This is to certify that the

thesis entitled

FACTORS CONTRIBUTING TO SUCCESS OR FAILURE AT WEIGHT LOSS MAINTENANCE

presented by

Gail Judith Haus

has been accepted towards fulfillment
of the requirements for
MASTERS degree in Human Nutrition

Major professor

Date 11-10-91

FACTORS CONTRIBUTING TO SUCCESS OR FAILURE AT WEIGHT LOSS MAINTENANCE

By

Gail Judith Haus

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Food Science and Human Nutrition

1991

ABSTRACT

FACTORS CONTRIBUTING TO SUCCESS OR FAILURE
AT
WEIGHT LOSS MAINTENANCE

By

Gail Judith Haus

This follow-up study examined factors contributing to weight maintenance over one to three year periods. Twenty-nine past participants (14 men and 15 women) from a six-month behaviorally oriented weight intervention program completed measurements. Heights, weights, waist/hip ratios, food and beverage intake from a three-day dietary record, weight history, social support and physical activity were assessed. Regardless of length of follow-up, relative weights were higher at follow-up than at post-program for all subjects (123% vs 112%, $p<.001$), for men (119% vs 107%, $p<.001$) and for women (128% vs 118%,$p<.001$). An earlier onset of overweight, repeated weight cycling, high daily fat consumption and reduced time in physical activity all were associated with increased weight regain ($p<.05$). Weight cycling and daily fat consumption explained 30% of the variance in relative weight change.

ACKNOWLEDGEMENTS

To members of my guidance committee:

To Dr. Sharon Hoerr, Department of Food Science and Human Nutrition, who served as my advisor, for her dedication to her students and her dedication to hard work. She was a constant source of support and encouragement for the past two years and she motivated me to work harder than I thought was possible.

To Dr. Rachel Shemmel, Department of Food Science and Human Nutrition, for her wonderful knowledge of my research topic and her interest in my project. She was always available for questions and provided much valuable insight.

To Dr. Jenny Bond, Department of Food Science and Human Nutrition, for her ability to see beyond the research project and put graduate school in the proper perspective. She also provided much valuable insight in the development of my research.

To Dr. Larry Hembroff, Director of the Center for Survey Research, for all the time he has invested in me, and all the valuable information he has passed on to me over the last year. I am especially grateful to him for his survey research knowledge, and for sharing as much with me as I was willing to learn.

To Dr. Brian Mavis, Department of Psychiatry, whose assistance with the planning and implementation of my research was invaluable. His knowledge and background with the Worksite Wellness programs at MSU was essential for the success of my study and his assistance was truly appreciated.

I am grateful to Dr. Won Song, Department of Food Science and Human Nutrition, for her assistance with the MSU Nutriguide database. She worked very hard to make it possible for my research data to be analyzed, and I am indebted to her.

To Carol Freisen, Pat Smith, Gail Mortensen, Amy Riley and Marci Askegard, graduate students who preceded me, who each provided me with bits of wisdom along the way, and who were truly missed this last year.

To Terri Carson, Darlene Zimmerman, Madhuri Kakarala, and Jai-Yau Doong, those who are next in line, for their support, wisdom and most of all their humor this past year. I also want to thank Linda Hudson for quietly but competently running the whole show in Anthony Hall.

Special thanks go to Jim who, almost tirelessly, bears the brunt of any of my frustrations, finds humor in every situation and has filled my life with some much needed comic relief these past two years (his love and support has helped too).

Most of all, I want to thank my parents, Ken and Judy,

and my brother, Brian. They are three of the people I admire most in this world, and have always been my greatest supporters. They have inspired me to strive to achieve to the best of my abilities and I could not have done it without them. Thank-you!

Ch

I.

II.

III

IV

V.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Obesity is a risk factor for a variety of chronic diseases including hypertension, atherosclerosis, diabetes and certain types of cancer (Bray, 1985). Some studies indicate that only the extremely overweight are at greater health risk than normal weight individuals, and that even the risk of the extremely overweight person may not be as great as that of the extremely underweight (Kraemer et al., 1990). However, based on life insurance actuarial tables, the health risks for obesity clearly increase with increasing severity of obesity and reach significance at weights greater than 20% above optimal or at a body mass index greater than 27 (Pi-Sunyer, 1991).

Although still somewhat controversial, the damaging physiological effects of weight cycling or repeated attempts at weight loss with subsequent weight regain (Blackburn et al., 1989) should be considered in the evaluation of weight control programs. Some investigators report that weight cycling adversely affects metabolic rate by increasing food efficiency and decreasing the rate of weight loss over time (Blackburn et al., 1989; Brownell et al., 1986; Gray et al., 1988; Yang et al., 1990). It has been suggested that the

body responds to dieting the way it does to famine, i.e. by increasing food efficiency and decreasing energy expenditure (Blackburn et al., 1989). There is also recent evidence that there is as much health risk from weight cycling as from obesity itself (Lissner et al., 1991).

The monetary magnitude of the business of weight loss has been increasing. As reported by Marketdata Enterprises (1989), $9.9 billion dollars were spent nationally in 1988 on the weight loss industry, including diet beverages and foods, health spas and exercise clubs, weight loss clinics and programs and over the counter appetite suppressants. Also reported by Marketdata Enterprises, one to three billion dollars were spent on fraudulent weight loss products. In Michigan alone, according to the Center for Health Promotion at the Michigan Department of Public Health, weight loss has become a multi-million dollar industry (Michigan Department of Public Health, 1988). Up to half of Michigan adults consider themselves to be somewhat or very overweight (MDPH, 1987); while results of the Behavior Risk Factor Survey in Michigan indicate that about one-fourth of adults are overweight from self-reported heights and weights (Hoerr, 1988). According to the latter report, more middle-aged people were overweight than those younger or older; females were overweight more frequently than males.

Psychological costs of weight loss and regain should be

considered as well in the assessment of weight loss programs. Many people attempt unsupervised weight reduction regimens or inappropriate methods which can have damaging effects psychologically, such as increased anxiety and depression (Wadden and Stunkard, 1985). Garner et al. (1985) question whether it is ethical to offer weight loss as a treatment, when the longterm success rates are so poor, especially considering the self-reproach and humiliation experienced by those who fail to maintain their weight loss.

There is general agreement that maintenance of weight loss is a problem (Hovell et al., 1988; Kramer et al., 1989; Perri et al., 1988) but not on what contributes to the problem. Several studies have examined possible factors affecting success or failure with the maintenance of weight loss (Bolocofsky et al., 1984; Foreyt, 1987; Hoiberg et al., 1984; Leon and Sternberg, 1984; Wing et al., 1990). Some points of agreement on what predicts successful weight maintenance have been found. A person's initial weight, past history of dieting, personality, locus of control orientation and social support all play a role (Bolocofsky et al., 1984, Hoiberg et al., 1984, Leon and Sternberg, 1985). Although these variables are interesting, most <u>cannot</u> be changed easily by treatment.

Lifestyle variables which might possibly be altered by treatment appear to be the most useful focus of research in weight loss maintenance. Examples of such variables are self

monitoring such as the keeping of food records and weighing oneself, increasing physical activity, the percentage of calories in a person's diet coming from fat and caloric distribution throughout the day.

It is important to examine modifiable factors, because if, in fact, particular behaviors and attitudes play a positive role in maintenance, teaching these behaviors can be incorporated into treatment and maintenance programs. Research on weight maintenance should focus on areas that offer potential for change, such as behavioral skills, physical activity and dietary factors, rather than primarily on description of subject demographics and past weight history. Research in the area of weight maintenance should demonstrate specific behaviors useful for people in their weight maintenance efforts.

Although there have been recent studies investigating weight maintenance (Forster et al., 1988; Griffiths and Holliday, 1987; Hovell et al., 1988; Kramer et al., 1986; Kramer et al., 1989; Lavery et al., 1989; Pavlou et al., 1989a; Perri et al., 1986; Perri et al., 1987; Perri et al., 1989; Stunkard et al., 1989; Van Dale et al., 1990; Wood, 1990), a review of previous investigations indicated that this present study was unique. This study stands out from the rest by: 1) addressing dietary factors, such as the percentage of calories coming from fat and time of day food is consumed; 2) obtaining 3-day food records from subjects,

in order to address dietary patterns in addition to dietary intake 3) measuring subjects rather than using self-reported anthropometrics from mail surveys; and 4) being a community-based study rather than a clinical study.

Factors contributing to weight maintenance success or failure over one to three year periods were examined for individuals who followed a six-month behaviorally oriented weight intervention program offered by Michigan State University's Healthy U Worksite Wellness Program. This research was important for the Healthy U program because of relevance to future weight control intervention programs in general and for support of these programs at MSU in particular. This study provided needed information regarding factors that contribute to a person's maintenance success following the program and provides ideas for improvements of future programs. Based on the monetary, physiological and psychological consequences of obesity, this research is also important for general knowledge about longterm effectiveness of behavior modification programs.

HYPOTHESES

1) Participants at all sites and all follow-up times of Michigan State University's Healthy U Worksite Weight Control Programs will gain weight between the end of the program and follow-up.

2) The prediction of weight change at follow-up from demographic and weight history variables (a) can be improved by the addition of selected lifestyle variables (b).

a) Demographic and weight history variables

The following variables have been demonstrated to account for change in relative weight, but were not the main focus of this research because these variables are unmodifiable or less modifiable than the lifestyle variables.

-age;

-gender;

-education;

-age of onset of overweight;

-number of weight loss attempts;

-number of times weight gained and lost;

-number of weight control programs completed; and

-social support.

b) Lifestyle variables

Nutrient intake:

-the percentage of calories from fat and total grams of fat;

-dietary nutrient density (INQ-1000$_c$=Index of Nutritional Quality per 1000 kilocalories for Calcium, Iron, Vitamin A, Vitamin C, Vitamin B-6, and Fiber);

-nutrient adequacy (MAR_e=Mean Adequacy Ratio for Calcium, Iron, Vitamin A, Vitamin C, Vitamin B-6, and Fiber);

-fiber consumption;

-fruit and vegetable consumption; and

-alcohol and beverage consumption.

Eating patterns:

-breakfast eating;

-caloric distribution throughout the day; and

-number of eating occasions.

Behavioral variables:

-frequency of counting calories; and

-frequency of recording foods eaten.

Activity:

-minutes of regular physical activity;

-repetitiveness of exercise;

-time of day of exercise (exercise pattern);

-lifestyle changes in physical activity since program participation; and

-"active" time versus "inactive" time (hours sleeping, relaxing and in light or moderate activity.

Fat distribution:

-body shape classification from waist/hip ratio (at risk or not at risk);

The following model (Figure 1.0) has been developed to portray the conceptual relationship between modifiable, less modifiable and unmodifiable factors and weight maintenance. This model was used in the design of the study and as an aid in determining factors to be measured in the study.

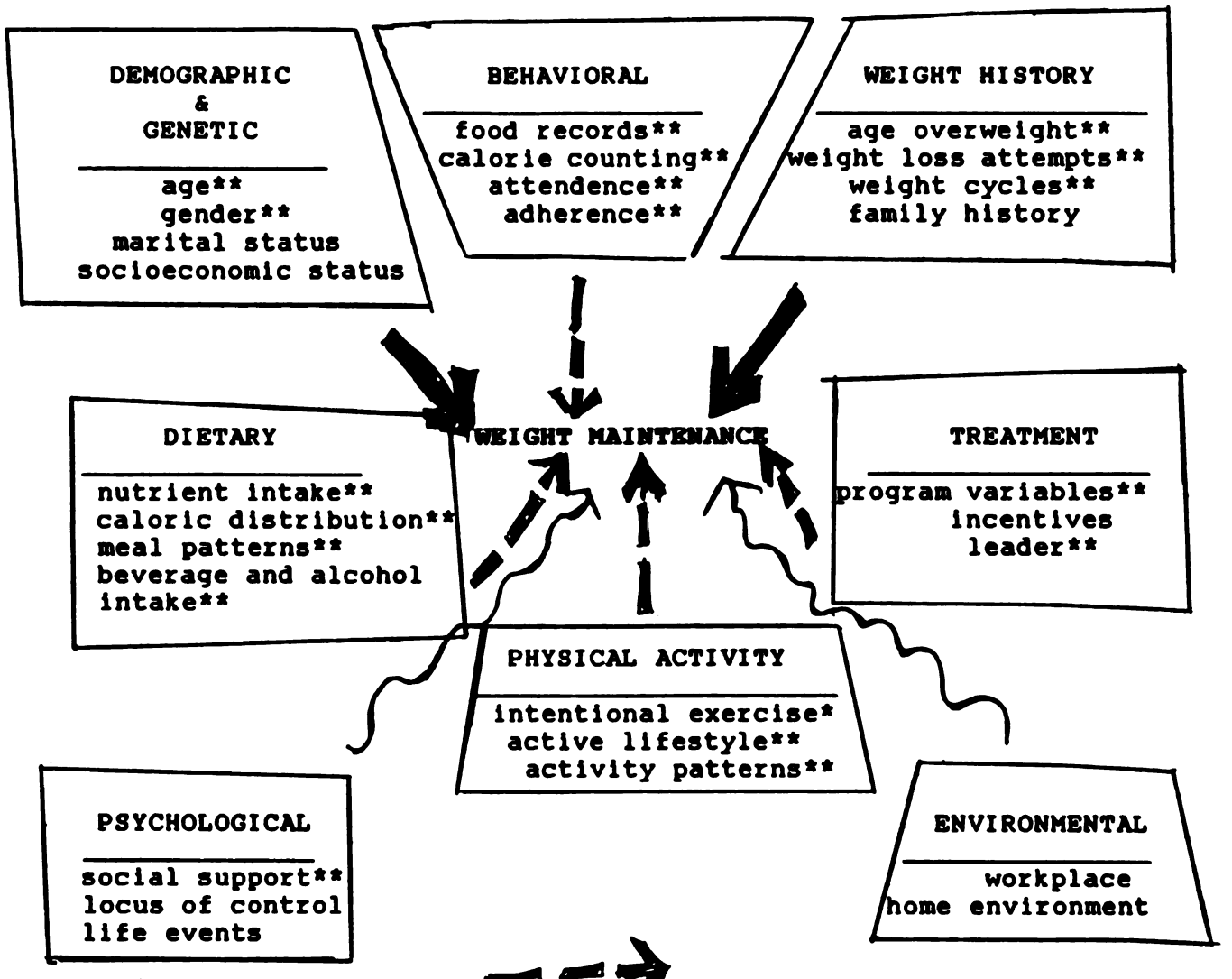


Figure 1.0 Conceptual model of variables that may be related to weight loss maintenance.

REVIEW OF THE LITERATURE

There have been few studies which have specifically addressed the relation between lifestyle variables examined in this research and weight maintenance. Therefore, the literature reviewed here pertains primarily to the relationship between dietary and exercise variables and either weight status or weight loss in the acute phase. A few studies reviewed do focus on the long term maintenance of weight loss.

The literature reviewed includes behavioral modification for weight control, and dietary variables, eating patterns and physical activity related to weight status, weight loss and weight loss maintenance. Body fat distribution and social support as possible factors related to weight status, weight loss and weight loss maintenance are also addressed.

Behavioral modification for weight control

There are many different approaches to the treatment of overweight, but behavioral therapy is increasingly used today in the treatment of obesity (Stunkard and Berthold, 1985). Studies involving behavioral treatments have shown some success with post-treatment weight loss (Graham et al., 1983; Hovell et al., 1988; Kramer et al., 1986; Lavery et al., 1989; Perri et al., 1988), but maintenance of weight loss continues to be problematic for the majority of obese

individuals receiving treatment (Kramer et al., 1989).

Behavior therapy is based on the assumption that all behavior, normal and abnormal, is acquired and maintained according to certain definable principles (Stunkard and Berthold, 1985). The behavioral treatment of obesity has continued to evolve since the 1970's with increases in the average length of treatment and increases in average weight losses as well (Foreyt, 1987). Behavioral treatments today are more comprehensive than in years past with a greater emphasis being placed on the development of exercise behaviors, nutrition education, social support and stimulus control techniques (Foreyt, 1987). Principles of behavior modification in the treatment of overweight include control of eating cues, contracting for weight loss, goal setting and use of self-monitoring skills (Lavery et al., 1989). Some additional areas of behavior modification include stimulus control techniques, planning a reward system and soliciting social support (Stunkard and Berthold, 1985).

Stimulus control techniques are used because stimuli regularly associated with a specific behavior may eventually serve as cues for that behavior. These cues will increase the probability that the behavior will be performed (Kazdin, 1989). Examples of stimulus control techniques include grocery shopping from a list, shopping for food <u>after</u> eating, storing food out of sight and leaving the table immediately after eating (Stunkard and Berthold, 1985).

Some potentially changeable behavioral factors appear to be predictive of success in weight maintenance. Perri and colleagues (1986) found that self-monitoring and peer support group meetings resulted in greater maintenance of weight loss over an eighteen month follow-up period than a maintenance program that did not focus on behavioral techniques. Lavery et al. (1989) and Perri et al. (1988) both concluded that use of behavioral techniques could be a successful adjunct to weight loss maintenance. Lavery and colleagues conducted a follow-up up study of a behavioral weight loss program and reported that because 37% of subjects had maintained weight losses at two years, behavior therapy had been successful. Perri and colleagues reported similar findings in a follow-up of 123 mildly to moderately obese adults. Graham and colleagues (1983) studied sixty participants from a behavioral weight loss program after four years and reported that the most successful weight loss maintainers adhered to behavioral principles and were more physically active than those who regained weight.

Dietary Variables

Nutrition has a major role in health promotion and disease prevention (USDHHS, 1989). Once prevalent dietary deficiencies have been replaced by excesses and imbalances of some food components in the diet. According to the Year 2000 Objectives for the Nation (USDHHS, 1989) chief among the dietary components involved in diet and health

relationships is the disproportionate consumption of foods high in fat, at the expense of other nutrients that may be more conducive to health. In relation to weight control, the five following dietary variables will be examined: dietary fat intake, dietary nutrient density, beverage and alcohol intake and dietary intake patterns.

Fat.

