.21
REAR THIGH mm	31.1	31.7	28.7	28.7	25.7	29.3	27.9	24.5
±	6.55	6.00	7.03	6.20	4.73	4.74	5.58	4.89
CALF mm	39.8	41.0	37.4	37.8	35.9	38.2	36.3	34.0
±	5.73	5.70	6.83	4.52	7.32	6.75	5.85	8.08

* mean±sd

group. The D group lost more mean body weight than the other three groups ($p<0.05$) (See Figure 1).

The range of weight loss in the D group was from .7 kg

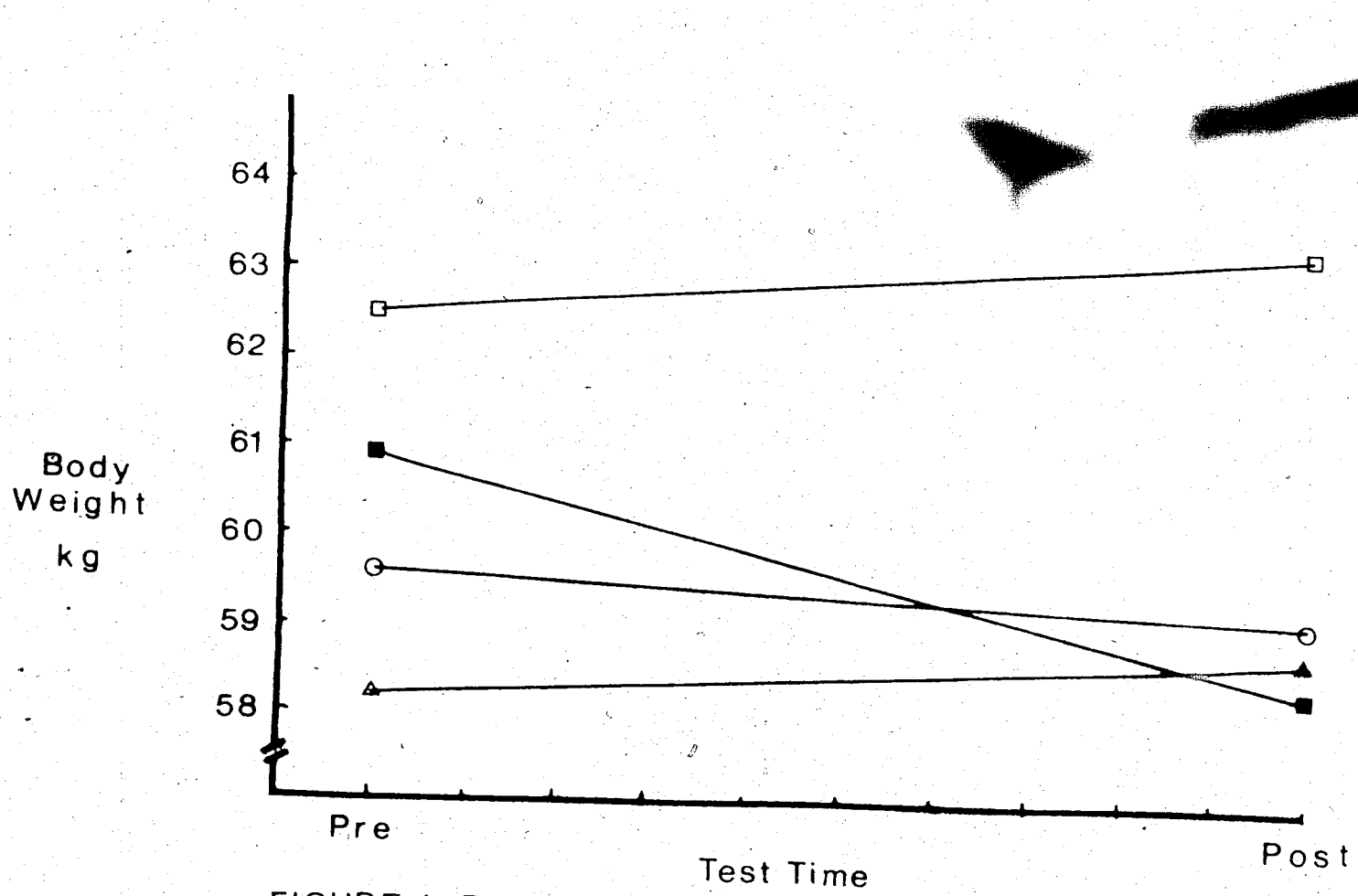


FIGURE 1: Effect of 10 Week Program on Body Weight

to 5.1 kg (Appendix N). The mean weight loss per week was approximately .26 kg (.57 pounds). Sloan and colleagues found a range of 3.5 pounds to 14.75 pounds mean weight loss for their group of 15 dieting overweight women. The mean weight loss was 8.5 pounds for the 12 week program, a mean reduction of 2/3 of a pound per week (87). The E group in this study gained .5 kg of mean body weight over the 10 week time period ($p>0.05$). Girandola (37) compared the effects of a 10 week program of high and low intensity exercise on college women. The results showed an increase in mean body weight for the high intensity group and a small decrease in mean body weight for the low intensity group ($p>0.05$). Wallace in 1975 also found a slight decrease in mean body weight of college women when they were given a four month cardiovascular training program (94). Generally, an exercise protocol of three sessions/week of approximately 45 minutes duration with a similiar intensity to jogging causes a mean loss of 0.5 kg per month body weight on an ad libitum diet (7). However, exercise periods of short duration (6 to 10 weeks) have shown that no change in mean body weight may occur because of alterations in body composition (61,71).

Zuti and Golding compared the effects of diet, exercise, and a combination of the two regimens on young women. The results indicated no difference between the three groups for mean body weight loss ($p>0.05$). Over the 16 week treatment period the diet group lost 11.7 pounds, the

exercise group lost 10.6 pounds and the combination group lost 12.0 pounds. All of the treatment groups reduced mean body weight with the combined regimen losing the most body weight ($p>0.05$) (108). Weltman et al reported significant differences in mean body weight that resulted from a 10 week treatment program on sedentary men. The difference in mean weight loss for the DE group and the D group were significantly greater than the E group. There was no difference between the mean body weight loss of the D group and the DE group. The C group did not change mean body weight (96).

SUMMARY:

The post mean body weights in the D group and the DE group were significantly different from the C group. The D group was different from the DE group ($p<0.05$). The E group and the C group gained slightly in post mean body weight values ($p>0.05$). Girandola also found a slight nonsignificant increase in the mean body weight of the high intensity exercise group. The C group gained slightly in mean body weight while the C group in the Weltman study showed no changes. The D group of this study showed the most weight loss ($p<0.05$) yet the DE group in the research done by Zuti showed the most reduction in mean body weight even though there was no difference among the three treatment groups. Weltman, however, found no difference in the mean weight reduction for the D and DE groups although they both

differed significantly from the E group.

B. SKINFOLD MEASUREMENTS:

The effects of the 10 week program on skinfold measurements are presented in Table 7. The ANCV analysis showed significant differences on tricep, subscapula, umbilical, pubis, front thigh and rear thigh skinfolds (See Appendices K-2, K-3, K-5, K-6, K-7, K-8 respectively.) Suprailiac (Appendix K-4) and calf (Appendix K-9) measurements were not significant. Comparative research on the effects of diet, exercise and the combination of the two regimens on individual skinfold measurements for college age women appears to be lacking.

TRICEP:

After the 10 week program, the mean tricep skinfold decreased from 20.8 mm to 19.8 mm in the D group, a reduction of 1.0 mm (Table 7). The skinfold thickness did not change in the DE group (18.3 mm). The C group increased mean skinfold thickness to 23.4 mm from 21.4 mm, a gain of 2.0 mm. The E group increased mean thickness 1.8 mm, a change from 17.8 mm to 19.6 mm (Figure 2). The Scheffe contrasts revealed (Appendix K-2) the D and the DE groups differed from the C group ($p<0.05$), and the D group was significantly different from the E group. The mean skinfold

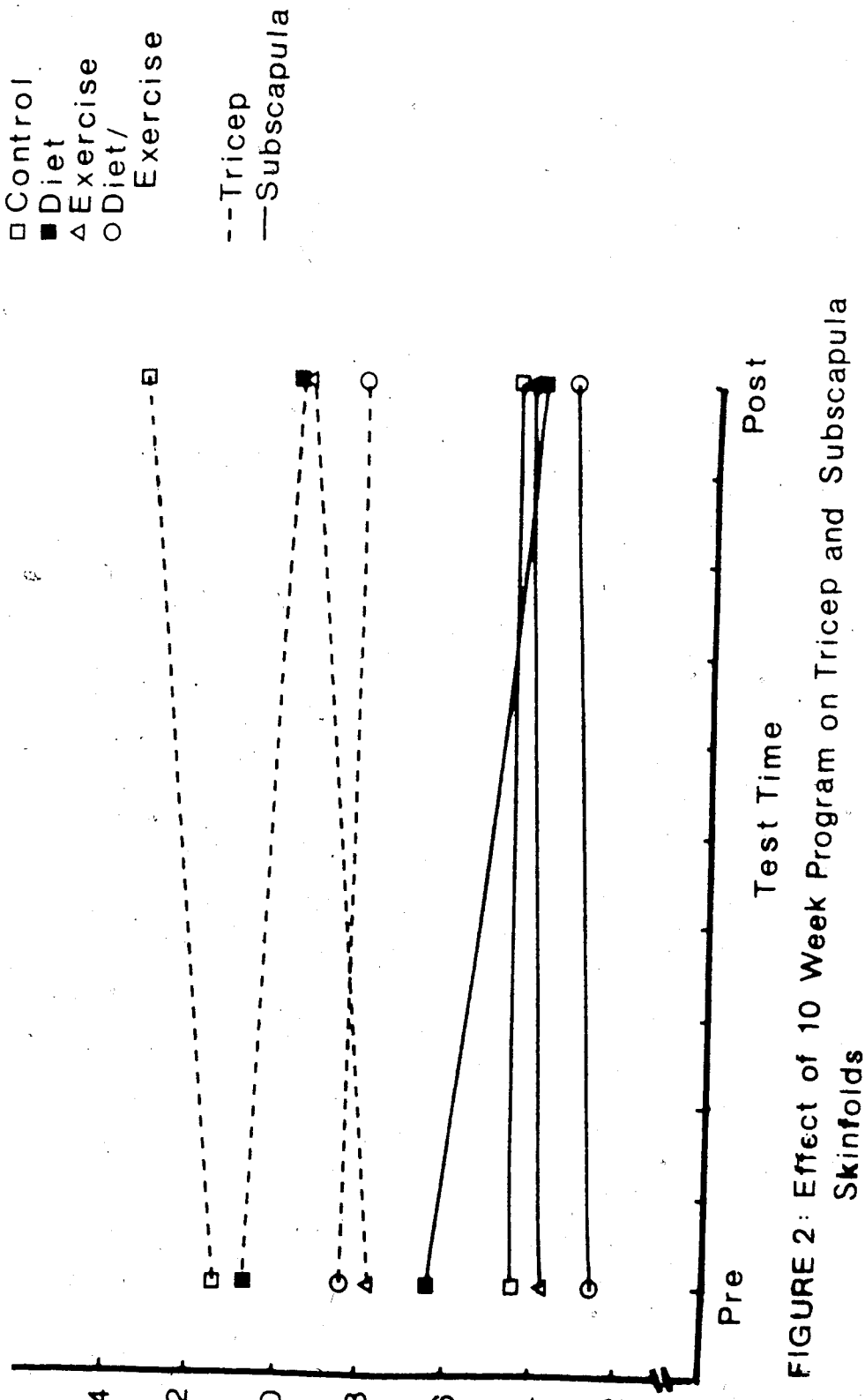


FIGURE 2: Effect of 10 Week Program on Tricep and Subscapula Skinfolds

thickness in the DE group did not change. The significant difference found between the DE and the C group was due to the control group's mean increase in tricep skinfold thickness. The D group was significantly different from the C group and the E group in tricep thickness. The D group was the only group that reduced the mean tricep skinfold.

The tricep skinfold measurement has been used occasionally in the literature as an indicator of obesity. The estimation parameter for the onset of obesity is a mean tricep thickness of 25.1 mm for young women (9,63,89). Most of the women who participated in this study were not labelled as obese when compared to this parameter but they were, with a few exceptions, slightly above the norms presented for this age group. Yuhasz found a mean tricep skinfold thickness range of 14.4 mm to 20.9 mm (107) for college age women; Sloan reported a mean of 16.08 mm (85). Ward (95) found a mean tricep skinfold thickness of 21.2 mm for thirty-six female subjects. Garrow (33) stated that the tricep skinfold measurement alone has its limitations because of the assumption that a constant relationship exists between the subcutaneous fat and inner body fat.

SUBSCAPULA:

The post measurements of the mean subscapula skinfold thickness showed an increase in the control group from 14.4 mm to 14.6 mm. An increase also occurred in the E group (13.7 mm to 14.4 mm) and the DE group (12.5 mm to 13.3 mm). The D group decreased from 16.3 mm to 14.1 mm, a reduction

of 2.2 mm (Table 7). A significant difference was found between the D group and the C group, the D group and the E group and the D group and the DE group. The D group lost 2.2 mm from the subscapula skinfold while the other three groups gained in thickness (Figure 2). The subscapula skinfold thickness range from 11.5 mm to 14.1 mm for college women (107). Ward (95) reported a mean of 14.1 mm on subscapula skinfold measurements for the female subjects. With the exception of the mean subscapula thickness found in the DE group, the D group, E group and the C group are at the upper border or above the norm for mean subcutaneous skinfold thickness for college women.

SUPRAILIAC:

The ANCV analysis revealed no significant differences between the four groups on pre and post means for the suprailiac skinfold ($p>0.05$) (Table 7 and Figure 4). A slight decrease was found in the mean skinfold values for the D group, from 13.7 mm to 11.9 mm, and the C group (14.8 mm to 14.7 mm). A small increase occurred in mean skinfolds in the E group, from 11.6 mm to 13.2 mm. The DE group did not change in pre and post mean suprailiac skinfold measurements (10.3 mm) (Appendix K-4). Data for college women ranged from 8.5 mm to 11.7 mm (107). The C group and D group were above 11.7 mm, the E group at the upper border line of this range, and the DE group at mid-range.

Noland and Kearney compared the effects of a specific

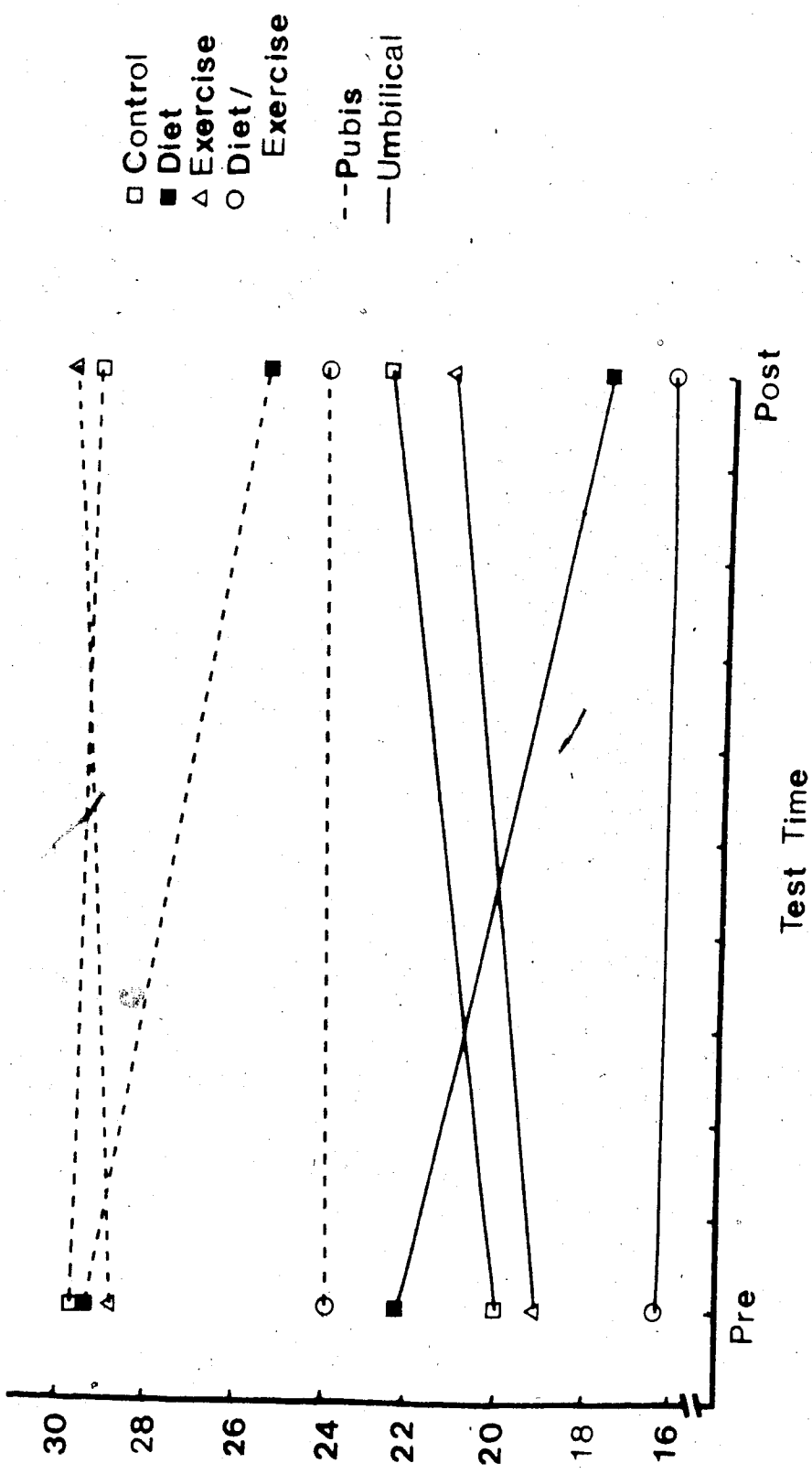


FIGURE 3: Effect of 10 Week Program on Pubis and Umbilical Skinfolds

and general exercise program on anthropometric responses of college women (74). The results showed significant alterations in the skinfold located at the iliac crest (suprailiac). A decrease occurred in both groups. The E group in this study had a slight gain in mean skinfold thickness.

UMBILICAL:

The control group gained 2.8 mm in mean umbilical skinfold thickness, from 20.0 mm to 22.8 mm, when pre and post data were analysed (Table 7). The D group lost 4.4 mm, from 22.2 mm to 17.8 mm. The E group gained 2.3 mm, an increase from 19.1 mm to 21.4 mm. The DE group slightly increased (16.3 mm to 16.4 mm) (Figure 3). The D group was found to be significantly different from the other three groups (Appendix K-5). Yuhasz reported a range of 12.8 mm to 16.2 mm for college women (107). All of the groups in this study are above the range for this age group.

Noland and Keaney found an increase of 1.6 mm in the skinfold two inches lateral of the umbilicus (umbilical) (74). The exercise group in this study also gained in mean umbilicus thickness.

PUBIS:

After the 10 week program, the results showed a change of 3.8 mm, from 29.3 mm to 25.5 mm in the D group for mean pubis skinfold thickness. The C group decreased slightly, 29.6 mm to 29.3 mm (Table 7). The E group and DE group gained in mean skinfold thickness, from 28.7 mm to 29.9 mm

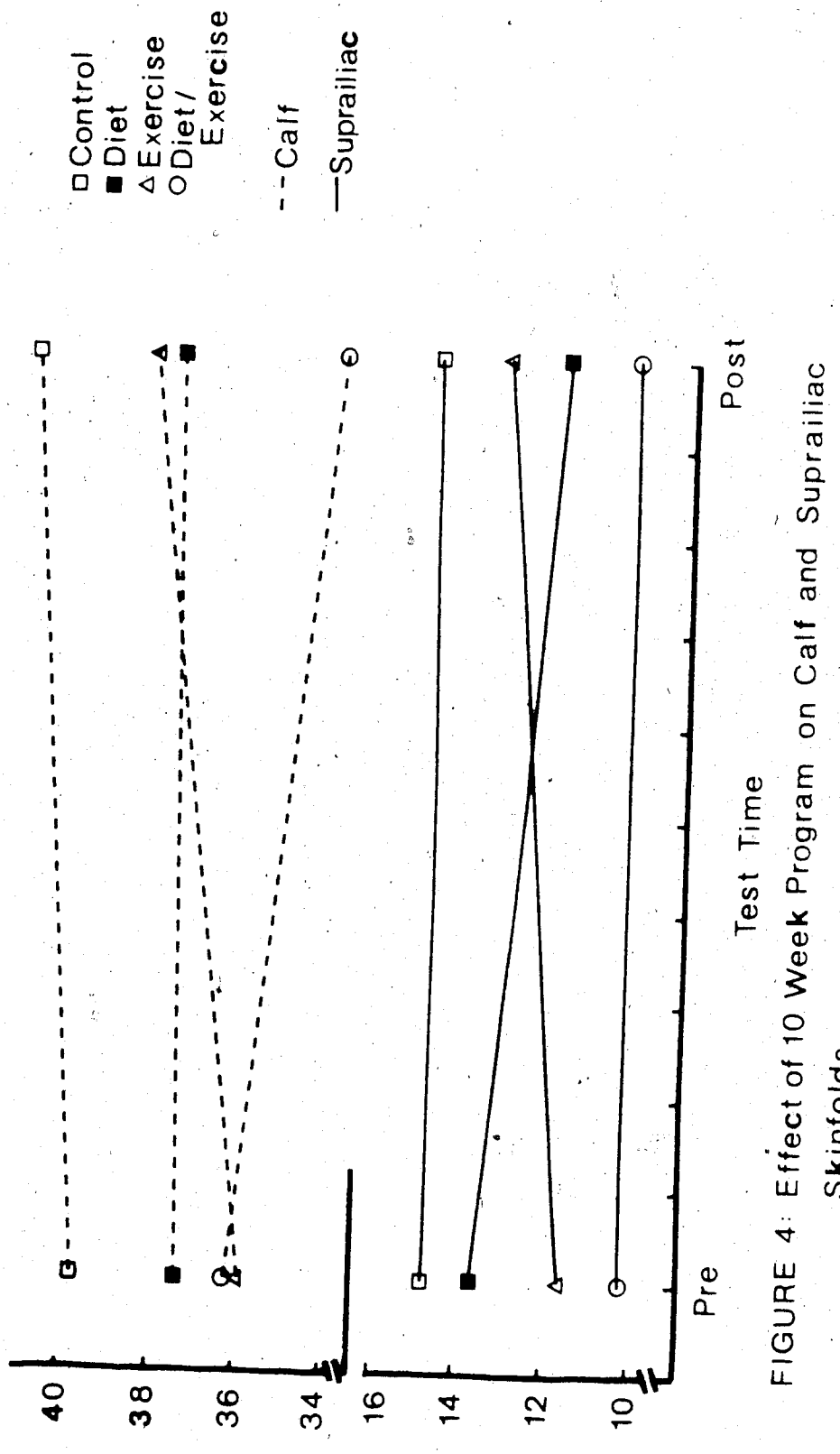


FIGURE 4: Effect of 10 Week Program on Calf and Suprailiac Skinfolds

(1.2 mm difference), and from 23.9 mm to 24.2 mm (.3 mm difference) respectively (Figure 3). Upon Scheffe post-hoc analysis, the D group differed significantly from the other three groups ($p<0.05$) (Appendix K-6). The norms reported for this skinfold are from 13.4 mm to 18.0 mm (107). All of the groups are above the norm for pubis skinfold. Jokl (48) stated that the abdominal skinfold may largely represent excess subcutaneous fat deposits more than the other skinfolds measured at other sites on the body.

FRONT THIGH:

The ANCV showed that the mean front thigh skinfold in the C group increased slightly, from 40.6 mm to 41.2 mm (Table 7). The D group decreased from 40.7 mm to 37.8 mm, a difference of 2.9 mm. The E group also reduced mean skinfold thickness, a change from 38.9 mm to 37.5 mm (1.4 mm loss). The DE group lost 4.5 mm, from 38.0 mm to 33.5 mm (Figure 5). The Scheffe contrasts showed significant differences between the C group and the DE group (Appendix K-7). The DE group lost the most front thigh skinfold thickness, although the D and E groups also reduced at this site. The range reported for this skinfold from a sample of college women, was from 22.9 mm to 26.1 mm (107). The women in the present study are well above this range.

