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EFFECTS OF DIET THERAPY, BEHAVIOR MODIFICATION, AND
EXERCISE ON WEIGHT REDUCTION AND BODY COMPOSITION

by

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CHAPTER 1

INTRODUCTION

Obesity is one of the most prevalent health problems in the United States today (145). Thirty-five percent of all American men and 40 percent of all American women 40 years and older are at least 20 percent overweight (133). Sixty million Americans consider themselves to be obese (134), and according to the U.S. Public Health Service (145) at least one in five Americans is found to be overweight.

Obesity has been associated with four different types of hazards to health: changes in various normal functions of the body; an increased risk of developing certain diseases; detrimental effects on established diseases; and adverse psychological reactions (144). The obese individual cannot achieve optimal health since he is more likely than his nonobese counterpart to develop diabetes mellitus, hypertension, coronary heart disease, kidney disease, gall bladder disease, and skeletal and joint problems (96). Psychologically he may have lower self-esteem, a poor body image, and a feeling of self-consciousness. Life expectancy is reduced in the heavier than average weight individual, surgery is generally more difficult, and the rate of accidents is higher (152,54). Because of the detrimental effects of obesity on humans, the American Heart Association, the U.S. Public Health Service, and most physicians recommend weight reduction for the overweight individual.

Obesity is not only a health hazard and psychologically distressing, it is also a social handicap and often leads to economic disadvantages. The social and economic costs of being overweight are staggering (96). Overweight

individuals often experience embarrassment, the inability to participate in social and pleasurable activities, and lack opportunity for occupational success. Obesity may even interfere with the simplest daily tasks such as dressing, walking, climbing, and self-care activities.

Obesity or overfat is generally defined as a condition involving an excessive proportion of fat or adipose tissue in the body mass. Some fat is essential, but Brozek et al. (19,20) recommend that men should not be greater than 16-19 percent fat and women not more than 19-23 percent fat. Overweight should not be confused with the terms obesity and overfat. Overweight refers to weighing more than is recommended according to height and weight charts. This weight can be due to increased muscle mass and not excess adipose tissue. An athlete who has increased his muscle mass may be heavier than normal for his height, and therefore be considered overweight even though he may be carrying very little adipose tissue.

Obesity is the result of a positive energy balance. It can be corrected by: (1) reducing caloric intake, (2) increasing caloric output, or (3) a combination of both. Most studies have been concerned with reducing caloric intake rather than increasing energy expenditure.

Much research has been published about obesity with little report of success. The Cornell Conferences on Therapy (26) concluded:

...most obese patients will not remain in treatment. Of those who do remain in treatment, most will not lose significant poundage, and of those who do lose weight, most will regain it promptly.

Medical treatments have included various diets, drugs, fasting, and psychotherapy, all generally leading to the same sad conclusions that more dieters fail than succeed (41). Anyone who has dealt with obese patients is depressingly aware of the failure of any one treatment to result in significant and sustained weight loss in all but a few cases (72). The percentage of individuals who drop out of treatment ranges from 20 to 80 percent (138,126).

Proper nutrition is a major problem for many Americans. One reason people eat food is to relieve hunger. However, they do not always choose foods that fulfill all the nutritional needs. Fad diets are popular, which makes proper choice of a nutritionally sound program of weight loss difficult. Traditional diet therapy, which is based on a nutritionally sound diet, has been used with limited success. Stunkard reported that of 100 consecutive obese out-patients admitted to a nutrition clinic, only 12 percent lost as much as 20 pounds and 28 percent never returned to the clinic (135).

Increasing caloric output by increasing physical activity is another means of weight reduction. Several researchers have suggested the desirability of combining physical activity with a reduction in caloric content (32, 70, 84, 133, 165). Using a combination of both will necessitate a smaller increase in caloric output and a smaller decrease in caloric input. The subject may, therefore, not experience so much hunger as on a very limited caloric diet.

Psychologists and physicians have recently focused attention on developing behavior modification techniques to control overeating. Some of the procedures tried have employed aversive conditioning, covert sensitization, contingency management involving self-control procedures, and contract systems using rewards. Most recently research workers interested in the control of overeating have focused their attention on the modification of the environment as a preferred approach to strengthening acceptable eating patterns (133).

Due to the relationship of obesity to health, social, and psychological disadvantages, a need exists to investigate further the effectiveness of different methods of weight reduction on body composition as well as on the amount of weight loss.

Statement of the Problem

This study investigated the effects of: (1) diet therapy, (2) diet therapy plus exercise, (3) behavior modification, and (4) behavior modification plus exercise on weight reduction and body composition. Subjects in the diet therapy group were given guidance in designing their own dietary regimens based on food choices from the "American Dietetic Association Exchange Lists for Meal Planning" (39). In addition to this dietary counseling, subjects in the diet therapy/exercise group were given assistance in planning supplemental programs of physical activity consisting of 250 kcal energy expenditure daily.

Subjects in the behavior modification group were to lose weight by alleviating inappropriate and problematic eating habits and establishing appropriate eating patterns. Habits Not Diets: The Real Way to Weight Control by James M. Ferguson, M.D. (42) was the manual used for this program. The behavior modification/exercise group and the behavior modification group met together; however, the exercise group received additional therapy in physical activity to increase daily energy expenditure by 250 kcal.

Hypothesis

Diet therapy, diet therapy/exercise, behavior modification, and behavior modification/exercise will affect weight reduction and body composition differently.

Limitations

Several limitations were present in this study. These limitations were not controlled by the investigators:

1. Subjects were randomly assigned to one of the four groups. Those already participating in exercise were randomly assigned to either the diet

therapy plus exercise group or the behavior modification plus exercise group. This was done to provide higher energy expenditure early in the study. Those already accustomed to exercise were considered to be more suitable to this program and hopefully this would facilitate better compliance to the program.

2. Attendance at weekly therapy sessions was encouraged; however, 100 percent attendance was not possible.

3. Behavior therapy sessions were conducted by this investigator, who is familiar with the behavior techniques, but is not a professional psychologist. Diet therapy was conducted by my associate, Joyce Oldenburg, who was a graduate assistant in nutrition.

4. Each subject was tested only for those parameters to which they voluntarily consented, thus not all subjects completed all tests for various reasons.

Delimitations

Due to the nature of this study, the following delimitations were incorporated into the procedures:

1. This study was delimited to 33 females ranging in age from 20 to 52 years.

2. Each subject was at least 20 pounds overfat.

3. All subjects were volunteers from the greater Manhattan area.

4. The experimental treatment lasted for only 12 weeks.

CHAPTER 2

REVIEW OF RELATED LITERATURE

An abundant amount of material has been published on the subjects of obesity, weight reduction, nutrition, behavior modification, body composition, body density, and physical activity. It is not relevant or practical to review all of the work in these areas within this chapter. This study specifically deals with behavior modification, diet therapy, and exercise, and their effects on weight loss, body composition, and body density. This chapter will discuss that research which deals with these topics.

Obesity

Theories about the etiology of obesity abound. As recently as 15 years ago, obesity was clinically considered to be a psychological problem. The rationale was simple. Obesity is due to overeating which is due to either lack of self-control or to more serious personality abnormalities (144).

Fortunately, new concepts have developed and obesity is now viewed as being extremely complex and a disorder of multiple origins rather than a single malady (133). This does not represent a rejection of the long-established concept that fat will accumulate only when the intake or consumption of energy exceeds the output, or the expenditure of energy (54). Usually, obesity is the result of overeating, metabolic imbalance, lack of physical activity, or a combination of these. The causes for obesity can be roughly divided among social, psychological, and biological explanations (133). Obesity, whatever its root causes, is the result of a positive energy balance.

According to the first law of thermodynamics, one kilocalorie represents the amount of heat necessary to increase the temperature of 1000 grams of water from 19°C. to 20°C. at STPD. A positive energy balance of approximately 3500 kilocalories will result in one pound of stored fat in the human body (73). The definition of the difference between overweight (better stated as overfat) and obesity has never been clearly defined. According to Bray et al. (16), a fat content above 25 percent of body weight for males and 30 percent for females is excessive; however, they state the fat content for most individuals is less than this. Guthrie (54) concludes that when 20 percent of the body weight of a man and 28 to 30 percent of the weight of a woman is composed of fat, the amount of fat is judged to be abnormally high, and the individual is described as obese. Ideally a normal man should be 16-19 percent fat and the normal woman 19-23 percent fat (20,19). An accurate measure of this fat percentage is possible only in a laboratory situation which is not a practical way for the public to determine obesity. Despite this lack of clear definition, the United States Public Health Department (145) states:

...a high proportion of our population weigh more than is considered desirable for optimum health. Those persons who are excessively overweight, regardless of the standard chosen, probably also are obese...

Stuart and Davis (133) list several easy tests for the public to determine obesity. They are:

1. Surface measures

- a. The "mirror" test--identification of a "fat" appearance when an individual views himself standing nude before a mirror;
- b. The "twist" test--twisting rapidly while nude and observing whether the superficial fat tissue moves in concert with the underlying tissue;
- c. The "ruler" test--determining whether the line running from the rib cage to the pelvis is flat or concave when a ruler is placed upon the area while lying flat (indicating no obesity).

2. Anthropometric measures

- a. The "belt" test--determining whether the circumference of the chest, at the level of the nipples, is greater than the circumference of the waist at the level of the navel;
- b. The "magic 36" test--determining whether the waist girth in inches, subtracted from the height in inches, yields a number greater than 36 (indicating no obesity);
- c. Reference to tables of average or desirable weight (these often disagree between different sources);
- d. The Ponderal index--determining whether the height in inches divided by the cube root of the weight in pounds yields a number greater than 12 (indicating no obesity).

Height and weight tables also give an indication of obesity. However, a football player can be overweight and not be overfat. By the same measure a person may be of normal weight for his height and be overfat. No matter what method is used, lean tissue and fat content can only be accurately assessed by chemical analysis. The general public is left with less than ideal conditions for determining what their desirable weight should be.

Weight Loss Methods

Within the past quarter century, some 2,000 lay and professional papers have been published about obesity (133). Some are fraudulent efforts not based on scientific research, while others are well-intended professional endeavors to deal with obesity. With few exceptions, the treatments have had mediocre results (133). No matter what method of treatment is used, for it to be effective in reducing weight, it is essential to create a caloric deficit.

Diet Therapy

Traditional diet therapy often originates in the doctor's office with the patient being referred to a dietician or nutritionist for dietary guidance. The patient is usually given excellent information about nutritional needs, caloric values of various foods and is prescribed the ideal diet.

Unfortunately, the patient is seldom able to follow the rigid dietary restrictions and usually ends up being more frustrated by failing to stick to the diet (72).

Stunkard (135) had reported that of 100 obese patients admitted to a nutrition clinic, only 12 percent lost as much as 20 pounds and 28 percent dropped out of the program. Two years after the treatment ended, only two of the initial 100 patients referred to the clinic had maintained their weight loss.

Stunkard and McLaren-Hume (138), and Shipman and Plesset (126) have cited dropout rates of 20 to 80 percent for those beginning an educational dietary counseling program. Only 25 percent of those remaining in treatment were able to lose as much as 20 pounds and only 5 percent lost 40 pounds or more.

Fasting

Semi-starvation (generally 300-600 kcal) or total fasting will result in rapid and steady weight loss. Successful treatment for obesity by fasting has been reported (35). However, the regimen was administered in a hospital with medical supervision. There are no long term follow-up results reported to determine whether such drastic procedure is more effective than other treatments (144). Fasting can be complicated by hypotension, electrolyte imbalance, metabolic derangements owing to protein loss and use of body fat as a primary source of fuel (15), changes in plasma amino acids, increased nitrogen excretion, anemia, gout, and decreased stamina (144). In periods of total abstinence from food ranging from 10 to 16 days, lean tissue contributed 59 to 66 percent of the weight loss (11,151). Fasting is also associated with a rapid weight gain following the termination of the fast. In one study (90), 25 patients hospitalized for a medically supervised fast lost an average of just under 30 pounds in 24 days. Within six months of discharge, however,

their average weight was two pounds greater than their prefasting weight. Because of potential hazards of starvation diets and the need for careful continuous medical supervision, such diets should never be self-administered (36).

Fad Diets

Many books and popular articles have been published about rapid effortless weight loss. Some programs even guarantee success. They advertise the "one diet" that will result in optimum weight loss in the shortest amount of time. If such claims were valid, then an estimated 60 to 70 million American adults and at least 10 million American teenagers who are overfat could be cured (73). The real fact is the American public is continuously bombarded by advertisement that claims to document examples of weight loss and in fact may possibly place the dieter's total health in jeopardy (73). The American Medical Association Council of Food and Nutrition in 1973 pointed out the dangers of the popular "Atkins" diet (6). They have stated the Atkins diet is neither new nor revolutionary. It is without scientific merit and is grossly unbalanced. The Council is deeply concerned about any diet that advocates an "unlimited" intake of saturated fats and cholesterol-rich foods.

There are many other popular fad diets some of which include the high protein, moderate-fat, moderate-carbohydrate diet; low protein, low-fat, "rice" diet; high-fat, low-carbohydrate (or carbohydrate-free) diet; the "drinking man's" diet; very low-protein diet, dubbed the "Rockefeller" diet; and the "Mayo" diet. These type of diets do not usually supply the proper nutrition in adequate amounts (96). Carbohydrates should not be avoided completely since muscle and nerve cells require carbohydrates for their metabolism (8). This is particularly important for the physically active individual. Weight loss depends on a negative caloric balance and studies done by Brewer (17), Fletcher (45), Pilkington (117), and Kinsell (82) have shown that varying

proportions of fat, carbohydrate, and protein have no relationship between weight loss and the composition of the diet consumed for a given caloric level.

Fad diets have short-term success and they have little lasting practical value (144). Most people cannot stay on restrictive diets indefinitely and eventually revert back to old eating habits causing weight gain.

Formula Diets

Liquid or powdered formula diets provide a method of ingesting strictly established amounts of food. This provides a simple rigid regimen that does not require counting calories and eliminates eating other foods, which may remove or minimize temptation to eat problematic foods. Numerous studies report successful weight loss during the first two to four weeks of formula diets; however, after that length of time attrition rates are high as well as the return to conventional foods. This results in most patients returning to their original weights (5,64,125,142).

Surgery

The most common form of surgery to reduce weight is the jejunoileal shunt operation, after which only about 14 inches of jejunum and four inches of terminal ileum remain in continuity, providing a very small surface for absorption of food (15). The aim of this operation is a controlled malabsorption state. Weight loss is slightly slower than with fasting and the degree of lean tissue loss seems to be the same for both treatments. The overall weight loss is variable and may stop considerably short of ideal weight (15). After surgery the patient has some digestive discomfort following meals which may restrain the patient and curb food intake. All effects and complications resulting from this surgery have to be considered. Among the reported complications are progressive liver failure resulting in death, intestinal obstruction, halothane jaundice, leaks at the site of the anastomosis, impaired

vitamin B₁₂ absorption, excessive fluid and electrolyte loss, and iron deficiency (161,115,124,107).

Drugs

Appetite-depressing drugs related to amphetamines may be effective for approximately six weeks, but are associated with many unpleasant side effects such as: excessive tension, gastrointestinal distress, insomnia, sweating, as well as creating serious additional risks for persons suffering from cardiac diseases (133,144,86). The use of anorexigenic (diminishing the appetite) agents in weight reduction regimens varies greatly in results. The newer anorexigenic drugs such as phenmetrazine, chlorphentermine, and denzphetamine do not appear to be superior to amphetamines. And they are just as likely to produce side effects (40,144).

Thyroid hormone is used as an adjunct to weight reduction on the basis that obese patients are in a hypometabolic state and can lose weight more easily if metabolic stimulation is accomplished (3,38). Most obese patients, however, are euthyroid--or normal rather than hypothyroid. In such cases if doses of thyroid hormone are large enough to be effective, unpleasant side effects include palpitation, tachycardia, nervousness, and insomnia (144).