Dietary fat has been proposed as a possible factor in the two leading causes of death in the United States, cancer and coronary heart disease. Trends in fat intake in the United States show that fat intakes range from 37% to 40% of total calories (Read et al., 1990, Block et al., 1988, Stephen and Wald, 1990). This percentage of energy intake as fat is greater than the recommendation for usual intake. The American Heart Association recommends that individuals consume less than 30% of energy intake as fat. The U.S. Public Health Service in the Year 2000 Health Objectives (USDHHS, 1989) also recommends that dietary fat intake be reduced to an average of 30 percent of calories or less.

The demographics of fat intake show that men and women consume proportionately similar amounts of fat. Although results from the Western Regional Project indicated that men consumed significantly more fat than women, 101 versus 76 grams (Read et al., 1990), for men this was 38.6% of total calories consumed and for women this was 38.7%. Fat intakes

were not significantly different when total energy intake was considered.

Data from the National Health and Nutrition Examination Survey (NHANES II) indicated that the macronutrient composition of the diet remained unchanged with increasing age, although absolute calorie intake appeared to decline (Block et al., 1988). The Western Regional Project data indicated that while the proportion of fat in men remained similar with increasing age, in women aged 70 years or above the fat intake was the lowest proportionately for all age groups (Read et al., 1990).

In addition to overall high consumption of fat in the United States, there is evidence that higher fat intakes are found in fatter people. Several studies have reported that fat people ingest more dietary fat that do lean people. In one study on the relation between body fat, diet composition, energy intake and exercise in adults, Miller and colleagues (1990) concluded that diet composition may play as important a role in fat deposition as do energy intake and exercise. Subjects were 216 adult males and females responding to advertisements for study volunteers; most were faculty, staff and students. When subgroups of lean and obese subjects were compared, the lean subjects derived 29% of their energy from fat and 53% from carbohydrate, versus 35% and 46%, respectively, for obese subjects. Adiposity was positively related to dietary fat

content as a percentage of daily energy intake and inversely related to dietary carbohydrate consumption for both genders.

There are various mechanisms whereby fat intake is hypothesized to influence weight status. These mechanisms include 1) a possible sensory preference by obese persons for high fat foods; 2) the inability to compensate the amount of food consumed when high-fat foods are eaten; and 3) an imbalance between fat intake and oxidation. Recent studies pertinent to each of these suggested mechanisms are reviewed briefly in this section.

Sensory preference for high fat foods.

There is evidence from a few laboratories that subjects, when presented with varying levels of fat in stimuli, will select foods with higher fat content. This has been found to be true especially for the obese.

Drewnowski and Greenwood published several studies in the last few years addressing whether or not humans have an innate preference for high fat foods. In 1983 Drewnowski and Greenwood examined the perception and hedonics for sweet and 'fatty' tastes using different combinations of milk, cream and sugaras sensory stimuli. Subjects were 16 normal weight undergraduate students (11 women and 5 men). The model food system used consisted of skim milk (0.1% fat), regular milk (3.5% fat), half and half (11.7% fat), heavy cream (37.6% fat) and heavy cream with 15% safflower oil to provide an

increasing fat content to 52.6% by weight. Sucrose was then added to each dairy product at levels of 0, 5, 10 and 20% by weight. The addition of sugar had only moderate effects on taste hedonics for skim milk but caused a substantial increase in preference ratings for heavy cream. This study illustrated that the acceptance of high-fat dairy products is enhanced by the addition of relatively small amounts of sucrose.

Drewnowski and Greenwood (1985) later examined if hedonic responsiveness to sweetened high fat foods varied as a function of subject's weight status and was enhanced in obese or dieting relative to normal weight individuals. Normal weight subjects (n=15) optimally preferred stimuli containing 20% lipid and less than 10% sucrose. Twelve obese subjects preferred high-fat stimuli (>34% lipid) with less than 5% sucrose, and formerly obese subjects (n=8) showed enhanced responsiveness to both sugar and fat. The reduced obese appeared to have an increased hedonic responsiveness for the taste of sweetened and fatty oral stimuli, and the obese subjects all preferred foods containing more lipid than sucrose.

In 1989 Drewnowski and Greenwood compared the ability of male and female subjects to evaluate the perceived sweetness, creaminess and fat content of selected liquid and solid foods. Twenty-five students of normal weight were first tested with sweetened mixtures of milk and cream and

then were retested three months later with solid blends of cottage cheese and cream cheese of comparable fat and sugar content. Subjects were capable of judging the increasing fat content of liquid mixtures but were unable to track the increasing fat content of solid foods, although they still preferred the higher fat foods. The elevated preferences reported for fat-rich solid foods in the absence of accurate sensory assessment of fat content suggest that food acceptability ratings do not necessarily depend on the conscious perception of food constituents. In this sense, fats could function as 'hidden calories' at the initial sensory level.

Mela and Sachetti (1991) recently examined whether preferences for a relative level of fat content in selected foods could be generalized to a preference for fat content in other types of foods. They investigated associations among dietary habits, body composition and sensory preferences for fat in foods. Subjects were 30 adults (21 women and 9 men) whose weights fell within normal range. Results showed no correlation between subjects' recorded fat intake from dietary records and the measured sensory preference for fat. The fat intake levels from dietary records were generally much lower than sensory preference levels for fat. Results showed no consistent correlation in preferred fat level from various food types. However, estimates of relative adiposity from bioelectrical impedance

and Body Mass Index were positively correlated with subjects' most preferred sensory level of fat for all food stimuli. This association was significant in women ($r=0.48$, $p< .05$), but not in men ($r=.40$, $p>.05$). There was no significant relationship between dietary fat intake and measures of adiposity, such as percent body fat.

Caloric compensation.

The second theory related to fat intake is that of caloric compensation. "Caloric Compensation" can be explained as: the tendency to adjust the amount of food consumed when the caloric density of the diet varies; specifically the inability of people to adjust caloric intake when high fat foods are eaten, thus contributing to overweight.

Lissner and colleagues, among others, have examined caloric compensation when the fat content of the diet is manipulated. Lissner et al., (1991) evaluated caloric compensation in 24 women who each consumed diets of low, medium and high fat content in sequence for three 2-week periods. Energy consumption was positively correlated with level of dietary fat. Therefore caloric intake was imprecisely regulated, when the fat content of the diet was altered. Errors in caloric regulation were not corrected within this two-week period.

Recently, caloric regulation in response to a reduction in fat content of the diet over an extended period was

reported (Kendall et al., 1991). Sixteen healthy, nonsmoking females aged 22-56 years were randomly assigned to either a low fat (20-25% kcal) or a control diet (35-40% kcal) for 11 weeks. After a 7-week washout period each subject received the alternate diet. Subjects were free to choose the types and portions of food provided by the nutrition research unit but the percentage of caloric intake as fat remained within the specified range for each treatment. There was no difference between the two diets in the grams of food subjects consumed. Weight loss occurred on both diets during both periods, but when the data for periods were pooled, weight loss was significantly greater on the low-fat diet. When the fat content of the diet was reduced from 35% to 22% of total calories, subjects showed poor regulation of caloric intake. On the low-fat diet caloric compensation was 35% complete at the end of 11 weeks; subjects on the low-fat diet lost 2.5 kg. The authors suggested that reductions in the fat content of the diet, without limitation on the amount of food consumed, may lead to a more permanent weight loss than can be achieved through dieting alone. It appears that caloric compensation for varying fat levels in food is not precise, and decreasing the fat content of food, without decreasing the amount of food consumed may spontaneously decrease energy intake.

Imbalance between fat intake and oxidation.

The final theory relates to the possible variance in oxidation for different substrates; fat and carbohydrate in particular. Carbohydrate (CHO) oxidation balances with intake because the body's glycogen stores are small in relation to daily CHO turnover. If fat oxidation matched fat intake as protein and CHO oxidation matches intake for these substrates, fat balance would be maintained as well.

Flatt, a prominent researcher in the area of nutrient oxidation, proposed that the fuel mix oxidized by the body over 24 hours must be the same as that of the food ingested; oxidation must equal intake (Flatt et al., 1985). The Respiratory Quotient (RQ), which describes the ratio of CO_2 produced to O_2 consumed during the oxidation of various nutrients is the concept used to examine substrate oxidation. Measurement of RQ makes it possible to determine the proportion of carbohydrate and fat being oxidized; when carobohydrate is the only fuel used, RQ=1.0, when fat is the predominate fuel, RQ=0.7. The CO_2:O_2 ratio from the oxidation of dietary nutrients is referred to as the Food Quotient (FQ) (Bray, 1979). If a constant body composition is to be maintained, it is hypothesized that the RQ averaged over 24 hours must equal the FQ.

Flatt and colleagues (1985) found that RQ did not equal FQ in a 9-hour period when volunteers were fed breakfasts with and without a fat supplement. Schutz, Flatt and Jequier

(1989) reported that a fat supplement of 1000 kcal/day failed to modify the oxidation of CHO, fat and protein up to 36 hours after the increased fat intake. Tremblay and colleagues (1989) investigated the short-term effect of a high-fat diet on spontaneous energy intake using the RQ-FQ model proposed by Flatt. Subjects were eight healthy, young, male, non-obese adults. The mean energy and nutrient intake during two days on diets with a FQ less than 0.85 (high fat) or greater than 0.85 (high CHO) was measured. When subjects selected foods with a FQ greater than 0.85 (high CHO), the mean energy intake was 2987 kcal/day, corresponding to the estimated daily energy needs of a moderately active young male adult. However this energy intake was increased by 1148 kcal/day when subjects consumed food with a FQ less than 0.85 (high fat). This short-term increase in energy intake could be due to the resistance of lipid metabolism to adapt rapidly in response to a high fat diet.

Tremblay and colleagues (1991) evaluated the short-term spontaneous energy intake of 15 young adult men under conditions designed to dissociate the effects of diet composition (CHO:fat) and energy density of the food. During one of two sessions the FQ of each food offered to subjects was greater than or equal to 0.85 (high CHO); it was less than or equal to 0.85 (high fat) in the alternative session. A substantial increase in energy intake in response to the diet with an FQ less than or equal to 0.85 (high fat) was

reported. These studies provide evidence that a high-fat diet may be associated with a substantial increase in energy intake, at least in short-term studies.

In summary, there are several mechanisms whereby dietary fat might play a role in weight control. Together these concepts supply sufficient evidence to consider dietary fat intake of importance in weight control and weight maintenance. There is a metabolic rationale to support the current recommendations to reduce fat intake to counter the trend toward increasing obesity.

Nutrient Density of Diet.

Other dietary factors in addition to fat intake may also relate to weight control; overall diet quality is one of these. Diet quality has several aspects; dietary nutrient density and nutrient adequacy are two components of diet quality that will be examined in this study. Literature related to the nutrient density of the diet will be reviewed on the following pages.

There is some question regarding the nutrient density of an individual's diet when the fat content of the diet is decreased. Several studies have reported a high nutritional density of the diet to be associated with a reduction of fat in the diet. Dougherty and colleagues (1988) studied the nutrient content of subjects' diets when fat content was reduced. During a 20-day baseline period all subjects consumed a diet containing 45% of total energy from fat and

having a P:S ratio of 0.2, i.e. a high-fat diet. Then, half the subjects consumed an intervention diet with 25% of total calories from fat and a P:S ratio of 1.5, that is, a low-fat diet, for 40 days. The other half continued the baseline diet. Although most types of foods contributed fewer calories during the intervention period, grains, fruits, vegetables and desserts contributed more. This change in source of calories increased the vitamin and mineral content for the low-fat diet. Compared to the high-fat diet, vitamin C, thiamin, riboflavin, niacin, vitamin B-6 and folate increased 12.5 to 24.1% and pantothenic acid and B-12 increased 3.3% and 6.7%, respectively, on the low-fat diet. When the amount of fat in the diet was reduced, there was improvement in the nutrient density of the diet.

Gorbach and colleagues (1990) also reported that the nutritional density of diets in their study improved when a low-fat dietary intervention was implemented. The purpose of their study was to examine the effects of a low-fat diet on the incidence of breast cancer in women at high risk. Subjects were 303 women aged 45-69 years. Of these, 173 randomly assigned subjects participated in the intervention by reducing their fat intake to 20% of caloric intake for 12 months. This was a reduction from 39% kcal as fat at baseline. The total caloric intake of women in the intervention decreased 25%, from 1,738 kcal at baseline to 1,300 kcal at 12 months. Even though not a weight reduction

intervention, these women also lost an average of 3.1 kg. For the intervention subjects, intakes of vitamins A and C increased 12% and 9% respectively, despite a reduced energy intake. Nutrient density of the diets (nutrients/1000 kcal), indicated a 20% to 50% increase in energy-adjusted intake of vitamins and minerals from food sources in the intervention group. Women in the control group reported a 7% decrease in total energy intake (1700 kcal to 1575 kcal by 12 months), but there was no significant weight loss nor did total fat intake change from baseline.

Further evidence for the effect of low-fat diets on nutrient density was reported by Schectman and colleagues (1990). The dietary intake of persons age 18 and over participating in the 1976-80 National Health and Nutrition Examination Survey (NHANES II) was studied. Dietary intakes were assessed by 24-hour recall and food frequency and adjusted for age, sex, race, education, smoking and socioeconomic status. Diets of those subjects on a self-reported "low cholesterol diet" (n=296) were compared to the diets of subjects not following a special diet (n=10,052). Dieters consumed 16% fewer calories than non-dieters and ate 25% less saturated fat and 21% less cholesterol. Although intakes of Vitamin A, thiamin, riboflavin, niacin, calcium and iron were not significantly different from non-dieters, ascorbic acid intake was 18% higher in the dieters than non-

dieters. The dietary nutrient density (nutrient/1000 kcal) for dieters was increased by 35% over non-dieters. The uthors concluded that a low-fat, low-cholesterol diet may be beneficial in improving overall dietary quality as measured by nutrient density.

It appears from results of these studies that lowering the fat content of a diet need not have a detrimental effect on overall nutritional quality as assessed by nutrient density, and may actually have a positive effect. However, it is not clear from research to date whether the nutritional density of a diet is related to weight control. The literature indicates that decreasing fat in a diet can improve nutrient density, but it is not known whether a diet with increased nutrient density is associated with weight maintenance success.

Beverages and Alcohol.

There is some evidence that both alcoholic and non-alcoholic beverages should be considered in the weight control equation. Teufel and Dufour (1990) reported that significantly higher energy intakes of obese subjects in their study could be attributed to their greater consumption of both alcoholic and non-alcoholic beverages. This study was conducted to document patterns of food use and nutrient intake associated with obesity in Native American women. Food use was determined through observation, dietary histories and 24-hour dietary recalls in 14 obese and 14

nonobese Hualapai Indian women. Non-alcoholic beverages, potatoes, beans, white wheat flour and canned goods predominated in diets of both groups. Both groups had high energy intakes (2,602±766 kcal/day), moderate fat intakes (101±25 g/day) and low intakes of crude fiber (5±2 g/day). The significantly higher energy intakes for the obese subjects was attributed to their greater consumption of alcoholic and non-alcoholic beverages, due to the similarity of diets for both groups with respect to other dietary variables. Non-alcoholic beverages consisted of drinks made from powdered mixes, canned fruit drinks, sweetened carbonated beverages, coffee and tea. Carbohydrate intake provided by beverages was reported to contribute to the greater energy intake of obese women in this study and the authors suggested that the substitution of low-calorie beverages might benefit weight control in this population.

Data from the 1977-78 Nationwide Food Consumption Survey were analyzed to examine alcohol intake (Windham et al., 1983). The nutrient density of diets of drinkers was found to be significantly less than that of non-drinkers with respect to protein, fat, carbohydrate, calcium, iron, phosphorus, vitamin A and thiamin. The mean daily caloric contribution of alcoholic beverages for the population aged 15 years and over was reported to be 4.5% for males and 3.5% for females. However, when the mean caloric contribution of alcoholic beverages was computed for the subsample of

individuals who reported consuming alcohol, the alcoholic beverage kilocalories as a percent of total dietary kilocalories accounted for 17% and 22% in males and females, respectively. The diets of a random subsample of approximately equal numbers of drinkers (n=504) and non-drinkers (n=523) were examined for nutrient density. Energy levels for drinkers averaged 2,037 kcal and for non-drinkers, 1,928 kcal. The nutrient densities for calcium, iron, phosphorus, vitamin A, thiamin and riboflavin were less for those subjects who consumed alcohol.

In contrast to the above study, de Castro and Orozco (1990), reported that alcohol <u>supplements</u> rather than displaces macronutrient-supplied calories. Twenty-three male and 69 female adult subjects maintained 7-day dietary records. Results indicated that 32 of 92 subjects did not ingest alcohol during the study period; they were designated the no-alcohol group. The remaining 60 subjects reporting alcohol consumption were subdivided into groups of low and moderate alcohol consumption. Results suggested that alcohol supplements, rather than displaces, macronutrient-supplied calories for both men and women, irrespective of body weight. Alcohol was associated with prolonged meal durations and alcohol calories appeared to be unregulated. Moderate alcohol ingestion did not decrease the intake of other nutrients and the total caloric intakes of drinkers compared with non-drinkers were not substantially different for

carbohydrate, fat or protein intakes but were greater because of the calories ingested as alcohol. The no-, low- and moderate-alcohol groups ingested 0, 35 and 140 kcal from alcohol respectively. The moderate-alcohol group ingested significantly more calories overall than did the no-alcohol group.

Alcohol might impact a person's diet either by increasing total energy intake or by decreasing the overall nutrient density of the diet. An average alcoholic drink (12 ounces of beer or one glass of wine) contributes at least 100 kcal to the daily total. Alcoholic beverages are a concentrated source of calories, carrying few, if any, other nutrients. Regardless by which means alcohol impacts the diet, it is important to consider alcohol intake of subjects in any study assessing nutrient intake, and seems especially important for studies on weight control.

Eating Patterns

Breakfast.

'Breakfast' means different things to different people. Some people eat little or nothing at breakfast time; for others it may be the most important meal of the day. Breakfast can be high in fat, or high in fiber, but usually not both. Breakfast can be bacon and eggs, or it can be oat bran. The important issue for this study is whether eating breakfast at all impacts weight maintenance. A short review of studies follows, both those reporting the national

profile of breakfast consumption as well as those reporting associations between breakfast eating and weight.