REAR THIGH:

The C group increased from 31.1 mm to 31.7 mm in mean rear thigh skinfold thickness over the 10 week time period (See Table 7). The mean rear thigh measurements of the D

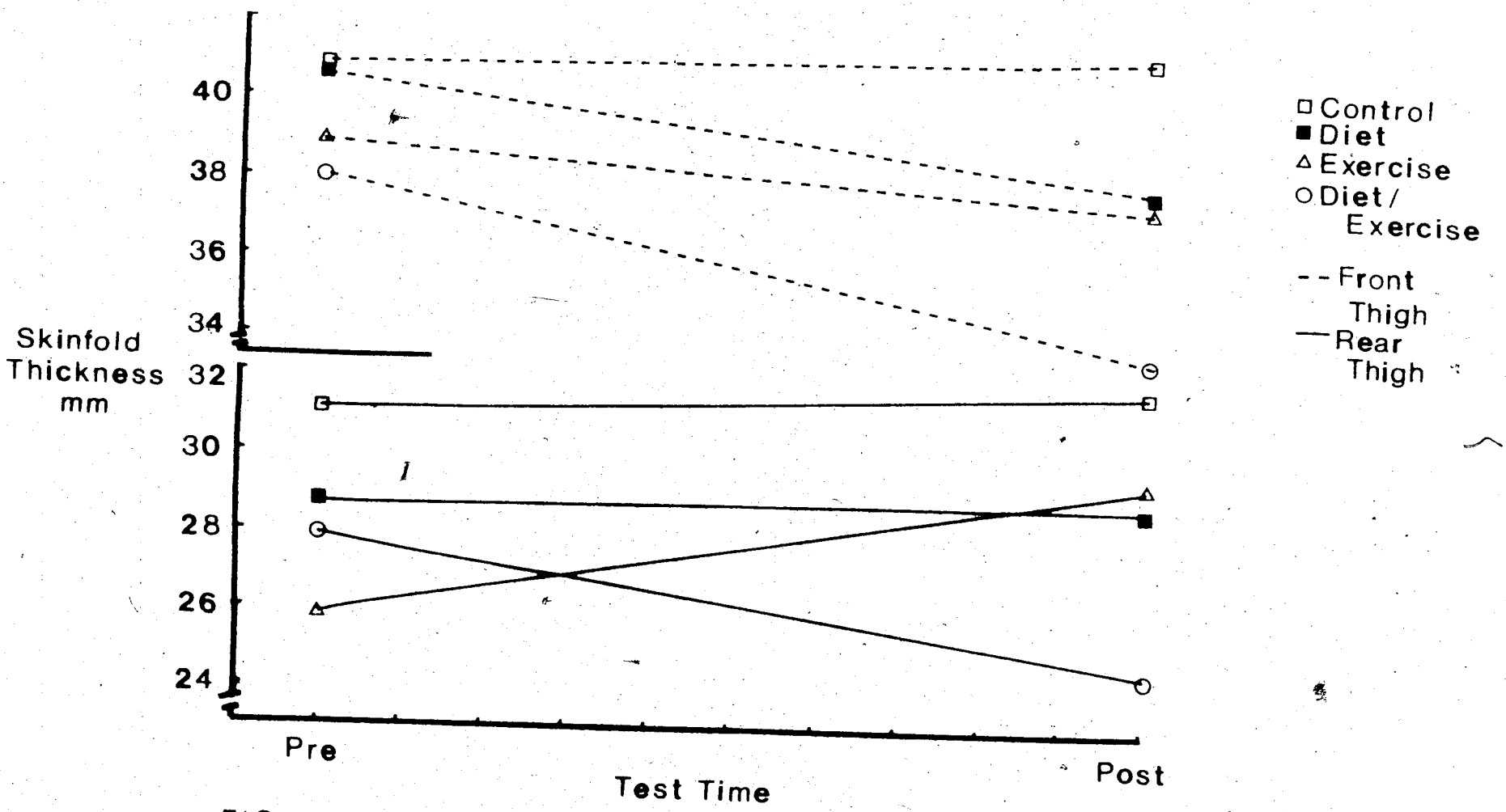


FIGURE 5: Effect of 10 Week Program on Front and Rear Thigh Skinfolds

group did not change (28.7 mm). The E group increased mean skinfold thickness from 25.7 mm to 29.3 mm, a gain of 3.6 mm. The DE group reduced 3.4 mm, from 27.9 mm to 24.5 mm (Figure 5). Differences were found between the C group and the DE group and between the DE group and the E group ($p<0.05$), when the post-hoc analysis was done (Appendix K-8). The DE group reduced the most in mean rear thigh skinfold thickness ($p<0.05$). The range for mean skinfold thickness found for this site is from 25.3 mm to 29.5 mm for college women (107). The only group above the range was the C group.

CALF:

The analysis of covariance failed to show significance in the mean calf skinfold thickness at the $p<0.05$ level. The C group, D group and E group showed increases in mean calf skinfold measurements (39.8 mm to 41.0 mm, 37.4 mm to 37.8 mm, and 35.9 mm to 38.2 mm respectively). The DE group reduced mean calf skinfold slightly, from 36.3 mm to 34.0 mm ($p>0.05$) (Table 7 and Figure 4). The ANCV table is found in Appendix K-9. Other data ranged from 18.3 mm to 21.1 mm for college women (107). The four groups in this study were above the range for mean calf skinfold thickness.

SUMMARY:

The women who volunteered for this project were compared to other women of college age with regard to mean skinfold thicknesses. The women in the present study are above the average on most of the mean skinfold measurements.

However, they are not obese according to their mean tricep skinfold measures. Results of the 10 week study showed that the control group increased slightly on most of the mean skinfold values ($p>0.05$). A small decrease was found in the mean suprailiac and pubis skinfolds. The diet group showed a significant decrease in the tricep, subscapula and umbilical skinfolds and a nonsignificant reduction in mean suprailiac, pubis and front thigh measurements. No change was found in the mean rear thigh pre and post values. The exercise group did not show significant differences on any of the mean skinfold sites. Slight increases were found in all of the mean skinfold measurements in the E group after the 10 week study, except for the front thigh skinfold which resulted in a decrease. Significance was found in the DE group on the pre and post values for front thigh and rear thigh skinfold thicknesses. A slight nonsignificant reduction was found in the post measurements for the calf skinfold. No change was reported for the tricep and suprailiac skinfold sites. Small increases were found in the mean post subscapula, umbilical and pubis skinfold measurements. The only decreases in mean skinfold thickness in the DE group was in the lower limb measurements, with the front thigh and rear thigh skinfolds significantly different from the other groups. The E group only showed a reduction in the front thigh skinfold ($p>0.05$). The D group showed a significant decrease in three of the five upper body measurements. Tricep, suprailiac, and umbilical mean post skinfolds were found to be significantly

different in the D group compared to the other three groups. The D group was the only treatment that showed a reduction in the upper body area. In addition, a slight decrease was found in the front thigh mean post skinfold site.

C. CIRCUMFERENCE MEASUREMENTS:

The pre and post mean circumference measurements for the four groups are presented in Table 8. The ANCV showed significant differences on the waist, hip, thigh and calf circumferences ($p<0.05$) (Appendices L-3, L-4, L-5, L-6 respectively). The upper arm and bust measurements were not significant ($p>0.05$). Research on the effects of diet, exercise, and the combination of the two regimens on individual circumference measurements is lacking for college age women.

UPPER ARM:

After the 10 week time period, there were no significant differences among the four groups on upper arm circumference (Table 8 and Figure 6). The four groups showed slight decreases in post mean upper arm circumference measurements. The C group showed a reduction of .1 cm, from 28.3 cm to 28.2 cm. The D group decreased from 28.2 cm to 26.5 [redacted] group from 28.6 cm to 27.5 cm and the DE grou[redacted] to 26.6 cm (Appendix L-1). Katch and Mc[redacted] d that the average value for young women (17-[redacted] years), [redacted] upper arm circumference measurement, was

TABLE 8
EFFECT OF 10 WEEK PROGRAM ON CIRCUMFERENCE * MEASUREMENTS

		GROUPS							
		C		D		E		DE	
		PRE	POST	PRE	POST	PRE	POST	PRE	POST
UPPER ARM cm		28.3	28.2	28.2	26.5	28.6	27.5	26.7	26.6
	±	1.51	1.88	2.81	1.39	3.56	2.06	2.18	2.25
BUST cm		90.3	89.7	91.6	89.1	89.2	88.2	89.2	87.8
	±	4.75	4.91	5.90	5.24	3.21	2.86	4.93	4.58
WAIST cm		74.5	77.8	74.5	73.2	71.6	72.4	70.5	72.0
	±	3.97	5.54	6.36	5.35	5.95	4.75	4.86	6.88
HIP cm		99.1	98.8	98.1	94.7	96.5	95.6	97.0	94.3
	±	2.61	3.64	5.21	4.73	5.26	4.47	3.97	4.00
THIGH cm		56.7	58.9	54.6	54.3	54.5	54.7	54.7	56.6
	±	2.31	4.00	4.01	3.33	2.46	3.26	3.77	3.50
CALF cm		36.2	36.2	35.8	34.8	35.3	35.1	35.0	34.5
	±	2.40	2.31	2.08	2.27	1.92	1.84	1.62	1.44

* mean±sd

25.2 cm with a range of 23.1 cm to 27.3 cm. Ward (95) found his thirty-six female subjects had a mean of 27.1 cm on biceps circumference. Young (104), in assessing the body composition of young women, found a mean biceps circumference of 27.25 cm (mean age of 20.36 years). With the exception of the DE group, the women are above the range on mean upper arm circumference measures.

BUST:

An ANCV indicated no difference on the pre and post

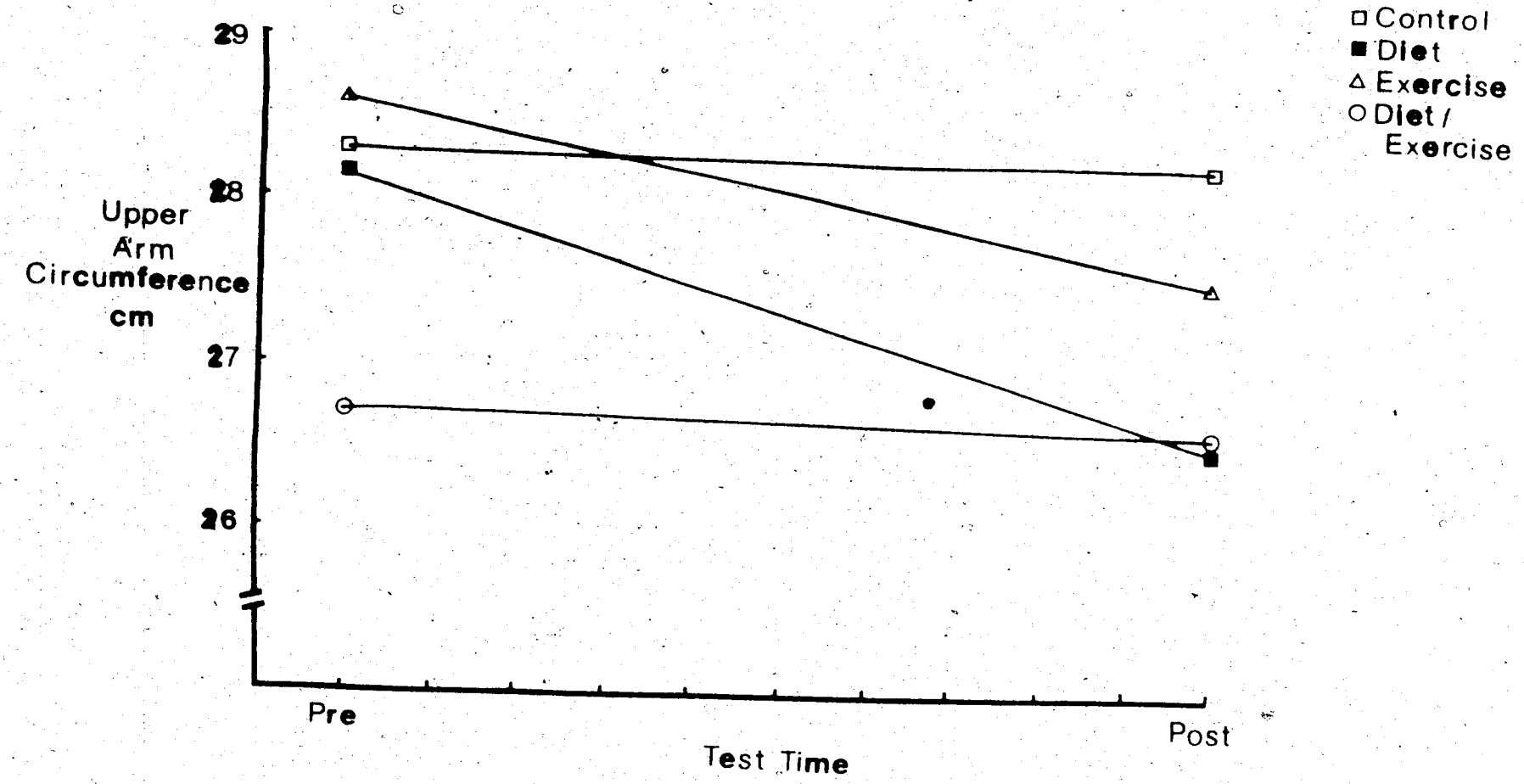


FIGURE 6: Effect of 10 Week Program on Upper Arm Circumference

means for bust measurements between the groups (Table 8 and Figure 7). The C group decreased from 90.3 cm to 89.7 cm, the D group reduced from 91.6 cm to 89.1 m, the E group dropped from 89.2 cm to 88.2 cm and the DE group decreased from 89.2 cm to 87.8 cm (Appendix L-2).

WAIST:

The waist circumference was significantly different (Table 8 and Figure 2). Scheffe contrasts showed a significant difference between the C and D groups. The control group gained 3.3 cm, from 74.5 cm pre mean waist measurement to 77.8 cm post measurement. The D group reduced 1.3 cm, from 74.5 cm to 73.2 cm. Both the E group and the DE group had nonsignificant increases in mean waist measures over the 10 week treatment, from 71.6 cm to 72.4 cm and from 70.5 cm to 72.0 cm respectively. The D group was the only group to reduce mean waist circumference measurement ($p<0.05$). The norms range from 60.6 cm to 76.76 cm for college women (95,85,104). The four groups were within the mean range for waist circumference for college women.

HIP:

After the 10 week program, the four groups showed a decrease in mean hip circumference (Table 8 and Figure 8). The C group reduced from 99.1 cm to 98.8 cm and the D group decreased from 98.1 cm to 94.7 cm. The E group showed a reduction of 96.5 cm to 95.6 cm and the DE group decreased from 97.0 cm to 94.3 cm. Upon post-hoc analysis (Appendix L-4), significant differences were found between

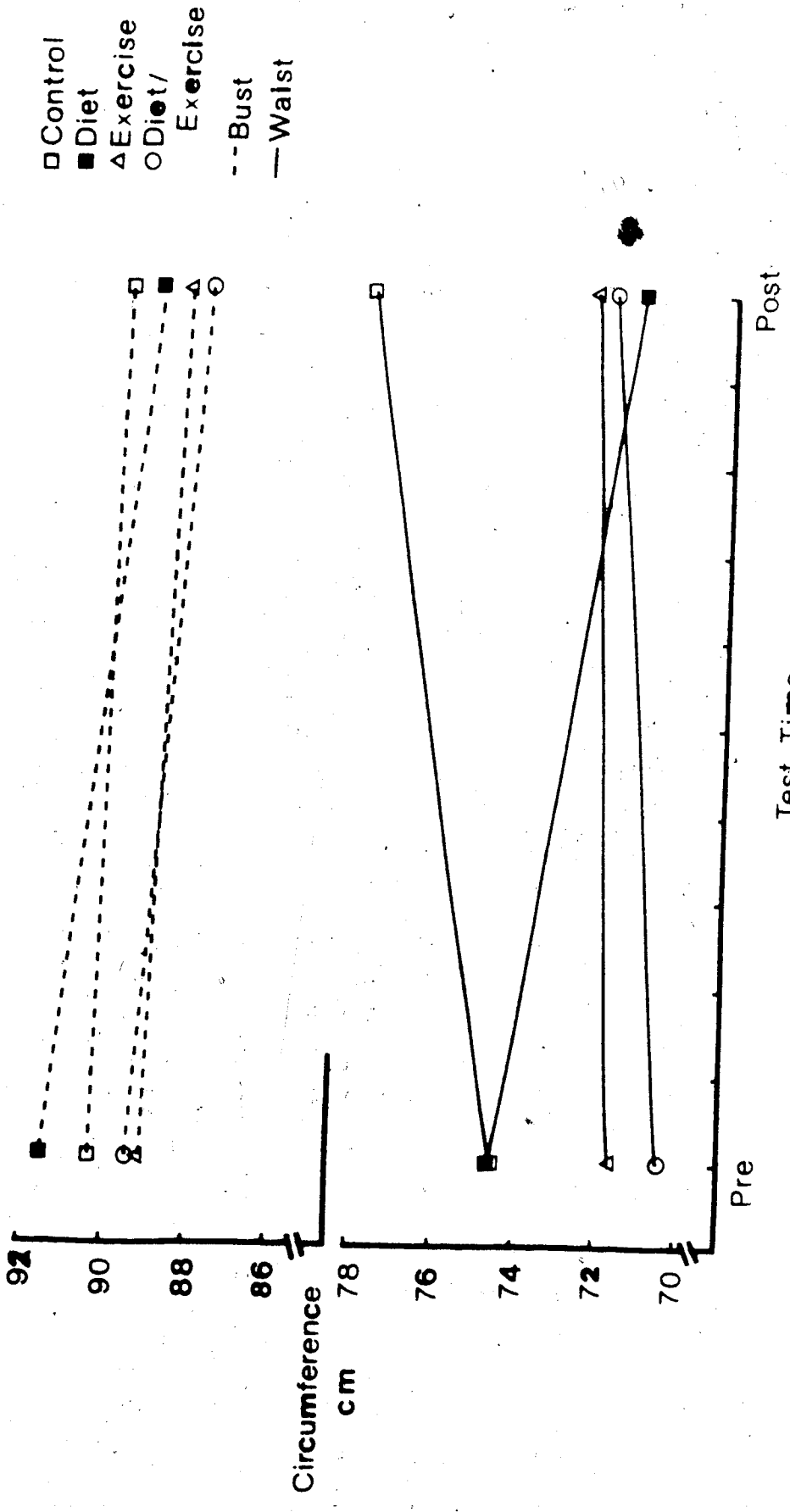


FIGURE 7: Effect of 10 Week Program on Bust and Waist Circumferences

the C and D groups and the C and DE groups. In addition, a difference was found between the D group and the E group ($p<0.05$). The D group decreased the most in hip circumference measurement although there was no difference between the D and DE groups on mean post values. Mean values on hip circumference for college age women were found to be 84.9 cm (95), 92.68 cm (85) and 97.36 cm (104). The C group and the D group in this experiment were above the mean values and the E group and the DE group were within the limits of other studies.

THIGH:

Significance was found after an ANCV was done on the pre and post values of the thigh circumference (Table 8 and Figure 9). The post-hoc analysis revealed that significant differences were found between the C group and the D group, and between the C group and the E group (Appendix L-5). The C group gained slightly in thigh measurement, increasing from 56.7 cm to 58.9 cm. The D group decreased in mean thigh circumference, from 54.6 cm to 54.3 cm. The E and DE group increased in post mean measurement, from 54.5 cm to 54.7 cm and from 54.7 cm to 56.6 cm respectively. Young found a mean thigh circumference for college women to be 57.59 cm (104). Sloan (85) reported a mean thigh circumference of 54.33 cm for his female subjects. Katch and McArdle found a mean value of 55.5 cm in thigh measures for women between 17 and 26 years. The women in this study had larger mean thigh circumference measurements than Sloan had reported,

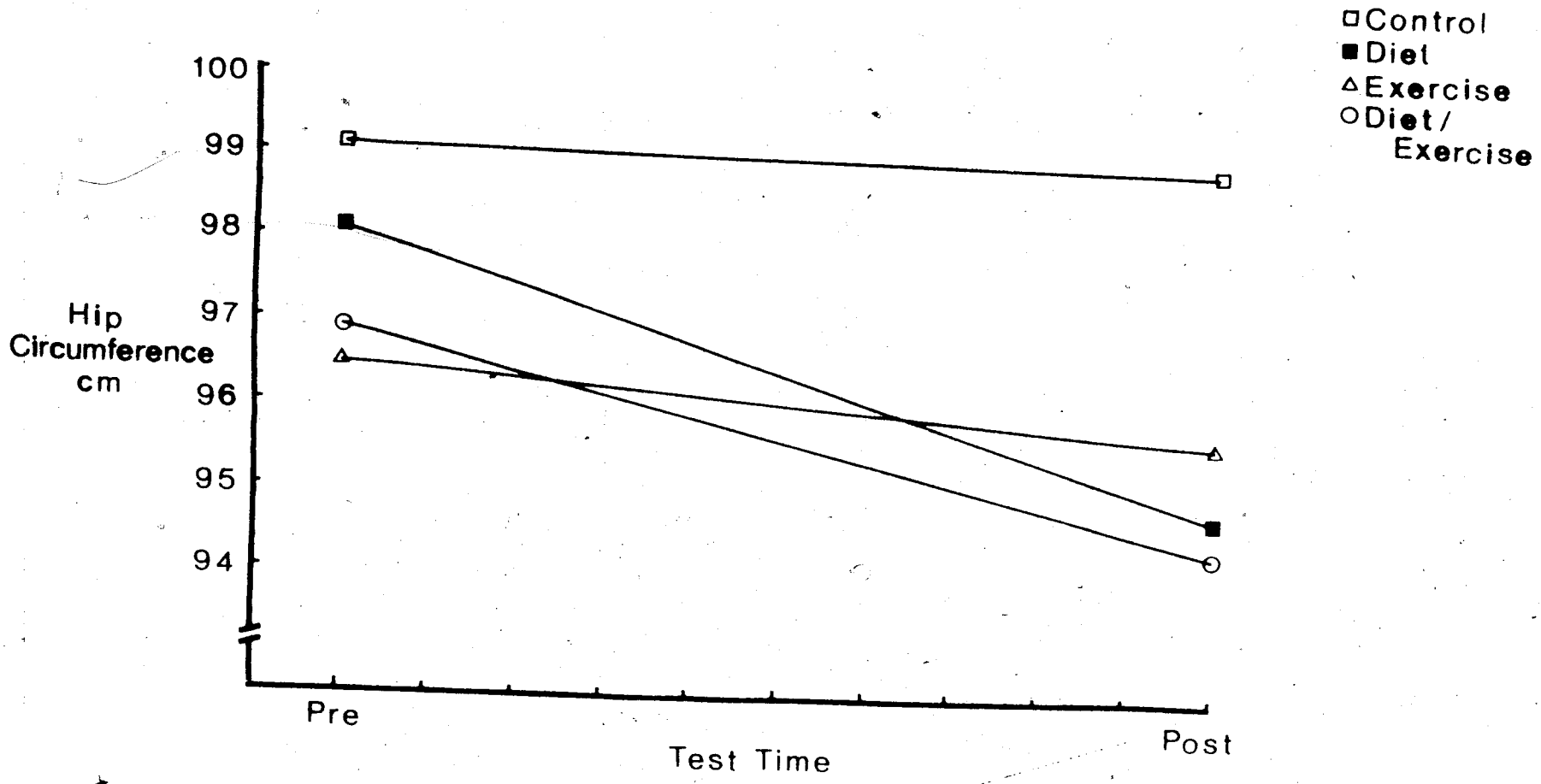


FIGURE 8: Effect of 10 Week Program on Hip Circumference

similar values to Katch and McArdle, and smaller mean thigh measurements than the women in the Young study.

CALF:

The pre and post mean calf circumference measurements are found in Table 8. The ANCV on this measure showed significance (Appendix L-6). The C group mean pre and post values did not change (36.2 cm). The D group, E group and DE group showed decreases in post mean measures. The D group changed from 35.8 cm to 34.8 cm, the E group reduced from 35.3 cm to 35.1 cm, and the DE group decreased from 35.0 cm to 34.5 cm (Figure 9). The Scheffe contrasts revealed a significant difference between the C group and the D group, and the D group and the E group. The mean calf measurements for college women were found to be 34.7 cm (53), 35.55 cm (104) and 36.6 cm (95). The values for mean calf circumference measurements for the D group, E group and DE group of this study were similar to the women in the Young report (104). The C group had mean measurements close to the values shown by Ward (95).