On-off Diet Effects

Bray et al. (15) state that possibly the most vexing problem for the obese is not weight reduction, but the maintenance of the reduced weight. The average diet conscious adult goes on 1.25 diets a year with the average diet lasting between 60 and 90 days. The dieter is, though, off the diet during roughly half the time (162). This has been shown to be detrimental to health. Lipids, such as cholesterol, are added to the bloodstream as one gains weight (133). The United States Public Health Service warns (144):

Serum cholesterol levels are elevated during periods of weight gain, thus increasing the risk of deposition. There is no evidence to show that once cholesterol is deposited it can be removed by weight reduction. It is possible that a patient whose weight has fluctuated up and down a number of times has been subjected to more atherogenic stress than a patient with stable though excessive weight.

It is, therefore, important to strive for a stable weight loss over time--a weight loss that can be maintained--to minimize adverse side effects.

Behavior Modification as a Means of Weight Reduction

Behavior modification as defined by Mahoney, Kazdin, and Lesswing (93) is: (1) the use of a broadly defined set of clinical procedures whose description and rationale often rely on the experimental findings of psychological research; and (2) an experimental and functionally analytic approach to clinical data, relying on objective and measurable outcome. The functionally analytic aspect of the definition means that the behavior modifier undertakes an experimental analysis of the problem behavior (27). Behavior modification is best defined by a rationale and a methodology and not by a specified theory or set of principles. This allows for the study of an extremely wide range of factors that may affect behavior and which may be employed in the modification of behavior. This approach to the study of behavior is called methodological behaviorism and was introduced by John B. Watson in 1913. Behavior modification draws from an ever-changing body of experimental findings and represents a scientific approach to the study of behavior and its modification (27).

According to Leonard S. Levitz (87) behavior therapy, as applied to obesity, is characterized by: (a) determination of observable eating and activity habit patterns; (b) measurement of the target behaviors before and during treatment; (c) a series of techniques abstracted from psychological research in learning; and (d) an educational approach to the development of self-management.

History

Applying behavior modification as an effective treatment for obesity began about a decade ago resulting in a substantial weight loss for mild to moderately obese persons (139). Many studies (18,63,133,135,1,88) support the theory that behavior modification treatment for weight loss seems to be superior to alternative approaches. Behavior therapy produces far fewer untoward symptoms than do traditional treatments (137). In addition, lower attrition rates for patients in behavior therapy have been reported by Levitz and Stunkard (88), as well as higher percentages of patients losing weight (137) than was found in other modes of treatment. However, the amount of weight loss has rarely been clinically significant and there has been large inter-subject variability reported within tests (48,116,69,7,81). Behavior modification appears to be more effective than any other traditional method, yet it has not been widely applied (88).

Stuart (130) was the first to successfully use all of the behavioral technology developed experimentally to control eating habits in a successful weight control program. He published his clinical paper in 1967 reporting the results of his treatment of ten women using primarily behavioral techniques over a period of one year. Two of the ten dropped out of treatment, 30 percent of the original sample lost more than 40 pounds, and 60 percent lost more than 30 pounds. Since that time several behavioral programs for weight control have been developed.

Relationship to Obesity

The newest behavioral approach to obesity begins with the assumption that all socially relevant behaviors are learned and maintained through interaction between the individual and relevant persons and situations in his environment. This implies that the environment rather than the person is the agent of control of human behavior. Therefore, efforts to modify behavior

should be addressed to changing the environment rather than the individual. It also implies that the social situation is as much a receptacle for the conditions associated with acceptable behavior as for unacceptable or problematic behavior. This reverses the approach that the social unit is credited with the control of desirable behavior while the individual is saddled with the responsibility for his own undesirable behavior (133). This situational control of eating is associated with the newer theories about human behavior in general. The old theory that "personality" caused behavior (133) is illustrated in Figure 1. The model which underlies the behavioral approach to the treatment of obesity utilizes the same basic elements as the psychological model, but the point of entry is different. For the behavioral therapist, the model can be represented as in Figure 2. Using the behavioral model approach, it is not necessary to isolate and remedy forces deep within the psychological make-up of the individual in order to change his eating patterns.

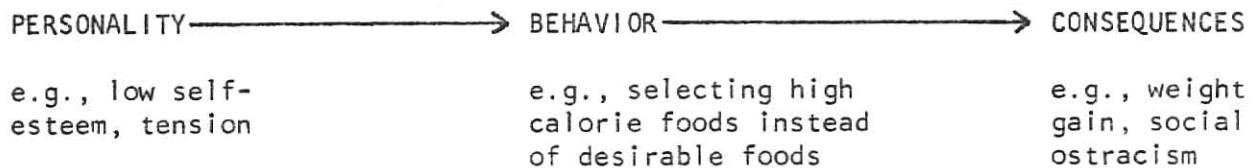


Figure 1

Psychological Approach
to Overeating

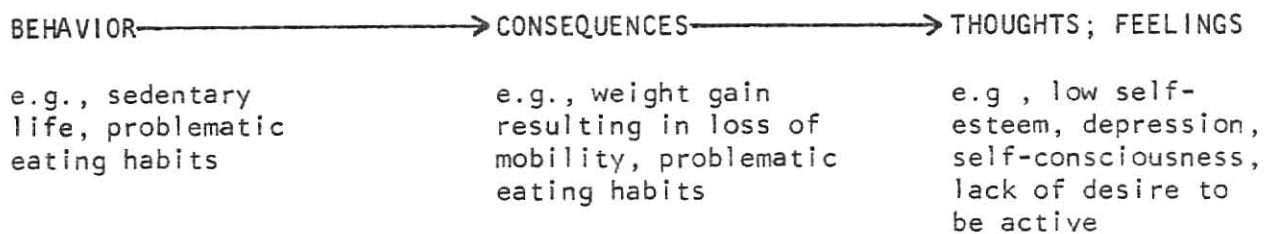


Figure 2

Behavioral Model
to Overeating

Simply stated, obesity, as seen by the behaviorist is a consequence of habits rather than a symptom of some underlying psychotic disorder (87). Stunkard (136) reported only minimal differences in psychological traits between obese and nonobese individuals of the same socio-economic class. Numerous efforts have been made to treat obesity from a psychotherapy view, but this approach in the treatment of overeating has met with little success (131).

Behavior modification treatment focuses on observable behavior and observable behavior change (27,87,72). In several respects, overeating is one of the most complex behavior problems that has been approached by the behavior therapist. It has proved very resistant to most types of therapeutic intervention, and the physiologic limitations on any intervention are not known (72). Treatment is complex because behavior monitoring and change are under the control of the patient. In treatment for obesity the therapist and patient are most interested in the specific behaviors that should be increased, decreased, eliminated, or initiated. According to Jordan and Levitz (72):

The most distinctive characteristic of behavior therapy is that it attempts to abstract effective clinical techniques from general psychology principles, primarily from research in human learning and social psychology. For example, independent of the specific technique, a process of shaping is implied throughout the therapeutic program.

Shaping refers to reinforcing small incremental steps or approximations toward a terminal response rather than reinforcing the terminal response itself. Responses which resemble the final response or which include components of that response are reinforced. Through reinforcement of successive approximations, the final behavior is gradually achieved (27). If eating a particular high calorie food represents a major habit problem, the goal would be to gradually reach a low level of consumption through a series of discrete steps.

Development of Technique

Traditional weight loss treatments began by assuming education and insight would help in changing dietary patterns. If a patient was educated

about nutritional needs and given the ideal diet and recipes for preparing these, it was presumed he would respond by changing the amount and type of food eaten. Unfortunately, this is not generally the case. Early treatment programs lacked neither the therapist's concern for the patient's well being nor motivation on the part of the patient. Nevertheless, the tools for changing undesirable behavior were missing (42). Through behavior modification the ABC framework (Figure 3) has been developed (133,42,109).

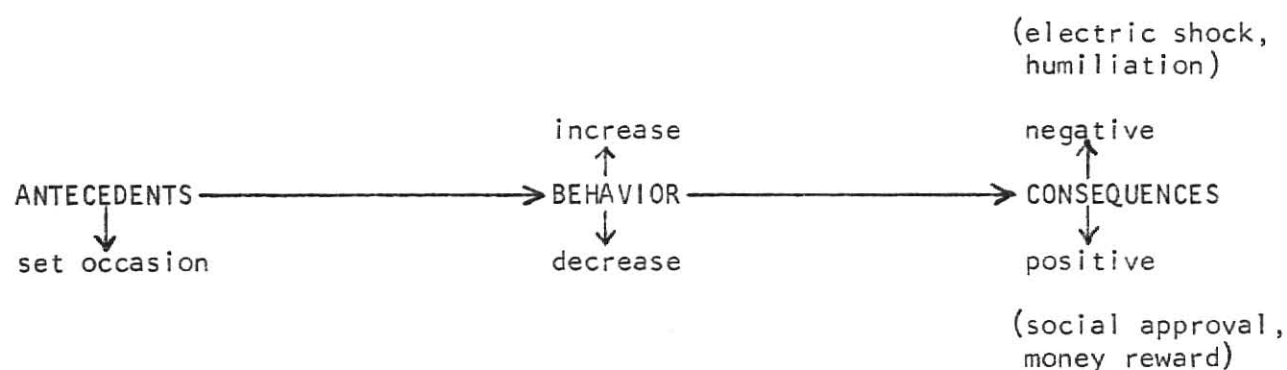


Figure 3

Schematic Representation of the Determinants of Simple Behaviors

Antecedent conditions set the occasion for the occurrence of certain responses. These conditions do not guarantee that the response will in fact occur, but they do increase the likelihood of its occurrence. Consequent conditions either accelerate the rate of a response or they decelerate the rate of a response. Stated more simply, those events which take place before an individual eats (antecedents) either increase the chances that eating will occur or decrease the chance that eating will occur. For example, walking past a candy store may set the stage for eating by visually reminding the individual about food. Sitting at a bridge table or watching T.V. may also cue an individual to eat if he generally eats in this situation. Merely walking in the front door may cue an individual to eat. Having nonfattening snacks readily available, keeping busy with a favorite hobby, or pre-planning meals may decrease

the likelihood of problematic eating. Consequences are the things which follow eating. Positive consequences might be social approval, money reward, or engaging in a favorite activity. Negative consequences might consist of punishment such as an electric shock, money taken away, or humiliation.

During the past two decades many techniques based on learning theory and aimed at the modification of human behavior have been developed and evaluated. These major techniques which have been applied to the problem of obesity fall into four general classifications according to Henry A. Jordan and Leonard S. Levitz (72):

1. Aversive Control--a real or imagined aversive stimulus (electric shock, nausea, bad odor) is associated with a favorite food or problematic behavior. A major purpose of aversive control procedures is to eliminate a response (27).

2. Contingency Management--specific positive or negative consequences are attached to desirable or undesirable eating behaviors or weight changes. The contingency (conditional response) between a behavior and its consequences may be managed by either a patient or by the therapist. An example might be a compliment from a spouse when desirable eating takes place, or loss of money or special privilege when problematic eating occurs.

3. Environmental Management--the patient is instructed in specific ways to change his environment so as to increase the probability of adaptive eating behavior or decrease the probability of problematic eating behavior. A good example would be to keep problematic food out of sight and hard to get, and desirable food easily accessible.

4. Self-monitoring--of either eating behavior or weight change, by which the person keeps continuous records of his behaviors, their antecedents and their consequences. Self-monitoring may help the client become more aware of eating and exercise habits while simultaneously acting as a reinforcer for progress or as a reminder that improvement has not been occurring (27).

One of the first studies conducted to develop behavior technique in the treatment of obesity was done by F.A. Moss in 1924 (106). He paired aversive stimuli, electric shock, with desired food in an effort to weaken the individual's attraction to it. After several trials in which a clicking noise was paired with vinegar consumption, the subject rejected orange juice when it was presented with the clicking noise. This same procedure was used by Wolpe (160), and Meyer and Crisp (101). In their studies two of three subjects did not remain in treatment, while one did lose considerable weight and maintained it for at least 20 months. Noxious odors were used to weaken the appeal of food by Kennedy and Foreyt (76). Their treatment was not very successful. There is little evidence to indicate that aversive procedures are an effective treatment for obesity (1).

The aversive conditioning technique of breath holding was employed by Tyler and Straughan (143). Subjects assigned to this treatment were asked to begin holding their breath as soon as they had thoughts about problematic foods and their appeal. Some of the unpleasantness associated with the breath holding was expected to be attributed to the thoughts about food. After nine weeks of treatment, the average weight loss was just .43 pounds.

Covert sensitization, another technique, was developed by Joseph Cautela (24). This technique relies extensively upon imagery. Cautela's subjects were asked to imagine that they were about to eat a problematic food and then immediately switch their thoughts to an unpleasant event, e.g. vomiting. The aversive event was designed to suppress the problem behavior. This technique was moderately successful.

The aversive stimuli and covert sensitization discussed above are deconditioning procedures which are designed to break down the association between positive reactions and problematic foods. As stated, the results of these deconditioning procedures have been poor (133,46). The reaction to

intervention is generally negative and the results of treatment disappointing. This may be explained by the fact that punishment leads to highly discriminative control over behavior. That is, if the punishing agent is not present, the problematic response is likely to reoccur. It is also possible that eating is so positively reinforcing that minor discomfort or inconvenience may not be enough to overcome the great pleasure of eating.

Conditioning positive reactions to desirable foods have produced a mixed outcome. Tyler and Straughan's study (143), compared a positive conditioning program using the Homme's coverant control technique (66), with an aversive technique, and a relaxation control group. Theoretically, coverant control therapy (CCT) is an application of Premack's differential probability principle, in which the emission of a high probability behavior is made contingent upon the emission of a desired low probability behavior (121). In theory, the low probability behavior is reinforced by the high probability behavior and hence should increase in frequency. Results of Tyler and Straughan's study (143) were discouraging as subjects undergoing this treatment lost .75 pounds during nine weeks of treatment. Horan (67) used the same technique showing more favorable results with the average weight loss of 5.66 pounds in contrast to 3.13 and 2.72 pounds lost by the two closest control groups. The utility of coverant conditioning for the treatment of obesity remains to be demonstrated. Mahoney (91,92) questions whether coverant control therapy, as it has been applied in the clinical setting, is truly an application of the Premack principle, since researchers have confused high probability behaviors with high frequency behaviors.

Operant treatments are concerned with strengthening or weakening existing responses in association with particular antecedent and consequent stimuli. The first paper on operant methods as applied to overeating was published by Ferster, Nurnberger, and Levitt (44). They theorized that the act of putting

food into one's mouth is reinforced by its immediate pleasurable consequences, while the negative consequences (i.e. getting fat) are postponed to some indefinite time in the future. The goal of treatment was to make the negative consequences more immediate so that they would become more potent as determinants of eating behavior. Subjects were trained to keep careful food records; schedule eating to occur at given intervals; gain stimulus control of all eating; and strengthen activities which would be incompatible with eating, e.g. housework or outdoor activities where eating is impossible. Although the results of treatment were not reported, Ferster was later quoted by Penich et al. (116) as saying the outcome was disappointing.

Stuart (130) reported the results of a program similar to that of Ferster et al. (44). The program, comprised of between 19 and 41 sessions, was a six-step curriculum involving procedures ranging from the use of Cautela's covert sensitization (24) to the techniques of manipulating the antecedents and consequences of eating as well as changing the act of eating itself. Weight loss for eight women over 12 months ranged from 29 to 47 pounds.

Harris (61) conducted the first controlled test of these methods using three techniques for treatment. These included: (1) training in the concepts of reinforcement for appropriate eating behavior; (2) analysis of the stimuli controlling eating behavior and reducing the number of stimuli, for example, the subject would avoid walking past pop and candy machines to reduce availability of problematic foods; and (3) slow down the rate of eating by chewing food slowly, taking short breaks during meals, and swallowing the last bite before putting more food into the mouth. After ten weeks in treatment, one half of the subjects were placed in an aversive conditioning program using Cautela's covert sensitization. The change in weight occurring in the experimentally conditioned group was significantly greater than that observed in the

control group. Furthermore, the difference between the two halves of the experimental group--those receiving and not receiving covert sensitization--was non-significant. This implied that receiving this additional treatment added little to the outcome.