Morgan and colleagues (1986) examined breakfast consumption patterns of the U.S. adult population using 3-day dietary records of adults aged 18 to 49 years from the USDA 1977-78 Nationwide Food Consumption Survey (NFCS). Approximately one-quarter of the adult population skipped breakfast regularly. Assessments of average intakes of seven frequently underconsumed nutrients (calcium, iron, magnesium, Vitamin A, pyridoxine, zinc and copper) showed that omission of the breakfast meal had a significant negative impact on nutrient adequacy. Consumption of fortified ready-to-eat cereal at breakfast increased daily intake levels of the under-consumed nutrients. Groups of adults who regularly consumed ready-to-eat cereal at breakfast had, on average, lower daily intakes of fat and cholesterol than those who consumed breakfast consisting of foods other than ready-to-eat cereal. There was about a 10 gram difference in fat intake for both males and females, with those consuming ready-to-eat cereal consuming about 10 fewer grams of fat than those consuming a breakfast consisting of other foods. The omission of breakfast, particularly for adult females, was a strong factor contributing to nutrient inadequacies.

Stanton and Keast (1989) conducted a study to verify the results of the NFCS study just described, and to examine

serum cholesterol as a variable. NHANES II, 1976-1980 data were analyzed which included 24-hour dietary recalls and serum cholesterol values. Respondents were divided into three breakfast consumption groups: 1) those who ate ready-to-eat cereals (RTE), 2) those who ate breakfast but did not eat RTE, and 3) those who skipped breakfast. Significant differences in fat intake were found for all age/sex groups. The group eating breakfast without RTE cereal had the highest levels of fat intake. For males 35-49 years old the RTE breakfast eater consumed 101 g fat, the breakfast skippers consumed 93 g fat and the non-RTE breakfast eaters consumed 109 g fat. This pattern was similar for all age groups. That is, the daily intake of total fat as well as cholesterol was directly related to the choice of breakfast food. Breakfast skippers had the lowest daily kilocalorie intake and the RTE breakfast group had the highest. However, the RTE breakfast group would have had lower dietary fat and cholesterol intakes than breakfast skippers had their total daily caloric intakes been equal as indicated by nutrient densities of fat and cholesterol. For females in all age groups, the RTE breakfast group had lower fat and cholesterol nutrient densities than either the non-RTE group or the breakfast skippers. Dietary cholesterol and fat intakes from breakfasts that include RTE cereal were minimal compared to breakfasts without RTE cereal.

In studies on the relation between breakfast eating and weight status, Fricker and colleagues (1990) and Bellisle (1988) reported that obese subjects ate less at the breakfast meal than non-obese counterparts. Fricker and colleagues classified 1312 middle-aged adults seeking medical advice for their weight at a French nutrition clinic into groups based on BMI, following the guidelines of NHANES II. Although all subjects entered the weight control unit because of a concern about body weight, some were not obese but normal weight or moderately overweight. The categories were as follows for both men and women: non-obese = BMI<27.3 (n=377); mildly obese = 27.3$\leq$BMI<32.3 (n=441); and massively obese BMI $\geq$32.3 (n=494). Food intake was assessed by a 24-hour dietary recall. The daily energy intake increased with corpulence status. At breakfast and lunch, the relative energy intake differed significantly between groups. Lunch provided a higher proportion of daily energy intake for mildly and massively obese than for non-obese. The reverse was true for breakfast, with breakfast providing a higher proportion of daily energy intake for non-obese than for mildly and massively obese.

Bellisle and colleagues (1988) studied food intake in 339 French children aged 7-12 years. Children were categorized (lean, slim, average, fat, obese) based on BMI. Food intake was estimated using a food frequency consisting of 40 foods or groups of foods representative of the French

diet. No difference in total estimated daily energy intake was observed among groups, but the distribution of intake varied. At breakfast, the obese ate significantly less than the lean, slim and average weight children. At dinner the obese ate more than the lean, slim and average children. Therefore, obese and fat children ate less at breakfast and more at dinner than leaner peers. The traditionally large meals of the day represented larger portions of daily energy intake for fat and obese children.

Although these two studies reported that heavier individuals eat less at breakfast, not all studies support this view. Dreon and colleagues (1988) found no relation between body fatness and caloric distribution throughout the day or number of meals and snacks. Subjects were 155 sedentary obese men aged 30-59 years. Nutrient intakes from 7-day dietary records were compared with hydrostatically determined body composition. Percent body fat ranged from 19 to 40. The number of meals eaten per day (4.5 $\pm$ 0.6) and the percent of calories from meals (82.4 $\pm$ 8.0) showed little deviation between body fatness groups. The authors suggested that the narrow range of body fatness or the homogenous dietary patterns of the overweight population may have negated any significant correlations.

Daily caloric distribution

Several studies have examined eating behaviors; both in obese individuals and differences between obese and nonobese

individuals. The following studies focus primarily on snacking habits and the distribution of calories throughout the day. Kayman and colleagues (1990) conducted a study which examined behavioral aspects of maintenance and relapse after weight loss in women. Obese women who regained weight after successful weight reduction (relapsers, n=44); formerly obese, average-weight women who maintained weight loss (maintainers, n=33); and women who had always remained at the same average, non-obese weight (control subjects, n=34) were interviewed. A questionnaire was administered which assessed eating habits and weight history. The questionnaire was developed specifically for this study and was not validated. Women in all three groups reported eating snacks (defined as food or beverage eaten between meals) every day or almost daily. However, relapsers ate significantly more snacks each day than did maintainers or control subjects (mean number of snacks eaten daily was 4.6, 1.5 and 2.0 for relapsers, maintainers and control subjects respectively). Relapsers also ate more candy and chocolate than did women in the other two groups (41%, 17% and 15% of subjects respectively). Both relapsers and maintainers drank more diet soda than did control subjects (41%, 31% and 8% of subjects respectively). No significant differences were found between the groups in choices of other snack foods or beverages, which included chips, crackers, cheese, pizza, fruits, vegetables, sweet baked goods, ice cream and coffee.

The majority of women in all groups ate lunch and dinner every day; more relapsers than maintainers and control subjects skipped breakfast either every day or most of the time (43%, 37% and 23% respectively).

Studies have also been conducted which assess differences in eating behaviors between obese and nonobese individuals (Brandon, 1987; and Schlundt et al., 1990). Eighty obese and 80 normal weight individuals participated in Brandons' study; ages ranged from 18 to 35 years; the majority were female (73 in the obese group and 67 in the nonobese group). Eating and exercise behavior were assessed using a previously validated questionnaire developed to determine the general eating patterns of the obese. The obese were more likely to report consuming the majority of their snacks in the late evening, while the majority of the nonobese reported largely midafternoon snacking. The obese subjects also ate breakfast less regularly (25% of the obese subjects reported consuming breakfast 5-6 times per week versus 48% of the nonobese). The obese were also more likely to report rapid eating (26% of obese versus 11% of nonobese), failing to control portion size (66% of obese versus 34% of nonobese), and eating in secrecy (36% of obese versus 8% of nonobese). The obese also reported a greater percentage of nibbling at food without being aware (41% of obese versus 20% of nonobese) and continuing to eat when full (74% of obese versus 45% of nonobese). There were

differences in the overall eating habits of the obese and nonobese.

Schlundt and colleagues (1990) examined eating behavior in a group of moderately obese women. Subjects were 96 women, 30 to 60% above ideal body weight and between 18 and 55 years old. Subjects were instructed how to keep a behavioral eating diary in which they entered 40 eating episodes. Self-reported episodes of overeating, impulsive or unplanned eating and skipping meals were analyzed. Overeating was rare at the breakfast meal; it occurred more often at supper (evening meal). Impulsive eating was highly associated with snacking. If overeating occurred at one meal, the probability that overeating would occur at the next meal was more than twice as high (0.52) than if overeating did not occur at the previous meal (0.25). Skipping breakfast was associated with a greater likelihood of overeating at lunch. Skipping lunch was associated with an almost 50 percent chance of overeating at supper. Supper was followed by a snack 87 percent of the time, with 69 percent of the snacks rated as having been unplanned.

There seems to be general agreement among studies that morning food consumption has an impact on food consumption later in the day. Breakfast eating itself might not be the main factor, but it is possible that eating breakfast might cause people to enter the lunch hour less hungry and therefore eat less at that meal. Studies were not found

which examined breakfast eating as a factor in weight loss maintenance. However, it appears that overweight individuals tend to be breakfast skippers and snackers at a higher frequency than average weight persons.

Physical Activity

Body weight is the result of a balance, or imbalance, between energy intake and expenditure. So far, studies have been reviewed which address the energy intake component of this equation. In this section, the energy expenditure component, specifically physical activity will be addressed.

Physical activity is only one component of energy expenditure, others being the basal metabolic rate (BMR), thermal effect of food and facultative thermogenesis, or heat production not accounted for by the other components (Brooks and Fahey, 1985). Because physical activity is the aspect of energy expenditure most easily controlled by the individual, it is considered a lifestyle factor of importance in weight control issues. There is not one specific definition for exercise, although both aerobic and anaerobic activities fall under this designation. Aerobic exercise (exercise that oxidizes primarily fatty acids as a fuel) is exercise of longer duration, such as walking or biking for more than 20 minutes. Anaerobic exercise (exercise using primarily glucose as a fuel) is rapid, and involves exercises such as weight lifting that involve short bursts of energy.

Research has shown that it is the aerobic activities, using more oxygen and burning more fat, that can benefit individuals the most in weight control efforts (Brooks and Fahey, 1985). Thus it is recommended that exercise for weight control should focus on long-term endurance activities for a minimum of 20 minutes three to five times per week. The amount of fat loss due to exercise is directly proportional to the distance and mass of the activity. At the same intensity of exercise, the obese will expend more energy and lose more fat than the lean because they do more work due to increased body mass (Brooks and Fahey, 1985). Blair and colleagues (1987) measured the energy expenditure of eight lean, eight adult-onset obese and eight child-onset obese women, all between the ages of 25 and 45. Continuous recording of each woman's activities was collected during three 24-hour periods. Results showed that mean daily energy expenditure was significantly higher for the obese women (2472 $\pm$ 488 Kcal) than for the lean (1979 $\pm$ 302) due to the higher energy costs of sedentary and light activity in the obese. It was found that energy expenditure during moderate to strenuous activity was similar between groups because lean women performed these activities more vigorously than obese women. The authors suggested that obese women possibly limit energy expenditure by reducing the vigorousness of weight-supported activities.

The remainder of this review will focus on studies in which aerobic exercise was examined in relation to various weight control aspects. The other studies reviewed focus on xercise and weight loss, exercise and weight maintenance, exercise and food intake and an active lifestyle in relation to weight status.

Exercise, weight loss and weight maintenance.

Exercise has been found by several studies to aid in weight loss and contribute to weight loss maintenance in both men and women (Hill et al. 1989; Pavlou et al., 1989a; Pavlou et al., 1989b; Van Dale et al., 1989). Van Dale and colleagues (1990) compared body composition and sleeping metabolic rate (SMR) in subjects who dieted without aerobic exercise to those who dieted and exercised. Thirty-two females and 12 males were followed for periods of 18, 36 or 42 months after diet and exercise treatments. The diet only group regained 90% of the weight lost, but the diet and aerobic exercise group regained 60% of lost weight. At the 42 month follow-up a lower SMR was found for non-exercising subjects (18.6 percent lower than before treatment) than for subjects who continued to exercise (only 9.8 percent below baseline values). At the last follow-up, the SMR of fat-free mass per kilogram body weight was nearly restored to baseline in the exercising group, whereas the non-exercising group showed depressed values. The authors concluded that

continued exercise contributed to the restoration of SMR and longterm weight maintenance.

Pavlou and colleagues (1989a) studied exercise and weight control in 160 male members of the Boston police department. The subjects, who were 26-52 years old and averaged 122% of ideal body weight, were randomly assigned to four diet and aerobic exercise or nonexercise groups for eight weeks. Follow-up measurements including weight, resting heart rate and blood pressure were performed at 6 and 18 months post-treatment. All groups lost significant amounts of weight. The exercise groups increased VO_2 Max and maintained weight losses at the 6 and 18 month follow-up periods. All non-exercise groups regained 60% and 92% of their weight losses at the 6 and 18 month follow-ups, respectively. The authors concluded that dietary treatment alone had no effect on maintaining weight loss, whereas exercise played a significant role in weight maintenance.

The effects of physical activity on a weight loss dietary regimen in women was studied as well by Pavlou and colleagues (1989b). Thirty-one volunteer, overweight women (ages 26-49 years) at 120-150% of ideal body weight who completed the 8-week study were randomly assigned to either an aerobic exercise or non-exercise group. All subjects were instructed to follow a 1000 Kcal/day low fat (20% fat, 30% protein, 50% carbohydrate) diet. The exercise group lost

more weight than did the non-exercise group over the 8-week period (8.3 ± 2.5 versus 6.4 ± 1.7 kg, $p < 0.05$). A reduction in percent body fat, estimated by bioelectrical impedance, was demonstrated in both groups with the percent change greater in the exercise group (-6.7 ± 3.1% versus -4.5 ± 2.5%). Resting Energy Expenditure, measured by indirect calorimetry, remained unchanged in the exercise group, but decreased in the nonexercise group. The findings suggested that aerobic exercise combined with caloric deficit leads to significantly greater fat and weight loss and weight maintenance than from caloric deficit alone.

In another study examining exercise and dietary intake, Ballor and colleagues (1990) found that differing aerobic exercise intensities did not significantly affect body mass, fat mass and skinfolds in 27 sedentary obese women. The effect of calorie restriction (1200 Kcal/day) in combination with high (80-90% of peak VO_2 Max) or low (40-50% of peak VO_2 Max) exercise work rates on the composition of lean body mass was determined in the women whose percent fat was 36.7 ± 4.2%. Subjects trained 3 days per week for 8 weeks. Those in the high intensity exercise group (n=14) exercised for 25 minutes per day, and those in the low intensity group (n=13), for 50 minutes per day. The diets were 52% CHO and 28% fat. From pretest to posttest measurements, both low and high intensity exercise groups

changed body composition: 1) for body weight, high intensity was -6.0 kg and low intensity, -5.6 kg; fat-free mass, high intensity was -1.4 kg and low intensity, - 0.9 kg, and for percent fat high intensity was -3.4 percent and low intensity, -3.7 percent. However, there were no between group differences for the body composition variables. The authors concluded that on a low-fat diet, intensity of aerobic exercise did not seem to affect body composition or rate of loss of body weight. It was also suggested that, due to the greater tolerance for the exercise in the low intensity group, low intensity aerobic exercise should be incorporated into weight loss regimens, at least initially.

Exercise and energy intake.

The effect of aerobic exercise on energy intake is not clear and might vary by gender and obesity status. In a study of the effects of exercise on food intake in obese versus nonobese women, Kissileff et al.,(1990) reported that food intake was decreased in non-obese women immediately following strenuous aerobic exercise. This effect was not seen in obese subjects. The nine obese subjects, ages 18 to 35 years, were non-smokers and did not exercise regularly. During the testing procedure, subjects either exercised at strenuous, then moderate intensities, on a stationary bicycle ergometer for 40 minutes or sat quietly in the laboratory. Intake of a liquid test meal (a strawberry yogurt shake: 1.04 Kcal/gram of unknown composition)

consumed 15 minutes after exercise was significantly less (620 g) after the strenuous than after the moderate exercise (724 g) for nonobese women, but there was no significant effect on intake for the obese women (532 g versus 581 g). The authors did not report baseline levels of food intake for the obese and non-obese, so it was unclear whether the exercise (regardless of whether strenuous or moderate) caused depressed levels of food intake overall for the day.

In a study examining aerobic exercise and energy intake in moderately overweight women, Keim and colleagues (1990) reported that exercise of various durations did not affect energy intake. Subjects were twelve women, age 21 to 36 years, 16-42% above desirable body weight, with 30-41% body fat. During a baseline period subjects consumed a diet prescribed to maintain their body weights. During the study subjects rotated through three 18-day treatment periods: no exercise, moderate duration exercise and long duration exercise. Daily exercise was prescribed to increase energy expenditure by 12.5 (moderate duration exercise) or 25 percent (long duration exercise) of energy intake necessary to maintain body weight during baseline. Subjects lived at home, but consumed all meals provided at the research center. Diets were self-selected from a variety of foods; dietary intake was monitored. Exercise duration affected neither energy intake nor macronutrient composition selected by subjects. The authors concluded that aerobic exercise of

various durations had no consistent effect on energy and nutrient intake in mildly obese women over a two week period.

Active lifestyle

An active lifestyle encompasses more than just intentional exercise sessions or exercise measured in a laboratory, as in some of the previous studies reported. An active lifestyle encompasses the energy expended in normal day-to-day activities. There is some evidence that day-to-day energy expenditure depends on weight status as discussed previously, gender and the amount of inactive time versus active time.

Gortmaker and colleagues (1990) concluded that inactivity is an important factor in the increase in obesity reported in recent population studies in the United States. Predictors of inactivity such as the amount of time spent sleeping per day, the amount of time spent riding in a car per day and the amount of time spent watching television were examined from self reports by faculty, staff and students at the Harvard School of Public Health. Adult obesity was estimated by BMI. In a multivariate logistic regression, television watching was independently associated with obesity, controlling for age. Among those reporting one hour or less per day of television viewing, the prevalence of obesity was 4.5%; among those reporting three or more hours per day, the prevalence was 19.2%. Based on these

findings it is possible that a reduction of sedentary activities might be as important as increasing aerobic exercise to weight status.

Based on the recent studies reviewed, it is fairly clear that aerobic exercise and possibly inactivity are important factors in weight control and therefore should be included in research assessing weight maintenance. There is some disagreement regarding whether intensity of aerobic exercise is crucial to weight loss and maintenance. It appears that the key factor is the exercise expenditure itself and its duration.

Regional body fat distribution

There is disagreement whether waist/hip ratio can be a predictor of ability to lose weight, or has a relationship to weight loss and weight maintenance success. However, there is some evidence that losing weight may change fat distribution patterns, and this in itself may be a positive health benefit.