SUMMARY:

There was no difference found on the upper arm comparison and the bust comparison for the four groups ($p>0.05$). All four groups on both measures showed a slight mean post reduction in circumference measurement. The post mean waist value was significantly different between the C group and the D group; the C group showed an increase in mean value and the D group a decrease in mean value. The E

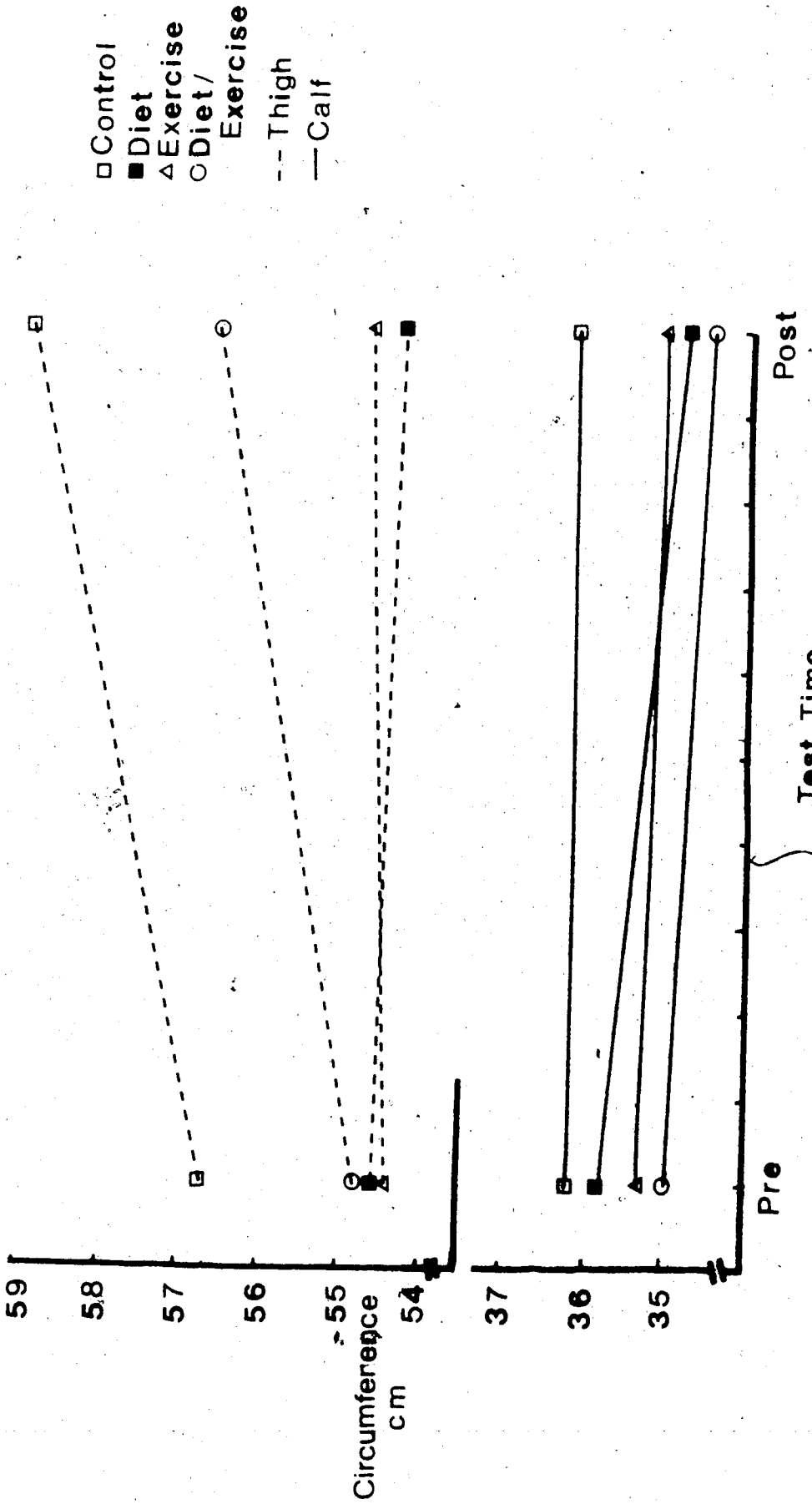


FIGURE 9: Effect of 10 Week Program on Thigh and Calf Circumferences

and DE groups increased in mean post measurements. All the groups reduced in mean hip circumference with significance found between the C group and the D group, the D group and the E group, and the C group and the DE group. The thigh mean post measures showed a decrease in D group circumferences, with a gain in the other three groups. Significance was found between the C group and the D group, and the C group and the E group. No change occurred in the pre and post mean calf circumference measures for the C group. The D group, E group and DE group decreased slightly. A difference was found between the C group and the D group, and the D group and E group. The C group showed an increase in mean waist and thigh measurements after the 10 week program, a reduction in mean upper arm and bust measures and remained the same on mean calf circumference. The D group decreased on all the mean circumference measurements with significance found on mean waist, hip, thigh, and calf measures. The E group showed a reduction in mean post upper arm, bust, hip and calf circumference. A mean gain occurred in waist and thigh measurements with a significant increase in thigh circumference. The DE group showed a reduction on mean upper arm, bust, hip, and calf measurements (the calf measure was found significant). A gain was noted in the mean waist and thigh circumference measurement for this group.

When mean circumference measures from the women in this study were compared to the normative data, most of the measurements were in the upper range or slightly above

normal.

D. FAT-FREE WEIGHT, BODY DENSITY, PERCENT BODY FAT:

The effect of the 10 week program on mean fat-free weight, body density and percent body fat measurements are found in Table 9. The ANCV performed on these variables resulted in significant differences on body density and percent body fat measurements (Appendices M-2 and M-3, respectively). Fat-free weight was found to be nonsignificant. (Appendix M-1).

FAT-FREE WEIGHT:

The ANCV showed no significant differences between the four groups on pre and post means for fat-free weight. However, slight increases were noted for all of the groups (Table 9). The C group gained from 46.1 Kg to 46.5 Kg and the D group increased from 43.8 Kg to 44.6 Kg. The E group increased post mean fat-free weight from 43.3 Kg to 44.9 Kg and the DE group from 45.0 Kg to 47.0 Kg (Figure 10 and Appendix M-1). Young (104) reported a mean fat-free weight of 42.2 Kg for young women. The subjects in this study have more mean fat-free weight than the women who participated in the Young study.

Zuti and Golding (108) found a decrease in lean tissue ($p>0.05$) over the 16 week treatment period in the diet only group, even though average protein intake was more than adequate. The exercise group and the combined diet and exercise group showed a slight gain in lean tissue. The

TABLE 9
EFFECT OF 10 WEEK PROGRAM ON FAT-FREE WEIGHT *,
BODY DENSITY *, AND PERCENT BODY FAT *

	GROUPS							
	C		D		E		DE	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
FAT-FREE WEIGHT kg	46.1	46.5	43.8	44.6	43.3	44.9	45.0	47.1
±	4.33	4.53	4.05	5.20	4.31	4.08	3.95	4.38
BODY DENSITY	1.038	1.038	1.033	1.044	1.039	1.043	1.043	1.052
±	0.005	0.005	0.009	0.011	0.009	0.009	0.008	0.009
PERCENT BODY FAT	26.3	26.0	28.2	23.7	25.9	23.9	24.0	20.2
±	2.30	1.94	3.91	4.75	3.89	3.87	3.30	3.52

* mean±sd

results of the present study showed no difference between the D group, E group, and the DE group; all gained mean fat-free weight.

Girandola (37) found a small increase in lean tissue in the low intensity group. The exercise group in this study also showed a slight gain. Malsbury (61) reported no significant difference between the low and high intensity exercise groups in fat-free weight measures.

Exercise may contribute to the preservation of lean body mass especially when the individual is on a restricted diet (55,69,78,79). The DE group in this study slightly gained fat-free weight; however, the D group did not lose.

BODY DENSITY:

After the 10 week program, the mean body density measurements were found to be significant (Table 9 and

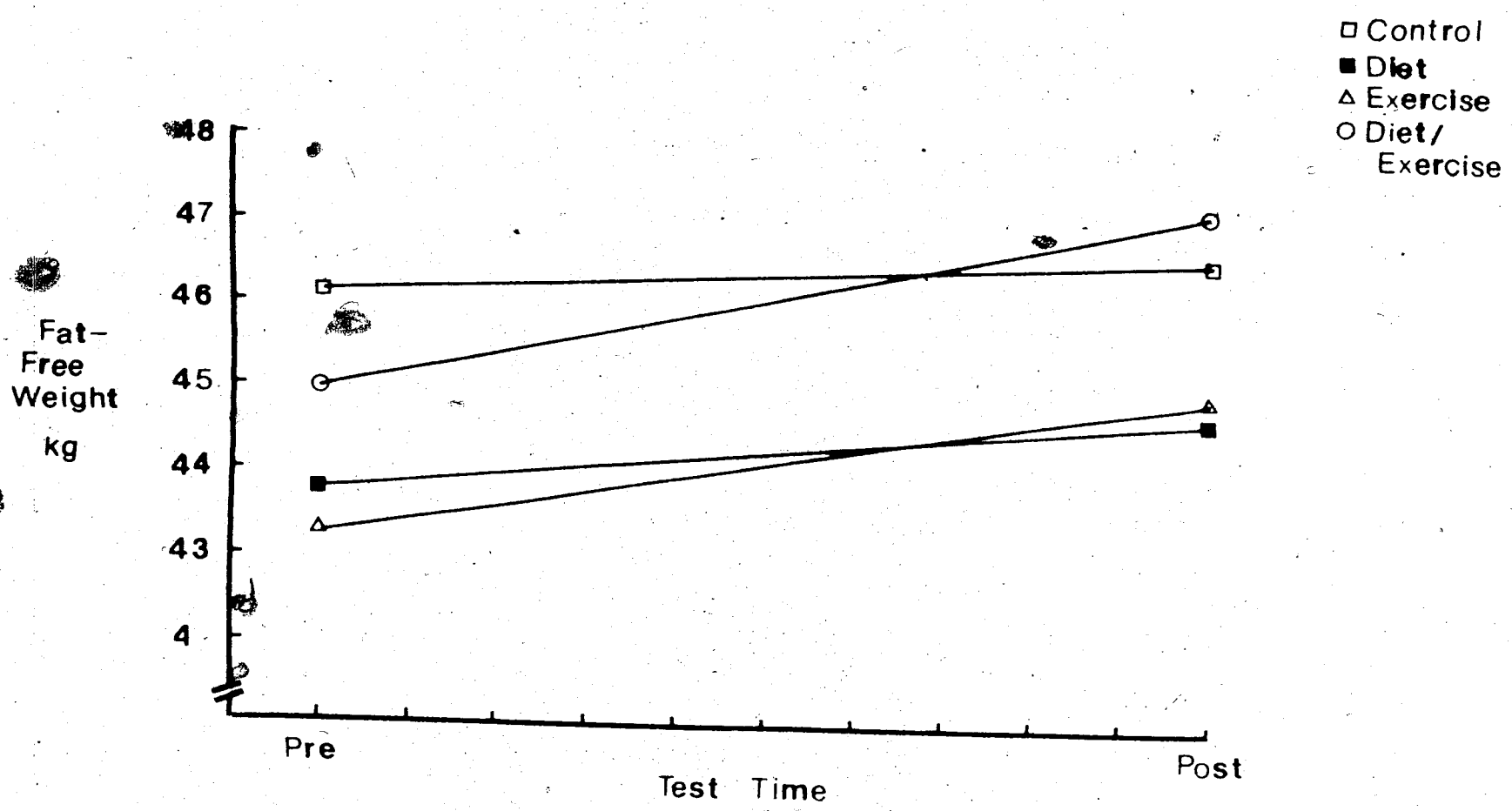


FIGURE 10: Effect of 10 Week Program on Fat-Free Weight

Figure 11). Upon analysis of the Scheffe contrasts, the differences were found between the C group and the D group and the C group and the DE group ($p<0.05$). Body density in the C group did not change over the 10 week time period (1.038). The D group increased in body density measurement, from 1.033 to 1.044. The E group and the DE group also gained, from 1.039 to 1.043 and from 1.043 to 1.052, respectively. There was no difference between the D group, E group, and the DE group; however, the D and DE groups gained more post mean body density.

Noland and Kearney reported a mean of 1.051 and 1.048 body density for the local and general exercise groups (74) Young found a mean of 1.034 in body density measurement of young women (mean age of 20.36 years) (104). Sloan (85) reported a mean body density of 1.047 for 50 young female students. The women in this study had lower mean body density measurements than the women in the Noland and Kearney report and the Sloan study, but were similar to the Young subjects.

Zuti and Golding (108) found that body density significantly increased in the D group, E group, and DE group over the 16 week time period. The women in this experiment also showed an increase in mean body density measurement, however, a significant difference was found between the C and D groups and the C and DE groups.

PERCENT BODY FAT:

The ANCV performed on the pre and post measurements

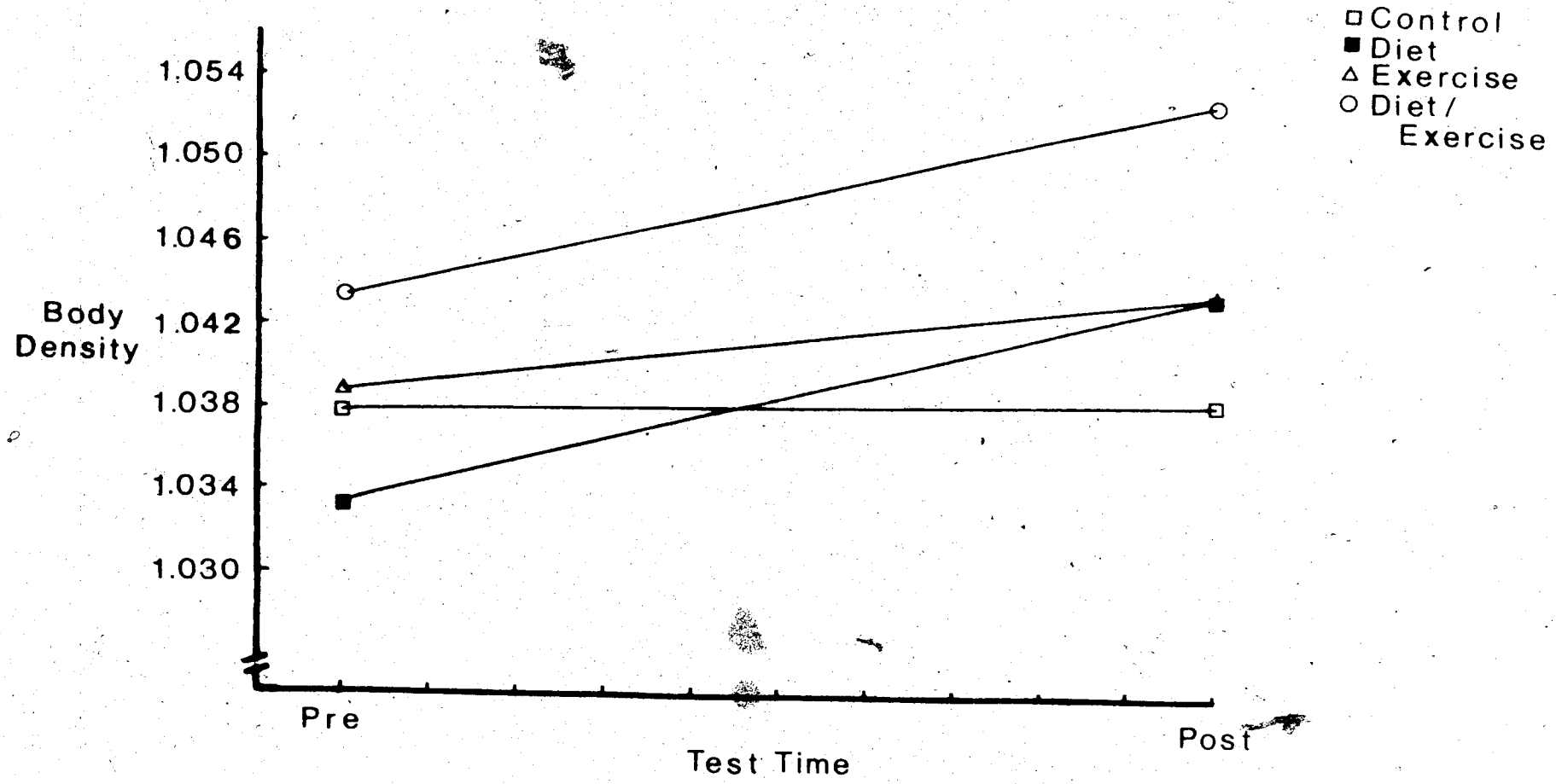


FIGURE 11: Effect of 10 Week Program on Body Density

indicated a significance in percent body fat. Post-hoc analysis showed significance between the C and D groups, and the C group and DE group (Appendix M-3). The pre mean percent body fat measure was 26.3% for the C group, which decreased to 26.0%. The D group lost 4.5% mean body fat, from 28.2% to 23.7%. The E group decreased from 25.9% to 23.9%, a loss of 2.0%. The DE group reduced from 24.0% to 20.2%, a reduction of 3.8%.

Percent body fat values for the women in the four groups in this study ranged from 20.0% to 34.6%, which fell into the range of other reports on sedentary women (55,61,99,104). Some authors have considered a percent body fat of over 30% as an indication of obesity (22,48,53,61,97). Other reports have stated 35% as borderline of obesity (63,104). Eight of the women in this study were over 30% body fat but all were under 35% (Appendix N).

Noland and Kearney reported that there was no significant difference between the local and general exercise groups on pre and post measures of percent body fat (74). The pre mean for percent body fat was 20.58% and 20.40% for the local and general exercise groups respectively. Weltman et al (96) found a significant decrease in percent body fat after the 10 week treatment in the D group, E group, and DE group. The DE group in the Weltman report showed a significantly greater reduction in percent body fat than any other group (3.60%). The D group

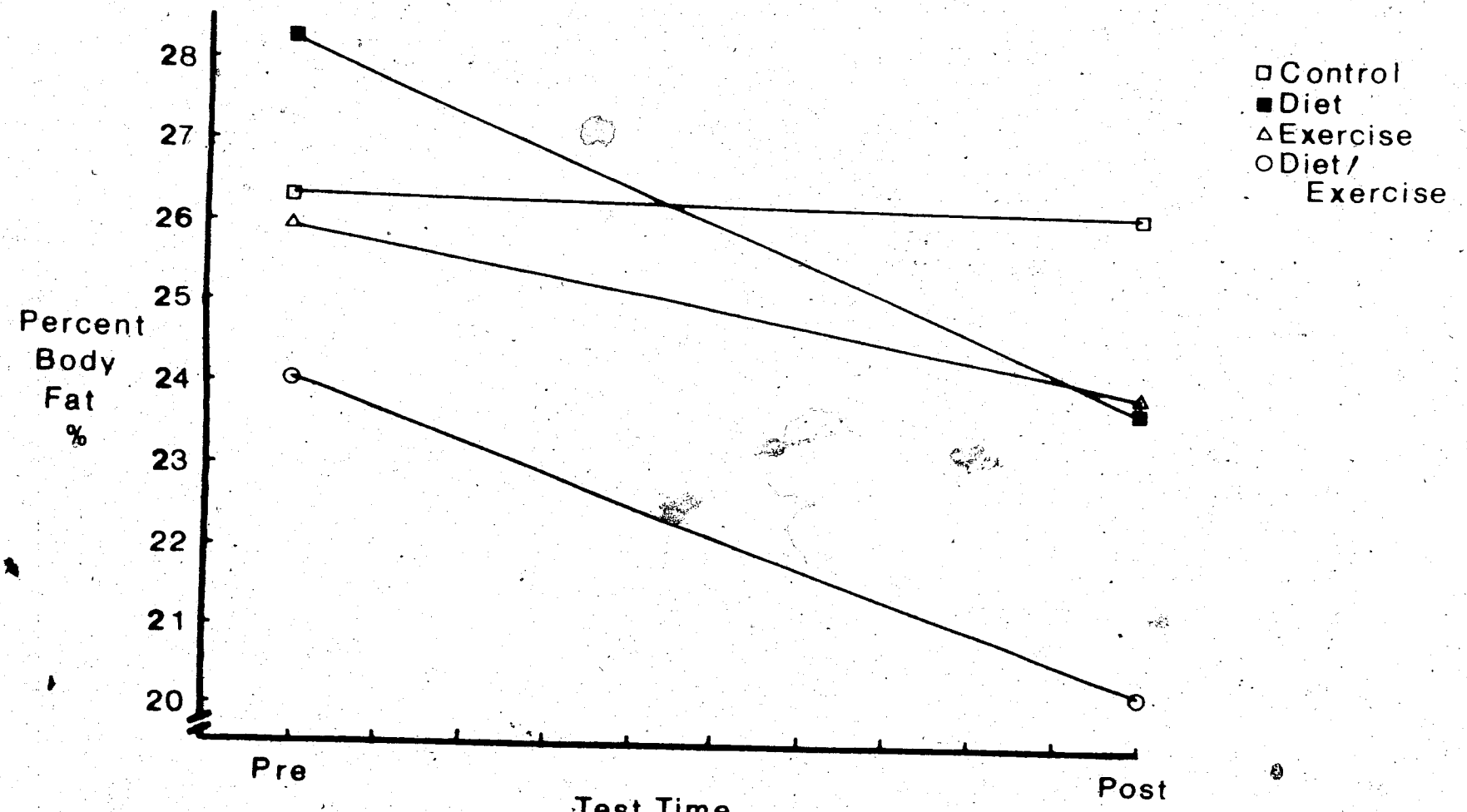


FIGURE 12: Effect of 10 Week Program on Percent Body Fat

had a greater significant reduction in percent body fat than the E group. In this study, the D group reduced the most percent body fat (4.5%), followed by the DE group with a loss of 3.8%, and the E group with a decrease of 2.0%. The D and DE groups were not significantly different from each other.

Malsbury (61) found no difference between the high and low intensity exercise groups in percent body fat. Girandola, (37) found a significant decrease in the low intensity group of 1.1% body fat. The exercise group in this experiment lost 2.0% ($p>0.05$).

SUMMARY:

After the 10 week time period, the four groups slightly gained in fat-free weight. The D group did not lose fat-free tissue as Zuti and Golding (108) reported in their 16 week study. Had the duration of this program been of the same length, perhaps a decrease in fat-free weight would have been seen in the D group. The E group and the DE group preserved fat-free tissue which is in agreement with the literature (55,69,78,79,108).

Significant increases in body density were concomitant with losses in percent body fat. The D group showed a greater but not significant decrease in percent body fat when compared to the E and DE groups. The diet group had a higher mean age than the other three groups. Because this group was older they may have been more responsible in adhering to a diet program which in turn may account for the

greater decrease in percent body fat. Other research reported that a combined regimen of diet and exercise was the most effective way of controlling adiposity. The D group and the DE group were not significantly different in body density and percent body fat measures. The literature also claimed that a dietary restriction will produce losses of lean body tissue. The D group in this study however did not lose fat-free weight and even showed a slight gain in tissue. Perhaps, if the duration of the restriction was longer, there may have been a reduction in fat-free weight shown.

In retrospect, the diet group decreased skinfold thickness in all but the rear thigh and calf skinfold measurements. The post mean circumference measures all decreased when compared to pre mean values. Fat-free weight increased slightly and body weight decreased significantly. Body density increased with a concomitant reduction of mean percent body fat measurements ($p<0.05$). The change in body weight was a result of body composition changes.

The E group gained mean body weight and increased in all mean skinfold measurements except for the front thigh skinfold. A reduction of mean circumference measurement was found in upper arm, bust, hip, and calf. An increase was recorded in mean post waist and thigh circumferences. Fat-free weight increased slightly and body density also increased. A reduction in percent body fat was reported even though most of the skinfolds taken resulted in an increase

in measurement. It may be that body weight increased because of the slight increase in fat-free weight. The reduction in mean percent body fat may be due to a change in internal body fat which cannot be accurately assessed by skinfold measurements alone.

The DE group showed a small decrease in body weight. Mean skinfold measurements did not show much difference between pre and post measures except for the front thigh and rear thigh, which decreased significantly. Circumference values showed a decrease in bust, hip, and calf. Increases occurred in waist and thigh circumference measures. The increases in circumferences occurred in the same sites as the E group. Fat-free weight increased slightly. The DE group showed significant changes in body density and percent body fat which were also found in the D group, although no difference was reported between the D and DE groups. The decrease in body weight could be attributed to the reduction in body fat. However, the changes in body composition may have been due to internal body fat reductions which cannot be recorded by skinfold assessment.

The C group showed increases in mean measurements or did not change on most of the variables. The D group was significantly different from the C group in mean body weight measurements, tricep, subscapula, umbilical, and pubis skinfold measures. The D group also differed from the C group ($p<0.05$) in waist, hip, thigh, and calf circumferences. Significance was also found between the C

and D groups on body density and percent body fat measurements.

The only significant difference found between the C group and the E group was in thigh circumference measures. The DE group was different from the C group on body weight, tricep, front thigh, and rear thigh skinfolds. Significance was noted between the C and DE groups on hip circumference only.

The D group and DE group differed only on subscapula, umbilical, and pubis skinfold measures. No differences were found between the D and DE groups on circumference measurements. Nonsignificance was also shown between these groups on fat-free weight, body density, and percent body fat. The E group differed from the DE group only on mean rear skinfold.