Dr. Janet P. Wollersheim (159) undertook a well controlled study to investigate this same approach. Her study involved 79 overweight students observed for 18 weeks of baseline, 12 weeks of treatment, and 8 weeks of follow-up. There were four experimental groups: a social pressure group (analogous to the TOPS program), a nonspecific treatment group seeking to develop insight into problematic eating, a focal treatment group using many of the operant procedures already described, and an untreated waiting-list control group. All subjects lost more than the control group, but the operant treatment was significantly more effective than the social pressure or insight groups. At follow-up, however, only the insight group failed to show a slight weight gain.

Penick et al. (116) compared the operant techniques with a psychotherapeutic group. Twenty-four percent of the psychotherapy group lost more than 20 pounds. In the behavior modification group 53 percent lost more than 20 pounds, 33 percent lost more than 30 pounds and 13 percent lost more than 40 pounds.

Harris and Bruner (62), and Hall (57), in separate studies, compared therapist controlled reinforcement with self-control procedures. In Harris and Bruner's study both treatments resulted in significant weight losses with the therapist reinforcement procedure being significantly more effective. For Hall, the therapist reinforcement treatment resulted in weight losses averaging one pound per week, while the self-control treatment was judged to be relatively ineffective. Jeffrey and Christensen (68) conducted a study combining therapist controlled reinforcement with self-control techniques and

compared the results with a no-treatment control and "will power" groups. Subjects in the experimental group completing treatment lost an average of 16.31 pounds, while the "will power" and control subjects lost 5.09 and 1.70 pounds respectively.

Most behavior modification studies have been conducted by professional therapists. Levitz and Stunkard (88) conducted a study using professional and lay therapists. Subjects came from existing TOPS (Take Off Pounds Sensibly) Chapters and they were divided into four treatment groups: behavior modification by a professional therapist, behavior modification conducted by a TOPS leader, nutrition education conducted by a TOPS leader, and continuation of the usual TOPS program. During the three-month treatment period, behavior modification produced significantly lower attrition rates and significantly greater weight losses than did the other treatment methods. The groups in which behavior modification was introduced by a professional therapist lost a mean of 4.2 pounds; the behavior modification taught by TOPS leaders lost 1.9 pounds; weight loss in nutrition education .2 pounds; and TOPS control condition group actually gained .7 pound. The subjects in the professional therapist's group achieved significantly greater weight losses than did the subjects in the group led by the TOPS chapter leaders even though both used exactly the same behavioral program. Levitz and Stunkard suggest a need for more studies done by lay therapists (88).

Ashby and Wilson (7) reported mean weight losses of 10.49 pounds and 7.93 pounds in two replications of an eight-week group behavioral treatment program. Using the same group behavioral treatment program, Kingsley and Wilson (81) reported figures that are comparable with a mean loss of 11.03 pounds. Behavioral treatments for obesity appear to produce favorable short-term results; however, data of follow-up studies have been weak (132).

Jeffrey et al. (69) completed a behavioral weight reduction program at Stanford University's Eating Disorders Clinic involving 108 clients. These clients lost an average of 12.8 pounds during the program and an additional .7 pounds during a one year follow-up. Ninety percent lost weight during treatment, and 43 percent lost additional weight during follow-up. However, weight changes by the end of the follow-up period were extremely variable ranging from 80 pounds lost to 40 pounds gained. Weight losses during follow-up were unrelated to weight losses during treatment.

Stunkard and Penick (139) reported on one of the few long term studies done on behavior modification in the treatment of obesity. Five years after the end of treatment 27 of 28 survivors were located. Seventeen patients were contacted by phone and 10 by personal contact. One year following treatment, most patients continued to lose weight, however, during the next four years they began to regain it. One year after treatment the majority of patients (17 of 28) in both the behavioral and traditional treatment conditions weighed less than they had at the end of the treatment. Five years after treatment only 7 of 26 weighed less. Paradoxically, those who lost weight during treatment in the behavioral program tended to regain it during follow-up, and those who failed to lose weight during treatment tended to lose during follow-up. This negative correlation between weight change during treatment and during follow-up was not found in the traditional treatment patients. Those who lost less during treatment, regained less during follow-up. In the time between the one and five-year follow-ups, the negative correlation occurred again for the behavioral group and, interestingly, the traditional treatment group also showed the negative correlation during this period.

Physical Activity and Obesity

Traditionally, physical activity has been ignored or discredited in weight control programs due mainly to two misconceptions about the role of exercise in the control of body weight. Many believe it takes entirely too much activity to play a significant role in reducing body weight and that increasing physical activity will automatically cause an increase in appetite (41,133,99,94,96). Actually, within the range of normal activity appetite and exercise are attuned. If activity is too intense to the exhaustion range, food intake decreases and weight actually drops. If activity decreases to the sedentary range, however, food intake does not continue to decrease correspondingly causing a weight gain (100,98,95). At very low levels of activity in animals as well as in men, food intake tends to increase. This phenomenon has long been known and practiced by farmers who "pen up" animals which they want to fatten (95).

Mayer (96,97) has reviewed a number of studies which have shown that in children and babies, obesity is more closely related to inactivity than to caloric intake. Inactivity has also been significant in perpetuating obesity in adults (53,63). Stuart (130) finds overeating and underexercising are the only two common characteristics in the obese.

To lose one pound of fat, one would have to walk approximately 36 miles in 12 hours or run a marathon of 30 miles in three hours (8). Small regular amounts of exercise, however, over a period of time do add up to a significant amount of calories expended. For example, one hour of walking, or 30 minutes of swimming or cycling, or 15 minutes of jogging each day should dispose of approximately half a kilogram of fat in two weeks or over 12 kilograms (about 25 pounds) in a year (8).

The exact caloric cost of activity is variable according to age, sex, body weight, and efficiency. Caloric expenditure increases in direct

proportion to body weight in activities which involve movement of body weight (60). Therefore, obese patients who engage in exercises which involve movement of the body weight such as walking or jogging gain this benefit as opposed to stationary cycling where they do not carry their own weight (59).

Goldsmith et al. (52) found a 15 percent increase in oxygen uptake above the fasting level during cycling at a work-load of 100 watts between two and three hours after a 500 kcal. pure protein meal. Miller et al. (103) found that light exercise for half an hour after a meal increased caloric expenditure, above fasting exercise level, by an amount equal to twice the specific dynamic action of the food eaten. Bray et al. (16) agreed with these findings when caloric intake exceeded 1,000 kcal.

Resting metabolic rate has been found to be raised about 25 percent above basal level for as long as 15 hours after strenuous exercise (37). This gives the extra benefit of not only burning calories during exercise, but for some time after. According to Mayer (96), the active man has two advantages in weight control: the increased cost of exercise and increased basal metabolism.

Although the benefits of exercise are well known, nearly every attempt to treat obesity focuses on dietary restrictions. The facts would seem to indicate that a program incorporating both restriction of caloric intake and moderate exercise should be effective in reducing weight. Such programs have been suggested by many (32,70,84,133,165), but actual programs seem to be few in number. Not very many studies have been done on the effects of physical activity alone (56), and there is a lack of published information on the response of adult females to exercise (34,49,80).

Lewis et al. (89) conducted a study on the effects of physical activity on weight reduction of women ages 30-52. After a 17-week program 22 women lost an average of 4.2 kg. There was an apparent increase in self-confidence

and a feeling of accomplishment in the group. Many also noted an increase in physical work capacity that enabled them to participate in other activity which they previously avoided.

Harris and Hallbauer (63) did one of the few studies combining behavior techniques and exercise. Subjects were divided into three groups: self-control/contract for eating group, self-control/contract/exercise group, and a control group. Subjects in all three program groups lost weight during the 12 weeks with no significant differences between groups. A seven-month follow-up revealed that the subjects in the two behavior therapy groups lost more than those in the control group and those in the exercise plus behavior modification group lost more than those in the group dealing only with behavior modification. Stalonas et al. (128) reported on another study investigating exercise and behavior modification. There were four groups in their study. One group was exercise and contingency components, a second group was exercise alone, a third group received just contingency components, and the fourth group was a basic program or control group. Significant weight loss was observed for all four groups at the end of the program and at the three-month follow-up. Only those exposed to exercise and/or contingency management maintained weight loss after one year. The influence of exercise at the one-year follow-up was noticeable, with mean weight losses of 12.25 and 14.6 pounds for those exposed to contingency management and exercise, respectively. This influence of exercise is consistent with the findings of Harris and Hallbauer (63). Exercise subjects were asked to gradually increase their energy output from 150 to 400 kcal above their basal level. Many subjects felt that starting at a low level helped them get into shape at a pace that was not too painful. This may have helped keep the subjects from dropping out of the program.

Grant Gwinup (56) studied the effect of exercise alone on the weight of obese women. Subjects were asked to pick a form of exercise which suited them

most. Interestingly those who stayed with the program chose walking as their exercise. Every subject lost a considerable amount of weight with a range for the group of 10-38 pounds and a mean of 22 pounds. Weight loss paralleled the length of time spent walking. When a certain amount of walking was maintained and weight stabilized at a lower level, more weight loss occurred when time of walking was increased. At least thirty minutes of walking time appeared to be necessary for the weight reduction to occur. Weight loss was maintained during a period of one year or longer. Motivation to continue to exercise was a critical factor and all who stayed in the program chose walking as opposed to those who chose jogging, swimming, or cycling and dropped out of the program.

Body Composition and Body Density

Classic information on weight loss, body composition changes, and anthropometric measurements comes from studies of fasting, semi-starvation, and starvation of subjects. Keys, Brozek and associates (78) conducted one of the most comprehensive studies on human starvation. In their study both physical activity and caloric intake were controlled. The study consisted of 12 weeks on control, 24 weeks of semi-starvation, 12 weeks of restricted recovery and 8 weeks of unrestricted recovery. The semi-starvation period consisted of 1570 kcal versus 3497 maintenance which represents an intake deficit of almost 2000 kcal/day. Body weight was reduced by 22 percent, muscle mass by 40 percent, and body fat by 68 percent. Following the weight loss, subjects regained more weight during recovery than they had lost with a peak weight exceeding control weight by 10 percent and body fat 40 percent higher than control. The subjects used in this study were normal men, not obese or lean, and these findings may not be the same for obese subjects.

Reports on clinical treatment of the obese have provided additional information on anthropometric and body composition changes with weight loss. In a series of seven obese subjects studied by Passmore et al. (114), the mean composition of weight loss during adherence for 45 days to a 400 kcal mixed diet was 78 percent fat, 5 percent protein and 17 percent water. This indicated that the contribution of fat to the fuel mixture being burned was 98 percent. The energy value per mean pound of weight loss was 3409 kcal. Thus, after six weeks on a diet very low in calories, these obese subjects were oxidizing a fuel mixture much higher in fat and lower in protein-derived substrate than that being utilized by the nonobese volunteers of Keys et al. (78). It appears that obese subjects use their fuel reserves more efficiently than lean persons under similar conditions (147). Van Itallie and Yang (147) state that the rate the body loses fat is almost entirely dependent on the size of the proximate energy deficit. During prolonged partial or total caloric restriction, the body adapts by increasing the relative contribution of its fat stores to the energy deficit and by conserving protein and water. Given the same degree of calorie privation, obese subjects accomplish the adaptation far more successfully than their lean counterparts.

Runcie and Hilditch (123) reported that 18 obese male adults after the 30th day of a total fast had a mean weight loss of .8 pound per day. Ninety-five percent of the expended energy was derived from body fat. This percent contribution of fat to the fuel mixture oxidized during starvation would be associated with a weight loss having an energy value of about 3300 kcal per pound.

In other studies it has been shown that overweight or obese subjects, as a result of semi-starvation, lose weight, reduce skinfolds and girths, lose body fat and lean tissue (50,51,23). During the first week or two of fasting or semi-starvation, body weight changes do not reflect changes in body

composition, in as much as most weight loss is from reduction in intestinal bulk and loss of water. During the first day or two stored glycogen is mobilized to cover the energy requirement (4,8,79,110). Since each gram of glycogen is stored together with about 2.7 grams of water, the mobilized glycogen liberates this water, which is eliminated and may thus account for the initial drop in body weight. Upon returning to an adequate diet, glycogen is again stored, together with the required amount of water.

After the initial loss of water and intestinal bulk, body reserves of carbohydrates are depleted. The source of energy is then obtained from metabolism of body fat and some body protein (114,50). The choice of fuel for the working muscle is carbohydrate and fat (8). Protein is not used as a fuel to any appreciable extent when caloric supply is adequate (25,85). The protein loss from the body can therefore result from inadequate dietary intake or from protein being metabolized for energy during fasting or semi-starvation (55,50).

During periods of weight changes, variations in body composition are difficult to assess. Weight measured on a balance beam scale does not give an accurate assessment of fat lost. Underwater weighing is a relatively accurate way to determine body composition and body fat (20,19).

Skinfold, body girth and body weight were used in early studies to estimate changes in body composition. However, Wilmore, Girandola and Moody (157) showed such methods for estimating body composition based on anthropometric measurements are not valid for predicting accurately changes in body composition. Even though skinfold and girth measurements do change with weight variations they may not be representative of overall changes in body composition and body density. For research purposes anthropometric measurements should be taken to reflect outward physical changes, but not to assess body composition.

Activity and Body Composition

Studies of physical activity and body composition have been conducted using a wide range of subjects including sedentary and active (157), young and old (118), lean and obese (12) and males and females (74,157). In many cases, however, researchers have failed to adequately control caloric intake and energy expenditure of the subjects. This allows for error and may affect the results.

Warnold et al. (149) conducted a study of eight hyperplastic obese women in a long-term weight reduction program consisting of a diet of approximately 1100 kcal/day. Energy expenditure and body composition changes were measured. No instructions with respect to physical activity were given. Body fat decreased from 43.5 kg. to 29.9 kg. in six patients who were followed for 32-38 weeks. Lean body weight was not assessed. Daily energy expenditures were calculated by the heart rate method (150). The mean actual weight loss was 18.2 kg. compared with the mean expected weight loss of 58.9 kg. The exceedingly large discrepancies between the expected weight reduction, calculated on the basis of energy balance and body composition changes, and the actual weight changes observed in this study agree with the findings of Brandfield and Jourdan (13) and Miller and Mumford (103). Warnold et al. (149) state that their observations implied that the validity of energy balance studies performed during weight change must be questioned. Methodological difficulties might conceal the true answer.

Studies that have investigated increased physical activity and weight loss (118,157,12,165,158,89,77) showed, the resulting changes in body composition have been a reduction in fat and an increase in lean tissue. Most studies (22,31,112,140,141) show similar results of increased body density and lean body weight, decreased body fat and skinfolds, when no caloric deficit and no appreciable weight change has occurred, but increased physical activity

has. Physical activity appears to protect against the loss of protein and muscle mass (lean body weight) that occurs when an individual is under negative nitrogen balance (28).

Much of the data on body weight and body composition changes with increased activity have been for normal men (not overweight or obese). Changes for overweight individuals as a result of increased activity and reduced caloric intake seem to be dependent on the nature and magnitude of the caloric deficit. That is, was the deficit from diet or more through increased activity. Knowlton and Weber (83) reported significantly reduced body fat in obese men who lost 14 pounds in a voluntary diet and exercise program. Their data indicated that the subjects also lost 2.8 pounds of lean tissue. This data is more closely related to diet data than exercise data, as most exercise studies show little or no loss or even gain in lean tissue. The subjects in this study created most of their caloric deficit through reduced intake (about 700 kcal/day) and not through increased activity (250-300 kcal/three times per week).

Lewis et al. (89) conducted a study using 22 obese women ages 30 to 52 in a 17-week weight reduction program of increased physical activity consisting of jog-walking 2.5 miles and one hour of calisthenics/week. Diet counseling was given but no specific dietary procedure was prescribed. After 17 weeks, fat body weight went from 30.9 kg to 25.6 kg. Lean body weight went from 45.2 kg to 46.3 kg. Upper arm girth went from 31.0 cm to 30.0 cm. Total body weight went from 76.2 kg to 72.0 kg. Lewis et al. (89) stated that the proportion of fat lost for a given loss of total weight tends to be greater when the energy deficit is achieved by increased exercise in addition to dietary modification rather than by caloric restriction alone. This evaluation agrees with studies previously cited.