The location of body fat is a factor in health risks associated with obesity. Abdominal or truncal obesity, as measured by waist/hip ratio has been implicated in the development of heart disease (Larsson et al, 1984), stroke (Welin et al, 1987), diabetes (Haffner et al, 1987) and hypertension (Blair et al, 1984). Men more often than women have fat in the abdominal region and fat in this region has been shown to be an independent marker of higher risk of

several chronic diseases (Stern and Haffner, 1986). Waist/hip ratios associated with high risk for obesity-related conditions such as diabetes, gall bladder disease and hypertension are 0.95 or above for men and 0.80 or above for women (USDA, 1990). The Dietary Guidelines Advisory Committee (1990) recommended that waist/hip ratio be conducted as part of the assessment of health risk from obesity. Some studies suggest that where fat is distributed may affect an individual's ease of weight loss. Wadden and colleagues (1988) examined changes in fat distribution accompanying weight reduction and reported that women with lower body obesity tended to lose more total body fat than did women with upper body obesity ($r = -0.26$). Subjects were 68 women who lost an average of 12.3 kg from an initial weight of 103.6 kg. The mean age was 42.5 $\pm$ 9.5 years old. Subjects with greater pretreatment waist/hip ratios showed greater reductions in this measure ($r = 0.32$), suggesting greater reductions in upper body obesity. Subjects, on average, reduced their waist/hip ratio 1.2% (from 0.827 to 0.817). Women with lower-body obesity also tended to lose more fat than did women with upper-body obesity. Thus, loss of fat was inversely related to the initial waist/hip ratio. Women with lower-body obesity lost more fat because they apparently reduced both their upper and lower fat stores while women with upper body obesity reduced primarily their upper-body fat stores. Vansant and colleagues (1988)

reported that body fat distribution was not a useful indicator of the ability to lose weight. The influence of body fat distribution on the degree of weight reduction was examined, along with blood lipids and blood glucose in 17 premenopausal women (BMI > 27) who followed an energy reduced diet for 8 weeks. Mean body weight reduction was 10.2±3.3 kg in the abdominal obese (n=8) and 9.6 ± 2.4 kg in the gluteal-femoral obese women (n=8). Body fat distribution was not related to the ability to lose weight, but in the abdominal obese women body fat distribution became more intermediate. This change coincided in the abdominal obese, after weight loss, with greater decreases in blood glucose and serum lipids than in the gluteal-femoral obese.

Lanska and colleagues (1985) also reported that waist/hip ratio was not a useful indicator of weight change. One hundred eighty-seven severely obese (>50 percent above ideal body weight) women were prospectively followed. Weights were recorded at the beginning and at the end of a 3-week hospitalization and every 3 months following hospitalization for two years during which subjects were prescribed a 1200 kcal exchange diet defined by the American Diabetes Association. The women were divided into three groups on the basis of waist/hip ratios: a lower-body obese group (n=63; WHR = 0.50-0.75), an intermediate group (n=68; WHR = 0.76-0.82), and an upper-body obese group (n=56; WHR = 0.83-1.04). There were no significant differences between

WHR groups in terms of any of the follow-up parameters including percentage of respondents at follow-up intervals, frequency of follow-up or duration of follow-up. A significant relationship between WHR and follow-up weights could not be detected. Therefore, while abdominal obesity is a health risk, there is not conclusive evidence that fat distribution plays a role in weight loss or maintenance.

Social support

Social support is cited as an important component in studies encompassing a variety of health issues and health promotion programs. For this review, only weight control issues were addressed. Studies were found which examined the relation of social support to weight control program attrition and also to weight loss maintenance, and a general overview of the definition of social support is given.

The literature examining the relationship between social support and health is sometimes difficult to interpret because of variation in definitions of social support. O'Reilly (1988) reviewed 33 studies using social support instruments and found only modest agreement in conceptual definition; concepts were frequently ill-defined. Particularly confusing appeared to be the definition of social support versus social network. Social support has been defined as one of the following (Kaplan et.al 1977): 1) The gratification of a person's basic social needs (approval, esteem, etc.) via social support; or

2) The relative presence or absence of psychological support resources from significant others.

The most important distinction in social support is between the number of relationships a person has and the person's perception of the supportive value of these social interactions (Schaefer et al., 1981). Whether social support relates positively to health appears to depend upon how social support is defined in studies. In a study of 50 functionally disabled wheel-chair bound individuals, McNett (1986) reported that the perceived availability of social support, rather than the actual use of social support, was significantly related to coping effectiveness. The perceived availability of social support and the coping responses were measured by previously validated instruments. McNett also reported that non-married subjects coped more effectively than married subjects. The finding that the use of social support did not have a significant effect on coping effectiveness was explained by the possibility of a negative impact of actually using social support to deal with problems in contrast to the beneficial effects of working things through by oneself. Funch and colleagues in a review of research on social support measures (1986) found perceived support to be a stronger predictor of health outcomes and positive well-being than the structure of the social support network itself.

In contrast to the findings on perceived social support and health, other studies have found direct spousal support to correlate with decreased attrition in weight reduction programs (Pratt, 1990). Zero attrition was found in a clinic-based behavioral weight loss program in which spouses supported each other (Brownell et al., 1978). Rosenthal and colleagues (1980) also reported that husbands' involvement in a behavioral weight-control program was associated with only 14% attrition rates of their wives. In addition, McClaren (1986) reported that obese people in group programs were less likely to drop out if they received support and motivation from important persons in the program.

In addition to studies on the relation of social support to attrition in weight control interventions, there have been two studies on the relation of social support to weight maintenance. Hart and colleagues (1990) reported results of 75 subjects followed for one year who were initially at least 10 kg over their recommended weights upon entry into one of five behavioral modification programs. Groups met for 2-hour sessions once a week for 15 weeks and emphasized nutrition and physical activity. Following completion of the 15-week course, support sessions were held once a week for a year. An assessment questionnaire was mailed to participants one year after course completion. Persons who lost at least five kilograms and maintained the

loss for one year had reported positive family support at the initial assessment.

In another study examining factors related to maintenance and relapse after weight loss in middle-aged women, 80% of subjects who maintained a weight loss used available social support (Kayman et.al, 1990). In comparison, only 38% of relapsers used available social support. Subjects were female volunteers who were subsequently categorized into relapsers, maintainers, or always average weight. Obese women who regained weight after successful weight reduction (n=44) were classified as relapsers. There were 30 maintainers and 34 women who had always remained at the same average, nonobese weight. Subjects were interviewed using a non-validated questionnaire developed specifically for the study which included a social support component. In addition to the findings on social support, it was reported that more maintainers than relapsers had completed college (30% versus 20%) and had salaried positions in addition to jobs as homemakers (77% versus 46%). The authors concluded that social support, or the perception that family or friends were available to discuss troubles and offer help when needed, seemed significantly greater for the maintainers than for the relapsers.

Cooke and Meyers (1980) in a review of the role of predictor variables in the behavioral treatment of obesity,

reported that social support appeared to bear a significant relationship to success in a behavioral weight reduction program. The authors concluded that social support was a valuable component for any weight reduction program and if social support is not provided, then one class of immediate reinforcement that could maintain continued weight loss efforts is missing. It appears that social support is an important correlate of weight loss and successful weight loss maintenance.

METHODS

Weight Control Program

The initial population of subjects for this study consisted of all participants in the Worksite Wellness weight control programs offered through the Michigan State University Healthy U Program. The weight control intervention program was conducted at four different sites on the Michigan State University campus between 1987 and 1990. These sites were the Plant and Soil Sciences Building (PSS), the Chemistry Building (CHE), Anthony Hall (ANT) and the Department of Public Safety (DPS). The earliest program began December, 1987 and the most recent starting date was February, 1990. There were seven programs in all, averaging 10 participants per program. Follow-up lengths, were 6 months, 24 months, 30 months and 42 months. Sessions were taught by three different leaders; two were graduate students with exercise physiology and nutrition backgrounds (1,2), and one was a faculty member in the Department of Psychology (3). Each program was taught by only one of these leaders. Leader #1 taught four classes, leader #2 taught 2 classes and leader #3 taught one class.

The program was a six month behaviorally oriented program which met weekly for eight weeks and then bi-weekly for another eight sessions (16 weeks) for a total program time of 24 weeks. In general, all participants in the program continued attending sessions throughout the 24

weeks. The instructional sessions included such topics as: 1) general nutrition principles; 2) a caloric exchange system based on food groupings used in meal planning; 3) caloric value of macronutrients; and 4) techniques for behavioral change (See Appendix A for outline of program). This intervention program used monetary contracting to motivate weight loss. Participants signed contracts stating the weight they expected to lose each week and essentially "bet on themselves". Participants were also grouped into teams which competed with each other for the pot of money at the end of the program. Participants could not lose their team's money, only their own. However, participants did not make money when they alone lost weight, it had to be a team effort. When an entire team was successful at weight loss, all members made money.

Subjects

Seventy-eight participants took part in the six MSU Healthy U weight control programs. The weight control program sites and follow-up times, where the initial population of 78 participated, can be found in Table 3.0.

Table 3.0 Distribution of initial population of weight control program participants by sites and length of follow-up (n=78).

Time since Program ended	Location of Program			
	PSS	CHE	ANT	DPS
T1 (6 mo)	n=16			
T2 (24 mo)	n=10	n=13	n=7	
T3 (30 mo)	n= 8	n=11		
T4 (42 mo)				n=13

PSS = Plant and Soil Science
CHE = Chemistry
ANT = Anthony Hall
DPS = Department of Public Safety

Of the total initial population of 78 participants, the initial sample size available for participation in the study was sixty-two. There were eight drop-outs from the programs and one person had since died. Seven of the initial treatment population of 78 were repeat participants. Of the group of 62, thirty-one (50%) became follow-up study participants and completed all measures. Twenty of the 62 program participants were unwilling to be measured for this follow-up study, but were willing to provide self-reported heights and weights over the phone. Additionally, one person was absent on maternity leave, and not included in the sample. Three participants were off campus on study leave and unable to be reached by phone or by mail. Out of the

group of 62, the final seven treatment participants were unwilling to provide self-reported data or could not be located, and therefore could not be included in the follow-up in any manner. Of the 31 subjects who completed all measures for the study, two had participated in weight control programs subsequent to the MSU program and were not included in the final sample used for analysis. Therefore, the response rate of the objectively measured was 50% and of objectively measured combined with self-reports was 83%. A summary of the sample population and subject selection was as follows (Figure 3.0).

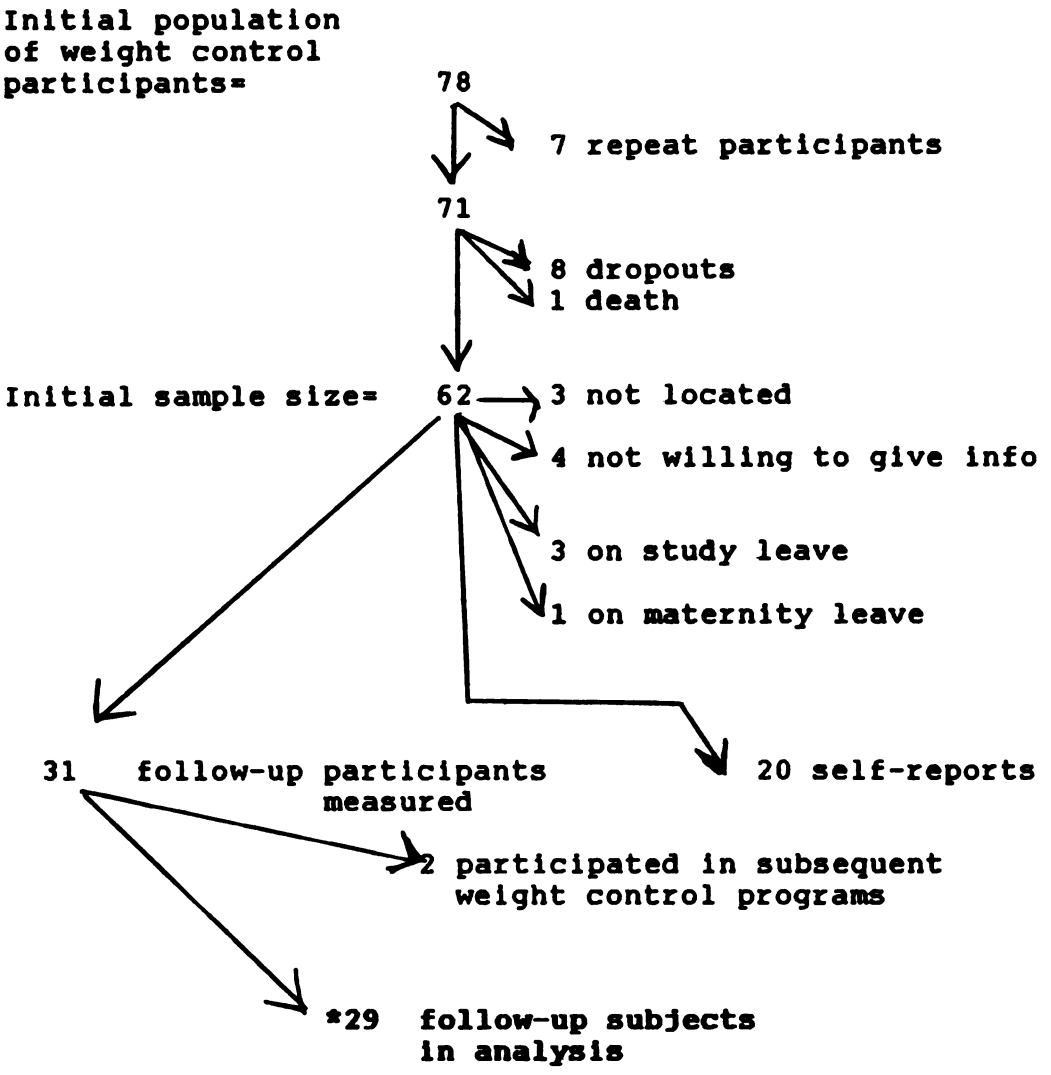


Figure 3.0 Flow of weight control program participants from initial population to follow-up subjects in analysis.

See Table 3.1 for distribution of initial sample by site and length of follow-up. The only measurements obtained on the initial population of weight control program participants were pre and post treatment weight values. No heights were obtained, although some self-reported heights were available.

It was not possible to compare demographic data of the original group of 78 program participants and the final follow-up subjects because many values were missing, especially from those participants who dropped out of the program. However, no significant differences could be found when demographic data of the initial sample of 64 and the 29 objectively measured follow-up subjects were compared. The average ages were 46 years for the initial sample (n=64) and 48 for the follow-up group (n=29). The average number of pounds lost during the program was 14 for the group of 64 and 13 pounds for the 29 follow-up subjects. Forty-one percent of the initial sample of 64 were males compared to 48 percent males in the follow-up subjects. Finally, of the initial sample of 64 participants, 67 percent consisted of MSU staff members, 17 percent were faculty and 11 percent were graduate students. This compared to 79 percent staff, 17 percent faculty and 3 percent graduate students in the final group of 29 follow-up subjects. The smaller percentage of graduate students in the follow-up group can be explained by the difficulty in tracking some of these participants

after they completed degrees and left the MSU campus. There were also no differences observed between these two groups in the percentage who were led by a particular program leader or by the program starting date.

Table 3.1 Distribution of initial sample (n=62) who were follow-up subjects (n=29) by site and length of follow-up.

Time since Program ended	Location of Program			
	PSS	CHE	ANT	DPS
T1 (6 mo)	6/14(43%)			
T2 (24 mo)	2/6 (33%)	6/11(55%)	5/6 (83%)	
T3 (30 mo)	4/7 (57%)	3/6 (50%)		
T4 (42 mo)				3/12(25%)

PSS = Plant and Soil Science
CHE = Chemistry
ANT = Anthony Hall
DPS = Department of Public Safety

The mean age of the 29 follow-up subjects whose data was analyzed was 48 years, ranging from 26 to 68 years. The majority were white or non-hispanics (94%) with the remainder of Asian origin. Length of follow-up time for subjects varied depending on the start date of the program in which they participated. Forty-five percent of the sample

had a follow-up length of time of 24 months, 24% had a follow-up time of 30 months, 21% had a follow-up time of 6 months, and the remaining 10% had a follow-up time of 42 months. Of the 29 subjects used for final data analysis, 52% were women (n=15) and 48% men (n=14). The majority of subjects (79%) were MSU staff, 17% were faculty and the remainder were graduate students. (See Table 3.2 for description of subjects in final sample).

Table 3.2 Weight control program description for subjects in final follow-up sample (n=29).

	Number of subjects	Percent of total
Participant gender		
Male	14	48
Female	15	52
Employee Level		
Staff	23	79
Faculty	5	17
Grad Student	1	3
Program Leader		
1	16	55
2	7	24
3	6	21
Program Start Date		
Jan 1989	8	28
Feb 1989	11	38
March 1988	7	24
Dec 1987	3	10

The average weight loss during the MSU program of the 29 follow-up subjects was 12.7 ± 6.5 (mean ± SD) pounds per subject. Of the 29 subjects, four (13%) began the program within ± 5% of their reference weight. Two subjects (7%) began the program at 107% of reference weight, and the remaining 23 subjects (80%) were greater than 110% above reference weight at the start of the program.

Subject selection

Because the subjects for this study were a convenience sample, the application of standard survey research techniques for maximizing response rates of random samples was not possible. However, the subject selection for this study was designed to maximize ease of participation for subjects and adapted from the Dillman method for random sample survey research (Dillman, 1978).

Past program participants were located through campus directories and contacted for participation in the study. Those who could not be located in the directories were located through campus records and forwarding addresses at former places of employment. Subjects were contacted by a letter explaining the purpose of the study and requesting their participation (Appendix B for a copy of the letter). A free computerized dietary assessment and 30 minute dietary consultation with a dietitian for each subject were provided as incentives for participation (a $30.00 value). Included with the mailing of the initial letter was a schedule of

meeting times and locations which had been set up around campus to accommodate as many subjects as possible (Appendix C for a copy of meeting times). One week following the mailing of the letter and schedule of meetings, each subject was contacted by telephone to schedule a meeting at a time convenient for him or her. During this meeting, appointments were made with each subject to visit the Nutrition Assessment Laboratory (NutritionWorks) for their dietary consultation and anthropometric measurements. The privacy of the laboratory setting was explained to subjects to encourage their participation.

Fourteen subjects (about 50%) were unwilling or unable to visit the laboratory, but willing to participate. These subjects were visited at their worksites for anthropometric measurements and questionnaire administration. The measurements were done in a private room at the worksite or in the subject's office. These subjects also received a free dietary consultation for their participation.