V. SUMMARY AND CONCLUSIONS

The purpose of this study was to examine the effects of a low-energy diet, an exercise program and a combined program of the same diet and exercise on changes in body composition of women and to compare the effects of the three treatments to a control group with no restrictions.

Forty-seven sedentary women were randomly assigned to one of four groups: a control group with no restrictions, a low-energy diet group, an exercise program three times per week, or a combined program of the same diet and exercise protocol. The duration of the study was 10 weeks.

The changes in body composition were assessed by skinfold measurements: subscapula, suprailiac, umbilical, pubis, front thigh, rear thigh, and calf. Circumference measures from upper arm, bust, waist, hip, thigh, and calf were also taken. Fat-free weight, body density, and percent body fat were estimated from hydrostatic weighing. The average weekly weight of each group was also recorded for the 10 weeks. A one-way analysis of covariance (ANCV) was used to determine changes in pre and post mean variables.

A. CONCLUSIONS:

Within the limitations of this study the following conclusions were made:

1) Body weight alone does not reflect changes in body

composition.

2) Skinfold measurement alone is not an accurate assessment of changes in body fat.

3) Percent body fat may be decreased by the regimen followed by the diet and the diet and exercise groups.

4) In general, it appears that skinfold measurements are best decreased by the program followed by the diet group.

5) Generally, it seems that circumference measures are best reduced following the program of the diet group.

6) Fat-free weight does not decrease regardless of diet, exercise, or diet in combination with exercise.

B. RECOMMENDATIONS:

1) More research is needed to assess the effects of a combined program of diet and exercise on the body composition of women.

2) Fitness levels should be determined before an exercise program of this type be utilized.

3) Daily energy expenditure should be assessed in combination with daily energy intake levels during preprogram and experimental conditions.

4) A research design utilizing a blocking variable to equate the groups may be advantageous.

REFERENCES

1) Bakker, H. and Struikenkamp, R. "Biological Variability and Lean Body Mass Estimates," *Hum. Biol.*, 49(2):187-202, 1977.

2) Barney, V., Hirst, C. and Jensen, C. *Conditioning Exercises: Exercises to Improve Body Form and Function*. St. Louis, The C.V. Mosby Co., 1969.

3) Behnke, A. "Comment on the Determination of Whole Body Density and a Resume of Body Composition Data," In *Techniques for Measuring Body Composition*. Ed. by J. Brozek and A. Henschel. Washington, D.C.: National Academy of Sciences - National Research Council, p. 118, 1961.

4) Behnke, A. "New Concepts of Height - Weight Relationships," In *Obesity*. Ed. by N.L. Wilson. Philadephia: F.A. Davis Co., p. 26, 1969.

5) Behnke, A. and Wilmore, J. *Evaluation and Regulation of Body Build and Composition*. Englewood Cliffs, New Jersey, Prentice - Hall, Inc., 1974.

6) Bjorntorp, P. "The Fat Cell: A Clinical View," In Recent Advances in Obesity Research: II. Ed. by G. Bray. London: Newman Publishing Ltd., p. 153, 1978.

7) Bjorntorp, P., Sjostrom, L. and Sullivan, L. "The Role of Physical Exercise in the Management of Obesity," In *The Treatment of Obesity*. Ed. by J. Munroe. Lancaster, England: M.T.P. Press Ltd., p. 123, 1979.

8) Bray, G. *The Obese Patient*. W.B. Saunders Co., 1979.

9) Bray, G. "Obesity," *DM* 26(1):1-85, 1979.

10) Brock, J. and Hansen, J. "Body Composition and Appraisal of Nutriture," In *Human Body*

Composition. Ed. by J. Brozek Oxford: Pergamon Press Ltd., p. 245, 1965.

11) Brozek, J. "Body Measurements, Including Skinfold Thickness As Indicators of Body Composition," In *Techniques for Measuring Body Composition.* Ed. by J. Brozek and A. Henschel. Washington, D.C.: National Academy of Sciences - National Research Council, p. 3, 1961a.

12) Brozek, J. "Methods for the Study of Body Composition," In *Techniques for Measuring Body Composition.* Ed. by J. Brozek and A. Henschel. Washington, D.C.: National Academy of Sciences - National Research Council, p. 278, 1961b.

13) Brozek, J., Grande, F., Anderson, J. and Keys, A. "Densitometric Analysis of Body Composition: Revisions of Some Quantitative Assumptions," *Ann. N.Y. Acad. Sci.* 110:113-140, 1963.

14) Buskirk, E. "Underwater Weighing and Body Density: A Review of Procedures," In *Techniques for Measuring Body Composition.* Ed. by J. Brozek and A. Henschel. Washington, D.C.: National Academy of Sciences, National Research Council, p.96, 1961.

15) Buskirk, E., Thompson, R., Lutwak, G. and Whedon, G. "Energy Balance of Obese Patients During Weight Reduction: Influence of Diet Restriction and Exercise," *Ann. N.Y. Acad. Sci.* 110:918-940, 1963.

16) Buskirk, E. "Increasing Energy Expenditure: The Role of E In *Obesity.* Ed. by N.L. Wilson. Philadelphia: F.A Davis Co., p. 163, 1969.

17) Canadian Diabetic Association. *Exchange Lists For Meal Planning For Diabetics in Canada.* Toronto, The Canadian Diabetic Association, 1978.

18) Carrol, C., Miller, D. and Nash, J. *The Science of Human Adaptation.* Iowa, Wm. C. Brown Co., 1976.

19) Caso, E. "Calculation of Diabetic Diets," *J. Amer. Dietet. Assoc.* 26:575-583, 1950.

20) Cooper, K.H. *Aerobics.* New York, M. Evans and Co. Inc., 1968.

21) Cooper, K.H. *The New Aerobics.* New York, M. Evans and Co. Inc., 1970.

22) Craddock, D. *Obesity and Its Management.* Edinburgh, London, and New York, Churchill Livingstone, 1978.

23) Craig, L.S. "Anthropometric Determinants of Obesity," In *Obesity.* Ed. by N.L. Wilson. Philadelphia: F.A. Davis Co., p. 13, 1969.

24) Department of Dietetic Service. *Diet Manual.* Gainsville, J.Hillis Miller Health Centre, University of Florida, 1971.

25) DiGennaro, J. *Individualized Exercise and Optimal Physical Fitness: A Review Workbook for Men and Women.* Philadelphia, Lea & Febiger, 1974.

26) Dohm, G., Beecher, G., Stephenson, T. and Womach, M. "Adaptation to Endurance Training at Three Intensities of Exercise," *J. Appl. Physiol.* 42(5):753-757, 1977.

27) Durnin, J. and Taylor, A. "Replicability of Measurements of Density of the Human Body as Determined by Underwater Weighing," *J. Appl. Physiol.* 15(1):142-144, 1960.

28) Durnin, J. "Possible Interaction Between Physical Activity, Body Composition and Obesity in Man," In *Recent Advances in Obesity Research: II.* Ed. by G. Bray. London: Newman Publishing Ltd., p. 237, 1978.

29) Enteman, C. Goldwater, W., Ayres, N. and Behnke, A. "Analysis of Adipose Tissue in Relation to Body Weight Loss in Man," *J. Appl. Physiol.*

13:129-134, 1958.

30) Ferguson, J.M. *Learning to Eat. Behaviour Modification for Weight Control.* Bull Publishing Co., 1975.

31) Flatt, J. "The Biochemistry of Energy Expenditure," In *Recent Advances in Obesity Research: II.* Ed. by G. Bray. London: Newman Publishing Ltd., p. 223, 1978.

32) Flint, M., Drinkwater, B., Wells, C. and Horvath, S. "Validity of Estimating Body Fat of Females: Effect of Age and Fitness," *Hum. Biol.* 49(4):559-572, 1977.

33) Garrow, J.S. *Energy Balance and Obesity in Man.* Amsterdam, Elsevier/North-Holland Biomedical Press, 1978a.

34) Garrow, J.S. "The Regulation of Energy Expenditure in Man," In *Recent Advances in Obesity Research: II.* Ed. by G. Bray. London: Newman Publishing Ltd., p. 200, 1978b.

35) Gerrard, O.M. Western Nutrition Consultant. The Canadian Diabetic Association, Edmonton, Alberta. *Interview.* 10, January, 1980.

36) Gilson, J. and Hugh-Jones, P. "The Measurement of the Total Lung Volume and Breathing Capacity," *Clin. Sci.* 7:185-216, 1949.

37) Girandola, R. "Body Composition Changes in Women: Effects High and Low Exercise Intensity," *Arch. Phys. Med. Rehabil.* 57:297-200, 1976.

38) Girandola, R., Wiswell, R., Mohler, J., Romero, G. and Barnes, W. "Effects of Water Immersion on Lung Volumes: Implications for Body Composition Analysis," *J. Appl. Physiol.* 43(3):276-279, 1977.

39) Glass, G. and Stanley, J. *Statistical Methods in Education and Psychology.* New Jersey,

Prentice-Hall, Inc., 1970.

40) Goldman, R. and Buskirk, E. "Body Volume Measurement by Underwater Weighing: Description of a Method," In *Techniques for Measuring Body Composition.* Ed. by J. Brozek and A. Henschel. Washington, D.C.: National Academy of Science - National Research Council , p.78, 1961.

41) Grande, F. " Nutrition and Energy Balace in Body Composition Studies," In *Techniques for Measuring Body Composition.* Ed. by J. Brozek and A. Henschel. Washington, D.C.: National Academy of Sciences - National Research Council, p. 168, 1961.

42) Grande, F. "Energetics and Weight Reduction," *Amer. J. Clin. Nutr.* 21:305-314, 1968.

43) Guenther, W. *Concepts of Statistical Inference.* U.S.A., McGraw-Hill, Inc., p. 362, 1973.

44) Hockey, R.V. *Physical Fitness The Way to Healthful Living* St. Louis, The C.V. Mosby Co., 1977.

45) Horton, E. "Diet, Muscle Metabolism and Capacity for Exercise in Obesity," In *Recent Advances in Obesity Research: II*: Ed. by G. Bray. London: Newman Publishing Ltd., 1978.

46) Hundley, J. "Need for Weight Control Programs," In *Weight Control.* Iowa: The Iowa State College Press, p. 1, 1955.

47) Johnson, P. *Statistical Methods in Research.* New-York, Prentice-Hall Inc., 1950.

48) Jokl, E. *Nutrition, Exercise and Body Composition.* Illinois, Charles C. Thomas Publisher, 1964.

49) Jolliffe, N. and Glenn, M. "Obesity," In *Clinical Nutrition.* Ed. by N. Jolliffe. New York: Harper & Brothers, p. 820, 1962.

50) Jordan, H., Levitz, L. and Kimbrell, G. *Eating is O New York, Rawson Associaton Publ'ishers, Inc., 1976.*

51) *Katch, F., Michael, E. and Horvath, S. "Estimation of Body Volume by Underwater Weighing: Description of a Simple Method," J. Appl. Physiol.* 28(5):811-815, 1967.

52) Katch, F. "Apparent Body Density and Variability During Underwater Weighing," *Res. Q.* 39(4):993-998, 1968.

53) Katch, F. and McArdle, W. *Nutrition, Weight Control and Exercise.* Boston, Houghton Mifflin Co., 1977.

54) Keys, A. and Brozek, J. "Body Fat in Adult Man," *Physiol. Rev.* 33:266-281, 1953.

55) Key, A. "Body Composition and Its Change With Age and Diet," In *Weight Control.* Ed. by E. Eppright, P. Swanson and Iverson, C. Iowa: The Iowa State College Press, 1955.

56) Kindl, M. and Brown, P. "Team Approach in the Treatment of Obesity," *J. Can. Diet. Assoc.* 38(4):278-281, 1977.

57) Kinsell, L.W. "Dietary Composition - Weight Loss: Calories Do Count," In *Obesity.* Ed. by N.L. Wilson. Philadelphia: F.A. Davis Co., p. 177, 1969.

58) Lamb, D. *Physiology of Exercise.* New York, Macmillan Publishing Co., Inc., 1978.

59) Lim, T. and Luft, U. "Body Density, Fat and Fat-Free Weight," *Amer. J. Med.* 30:825-831, 1961.

60) Liguori, C. Dietitian, Royal Alexandra Hospital, Edmonton, Alberta. *Interview.* 10, January, 1980.

61) Malsbury, R.A. "The Effect of Intensity of Exercise on Body Composition Changes in Women," Unpublished Master's Thesis, University of Alberta, 1980.

62) Mayer, J. "The Role of Exercise and Activity in Weight Control," In *Weight Control*. Iowa: The Iowa State College Press, p.199, 1955.

63) Mayer, J. *Overweight Causes, Cost and Control*. Englewood Cliffs, N.J., Prentice-Hall, 1968.

64) Meneely, G. and Kaltreider, N. "Use of Helium for Determination of Pulmonary Capacity," *Proc. Soc. Exp. Biol.* 46:266-269, 1941.

65) Meneely, G. and Kaltreider, N. "The Volume of the Lung Determined by Helium Dilution. Description of the Method and Comparision With Other Procedures," *J. Clin. Invest.* 28:129-139, 1949.

66) Meneely, G., Ball, C., Kory, R., Callaway, J., Merril, J., Mabe, R., Roehm, D. and Kaltreider, N. "A Simplified Closed Circuit Helium Dilution Method for the Determination of the Residual Volume of the Lungs," *Amer. J. Med.* 28:824-831, 1960.

67) Moody, D.L., Kollias, J. and Buskirk, E.R. "The Effect of a Moderate Exercise Program on Body Weight and Skinfold Thickness in Overweight College Women," *Med. Sci. Sports.* 1:75-80, 1969.

68) Moody, D.L., Wilmore, J., Girandola, R. and Royce, J. "The Effects of a Jogging Program on the Body Composition of Normal and Obese High School Girls," *Med. Sci. Sports.* 4(4):210-213, 1972.

69) Morehouse, L. and Miller, A. *Physiology of Exercise*. St. Louis, The C.V. Mosby Co., 1976.

70) Motley, H. "Comparison of a Simple Helium-Closed Circuit With the Oxygen-Open Circuit Method for Measuring Residual Air," *Amer. Rev. Tuber.* 76:601-615, 1957.

71) Mottola, M.F. "The Effects of Caloric Restriction and Physical Exercise on Body Weight, Total Percent Body Fat, LBW and Girth Circumference in Overweight Sedentary Females," Unpublished manuscript. University of Western Ontario, 1978.

72) Mottola, M.F. "To Test the Validity of the Godart Pulmotest and Helium-Analyser in the Anthropometry Lab with the Reference to the Helium-Dilution Technique in Combination with Underwater Weighing for the Determination of Body Density and Percent Body Fat," Unpublished manuscript, University of Alberta, 1980.

73) Moyer, N. "A Comparison of Methods Used to Estimate Body Density," Unpublished Masters Thesis, University of Alberta, 1971.

74) Noland, M. and Kearney, J. "Anthropometric and Densitometric Responses of Women to Specific and General Exercise," *Res. Q.* 49(3):322-328, 1978.

75) Ohlson, M., Brewer, W., Kereluk, D., Wagoner, A. and Cederquist, D. "Weight Control Through Nutritionally Adequate Diets," In *Weight Control*. Iowa: The Iowa State College Press, p. 170, 1955.

76) Ohlson, M., Biester, A., Brewer, W., Hawthorne, B. and Hutchinson, M. "Anthropometry and Nutritional Status of Adult Women," In *Body Measurements and Human Nutrition*. Ed. by J. Brozek. Wayne University Press, p. 79, 1956.

77) Olesen, K. "Body Composition in Normal Adults," In *Human Body Composition*. Ed. by J. Brozek. Oxford: Pergamon Press, Ltd., p. 183, 1965.

78) Oscai, L. and Holloszy, P. "Effects of Weight Changes Produced By Exercise, Food Restriction, or Overeating on Body Composition," *J. Clin. Invest.* 48:2124-2128, 1969.

79) Parizkova, J. "Nutrition and It's Relation to Body Composition in Exercise," *Proc. Nutr. Soc.* 25:93-99, 1966.

80) Prudden, B. *Testing and Training for Physical Fitness.* The Institute of Physical Fitnes, Inc. New York, David G. Smith Printing Publishing, Glenwood, Canada, 1962.

80A) Pulmonary Lab. Clinical Sciences, University of Alberta, Edmonton. Interviews and consultation. June, 1979 to May, 1980.

81) Revell, D. *Gourmet Recipes for Diabetics.* Springfield, Ill., U.S.A., Charles C. Thomas Publisher., 1971.

82) Robertson, C., Engle, C. and Bradley, M. "Lung Volumes in Man Immersed to the Neck: Dilution and Plethysmographic Techniques," *J. Appl. Physiol.* 44(5):679-682, 1978.

83) Sawka, M., Weber, H. and Knowlton, R. "The Effect of Total Body Submersion on Residual Lung Volume and Body Density Measurements in Man," *Ergonomics.* 21(2):89-94, 1978.

84) Scheffe, H. *The Analysis of Variance.* New York, J. Wiley and Sons, Inc., 1959.

85) Sloan, A., Burt, J. and Blyth, C. "Estimation of Body Fat in Young Women," *J. Appl. Physiol.* 17(6):967-970, 1962.

86) Sloan, A. and Bredell, G. "A Comparison of Two Simple Methods for Determining Pulmonary Residual Volume," *Hum. Biol.* 45(1):23-29, 1973.

87) Sloan, C., Tobias, D., Stapell, C., Ho, M. and Beagle, W. "A Weight Control Program for Students Using Diet and Behaviour Therapy," *J. Amer. Dietet. Assoc.* 68(5):466-468, 1976.

88) Smith, U. "Human Fat Cell Metabolism," In *Recent Advances in Obesity Research: II.* Ed. by G. Bray. London: Newman Publishing Ltd., p. 190, 1978.

89) Stuart, R. and Davis, B. *Slim Chance in a Fat World: Behaviour Control of Obesity.* Ill., Research Press, 1975.

90) Tanner, J. and Whitehouse, R. "The Harpenden Skinfold Caliper," *Amer. J. Phys. Anthrop.* 13:743-746, 1955.

91) The President's Council on Physical Fitness. *Adult Physical Fitness A Program for Men and Women.* Washington, D.C., U.S. Government Printing Office, 1963.

92) Turner, D. *Handbook of Diet Therapy.* Chicago and London, The University of Chicago Press, 1970.

93) Vanderbilt University Hospital. *Diet Manual.* Vanderbilt University Press, Nashville, 1961.

94) Wallace, J.P. "Responses of the Composition of Body Fat to Cardiovascular Training in College Women," *Res. Q.* 46(3):317-322, 1975.

95) Ward, G., Krzywicki, H., Rahman, D., Quaas, R., Nelson, R. and Consolazio, F. "Relationship of Anthropometric Measurements to Body Fat as Determined by Densitometry, Potassium-40 and Body Water," *Amer. J. Clin. Nutr.* 28:162-169, 1975.

96) Weltman, A., Matter, S. and Stamford, B. "Caloric Restriction and/or Mild Exercise: Effects on Serum Lipids and Body Composition," *Amer. J. Clin. Nutr.* 33(5):1002-1009, 1980.

97) White, G. and Young, R.J. "Effect of a Twelve Week Exercise Program on Cardiorespiratory and Body Composition Variables in Non-Obese Young and Middle-Aged Females," *Brit. J. Sports Med.* 12(1):27-32, 1978.

98) Wilmore, J. "The Use of Actual, Predicted and Constant Residual Volumes in the Assessment of Body Composition by Underwater Weighing," *Med. Sci. Sports.* 1(1):87-90, 1969.

99) Wilmore, J. and Behnke, A. "An Anthropometric Estimation of Body Density and Lean Body Weight in Young Women," *Amer. J. Clin. Nutr.* 23(3):267-274, 1970a.

100) Wilmore, J., Girandola, R. and Moody, D. "Validity of Skinfold and Girth Assessment for Predicting Alterations in Body Composition," *J. Appl. Physiol.* 29(3):313-317, 1970b.

101) Winer, B. *Statistical Principles in Experimental Design.* New York, McGraw-Hill Book Co., 1962.

102) Winer, B. *Statistical Principles in Experimental Design.* New York, McGraw-Hill Book Co., 1962.

103) Young, C., Gehring, B., Merrill, S. and Kerr, E. "Metabolic Responses of Young Women While Reducing," *J. Amer. Dietet. Assoc.* 36:447-452, 1960.

104) Young, C. Martin, E., Chihan, M., McCarthy, M., Manniello, J., Harmuth, E. and Fryer, J. "Body Composition of Young Women," *J. Amer. Diet. Assoc.* 38:332-340, 1961.

105) Yuhasz, M.S. "The Effects of Sports Training on Body Fat in Man with Predictions of Optimal Body Weight," Unpublished PhD Dissertation, University of Illinois, 1962.

106) Yuhasz, M.S. *The Basic Workout.* London, Faculty of Physical Education, The University of Western Ontario, 1976.

107) Yuhasz, M.S. *Physical Fitness and Sports Appraisal Laboratory Manual.* The University of Western Ontario, 1977.

108) Zuti, W. and Golding, L. "Comparing Diet and Exercise as Weight Reduction Tools," *Physician Sports Med.* 4:49-53, 1976.