Zuti and Golding (165) reported on their study of 25 women ages 25-42 who were from 20 to 40 pounds overweight. The subjects were randomly assigned

to a diet group, an exercise group, or a combination exercise/diet group. After 16 weeks in the program average weight loss was: diet group 11.7 pounds, combination group 12.0, and exercise group 10.6 pounds. Other results were: loss of total body fat in pounds--diet group 9.26, combination group 13.06, exercise group 12.5; lean body weight in pounds--diet group -2.42, combination group +1.05, and exercise group +2.008; percent fat changes--diet group -3.767, combination group -6.3, and exercise group -6.115. Other studies (118,119,29,157), have indicated that the more intense the training, the greater the increase in density. Zuti and Golding's (165) data was consistent with these findings. The slight increase in lean tissue for the combination and exercise group was not statistically significant, however, nor was the increase itself. These findings agree with other investigators (78, 111,50) who have shown only slight and insignificant changes in lean body weight.

Boileau and associates (12) compared the response of obese men and non-obese men to physical activity. They did not reduce caloric intake and reported similar changes in weight and body composition as have other studies dealing with exercise. The obese and lean men had similar changes, but the magnitude of the changes in skinfolds and body composition changes was greater in the obese men. The obese men had a significant weight loss while the lean men did not. The changes in weight, skinfolds and body composition for the obese were consistent with other exercise studies done on normal weight men.

Summary

Body weight is reduced by changing the energy balance to create a deficit. Various methods reviewed have shown varying degrees of success. However, no method has been able to show large numbers of graduates, i.e. those who can maintain a normal weight indefinitely. Behavior modification

has shown some indication of being more successful than other conventional methods. This does not necessarily mean it is very effective as a treatment for obesity. Furthermore, most studies done with behavior techniques have been in a clinical setting using professional behavior therapists. Jordan and Levitz (71) state that additional studies are clearly indicated to explore and perfect methods for implementing the use of behavior modification techniques by lay leaders.

Physical activity has been shown to make appetite more normal. The benefits of exercise in the treatment of obesity are well known, but few weight loss programs actually include physical activity. As stated in the literature, many recommend such programs.

Reviewed literature has indicated that with a reduction in body weight, changes in body composition are reflected in girth measurements, skinfolds, total body fat, lean body weight, and body density. Weight loss which includes exercise has caused an increase in lean tissue and a reduction in body fat. The loss of lean tissue is considered undesirable, while the loss of body fat is desirable.

Studies reviewed indicate there are no known cures for obesity and more research in the areas of behavior modification, diet therapy, and exercise are clearly indicated.

CHAPTER 3

METHODOLOGY AND PROCEDURES

This chapter describes the methods and procedures used in this study and explains the selection of subjects, testing procedures, treatment, and statistical methods used. This study was comprised of two weeks of preliminary testing, 12 weeks of treatment, two weeks of post testing, and a three-month follow-up evaluation.

Subjects

Subjects were recruited on a volunteer basis as a result of advertising in the Manhattan Mercury and the Kansas State Collegian newspapers. Sixty-six women volunteered, 58 of whom were actually tested and began the program. Due to attrition caused by failure to complete testing and/or treatment, illness, disinterest, or outside conflicts, the group was reduced to 33. Each subject met the following criteria:

1. Premenopausal female
2. Greater than 15 pounds overfat
3. Eighteen years or older
4. Not pregnant
5. In good health with no cardiovascular problems, infectious disease, or metabolic conditions

The mean age of the 33 subjects was 34.3 years with a S.D. of 8.6. They had an average height of 64 inches with a S.D. of 2.5, and an average weight of 158.4 pounds with S.D. of 27.2. The mean percentage fat for the group was 37.8 with S.D. of 5.4.

Informed Consent

This study was submitted for approval to the committee for the Rights and Welfare of Human Subjects in both the College of Home Economics and the College of Arts and Science Department of Health, Physical Education, and Recreation at Kansas State University. Prior to entry into the program, each subject was advised of all procedures and methods to be used. A signed consent form (Appendix A) was then obtained from each subject.

Equipment

The following equipment was used in this study:

1. Homs full capacity beam scale (Model 300T Serial no. 5314) with adjustable tare and calibrated to one ounce (Douglas Homs Corp., Belmont, California).
2. Health-o-meter (Continental Scale Corp., Chicago, Ill. #400 DGM) was used to measure subject's height.
3. Anthropometry equipment (Siber Hegner and Co., Inc., 8 W. 30th Street, New York 1, NY) included the following:
 - a. Anthropometer--calibrated in centimeters
 - b. Large sliding compass--calibrated in centimeters
 - c. Small sliding compass--calibrated in centimeters
 - d. Small spreading calipers--calibrated in centimeters
 - e. Large spreading calipers--calibrated in centimeters
4. Harpended skinfold calipers--calibrated in 0.2 millimeters. (John Bull, British Indicator, Ltd., Leeds, England).
5. Underwater weighing equipment included the following:
 - a. Tank constructed of concrete built into the floor of the Exercise Physiology Research Lab of Kansas State University. It measures six feet long by four feet wide by six feet deep. It was designed by William B. Zuti.

- b. City water was used. The temperature was maintained at 37 degrees centigrade ± 1 degree.
 - c. Electronic "force cube" transducers similar to Ackers and Buskirk's system (2) were used to measure underwater weight. The weighing platform, on which the subject sat, was constructed of aluminum and nylon webbing. The platform was suspended on the four force cubes mounted near the top edge of the tank. The subject's weight caused compression of the strain gages which was electronically transmitted to a servo-chart recorder (Model Eu-208; Heath Co., Benton Harbor, Michigan) which recorded the underwater weight. The subject wore a vest weighing fifteen pounds to help hold her on the platform during the submerged portion of the underwater weighing test.
6. Sphygmomanometer and stethoscope were used to take blood pressure.
 7. Urinary collection jug containing approximately 10 ml of toluene (a preservative). See Joyce Oldenburg theses, 1979, for more detail.
 8. Blood collection equipment (Oldenburg)
 9. Camera

Preliminary Testing Period

Subjects were evaluated for the following parameters: (1) selected anthropometric measurements; (2) body composition; (3) systolic and diastolic blood pressure; and (4) three-day dietary food intake.

Measurements Taken

Body weight, anthropometric measurements, and body composition were taken during the preliminary pre-test period. The measurements taken and their explanation follow:

1. Body weight--This measurement of land weight was taken in a swim suit on a balance beam scale to the nearest ounce.
2. Skeletal measurements--These measurements were taken with the anthropometric equipment according to the procedure described by Montagu (104), Wilmore and Behnke (155), von Döbeln (148), and Zuti and

Golding (164). These measurements and their locations taken to the nearest 0.05 centimeters included the following:

- a. Wrist width was measured with a small sliding compass between the styloid processes of the radius and ulna.
 - b. Elbow width (both right and left) was measured with a small sliding compass across the epicondyles of the humerus. Measurement was taken with the elbow flexed.
 - c. Knee width was measured with a small sliding compass across the condyles of the femur. Measurement was taken with the knee flexed.
 - d. Ankle width was measured with a small spreading caliper at the greatest distance between the malleoli.
 - e. Bi-acromial width was measured with a sliding compass across the most lateral aspect of the acromion processes of the scapula, with the arms at the side.
 - f. Chest breadth was measured with a sliding compass across the angle of the sixth rib with the arms at the side. The mean was taken between inspiration and expiration measurements.
 - g. Thorax diameter (chest depth) was measured with spreading calipers from the mesosternal position to the spine of the thorax vertebrae at a corresponding height. The mean was taken between inspiration and expiration measurements.
 - h. Bi-iliac diameter (hip breadth) was measured with a sliding compass across the most lateral aspects of the iliac crests.
 - i. Bi-trochanter diameter was measured with spreading calipers across the most lateral portion of the greater trochanters of the femur. Measurement was taken with the feet placed together.
 - j. Upperarm length was measured with a sliding compass from the lateral margin of the acromial process of the scapula to the tip of the olecranon process with the arm relaxed but slightly flexed at the elbow.
 - k. Lower arm was measured with a sliding compass from the tip of the olecranon process to the styloid process with the arm relaxed but slightly flexed at the elbow.
3. Skinfold measurements--These measurements of subcutaneous fat were taken on the left side of the body using Harpenden calipers in the manner described by Pascale et al. (113), Brozek and Keys (20), Wilmore and Behnke (155), Damon (30), and Zuti and Golding (164).

These measurements and their locations taken to the nearest 0.2 millimeters included the following:

- a. Cheek was taken as a vertical fold, midway between the corner of the mouth and the temporalis of the mandible.
 - b. Pectoral was taken on the pectoral line about two-three inches below the anterior axillary fold toward the nipple. The measurement is taken with the fold parallel to the pectoral tendon line.
 - c. Scapula was taken on the interior angle of the scapula with the fold parallel to the vertebral border of the scapula.
 - d. Mid-triceps was taken as a vertical fold midway between the acromion and olecranon processes on the posterior side of the arm hanging relaxed.
 - e. Mid-axillary was taken as a vertical fold on the mid-axillary line at the mid-sternal level.
 - f. Umbilicus (abdominal) was taken as a vertical fold adjacent to the umbilicus.
 - g. Iliac crest was taken as an oblique fold on the iliac crest at the mid-axillary line.
 - h. Pubic was taken as a horizontal fold midway between the pubic symphysis and the umbilicus.
 - i. Interior thigh (groin) was taken as a vertical fold just below the pubis on the interior mid-line of the thigh.
 - j. Front thigh was taken as a vertical fold on the anterior side of the thigh midway between the knee and the hip joint.
 - k. Rear thigh was taken as a vertical fold opposite the anterior thigh measurement.
 - l. Lateral thigh was taken as a vertical fold at the level of the gluteal furrow on the lateral mid-line.
 - m. Calf was taken as a vertical fold at the largest portion of the posterior lower leg.
4. Body circumference--These measurements of the trunk and limb girths were taken using a steel tape measure on the right side according to the methods described by Behnke (10), Montagu (104), Steinkamp et al. (129), Wilmore and Behnke (155), and Zutí and Golding (164). These measurements and locations to the nearest 0.1 centimeters included the following:

- a. Neck was measured just below the larynx.
- b. Maximum upper arm (biceps flexed) was measured at the point of the greatest circumference with the elbow in a flexed position.
- c. Upperarm (biceps extended) was measured at the maximal girth of the mid-arm when the elbow is locked in maximal extension with the underlying muscle fully contracted.
- d. Chest (normal, minimum, maximum). All three of these chest girth measurements were taken at the nipple line in a horizontal plane: minimum girth, at the point of maximum exhalation; maximum girth, at the point of maximum inhalation; and normal girth, at the midpoint of normal inhalation and exhalation.
- e. Chest (above the bust line) was measured in the horizontal plane just above the bust line in the axillary folds, and recorded at the midpoint of normal respiration.
- f. Chest (below the bust line) was measured in the horizontal plane just below the bust line and recorded at the midpoint of normal respiration.
- g. Waist was measured in the horizontal plane positioned at the narrow part of the waist.
- h. Hips at the iliac crest were measured in the horizontal plane positioned on the iliac crest.
- i. Maximum hip was measured in the horizontal plane at the maximal protrusion of the gluteal muscles, subject's legs together.
- j. Maximal diameter around both thighs was measured in the horizontal plane with the tape at the greatest lateral protrusion of the upper thigh, subject's legs together.
- k. Thigh at groin level was measured in the horizontal plane at groin, measurement taken just on the right leg with subject supporting her weight on that leg.
- l. Mid thigh was measured with subject in same position as thigh at groin with tape positioned midway between the level of the pubic symphysis and the patella.
- m. Thigh (two inches above patella) was measured in the horizontal plane with the tape positioned two inches above the patella with the subject's weight on that leg.
- n. Maximum lower leg (calf) was measured in the horizontal plane with the tape positioned at the largest portion of the calf and the subject standing with her weight on that leg.

Photograph

A frontal photograph, using a somatotype stance, was taken to provide a visual record of the subject's appearance. The subject, clad in a bathing suit, assumed a standing position with the elbows, wrists, and fingers in the extended position. The hands were held so the fingers were about six inches from the thigh with palms facing the thigh. Heels were placed together with the toes pointing out slightly. Black and white film was used. Subjects were identified by number. A photograph was given to each subject to use as her personal visual reference.

Body Density

Determinations of body density were made by underwater weighing. The procedure (163) was a modification of the one described by Buskirk (21). Prior to testing, the weighing platform and the weighted vest were placed in the tank to allow saturation of porous material. The chart recorder for underwater weighing was electronically calibrated to zero with the vest on the platform.

A brief explanation of tank procedure was made before the subject entered the tank. This procedure was followed:

1. Subject entered tank trying not to disturb the water.
2. A 15 pound weighted vest was placed on the subject.
3. The subject was floated onto the platform chair by two assistants.
4. Several practice sessions consisted of totally, forcefully exhaling leaning forward to completely submerge, and remaining in this position for several seconds being as quiet as possible.
5. When subject felt comfortable with exhaling and submerging, the strain gages were unblocked (activated).
6. At will subject forcefully exhaled, submerged, and remained as quiet as possible.
7. The underwater weight was transcribed on paper by the chart recorder. Each 2.5 millimeter square equals .2 pound.

8. Exhaling and submerging was repeated and another reading was recorded.
9. Strain gages were reblocked.
10. Subject was floated off chair and vest was removed.
11. Vest was placed on platform chair, strain gages were unblocked, chart recorder was checked for electronic drift and calibration was corrected if necessary.
12. Strain gages were reblocked.
13. The same procedure was repeated until there were a minimum of six readings including three stable readings.

Body density was computed using Buskirk's (21) equation:

$$D_B = \frac{M_{BA}}{\frac{(M_{BA} - M_{BW})}{D_W} - RV}$$

Where D_B is the density of the body, M_{BA} is the mass of the body in air, M_{BW} is the mass of the body underwater, D_W is the density of the water, and RV is the pulmonary residual volume.

Residual lung volumes were estimated by the methods described by Wilmore (154). The vital capacity was measured with a Collins 13.5 liter spirometer. Residual volume was estimated by using .30 x vital capacity.

Density was converted to percentage fat using an equation proposed by Brozek et al. (63):

$$\% \text{ Fat} = 100 \times \left(\frac{4.570}{\text{Density}} - 4.142 \right)$$

Blood Pressure

Systolic and diastolic blood pressures were taken with a stethoscope and sphygmomanometer. Subjects were seated in a chair during blood pressure evaluation.

Three-day Dietary Intakes

Type of food and quantity eaten were recorded by each subject for one week (Appendix B). Dietary intake was assessed by randomly selecting three days from the one-week record. Daily nutrient intake was determined as the mean of the three-day dietary assessment. Nutrients assessed included: kilocalories; protein, fat, carbohydrate, fiber, ash, saturated fatty acids, polyunsaturated fatty acids, monosaturated fatty acids (gm/day); sodium, potassium dietary cholesterol (mg/day); and calcium, iron, vitamin A, ascorbic acid, phosphorus, thiamine, riboflavin, and niacin (percentage of Recommended Dietary Allowances). The DIETETIC COM-PAK program, written by the Department of Nutrition and Dietetics at the University of Missouri Medical Center, and modified by the Department of Dietetics, Restaurant and Institutional Management, Kansas State University, was used to compute nutrient intake.

Because several subjects did not keep complete and accurate enough records, these preliminary three-day dietary intakes were not assessed.

Experimental Treatment Period

For the 12-week experimental treatment, subjects were randomly assigned to one of four groups: (1) diet therapy, (2) diet therapy plus exercise, (3) behavior modification, and (4) behavior modification plus exercise. Because many of the subjects were already participating in some form of regular exercise, they were assigned to one of the exercise groups.

Weekly sessions, lasting approximately one hour, were conducted for the diet therapy groups and the behavior modification groups. The behavior modification classes were taught by the principal investigator and the diet therapy classes were taught by my associate from the Department of Foods and Nutrition. Two of the meetings were slide presentations dealing with factors

associated with increased risk of coronary heart disease development and factors associated with the origin and propagation of obesity.

During the twelfth week of experimental treatment, subjects were instructed to carefully measure and define all food and drinks consumed for one week. From this record three days were randomly selected to assess dietary intake. Daily nutrient intake was determined as the mean of the three-day dietary assessment. The DIETETIC COM-PAK program was used to compute nutrient intake.