Procedures

After approval for this study by the University Committee on Research involving Human Subjects (UCRIHS), a pilot study was administered in March, 1991 using a Healthy U weight control program group (n=12) which had completed the program November 1990 (See Appendix D for UCRIHS approval letter). This group differed from the final study program participants because the subjects in the pilot study

contracted for behavior changes rather than for weight loss. Because of this difference, the subjects from the pilot study could not be combined with those from the final study for analysis. The same procedures were followed for pilot subjects as for the final study which was conducted in May and June 1991. Data collected from this pilot test group were used to identify problems and revisions necessary prior to the final study.

After initial contact of subjects by letter, meetings were held at various locations around campus. The purpose of these meetings was to explain the study to the participants, to obtain signed consent forms (Appendix E for copy of consent form), to distribute the food record form and to teach the subjects how to complete this form. Subjects were asked to return the 3-day food records by mail or the records were picked up by the primary investigator prior to each subject's appointment at the laboratory so that dietary intake could be analyzed and feedback on nutrient intake provided at the laboratory visit.

Subjects then visited the Nutrition Assessment Laboratory on campus for anthropometric measurements and a dietary consultation. When the subjects visited the laboratory they completed a survey instrument consisting of questions on physical activity, social support and weight history. A brief food frequency was also administered at time of the subjects' visit to the laboratory. The survey

instrument was completed by the subjects prior to receiving feedback on their dietary intake and prior to obtaining anthropometric measurements. Data collection for each subject took approximately one hour. Data were collected by the primary investigator alone, and required about two months to complete.

Measurements

Dietary Assessment

Nutritional Analysis Software. The dietary analysis was done using the MSU Nutriguide dietary analysis computer software program (MSU Nutriguide, 1988). A comparison of database completeness between the MSU Nutriguide program and Nutritionist III (N-Squared Computing, 1990) indicated that for fat, MSU Nutriguide was 99 percent complete, compared to Nutritionist III which was 88 percent.

Initially, the database on the MSU Nutriguide software for fiber was incomplete, but these data were completed prior to analyzing the dietary intake data for this study. The fiber database was completed by students in the Department of Food Science and Human Nutrition under the supervision of Won Song, MSU Nutriguide author. Data on dietary fiber came from sources such as the USDA Nutrient Databank (USDA, 1989). With respect to the other targeted nutrients, MSU Nutriguide was 85% complete for Vitamin A, 85% complete for Vitamin C, 75-80% complete for Vitamin B-6, 95-100% complete for Calcium and 95-100% complete for Iron.

Food and Nutrient Intake. Dietary intake information was gathered using a 3-day food record found in Appendix F. The record was a detailed description of types, amounts, times and places food and beverages were consumed over two weekdays and one weekend day. Reports indicate that people eat differently on weekends than they do on weekdays, and if an accurate assessment of intake is desired, both weekend and weekdays must be included (Willett, 1990). Eating patterns and nutrient intake were assessed from this instrument, which was completed by subjects prior to coming to the lab for measurements. Subjects were trained in how this record should be completed. The training involved having the primary investigator (a Registered Dietitian) demonstrate food portion sizes with food models and serving utensils. The importance of recording recipes, condiments, beverages, where and when food was eaten and other details pertinent to the dietary record were explained according to recommended procedures (Willett, 1990). It was necessary that subjects carefully record times of intake as well as the actual amount of intake in order to assess food patterns. Subjects were also asked to record where food was eaten because this helped the primary investigator calculate nutrient information. For example, if the subject indicated consumption of a chicken salad at McDonalds, the investigator was able to enter the appropriate foods because salads at McDonalds are generally of standard content and

size. The information from the 3-day food records was analyzed for fat, calcium, iron, vitamins A and C, dietary fiber, and vitamin B-6 content.

Dietary quality was evaluated by two indices, nutrient density (INQ) and mean adequacy ratio (MAR) for calcium, iron, vitamins A, C, B-6 and dietary fiber. Nutrient density was assessed using the Index of Nutritional Quality, a nutrient density ratio which can be used to compare actual nutrient density per 1000 kcal of subjects' daily dietary intake to the recommended nutrient density per 1000 kcal of dietary intake based on age and sex specific Recommended Dietary Allowances and Recommended Energy Intake (Hansen and Wyse, 1980). An Index of Nutritional Quality-1000 score was calculated from the mean of a subjects three-day record as follows.

$$\text{INQ-1000} = \frac{\text{Nutrient Intake X 1000/Total Kilocalorie Intake}}{\text{Nutrient RDA X 1000/Recommended Energy Intake}}$$

The INQ-1000 was averaged to provide a score for nutrient density called INQ-1000-6. The score for each nutrient was truncated at 100 to remove the influence that excessive consumption of one nutrient might have on the average score.

A mean adequacy ratio (MAR) score was also calculated for the same six nutrients from each subject's mean dietary

intake for three days. The MAR is an average of selected Nutrient Adequacy Ratios (NAR) calculated by dividing the actual intake of a nutrient by that nutrient's RDA and multiplying by 100 (Madden and Yoder, 1972). Therefore, NAR's were calculated for the six targeted nutrients; these values were then averaged to obtain the MAR-6. The formula for NAR is as follows.

$$\text{NAR} = \frac{\text{Actual Intake of Specific Nutrient}}{\text{Recommended Dietary Allowance for the nutrient}} \times 100$$

NAR scores were also truncated at 100 to remove the influence that excessive consumption of one nutrient might have on the average score.

Fruit and vegetable consumption was calculated by adding up the servings of fruits and vegetables consumed in each subject's 3-day food record and then averaging this value to obtain the mean daily fruit and vegetable consumption. Serving sizes of fruits and vegetables were determined using the diabetic exchanges for meal planning (American Diabetes Association, 1986). For example: 4 ounces of fruit juice, one medium apple, one cup of raw vegetables or 1/2 cup of cooked vegetables were all considered one fruit or vegetable serving, respectively. In addition, the average ounces of fruit juice consumed per day was examined separately from the total fruit and vegetable consumption.

Eating Patterns. Eating patterns were evaluated from the 3-day food records. Breakfast consumption was defined as the percentage of calories consumed at the breakfast meal and as the number of times per week breakfast was eaten. Daily caloric distribution patterns were assessed by the percentage of daily calories consumed at each meal and by the percentage of calories consumed as snacks. Percentage of daily calories consumed as snacks was then further divided to assess the time of day snack calories were consumed. Snack calories were examined as the percentage of daily caloric intake consumed as all snacks combined, the percentage of daily calories consumed as afternoon snacks and the percentage of daily calories consumed as evening snacks. Afternoon snacks consisted of any food or beverage consumed between the lunch meal and the dinner meal. Evening snacks consisted of any food and beverage consumed after the dinner meal.

Food Frequency for Beverages and Alcohol. A brief food frequency found in Appendix G focused specifically on beverages and alcohol and was adapted from the food frequency developed by Walter Willett (1988). The responses from this instrument were analyzed by calculating the number of diet beverages consumed per month, the number of regular beverages consumed per month, the ratio of regular beverages to diet beverages, the number of cups of caffeinated coffee consumed per month, and the number of alcoholic drinks

consumed per month. One serving of diet or regular beverage was defined as 12 ounces. One serving of coffee was one cup. Twelve ounces of beer, four ounces of wine or one ounce of liquor were each defined as one alcohol serving (American Diabetes Association, 1986).

Demographic Information.

Included with the 3-day dietary intake record was a one page demographic information sheet found in Appendix H and adapted from the Health Habits and Diet Questionnaire developed by Gladys Block for the National Cancer Institute (Block, 1987). This set of questions asked the subject's name, address, telephone, birthdate, age, sex, race, educational level and whether or not they smoked cigarettes. These questions were important for background information on the subjects as well as for correctly analyzing the dietary information from the food records. For example, to use the MSU Nutriguide program, each subject's age and sex were needed to calculate the appropriate RDA's. Years of school or education was considered to be a non-modifiable variable. The years of school were also categorized by high school graduate, some college or college graduate and post-college education.

Survey Instrument Administered at Laboratory

The four parts of a questionnaire completed by the subjects upon their visit to the Nutrition Assessment Laboratory are explained in this section.

Weight/Diet History. This section, found in Appendix I, assessed the subjects' weight history. This short, straight-forward list of questions required only brief responses from subjects.

Some of the questions used (Q# 2,3,5,6,7,8 and 13) were adopted from an earlier instrument developed by Susan Kayman (1990). Her screening component adopted for this study contained the following questions regarding weight history: age of onset of overweight, number of weight changes over time, number of weight loss attempts, the number of weight programs previously completed, the number of weight programs enrolled in and a description of previous attempts to lose weight. For this section, weight cycling was defined as repeated weight loss and then regain (Rodin, 1990); specifically a weight change of $\pm$ 5 pounds.

Four additional questions were added by the primary investigator to Kayman's portion of the questionnaire: 1) the frequency of weighing oneself per day or per week, 2) the frequency of counting calories, 3) recording foods consumed per day, per week or per month, and 4) the frequency of breakfast consumption. These questions were added to assess possible behavioral changes subsequent to the weight control program. Additional questions addressed participation in weight control programs subsequent to the MSU Healthy U program and were used as selection criteria for the final follow-up sample.

Physical Activity. This part of the questionnaire, found in Appendix J, assessed physical activity. Because an active lifestyle, not just "exercise", might be important for weight control, the physical activity component of the survey consisted of two parts addressing both exercise and behavioral aspects of an active lifestyle. Parts I and II of the physical activity component are described as follows.

Part I: Exercise

This first part was a set of 12 questions currently in use for the third National Health and Nutrition Examination Survey (NCHS, 1990). Questions assessed the type and frequency of exercise during the past month, typical physical activities and self perceptions of physical activity. Subjects were categorized based on the frequency and duration of activities as follows (Blair, 1989).

1) "Low physical activity": Subjects not meeting either of the following criteria.

2) "Moderately active": Subjects who run, swim, dance, bicycle or do aerobics for less than thirty minutes at least three days per week or walk two miles in 30-40 minutes, lift weights, garden or do calisthenics at least 4 days per week.

3) "Highly active": Subjects who run, swim, dance, bicycle or do aerobics for at least thirty minutes each day for 5-6 days per week or walk two miles in 20-24 minutes, lift weights, garden or do calisthenics at least 5-6 days per week.

Data from this part of the questionnaire were examined two ways. First, the subjects were categorized as described above by assigning dummy variables to each classification and entering these variables into the data analysis. Secondly, total minutes of activity per week or per month were calculated and this value (minutes) was used in data analysis.

Part II: Active Lifestyle

This second portion of the questionnaire consisted of five questions. The first two questions were designed to assess 1) repetitiveness of a subject's formal exercise (exercise pattern) and 2) time of day of exercise. The third question assessed lifestyle changes in activity. The fourth and fifth questions were included to get an idea of the time subjects might spend being "inactive" versus time "active".

Questions #1, #2 and #3 were followed by a listing of responses which subjects checked appropriately as "yes" or "no". Face validity for both sets of questions in Part II was established by having graduate students and faculty in the Department of Food Science and Human Nutrition, an exercise physiologist and an epidemiologist complete the questionnaire and comment. Information from this part of the activity questionnaire was analyzed by using each response to the first three questions (Q #1, #2, #3) as independent variables. The lifestyle change responses in Question #4 were used to obtain a summated score (i.e. the number of

different lifestyle changes related to activity as a variable). Question #5 was analyzed by entering the number of hours from each activity category independently into a regression equation or by comparing to weight category.

Social Support. Based on the research indicating the importance of perceived social support to weight maintenance, an instrument assessing perceived support was used for this study. This instrument, found in Appendix K, was an adaptation of a short scale to measure social support (SSS) developed by Funch and colleagues (1986). The reliability and validity of this instrument was established by Funch and colleagues on data from three samples: HMO clients in a weight loss program (n=268); chronic facial pain patients (n=92) and colorectel cancer patients (n=318). Internal consistency alphas for this scale ranged from 0.61 to 0.84. These alpha levels were stable for different age and sex groups. Funch and colleagues also reported that the validity assessments, both criterion and construct validation, were supportive of the usefulness of this instrument for various intervention programs. In analyses by Funch, correlation coefficients between the SSS scale and measures of psychological status (anxiety and depression) showed that the SSS score was significantly related to these dependent variables (-0.33 and -0.42 respectively; $p<0.001$). Funch and colleagues also compared the SSS scale with two other perceived support scales (Family Support, FAMSUP and

Family Activity, FAMACT) which had been tested on several different populations and found to be reliable. The correlation between SSS and these scales was reported as 0.40 and 0.46 respectively ($p<0.001$).

The set of response categories in the original instrument (not at all, a little, usually, completely) do not represent different points on a continuum. "A little" refers to a quantity and "usually" refers to a frequency. Therefore, the wording was changed by the primary investigator for this study so that all options referred to quantities of helpfulness (not at all, not very, somewhat and very helpful). This was done because it was more useful for this study to have all the responses measuring a single construct.

In this study subjects were asked to rate the amount of support received from each of several sources with respect to a specific situation (e.g. dieting or weight maintenance) on the SSS instrument. Five sources of support were considered: spouse, children, other relatives, friends and coworkers. Individuals were asked to rate the support received on a scale of "one" (not helpful at all) to "four" (very helpful). If a particular source was not applicable, a "0" was given for that item. (Subjects placed a checkmark under the not applicable column which had a value of zero.) Generally a category was non-applicable, if a subject had no one in that category (e.g. no spouse or children). Perceived

support was considered as the mean support score from all the sources indicated available, and provided a score of the average amount of perceived support from available sources.

According to this scoring method, higher scores indicated greater perceived availability of social support. Total scores could range from 0-20, with a score of 20 indicating the greatest perceived support. The mean support score from each of the sources available was used as variable for data analysis. Mean scores could range from 0-4, with a score of 4 being the highest possible mean score.

Anthropometric Measurements

Heights and Weights. Height and weight measurements were taken following standardized procedures (Lohman et al., 1988) using a stadiometer (Holtain Portable Stadiometer, Seritex Inc.) and a calibrated balance beam scale. Subjects were weighed on an uncarpeted surface according to the following protocol.

1) Confirmed that sliding weights on the horizontal beam were in the zero position and the scale was balanced.
2) The subject stood still in the middle of the weighing surface. Subjects were weighed without shoes and wearing light indoor clothing.
3) The beam weight was moved away from the zero notch until the beam balanced.
4) Measurements were read and recorded to the nearest

0.2 kg.

5) The subject was asked to step off the scale and then the procedure was repeated until two readings agreed within 0.2 kg.

6) The average of these two measurements was recorded.

Frame size was determined for each subject by measuring elbow breadth as explained in Appendix L. Elbow breadth measurement required a broad-faced sliding caliper (Seritex, Inc.) to measure the distance between the epicondyles of the humerus (Lohman et al, 1988). The subject flexed the right elbow to a 90 degree angle, and the measurer held the caliper at a slight angle on either side of the epicondyles. Firm pressure was exerted to decrease the influence of soft tissue and the measurement was recorded to the nearest 0.1 cm.

Standing height measurements were performed using a stadiometer according to the following procedure.

1) Subjects stood erect so that head, shoulder blades, buttocks, and heels were touching the back of the stadiometer. Subjects looked straight ahead with feet together. The head was positioned so that the corner of the eye was in a straight line with the top of the earlobe, i.e. the Frankfort plane.

2) The movable headboard was lowered until it firmly touched the crown of the subject's head.

3) The stature measurement was read to the nearest

millimeter and recorded.

4) This process was repeated until two measures were in agreement within 0.2 of a millimeter. Measurements were averaged and recorded.

Reference weights were calculated as the midpoint of the range of weights for height and gender using the 1983 data from the Metropolitan Life Insurance Company found in Appendix M. After review of the literature on weight maintenance, the Metropolitan Insurance Company weights-for-heights were selected as the weight standard to enhance comparability of results to other weight maintenance studies.

Relative percent overweight at follow-up was calculated for each subject as: (Actual weight/Reference Weight) x 100. This value was compared to a relative percent overweight calculated from each subject's post-treatment weight value to determine percentage change in relative weight from post-treatment to follow-up. It was assumed that the height of subjects remained constant from post-treatment to follow-up.

Body Shape Classification. Waist/Hip ratios of subjects were calculated for this study according to the following procedure (Lohman et al., 1988):

1) With the subject standing, waist circumference was measured to the nearest 1 mm at the level midway between the lower rib and the iliac crest. A fiberglass tape measure was used and three

measurements were taken and averaged.

2) Hip circumference was measured three times to the nearest 1 mm at the widest point between hip and buttocks.

3) Waist circumference was divided by hip circumference to obtain a ratio.

Subjects were classified into two groups based on their waist/hip ratios. These groups were an 'at risk' group which was a waist/hip ratio >0.8 for women and >1.0 for men and a 'not at risk' group, which was waist/hip ratio values which fell below these cutoffs. The average female waist/hip ratio is 0.7 with a waist/hip ratio of greater than 0.8 indicating health risk (USDA, 1990). The average male waist/hip ratio is 0.9 with a value greater than 1.0 indicating health risk (USDA, 1990). A Chi Square analysis was conducted examining weight loss, relative weight change, and weight category based on these at risk categories.

Data Analysis. All statistical analyses were run using the Statistical Package for the Social Sciences (SPSS/PC, 1988) on a personal computer compatible with an IBM PC having a 40 megabyte hard drive. A codebook for the data can be found in Appendix N.

Hypothesis One

The main outcome variable for all subjects was their change in relative weight. Mean relative weights at post-treatment and at follow-up were compared to determine if the

difference was statistically significant in a positive direction using a one-tailed *t*-test. Additional *t*-tests were conducted between initial relative weights, post-program relative weights and follow-up relative weights to determine if subjects' follow-up weights were different from their pre-program weights. This was done using the Dunnett method of multiple comparisons. The Dunnett method is used to compare each of several means with only one predesignated mean (Glass and Hopkins, 1984), in this case the initial relative weight.