APPENDIX A

ALPHABETIC CALORIE CHART

ALPHABETIC
CALORIE-CHART

T—Tablespoon

Food	Calories
A	
Abalone, 4 oz. canned	90
Almonds:	
dried, 1/2 cup shelled	425
roasted & salted, 1/4 lb.	711
roasted & salted, 10 nuts	63
roasted & unsalted, 10 nuts	61
roasted & salted, chopped, 1 T	37
Anchovies, 4 fillets, canned	28
Anchovy paste, 1 oz.	40
Apple, 1 med. fresh	70
1 large fresh	117
1 cup slices	83
1 large baked	158
Apple brown Betty, 1/2 cup	175
Apple juice, 8 oz	125
Apple pie, 1/6 of 9" pie	373
Apple sauce, sweetened, 1/2 cup	100
Apple sauce, unsweetened, 1/2 cup	50
Apricots, fresh 3 average	58
Apricots, sweetened, canned, 4 halves	105
Apricots, dried 1/2 cup	195
Apricots, frozen, 1/2 cup sweetened	128
Apricots, strained, canned 1 oz.	17
Asparagus, 6 spears, canned	20
Asparagus, 6 spears, frozen	20
Asparagus, boiled, drained 6	19
Avocados	
1/2 average California	185
1/2 average Florida	157
B	
Bacon, 2 slices broiled or fried drained	98
Bacon, Canadian 1 slice broiled or fried, drained	57
Bagel, medium	125
Bamboo shoots, 1/2 cup raw	20
Banana, 1 large	120
Beet greens, boiled, 1/2 cup	20
Beets: 1/2 cup, boiled, drained	25
1/2 cup, canned w/liquid	45
1/2 cup, canned, drained	30
Biscuits, 1 medium	130
1 small	82
Blackberries, 1/2 cup fresh	42
1/2 cup canned, heavy syrup	114
1/2 cup juice packed, w/liquid	65
1/2 cup water packed, w/liquid	50
Blood pudding or sausage, 4 oz	447
Blintzes, 1 small	152
Blueberries: 1/2 cup fresh	43
canned, 1/2 cup with syrup	126
canned, 1/2 cup water packed	47
frozen, 1/2 cup sweetened	90
frozen, 1/2 cup unsweetened	40
Bluefish, baked, 4 oz with 2 tsp butter	168
broiled, 4 oz with 2 tsp butter	180
fried, 4 oz	230
Bockwurst, 4 oz.	300
Bologna, 2 oz all meat	150
Bologna, 2 oz. with cereal	145
Bouillon cube, 1 cube	5
Boysenberries, canned, 1/2 cup with liquid	45
frozen, 1/2 cup sweetened	72
Brains, 4 oz. raw	150
Braunschweiger, 4 oz	364
Brazil nuts:	
1/4 lb. shelled	740
1/2 cup shelled	458
4 oz.	100
Bread:	
Italian, slice	56
protein, slice	45
pumpernickel, 1 slice	74
raisin, 1 slice	63
rye, 1 slice	55
white, 1 slice	60
whole wheat, 1 slice	55
Bread sticks, 1/2 lb. salted	871
Breadcrumbs, 1 T dry, grated	25
Broccoli, 2 lge. spears	65
boiled, drained, cut 1/2 cup	20
frozen, 1/2 cup chopped	28
frozen, 2 spears	55
Brown betty, 1/2 cup	250
Brussel sprouts, 1/2 cup boiled	25
frozen, 1/2 cup	35
Butter 1T salted or unsalted	100
Buttermilk 8 oz. glass	85
Butternuts, 4 — 5 nuts	95

Banana. 1/2 cup fresh slices	64
Banana cream pie 1/6 of 9" pie	300
Banana fritter. 1	180
Barley. 2 T pearled, dry	98
Bass. baked or broiled, 4 oz.	180
Bean sprouts. raw. 1/2 cup	16
Bean sprouts. raw. 1/2 cup soy	25
Beans:	
1/2 cup baked. canned	160
4 oz canned barbecue	124
butter. frozen. 1/2 cup	313
green. 1/2 cup cooked	14
green. canned. 1 oz.	6
kidney. 1/2 cup cooked	115
lima. 1/2 cup cooked or canned	80
lima. 3 tbsp. frozen	110
navypea. 1/2 cup cooked	118
soup. home made. 1 cup	260
wax. 1/2 cup boiled	16
wax. canned 1/2 cup with liquid	23
wax. frozen. 1/2 cup cut	25
Beans & frankfurters. canned 4 oz.	164
Beans & groundbeef. 4 oz. canned	140
Beef:	
brisket. lean & fat. 4 oz. braised	470
brisket. braised lean only 4 oz.	255
brisket. 3 med slices	350
chuck. 4 oz. lean and fat. pot roasted	487
chuck. ground. 4 oz	315
corned. 4 oz.	288
corned. 1/2 cup hash	145
chuck steak. lean and fat. 4 oz. broiled	517
club steak. lean. 4 oz. broiled	278
flank steak. 4 oz. lean only. pot roasted	223
lean only. 3 oz	110
round. 3 oz.	197
rump. lean and fat. roasted 4 oz	237
sirloin. 4 oz lean broiled	245
sirloin. 4 oz lean and fat broiled	555
short ribs. 4 oz	485
steak. club. 4 oz	330
steak. filet Mignon. 4 oz	400
steak. flank. 4 oz	280
steak. porterhouse 4 oz	290
steak rib. 4 oz	315
steak tenderloin 4 oz	270
stew meat. chuck. 4 oz.	410
stew meat. round. 4 oz.	315
tongue. boiled. 4 oz.	268
Beef. corned. 4 oz. med. fat boiled	425
lean canned. 4 oz.	210
Beef. chipped or dried. uncooked 4 oz.	231
Beef pie. frozen 8 oz pie	436
Beef stew. canned. 4 oz.	90

C

Cabbage:	
1/2 cup raw. chopped	12
1/2 cup white boiled. drained	17
1/2 cup red. raw shredded	15
Cake:	
angel. plain 3" slice	155
cheese. 2" slice	250
cup cake. 1 average. plain	130
cup cake. 1 chocolate	200
fruit cake. 1/4" slice	70
gingerbread. 1 med. sq.	180
jelly roll. 1 med. slice	150
marble. 1 med slice	180
pound. 1 med slice	125
sponge. 1" slice	75
Candy: almond joy. 10¢ bar	235
chocolate milk. 1 oz	148
chocolate fudge. 1 oz	125
gum drops. 1 large	50
jelly beans. 10. or 1 oz.	100
jujubes. 1 pc.	1
life savers. all flavors. 1 pc.	10
life savers. 1 pc. mint	8
peanut brittle. 1 oz.	120
sourballs. 1	20
Cantaloupe:	
1/2 5" diam. melon	55
1/2 cup diced	35
Cabiodia. 2 oz.	288
Carrots. 1 average raw	20
1/2 cup canned with liquid	34
Casaba melon. fresh. 8 oz.	30
Cashew nuts. roasted. salted or unsalted. 6—8	84
Catsup. 1 T	18
Caukflower. 1 cup cooked	28
1 cup frozen	45
Caviar. granular. 1 oz.	75
Celery 1 stalk	6
1/2 cup raw. diced	9
1/2 cup boiled. drained	9
soup. 1 cup. creamed	200
Cereal	
all bran. 1 cup	195
cheerios. 1 cup	100
corn flakes	80
cream of wheat. 1 cup cooked	133
farina. instant cooking. 1 cup cooked	105
grape-nuts. 1 cup	400
grape-nut Flakes. 1 cup	150
oat flakes. 1 cup	165
oatmeal. 1 cup cooked	130
pep. 1 cup	106
puffed rice. 1 cup	51

Food	Calories
rice krispies, 1 cup	106
shredded wheat 1 biscuit	65
special K, 1 cup	70
wheat, rolled, 1 cup cooked	177
wheaties, 1 cup	108
Cervelat, soft, 2 oz	175
Chard, Swiss, cooked 1/2 cup	14
Cheese	
blue or Roquefort, 1 oz	105
cheddar or American, 1" cube	70
cheddar or American, 1 cup grated	445
cheddar processed, 1 oz	105
Cottage cheese, from skim milk	
creamed, 1 cup	240
creamed, 1 oz	30
uncreamed, 1 cup	195
uncreamed, 1 oz	25
cream cheese, 1 oz.	105
swiss, 1 oz. domestic	105
Cheese doodles, 10 pcs	25
Cheese straws, 1 oz.	128
Cherries	
raw, sweet, with stems, 1 cup	80
canned, red sour, pitted, 1 cup	230
marashino, 2 average, bottled	20
Chestnuts, fresh, 2 large	29
dried, shelled 1/2 cup	190
Chicken, cooked	
broiled, 3 oz flesh only	115
fried, 1/2 breast	155
fried, drumstick	90
canned, boneless, 3 oz	170
a la king, 1/2 cup	235
pie 8 oz. frozen	495
stew, 4 oz. canned	94
Chop suey, canned, with meat, 4 oz	72
Chow mein, chicken, canned, without noodles 4 oz	43
Clams	
raw, meat only, 3 oz	65
canned solids and liquid, 3 oz	45
Fried, 5	125
steamed with butter, 12	300
Cocoa, mix, powder, 2 heaping tsp	50
Cocoanut, fresh, 1/2 cup, shredded	170
fresh, 2" sq x1/2"	156
dried, 1/2 cup sweetened	170
Coconut milk, 1/2 cup	27
Cod, 4 oz broiled with butter	195
Coffee, 1 cup instant, plain	3
Coffee, 1 cup, prepared, plain	2
Cookies 1 butter	41
1 chocolate	49
1 chocolate chip	60
1 creme sandwich	50
1 fig newton	60
1 ginger snap	32
1 graham cracker	18
1 lemon snap	17
1 lorna doone	38
1 mallomar	60
1 macaroon	85
1 oatmeal	61
1 peanut	34
1 social tea	21

Food	Calories
E	
Eggs:	
1 whole large, raw	80
1 whole fried, med	110
1 omelette, plain	110
1 cheese omelette, 2 eggs	300
1 Spanish omelette, 2 eggs	335
F	
Fats, cooking & vegetable, 1 T	110
Figs, 3 small raw	90
dried, large, 1	60
Filberts, 10-12, shelled	95
Finnan haddie, 3 oz.	100
Fish cakes, fried, 2	300
Fish sticks, frozen, cooked, 6	250
Flounder, 4 oz. uncooked	85
Flounder, baked with butter, 4 oz.	222
Frankfurters, cooked, 1 average	150
Fruit cocktail, 1/2 cup canned w/syrup	100
Fruit salad, canned, 4 T	200
G	
Garlic, raw, 1 average clove	3
Gefilte fish, 8 oz.	150
Gelatin, prepared, 1/2 cup	80
Goose, roasted, meat only 4 oz.	260
Gooseberries, fresh, 1/2 cup	30
Gooseberries, 1/2 cup canned, w/ syrup	105
Grapefruit, raw, med 1/2	60
Grapefruit, canned w/ syrup, 1/2 cup	90
Grapefruit, juice, 1 cup, fresh	95
Grapefruit, juice, frozen, sweetened 6oz.	350
Grapes, raw, American type, 1 cup	65
Grapes, raw, European type, 1 cup	95
Grapejuice, bottled or canned, 1 cup	165
Gravy, 4 T	135
Grits, cooked, 1 cup	160
Gum, chewing, 1 stick	10
H	
Haddock, frozen, 2 fillets, 4 oz	88
Haddock, 3 oz. fried	140
Ham, light cured, lean and fat roasted, 3 oz.	245
sliced boiled, 3 oz.	200
spiced, canned, 2 oz.	165
canned, deviled, 4 oz.	400
Hazelnuts, 10	100
Headcheese, 2 oz.	155
Heart, beef, lean, 4 oz.	120
chicken, 4 oz. boiled	195
Herring: 1 medium Atlantic	210
1 " Pacific	110
kippered, 2 oz.	120
marinated with cream, sm. pc.	140
pickled, Bismarck, 2	250
smoked, kippered, 4 oz.	240
Hickorynuts, 10 small	70
Honey, 1T strained	65
Honeydew melon, 1 wedge, med.	50
Horseradish, 1T	5
Huckleberries, 1 cup	85

1 sugar Wafer	18
1 vanilla wafer	14
1 waffle creme	48
Corn:	
1 ear, boiled, drained, on cob	70
1/2 cup, boiled, drained, kernels	69
1/2 cup, canned, cream style	95
1/2 cup, canned, whole kernels	70
1/2 cup, frozen, with butter sauce	100
Corn fritter, 1	95
Cornstarch, 1 T	29
Cowpeas, canned, 1/2 cup with liquid	71
Crabmeat, 4 oz.	120
Crabapples, 1 average	30
Cracker meal, 1 T	45
Crackers:	
ritz, 1	17
saltines, 1	15
soda, 1	25
triangle thins	9
triscuits	22
zwieback	30
Cranberries:	
fresh, 1/2 lb.	100
juice, cocktail 8 oz	165
sauce, jelled, canned, 4 oz	186
sauce, whole, canned, 4 oz	195
Cream:	
light or table, 1 T	31
half and half, 1 T	20
heavy, 1 T	51
sour, 1 T	30
whipped, 1 T	25
Crisco, 1 T	108
Cucumber, 1 med. raw, pared	30

D

Dandelion greens, raw, 1/4 lb.	50
Dates, natural, dry, 1	20
Doughnuts, 1, cake type	130
Doughnuts, 1, jelly	174
Duck, 4 oz. meat only, roasted	350

I

Ice cream:	
chocolate, 1/4 pt.	150
coffee, 1/4 pt	175
custard, 1/4 pt	155
milk sherbert, 1/4 pt	145
strawberry, 1/4 pt	185
vanilla, 1/4 pt	150
ices, 1/4 pt.	120
Ice cream cone, sugar, 1	37
Ice cream sandwich, 1	210

J

Jams and preserves, all flavors 1 T	55
Jellies, 1T	55
Junket, 1/2 cup with whole milk	115

K

Kale, 1 cup boiled, drained	30
Kale, 1 cup frozen chopped	45
Kidneys, beef or veal, 4 oz	160
Kidneys, lamb, 4 oz	120
Kidneys, pork, 4 oz	135
Knockwurst, 4 oz	315
Kohlrabi, 1/2 cup boiled, drained	20
Kumquats, fresh, 5 average	65

L

Lamb, trimmed, cooked	
chop, thick with bone, broiled, 1	400
lean and fat, 4 oz	400
lean only, 2.6 oz	140
leg, roasted, lean and fat, 3 oz	235
only, 2.5 oz	130
shoulder, roasted, lean and fat, 3 oz	285
shoulder, roasted, lean only, 2.3 oz	130
shish kebab, 6 pcs	510
Lard, 1 T	123
Leeks, raw, 1 med	15
Lemon juice, fresh, 1/2 cup	30
fresh, 1	5
canned or bottled, 1 T	3
frozen, concentrate, 1 T	17

Food	Calories
Lemonade, 8 oz frozen diluted	110
Lemonade pink, 8 oz frozen diluted	100
Lemons fresh, 1 average	20
Lentils cooked, 1/2 cup whole	100
Lettuce Boston or Bibb 1/2 lb	25
Iceberg 1/2 lb	28
Romaine, 1/2 lb	25
Simps., 1/2 lb	25
Lichee nuts 5	40
Lime juice, 1T. fresh	5
Lime juice 1T. canned or bottled	4
Limeade, 8 oz glass frozen diluted	100
Limes 1 average fresh	20
Liver beef, fried, 2 oz	130
Calves, fried, 2 oz	150
chicken, simmered 2 oz	95
lamb, 2 oz broiled	150
Liverwurst, fresh 2 oz.	175
smoked 2 oz	182
Lobster, canned or cooked, 6 oz	135
Lobster, average, baked or broiled	315
Lobster tail, African, 1 broiled	180
Lox 2 oz	190

M

Macadamia nuts, 10 nuts shelled	170
Macaroni 1/2 cup boiled 8 10 min	95
" " " 14 20	78
" cup with cheese	235
Mackeral broiled, 4 oz w/butter	262
canned with liquid 4 oz	205
salted, 4 oz	250
Malted milk powder 1/2T	100
Mango, 1 average fresh	130
Margarine, 1 T	100
pat or square	50
Marmalade, 1 T	55
Mayonnaise, 1 T	110
Meat loaf, beef & pork, 2 slices	500
Meatballs, 2 average	300
Melon balls, frozen 4 oz	38
Milk cow's, 8 oz glass whole	160
buttermilk, 8 oz. glass, cultured	89
fluid, non fat, 8 oz glass	90
evaporated, unsweetened, 1 cup	345
condensed, sweetened 1 T	65
dry, whole, 1 cup	515
dry, nonfat, instant, 1 cup	250
chocolate flavor 1 cup	190
Molasses 1T light cane	50
1T blackstrap	43
Muffins bran, 1 average	105
blueberry, 1 average	125
corn 1 average	105
date, 1 average	140
English, 1 average	125
raisin, 1 average	130
whole wheat, 1 average	120
Mushrooms raw 1/4 lb	30
canned 4 oz with liquid	20
Mussells, raw meat only 4 oz	108
Mustard, prepared 1T	10

N

Nectarines 1 average fresh	30
Noodles, egg, cooked, 1/2 cup	100
Noodles fried canned 4 oz	550
Nuts see individual listings	

Food	Calories
Parsley, raw 1T	1
Parsnips, 1/2 cup boiled drained	50
Pastrami 2 oz	171
Pate de foie gras canned 1 oz	131
Pastry, apple turnover 1	270
Danish, 1 small	205
Peaches, 1 average fresh	35
1/2 cup canned w/ syrup	100
1/2 cup dried	210
1/2 cup sweetened frozen sliced	100
Peanut butter 1T	95
Peanuts, raw 1/4 lb shelled	640
roasted 1/4 lb shelled	660
roasted & salted 1/4 lb	660
Pears 1 fresh average	100
1/2 cup canned, w/syrup	97
1/2 cup dried	214
Peas fresh, 1/2 cup boiled	58
canned, 1/2 cup w/liquid	70
frozen, 1/2 cup	70
split, boiled 1/2 cup	115
Peas & carrots, 1/2 cup frozen	51
Pecans, whole, 6	105
1T chopped	50
Peppers raw green, 1 average	15
raw red 1 average	20
Perch, 4 oz raw, white	135
Persimmons 1 average	85
Pickle relish 1 T barbecue	31
1 T hamburger	18
1 T sweet	18
Pickles, 1 large dill	15
1 large sour	15
1 average sweet	30
Pie, 1/7 of 9" diam pie	
apple, 1 sector	345
cherry, 1 sector	355
custard, 1 sector	280
lemon meringue, 1 sector	305
mince, 1 sector	365
pumpkin, 1 sector	275
Pig's feet, boiled, 3 oz	130
pickled, 3 oz	175
Pimientos, 1 average, canned	10
Pineapple, 1 slice, fresh	45
1 large slice canned w/syrup	90
1/2 cup frozen, sweetened, chunks	100
Pineapple juice, 8 oz. glass unsweetened, canned	138
frozen, unsweetened, 8 oz glass diluted	130
Pineapple-grapefruit juice, canned, 8 oz glass	135
Pineapple-orange juice, canned, 8 oz glass	135
Pine nuts, 1/8 lb shelled	310
Pistachio nuts, 1/8 lb shelled	338
Pizza pie, average wedge	240
Plums, 1 fresh average damson	36
1 fresh average prune type	24
canned, purple w/syrup, 4 plums	135
Popcorn, 1 cup plain	54
popped, sugar-coated, 2 oz	218
Pork	
lean only, 1.7 oz. chop	130
lean and fat, 2.3 oz chop	260
roast, lean and fat, 3 oz	310
roast, lean only, 2.4 oz	175
spareribs, 4 med	168
tenderloin, 4 oz	280
Potato chips 10	115

O

Oil cod liver 1 T	100
corn 1 T	122
cottonseed 1 T	125
mineral 1 T	5
olive 1 T	125
peanut 1 T	124
safflower 1 T	128
salad 1 T	124
soybean 1 T	125
Okra boiled, drained, 8 average	25
frozen 1/2 cup	35
Olives 5 large green	35
5 green stuffed, medium	65
ripe or black, 5 large	43
Onions 1 T chopped raw	4
1/2 cup boiled, drained	30
4 average sour pickled	4
Onion rings, frozen 4 oz	145
Oranges, raw	
California, navel (winter) 1	60
Florida, all varieties, 1	75
Orange juice, 1 cup California	115
1 cup Florida	100
1 cup canned, unsweetened	110
Orange & grapefruit juice	
frozen concentrate, undiluted, 1 can	325
Oysters meat only, raw 1319 med	160
stew with milk, 1 cup	212
fried 5	250

P

Pancakes 4 diameter	
1 buckwheat	55
1 wheat	60
Papaya juice 8 oz glass canned	120
Papayas, 1/2 cup cubes	35
Potatoes	
1 med. baked, peeled after baking	90
1 med. boiled, peeled after boiling	105
1 med. boiled, peeled before boiling	80
1 cup mashed w/milk	125
1 cup mashed w/milk and butter	185
10 pcs french fried	155
10 pcs frozen heated	125
Potatoes, sweet, 1 average, baked	155
1 average, boiled,	170
1 small, candied	315
Pretzels, 10 small sticks	40
1 large pretzel	134
Prunes, 1 large dried	20
Prune juice canned, 1 cup	200
Pumpkin, 1/2 cup canned	38

Q

Quince, 1/4 lb.	78

R

Rabbit, 4 oz. stewed, meat only	245
Radishes, 4 small without tops	5
Raisins, dried, 1/4 cup	115
Raspberries, 1 cup black	100
1 cup red	70
Rhubarb, 1/2 cup cooked, sweetened	195
Rice, white, cooked, 1 cup	185
brown, cooked, 1 cup	200
white, precooked, 1 cup	210
fried, 1 cup	260
spanish, 1 cup	175
Rolls, plain, 1	115
hard, round, 1	160
frankfurter, 1	160
hamburger, 1	150
sweet, 1	135
Rutabagas 1/2 cup boiled drained	35

Food	Calories
S	
Salad (lettuce), raw, butterhead as Boston types, head, 4" diam	30
Salad dressing	
1T blue cheese	85
1T French	63
1 T mayonnaise	105
1 T Roquefort	85
1 T Russian	106
Salami, 4 oz cooked	352
Salmon, 4 oz canned, Atlantic	230
4 oz canned, pink	165
4 oz canned, red	195
4 oz. smoked	200
4 oz broiled with butter	240
Sardines, canned in brine 4 oz	220
" in oil, 4 oz.	190
" in tomato sauce, 4 oz	225
Sauces	
barbecue 1 T	18
chocolate 1 T	65
fudge 1 T	85
soy 1 T	
tartar 1 T	95
tomato canned, 1/4 cup	40
worcestershire 1T	12
Sauerkraut, 1 cup, canned, w/liquid	40
Sausage, pork	
4 oz. brown and serve	480
4 oz. links or bulk, cooked	538
4 oz. links, smoked, country style	390
4 oz canned, drained	439
4 oz. Vienna, canned	275
Scallops, 4 oz. bay or sea, steamed	128
4 oz breaded, fried, frozen, reheated	225
4 oz. broiled	175
Sesame seeds, 1 oz	160
Shortening, 1 T	100
Shad, 4 oz	190
Shrimp, canned, meat only, 4 oz	135
Smelt, fried, 2 small	250
Sole, fillets, 2, frozen	88
Soups, canned, ready-to-serve (prepared with equal amount of water)	
bean with pork 1 cup	170
beef noodles 1 cup	170
beef bouillon, broth, consomme, 1 cup	30
chicken noodle 1 cup	65
clam chowder 1 cup	85
corn chowder 1 cup	200
green pea 1 cup	130
lentil 1 cup	130
mushroom cream of 1 cup	210
onion 1 cup	50
tomato 1 cup	90
vegetable w/beef 1 cup	80
Spaghetti, boiled 8-10 minutes, drained 1 cup	195
boiled 14-20 minutes, drained 1 cup	155
canned, in tomato sauce w/cheese 4 oz	86
Spinach, raw 4 oz trimmed	20
boiled 1 cup	42
frozen, leaf 1 cup	50
frozen, chopped, 1 cup	46
Squash, cooked, summer, 1 cup diced	30
baked, winter, 1 cup mashed	130
frozen, yellow, 1 cup	42

Food	Calories
Strawberries, 1 cup fresh	55
frozen, 1/2 cup, halves	155
frozen, 1/2 cup, whole	100
Succotash, 1/2 cup frozen	90
Sugar (cane or beet)	
1 T granulated	45
1 lump	25
1 T powdered	30
1 T brown	50
Sweetbreads, 4 oz beef, braised	363
4 oz calf, braised	191
4 oz lamb braised	198
Swordfish, 4 oz broiled with tsp butter	193
Syrups	
1 T chocolate	49
1 T corn	57
1 T maple	50
1 T light molasses	50
1 T blackstrap molasses	43
T	
Tangerine, 1 average	40
Tangerine juice, frozen, unsweetened, 1 glass	115
Tangerine juice, canned, 8 oz glass, sweetened	125
Tea, bags or loose, 1 cup, plain prepared	1
Tea, instant, prepared, plain 1 cup	4
Thuringer 2 oz.	175
Toast, melba, 1 slice	25
Tomato, 1 average, fresh	35
Tomatoes	
canned, stewed, 1/2 cup	33
juice, 8 oz glass canned	46
juice cocktail, canned, 8 oz	51
Tongue	
4 oz. beef, braised	277
2 oz deviled or potted, canned	165
2 oz. pickled	151
Tuna	
canned, in oil, drained, solids 4 oz	225
canned in water, w/liquid, 4 oz	144
pie frozen, 8 oz	452
Turkey, roasted, 4 oz. dark meat	230
roasted, 4 oz. light meat	200
8 oz. turkey pie frozen	447
turkey potted, 4 oz.	283
Turnip greens, boiled, 1/2 cup	15
Turnips, boiled, drained, 1 cup	36
V	
Veal, cooked	
cutlet, without bone broiled 3 oz	185
roast, med fat 3 oz	230
Venison, 3 oz. roasted	170
W	
Waffles, 1 medium	215
Walnuts, 1/2 cup black, halves	315
1/4 lb. English shelled	438
1 T English chopped	52
Water chestnuts, raw, Chinese, 1/2 lb	135
Watercress, raw, 1/4 lb	20
Watermelon, fresh, 1/2 cup cubes or balls	26
fresh, 1/2 lb.	27
Weakfish, 4 oz. broiled	237
Wheat germ, 1 T	29
Whitefish 4 oz. smoked	176
Y	
Yogurt, 1 cup, skimmed milk	120
Z	
Zucchini, cooked, plain, drained cup	40
	30

APPENDIX B

INSTRUCTIONS FOR FOOD BEHAVIOUR RECORD

INSTRUCTIONS FOR FOOD BEHAVIOUR RECORD

1) Do not leave any column blank on the food behaviour record.

2) Record the time of beginning and the time of ending each meal or snack. An entry should be considered a separate meal or snack if there has been a lapse of fifteen minutes between bites.

3) Record the place where eaten. If at home, the room. If away from home, the name of the restaurant or store and whether at a counter, table, desk, etc.

4) Physical position. Use the following code: standing (1), sitting (2), and lying down (3).

5) Alone or with whom. If alone, write "alone." If with one or more people, write the number and relationship, for example, "3 - boyfriend and other couple."

6) Associated activity. Anything that you are doing while eating, such as reading, watching TV, talking, studying, etc.

7) Mood. Record your mood just before you begin eating. Use the first letter of whichever word most nearly coincides with your mood: Neutral, Content, Tense, Depressed, Angry, Happy, Bored, Fatigued, Rushed.

8) Hunger. Record your feeling of hunger just before eating using the following code: no hunger (0), faint hunger (1), mild hunger (2), moderate hunger (3), great hunger (4), extreme hunger (5).

9) Record the name of the food and the amount eaten. In the next column note if this was a meal (M) or a snack (S).

10) Look up the number of calories in each portion and record the value. Refer to "Calorie Chart" for calorie values.