Diet Therapy Group

The aim of the diet therapy group was to lose weight by restricting total caloric intake. Individual energy requirements were estimated for each subject based on the energy needs for basal metabolic rate, specific dynamic action, and physical activity. To attain a weight loss of approximately one pound per week, 500 kcal were subtracted from the estimated total energy needs of each subject (Appendix C).

Women in the diet therapy groups received the "American Dietetics Association Exchange Lists for Meal Planning" (39). This exchange list furnished subjects with guidelines to assist them in designing their dietary regimens which were to be followed throughout the study. The number of food exchanges allowed from each food group was determined by the individual's energy needs. Approximately 20 percent of the total energy allowance was derived from protein, 30 percent from fat, and 50 percent from carbohydrate. (An example 1200 kcal diet is shown in the Appendix D).

Six weeks after the beginning of the experimental period, a short questionnaire (Appendix E) was completed by women in this group. The primary purpose of the questionnaire was to evaluate subject compliance to an energy-reduced, food-exchange diet.

Diet Therapy and Exercise Group

In addition to decreasing caloric intake by dietary restriction, subjects in the diet therapy/exercise group were instructed to increase energy expenditure by developing individualized programs of physical activity. During the last week of the experimental period, each subject kept a record of physical activity. MET and energy expenditure (kcal) levels were estimated using tables from Fox et al. (47). One MET level is defined as the amount of oxygen consumed during resting metabolism which is equivalent to 3.5 ml O₂/kg/min.

Behavior Modification Group

Subjects in the behavior modification groups were to lose weight by changing poor eating patterns to appropriate eating habits rather than by following a special restrictive diet. No nutritional information was introduced. The basic format for the weekly sessions was taken from James M. Ferguson's book Habits Not Diets (42). Each week before class subjects were to weigh themselves in standard street clothes with no shoes. They recorded their weight on a chart (42:246). This chart was for their own information. Emphasis was placed on eating pattern changes and not on weight loss. Weekly lessons were informal with some time devoted to lecture, discussion of previous week's problems, going over homework, and expressing and exchanging ideas. The following is a brief outline of material covered. For more detail and information consult Ferguson (42).

- Lesson one: (a) What is obesity, causes
(b) Habit awareness
(c) Weight loss not a behavior
(d) Homework: food diary

- Lesson two: (a) Talk about personal contract
(b) Weight chart and homework review
(c) House plan
(d) Cue elimination
(e) Eating place record
(f) Homework: house plan, eating record, food diary

- Lesson three: (a) Check homework, weight record
(b) Discuss problems
(c) Slide presentation: obesity origin, propagation
(d) Homework: eating place record, food diary
- Lesson four: (a) Check homework, weight chart
(b) Changing act of eating
(c) Bites per minute, new techniques, be creative
(d) Homework: food diary, eating place record, cue elimination exercises--necessity of practice
- Lesson five: (a) Review homework, weight chart
(b) Answer questions in book
(c) Behavior chains and alternate activities
(d) Homework: food diary, eating place record, alternate activities, record behavior chains
- Lesson six: (a) Review homework, questions, weight record
(b) Importance of practice
(c) Problem solving--become own therapist
(d) Maintenance
(e) Homework: food dairy, behavior checklist, problem solving, behavior prescription sheet
- Lesson seven: (a) Review and discuss, weight chart
(b) Slide presentation--risk of coronary heart disease, blood lipids, HDL, LDL, VLDL, triglycerides, cholesterol
(c) Questions and discussion
(d) Homework: food diary, behavior checklist
- Lesson eight: (a) Review homework, weight chart
(b) Maintenance
(c) Answer handout (42:145)
(d) Pre-planning
(e) Homework: food diary, behavior checklist, pre-plan one meal a day
- Lesson nine: (a) Homework review, weight chart
(b) Cue elimination: part two
(c) Homework: food diary, pre-plan at least one meal or snack a day, behavior checklist
- Lesson ten: (a) Review homework, weight chart
(b) Discussion cue elimination: part two
(c) Review cue elimination: part one
(d) Discuss and exchange ideas that work, problems to be solved
- Lesson eleven: (a) Review homework, weight chart
(b) Review pre-planning
(c) Cue elimination
(d) Snack and holiday control
(e) Homework: food diary (very detailed for dietary record)

- Lesson twelve: (a) Review homework, weight chart
(b) Presentation on exercise and fitness
(c) Answer questions
(d) Discussion on maintenance

Behavior Modification and Exercise

Behavior modification and behavior modification/exercise subjects met together and behavior modification treatment for both was identical. An individualized physical activity program was planned for each exercise subject. The subjects followed recommendations to increase energy expenditure by 250 kcal per day. Each subject kept records of physical activity which were checked periodically. MET and energy expenditure (kcal) levels were estimated using tables from Fox et al. (47).

Post Testing Period

A post-testing period of two weeks followed the 12 weeks of treatment. During testing all parameters were re-evaluated.

Post Treatment Follow-up

Twelve weeks after the completion of post-testing, subjects were evaluated for changes in anthropometric measurements, body density and body composition.

Statistical Treatment of Data

The analysis of variance design (127) was used to determine if any significant differences occurred among subjects in the four experimental groups between preliminary and post treatment, post treatment and follow-up evaluation, and preliminary and follow-up evaluation. The 0.05 level of probability was used as the statistical criterion for significance. The means of

differences (pre-post, post-follow-up, and pre-follow-up) were compared to zero using the least significant difference procedure (127).

CHAPTER 4

RESULTS AND DISCUSSION

The results of this study are presented and discussed in this chapter. Data was collected before treatment began (pre-treatment), at the conclusion of treatment (post-treatment), and 12 weeks after therapy was terminated (follow-up). Analysis of variance was used to determine if any significant difference occurred among the four different groups. The mean differences were compared to zero using the least significant difference procedure. Blood lipid survey, urinary creatinine excretion values, fasting serum lipids, blood serum constituent values, nutrient intake values, and individual subject evaluations appear in the Appendix. For discussion on these subjects refer to Joyce Oldenburg's 1979 Master's Thesis, Department of Food and Nutrition, KSU.

Changes in Body Weight

The data (Table 1) show that the greatest average weight loss over the 12-week treatment period was -6.9 pounds for the behavior modification (BM) group. The behavior modification/exercise (BM/E) group lost a mean of -4.0 pounds, the diet therapy (DT) group lost -1.7 pounds, and the diet therapy/exercise (DT/E) group gained a mean of +1.2 pounds over the 12-week treatment period. Only the behavior modification group loss of -6.9 pounds was statistically significant at the 0.05 level. Although none of the other groups showed statistically significant weight losses, the BM/E group showed the second greatest loss of -4.0 pounds.

TABLE 1

Mean pre and post treatment and follow-up values of selected body composition parameters for obese (mean=38% fat) women aged 20-52 years

Parameters	Groups							
	BM/E ^a	(n)	BM ^b	(n)	DT/E ^c	(n)	DT ^d	(n)
Weight (lb)								
Pre	178.4±7.8 ^e	(9)	147.0±8.3	(8)	137.9±9.6	(6)	162.5±8.3	(8)
Post	169.7±7.2	(8)	141.1±7.7	(7)	139.0±9.1	(5)	153.0±7.7	(7)
Follow-up	170.4±7.6	(8)	141.1±7.6	(8)	139.0±8.8	(6)	161.0±7.6	(8)
Post-pre	-4.0±4.4	(8)	-6.9±4.7*	(7)	+1.2±6.2	(4)	-1.7±5.1	(6)
Post-follow-up	+0.6±2.2	(8)	+1.9±2.4	(7)	-0.4±2.8	(5)	+1.6±2.6	(6)
Pre-follow-up	-3.4±4.3	(8)	-5.9±4.3*	(8)	+1.8±5.4	(5)	-0.2±4.5	(7)
Density								
Pre	1.008±.004	(9)	1.012±.004	(8)	1.002±.006	(4)	1.008±.005	(6)
Post	1.012±.004	(8)	1.016±.005	(6)	1.013±.006	(4)	1.018±.005	(6)
Follow-up	1.013±.006	(5)	1.024±.007	(4)	1.016±.014	(1)	1.016±.010	(2)
Post-pre	-.003±.003	(8)	-.0042±.0035*	(6)	+.001±.005	(3)	-.0008±.004	(5)
Post-follow-up	+.0001±.003	(5)	+.001±.003	(3)	-.0007±.006	(1)	+.002±.004	(2)
Pre-follow-up	-.0017±.008	(5)	-.0087±.0085*	(4)	-.0013±.0169	(1)	-.0029±.012	(2)

^aBM/E=behavior modification plus exercise. ^bBM=behavior modification. ^cDT/E=diet therapy plus exercise.

^dDT=diet therapy. ^eStandard deviation of the mean

*Significant at the 0.05 level

Note: treatment period was 12 weeks in duration.

follow-up was three months after treatment ended.

Comparing pre and post evaluation weights (Table 1) would suggest that the BM/E group lost a mean of -8.7 pounds. The actual mean loss for this group was -4.0 pounds. The difference between 8.7 and 4.0 shows up statistically due to the absence of one of the heavier subjects during post testing evaluation. This same difference is seen in the DT group. By comparing pre and post differences, it appears that the DT group lost -9.5 pounds; however, they actually lost a mean of only -1.7 pounds. This difference is again due to the absence at post weighing of one of the heavier subjects in the group. Actual mean differences are shown in Table 1 and should not be calculated by subtracting pre and post weights.

This study attempted to produce a loss of approximately one pound per week. None of the groups accomplished this. There are several possible reasons why this projected weight loss was not achieved. One possible reason is that the caloric deficit necessary to lose one pound per week was not attained. A short questionnaire (Appendix E) evaluated the DT and DT/E subject compliance to their energy reduced, food-exchange diet. Evaluation of the completed questionnaire suggests that subjects in the diet therapy groups did not adhere closely to their diets. The average score was 3.5 on a scale of 1 to 5. One represented very good adherence to the diet and 5 represented poor adherence to the diet. The score of 3.5 indicated their compliance to the diet was only fair to poor.

The behavior modification therapy groups were not to count calories. However, energy levels determined from the three-day dietary intake assessment at the end of treatment indicated the subjects in the BM group consumed the least amount of energy, 1200 kcal/day. The BM/E group consumed an average of 1506 kcal/day, the DT/E group 1344 kcal/day, and the DT group consumed 1305 kcal/day. Other studies (146,9) suggest that dietary records kept by obese patients may not be accurate. They noted that errors on the low side of

estimating kcal were due primarily to underreporting and to inadequate descriptions of portion sizes. The latter problem is especially important for foods high in calories per unit weight. Comparisons of a research dietary history with a 24-hour recall of food in normal and overweight individuals showed reasonably good agreement in normal weight subjects. Among the obese, however, the discrepancy between estimates was more than 800 kcal per day (9), suggesting that estimates of energy intake by overweight individuals are at least moderately uncertain and may often be quite unreliable.

A second possible explanation for not attaining the projected weight loss is that estimation of daily caloric expenditure for the exercise groups, unless done by direct or indirect calorimetry, is subject to error. Subjects recorded their own energy expenditures which were estimations taken from activity tables giving caloric costs for various activities. Subtle changes in daily activity during the treatment period could have gone undetected due to the rather general manner of describing these activities. These changes could account for the subjects not attaining the desired loss. This study was conducted during the winter of 1978-79 which was particularly severe in Kansas and this could have caused a decrease in daily activity for many of the subjects. Normal outdoor activity was curtailed due to the cold temperatures, ice, and snow. This harsh winter may have been responsible for not only reduced physical activity, but also depression which may have been a factor. Lack of physical activity and depression would adversely affect motivation which is so important in a weight loss program. However, none of these factors were quantified and this remains as speculation on the part of this investigator.

Assessment of physical activity records indicated subjects in the two exercise groups expended approximately 250 kcal daily in some form of additional physical activity. Comparing the three-day dietary intake assessment, however, suggests that the BM/E group, consuming an average of 1506 kcal/day

most likely followed their exercise programs more closely than did the DT/E group, who consumed an average of 1344 kcal/day. According to the data, the BM/E group consumed 200 kcal/day more than the DT/E group, yet lost an average of -4.0 pounds while the DT/E group actually gained +1.2 pounds.

The three-month follow-up-post evaluations showed the subjects in the BM/E group and the DT/E group were more successful than the non-exercise groups. The DT/E group lost -.4 pound and the BM/E showed a mean gain of only +.6 pound; while the BM group had a mean gain of +1.9 pounds and the DT group a mean gain of +1.6 pounds.

In the follow-up-pre test evaluations the BM group maintained a statistically significant ($P \leq .05$) loss of -5.9 pounds. The BM/E group maintained a loss of -3.4 pounds, the DT group lost only -.2 pounds, while the DT/E group gained +1.8 pounds.

Harris and Hallbauer (63) reported on a similar 12-week study investigating DT, BM, and exercise on weight reduction. Results from their study show a mean loss of -7.0 pounds for the BM/E group, -6.0 pounds for the BM group and -4.5 pounds for the DT group. Results from their seven-month follow-up showed subjects in their study were more successful than subjects in this study. Their BM group maintained their loss, the BM/E group lost two more pounds, while the DT group gained 7.5 pounds. The reason for the difference in success of weight loss is not known. One possible explanation is that Harris and Hallbauer conducted their study from mid-March to early June while this study began in September and ended just before Christmas. This study follow-up was in March. Possible differences might be explained by holidays, Thanksgiving and Christmas, when problematic eating is more likely to occur (42); and the time of year, fall and winter, when weight gain is more probable (120,14).

Harris and Bruner (62) reported that behavioral treatment produced significant weight loss over a three-month treatment period, but this loss was not maintained at a seven-month follow-up. Although the present study had a three-month follow-up, the BM group weight loss was still significant ($P \leq .05$). It is impossible to say what a seven-month follow-up would reveal. Hall *et al.* (58) reported that two self-control behavioral treatment programs were significantly more effective than an attention-placebo treatment at post-treatment and a three-month follow-up. A six-month follow-up, however, showed that this difference had disappeared.

Levitz and Stunkard (88) report more positive results. They showed that compared to nutrition education and TOPS control treatment, behavior therapy produced significantly lower patient attrition rates and significantly greater weight loss at post-treatment and nine-month follow-up. The present study shows attrition rates were slightly lower for the subjects in the two behavior modification groups (41%) as compared to the two diet therapy groups (45%). Also, the DT groups were not adhering to their diet. Brightwell (18) has also suggested that motivation is more easily developed in behavior modification programs than in traditional weight loss programs. The results of this study tend to support Brightwell's, and Levitz and Stunkard's observations.

In summary, the BM group was the only group that showed a significant ($P \leq .05$) reduction in weight. Post weight reduction was -6.9 pounds and follow-up was -5.9 pounds. At post testing evaluation the two exercise groups did better than the non-exercise groups. Comparing follow-up-pre test evaluations showed both behavior modification groups were more successful than the two diet therapy groups.

Changes in Body Composition

Body composition changes will be discussed as they relate to density (D), percentage fat (% fat), total body fat (TBF), and lean body weight (LBW).

The relationship between these parameters will also be discussed.

Density

The data (Table 1) indicated that there was an increase in body density in all four groups at the three-month follow-up-pre evaluation. Only the BM group had a statistically significant increase in density. This increase agrees with other studies (78,33,50,119,156,105) which show that a caloric deficit will result in an increase in body density.

Several studies (22,31,112,29,141) indicate there is an increase in body density with training when diet is not controlled. Other studies (118,119,157,112,29) indicate that the more intense the training, the greater the improvement in density. This study does not support these statements since density changes were not significant in the exercise groups. It is not known why this study did not show significant changes in density in the exercise groups.

An increase in body density can occur in several ways from changes in total body fat (TBF) and changes in lean body weight (LBW), since body fat is less dense than lean tissue. Changes that cause an increase in density include:

1. TBF remains constant and LBW increases
2. TBF decreases and LBW remains constant
3. TBF decreases and LBW increases
4. TBF decreases and LBW decreases less than TBF

Post-pre test evaluations (Table 1) show the following changes in body density. The BM group had the greatest increase in D (+.0042) which was significant ($P \leq .05$). This increase was due to a greater decrease in TBF (-4.9 lbs.) than LBW (-1.4 lbs.). The BM/E group showed an increase in D (+.0027) due to a greater decrease in TBF (-3.7 lbs.) than in LBW (-.3 lbs.). The DT group showed a very slight increase in D (+.0008) by having a greater

decrease in TBF (-1.0 lbs.) than LBW (-.4). Only the DT/E group had a decrease in D. They lost D (-.001) by increasing TBF (+1.1 lbs.) more than LBW (+.2 lbs.).