In order to analyze the data, sites at each time period were pooled prior to statistical analysis of follow-up measures. The assumption was made that all the programs were similar. This assumption could be made because the program leaders were trained together on administration of the program and the same basic format was followed for each program. Even though it was necessary to pool sites in order to have adequate sample size, an evaluation of site differences for the total sample of 71 subjects by demographics was done. Demographic information compared by site was the percentage of males and females at each site, proportions of faculty and staff at each site and mean ages and mean weight changes of subjects at each site (See Appendix O for this demographic information). None of these values were significantly different for the initial sample

of 78 subjects, so it was determined prior to starting the study that sites would be pooled for analysis.

After follow-up measures were obtained, it was determined by Chi-square analysis whether times of follow-up could be pooled for final analyses of the 29 subjects. Follow-up weight changes were assessed for the pooling procedure, as well as subject demographics such as sex and employee level (Table 3.3). It was determined that sites were sufficiently similar to allow for all the subjects to be grouped together for final analyses because no significant differences were observed in demographics when the above procedures were conducted.

Table 3.3 Number of subjects in specific demographic categories (n=29).

Variable	Months since program end				
	6	24	30	42	Total
		Weight category			
Losers[a]	0	0	0	0	0
Maintainers[b]	2	4	2	1	9
Gainers[c]	4	9	5	2 [d]	20
		Gender			
Male	3	7	3	1	14
Female	3	6	4	2 [e]	15
		Occupation			
Faculty	1	2	1	1	5
Staff	5	10	6	2	23
Grad Student	0	1	0	0 [g]	1

[a]Subjects whose follow-up relative weights were >5% below post-program relative weights

[b]Subjects whose follow-up relative weights were within $\pm$5% of post-program relative weight

[c]Subjects whose follow-up relative weights were >5% above post-program relative weights

[d]Follow-up time by weight category, (X^2=2.7; p=.44)

[e]Follow-up time by gender, (X^2=.52; p=.91).

[g]Follow-up time by occupation, (X^2=2.4; p=.88).

In addition to the analyses conducted on the study sample of 29 subjects, self-reported heights and weights were obtained from 20 additional participants not willing to be measured. Change in relative weight was examined for this group by *t*-tests of pre, post and follow-up weights and by Chi-square analyses for weight category and gender.

Hypothesis Two

Descriptive data. After elimination of the two subjects who had participated in subsequent weight control programs, descriptive statistics were used to characterize the final sample of 29 subjects. These subjects were then classified as maintainers (n=9) or gainers (n=20). 'Maintainers' had a follow-up relative weight that was within $\pm$ 5% of their post-program relative weight. 'Gainers' had a follow-up relative weight that was > 5% of their post-program relative weight. In this sample of subjects, there were no 'losers' (a relative weight at follow-up < -5% of the post-program relative weight). Descriptive statistics characterized the subjects in each of these categories. Student's *t*-test analysis for unmatched pairs was also used to determine if differences found between 'maintainers' and 'gainers' on specific variables were significant.

The final sample of 29 subjects was divided by gender (14 males and 15 females) and characterized by descriptive and *t*-test statistics. When significant differences were observed by gender, results of these analyses were reported.

Correlations. Simple linear regression of each of the variables hypothesized to play a role in weight maintenance and relative weight change was conducted (specifically dietary, physical activity, social support, behavioral, and weight history variables). The Pearson product moment coefficient of correlation was used for continuous variables (Glass and Hopkins, 1984). For any variables which were ranked or categorized, Chi-square analysis was used.

Regression. Adequate sample size for multiple regression analysis is difficult to determine (personal communication, Dr. John Gill). Adequate sample size varies depending on the number of predictors (independent variables) to be added into the equation and the percent of variance that one wishes to explain with each predictor variable separately and with the predictor variables combined. Examination of studies related to weight maintenance which used regression as a method of data analysis (Jeffery et al., 1983, Wing et al., 1990, Stein et al., 1981), showed that from 0.28 to 0.58 of the variance in weight change has been explained. Based on the use of regression techniques in these studies (n's = 89, 178 and 63, respectively) as well as others reported in the literature, it had been determined by the primary investigator that an expected sample size of 70 subjects would be adequate for multiple regression techniques. However, the number of subjects actually obtained in this

study was insufficient to allow multiple regression techniques to be used appropriately as originally planned. Due to the small sample size, only two variables were included in the final regression equation, thus reducing the percentage of variance in weight maintenance that could be explained. Regression analyses were run using various techniques, forward selection, backward selection, stepwise selection and forced entry, to experiment with all variables and identify the two variables most useful in the regression equation.

Other Analyses

Program variables. Correlational analyses were run following data collection to examine the relationship between percent adherence (how well the subject met the programs goals) and relative weight change. Frequencies were calculated on the sample to examine the variable of weight program leader relative to the weight category of the subjects. Chi-square analysis was employed to examine this variable.

Due to the difficulty that was met in obtaining 3-day food records from over half of the subjects, correlational analyses were conducted to examine the relationship between the number of times a subject had to be contacted to obtain the completed food record and their relative weight change.

Funding and Equipment

Estimated expenses for this research project were approximately $25,000.00. Printing costs of the questionnaire and the letters to subjects was about $400.00. Funding for the printing and mailing was from the Department of Food Science and Human Nutrition annual yearend funds for graduate student research. The scales ($400.00), measuring tapes ($35.00), other anthropometric equipment ($1400.00), food models ($100.00), computer ($2500.00) and statistical analysis software ($100.00) were provided by Dr. Hoerr and the Nutrition Assessment Laboratory at Michigan State University, at an estimated cost of $5500.00. The MSU Nutriguide Computer program ($100.00) used for the dietary analysis was provided by Dr. Song at Michigan State University. Graduate research assistantship support (0.50 FTE for two years: $19,000) was provided by the Department of Food Science and Human Nutrition at Michigan State University and by a grant to Dr. Hoerr from the William Kellogg Foundation for Healthy U.

RESULTS

Hypothesis 1

Ho Participants at all sites and all follow-up times of Michigan State University's Healthy U Worksite Weight Control Programs will gain weight from post-treatment to follow-up.

A significant positive change in relative weight was observed between post-treatment and follow-up in the final group of 29 subjects and also when separated by men and women and maintainer or gainer (Table 4.0). In the group of 20 program participants who gave self-reported heights and weights there was also a significant positive change in relative weight between relative weight at post-treatment and self-reported weight at follow-up. However, no difference was found between initial weight and follow-up weight in this group. A significant difference could not be found by Chi-square analyses in the self-report group by sex, by follow-up time or by building.

Table 4.0 Mean relative weights for measured follow-up subjects (n=29) and program participants who self-reported follow-up weights (n=20) at pre, post and follow-up times (Mean ± SD).

	Percentage of Relative Weight		
Subjects	Pre Treatment	Post Treatment	Follow-up (6,24,30,42mo)
Measured			
All (n=29)	121 ± 17	112 ± 17 a,***	123 ± 19 b,***
Men (n=14)	117 ± 13	107 ± 12 a,***	119 ± 18 b,***
Women (n=15)	125 ± 20	118 ± 20 a,***	128 ± 21 b,***
Maintain (n=9)	117 ± 16	108 ± 14 a,***	111 ± 14
Gainers (n=20)	123 ± 18	115 ± 18 a,***	129 ± 19 b,***
Self-reports			
All (n=20)	122 ± 20	111 ± 18 a,***	118 ± 15 b,**

a pre, post comparison, Dunnett's multiple contrast *t*-test.

b post, follow-up comparison, Dunnett's multiple contrast *t*-test.

c pre, follow-up comparison, Dunnett's multiple contrast *t*-test.

** p<.01
*** p<.001

Table 4.1 Mean relative weight change[a] and number of gainers[b] (G) and maintainers[c] (M) by site and follow-up time.

Time since Program ended	Location of Program			
	PSS	CHE	ANT	DPS
T1 (6 mo)	+16% (5G;1M)			
T2 (24 mo)	+4% (0G;2M)	+14% (6G;0M)	+9% (2G;3M)	
T3 (30 mo)	+9% (3G;1M)	+10% (2G;1M)		
T4 (42 mo)				+8% (2G;1M)

[a]Increase in mean relative weight percent for subjects at each site.

[b] Number of gainers; follow-up relative weight was >5% above post-treatment relative weight.

[c] Number of maintainers; follow-up relative weight was within ± 5% of post-treatment relative weight.

PSS = Plant and Soil Science
CHE = Chemistry
ANT = Anthony Hall
DPS = Department of Public Safety

The change in relative weight from post treatment to follow-up and the number of maintainers and gainers at each site and follow-up time is reported in Table 4.1. Sixty-nine percent of the subjects regained the weight they had lost, that is were "gainers". No relation was found between time of follow-up and the percentage of gainers or maintainers at each site ($X^2 = 2.7$; $p=.44$).

Hypothesis 2

Ho The prediction of weight change at follow-up from demographic and weight history variables can be improved by the addition of selected lifestyle variables.

The descriptive data for all variables is reported first. Following the descriptive data, correlation matrices for categories of variables and regression equations to predict weight change are reported.

Descriptive data for non-modifiable variables (demographic, weight history and social support).

Demographic variables

* **age**
* **gender**
* **education**

Of the 29 subjects in the final study, 52% were women (n=15) and 48% men (n=14). The mean age was 48 years, ranging from 26 to 68 years. The demographic data for the total group of follow-up subjects and by maintainers and gainers is in Table 4.2.

Table 4.2 Demographic data for total group of follow-up subjects and by maintainers and gainers (Mean +SD).

Variable	Total sample (n=29)	Maintainers (n=9)	Gainers (n=20)
Subject Age (yr)	48 ± 11	49 ± 10	48 ± 12
Gender			
Males	14	5	9
Females	15	4	11
Education (yrs school)	15 ± 2	16 ± 2	14 ± 2*

* Maintainers vs gainers, Student's t-test, $p<.05$.

Education was examined in several ways. Men had completed significantly more years of school than women, 15.9 ± 1.7 versus 13.6 ± 1.9 years, $p<.01$. In addition, the mean number of years in school for those who maintained weight losses was significantly higher (15.8 ± 1.9 years) than for those who regained weight (14.2 ± 2.1 years, $p<.05$). Sixty-seven percent of those who maintained weight losses had a post-graduate education; only 30% of those who regained weight loss had an equivalent amount of schooling ($X^2= 1.3$; $p=.53$, NS).

Weight history and social support variables

- **age of onset of overweight**
- **number of weight loss attempts**
- **weight cycling**
- **number of weight control programs completed**
- **social support**

Descriptive data for weight history and social support variables are reported in Table 4.3.

Table 4.3 Weight history and social support variables (mean ± SD) for maintainers and gainers.

Variable	Total sample (n=29)	Maintainers (n=9)	Gainers (n=20)
Age overwt(yr)	27.5±15.3	33.3± 7.5	25.7±16.7*
Loss attempts	9.6±18.6	5.9± 8.2	11.2±22.1*
Wt cycle[a]	6.4±13.7	1.8± 1.8	8.5±16.1*
Wt programs[b]	1.6± 1.4	1.2± 0.8	0.9± 0.6
Social support[c]	2.7± 0.7	2.9± 0.7	2.6± 0.7

[a] Number of times weight gained and lost.

[b] Number of weight control programs completed.

[c] Average perceived social support score; range is 1 to 4.

* Maintainers vs gainers, Student's *t*-test, $p<.05$.

Age overweight

The mean age of onset of overweight was 27.5 years, ranging from 5 to 60 years. Subjects who regained their weight losses reported being overweight at a significantly younger age than those who maintained weight losses. Only one of the subjects who maintained a weight loss reported becoming overweight as a child. In contrast, seven of those who regained weight losses (35%) reported becoming overweight as a child.

Weight loss attempts

Subjects averaged about 10 weight loss attempts in the last five years, ranging from zero to 100 attempts. Subjects who regained weight losses after the MSU program reported significantly more previous weight loss attempts than those who did not.

Weight cycling

Subjects averaged about 6 times for losing and regaining weight in the last five years, ranging from zero to 60 times. Those subjects who regained MSU program weight losses reported a significantly higher number of weight cycles than those subjects who maintained MSU program weight losses.

Weight control programs completed

The mean number of weight control programs entered was 1.6 $\pm$ 1.4, ranging from zero to six. The mean number of weight control programs completed was 1.0 $\pm$ 0.7, ranging

from zero to three. No significant differences in number of weight control programs completed could be found when examined by weight category. The only statistically significant gender difference observed in any of the non-modifiable variables was in the number of weight control programs completed. Women completed significantly more programs than did the men (1.2 $\pm$ 0.8 versus 0.7 $\pm$ 0.5, $p<.05$).

Social Support

The mean perceived social support score was 2.7 $\pm$ 0.7 out of a possible five, ranging from 1.5 to 4.0. A score of five indicated maximal support from all sources. A significant difference was not found in social support when examined by weight category or gender.

Descriptive data for modifiable variables (lifestyle variables)

Food and Nutrient Variables

- **the percentage of calories from fat and total grams of fat;**
- **dietary nutrient density (Index of Nutritional Quality per 1000 kilocalories for Calcium, Iron, Vitamin A, Vitamin C, Vitamin B-6 and Fiber;**
- **mean adequacy ratio (MAR_a), for the same six nutrients as above;**
- **grams of dietary fiber;**
- **fruit and vegetable consumption;**
- **total daily kilocalorie intake; and**
- **kilocalories per kilogram body weight**

The mean values for food and nutrient variables are reported in Table 4.4 for all final follow-up subjects and for gainers and maintainers. Values are also reported for these variables by gender. The mean percentage of calories consumed as fat by the follow-up subjects was only 32% or a mean of 71 grams of fat. The subjects who maintained weight losses tended to consume less total fat and had a lower percentage of calories coming from fat, but these differences were not significant when examined by weight category. When examined by gender, women consumed a higher percentage of calories from fat (35.5%) than did men (30.8%).

The mean INQ-1000$_6$ for the follow-up subjects was 79 and ranged from 64 to 95. The mean MAR-6 was 75, ranging from 46 to 97. The mean grams of dietary fiber consumed per day was 10, ranging from 4 to 27. The mean number of servings of fruits and vegetables per day for the total study sample was 4.8, ranging from 1.3 to 10.7. Significant differences were not found in consumption of fruit and vegetables when examined by weight category.

Females consumed a higher percent of calories as fat than males, and had lower fiber intakes and lower dietary scores for nutrient density and nutrient adequacy. Significant gender differences were not found in total grams of fat or fruit and vegetable intake. Women consumed fewer total calories per day than did men ($p<.05$). Although significant differences were not found on a kcal/kg body weight basis between men and women, women's mean values tended to be less than men's. Probably more importantly, differences were not found in caloric intakes between maintainers and gainers.

Table 4.4 Food and nutrient variables (mean ± SD) for maintainers, gainers, men and women.

Variable	Total sample (n=29)	Maintainers (n=9)	Gainers (n=20)	Men (n=14)	Women (n=15)
% Kcal Fat	32±7	31±7	33±7	30±8	35±5*
Fat (g)	71±19	67±15	73±20	74±22	69±16
INQ-1000$_c$[a]	79±9	80±9	79±9	83±8	76±8*
MAR$_c$[b]	75±11	76±9	75±12	79±10	72±11*
Fiber (g)	10±5	12±7	10±4	12±6	8±3*
Fruit/Veg[c]	5±2	5±2	5±2	5±2	5±2
Kcal[d]	2095±607	2112±755	2088±550	2418±678	1794±329*
Kcal/kg[e]	25±7	28±7	24±6	28±7	23±6

[a] Index of Nutritional Quality/1000 kcal diet averaged for six nutrients.

[b] Mean Adequacy Ratio averaged for six nutrients.

[c] Average number of servings of fruits and vegetables per day.

[d] Total daily caloric intake, averaged for three days.

[e] Average total daily caloric intake per kilogram body weight.

* Men vs women, Student's *t*-test, $p<.05$.

Beverage consumption variables

The mean values for the study sample and by maintainer or gainer are reported in Table 4.5. No significant differences could be found when these variables were examined by weight category. When examined by gender the only difference found was in the mean number of alcoholic drinks consumed per month, with men consuming significantly more than women.

Table 4.5 Beverage consumption (mean ± SD) for maintainers, gainers, men and women.

Beverage	Total sample (n=29)	Maintainers (n=9)	Gainers (n=20)	Men (n=14)	Women (n=15)
Alcohol[a]	15±40	19±47	13±37	29±54	2± 4*
Diet[b]	51±76	44±57	54±84	74±99	29±34
Regular[c]	14±23	17±31	13±20	10±15	18±29
Coffee[d]	31±51	33±50	30±53	41±60	22±41

[a] Mean number of alcoholic drinks per month.

[b] Mean number of diet beverages consumed per month.

[c] Mean number of regular sweetened beverages consumed per month.

[d] Mean number of cups of coffee consumed per month.

* Men vs women, Student's *t*-test, $p<.05$.

Eating Patterns

- **breakfast eating (times per week)**
- **caloric distribution throughout the day (percent of calories at breakfast, lunch, dinner and snacks)**
- **number of eating occasions per day**

The means for the eating pattern variables are reported in Table 4.6, for the total sample and by weight category. For all subjects, the mean reported frequency of breakfast eating was six times a week; a significant difference was not found by weight category. A significant difference was also not found between the percentage of calories consumed as dinner and as snacks between maintainers and gainers, although gainers tended to eat more at dinner ($p<.10$) and maintainers tended to consume more calories as snacks ($p<.10$). When snack calories were divided as either afternoon snacks or evening snacks, again no significant differences were observed. When snacks and meals were grouped as total afternoon calories and total evening calories, still no significant differences were found, either between maintainers and gainers or by gender.

The mean number of eating occasions per day for the study sample was 4.4 and ranged from 2.7 to 7.0. There were no significant differences found in mean number of eating occasions when examined by gender or by weight category. When categorized by gender, significant differences were not

found in caloric distribution by breakfast, dinner or snacks.

Table 4.6 Eating patterns (Mean ± SD) for maintainers, gainers, men and women.