APPENDIX C

FOOD BEHAVIOUR RECORD

FOOD BEHAVIOR RECORD

DAY _____ NAME _____

TIME Start	TIME End	Place	Physical Position	Alone or With Whom	Associated Activity	Mood	Hunger	Food & Amount	M or S	Calories

APPENDIX D

ACTIVITY RECORD SHEET

ACTIVITY RECORD SHEET

DAY _____

ACTIV. TYPE walk, run, jog skip, swim, climb	TIME Min/Sec	INTENSITY leisurely, slow briskly, moderate

APPENDIX E

COMPLETE EXCHANGE LISTS FOR DIABETIC EXCHANGE DIET

EXCHANGE LISTS FOR RESTRICTED CALORIE DIETS

MILK EXCHANGES—LIST 1

One milk exchange is equivalent to the size of serving listed below.

Skim milk	½ cup	Buttermilk, skim	½ cup
Powdered skim milk	2 tbsp.	Powdered instant skim milk	2 tbsp.
2% Milk (deduct ½ fat exchange)	½ cup	Yoghurt, plain	½ cup

VEGETABLE EXCHANGES—LIST 2

One vegetable exchange is equivalent to 1 serving of the size indicated in Group A or 2 servings of the size indicated in Group B.

GROUP A—

1 cup—	½ cup—
Beet greens, cooked	Beets, cooked or canned
Kohlrabi, cooked	Broccoli, cooked (4 stalks)
Tomatoes, canned	Brussel sprouts, cooked
Vegetable juice	Carrots, raw, diced or cooked
Tomato juice	Mixed carrots and peas
Sauerkraut, canned	Dandelion greens, cooked
	Onions, chopped or 1 medium
	Parsnips
	Peas, green
	Squash, Hubbard or pepper, baked or mashed
Canned condensed soup—	Turnips, yellow or white, cooked
3 level tbsp.	Vegetables mix (carrots, peas, limas, corn)

In addition one vegetable from Group B may be taken at each meal, if desired.

VEGETABLE EXCHANGES—LIST 2

One vegetable exchange is equivalent to 1 serving of the size indicated in Group A or 2 servings of the size indicated in Group B.

GROUP B—

Asparagus	5 stalks
Beans, yellow or green, canned or cooked	½ cup
Bean sprouts, raw	1 cup
Cabbage, raw or cooked	½ cup
Cauliflower, cooked	½ cup
Celery, raw	4 stalks
Celery, chopped or cooked	½ cup
Chard, cooked	½ cup
Cucumber	8 slices or ½ medium
Endive	1 stalk—6"
Kale	½ cup
Lettuce	4 large leaves or ⅛ head
Onion, green	2
Pepper, green, raw or cooked	1 medium
Pimento, canned	3 tbsps.
Radish	6
Spinach, cooked or canned	½ cup
Tomato juice (no sugar added)	½ cup
Tomato, raw	1 medium (2¼" dia.)
Vegetable marrow, cooked	½ cup
Zucchini	½ cup

FRUIT EXCHANGES—LIST 3

One fruit exchange contains 10 gms. of carbohydrate and is equivalent to the measure indicated below. All fruit is fresh, cooked or canned, without added sugar.*

Apple: raw	½ medium
juice	⅓ cup
sauce	½ cup
Apricots	2 medium
Bananas	½ small
Berries: blackberries	½ cup
raspberries	½ cup
gooseberries	¾ cup
strawberries	1 cup
blueberries	½ cup
Cantaloupe	1 cup or ½ of 5" dia.
Cherries	10 large
Grapefruit: raw	½ small
juice	½ cup
Grapes	14
Grape juice	¼ cup
Honeydew melon	¾ cup or ½ of 5" dia.
Ice cream: plain vanilla, strawberry, chocolate—deduct 1 fat exchange	⅓ cup
Nectarines	1 medium (2½" dia.)
Orange	1 medium (2½" dia.)
Orange juice	½ cup
Peach	1 medium
Pear	1 small
Pineapple	½ cup crushed or cubed or 2 slices
Pineapple juice	⅓ cup
Plums	2 medium
Prunes, cooked	2
Tangerine	1 (2½" dia.)
Watermelon	1 cup diced
or 1 slice	1" x 5" triangle

* If a controlled amount of sugar has been used in sweetening, read label for size of serving equivalent to one exchange.

BREAD EXCHANGES—LIST 4

One bread exchange is equivalent to one slice of cracked wheat, whole wheat, white, brown, or rye bread or as indicated below.

Bread (plain or toasted)	1 slice
Bagels	½
Breadsticks	5
Hamburger bun (3½")	½ bun
Wiener bun (6")	½ bun
Melba toast (commercial)	4 rectangular slices
	8 round slices
Matzos (6" square)	1
Arrowroots	3
Graham wafers (2" square)	4
Rusks	1½ biscuits
Soda biscuits (2" square)	6
Cereals: hot, dry	2 tbsps.
cooked	½ cup
cold, flaked	¾ cup
puffed	1 cup
shredded wheat	½ biscuit
Corn, canned	½ cup
Corn on the cob (4½" x 1½" x 2")	1 cob
Potatoes	1 small or ½ cup mashed
Macaroni, cooked	½ cup
Rice, spaghetti, noodles, cooked	½ cup

MEAT EXCHANGES—LIST 5

One meat exchange is equivalent to one ounce of cooked meat or the size of serving listed below.

Meat and Poultry	
Sliced, medium-fat beef, veal, lamb, pork, ham, poultry, liver, tongue	1 slice 4" x 2" x ⅛"
Minced	2 tbsps. or small patty (3 tbsps. raw)
Chops: lamb	1 small chop, 3 oz. raw with bone
pork or veal	½ medium chop, 4 oz. raw with bone
Steak, beef	4" x 2" x ¼"
Bacon—back or side (crisp)	3 slices
Luncheon-type meats	1 slice, ⅛" thick
Liverwurst, salami, summer sausage	1 slice, ¼" thick (1½"–2" dia.)
Sausages	1½ (16 per lb.)
Wieners	1 (9 per lb.)
Fish	
Fillets and steaks, haddock, halibut, cod, sole, whitefish, salmon	1 piece 2" x 1" x 1"
Canned chicken haddie, crabmeat, lobster, salmon, tuna fish, etc.	¼ cup
Sardines (drained)	3 fish 3" each
Clams, oysters, scallops, plain	3 medium
Shrimps, plain	5 medium
Cheese	
Cheddar or processed	1 cube, 1½" x 1" x 1"
	1 slice (packaged) 3½" x 3½" x ⅛"
Gruyere	1½ sections
Dried, grated (Parmesan)	4 level tbsps.
Cottage	3 tbsps.
Eggs	1 medium

FAT EXCHANGES—LIST 6

One fat exchange is equivalent to the size of serving listed below.

Butter or margarine	1 tsp. or 1 pat 1" x 1" x ¼"
Cooking fat or oil	1 tsp.
French dressing	1 tbsp.
Mayonnaise	1 tsp.

LIST A—FREE FOODS

These foods contain little or no food value and may be used as desired to add zest to your diet.

Approved sweetener
Beverages: artificially sweetened carbonated beverages (only those containing less than 1 cal. per oz.)
clear tea or coffee
Bouillon
Clear broth
Consomme
Flavouring (vanilla, lemon extract)
Watercress
Gelatine: plain
artificially sweetened jelly powders
Horseradish
Mushrooms
Parsley
Rennet tablets
Seasonings, spices and herbs
Vinegar

LIST B—CALORIE POOR FOODS

These foods contain very little food value in the amounts listed below. You may choose two servings of these foods per day in addition to your diet.

Cocoa	1 tsp.
Cranberries, cooked without sugar	1 tbsp.
Cream substitute—non dairy	1 tsp.
Lemon: juice	1 tbsp.
wedge or slice	1 medium
Meat sauces: catsup	1 tsp.
steak sauce	1 tsp.
chili sauce	1 tsp.
Pickles: dill unsweetened	1 medium
sour, mixed	4 pieces
sweet, mixed (diet)	4 pieces
Pimento or chopped green pepper	1 tbsp.
Prepared mustard	1 tsp.

APPENDIX F

RECORDING SHEET FOR DIABETIC EXCHANGE DIET

RECORDING SHEET FOR DIABETIC EXCHANGE DIET

CALORIC LEVEL _____

Fruit (list 3) _____ Exchanges
Meat (list 5) _____ Exchanges
Vegetables (list 2) _____ Exchanges (group A)
(group B)

Milk-skim (list 1) _____ Exchanges
Bread (list 4) _____ Exchanges
Fat (list 6) _____ Exchanges

MENU PATTERN / DAY _____

MEAL/SNACK	EXCHANGE	AMOUNT	MENU
Breakfast			
Snack			
Lunch			
Snack			
Dinner			
Snack			

APPENDIX G

WRITTEN EXERCISE PROGRAM FOR READING WEEK

EXERCISE PROGRAM

Allow approximately twenty-five minutes - use slow to moderate music Do each of the exercises listed below five times unless otherwise specified.

POSITION: Seated cross-legged on the floor.

1) head circles
2) reverse direction
3) head forward and back
4) head side to side

5) shoulder shrugs using both shoulders
6) shoulder shrugs - one shoulder than other shoulder
7) shoulders forward and back - both
8) one shoulder forward the other shoulder back - reverse
9) shoulder rotations - circle them both forward
10) circle them both backwards
11) one shoulder (right one) circling
12) one shoulder (left one) circling

13) arm circles - large circles using both arms
14) reverse direction
15) lift the arms up above the head touching opposite shoulder blade and down to the ground

POSITION: Seated - knees bent - hips and knees rotated outward with the bottoms of the feet together

1) pull body up - sitting tall - arms above head - reach forward - stretch up
2) reach over right leg - stretch up
3) reach over left leg - stretch up
4) gently push leg down to the floor with arms
5) "push through" stretching forward and come up - arms above head
6) "push through" stretching forward and come up - arms stretch back and put hands on the foor behind you - head stretching back also

POSITION: Sitting tall - legs straight out in front of you

1) bend at the waist stretching forward - come up
2) opposite hand holds opposite foot (straight legs) - free

arm swings forward twice and back behind body twice - repeat other side
3) quick toe touching with opposite hand while other arm is flung back - alternating sides
4) "up and over" arm is brought back and circled up and brought forward to touch toes - straight legs - alternating arms as in front crawl in swimming
5) "push through" - come up
6) "push through" - stretch back

SHAKE OUT LEGS

POSITION: Right leg straight forward with left leg bent behind body as in a "L" position

1) sit tall - stretch up - bend over straight leg - come up
2) repeat #1 and ease yourself back so that the shoulders are touching the floor behind you - come up
3) change legs and repeat,

POSITION: Legs spread apart

1) bend from the waist over the right leg and come up (straight back)
2) repeat over left leg
3) sit tall - bend forward reaching through the centre of your legs - come up
4) circle the upper body around starting with right leg, centre, and left leg and up - reach with the arms
5) reverse circle
6) side bends with right arm across body - left arm up - bend over right leg stretching side of body - come up - repeat other side
7) "push through" centre - come up
8) "push through" centre - stretch back
9) grab calf or feet with both hands and pull yourself down to centre - come up

SHAKE OUT LEGS AND BRING THEM TOGETHER

POSITION: Right leg straight out in front (sitting) and left leg bent up

1) rotate left knee across right leg so that the knee touches floor on both sides of the straight leg
2) repeat with other leg

POSITION: Both knees bent up - sitting

1) sitting tall - both knees go to right side then left side

POSTION: Both knees are bent on floor on right side of body

1) side reaches right side - up - then left side
2) repeat with both knees bent on left side of body
3) sitting with knees on left side of body - come up to kneeling position and sit on other side with knees bent on right side of body - repeat to other side

POSITION: On all "fours"

1) bring knee and head together under body then extend leg back and straighten
2) repeat with other leg
3) leg off floor and straight out to one side - swing leg forward and back
4) repeat with other leg
5) bend elbows and stretch body forward and stretch back - then come back to crouching position with arms straight out in front
6) ladies' pushups **DO 10** - stretch back and **DO 5 MORE**

POSITION: Kneeling on one leg with other leg straight out to the side

1) side bends - right side then left side
2) arms straight up and through the centre of the legs
3) repeat #1 and #2 with other leg stretched to the side

POSITION: Sitting with knees bent up - arms back behind you

1) sitting tucks - keeping heels off the floor, extend legs straight out in front of you and bring them back in again **DO 15**
   SHAKE OUT LEGS
2) legs straight out in front of you - "scissors" - make small scissors with the legs by alternating the legs crossing above and below each other - as you are doing this raise the legs up to vertical and then down - do not let them drop to the floor **RAISE AND LOWER LEGS 3 TIMES**
   SHAKE OUT LEGS
3) raise one leg up then the other leg - they are straight and do not touch the floor

4) bend the legs coming in towards the body and extend the out as in a "bicycle"
SHAKE OUT LEGS
5) leg circles - start with legs straight out on the floor bring them up to vertical - open them up and out circling down - do not touch floor
6) reverse the circle
SHAKE OUT LEGS

POSITION: Standing with legs shoulder width apart

1) stretch up with arms above the head - bend forward to centre and touch hands on the floor - come up
2) stretch up with arms above head - bend over right leg - hands on floor - come up
3) repeat #2 bending over left leg
4) bend over right leg, centre, left leg then up
5) repeat #4 starting with left leg
6) stretch up - bend in centre touch floor with hands - go through legs come up
7) circling the body around starting right side passing through centre to left side then up
8) repeat #7 reversing the circle
9) side bends - right side then left side
10) body twists - arms fling out to the side
11) body rotation - hands on hips - lean forward, lean to right side, lean back, lean to left side, repeat upper body circle
12) repeat #11 rotating the other way

POSITION: Standing with right foot forward

1) "lunges" - bend the right leg (forward leg) keeping the left leg straight as arms swing forward on horizontal plane - then straighten forward leg as arms swing backwards
2) repeat with left leg forward

POSITION: Standing with legs apart - shoulder width

1) hands on hips - bend knee twice on right side
2) repeat #1 bending knee twice on left side
3) repeat with only bending once on each side

PUT ON FASTER MUSIC - ALLOW 5 - 7 MINUTES - TRY TO KEEP MOVEMENT CONTINUOUS

1) small jumps on the spot **DO 20**
2) two jumps out - two jumps in **DO 10**
3) one jump out - one jump in **DO 5**
4) add arms - "stride jump" - **DO 10**
5) "stride jumps" change to "leg crosses" - in front - behind - when bringing legs in - **DO 10**
6) kick legs straight out in front - arms flinging up and down **DO 10**
7) kicking legs backwards - arms still moving - **DO 10**
8) legs moving side to side - arms still moving - **DO 10**
9) skipping on spot or around room - **DO 5**
10) skipping backwards - **DO 50**
11) hop **10 TIMES** on one foot
12) hop **10 TIMES** on the other foot
13) jump then kick - on one foot then other foot - **DO 10** on each leg
14) slide steps - **DO 20** - then **DO 20** going the other way
15) running on the spot - count **ONE** every time your foot touches the floor - **DO 76**
16) running on spot with knees high - **DO 20** counting as in #16
17) small jumps on the spot - **DO 10**
18) **DO ONE BIG JUMP** - continue small jumps on spot - **DO 10 MORE** small jumps
19) **DO TWO BIG JUMPS** - continue small jumps on spot - **DO 10 MORE** small jumps
20) **TRY FOR THREE BIG JUMPS** - continue small jumps on spot - **DO 10 MORE** small jumps
SHAKE EVERYTHING OUT

WARMING DOWN: Standing with feet shoulder width apart

1) stretch up and walk out with hands - keeping the knees straight - stretch back - walk the hands back up and stretch up - **DO 5**
2) reach forward stretching the back of the legs - come up - **DO 4**
3) standing - bend elbows - put hands on shoulders - circling with elbows **DO 5** forward - **DO 5** backward
4) hands behind head - bring right leg up and touch left elbow to right knee - repeat with other side - **DO 5** on **EACH** side

POSITION: Sitting on floor with legs straight out in front of you

1) "bum walking" - **DO 15** forward **DO 15** backward
2) repeat #1 - **THREE TIMES**

POSITION: On right side

1) raise left leg **FIVE TMES** and on **FIFTH** time hold on to leg
2) repeat #1 **THREE TIMES**
3) roll over on to left side and repeat #1 and #2

POSITION: Lying on stomach

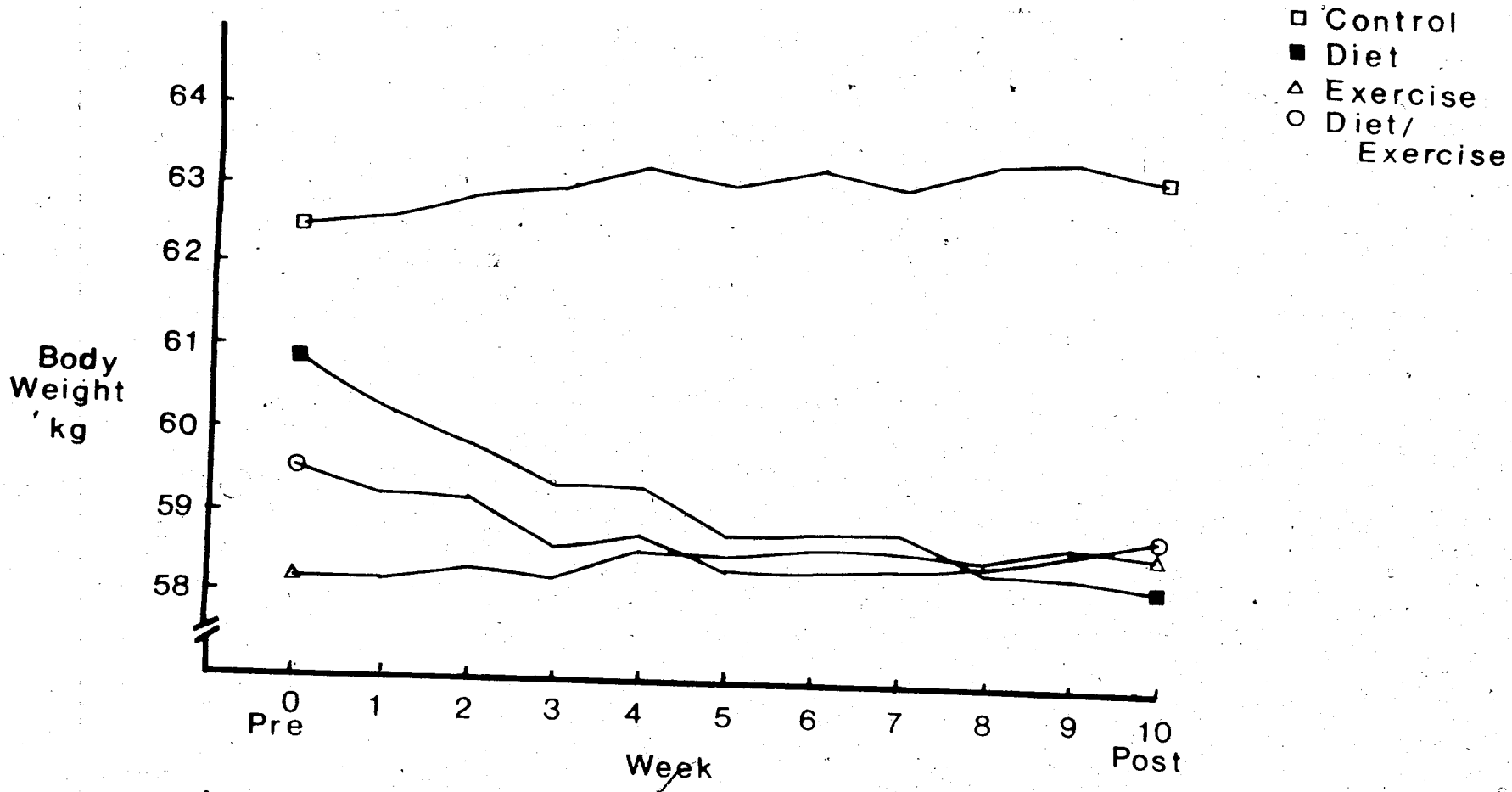
1) raise one leg - **DO 10**
2) raise other leg - **DO 10**
3) raise both legs together - raise **5 TIMES** - on **FIFTH** time **HOLD**
4) repeat #3 **THREE TIMES**
5) front raises - raise the front **5 TIMES** on the **FIFTH** time **HOLD**
6) repeat #5 **THREE TIMES**
7) raise front and legs altogether - raise **THREE TIMES** and on **THIRD TIME HOLD**

SHAKE OUT BODY - ARMS THEN LEGS

THANK YOU - I'm doing these with you in spirit!!

APPENDIX H

AVERAGE WEEKLY WEIGHTS FOR THE FOUR GROUPS



Average Weekly Weight of the Four Groups

APPENDIX I

INSTRUCTIONS FOR OPERATION OF PULMOTEST AND HELIUM-ANALYSER

PRELIMINARY INSTRUCTIONS FOR OPERATION OF GODART PULMOTEST AND HELIUM-ANALYSER FOR THE USE OF THE CLOSED-CIRCUIT HELIUM DILUTION TECHNIQUE

For further information refer to *Godart Pulmotest Manual* and *Concise Instructions Manual* (80A).

1) **FILLING THE ABSORBERS:**

Pull the four plexiglass absorbers from their sockets, located at the right side of the helium-analyser. Remove the top neoprene cap from each of the absorbers. Place a gauze pad (large enough to completely cover the bottom of the tubes) at the bottom of each absorber. Fill the absorbers to approximately 2 cm from the top. The 2 larger absorbers are filled with indicator soda lime and the 2 smaller with anhydrous calcium chloride ($CaCl_2$). Cover each with another gauze pad and replace the neoprene caps. There should be no gauze threads between the plexiglass wall and the neoprene caps. The caps must be secured tightly. Replace the absorbers in their appropriate sockets.

Remove the absorber from the left front panel of the Pulmotest. Dismantle and place a gauze pad (large enough to completely cover the wire mesh) at the bottom of the absorber. Fill the absorber with indicator soda lime to approximately 5-5.5 cm from the top. Replace screws and check that they are tight and secure. Reattach the absorber to the Pulmotest.

2) The "Five-Way valve" on the helium-analyser should be set on closed-circuit (Clos. circ.).

3) The "sensitivity" knob on the analyser should be set at "0.1".

4) Check tubing connections between Pulmotest and helium-analyser. Connecting nipples for the Pulmotest are located at the rear of the apparatus, those of the analyser at the right side of the machine.

Pulmotest "+" to "in" of Analyser
Pulmotest "-" to "out" of Analyser

5) "T"-piece tubing intersects tubing from Pulmotest "-" to Analyser "out". The third part of the "T"-piece should be connected to a helium gas cylinder.

6) The nipple of the Pulmotest labelled "O_2-supply" is connected to an oxygen cylinder.

7) Switch on analyser ("pump" and "mains"). Warm up time is at least **60 MINUTES.**

8) Adjust "current" knob on analyser to 150mA.

9) Turn the small stopcock at the rear of the Pulmotest to the left. Pour distilled water slowly into the top of the left spirometer bell of the Pulmotest. Observe the water level indicator located at the side of the left spirometer bell. Fill until the water level is mid-way between the red lines near the top of the water level

indicator.

10) Level the Pulmotest by turning the large screws located under the front left and right sides of the apparatus. The machine is level when the 'bubble' at the top of the Pulmotest (directly in front of the Kymograph) is exactly centred in the circle indicator.
11) The right side of the Pulmotest is not in use and thus the absorber should be removed (if it hasn't been already). The two 'holes' should be plugged with #5 rubber stoppers.
12) Switch on the Pulmotest starting at the **bottom** of left front panel. All switches on **left** side should be placed in the 'up' position. Allow at least **30 MINUTES** warm up time.
13) Place the "flowmeter" knob at the front of the Pulmotest at "0". Check the "flowmeter" indicator located at the left side of the Pulmotest is at the 'zero' line. If not, calibrate it by turning the "flowmeter corr." knob (also on left side of Pulmotest) until the liquid level registers 'zero'.
14) Switch the same "flowmeter" knob to the 'left'. Adjust the pump speed by slowly turning the large "Regl. Pump" knob (left side of Pulmotest) until flowmeter indicator registers 'zero'.
15) The "Pump Corr." knob at the left side of the Pulmotest should be turned completely to the left.
16) "Stab. stopcock" knob at front of Pulmotest should be "closed" (to right).
17) When both apparatus have warmed up sufficiently, ensure galvanometer needle (top of analyser) rests on 'zero'. If not, adjust "Zero correction" knob (top of Analyser).

DETERMINATION OF DEAD SPACE:

1) Check all absorbers, for appropriate filling - replace chemicals if exhasted.
2) Follow preceding instructions 1 - 16.

Procede as follows:

1) Open two-way stopcock, press left spirometer bell down. Close two-way stopcock.
2) Pull out kymograph knob labelled "kymogr. mm/min" at front of Pulmotest.
3) Rotate kymograph a few mm.
4) Slowly admit approximately 1/2 litre of helium gas into the system. (Watch the left bell rise **slowly**).
5) Open two-way valve quickly while gently pressing down on left spirometer bell returning it to the bottom position. Close the two-way stopcock quickly.