Comparing follow-up-pre tests shows an increase in D for all four groups. The BM group again showed the greatest increase in D (+.0087) significant ($P \leq .05$). The BM/E group showed an increase in D (+.0016). The DT/E group had a gain in D (+.0013) by decreasing TBF (-.4) and increasing LBW (+1.5). The DT group showed an increase in D (+.0029) by decreasing TBF (-1.9) and increasing LBW (+.8).

In summary, only the BM group had a significant ($P \leq .05$) increase in density in post and follow-up evaluations. All groups showed an increase in density in the follow-up evaluation.

Total Body Fat

The total body fat (TBF) is calculated by multiplying the percentage fat by the total body weight. The data (Table 2) show that only the BM group produced a significant change in TBF (-4.9 lbs.) in the post-pre test evaluation. Although not significant ($P \leq .05$), the BM/E group showed a reduction in TBF (-3.7 lbs.), as did the DT group (-1.0 lbs.). The DT/E group recorded an increase in TBF (+1.1 lbs.). In the follow-up-pre evaluation all groups showed a reduction in TBF. The greatest losses were in the two behavior modification groups; BM (-7.0 lbs.), and BM/E (-2.1 lbs.). The diet therapy groups also showed losses in TBF; DT (-1.0 lbs.), and DT/E (-.4 lbs.). These reductions in TBF agree with other studies (50,23,83) that have reported a reduction in TBF with negative caloric balance.

Lean Body Weight

Lean body weight (LBW) is the total body weight with all fat removed. It is calculated by subtracting the total body fat (TBF) from body weight.

TABLE 2

Mean pre and post treatment and follow-up values of selected body composition parameters for obese (mean=38% fat) women aged 20-52 years

Parameters	Groups							
	BM/E ^a	(n)	BM ^b	(n)	DT/E ^c	(n)	DT ^d	(n)
Total body fat (lb)								
Pre	71.2±5.6 ^e	(9)	55.0±6.0	(8)	45.8±8.5	(4)	64.4±6.9	(6)
Post	64.5±4.8	(8)	50.8±5.6	(6)	50.5±6.8	(4)	52.1±5.6	(6)
Follow-up	63.4±7.6	(5)	44.7±8.5	(4)	52.4±17.0	(1)	57.2±12.0	(2)
Post-pre	-3.7±3.7	(8)	-4.9±4.3*	(6)	+1.1±6.1	(3)	-1.0±4.7	(5)
Post-follow-up	+0.5±2.9	(5)	+2.8±3.8	(3)	-0.4±6.5	(1)	+0.2±4.6	(2)
Pre-follow-up	-2.1±8.0	(5)	-7.0±8.9	(4)	-0.4±17.8	(1)	-1.0±12.6	(2)
Lean body weight (lb)								
Pre	107.2±3.8	(9)	91.5±4.1	(8)	92.5±5.7	(4)	97.9±4.7	(6)
Post	105.2±3.9	(8)	90.1±4.5	(6)	87.2±5.5	(4)	96.9±4.5	(6)
Follow-up	103.8±6.2	(5)	91.4±6.9	(4)	94.7±13.9	(1)	100.1±9.8	(2)
Post-pre	-0.3±1.5	(8)	-1.4±1.7	(6)	+0.2±2.4	(3)	-0.4±1.9	(5)
Post-follow-up	+0.3±1.4	(5)	+1.3±1.7	(3)	+0.5±3.0	(1)	+1.8±2.1	(2)
Pre-follow-up	-0.7±2.3	(5)	-0.3±2.6	(4)	+1.5±5.2	(1)	+0.8±3.7	(2)
Percentage body fat								
Pre	39.3±1.8	(9)	37.4±1.9	(8)	33.1±2.7	(4)	39.1±2.2	(6)
Post	37.5±1.8	(8)	35.8±2.1	(6)	36.7±2.6	(4)	34.8±2.1	(6)
Follow-up	37.1±2.8	(5)	32.3±3.1	(4)	35.6±6.3	(1)	36.5±4.4	(2)
Post-pre	-1.2±1.3	(8)	-1.9±1.6*	(6)	+0.5±2.2	(3)	-0.3±1.7	(5)
Post-follow-up	+0.1±1.0	(5)	+0.4±1.3	(3)	-0.3±2.2	(1)	-0.2±1.6	(2)
Pre-follow-up	-0.7±3.3	(5)	-3.8±3.7*	(4)	-0.6±7.4	(1)	-0.6±5.2	(2)

aBM/E=behavior modification/exercise.

bBM=behavior modification.

cDT/E=diet therapy/exercise. DT=diet therapy.

eStandard deviation of the mean *Significant at the 0.05 level

Note: treatment period was 12 weeks in duration, follow-up was three months after treatment ended.

The loss of lean tissue is considered undesirable. Lean body weight did not change significantly in any group. Only the DT/E group showed a gain in LBW in both the post-pre evaluations (+.2 lbs.) and the follow-up-pre evaluations (+1.5 lbs.). In the post-pre evaluation the BM/E group showed only a slight decrease in LBW (-.3 lbs.) with a weight loss of -4.0 pounds. LBW comprised 7.5% of the weight loss (Figure 4). The DT group showed a greater loss of lean tissue (-.4 lbs.) with a weight loss of only -1.7 pounds. Lean tissue loss was 23.5% of weight lost. The BM group showed a loss of lean tissue (-1.4 lbs.) with the loss of -6.9 pounds. LBW comprised 20% of weight lost. Only the DT/E group had a gain in lean tissue (+.2 lbs.) with a gain in weight (+1.2 lbs.).

In the follow-up-pre evaluation both diet therapy groups showed a gain in lean tissue. The DT/E group showed a gain in LBW (+1.5 lbs.) with a weight gain of +1.8 pounds. The DT, however, showed a gain in LBW (+.8 lbs.) with a loss in weight (-.2 lbs.). The BM/E group showed a loss in lean tissue (-.7 lbs.) with a weight loss of -3.4 pounds. The BM group also had a loss in LBW (-.3 lbs.) with a weight loss (-5.9 lbs.).

The data from the post-pre test evaluations agree with other investigators (78,50,23) who have reported the loss of lean tissue with reduced caloric intake. Studies (12,157) investigating the effects of exercise have reported that subjects who exercise gain in lean tissue. The data from the DT/E group is consistent with these studies. However, not all studies using exercise have shown a gain in lean tissue. Knowlton and Weber (83) reported a loss of 2.8 pounds lean tissue with subjects losing 14 pounds through exercise and diet over a 16-week treatment period. The BM/E group data is consistent with this study.

The cause of lean tissue loss during reduced caloric intake has been attributed to protein loss resulting from inadequate dietary intake or from

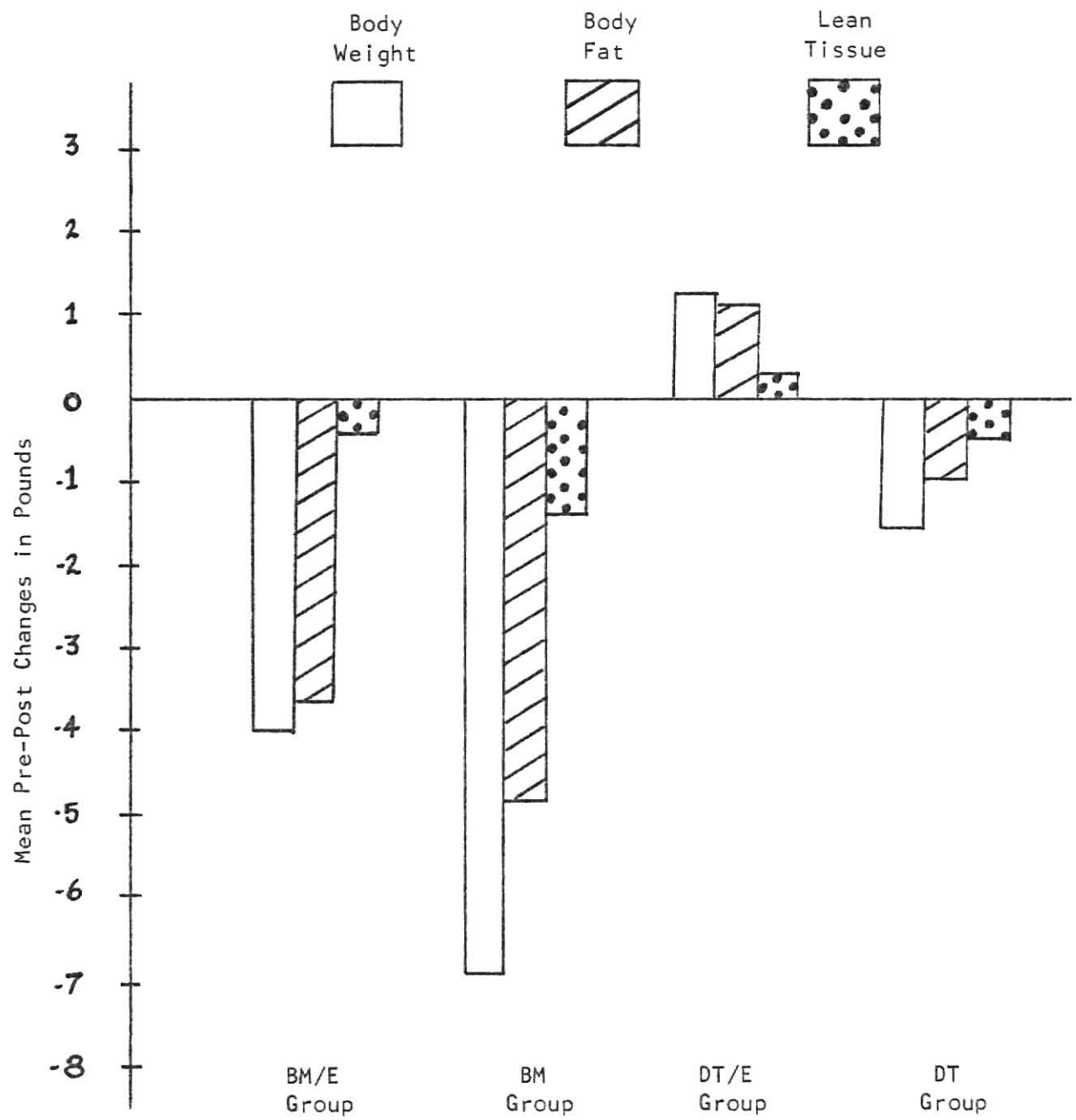


Figure 4
Body Weight, Body Fat and Lean Tissue
Changes from Pre to Post Tests

protein being metabolized for energy during fasting or semi-starvation (55,50). The data from the present study indicated that each group consumed an adequate amount of protein. The recommended protein intake is approximately 50 gr/day (108). The three-day dietary records reveal (Table 3) that all groups had 50 or more gr/day of protein. The loss of lean tissue could be due to protein metabolism for energy; however, this is unlikely with the relatively mild deficit of 250 kcal/day. The cause of the increase in lean tissue by individuals in the DT group is unknown. Helander (65) attributed increase in lean tissue by individuals participating in exercise programs to enlargement of existing muscle fibers with increase in myofibrils and sarcoplasm proteins. Another explanation for the changes could be the fluctuation in total body water which could affect determinations of LBW. If an individual retains water, this would show up as an increase in land weight. Density measured by underwater weighing would then be inaccurate. However, over an extended time (12 weeks) this would not seem likely.

Interrelationship of Density, Percentage Fat, Total Body Fat and Lean Body Weight

This study showed an improvement in D, % fat, and TBF for all groups in the follow-up-pre test evaluations. Investigators (78,51,33,50), studying the effects of reduced caloric intake, have reported a reduction in TBF and an increase in body density. This data is consistent with this study. Some researchers (23,83) have reported some reduction in LBW with caloric restriction which is consistent with the behavior modification groups. Others (1,5,12) have shown a gain in LBW for both men and women with moderate exercise (250-600 kcal/day) during negative caloric balance. The diet therapy groups, exercise and non-exercise, in this study showed a gain in LBW. This gain in LBW for the non-exercise group cannot be explained.

TABLE 3

Post treatment values of nutrient intake for obese (mean=38% fat) women aged 20-52 years

Nutrient (daily intake)	BM/E (n=9)	BM (n=8)	DT/E (n=7)	DT (n=9)
Kilocalories	1506±143.3*	1165±143.3	1344±143.3	1305±134.4
Protein (gm)	72± 5.3	55± 5.3	50± 5.3	58± 4.9
Fat (gm)	73± 8.1	42± 8.1	55± 8.1	56± 7.5
Carbohydrate (gm)	135± 20.0	145± 20.0	163± 20.0	146± 18.7
Fiber (gm)	2± 0.4	2± 0.4	2± 0.4	2± 0.4
Calcium (% of RDA)	77± 12.6	51± 12.6	61± 12.6	82± 11.8
Phosphorus (% of RDA)	120± 11.4	96± 11.4	99± 11.4	109± 10.6
Iron (% of RDA)	56± 6.9	57± 6.9	46± 6.9	47± 6.4
Sodium (mg)	2511±302.9	1510±302.9	2207±302.9	1806±283.3
Potassium (mg)	1513±158.2	1324±158.2	1531±158.2	1415±148.0
Vitamin A (% of RDA)	111± 23.2	81± 23.2	69± 23.2	78± 21.7
Thiamine (% of RDA)	79± 9.9	68± 9.9	71± 9.9	74± 9.2
Riboflavin (% of RDA)	98± 12.2	89± 12.2	69± 12.2	83± 11.4
Niacin (% of RDA)	98± 11.1	92± 11.1	75± 11.1	82± 10.5
Ascorbic acid (% of RDA)	139± 38.1	150± 38.1	145± 38.1	147± 35.6
SFAe (gm)	17± 2.4	8± 2.4	15± 2.4	15± 2.3
UFAf (gm)	20± 2.7	10± 2.7	14± 2.7	15± 2.5
PUFAg (gm)	10± 2.1	4± 2.1	7± 2.1	6± 2.0
Dietary cholesterol (gm)	340± 65.5	242± 65.5	175± 65.5	251± 61.3

aBM/E=behavior modification/exercise. bBM=behavior modification. cDT/E=diet therapy/exercise. dDT=diet therapy.

eSFA=saturated fatty acids. fUFA=mono unsaturated fatty acids. gPUFA=polyunsaturated fatty acids.

*Standard error of mean.

Anthropometric Measures

All of the skinfold and girth measurements taken in this study were reduced as a result of the weight losses. None of the changes were significant. The changes in skinfold measurements in this study were comparable with other investigators (12,111,103) who have reported uniform reduction in skinfold measurements with weight loss.

In the pre treatment evaluations, girth measurements (except neck, thigh groin, thigh min., calf, and patella) correlated well ($r \geq .6$) with D, % fat, TBF, and LBW. In the post girth measurements, none of the parameters (except chest above, waist, and iliac) correlated well ($r \geq .6$) with D or % fat. All parameters (except neck and thigh groin) correlated well ($r \geq .6$) with TBF in post evaluations. Note: in this entire section correlated well= $(r \geq .6)$ unless otherwise stated. In the follow-up evaluation, only the waist, iliac, hip max., thigh max., and thigh groin girth measurements correlated well with D and % fat. All parameters (except neck and calf) correlated well with TBF. LBW correlated well with all parameters except iliac, thigh max., and thigh groin. Weight correlated well with all follow-up girth measurements.

In the pre-post girth measurement evaluations, weight, D, % fat, and TBF correlated well with only bicep extended, chest nipple, waist min., hip max., thigh max., and calf. LBW only correlated well with bicep extended and waist min. In the post-follow-up girth measurement evaluations weight correlated well with only waist, hip max., and thigh max. measurements. Density, % fat and TBF correlated well only with neck and waist girth measurements. The data indicated that girth measurements from pre-post and post-follow-up evaluations did not accurately reflect changes in body composition. In the pre-follow-up girth measurement evaluations, weight, D, % fat, and TBF correlated well with all parameters except neck, thigh min., and patella. LBW only correlated well with waist min.