Variable	Total Sample (n=29)	Maintainers (n=9)	Gainers (n=20)	Men (n=14)	Women (n=15)
Break[a]	5.6± 2.4	6.0± 2.0	5.4± 2.0	5.9± 2.0	5.3± 2.7
Break%[b]	15.9± 7.3	16.0± 5.4	15.8± 8.2	17.8± 8.1	14.1± 6.2
Lunch%[c]	25.5±12.9	24.8± 8.5	25.8±14.7	19.6±13.0	31.0±10.5**
Dinner%[d]	38.3±15.6	33.2±13.5	40.6±16.2	40.5±16.2	36.2±15.2
Snacks%[e]	20.2±15.1	25.7±16.1	17.8±14.4	22.1±18.2	18.5±12.0
Afternoon Snacks%[f]	5.4±6.0	6.3±6.1	5.0±6.1	4.7±5.9	6.0±6.4
Evening Snacks%[g]	11.7±7.0	15.4±19.7	10.1±10.3	15.1±17.3	8.5±8.9
Eating Occ[h]	4.4±1.1	4.8±1.1	4.3±1.0	4.5± 1.2	4.4± 1.0

[a] Average times breakfast eaten per week

[b] Percent of daily calories consumed at breakfast

[c] Percent of daily calories consumed at lunch

[d] Percent of daily calories consumed at dinner

[e] Percent of daily calories consumed as all snacks combined

[f] Percent of daily calories consumed as afternoon snacks

[g] Percent of daily calories consumed as evening snacks

[h] Average number of eating occasions per day

** Men vs women, Student's t-test, $p<.01$.

Behavioral variables

- **frequency of counting calories**
- **frequency of recording foods eaten**

Only one subject reported recording foods consumed. Therefore, this subject was grouped with the subjects who reported counting calories (n=20) and analyses were run with all subjects together (n=21). The mean frequency of calorie counting and food recording was 6.7 ± 12.2 times per month, with a range from zero to 30 times per month. No significant differences were found between maintainers and gainers nor differences by gender (Table 4.7).

Table 4.7 Average times per month (Mean ± SD) for counting calories (n=20) or recording foods (n=1).

	Recorded Food/Calories (times/mo)
Total sample (n=29)	6.7±12.2
Maintainers (n=9)	10.9±14.0
Gainers (n=20)	4.8±11.0
Males (n=14)	8.6±14.1
Females (n=15)	4.9±10.3

Physical activity variables

The means for the physical activity variables are reported in Table 4.8, for the total sample and by weight category.

Table 4.8 Physical activity variables (mean ± SD) for maintainers, gainers, men and women.

Variable	Total sample (n=29)	Maintainers (n=9)	Gainers (n=20)	Men (n=14)	Women (n=15)
Physmin[a]	191±143	264±201	158±96	237±170	148±99
PAchanges[b]	2.0±1.3	1.9±1.5	2.0±1.5	2.1±1.5	1.9±1.2
SleepHrs[c]	7.1±0.9	6.9±0.8	7.2±0.9	6.9±0.8	7.3±0.9

[a] Mean number of minutes spent in physical activity per week.

[b] Mean number of changes made in physical activity.

[c] Mean number of hours spent sleeping per night.

The mean number of minutes spent in leisure-time physical activity per week for the total sample group was 191 ± 143; ranging from 5 to 695 minutes per week. An outlier for this variable accounting for 13% of the total minutes of physical activity per week can be seen on the scatterplot in Appendix P. The difference between

maintainers and gainers in minutes spent in physical activity was not significant, although the mean value was higher for maintainers. The difference in minutes of physical activity between men and women approached significance ($p<.10$) with men exercising more per week than women. The average number of minutes for men (n=14) was 237 $\pm$ 170 and for women, 148 $\pm$ 99 minutes (Student's *t*-test, $p<.10$).

No relationship was found between pattern of exercise (time of week or season of exercise) and weight category by Chi-square analysis ($X^2 = .56$; $p=.91$). Exercise pattern also did not differ by gender. When the time of day of exercise was categorized as morning or evening and by before a meal or after a meal, again no relationships were found either by weight category or by gender.

The number of changes in routine physical activity made during, or since completing, the MSU Weight Control Program was not significantly correlated with relative weight change ($r=.03$). Five subjects indicated they had made *no* changes in physical activity. The number of hours spent sleeping in a typical *weekday* was compared by weight category as shown in Table 4.8. The majority of those who maintained weight losses (78%) slept from 4 to 7 hours per night while 45% of those who regained weight losses slept more than 7 hours per night ($X^2 = 0.73$; $p=.39$).

Table 4.9 Percentage of maintainers and gainers by sleep categories.

	Hours of sleep	
	4.0-7.0 (n=18)	7.1-9.0 (n=11)
Maintainer (n=9)	78%	22%
Gainer (n=20)	55%	45%

X^2 = 0.73; p=.39.

In addition, the number of hours spent sleeping was compared to total grams of fat and the percentage of calories coming from fat in the diet. A significant relationship could not be found between total grams of fat and the number of hours spent sleeping, but the correlation between the percentage of calories coming from fat and the hours spent sleeping ($r=.37$, $p<.05$) indicated that as hours spent sleeping increased, the percentage of calories coming from fat also increased.

The number of hours spent relaxing in a typical weekday was also compared to weight category, and there was no significant difference ($p<.23$). However, there appeared to be a trend towards increasing hours spent relaxing in the gainers. The hours spent in light and moderate activity were

negatively correlated with relative weight change (r=-.19 and r=-.23, respectively; p=.40, p=.34 respectively). Therefore there was a trend for decreased weight regain with increasing hours of light or moderate activity. No significant differences or trends were observed for hours spent sleeping, relaxing, in light activity or in moderate activity on a typical weekend day when compared to weight category.

Subjects' body shape classification; 'at risk'(>1.0 for men and >0.8 for women) or 'not at risk" by Waist/Hip ratio

There were six subjects who fell into the 'at risk' category, the remaining 23 subjects were 'not at risk'. Chi-square analysis revealed that there was not a significant difference between weight maintenance and gain for this variable. However, eight of the nine subjects (89%) who maintained their weight losses fell into the 'not at risk' category, meaning they did not have abdominal obesity. Of those who regained weight losses, 5 out of 20 (25%) had an abdominal pattern of fat distribution. When examined by gender, two men fell into the 'at risk' category (14%) compared to 12 (86%) who were 'not at risk'. Four women (27%) were 'at risk' and 11 women (73%) were 'not at risk'.

Table 4.10 Percentage of maintainers and gainers by waist/hip ratio.

Waist/hip ratio	Maintainer (n=9)	Gainer (n=20)
At risk[a] (n=6)	11% (1)	25% (5)
Not at risk[b] (n=23	89% (8)	75% (15)

[a] Waist/hip ratio >0.8 for women and >1.0 for men

[b] Waist/hip ratios falling below the above cut-offs

X^2 =.73; p=.40.

Correlation matrices

Demographic variables There were no significant correlations found between demographic variables and relative weight change (Table 4.11). However, a trend was observed for less weight regain with both increased age and increased years of school ($p<.10$ for both).

Table 4.11 Correlation matrix of demographic variables with relative weight change (n=29).

	1	2	3
1) Wt Change[a]	1.00		
2) Age[b]	-.25	1.00	
3) Education[c]	-.28	-.22	1.00

[a] Relative weight change

[b] Age of subject at follow-up

[c] Average number of years of school

Weight history and social support variables(Table 4.12) The older the age of onset of overweight, the less weight was regained ($r=-.41$, $p<.05$). In examining weight loss attempts and relative weight change ($r=.79$, $p<.001$) there was one subject with an extremely high value (100) that appeared to be an outlier. The total number of weight loss

attempts for the group was 276: the subject who reported 100 weight loss attempts accounted for 36% of the total reported. (See scatter-plot in Appendix Q). For this reason the outlier was excluded from the analysis and a significant difference was no longer observed ($r=.29$, $p<.34$). The correlation coefficient with the outlier excluded was used for further analyses. As the number of weight cycles or rebounds after weight loss increased, the amount of weight regained also increased ($r=.55$, $p<.01$).

The final non-modifiable variable examined was perceived social support. A significant association was not found between summated perceived social support score and relative weight change ($r=-.14$, $p=.24$). Unfortunately there were not sufficient questions to examine potential relationships for types of social support in greater detail such as familial versus worksite social support constructs.

Table 4.12 Correlation matrix of weight history and social support variables with relative weight change (n=29).

	1	2	3	4	5	6
1) Wt Change[a]	1.00					
2) Ageovwt[b]	-.41*	1.00				
3) Lossatt[c]	.29	-.25	1.00			
4) Wtcycle[d]	.55**	-.25	.54**	1.00		
5) Programs[e]	-.37	.46**	-.24	-.22	1.00	
6) Socsup[f]	-.04	-.18	-.15	-.18	-.29	1.00

[a] Relative weight change

[b] Age first became overweight

[c] Number of weight loss attempts, n=28 after outlier of 100 attempts was excluded from analysis

[d] Number of times weight gained and lost

[e] Number of weight control programs completed

[f] Mean perceived social support score

* - .05; Pearson correlation coefficient
** - .01; Pearson correlation coefficient

Nutrient intake variables (Table 4.13) Both the percentage of calories coming from fat and the total grams of fat were positively correlated with relative weight change ($r=.18$, NS and $r=.40$, $p<.05$ respectively), meaning that as fat intake increased weight was gained. Neither the $INQ\text{-}1000_s$ nor the MAR_s or the mean grams of dietary fiber consumed per day was related to weight outcome. Although a significant difference was not found between mean number of fruit and vegetable servings and weight change ($r=-.21$, $p=.14$), fruit and vegetable consumption was inversely related to percentage of calories coming from fat; $r=-.56$ ($p<.001$) as well as positively correlated to dietary nutrient density ($INQ\text{-}1000_s$; $r=.50$, $p<.01$).

Beverage variables (Table 4.14) The greater the number of diet beverages consumed, the greater relative weight change ($r=.62$, $p<.01$). That is, more weight was gained. No significant relationships were found for alcohol, regular sweetened beverage or coffee intake. Due to the standard deviations larger than mean values for these variables, scatter-plots of these variables were done. An outlier was present in the data for diet beverage consumption (Appendix R), and the correlation of relative weight change and diet beverage consumption was recalculated after removal of the outlier. The association was no longer significant ($r=.01$).

Table 4.13 Correlation matrix of dietary variables with relative weight change (n=29).

	1	2	3	4	5	6	7	8	9
1) Wt Chg[a]	1.00								
2) % Fat	.18	1.00							
3) Fat g	.40*	.51**	1.00						
4) INQ[b]	.03	-.42*	-.21	1.00					
5) MAR[c]	.02	-.54**	.10	.77***	1.00				
6) Fiber[d]	-.17	-.54**	-.09	.20	.37	1.00			
7) Ft/Veg[e]	-.21	-.56***	-.38*	.50**	.55**	.04	1.00		
8) Tot/Kcal	.17	-.42*	.49**	.11	.54**	.60	.03	1.00	
9) Kcal/kg	-.17	-.49**	.21	-.04	.41*	.41*	.28	.73***	1.00

[a] Relative weight change

[b] Index of Nutritional Quality, a nutrient density score

[c] Mean adequacy ratio-a dietary quality score

[d] Mean grams of dietary fiber consumed per day

[e] Mean servings of fruits and vegetables per day

* p< .05; Pearson correlation coefficient
** p< .01; Pearson correlation coefficient
*** p< .001; Pearson correlation coefficient

Table 4.14 Correlation matrix of beverage variables with relative weight change (n=29).

	1	2	3	4	5
1) Wt Change[a]	1.00				
2) Alcohol[b]	-.26	1.00			
3) Diet[c]	.01	-.14	1.00		
4) Regular[d]	-.17	.18	-.23	1.00	
5) Coffee[e]	.01	.11	-.32	-.01	1.00

[a] Relative weight change

[b] Mean number of alcoholic drinks per month

[c] Mean number of diet beverages consumed per month, n=28 with outlier consuming 360 drinks/mo excluded from analyses

[d] Mean number of regular sweetened beverages consumed per month

[e] Mean number of cups of coffee consumed per month

Eating pattern variables (Table 4.15) A significant relationship was not found between the frequency of eating breakfast and relative weight change (r=-.15, p=.34). A significant relationship was also not found between the mean number of eating occasions per day and relative weight change (r=-.14, p=.24). There were no significant associations observed between caloric distribution variables for meals and relative weight change. However, all of the snack variables were negatively correlated with relative weight change, meaning that the more calories consumed as snacks, less weight was regained.

Table 4.15 Correlation matrix of eating pattern variables with relative weight change (n=29).

	1	2	3	4	5	6	7	8
1) Wt Chg[a]	1.00							
2) Break%[b]	-.15	1.00						
3) Lunch%[b]	.23	-.27	1.00					
4) Din%[b]	.12	-.07	-.39	1.00				
5) Snack%[b]	-.24	-.16	-.32	-.64***	1.00			
6) Aft Snack%[b]	-.17	.00	-.19	-.31	.47**	1.00		
7) Evening Snack%[b]	-.13	-.14	-.20	-.56***	.80***	-.12	1.00	
8) Eating Occasions[c]	-.14	-.01	.02	-.38	.38	.58***	.04	1.00

[a] Relative weight change

[b] Percentage of calories consumed at breakfast, lunch, dinner, all snacks, afternoon snacks or evening snacks

[c] Number of eating occasions

*** - .001; Pearson correlation coefficient
** - .01; Pearson correlation coefficient

Behavioral and activity variables (Table 4.16) The self-reported frequency of counting calories was not significantly related to relative weight change ($r=.22$, $p=.12$). In spite of the outlier in minutes of physical activity per week discussed earlier, there appeared to be a trend toward decreased weight regain with increased minutes of physical activity ($r=-.34$, $p<.10$).

Table 4.16 Correlation matrix of behavioral and activity variables with relative weight change (n=29).

	1	2	3	4
1) Wt Change[a]	1.00			
2) Count[b]	-.22	1.00		
3) Physmin[c]	-.34	.40*	1.00	
4) Sleep[d]	.24	-.26	-.18	1.00

[a] Relative weight change

[b] Frequency of counting calories or recording foods eaten

[c] Minutes per week of physical activity

[d] Hours per day spent sleeping

* - .05; Pearson correlation coefficient

Program Variables

Adherence to program goals

There was not a significant association found ($r=-.09$, $p=.31$) in the sample of 29 subjects for percent adherence to program goals (as measured by weekly weight loss according to the amount stated in each subject's contract) and relative weight change. However, when comparing adherence to program goals and attendance by gender, it was discovered that the men had significantly greater adherence to program goals and attendance than the women ($p<.05$).

Program leader

No significant relationship could be found between program leader and weight category (maintainer or gainer) by Chi-square analysis (Table 4.17). However, while Leader #1 had 55% (n=16) of the total subjects participating in classes, he had 78% of those who maintained weight losses (n=7). In other words, 44% of the participants in classes led by Leader #1 maintained weight losses, compared to 29% (n=2) of those in classes led by Leader #2 and 0% in classes led by Leader #3.

Table 4.17 Percentages of maintainers and gainers by program leader

	Leader #1	Leader #2	Leader #3
Maintainers (n=9)	78%	22%	0%
Gainers (n=20)	45%	25%	30%

X^2 =3.9, p=.14.

Food record completion

The number of times a subject was contacted for the return of the three-day dietary record was significantly related to relative weight change (r=.37, p<.05). Therefore, as number of times of contact to obtain a dietary record increased, the amount of weight regained also increased.

Regression Analyses

When demographic and weight history variables were entered into the regression equation, only weight cycling was significant; regardless of the method used (forced entry, forward selection, backward selection or stepwise selection). See Table 4.18.

Table 4.18 Stepwise prediction of change in relative weight from weight history and demographic variables (n=29).

Step		b	R	R^2	Adj. R	p
1	Weight cycling	.36	.55	.30	.27	.004

Regression equation: $Y=.36x_1 + 9.5$ (constant).

When lifestyle variables were entered into the regression equation, in stepwise fashion, total grams of fat consumed per day was the only independent variable that met criteria ($p<.05$) to enter the equation (Table 4.19). When all variables (demographic, weight history and lifestyle variables) were entered into the regression equation together, weight cycling was entered first into the equation regardless of the method used.

Table 4.19 Stepwise prediction of change in relative weight from lifestyle variables (n=29).

Step		b	R	R^2	Adj. R	p
1	Fat (grams)	.30	.40	.17	.13	.03

Regression equation: $Y=.30x_1 + -3.5$ (constant)

When variables were selected for the regression equation based on the correlations seen with relative weight change, the following variables were entered: weight cycling, age of onset of overweight, grams of fat consumed per day and minutes spent in physical activity. Because of the small sample size (n=29), the two of these variables that were the best predictors of relative weight change were selected for the final regression equation. As was the case using all other methods of regression analyses, weight cycling and total grams of fat consumed proved to be the best predictors (Table 4.20) Together, these variables accounted for 30% of the variance in relative weight change.

Table 4.20 Prediction of change in relative weight from all variables combined (n=29)

.

Variable	b	R	R^2	Adj. R	p
Fat (grams)	.15	.40	.17	.13	.03
Weight cycling	.34	.62	.39	.30	.01

Regression equation: $Y=.15x_1 + .34x_2 - 2.07$ (constant)

DISCUSSION

I. Hypothesis 1.

Ho Participants at all sites and all follow-up times of Michigan State University's Healthy U Worksite Weight Control Programs will gain weight from post-treatment to follow-up.

Healthy U weight control participants gained weight from post-treatment to follow-up. This was true for both the objectively measured subjects and the self-reports, as well as for men and women. Sixty-nine percent of the total objectively measured group regained their lost weight, 64% of the self-reports, 64% of the men and 73% of the women. Findings in the literature support this finding (Hovell et al., 1988, Perri et al., 1988, Kramer et al., 1989), although 64% is a slightly lower than average rate of recidivism. The sixty-nine percent value for weight regain in this group is similar to that in a study by Forster et al. (1988) who reported a value of 75% weight regain one year following a worksite weight control program. Stunkard and colleagues in 1989 reported that 73% of their subjects in a worksite weight control program had regained weight losses after one year. Therefore, this study was not unique when the total percentage of subjects regaining weight was examined.

This study was unique, however, in that weight regain did not increase with increasing time. Weight regain was as high after only six months since post-treatment as it was after nearly four years (42 months). This finding is contradictory to other reports in the literature (Stunkard et al., 1989; Perri et al., 1984). Stunkard reported a maintenance rate in subjects of 54% at six months, 51% at eight months and only 27% after one year. The failure to find increasing weight regain with increasing length of follow-up might be due to the small sample size, to obtaining only half of the actual participants at each time period and to specific characteristics of certain groups. For example, the time period of six months follow-up contained the subjects with high rates of weight cycling, for whom weight loss and weight regain is the usual pattern. Unfortunately, due to the sample size and only 50% response rate for objectively measured subjects, it was not possible to find differences between sites and times that might have better explained the pattern of weight regain in these subjects.