6) After the galvanometer has stabilized, record the reading (C_1).
7) Rotate kymograph drum a few mm. Open two-way stopcock while gently lifting the left spirometer bell until pen reaches approximately the 3 1/2 litre mark. Quickly close the two-way valve.
8) When galvanometer reading stabilizes, record the second reading. This should be less than the first (C_2).
9) Measure the room air volume added to the spirometer with a mm ruler (on kymograph paper).
10) Push in kymograph knob ("Kymogr. mm/min) to clear pen of paper.
11) Air out system - open two-way stopcock and gently press left spirometer bell then gently lift it. Repeat until galvanometer on analyser registers 'zero'.

FORMULA

$$C_1 V_1 = C_2 V_2$$

where:

C_1 = initial helium reading

C_2 = final helium reading

V_1 = x

V_2 = x + the volume measured on kymograph paper ÷ 30 mm

NOTE: 30 measured mm equals one litre on kymograph paper

EXAMPLE:

let:

$C_1 = 90.6$

$C_2 = 59.2$

$V_1 = x$

$V_2 = x + (120 \text{ mm} \div 30 \text{ mm})$

$C_1 V_1 = C_2 V_2$

$90.6x = 59.2 (x + 4.0)$

$90.6x = 59.2x + 236.8$

$31.4x = 236.8$

$$x = 7.54 \text{ litres}$$

$$Vs = 7.54 + 4.0$$

$$Vs = 11.54 \text{ litres}$$

Thus the dead space of the apparatus is 11.54 litres (Vs).

Repeat until galvanometer on analyser registers 'zero'.

Continue as follows:

DETERMINATION OF FUNCTIONAL RESIDUAL CAPACITY (FRC):

1) Pull out kymograph knob ("Kymogr. mm/min") until pen rests on kymograph paper. Gently lift spirometer bell until pen rests on 3 1/2 litre line. Quickly close two-way stopcock.
2) Turn "O_2-supply" knob at front of Pulmotest to "right". Slowly admit oxygen into the system (right bell should rise) to within approximately 8 cm from the top. Return "O_2-supply" knob to "0".
3) Attach mouthpiece to stopcock.
4) Slowly admit 1/2 litre of helium gas into the system (left bell will rise). When galvanometer has stabilized record first helium reading. (C_1). The pen should rest on the **3 litre** line.
5) Subject inserts mouthpiece and applies nose clips. Ensure both are positioned correctly.
6) Record spirometer temperature of Pulmotest and subject's name and the date.
7) Switch kymograph knob ("Kymogr. mm/min") to "30" mm/min.
8) Subject relaxed and breathing normally. Introduce the subject into the apparatus by opening the two-way stopcock at the end of a normal expiration. The pen should rise from the 3 litre mark (on kymograph). It is important that the subject be turned into the machine **exactly** at the end of a normal expiration.
9) Switch stabilizing stopcock ("Stab. stopcock") at front of Pulmotest to "open" position. Regulate the level of O_2-stabilizer by adjusting "Level-stabilizer" knob at left side of Pulmotest.
10) Subject takes series of easy deep relaxed breaths (approximately 6 - 8) to facilitate the mixing of gases in lung and spirometer. Subject returns to normal breathing.
11) Galvanometer should stabilize within approximately 3 - 5 minutes. Record second helium reading. (C_2).

FRC FORMULA:

$$FRC = \frac{C_1 - C_2}{C_2} \times Vs$$

where:

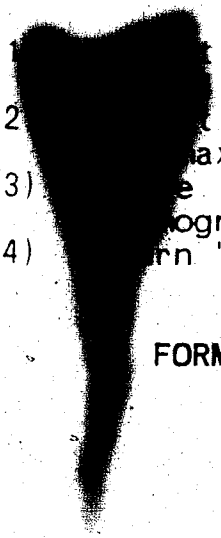
C_1 = initial helium reading

C_2 = second helium reading

Vs = apparatus dead space

Vs = apparatus dead space

VITAL CAPACITY DETERMINATION (VC):



1) [redacted] maximally inhales followed immediately by a expiration. Subject returns to normal breathing.
2) [redacted] exhales as much as possible followed immediately [redacted]aximal inspiration.
3) [redacted] subject from apparatus. Push in kymograph knob [redacted]ogr. mm/min") and return knob to "0" position.
4) [redacted]rn "Stab. stopcock" knob to "closed" position.

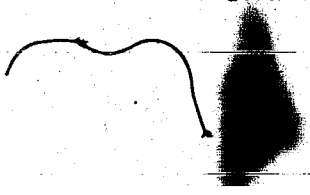
FORMULA:

VC is measured with a mm ruler from the kymograph paper (located on Pulmotest). The largest VC measurement is taken and multiplied by a correction factor at the specified spirometer temperature (Correction factors located Appendix I, Table A) (72).

EXAMPLE:

spirometer temperature	= 27°C
correction factor	= 0.03189
vital capacity	= 170 mm
corrected VC	= 170 mm X 0.03189
	= 5.4213 litres

EXPIRATORY RESERVE VOLUME (ERV):



The ERV measurement is taken from the largest VC recording. A mm ruler measures the distance between the average normal expired breaths to the end of the maximal expiration of the VC.

EXAMPLE:

spirometer temperature	= 27°C
correction factor	= 0.03189
ERV	= 38 mm
corrected ERV	= 38 mm X 0.03189
	= 1.21182 litres

RESIDUAL VOLUME DETERMINATION (RV):

The RV is calculated from the formula:

$$RV = FRC - ERV$$

INSTRUCTION FOR APPARATUS 'SHUT DOWN':

1) Ensure apparatus has 'aired' out for at least 10 munutes. Galvanometer should register "zero".
2) Switch off helium-analyser.
3) Switch off Pulmotest (reverse #2 of *Preliminary Instructions*).
4) Turn small stopcock at rear of Pulmotest to left. (this drains water from bells).
5) Remove top rubber stopper from right side of Pulmotest to let out air from right spirometer bell. Replace stopper.

TABLE A

SPIROMETER TEMPERATURES AND CORRECTION FACTORS

SPIROMETER TEMPERATURES °C	CORRECTION FACTORS
20	0.03306
21	0.03288
22	0.03273
23	0.03255
24	0.03240
25	0.03225
26	0.03204
27	0.03189
28	0.03171
29	0.03153
30	0.03135

TABLE B

WATER TEMPERATURES AND CORRECTION FACTORS FOR WATER DENSITY

WATER TEMPERATURES °C	WATER DENSITY
22	0.9978
23	0.9976
24	0.9973
25	0.9971
26	0.9968
27	0.9965
28	0.9963
29	0.9960
30	0.9957
31	0.9954
32	0.9951
33	0.9947
34	0.9944
35	0.9941

APPENDIX J

CALCULATION PROCEDURE FOR DETERMINING BODY COMPOSITION

CALCULATION PROCEDURE FOR DETERMINING BODY COMPOSITION BY CLOSED-CIRCUIT HELIUM DILUTION TECHNIQUE AND HYDROSTATIC WEIGHING

1) Water Density at Temperature Observed _____

2) Dry Body Weight _____ kg

3) Corrected Vital Capacity _____ l

4) Residual Volume _____ l

5) Volume Gastro-Intestinal Tract* _____ l

6) Submerged Weight = $\dfrac{(8.22 \times \text{chart reading}) - 8.22}{(\quad 75 \quad)}$

= _____ kg (negative value)

7) Total Gas Volume (at 37°C) = (3) + (4) + .1 _____ l

8) Weight Equivalent of Gas Volume
(Total Gas Volume X Dw) (7) X (1) _____ l

9) Corrected Submerged Weight (6) + (8) _____ kg

10) Difference in Air to Water Weight (2) - (9) _____ kg

11) Body Volume (10) ÷ (1) _____

12) Body Density (2) ÷ (11) _____

13) Fat Fraction $\dfrac{4.570 - 4.142}{\text{Db}(12)}$ _____

14) Percent Body Fat (13) X 100 _____ %

15) Fat Weight (13) X (2) _____ kg

16) Fat Free Weight (2) - (15) _____ kg

* Volume of Gas in Gastro-Intestinal tract assumed to be .1 litres
l = litre, kg = kilogram

Revised Aug. 1979, M.F. Mottola

APPENDIX K

APPENDIX K-1: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON BODY WEIGHT

APPENDIX K-2: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON TRICEP SKINFOLD

APPENDIX K-3: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON SUBSCAPULA SKINFOLD

APPENDIX K-4: SUMMARY OF ANCV ON SUPRAILIAC SKINFOLD

APPENDIX K-5: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON UMBILICAL SKINFOLD

APPENDIX K-6: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON PUBIS SKINFOLD

APPENDIX K-7: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON FRONT THIGH SKINFOLD

APPENDIX K-8: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON REAR THIGH SKINFOLD

APPENDIX K-9: SUMMARY OF ANCV ON CALF SKINFOLD

APPENDIX K-1

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON BODY WEIGHT

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.11727600E+02	0.39091997E+01	0.18934745E+01	0.147
ERR	39	0.80519714E+02	0.20646076E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.27873688E+02	0.12690829E+02	0.000
WTH	42	0.21963644E+01		

R SQ= 0.94563890E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.63274933E+02	0.61213654E+02
2	0.58316589E+02	0.57758881E+02
3	0.58690887E+02	0.60744141E+02
4	0.59133255E+02	0.59870387E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES @.9500	@.9900	
CNTRL						
DIET	3.4547	32.332	*.0000	1.7694	2.1784	* p<0.05
EXER	.46940	.54289	.4653	1.8553	2.2842	
DEXER	1.3435	4.7906	*.0342	1.7876	2.2008	
DIET						
EXER	-2.9853	22.734	*.0000	1.8234	2.2449	
DEXER	-2.1112	12.101	*.0012	1.7675	2.1761	
EXER						
DEXER	.87407	1.9841	.1663	1.8071	2.2249	

APPENDIX K-2

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON TRICEP SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F
DIF	3	0.5115858 5E+02	0.17052856E+02	0.32865181E+01
ERR	39	0.20236046E+03	0.51887693E+01	

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.25563553E+02	0.42350636E+01	0.011
WTH	42	0.6 361671E+01		

R SQ= 0.82667679E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.23383316E+02	0.21651169E+02
2	.19749985E+02	0.18562073E+02
3	0.19581802E+02	0.21351486E+02
4	0.18266663E+02	0.19564453E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	3.0891	9.4716	*.0037	2.9231	3.5989
EXER	.29968	.80697 -1	.7778	3.0723	3.7826
DEXER	2.0867	4.1398	*.0482	2.9868	3.6772
DIET					
EXER	-2.7894	7.1032	*.0109	3.0480	3.7526
DEXER	-1.0024	.96903	.3306	2.9654	3.6510
EXER					
DEXER	1.7870	3.0332	.0889	2.9882	3.6790

* $p<0.05$

APPENDIX K-3

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON SUBSCAPULA SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.12328995E+02	0.41096649E+01	0.14415894E+01	0.245
ERR	39	0.11118077E+03	0.28507884E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.16678055E+02	.58714411E+01	0.002
WTH	42	0.29407082E+01		

R SQ= 0.85655338E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.14583333E+02	0.14436011E+02
2	0.14133331E+02	0.12291620E+02
3	0.14354543E+02	0.14836643E+02
4	0.13349995E+02	0.14897072E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA		MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL						
	DIET	2.1444	9.1682	*.0042	2.0625	2.5393
	EXER	-.40064	.31229	.5792	2.0879	2.5705
	DEXER	-.46107	.42384	.5186	2.0625	2.5393
DIET						
	EXER	-2.5450	12.131	*.0012	2.1280	2.6199
	DEXER	-2.6055	12.667	*.0009	2.1319	2.6248
EXER						
	DEXER	-.60432 -1	.70650 -2	.9334	2.0938	2.5779

* $p < 0.05$

APPENDIX K-4

SUMMARY OF ANCV ON SUPRAILIAC SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.19792725E+02	0.65975742E+01	0.84062995E+00	0.476
ERR	39	0.30320093E+03	0.77743826E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.18440018E+02	0.23978195E+01	0.081
WTH	42	0.76906324E+01		

R SQ= .66388196E+1

GRP	UNADJ MEAN	*ADJ MEAN
1	0.14666664E+02	0.12829227E+02
2	0.11941662E+02	0.11024718E+02
3	.12272686E+02	0.14590460E+02
4	0.10316662E+02	0.12279756E+02

APPENDIX K-5

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON UMBILICAL SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.323479 [illegible]E+02	0.10782633E+02	0.91885763E+00	0.441
ERR	39	0.45760064E+03	0.11734688E+02		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.11872241E+03	.10176129E+02	0.0 [illegible]
WTH	42	0.11666870E+02		

R SQ= 0.75180358E+00

GRP	UNADJ MEAN	ADJ MEAN
1	.22774979E+02	.22257763E+02
2	0.17791656E+02	0.15221247E+02
3	0.21409088E+02	0.21490750E+02
4	0.16416656E+02	0.19253052E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	7.0296	24.990	*.0000	4.0952	5.0419
EXER	.56005	.15390	.6968	4.1574	5.1186
DEXER	2.9977	4.4198	*.0416	4.1526	5.1126
DIET					
EXER	-6.4695	19.961	*.0001	4.2170	5.1919
DEXER	-4.0318	7.4764	*.0091	4.2942	5.2870
EXER					
DEXER	2.4377	2.8512	.0987	4.2043	5.1762

* $p < 0.05$

APPENDIX K-6

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON PUBIS SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.57546387E+01	0.19182129E+01	0.13551295E+00	.938
ERR	39	0.55205273E+03	0.14155198E+02		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.52292480E+02	0.39373522E+01	0.015
WTH	42	0.13281128E+02		

R SQ= 0.70811778E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.29333282E+02	0.27679214E+02
2	0.25558316E+02	0.24146835E+02
3	0.29872691E+02	0.29057526E+02
4	0.24166641E+02	0.27929382E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA		MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL						
	DIET	3.5324	5.6351	*.0223	4.3336	5.3354
	EXER	-1.3783	.81854	.3708	4.4368	5.4625
	DEXER	-.25022	.25029	-1 .8751	4.6060	5.6708
DIET						
	EXER	-4.9108	10.408	*.0024	4.4329	5.4578
	DEXER	-3.7826	5.7900	*.0206	4.5780	5.6364
EXER						
	DEXER	1.1281	.50508	.4812	4.6228	5.6915

* $p < 0.05$

APPENDIX K-7

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON FRONT THIGH SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.18817725E+03	0.62725239E+02	0.26068859E+01	0.065
ERR	39	0.93840112E+03	0.24061554E+02		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.75647705E+02	0.29202248E+01	0.050
WTH	42	0.26823286E+02		

R SQ= 0.33412433E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.41166595E+02	0.40544159E+02
2	.37774933E+02	.37183670E+02
3	0.37518127E+02	0.37897766E+02
4	0.33508270E+02	0.34373932E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	3.3605	2.5263	.1195	6.1573	7.5807
EXER	2.6465	1.4835	.2300	6.3276	7.7905
DEXER	6.1703	8.3215	*.0062	6.2292	7.6683
DIET					
EXER	-.71403	.10806	.7440	6.3257	7.7881
DEXER	2.8098	1.7272	.1959	6.2262	7.6656
EXER					
DEXER	3.5238	2.6507	.1110	6.3032	7.7604

* $p < 0.05$

APPENDIX K-8

SUMMARY OF ANCV AND SCHEFFE CONTRASTS OF REAR THIGH SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.46352783E+02	0.15450928E+02	0.57533568E+00	0.635
ERR	39	0.10473647E+04	0.26855509E+02		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.84928131E+02	0.32613363E+01	0.031
WTH	42	0.26040894E+02		

R SQ= 0.23246628E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.31649903E+02	0.30464316E+02
2	0.28666626E+02	0.28517853E+02
3	0.29272705E+02	0.30464509E+02
4	0.24533295E+02	0.24775177E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA		MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900	
CNTRL							
	DIET	1.9465	.85630	.3601	6.1258	7.5420	
	EXER	-.13457 -3	.36352 -8	1.0000	6.5000	8.0027	
	DEXER	5.6892	7.1922	* .0104	6.1780	7.6062	* p<0.05
DIET							
	EXER	-1.9466	.80992	.3733	6.2992	7.7555	
	DEXER	3.7427	3.2187	.0800	6.0754	7.4799	
EXER							
	DEXER	5.6893	7.0239	* .0113	6.2517	7.6969	

APPENDIX K-9

SUMMARY OF ANCV ON [illegible] SKINFOLD

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.22351831E+03	0.74506104E+02	0.28882732E+01	0.048
ERR	39	0.10060471E+04	0.25796066E+02		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.58166504E+02	0.19868755E+01	0.131
WTH	42	0.29275360E+02		

R SQ= 0.35926759E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.40999954E+02	0.39569550E+02
2	0.37749954E+02	0.37730881E+02
3	0.36190842E+02	0.39074387E+02
4	0.33974930E+02	0.34614471E+02

APPENDIX L

APPENDIX L-1: SUMMARY OF ANCV ON UPPER ARM CIRCUMFERENCE

APPENDIX L-2: SUMMARY OF ANCV ON BUST CIRCUMFERENCE

APPENDIX L-3: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON WAIST CIRCUMFERENCE

APPENDIX L-4: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON HIP CIRCUMFERENCE

APPENDIX L-5: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON THIGH CIRCUMFERENCE

APPENDIX L-6: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON CALF CIRCUMFERENCE

APPENDIX L-1

SUMMARY OF ANCV ON UPPER ARM CIRCUMFERENCE

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.39625214E+02	0.13208405E+02	0.77080488E+01	0.000
ERR	39	0.66829880E+02	0.17135859E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.56498566E+01	0.22290516E+01	0.099
WTH	42	0.25346451E+01		

R SQ= 0.38436067E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.28199966E+02	0.28014648E+02
2	.26474945E+02	0.26335312E+02
3	0.27463623E+02	0.27181412E+02
4	0.26549957E+02	0.27133575E+02

APPENDIX L-2

SUMMARY OF ANCV ON BUST CIRCUMFERENCE

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.13382339E+02	0.44607792E+01	0.10353212E+01	0.388
ERR	39	0.16803514E+03	0.43085928E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.63983555E+01	0.14812841E+01	0.233
WTH	42	0.43194637E+01		

R SQ= 0.80929768E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.89733231E+02	0.89560806E+02
2	0.89091614E+02	0.87857483E+02
3	0.86336258E+02	0.89106094E+02
4	.878 8243E+02	0.8850885 E+02

APPENDIX L-3

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON WAIST CIRCUMFERENCE

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.43229980E+02	0.14409993E+02	0.12719707E+01	0.297
ERR	39	0.44182568E+03	0.11328863E+02		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.44714922E+02	0.39717756E+01	0.016
WTH	42	0.11548944E+02		

R SQ= 0.68250322E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.77799927E+02	0.76344711E+02
2	0.73166580E+02	0.71660049E+02
3	0.72418091E+02	0.73469971E+02
4	0.72016617E+02	0.74014145E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	4.6846	11.398	* .0016	4.0410	4.9752
EXER	2.8749	3.9687	.0529	4.2026	5.1742
DEXER	2.3308	2.6404	.1117	4.1773	5.1430
DIET					
EXER	-1.8098	1.5706	.2171	4.2055	5.1778
DEXER	-2.3538	2.6878	.1086	4.1813	5.1479
EXER					
DEXER	-.54408	.14635	.7040	4.1419	5.0994

* $p<0.05$

APPENDIX L-4

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON HIP CIRCUMFERENCE

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.11502930E+02	0.38343096E+01	0.92888832E+00	0.436
ERR	39	0.16098608E+03	0.41278477E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.26445389E+02	0.64392372E+01	0.001
WTH	42	0.41068811E+01		

R SQ= 0.79468644E+00

GRP	UNADJ MEAN	ADJ MEAN
1	.98833267E+02	0.97609694E+02
2	0.94716583E+02	0.94368576E+02
3	0.95527213E+02	0.96640610E+02
4	0.94316589E+02	0.94958901E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES ●.9500	●.9900
CNTRL					
DIET	3.2410	15.283	*.0003	2.4143	2.9724
EXER	.96849	1.2602	.2680	2.5125	3.0933
DEXER	2.6504	9.9792	*.0029	2.4434	3.0082
DIET					
EXER	-2.2725	7.1233	*.0108	2.4796	3.0529
DEXER	-.59056	.50650	.4806	2.4166	2.9753
EXER					
DEXER	1.6819	3.9595	.0531	2.4615	3.0306

* p<0.05

APPENDIX L-5

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON THIGH CIRCUMFERENCE

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.59567871E+01	0.19855957E+01	0.23855996E+00	0.869
ERR	39	0.32460693E+03	0.83232546E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.23437897E+02	0.29779177E+01	0.042
WTH	42	0.78705645E+01		

R SQ= 0.43984115E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.58893255E+02	0.57777527E+02
2	0.54309243E+02	0.54687851E+02
3	0.54776282E+02	0.55219208E+02
4	0.56616678E+02	0.56900009E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	3.0905	6.9274	*.0118	3.4195	4.2101
EXER	2.5592	4.5231	*.0394	3.5044	4.3145
DEXER	.87832	.56296	.4573	3.4091	4.1973
DIET					
EXER	-.53130	.20578	.6524	3.4109	4.1994
DEXER	-2.2122	3.7297	.0602	3.3359	4.1071
EXER					
DEXER	-1.6809	2.0583	.1588	3.4120	4.2008

* $p < 0.05$

APPENDIX L-6

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON CALF CIRCUMFERENCE

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.10262745E+01	0.33420813E+00	0.49045390E+00	0.691
ERR	39	0.26575623E+02	0.68142617E+00		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.22059631E+01	0.33595476E+01	0.028
WTH	42	0.65662491E+00		

R SQ= 0.85319734E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.36216629E+02	0.35635667E+02
2	0.34766632E+02	0.34668948E+02
3	0.35054474E+02	0.35297195E+02
4	0.34533295E+02	0.35051437E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	1.0247	9.5464	* .0035	.96584	1.1891
EXER	.33638	.96707	.3310	.99617	1.2265
DEXER	.58212	2.9670	.0923	.98420	1.2117
DIET					
EXER	-.68832	4.1244	* .0486	.98705	1.2152
DEXER	-.44258	1.7628	.1914	.97079	1.1952
EXER					
DEXER	.24574	.52726	.4718	.98556	1.2134

* $p < 0.05$

APPENDIX M

APPENDIX M-1: SUMMARY OF ANCV ON FAT-FREE WEIGHT

APPENDIX M-2: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON BODY DENSITY

APPENDIX M-3: SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON PERCENT BODY FAT

APPENDIX M-1

SUMMARY OF ANCV ON FAT-FREE WEIGHT

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.12369537E+02	0.41231785E+01	0.14062297E+01	0.255
ERR	39	0.11435117E+03	0.29320687E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.64456377E+01	0.21363258E+01	0.110
WTH	42	0.30171595E+01		

R SQ= 0.87214458E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.46516617E+02	0.44960805E+02
2	0.44574951E+02	0.45416199E+02
3	0.44881767E+02	0.46149414E+02
4	0.47058243E+02	0.46610748E+02

APPENDIX M-2

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON BODY DENSITY

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.12913696E-03	0.43045642E-04	0.12677269E+01	0.299
ERR	39	0.13242441E-02	0.33954973E-04		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.23795718E-03	0.68765182E+01	0.001
WTH	42	0.34604309E-04		

R SQ= 0.59295392E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.10381660E+01	0.10386029E+01
2	0.10435829E+01	0.10426566E+01
3	0.10434542E+01	0.10431643E+01
4	0.10522499E+01	0.10479755E+01

SCHEFFE CONTRASTS

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900
CNTRL					
DIET	-.90910 -2	13.714	* .0006	.71491 -2	.88019 -2
EXER	-.45631 -2	3.4259	.0712	.71796 -2	.88394 -2
DEXER	-.93691 -2	14.229	* .0005	.72333 -2	.89055 -2
DIET					
EXER	.45279 -2	3.2105	.0804	.73593 -2	.90607 -2
DEXER	-.27806 -3	.11114 -1	.9165	.76813 -2	.94571 -2
EXER					
DEXER	-.48060 -2	3.6491	.0629	.73269 -2	.90207 -2