In summary, correlations between D, % fat, TBF, LBW and pre girth measurements were good. Fewer post girth measurements correlated well with the parameters. Many follow-up girth measurements correlated well with the parameters. Only a few pre-post girth evaluations correlated well with TBF, D, % fat, and weight. LBW did not correlate well with girth measurements in the pre-post evaluations. There were few good correlations in the post-follow-up girth evaluations. In the pre-follow-up girth evaluations, D, % fat, weight, and TBF correlated well with most of the parameters.

In the pre skinfold evaluations only abdominal, iliac front, iliac supra, pubic, groin, thigh front, and thigh rear correlated well with D, % fat, and TBF. LBW did not correlate well with any skinfolds in the pre evaluations. In the post skinfold evaluations D, % fat, and TBF correlated well with only abdominal, iliac front, pubic, groin and lateral thigh skinfold measurements. LBW and weight did not correlate well with any of the skinfolds. In the follow-up skinfold evaluations D, % fat, and TBF correlated well with only selected skinfolds. They were: abdominal, iliac front, pubic, groin, thigh front, thigh rear, and lateral thigh skinfolds.

In the pre-post skinfold evaluations D, weight, % fat and TBF correlated well with more parameters. They were: scapula, triceps, mid-axillary, iliac supra, pubic, groin, thigh front, and lateral thigh skinfolds. In the post-follow-up skinfold evaluations correlations were very poor. Weight correlated well only with two skinfolds, iliac supra and pubic. None of the other parameters correlated well with any of the skinfolds. The data indicated in the time from post to follow-up, skinfolds did not accurately indicate changes in body composition. In the pre-follow-up evaluations of skinfolds, the number of correlations was considerably better. TBF correlated well with seven skinfolds: scapula, triceps, mid-axillary, iliac front, pubic, groin, and thigh rear. Weight correlated well with six skinfolds: scapula, triceps,

iliac front, iliac supra, groin, and calf. LBW only correlated well with the iliac supra skinfold.

In summary, only selected skinfolds (abdominal, iliac front, pubic, groin, thigh front, thigh rear, and lateral thigh) correlated well with weight, D, % fat, and TBF in the pre, post, and follow-up evaluations. LBW did not correlate well with the skinfolds. In the pre-post test skinfold evaluations, again only selected skinfolds correlated well with the parameters. In the post-follow-up only weight correlated well with two skinfolds. In pre-follow-up skinfold evaluations, the parameters correlated well with only selected skinfolds. LBW did not correlate with the skinfolds.

This data indicated that girth and skinfold measurements were not accurate in predicting LBW. They did give an indication of % fat, TBF, D, and total weight in general. Girth measurements appeared to correlate better with the body composition parameters than did skinfold measurements. This data agrees with Wilmore, Girandola, and Moody (157) who reported estimations of body composition based on anthropometric measurements are not valid for predicting changes in body composition. The reduction of body weight does produce changes in body composition; however, it may be that the changes in anthropometric measurements do not discriminate enough to detect those changes in body composition.

Blood Pressure

Table 4 summarizes the mean pre and post evaluation for all four groups. Different values indicate changes between initial and final evaluations. No significant changes were found in either systolic or diastolic blood pressures for subjects in any of the study groups. Diastolic blood pressure was moderately correlated ($r=.48$) with body weight. Wilcox (153) reported a lower correlation ($r=.38$) between diastolic blood pressure and body weight in 70

TABLE 4

Mean pre and post treatment values for systolic and diastolic blood pressures in obese (mean=38% fat) women aged 20-52 years

Blood pressure	Groups			
	BM/E ^a	BM ^b	DT/E ^c	DT ^d
Systolic blood pressure (mm/Hg)				
Pre	124.5±4.8 ^e (6)	120.9±4.4 (7)	106.0±5.2 (5)	111.8±4.1 (8)
Post	113.4±3.7 (8)	108.3±4.3 (6)	116.3±3.9 (7)	107.1±3.5 (9)
Difference ^f	-8.3 (6)	-7.6 (5)	+10.8 (5)	-2.5 (8)
Diastolic blood pressure (mm/Hg)				
Pre	85.0±3.3 (6)	75.1±3.1 (7)	68.0±3.6 (5)	76.8±2.9 (8)
Post	77.1±3.1 (8)	72.5±3.4 (6)	71.9±3.2 (7)	75.9±2.8 (9)
Difference	-4.7 (6)	-1.4 (5)	+4.4 (5)	+1.4 (8)

^aBM/E=behavior modification/exercise ^bBM=behavior modification ^cDT/E=diet therapy/exercise ^dDT=diet therapy

^eStandard deviation of mean. ^fDifference between post minus pre tests.

Note: time between pre and post was 12 weeks.

massively obese women (mean age=34 years, mean weight=228 pounds, mean height=65 inches).

Dietary Intake

The post treatment data in Table 3 indicate that all four treatment groups met two-thirds of the Recommended Dietary Allowances for all nutrients but iron. Subjects in all four groups ingested about 1300 kcal/day with about 20 percent of this energy derived from protein, 30 percent from fat, and 50 percent from carbohydrate. Although mean energy intakes were not significantly different between the four groups, the data indicates that the BM group ingested the least amount of energy (1200 kcal/day). This group lost the greatest amount of weight. Even though subjects in the behavior modification group did not receive nutritional guidance, they adopted basically nutritionally sound dietary patterns. Ritt et al. (122) reported similar results.

Summary

The data from this study support the hypothesis that DT, DT/E, BM, BM/E will affect weight reduction and body composition differently. On the basis of the results of this study, the behavior modification group showed the most beneficial results. This group showed the greatest loss of body weight, loss of total body fat and decrease in percentage body fat. The behavior modification/exercise group was the next most successful group in weight reduction, loss of total body fat, and percentage fat. All groups showed an increase in body density in the follow-up evaluation. In the post-pre evaluation the exercise groups showed more desirable results of maintaining or increasing lean body tissue.

CHAPTER 5

SUMMARY AND CONCLUSION

This study evaluated weight changes and body composition changes as a result of treatment by: behavior modification (BM), behavior modification plus exercise (BM/E), diet therapy (DT), and diet therapy plus exercise (DT/E).

Summary

Weight reduction is a very complex problem that deserves further scientific research. Obesity causes health and mental problems for many people. Although some individuals are able to lose weight, few obese people are permanently successful in maintaining desirable weight.

In this study, three groups, BM, BM/E, and DT showed weight losses over the 12-week experimental treatment period and at the three-month follow-up evaluations. Only the BM group lost a significant ($P \leq .05$) amount of weight at post testing (-6.9 lbs.) and follow-up (-5.9 lbs.). Weight changes in the other groups were not significant (BM/E -4.0 post, -3.4 follow-up; DT -1.7 post, -.2 follow-up; and DT/E +1.2 post, +1.8 follow-up). The DT and DT/E groups showed gains in lean tissue. The loss of lean tissue is considered undesirable. DT/E data showed post test and follow-up test gains in LBW. DT data showed a gain in LBW in follow-up testing. The BM group had the best overall changes showing a post weight loss -6.9 lbs., TBF -4.9 lbs., % fat -1.9%; and follow-up weight loss -5.9 lbs., TBF -7.0 lbs, and % fat -3.8%. All body composition measurements, except LBW, had a significant ($P \leq .05$) improvement as a result of treatment in the BM group. The BM/E group was the

next most successful group. They showed improvement in all body composition parameters except LBW (post wt. -4.0 lbs., TBF -3.7 lbs., % fat -1.2%; follow-up wt. -3.4 lbs., TBF -2.1 lbs., % fat -0.7%). The DT group showed improvement in all body composition measurements (post wt. -1.7 lbs., TBF -1.0 lbs., LBW -0.4 lbs., % fat -0.3%; follow-up wt. -.2 lbs., TBF -1.0 lbs., LBW +0.8 lbs., % fat -0.6%). The DT/E group showed the least improvement due to treatment (post wt. +1.2 lbs., TBF +1.1 lbs., LBW +0.2 lbs., % fat -0.6%). All anthropometric measurements showed a reduction as a result of weight loss but were unaffected by the methods used to create caloric deficit. Attrition rates were slightly less for both behavior modification groups (41%) than for the diet therapy groups (45%).

No significant changes were found in either the systolic or diastolic blood pressures for subjects in any of the four treatment groups. Diastolic blood pressure was moderately correlated ($r=.48$) with body weight.

Mean energy intakes were not significantly different among subjects in the four treatment groups. BM subjects, however, consumed the least amount of energy (1,165 kcal/day) and lost the most weight (-6.9 lbs.). Subjects in the two diet therapy groups indicated fair to poor adherence to their energy reduced, food-exchange diets. Diet analysis indicated that 20% of the total energy consumed by all subjects was derived from protein, 30% from fat, and 50% from carbohydrate. Subjects in all four groups met two-thirds or more of the Recommended Dietary Allowances for all nutrients but iron.

Conclusions

Based on the results of this study the following conclusions apply to weight loss:

1. Motivated individuals using a reduced caloric diet, exercise, or a combination of diet and exercise to create a caloric deficit, can lose weight and maintain good nutritional status.

2. Behavior modification techniques applied to obesity can show significant reductions in body weight, total body fat, and percentage fat as determined by underwater weighing.

3. Attrition rates are lower in BM therapy programs than in conventional diet therapy programs.

4. All skinfold and body girth measurements are reduced as a result of weight loss.

5. Skinfold and girth measurements are not as accurate in assessing density, % fat, and lean body weight as underwater weighing especially during periods of weight loss. This means it is more difficult to determine ideal weight through skinfolds and girth measurements.

Recommendations

Based on the results of this study, the following recommendations are made for those interested in weight reduction or further research in this area.

Recommendation for individuals interested in losing weight:

The use of behavior modification as a means of weight loss and weight control.

Recommendations for further research include:

1. Should this study be repeated, the same therapist should be used for both groups to provide a better means of control.

2. Larger numbers of subjects in each group would allow more degrees of freedom statistically and provide for a better statistical analysis.

3. Subjects should be in an organized exercise class for more constant regulation of activity. This would provide a better means of assessing energy expenditure.

4. Treatment should last longer than 12 weeks, preferably 24 weeks or longer depending on the individual.

5. Six-month, one-year, two-year and longer follow-ups would provide more information on long-term success rates.

This investigator observed that those who were motivated and excited about the behavior therapy adhered to the program and adapted at least some of the principles to their daily lives. Subjects in the behavior therapy program were selective about the concepts that were significant and relevant to them. This indicates that behavior therapy should be individualized to suit the needs of the individual. Those subjects who were not motivated by the new behavior techniques found it very difficult to comply with any of the program. Some subjects might respond to a combination of diet therapy and behavior modification.

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APPENDIX A

CONSENT FORM

I _____ have volunteered to participate in an experiment designed to study the effectiveness of different methods of weight control. I have been asked to complete the study which will conclude Dec. 15, 1978, but I should feel free to withdraw at any time. A follow-up test will be done in March of 1979 if I can participate. I understand that I may refuse to undergo any of the testing procedures without prejudice.

Participation will require the following physical measurements and tests:

- (1) Body weight--taken initially and on a weekly basis
- (2) Body height--taken initially
- (3) Skinfolds--taken initially, at the midpoint, and end
- (4) Underwater weighing--taken initially, at the midpoint, and end.
(Weighing will be done while in a swimming suit.)
- (5) Bone diameters and girth measurements will be taken initially
- (6) Blood pressure--initial, midpoint, and final
- (7) Three day dietary food records will be obtained three times during the study
- (8) A 24-hour urine collection--taken initially, at the midpoint and final stages of testing
- (9) Fasting blood will be obtained by veinipuncture at the beginning and end of the study period. This will be done under the supervision of medical or allied health personnel.

All final testing will be done before the end of the 1978 school semester. A follow-up test will be planned for March 1979, using the same testing procedures as above.

I will be required to attend 12 weekly instructional and educational meetings, lasting from 30 to 60 minutes.

I will feel free to ask questions about testing procedures. All results will be kept strictly confidential. I will have an opportunity at the end of the study to find out the conclusions.

To my knowledge, I am in a good state of health. I am not pregnant and do not have any cardiovascular problem, infectious disease or metabolic condition which could limit my participation in the study. If pregnancy occurs, I will voluntarily withdraw from the study.

I have read and understand the above statement. I hereby voluntarily consent to participate.

Date _____

Signature _____

Witness _____

APPENDIX B

DIETARY RECORD

Name _____ Date _____ Day _____
 Place eaten: _____ Dinner _____ Supper _____
 Breakfast _____ Lunch _____ Dinner _____

Food	Estimated measure	Kind of ingredients
Breakfast		
Between Meals		
Lunch or Dinner		
Between Meals		
Dinner or Supper		
Between Meals		

APPENDIX C

CALCULATION OF DAILY ENERGY REQUIREMENTS¹

1. Energy expenditure for basal metabolic rate (BMR)

(A) _____ (weight in kg) x 1 kcal = (B) _____

To find the daily expenditure for BMR, multiply (B) by 24 hours.

(B) _____ x 24 hr = (C) _____

2. Energy expenditure for activity

Sedentary	20% of BMR
Light activity	30% of BMR
Moderate activity	40% of BMR
Heavy activity	50% of BMR

Select the appropriate activity level and calculate the number of kcal you denote to activity

_____ % of (C) _____ = (D) _____

3. Energy expenditure for specific dynamic action (SDA)

Estimation of SDA

10% of (C) _____ + (D) _____ = (E) _____

4. Total daily energy expenditure

(C) _____ + (D) _____ + (E) _____ = TOTAL _____

¹Williams, S.R. Nutrition and Diet Therapy. (2nd ed.). St. Louis: C.V. Mosby Co., 1973, p. 484.

APPENDIX D

1,200 KILOCALORIE DAILY FOOD PLAN

6 meat exchanges
 4 bread exchanges
 2 milk exchanges
 3 vegetable exchanges
 3 fruit exchanges
 3 fat exchanges

Breakfast:	1 oz. toast	1 bread
	1 tsp. margarine	1 fat
	1 orange	1 fruit
	1/3 C. cottage cheese	1 meat
	coffee	
Lunch:	chicken sandwich:	
	(2 slices bread	2 bread
	2 oz. chicken	2 meat
	1 tsp. mayonnaise)	1 fat
	cucumber slices	1 vegetable
	carrot sticks	1 vegetable
	3/4 C. plain yogurt	1 milk
	1/2 C. strawberries	1/2 fruit
	iced tea	
Dinner:	3 oz. broiled lean beef	3 meat
	baked potato	1 bread
	1 T. sour cream	1 fat
	broccoli spears	1 vegetable
	apple sliced on	1 fruit
	lettuce leaf	
	coffee	
Snack:	banana milk shake	
	(1/4 banana	1/2 fruit
	1 C. skim milk	1 milk
	artificial sweetener)	

APPENDIX E

QUESTIONNAIRE EVALUATING SUBJECT COMPLIANCE TO
AN ENERGY-RESTRICTED FOOD EXCHANGE DIET

1. On a scale from 1 to 5, with 1 representing very good adherence and 5 representing very poor adherence, please indicate how closely you've been following your diet. _____
2. When are you most likely to be tempted not to follow your diet? Please check the appropriate answer.

_____ morning

_____ afternoon

_____ evening
3. Is it more difficult to follow your diet when you are alone or with others?

4. Please list two of your favorite foods. Have you included them in your diet plan?

APPENDIX F

BLOOD LIPID SURVEY

Name _____ Local Physician _____

Telephone Number _____

Height _____

Weight _____

Age _____ Date Form Completed _____

1. Are you now on diet therapy for hyperlipidemia or a low cholesterol diet? Yes _____ No _____

2. Have you ever been advised by your physician to eat a low cholesterol diet? Yes _____ No _____

3. Are you taking drugs for hyperlipidemia? Yes _____ No _____

If yes indicate drug and dosage

a) clofibrate (Atromid-S) _____

b) thyroxine _____

c) nicotinic acid _____

d) cholestyramine _____

e) other _____

4. Are you taking oral contraceptives? Yes _____ No _____

If yes indicate type (name) _____

5. Are you taking any androgenic steroid? Yes _____ No _____

If yes indicate drug and dosage

a) fluoxymesterone _____

b) oxymethalone _____

c) norandrolone _____

d) testosterone _____

e) other _____

6. Do you smoke? Yes _____ No _____

If yes, please indicate

cigarettes _____ packs/day _____

cigars _____

pipe _____

7. Have you ever taken any medicine for heart trouble? Yes _____ No _____

If yes, type _____

Do you take it now? Yes _____ No _____

8. Have you ever been told that you have high blood pressure? Yes _____ No _____

If yes, what was your age? _____

9. Have you ever taken any medicine for high blood pressure? Yes ____ No ____
 If yes, when? ____
 For how long? ____
 Do you take it now? Yes ____ No ____
10. Have you ever had a heart attack? Yes ____ No ____
 If yes, at what age? ____
11. Is your mother alive? Yes ____ No ____
 If yes, a) age now ____
 b) Has she ever been thought to have heart disease?
 Yes (describe) ____ No ____
 If no, a) cause of death? ____
 b) age at death ____
12. Is your father alive? Yes ____ No ____
 If yes, a) age now ____
 b) Has he ever been thought to have heart disease?
 Yes (describe) ____ No ____
 If no, a) cause of death? ____
 b) age at death ____
13. How many brothers and sisters have you who are alive now?
 Brothers? ____ Ages? ____
 Sisters? ____ Ages? ____
14. Have any of them ever had heart trouble? Yes ____ No ____
 not applicable ____
 If yes, give details as follows
- | | <u>Brother or Sister</u> | <u>Age When Trouble Started</u> | <u>Nature of Illness</u> |
|----|--------------------------|---------------------------------|--------------------------|
| a) | _____ | _____ | _____ |
| b) | _____ | _____ | _____ |
| c) | _____ | _____ | _____ |
| d) | _____ | _____ | _____ |
15. Have you ever had blood drawn for a test for cholesterol, triglycerides or lipoproteins (fats)? Yes ____ No ____
 If yes, please record the known values
 cholesterol ____ date ____
 triglycerides ____
 lipoproteins ____

16. Have your children had blood drawn for a test of cholesterol, triglycerides or lipoproteins?

Yes _____ No _____
Not known _____

If yes, please record the known values

	Son	Daughter	Age
cholesterol	_____	_____	_____
triglyceride	_____	_____	_____
lipoproteins	_____	_____	_____

17. Has anyone in your family ever had diabetes (sugar disease)?

Yes _____ No _____

If yes, which of your relatives (e.g. brother, cousin, parent) _____

18. If you are married, does your spouse suffer from

- a) heart trouble Yes _____ No _____
- b) high blood pressure Yes _____ No _____

19. What medications are you presently taking?

Please do not write below this line.

NAME: _____

DATE: _____

Serum cholesterol mg/dl: _____

Serum triglyceride mg/dl: _____

Lipoprotein electrophoresis: _____

Check one

- Normal _____
- Type I _____
- Type II _____
- Type III _____
- Type IV _____
- Type V _____

Chylomicrons present

- Yes _____
- No _____

Other abnormality (specify)

APPENDIX G

Pre and post treatment values of urinary creatinine excretion (UCE) for obese (mean=38% fat) women aged 20-52 years.

Urinary creatinine excretion (g/24 hr)	Groups				DT ^d	(n)
	BM+EX ^a	(n)	BM ^b	(n)	DT+EX ^c	(n)
Pre	1.58±.11 ^e	(7)	1.28±.11	(8)	0.98±.12	(6)
Post	1.31±.09	(9)	1.20±.11	(6)	1.12±.11	(6)
Difference ^f	-0.27 ^{g*}	(7)	+0.01	(6)	+0.14 ^g	(6)
					-0.10	(8)

^aBM+EX=behavior modification plus exercise. ^bBM=behavior modification. ^cDT+EX=diet therapy plus exercise. ^dDT=diet therapy. ^eStandard error. ^fDifference represents the change or difference between pre and post measurement values. ^gUCE difference values for subjects in these groups are significantly different from one another at the P≤0.05 level. *Significant at the P≤0.05 level. Note: treatment period was 12 weeks in duration.

APPENDIX H

Pre and post treatment values for fasting serum lipids in obese (mean=38% fat) women aged 20-52 years.

Parameters	Groups							
	BM+EX ^a	(n)	BM ^b	(n)	DT+EX ^c	(n)	DT ^d	(n)
Triglyceride (TG-mg/dl)								
Pre	66.9±12.30	(8)	83.8±12.30	(8)	58.9±13.10	(7)	98.0±11.50	(9)
Post	55.9± 8.50	(8)	44.3± 9.80	(6)	59.7± 9.80	(6)	79.0± 8.00	(9)
Difference	-13.4	(7)	-14.7	(6)	+5.2	(6)	-19.0*	(9)
Cholesterol (mg/dl)								
Pre	186.8±10.10	(8)	196.9±10.10	(8)	176.7±10.80	(7)	202.1± 9.50	(9)
Post	168.1±11.40	(8)	192.7±13.10	(6)	182.5±13.10	(6)	200.2±10.70	(9)
Difference	-17.7*	(7)	0.0	(6)	+6.0	(6)	-1.9	(9)
Low density lipoprotein ^g (LDL-mg/dl)								
Pre	125.9± 9.10	(8)	127.4± 9.10	(8)	119.4± 9.80	(7)	138.4± 8.60	(9)
Post	109.6±10.50	(8)	128.6±12.20	(6)	118.2±12.20	(6)	139.0± 9.90	(9)
Difference	-13.9	(7)	-11.6	(6)	-1.0	(6)	-0.6	(9)
High density lipoprotein (HDL-mg/dl)								
Pre	47.5± 3.40 ^e	(8)	52.8± 3.40	(8)	45.6± 3.70	(7)	44.1± 3.20	(9)
Post	47.4± 3.50	(8)	55.2± 4.00	(6)	52.3± 4.00	(6)	45.4± 3.30	(9)
Difference ^f	-1.1	(7)	0.0	(6)	+6.0	(6)	+1.3	(9)
HDL/cholesterol ratio								
Pre	0.26±0.02	(8)	0.27±0.02	(8)	0.26±0.02	(7)	0.22±0.02	(9)
Post	0.29±0.02	(8)	0.29±0.02	(6)	0.29±0.02	(6)	0.23±0.02	(9)
Difference ^f	+0.03*	(7)	-0.01	(6)	+0.02*	(6)	+0.01	(9)

^aBM+EX=behavior modification plus exercise. ^bBM=behavior modification. ^cDT+EX=diet therapy plus exercise. ^dDT=diet therapy. ^eStandard error. ^fDifference represents the change or difference between pre and post treatment measurement values. ^gCalculated by Fredrickson et al. (84) formula: LDL=chol.-HDL-TG/5. *Significant at the P≤0.05 level. Note: treatment period was 12 weeks in duration.

APPENDIX I

Pre treatment blood serum constituent values for obese (mean=38% fat) women aged 20-52 years.

Constituents	Groups			
	BM+EX ^a (n=8)	BM ^b (n=8)	DT+EX ^c (n=7)	DT ^d (n=9)
Glucose (mg/dl)	81.5±1.60 ^e	74.6±2.71	77.7±1.73	77.3±2.99
Urea (mg/dl)	12.7±1.20	13.8±1.01	11.4±1.19	13.3±0.84
Creatinine (mg/dl)	0.8±0.03	0.8±0.03	0.8±0.02	0.8±0.03
Calcium (mg/dl)	8.5±0.09	8.5±0.14	8.7±0.11	8.7±0.11
Phosphorus (mg/dl)	3.6±0.08	3.7±0.11	3.7±0.13	3.6±0.14
Alkaline phosphatase (I.U.)	68.6±5.34	65.3±3.75	61.4±7.04	69.3±9.81
Glutamic pyruvic (units/ml) transaminase	14.4±3.27	11.6±1.28	11.9±1.29	17.1±3.76
Sodium (mEq/L)	138.1±0.47	139.0±0.65	138.6±0.37	139.1±0.75
Potassium (mEq/L)	4.4±0.20	4.9±0.18	4.6±0.17	4.6±0.10
Carbon dioxide (mM/L)	27.9±1.01	26.1±0.72	26.6±0.92	26.8±1.18
Total protein (mg/dl)	6.9±0.15	7.0±0.07	6.9±0.16	7.1±0.15
Albumin (gm/dl)	4.2±0.12	4.3±0.05	4.2±0.10	4.3±0.07
Chloride (mEq/L)	106.0±0.94	105.6±0.56	106.9±1.52	105.7±0.69

^aBM+EX=behavior modification plus exercise. ^bBM=behavior modification. ^cDT+EX=diet therapy plus exercise.
^dDT=diet therapy. ^eStandard error.

APPENDIX J

INDIVIDUAL SUBJECT VALUES

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride ^a	Cholesterol ^a	HDL ^a	LDL ^a	HDL/chole
9004	1 ^b	42	58.5	176* 175**	41.8 40.2	36 30	150 146	53 52	90 88	.35 .36
9007	1	31	63.3	144 134	36.2 32.8	47 22	196 156	75 43	112 109	.38 .28
9008	1	47	65.0	156 163	38.0 40.6	86 68	170 162	45 54	108 94	.26 .33
9010	1	34	64.0	167 165	37.8 37.0	193 88	238 155	50 40	125 97	.21 .26
9011	1	39	70.0	223 211	43.5 40.4	44 35	171 127	39 53	123 67	.23 .42
9013	1	34	65.4	142 139	30.4 29.9	98 54	179 180	44 42	115 127	.25 .23
9039	1	30	66.0	216 ---	44.0 ---	--- 66	--- 166	-- 47	--- 106	--- .28
9043	1	31	69.0	231 222	42.8 41.7	89 84	260 253	47 48	195 188	.18 .19
9051	1	46	67.0	150 149	38.8 37.0	60 ---	191 ---	40 --	139 ---	.21 ---

^aSerum lipid measurement units = (mg/dl). ^b1=behavior modification plus exercise. *=pre treatment measurement. **=post treatment measurement.

INDIVIDUAL SUBJECT VALUES (Cont.)

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceridea	Cholesterol ^a	HDL ^a	LDL ^a	HDL/chole
9001	2 ^b	35	62.0	141* 142**	36.2 37.6	57 43	195 207	49 49	135 149	.25 .24
9009	2	22	63.0	128 121	38.3 35.1	30 37	192 208	63 65	123 136	.33 .31
9018	2	33	66.6	164	34.4	55	163	46	106	.28
9028	2	51	62.0	168 156	41.4 39.7	123 ---	233 ---	41 --	167 ---	.18 ---
9034	2	20	61.5	140 ---	35.6 ---	193 ---	238 ---	50 --	149 ---	.21 ---
9040	2	42	63.9	151 151	46.2 45.3	119 77	194 193	75 79	95 98	.39 .41
9047	2	31	64.0	135 135	29.5 28.8	45 39	177 169	40 45	128 116	.23 .27
9053	2	38	64.3	148 142	37.5 ---	48 34	183 181	58 62	115 112	.32 .34

^aSerum lipid measurement units = (mg/dl). ^{b2}=behavior modification. *=pre treatment measurement.
**=post treatment measurement.

INDIVIDUAL SUBJECT VALUES (Cont.)

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride ^a	Cholesterol ^a	HDL ^a	LDL ^a	HDL/chole
9026	3 ^b	43	60.0	132* 133**	--- 40.3	61 39	211 204	42 54	157 142	.20 .26
9030	3	35	65.1	146 147	36.2 35.9	43 86	172 204	50 60	113 127	.29 .29
9036	3	20	64.0	139 ---	27.2 ---	31 54	141 153	39 45	96 97	.28 .29
9042	3	38	61.0	127 128	35.3 35.3	49 42	184 187	50 63	124 116	.27 .34
9048	3	35	66.5	142 144	33.7 35.4	85 ---	178 ---	41 --	120 ---	.23 ---
9052	3	21	63.0	142 ---	--- ---	46 34	170 137	47 42	114 88	.28 .31
9054	3	20	63.0	--- 146	--- ---	97 103	181 210	50 50	112 139	.28 .24

^aSerum lipid measurement units = (mg/dl). ^b3=diet therapy plus exercise. *=pre treatment measurement. **=post treatment measurement.

INDIVIDUAL SUBJECT VALUES (Cont.)

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride ^a	Cholesterol ^a	HDL ^a	LDL ^a	HDL/chole
9003	4 ^b	27	146	---*	---	72	172	43	115	.25
				---**	---	55	202	43	148	.21
9006	4	35	65.0	144	33.8	62	210	46	152	.22
				146	33.9	68	209	48	147	.23
9014	4	31	65.0	180	---	116	234	54	157	.23
				177	---	54	187	55	121	.29
9023	4	41	61.0	144	37.3	103	230	43	166	.19
				144	37.0	69	249	48	187	.19
9024	4	45	62.9	166	37.7	103	233	43	169	.18
				161	37.0	104	255	50	184	.19
9041	4	49	63.0	154	43.9	128	221	48	147	.22
				154	44.2	122	207	50	133	.24
9045	4	31	67.0	162	30.4	78	203	54	133	.27
				157	29.4	55	182	47	124	.26
9046	4	29	60.0	206	51.1	126	153	35	93	.23
				---	---	93	146	32	95	.22
9056	4	26	64.0	---	---	94	163	31	113	.19
				132	27.4	92	165	36	111	.22

^aSerum lipid measurement units = (mg/dl).

^b4=diet therapy.

*=pre treatment measurement.

**=post treatment measurement

EFFECTS OF DIET THERAPY, BEHAVIOR MODIFICATION, AND
EXERCISE ON WEIGHT REDUCTION AND BODY COMPOSITION

by

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AN ABSTRACT OF A MASTER'S THESIS

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Thirty-three premenopausal, non-pregnant, obese (mean=38% fat) adult females age 20 to 52 years were studied to investigate the effectiveness of diet therapy, behavior modification, and exercise on weight reduction and body composition. Subjects were randomly assigned to one of four groups: (1) behavior modification, (2) behavior modification plus exercise, (3) diet therapy, and (4) diet therapy plus exercise. Treatment lasted for 12 weeks. Subjects in the behavior modification groups were to lose weight by correcting problematic eating patterns and develop appropriate eating habits. Subjects in the diet therapy groups were to lose weight by following their individualized energy-restricted diets. Exercise subjects were to increase their physical activity by 250 kcal/day. Subjects were tested before and after the 12-week experimental period and again three months later for changes in body density, skinfold and girth measurements, and blood pressure.

The attrition rate for subjects in the two behavior modification groups was slightly less than for subjects in the diet therapy groups. Only subjects in the behavior modification group lost a significant ($P \leq 0.05$) amount of weight (-6.9 lbs.), total body fat (-4.9 lbs.), and percentage body fat (-1.9%) due to treatment. The behavior modification plus exercise group was the next most successful group losing -4.0 pounds, -3.7 pounds total body fat and a 1.2% decrease in percentage body fat. The diet therapy group lost -1.7 pounds, -1.0 pounds total body fat, and -0.3% of body fat percentage. Diet therapy plus exercise group gained +1.2 pounds, +1.1 total body fat, and increased percentage body fat by .5%. No significant changes in lean body weight occurred for subjects in any of the four groups; however, subjects in the two exercise groups had a greater tendency to retain lean body tissue than the non-exercise

subjects. All skinfold and girth measurements were reduced with weight loss but there was no difference in reduction among the methods. No significant changes were found in blood pressure. Diastolic blood pressure was moderately correlated ($r=.48$) with total body weight. Average energy intakes were not significantly different among subjects; however, subjects in the behavior modification group consumed the least amount of energy (1,165 kcal/day). Subjects met two-thirds of the Recommended Dietary Allowances for all nutrients but iron.

Results of this study indicated that behavior modification is more successful than traditional diet therapy and motivation is more easily developed in behavior modification therapy than in diet therapy. Increasing physical activity (250 kcal/day) during weight loss may promote retention of lean body tissue.