* $p < 0.05$

APPENDIX M-3

SUMMARY OF ANCV AND SCHEFFE CONTRASTS ON PERCENT BODY FAT

TEST FOR HOMOGENEITY OF REGRESSION

SOURCE	DF	SS	MS	F	P
DIF	3	0.23517426E+02	0.78391418E+01	0.13521605E+01	0.272
ERR	39	0.22610220E+03	0.57974920E+01		

ADJUSTED ANALYSIS OF VARIANCE

SOURCE	DF	MS	ADJ F	P
GRP	3	0.43194336E+02	0.72677059E+01	0.000
WTH	42	0.59433241E+01		

R SQ= 0.60246211E+00

GRP	UNADJ MEAN	ADJ MEAN
1	0.26059781E+02	0.25917603E+02
2	0.23705826E+02	0.21936417E+02
3	0.23870880E+02	0.24067996E+02
4	0.22211655E+02	0.22196854E+02

SCHEFFE CONTRASTS

PAIRWISE STRATA		MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES .9500	.9900	
CNTRL							
	DIET	3.9813	15.351	*.0003	2.9593	3.6434	* p<0.05
	EXER	1.9096	3.5176	.0677	2.9652	3.6506	
	DEXER	3.9290	14.733	* .0004	2.9811	3.6702	
DIET							
	EXER	-2.0717	3.9279	.0541	3.0441	3.7479	
	DEXER	-.52216 -1	.22949 -2	.9620	3.1743	3.9082	
EXER							
	DEXER	2.0194	3.7839	.0585	3.0234	3.7223	

APPENDIX N

APPENDIX N-1: RAW DATA OF CONTROL GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

APPENDIX N-2: RAW DATA OF DIET GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

APPENDIX N-3: RAW DATA OF EXERCISE GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

APPENDIX N-4: RAW DATA OF DIET/EXERCISE GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

APPENDIX N-5: RAW DATA OF CONTROL GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

APPENDIX N-6: RAW DATA OF DIET GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

APPENDIX N-7: RAW DATA OF EXERCISE GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

APPENDIX N-8: RAW DATA OF DIET/EXERCISE GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

APPENDIX N-9: RAW DATA OF CONTROL GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

APPENDIX N-10: RAW DATA OF DIET GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

APPENDIX N-11: RAW DATA OF EXERCISE GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

APPENDIX N-12: RAW DATA OF DIET/EXERCISE GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

APPENDIX N-1

RAW DATA OF CONTROL GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

Subject No.	Tricep		Subscapula		Suprailiac		Umbilical		Pubis		Front Thigh		Rear Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	24.8	29.3	19.9	20.6	16.1	20.9	17.5	25.1	33.3	36.3	49.1	50.7	42.0	36.5	49.1	54.5
2	22.0	20.6	10.8	10.5	10.9	8.4	13.9	9.7	20.7	17.0	43.7	46.7	41.1	38.4	44.1	37.8
3	20.3	26.7	09.3	09.6	21.5	11.7	20.2	22.6	24.7	29.4	23.1	36.4	31.2	31.5	36.7	38.9
4	24.0	29.7	16.5	19.1	15.6	18.5	23.7	28.7	33.4	34.9	46.3	39.7	38.2	33.3	41.5	40.2
6	21.5	20.6	15.0	16.3	16.4	17.2	19.5	19.4	28.8	26.9	41.6	39.9	32.3	30.0	38.1	41.2
7	17.3	15.7	16.3	14.1	12.1	12.5	22.7	23.0	31.2	31.1	35.1	32.2	23.0	27.1	33.2	36.6
8	12.5	13.2	11.3	11.0	13.2	10.7	18.4	21.5	27.9	25.9	45.9	40.0	27.7	25.1	39.7	37.3
10	20.1	22.6	10.6	10.3	12.7	13.3	23.0	22.5	29.9	28.6	42.9	48.5	23.0	37.2	38.4	48.7
11	19.6	19.1	17.1	15.6	17.4	16.2	19.0	22.3	37.4	26.3	42.4	38.3	22.8	18.5	42.3	43.4
12	19.4	21.0	18.4	18.2	13.7	15.5	26.4	25.4	38.9	34.1	43.1	44.7	26.5	27.3	37.7	41.7
13	30.2	38.9	11.1	12.4	11.1	13.5	11.7	24.3	27.4	26.3	43.6	40.3	34.4	38.5	48.5	40.3
20	24.9	23.2	16.5	17.3	16.9	17.6	24.1	28.8	31.3	35.2	32.6	36.6	31.1	36.4	27.9	31.4
$\bar{X}$	21.4	23.4	14.4	14.6	14.8	14.7	20.0	22.8	29.6	29.3	40.8	41.2	31.1	31.7	39.8	41.0
SD	±4.23	±6.64	±3.42	±3.64	±2.96	±3.46	±4.12	±4.75	±4.40	±5.23	±6.88	±5.21	±5.21	±6.00	±5.73	±5.70

APPENDIX N-2

RAW DATA OF DIET GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

Subject No.	Tricep		Subscapula		Suprailiac		Umbilical		Pubis		Front Thigh		Rear Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	18.2	20.5	17.9	17.6	10.9	10.2	17.9	18.2	25.8	25.7	42.3	42.4	27.9	27.7	40.7	35.5
2	26.7	26.5	13.9	13.3	13.3	09.7	21.2	17.6	32.9	32.1	40.1	41.1	22.5	34.4	33.5	40.3
3	23.7	21.7	13.5	09.9	14.1	10.9	20.7	14.1	24.3	19.6	42.3	40.4	32.9	36.7	41.8	44.1
4	26.1	27.6	21.9	20.1	21.1	25.7	23.5	20.4	37.2	33.3	48.3	40.7	22.5	35.3	46.4	41.5
5	14.8	14.5	07.6	07.7	09.7	09.6	20.1	19.1	27.6	25.5	21.5	35.9	23.5	23.1	25.0	32.7
6	15.0	13.3	09.5	08.2	09.3	06.7	16.7	13.5	28.3	23.4	43.7	37.7	29.0	22.1	42.3	41.1
7	22.1	22.3	17.8	16.7	09.7	10.5	21.9	13.3	25.2	23.9	43.7	40.9	23.9	23.8	34.1	37.4
8	13.1	11.2	09.7	09.5	06.3	05.2	18.9	10.3	31.7	23.5	47.3	33.7	36.1	19.5	40.1	30.7
9	15.5	14.9	25.3	22.1	19.6	15.2	33.0	26.7	35.6	31.9	32.1	29.7	15.8	32.3	23.5	36.7
10	32.0	29.9	26.9	21.9	27.2	21.4	39.7	36.5	37.3	34.3	48.7	39.9	33.7	30.9	43.2	45.3
11	16.3	16.5	12.6	12.0	09.0	07.9	12.5	11.7	21.7	17.5	36.5	36.1	36.7	28.4	37.5	32.5
15	26.4	18.1	19.4	10.6	14.2	10.3	21.4	12.1	23.6	15.4	42.2	34.8	40.4	38.8	40.6	35.2
$\bar{X}$	20.8	19.8	16.3	14.1	13.7	11.9	22.3	17.8	29.3	25.5	40.7	37.8	28.7	28.7	37.4	37.8
SD	±5.87	±9.77	±6.00	±5.10	±5.83	±5.76	±6.99	±7.16	±5.27	±6.02	±7.37	±3.64	±7.03	±6.20	±6.83	±4.52

APPENDIX N-3

RAW DATA OF EXERCISE GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

Subject No.	Tricep		Subscapula		Suprailiac		Umbilical		Pubis		Front Thigh		Rear Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	21.3	23.3	17.1	16.1	19.7	18.4	29.7	27.5	33.5	33.7	44.1	44.3	29.0	22.7	35.5	39.5
2	11.1	12.9	11.1	12.1	08.4	11.7	14.3	17.5	24.2	25.8	43.6	38.7	22.4	26.9	44.7	46.5
3	12.5	13.9	08.7	09.1	10.4	09.9	19.5	23.1	31.7	30.1	38.9	36.5	23.0	29.5	35.6	40.3
4	14.8	17.6	17.8	19.7	08.7	09.7	12.3	11.3	23.1	24.8	37.9	37.1	24.1	28.4	37.6	43.7
5	18.5	19.8	19.0	18.8	13.8	13.9	17.5	19.6	28.2	28.8	43.7	47.5	24.9	22.9	47.3	40.1
7	32.9	33.9	18.8	17.3	14.3	15.6	26.1	22.6	34.6	34.3	39.4	41.5	36.7	37.3	35.7	44.9
9	21.8	24.7	06.1	08.5	06.1	07.9	08.1	10.9	18.2	20.7	44.7	42.7	25.0	32.3	33.7	42.4
10	12.5	15.4	07.7	08.2	05.7	07.2	08.0	16.4	18.1	20.8	26.6	33.0	22.1	36.8	20.2	35.4
11	13.5	16.4	14.6	17.2	16.0	17.0	26.0	29.2	34.6	38.8	31.9	31.8	23.1	27.6	35.7	30.6
12	14.2	15.7	13.5	16.0	14.1	16.8	27.4	33.3	37.7	40.4	41.9	25.6	20.1	25.4	42.1	34.3
13	22.6	21.8	16.1	14.9	10.1	17.4	21.3	24.1	31.7	30.4	35.3	34.0	32.1	32.2	26.5	22.4
$\bar{X}$	17.8	19.6	13.7	14.4	11.6	13.2	19.1	21.4	28.7	29.9	38.9	37.5	25.7	29.3	35.9	38.2
SD	±6.12	±5.83	±4.42	±4.00	±4.16	±3.91	±7.38	±6.79	±6.51	±6.29	±5.47	±6.02	±4.73	±4.74	±7.32	±6.75

APPENDIX N-4

RAW DATA OF DIET/EXERCISE GROUP ON SKINFOLD MEASUREMENT (mm) PRE AND POST PROGRAM

Subject No.	Tricep		Subscapula		Suprailiac		Umbilical		Pubis		Front Thigh		Rear Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	12.1	10.9	09.1	08.1	05.5	04.3	09.8	06.0	14.2	08.7	30.8	23.3	28.8	18.0	24.8	18.0
2	18.4	19.2	16.9	19.1	12.8	18.6	19.4	22.3	21.5	34.4	43.0	45.1	27.4	26.9	36.3	38.0
3	25.9	22.5	15.5	14.3	17.1	14.3	24.7	26.7	31.3	29.9	48.2	44.3	25.6	16.7	38.3	45.9
4	19.1	18.4	11.0	11.3	07.4	06.3	14.5	14.4	22.9	23.4	28.5	21.4	21.4	22.6	27.9	20.1
5	22.6	22.7	16.4	19.3	12.5	12.7	20.5	20.1	21.1	29.5	37.6	36.5	36.5	34.5	44.1	38.3
6	15.5	17.1	09.8	10.1	05.3	06.1	10.7	10.7	21.6	19.7	37.5	20.5	24.7	25.0	38.4	37.5
7	12.4	15.1	09.7	13.1	05.3	05.9	06.9	08.3	12.7	15.7	39.5	35.9	25.0	23.0	37.5	33.1
8	22.1	22.0	11.4	12.5	11.2	13.9	20.5	18.1	28.5	27.7	44.7	39.9	40.0	32.7	44.9	44.7
9	23.8	23.3	20.9	21.5	17.3	16.1	27.6	27.1	33.6	33.1	34.8	32.3	30.6	24.0	34.7	30.3
10	16.6	16.5	11.1	11.9	08.9	07.7	14.3	16.3	25.9	26.1	45.2	38.5	23.3	22.7	31.7	32.2
11	14.9	15.4	09.7	10.9	12.7	11.7	16.7	19.9	31.0	27.9	33.7	27.1	20.7	23.4	42.1	37.3
12	15.9	16.1	08.1	08.1	07.1	06.2	09.5	07.1	22.1	13.9	32.5	37.3	30.2	24.9	34.9	32.3
$\bar{X}$	18.3	18.3	12.5	13.4	10.3	10.3	16.3	16.4	23.9	24.2	38.0	33.5	27.9	24.5	36.3	34.0
SD	±4.31	±3.65	±3.80	±4.23	±4.15	±4.58	±6.18	±6.96	±6.24	±7.71	±5.98	±8.21	±5.58	±4.89	±5.85	±8.08

APPENDIX N-5

RAW DATA OF CONTROL GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

Subject No.	Upper Arm		Bust		Waist		Hip		Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	31.1	31.4	95.3	93.3	76.5	80.5	101.7	101.0	56.1	62.0	36.4	37.8
2	26.1	27.0	86.6	86.1	69.7	73.2	98.4	95.8	54.5	54.6	37.6	37.4
3	27.7	28.5	84.7	87.9	71.4	76.2	103.8	107.1	56.8	67.8	37.0	35.0
4	30.3	31.0	96.3	95.9	81.9	87.7	100.6	99.0	55.9	61.5	39.4	39.7
6	26.9	25.7	90.1	86.6	73.5	75.4	96.6	96.2	56.8	56.5	36.2	35.7
7	27.4	26.6	83.1	80.9	70.2	72.6	95.5	93.7	57.3	54.8	31.1	30.5
8	28.5	27.5	87.8	91.4	71.4	77.7	100.4	99.1	59.1	58.1	37.5	37.2
10	28.9	29.0	94.9	95.4	75.1	87.0	98.8	99.4	58.6	59.6	36.2	36.9
11	26.0	25.4	88.3	86.9	69.5	70.0	94.2	95.0	56.3	56.0	35.4	35.5
12	29.2	27.7	98.5	97.9	79.5	81.1	98.5	96.4	55.7	57.7	38.1	37.1
13	29.2	30.4	91.6	89.7	76.4	80.8	99.9	103.5	61.4	63.7	38.2	38.2
20	28.7	28.2	86.8	84.8	78.3	71.4	101.1	99.8	51.7	54.3	31.7	33.6
$\bar{X}$	28.3	28.2	90.3	89.7	74.5	77.8	99.1	98.8	56.7	58.9	36.2	36.2
SD	±1.51	±1.88	±4.75	±4.91	±3.97	±5.54	±2.61	±3.64	±2.31	±4.00	±2.40	±2.31

APPENDIX N-6

RAW DATA OF DIET GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

Subject No.	Upper Arm		Bust		Waist		Hip		Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	26.5	26.5	90.7	88.3	70.0	72.5	101.5	99.1	53.0	57.1	38.0	37.3
2	29.6	28.7	94.5	93.2	76.6	75.1	101.9	99.1	56.2	57.5	33.9	32.1
3	27.4	25.8	86.5	84.2	72.2	69.2	99.5	95.0	59.1	57.0	34.4	33.0
4	29.0	27.7	100.0	97.9	82.9	80.6	98.5	98.1	59.1	57.2	37.1	38.2
5	25.1	25.2	86.5	82.2	67.6	68.3	92.6	91.2	51.0	53.8	36.0	34.0
6	26.7	25.2	95.6	79.9	79.9	76.9	101.0	95.6	51.6	51.7	36.9	35.3
7	28.7	28.2	88.6	87.4	74.1	74.2	96.5	94.5	54.4	54.8	38.7	37.3
8	26.4	25.4	91.6	86.5	74.9	70.3	103.2	97.5	57.5	56.1	37.0	35.3
9	36.1	25.9	102.6	98.6	83.1	81.3	83.4	81.1	44.9	46.1	34.0	33.1
10	30.4	28.4	93.4	91.0	82.3	78.1	101.4	94.9	58.0	56.6	33.5	32.6
11	26.7	26.4	89.0	88.1	66.0	69.0	99.8	96.4	55.6	53.5	31.8	31.5
15	26.2	24.3	80.2	81.5	64.5	62.5	98.0	93.3	53.1	50.3	37.9	37.5
$\bar{X}$	28.2	26.5	91.6	89.1	74.5	73.2	98.1	94.7	54.6	54.3	35.8	34.8
SD	±2.81	±1.39	±5.90	±5.24	±6.36	±5.35	±5.21	±4.73	±4.01	±3.33	±2.08	±2.27

APPENDIX N-7

RAW DATA OF EXERCISE GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

Subject No.	Upper Arm		Bust		Waist		Hip		Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	30.0	29.8	92.1	87.5	76.5	76.3	104.0	103.1	57.7	59.1	37.6	37.5
2	22.3	23.2	85.6	86.8	64.4	64.3	92.1	91.2	52.1	53.5	32.6	32.8
3	27.5	25.3	85.3	83.3	65.8	68.4	90.5	90.2	50.7	51.8	34.2	33.9
4	28.7	28.7	91.3	94.6	76.4	75.7	97.1	95.1	57.2	56.8	34.6	34.4
5	26.6	26.5	86.4	86.4	72.0	74.1	90.6	91.5	54.4	55.7	34.8	35.0
7	31.6	30.6	94.3	89.9	78.2	79.9	100.0	99.9	56.4	61.0	38.7	38.2
9	25.8	26.5	86.1	88.7	64.6	70.6	93.7	94.5	50.2	56.1	32.5	33.0
10	27.7	29.3	86.6	87.6	70.1	70.0	96.8	99.6	53.5	53.6	36.8	36.2
11	28.5	27.9	90.8	88.6	69.1	70.8	94.5	91.7	56.0	52.3	35.1	34.3
12	36.6	26.3	89.2	87.7	67.2	67.4	94.6	93.1	54.7	49.1	34.5	33.1
13	30.5	28.0	93.6	90.6	83.3	79.1	107.9	102.0	56.4	53.1	37.2	37.2
$\bar{X}$	28.6	27.5	89.2	88.2	71.6	72.4	96.5	95.6	54.5	54.7	35.3	35.1
SD	±3.56	±2.06	±3.21	±2.86	±5.95	±4.75	±5.26	±4.47	±2.46	±3.26	±1.92	±1.84

APPENDIX N-8

RAW DATA OF DIET/EXERCISE GROUP ON CIRCUMFERENCE MEASUREMENT (cm) PRE AND POST PROGRAM

Subject No.	Upper Arm		Bust		Waist		Hip		Thigh		Calf	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	24.6	24.1	87.9	82.8	67.1	63.5	97.1	91.2	49.7	53.3	35.2	34.0
2	31.1	31.6	95.6	93.6	76.7	83.2	96.7	96.0	56.9	58.0	35.2	35.5
3	27.3	26.4	92.7	90.3	75.3	72.2	99.9	96.0	57.6	57.9	35.0	33.6
4	24.5	24.6	84.2	83.3	62.9	64.3	89.0	86.5	47.3	50.5	32.1	31.9
5	28.9	28.1	97.4	93.2	73.1	78.4	100.5	99.9	57.6	62.2	37.2	36.6
6	26.4	26.7	85.1	84.5	70.7	70.9	98.5	95.6	56.6	56.5	37.1	36.0
7	23.7	24.4	80.8	82.5	62.3	66.0	92.3	93.8	51.4	54.7	33.3	34.1
8	28.2	28.4	90.9	92.2	77.7	86.2	102.3	101.5	62.3	63.2	36.6	36.7
9	28.7	29.0	94.6	93.3	71.5	69.7	101.3	96.2	54.8	59.0	35.4	34.4
10	26.0	25.3	90.9	90.8	70.8	69.2	93.2	89.8	54.7	55.2	34.5	34.5
11	24.0	23.9	86.0	85.1	72.4	72.7	93.7	91.9	54.5	54.6	32.5	32.4
12	26.4	26.1	85.4	82.1	65.8	67.9	98.5	93.4	53.7	54.3	36.2	34.7
$\bar{X}$	26.7	26.6	89.2	87.8	70.5	72.0	97.0	94.3	54.7	56.6	35.0	34.5
SD	±2.18	±2.25	±4.93	±4.58	±4.86	±6.88	±3.97	±4.00	±3.77	±3.50	±1.62	±1.44

APPENDIX N-9

RAW DATA OF CONTROL GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

Subject No.	Body Weight		Fat Free Weight		Body Density		Percent Body Fat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	65.2	67.5	46.7	47.2	1.033	1.029	28.34	30.06
2	62.6	61.9	47.9	45.7	1.044	1.038	23.53	26.12
3	63.5	65.7	48.7	46.5	1.045	1.041	23.27	24.87
4	70.8	72.6	54.1	52.6	1.044	1.035	23.58	27.54
6	58.6	58.3	43.8	43.4	1.040	1.039	25.29	25.61
7	49.8	50.6	36.3	36.3	1.035	1.034	27.16	27.59
8	63.9	64.2	45.9	49.2	1.033	1.045	28.14	23.33
10	66.7	69.5	48.5	51.4	1.035	1.038	27.24	26.06
11	53.2	52.1	40.5	40.1	1.043	1.045	23.89	23.09
12	65.9	65.2	47.7	49.2	1.034	1.042	27.60	24.48
13	65.7	68.5	48.6	50.9	1.038	1.039	25.97	25.77
20	64.0	63.2	44.2	45.4	1.027	1.033	30.93	28.09
$\bar{X}$	62.5	63.3	46.1	46.5	1.038	1.038	26.25	26.05
SD	±5.66	±6.41	±4.33	±4.53	±.0054	±.0046	±2.30	±1.94

APPENDIX N-10

RAW DATA OF DIET GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

Subject No.	Body Weight		Fat Free Weight		Body Density		Percent Body Fat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	58.4	57.2	41.1	41.7	1.030	1.036	29.69	27.09
2	64.2	61.9	44.8	44.0	1.028	1.031	30.22	29.00
3	55.9	53.7	42.2	43.6	1.042	1.055	24.51	18.89
4	70.0	69.3	47.4	54.6	1.023	1.050	32.34	21.23
5	58.0	56.8	44.3	44.6	1.044	1.049	23.61	21.41
6	65.0	61.3	49.4	50.2	1.043	1.057	24.03	18.14
7	63.6	61.8	49.6	50.7	1.048	1.057	21.99	18.01
8	64.7	59.7	48.3	49.0	1.040	1.057	25.36	18.01
9	54.9	51.6	38.4	38.8	1.029	1.041	30.10	24.84
10	64.0	58.9	41.9	40.9	1.018	1.027	34.56	30.61
11	57.9	56.1	40.3	40.6	1.028	1.034	30.40	27.67
15	54.6	51.5	37.3	36.2	1.025	1.029	31.67	29.75
$\bar{X}$	60.9	58.3	43.8	44.6	1.033	1.044	28.21	23.72
SD	±4.71	±4.81	±4.05	±5.26	±.009	±.011	±3.91	±4.75

APPENDIX N-11

RAW DATA OF EXERCISE GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

Subject No.	Body Weight		Fat Free Weight		Body Density		Percent Body Fat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	66.2	65.9	44.1	44.9	1.021	1.025	33.45	31.89
2	50.0	52.2	38.3	39.3	1.044	1.041	23.38	24.78
3	48.6	48.3	38.3	38.8	1.050	1.053	21.15	19.69
4	60.8	59.8	46.1	46.9	1.042	1.049	24.19	21.64
5	57.8	59.8	45.3	48.0	1.049	1.053	21.62	19.78
7	69.9	69.5	51.3	50.3	1.037	1.034	26.60	27.68
9	50.4	53.2	37.0	41.1	1.037	1.046	26.59	22.78
10	59.0	59.5	[illegible].3	47.2	1.041	1.046	24.86	22.68
11	60.5	60.0	45.7	49.7	1.042	1.056	24.46	18.77
12	64.7	64.2	39.2	40.1	1.039	1.041	25.49	24.98
13	52.6	53.2	47.1	47.4	1.021	1.034	33.34	27.91
$\bar{X}$	58.2	58.7	43.3	44.9	1.039	1.044	25.92	23.87
SD	±6.79	±6.14	±4.31	±4.08	±.0092	±.0091	±3.89	±3.87

APPENDIX N-12

RAW DATA OF DIET/EXERCISE GROUP ON BODY WEIGHT (kg), FAT-FREE WEIGHT (kg), BODY DENSITY AND PERCENT BODY FAT PRE AND POST PROGRAM

Subject No.	Body Weight		Fat Free Weight		Body Density		Percent Body Fat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	56.2	53.5	44.0	45.5	1.049	1.065	21.64	15.00
2	63.9	65.5	47.7	51.4	1.040	1.049	25.40	21.53
3	63.6	60.4	45.7	46.9	1.033	1.047	28.19	22.32
4	47.0	47.2	36.6	37.4	1.048	1.051	22.09	20.82
5	68.3	67.6	46.8	49.5	1.033	1.036	28.25	26.85
6	63.8	64.3	51.1	53.9	1.053	1.062	20.00	16.16
7	49.9	52.1	40.2	42.6	1.053	1.057	20.00	18.20
8	69.9	69.2	51.1	52.6	1.306	1.043	26.87	23.96
9	64.5	62.4	45.8	47.6	1.031	1.044	28.93	23.74
10	55.8	55.8	44.4	46.1	1.051	1.059	20.45	17.37
11	54.6	55.0	42.9	43.8	1.049	1.052	21.46	20.37
12	57.6	56.6	43.7	47.4	1.043	1.062	24.18	16.22
$\bar{X}$	59.6	59.1	45.0	47.1	1.043	1.052	24.00	20.21
SD	±6.87	±6.52	±3.95	±4.38	±.0080	±.0090	±3.30	±3.52