In examining the data for the total sample, men, women and gainers, it was found that for each of these groups the mean follow-up relative weight was actually higher than the initial weight (pre-treatment). The only group for which this was not the case was the group who self-reported their follow-up weights. Although it might appear that the group

of self-reports had done better as a whole at weight maintenance, this was probably not the case. Studies have shown that persons who self-report their weight tend to under-report by about five pounds (Forster et al., 1988, Wing et al., 1979). Rowland (1990) reported that errors in self-reporting weight were directly related to a person's overweight status, with bias and unreliability directly increasing with the magnitude of overweight. Therefore, the self-reported weights in this study are likely not an accurate representation of the actual weights of these subjects. Most likely the self-reported group did not have better success than did the objectively measured subjects.

II. Hypothesis 2.

Ho The prediction of weight change at follow-up from a) demographic and weight history variables can be improved by the addition of b) selected lifestyle variables.

Demographic variables

Surprisingly, none of the demographic variables (age, gender or education) were significantly correlated with relative weight change. This is contradictory to several studies in the literature (Foreyt et al., 1982; Stuart, 1980; Kahn et al., 1991; and Kahn and Williamson, 1990). However, the present study was unique in the proportion of men and women involved. Almost half (45%) of the total participants in these weight control programs were men, which differs from most weight control intervention programs

which involve a greater percentage of women (Foreyt et al., 1982). In addition to the high percentage of men participating in the MSU programs, a similar high percentage of men participated in the follow-up study (n=14, 48%). The high percentage of male participants and subjects might be partly explained by the fact that it was a university program composed of faculty and staff of Michigan State; with the faculty being primarily males. There was not a significant difference in the number of males and females in each weight category at follow-up, maintainers or gainers. This finding is somewhat contradictory to the literature which reports that men tend to fare better at weight maintenance (Foreyt et al., 1982, Stuart, 1980).

Years of education was significantly different between maintainers and gainers, with maintainers averaging 16 years of school (a college graduate) and gainers averaging 14 years (not a college graduate). This finding is consistent with reports that less educated people tend to have greater weight gain than those with more education when weight changes are examined over a period of years, not necessarily following a weight control program. Kahn and colleagues (1991) reported that women with only a 12th grade education had significantly greater weight gain over a 10 year interval than women who had gone beyond the 12th grade. Kahn and Williamson (1990) reported that for men, the mean

10-year increase in Body Mass Index was greater for men with 12 years or less of education than it was for men who studied beyond the 12th grade.

Weight history and social support variables.

These variables have been termed "non-modifiable" and were not the main focus of this research, because, as with the demographic variables, they are not alterable with treatment. Consistent with most literature in the field, several of the weight history variables in this study were significantly related to relative weight change and differed between maintainers and gainers. Gainers were younger when they became overweight, had more weight loss attempts in the last five year period and weight cycled more frequently in the last five years than did maintainers. Similar findings were reported by Colditz and colleagues (1990) who found that prior weight changes were stronger predictors of recent weight gain than other factors measured, such as intake patterns of specific nutrients. Holberg and colleagues (1984) reported that maintainers in their study had a history of few dieting attempts and were adults at the time they became overweight.

Perhaps the most important finding from weight history variables was the association between the number of weight cycles in the last five years and relative weight change. Weight cycling was the best predictor of relative weight change and was the most highly correlated with relative

weight change of any of the variables measured, including both demographic and lifestyle variables. Weight cycling was the most significant variable in the weight maintenance equation. Unfortunately it is a non-modifiable variable, at least for the subjects in the present study. Weight cycling has been reported to have adverse psychological effects (Garner et al., 1985; Stunkard and Wadden, 1990), such as self-reproach and humiliation for repeated bouts of weight loss and the inability to keep off the weight. Weight cycling has also been demonstrated to have adverse physiological effects both on health in general and on the ability to maintain future weight losses. Blackburn and colleagues (1989) reported that repeated dieting may lead to a metabolic slowdown making the body more efficient at fat metabolism and storage over time. Although increased metabolic efficiency has been disputed by other researchers (Gray et al., 1988; de Groot et al., 1990), in the study by Blackburn et al. a decrease in weight loss velocity occurred after repeated efforts to diet over a nine year period.

With respect to general health risks, Lissner and colleagues (1991) reported that fluctuations in body weight may have negative health consequences, over and above the negative health consequences associated with obesity alone. Using 32-year follow-up data from the Framingham Heart Study the degree of variability of body weight was compared to total mortality, mortality from coronary heart disease, and

morbidity due to coronary heart disease and cancer. It was found that subjects with highly variable body weights had increased total mortality, mortality from coronary heart disease and morbidity due to coronary heart disease. This was true for both men and women and after controlling for obesity and five other indicators of cardiovascular risk. The relative risks were higher in subjects whose weight varied substantially, as compared to those whose weight was relatively stable, with odds ratios ranging from 1.27 to 1.93. It was suggested that it might be healthier to be a stable overweight person than to be a person whose weight varies substantially over time.

Food and Nutrient Variables

Only one of the food and nutrient intake variables, total grams of fat, was significantly related to the outcome variable, relative weight change, but there were trends in other measures of nutrient intake which were worth noting.

The mean percentage of daily calories coming from fat in this study was about 33%. This value is less than the reported national average for fat consumption, which ranges from 37% to 40% of total calories (Read et al., 1990, Block et al., 1988, Stephen and Wald, 1990). The lower than average value for fat intake might be explained by the fact that the subjects in this study were being followed-up after a program in which determining fat content of foods and cutting back on fat intake was emphasized. Therefore, these

people were "fat-conscious", and probably more aware of the fat intake in their diets than the general public. In spite of this, the 33% of calories coming from fat is still higher than the recommendations for usual intake; such as the recommendation by the American Heart Association that individuals consume less than 30% of energy intake as fat. So the majority of these individuals, while reporting less fat than the national averages, still had higher intakes than recommended.

Although the percentage of calories coming from fat was hypothesized to be a factor in weight maintenance, it is not too surprising that the total grams of fat, and not the percentage of calories coming from fat, was the significant predictor. This is likely because the percentage of fat is contingent upon total calories; the more total calories consumed, the lower the percentage will be coming from fat, unless fat intake increases at the same rate. Total grams of fat do not reflect the impact of total calories. In other words, those individuals with higher total grams of fat may also have had higher total calorie intake from other sources. Therefore the fat intake would not have been reflected in the percentage of calories coming from fat. This was evident in the present study because the total caloric intake was significantly related to total grams of fat; with higher caloric intake there was a higher fat intake. The opposite was true for the percentage of calories

coming from fat; as total caloric intake increased, percentage of calories coming from fat decreased significantly.

Although there is little literature pertaining to fat intake and maintenance of weight loss, the association between total fat intake and relative weight change can be compared to reports in the literature on weight loss programs. In these shortterm studies persons consuming low-fat diets lost more weight than those consuming more fat (Kendall et al.,1991). In the Kendall study, subjects consuming a low-fat diet lost twice the amount of weight in 11 weeks as subjects consuming a control diet. Therefore, low fat intake has been associated with weight loss, and the present study provides evidence that fat intake may also be associated with maintenance of weight loss.

None of the nutrient intake variables other than fat were significantly related to relative weight change. However, the mean values and correlation coefficients for several of the nutrient variables were in the predicted directions. For example, although percentage of calories coming from fat was not a significant association, it was observed that as the percentage of calories increased weight regain also increased. In addition, as dietary fiber and fruit and vegetable intakes increased there was a negative correlation with relative weight change; less weight was regained. Possibly with a larger sample some of the observed

trends would have reached significance statistically. Total grams of fat consumed and dietary nutrient density measured by the INQ and MAR scores were significantly inversely correlated. These findings are consistent with those showing an improvement in vitamin and mineral status when the fat content of the diet is reduced (Dougherty et al., 1988; Gorbach et al., 1990; Schectman et al., 1990). Therefore, while the findings of this study were consistent with literature that decreasing the fat content of the diet is related to improved nutrient density and nutrient adequacy scores, this study did not demonstrate clearly that subjects who had diets higher in nutrient density or quality had better success at maintaining weight losses, than those who did not.

It should also be noted that increasing fruit and vegetable intake, while not significantly related to relative weight change, was significantly related to reduced percentage of calories coming from fat, total grams of fat, and improved nutrient density and nutrient adequacy. These associations are important, because it appears that increasing fruit and vegetable intake has a beneficial effect on other dietary components. The association between fruit and vegetable intake and percentage of calories from fat is especially important, because increasing consumption of fruit and vegetables can be encouraged as a positive

modifiable step in lowering the fat content of a diet and subsequently aiding in weight control.

This finding of reduced fat intake with increased fruit and vegetable intake conflicts with research by Patterson and colleagues (1990), however, who examined fruit and vegetable intake in the U.S. diet. They reported that as servings of fruits and vegetables increased, total caloric intake and fat intake increased as well, although the percentage of calories coming from fat remained constant. This finding likely was explained by the addition of fats and oils to the most frequently consumed vegetables, potatoes and salads.

The association between fruit and vegetable intake and INQ-1000$_c$ and MAR$_c$ is not surprising considering the six nutrients (vitamin A, vitamin C, vitamin B-6, calcium, iron and fiber) used for these dietary scores. Fruits and vegetables are sources of most of these nutrients. Consumption of fruits and vegetables could be expected to positively impact the dietary scores, even though the scores were truncated at 100 to remove the impact of any specific nutrient which may be consumed in high quantities.

Beverage variables

Beverages, especially alcohol, have been reported in the literature to impact a person's diet by either increasing the total energy intake or by decreasing the nutrient density of the diet. It appeared that the later was

the case in the present study. None of the beverage variables examined (alcohol, diet beverages, regular sweetened beverages and coffee) were significantly related to the outcome variable, relative weight change. Although there is little literature on beverage intake and weight maintenance, Teufel and Dufour (1990) reported that significantly higher energy intakes in obese subjects could be attributed to their greater consumption of alcoholic and non-alcoholic beverages.

As consistent with other literature, however, it was found in the present study that as alcohol intake increased, the trend was for the nutrient density of the diet to decrease slightly although not significantly. Windham and colleagues (1983) reported similar findings, and found that people consuming alcohol had significantly lower nutrient densities than those persons not consuming alcohol. In the present study, alcohol appeared to displace rather than supplement energy intake. Although less weight was gained with increasing alcohol consumption, the quality of the diet as measured by the INQ-1000$_s$ declined as well. Based on scatterplots for alcohol consumption, it was evident that there were a few subjects who were heavier drinkers, for whom the alcohol displacement theory may apply. The majority of the subjects, however, were light drinkers and alcohol probably was not a major factor in their weight maintenance or regain.

Coffee intake was fairly consistent throughout maintainers, gainers, men and women, with a mean for the combined group of about 31 cups of coffee per month, or one cup per day. Coffee consumption did not appear to be related to weight maintenance in these subjects, nor has it been reported in the literature to have an effect.

Diet beverage intake had no association with relative weight change, after removal of an outlier who consumed 360 diet beverages per month and who also had the highest number of weight loss attempts as well as the greatest overall relative weight change. Although exclusion of this subject negated the relationship of diet beverages to weight change in this study, there is recent literature to support that increased diet beverage consumption is found in subjects who relapse from weight losses. Kayman and colleagues (1990) reported that relapsers in their study drank significantly more diet beverages than did control subjects and that this finding merited further study. Therefore, while there was a single subject in the present study who backed the finding of Kayman, and this subject was excluded, the potential importance of the relationship should not be dismissed. It might be explained in part by perception of diet beverages as a "weight control aid". Those people consistently trying to lose weight may be consuming more diet beverages as an adjunct to this effort. However, those people who are consistently attempting to lose weight, as discussed in the

weight cycling section, may in fact be the people with the least success at keeping off weight.

Eating pattern variables

The failure to find a relationship between breakfast consumption or percentage of calories consumed at breakfast and weight status in this study contradicts work of others. Fricker and colleagues (1990) and Bellisle (1988) found heavier individuals ate less at breakfast than their non-obese counter-parts. The results of the present study indicate, however, that neither the reported times per week breakfast was consumed or the percentage of calories consumed at breakfast was predictive of relative weight change.

There were interesting and contradictory findings in distribution of calories consumed after breakfast. A large percentage of calories was consumed at dinner and in the evening (about half) by both maintainers and gainers. A highly significant negative correlation between the percentage of calories consumed at dinner and the percentage of total snack calories and evening snack calories was observed, indicating that subjects in the present study, if eating a large dinner, were not snacking in the evening and if eating a smaller dinner, snacked in the evening. This contradicts a study by Schlundt and colleagues (1990) who reported that dinner was followed by a snack 87% of the time

in their subjects; in the present study dinner was followed by a snack less than half of the time.

Gainers tended to consume a smaller percentage of snacks as evening snacks than did maintainers. Although no studies have specifically addressed weight maintenance and caloric distribution from snacks, Brandon in his study (1987) did report that obese individuals consumed the majority of snacks in late evening, and the non-obese, largely in the mid-afternoon.

In the present study, maintainers and gainers consumed equivalent amounts of food late in the day, with gainers consuming the majority of calories as meals while maintainers consumed the majority as snack calories. No literature was found to support this finding in relation to weight maintenance. However, Dreon and colleagues (1988) did compare overweight and normal weight individuals and found no relation between body fatness and caloric distribution throughout the day or number of meals and snacks consumed. These authors suggested that homogenous dietary patterns of their population might have negated significant correlations. In the present study, homogeneity of dietary patterns might be an explanation as well, because every individual was faculty or staff of Michigan State University, working during the day. For this group, the daily pattern of intake was similar, probably due to work schedules and food availability.

Behavioral and Activity variables

The self-monitoring behavior of counting calories or recording foods eaten appeared to be a beneficial activity. Although not a significant relationship, the more a subject counted calories or recorded foods eaten, the less weight they tended to regain. In addition, maintainers reported counting calories or recording foods eaten about 11 times per month compared to gainers who reported a five time per month frequency of calorie counting or food recording although this also was not a significant difference.

This trend is supported by literature in which the use of self-monitoring techniques, such as food recording, was reported to help people maintain weight losses (Schlundt et al., 1988; Gormally and Rardin, 1981). It was particularly interesting in the present study that the subjects who reported counting calories often indicated that it was specifically "fat" calories that they counted. This was likely because the caloric density of fat, as compared to that of carbohydrate and of protein, had been emphasized by program leaders in the Michigan State weight control program.

Minutes spent in physical activity proved to be significantly associated with relative weight change. The more minutes per week of activity, the less weight was regained. This is consistent with nearly all the weight loss and weight maintenance literature. Hill (1989), Pavlou

(1989) and Van Dale (1989) each reported that aerobic exercise aided in weight loss and maintenance of weight loss. For the present study the specific variable measured was the mean number of minutes spent in physical activity per week. Therefore, this was more a measure of duration of physical activity, or the amount of active time, than it was a measure of the type of activity in which subjects participated. Activities such as gardening, dancing, walking and running all counted towards the total weekly minutes of physical activity. From this present study it is concluded that regardless of exercise intensity, physical activity itself of sufficient duration is beneficial in weight maintenance. This is consistent with findings of Hoiberg and colleagues (1984) who reported that physical activity participation of any type was a significant correlate of weight loss maintenance in their subjects.

In addition to the minutes spent in physical activity variable, there was a trend for increased weight regain with hours of inactivity. Although time spent watching television was not included as a separate variable in the present study, the variable of "hours spent in inactivity" included time spent sitting and time spent watching T.V. Dietz and Gortmaker (1985) and Gortmaker et al., (1990) reported that television viewing, a sitting activity, was associated with both the onset of obesity and a decrease in the remission of obesity. It was suggested that the effect was in decreased

activity levels overall, which is consistent with trends found in the present study.

Body shape classification

An interesting finding of this study was that five out of six subjects with abdominal pattern of fat distribution were gainers. It is not clear whether this suggests that subjects who have an abdominal pattern of fat distribution have more difficulty with weight maintenance than those who do not.

The literature on fat distribution and weight loss is contradictory. Some researchers report that fat distribution can predict weight loss success (Wadden et al., 1988) and other researchers report that fat distribution is not a useful indicator of the ability to lose weight (Van Sant et al., 1988; Lanska et al., 1985). Researchers do agree that abdominal obesity is a health risk for cardiovascular disease, stroke and diabetes (Blair et al., 1984; Haffner et al., 1987; Larsson et al., 1984; Welin et al., 1987).

Rodin and colleagues (1990) examined whether or not repeated cycles of weight gain and loss influenced fat distribution toward a more abdominal pattern in premenopausal women. They reported that waist/hip ratio was significantly associated with a higher degree of weight cycling, controlling for age and parity. Body Mass Index and waist/hip ratio were significantly associated only in those subjects who were weight cyclers. Because of the possibility

of this association, it would have been helpful, for the present study, to know if the "at risk" subjects in the gainers group were at risk before they lost weight in the process of completing the weight control program. If they were not, and in fact acquired this abdominal pattern of fat distribution in the process of regaining the weight they had lost, then perhaps, as with weight cyclers, these subjects would have been better off prior to the weight loss. By losing weight and then regaining it abdominally, they may have increased their health risks.

Program variables

Although adherence to program goals was not related to success at weight loss maintenance in this study, Perri and colleagues (1987) did report such an association in an intervention program. It should be noted that the focus of the MSU Healthy U worksite weight control program has changed from one of weight loss to one of behavior modification. As of June, 1990, participants no longer contracted for specific amounts of weight they planned to lose, but began contracting for behaviors that they planned to change.

Although not significant, Program Leader #1 had more maintainers than did the other two program leaders. This can be partially explained by the fact that Program Leader #1 had more total classes and more total program participants than did the other two. Group dynamics, the composition of

each of the classes and leader characteristics probably impacted outcome too. Foreyt and colleagues (1981) reported that weight lost during treatment might by explained by changes in specific eating behaviors caused by therapist contact rather than by the effect of self-applied behavioral techniques on eating. Certain people respond better and may be more motivated by a certain leader style which can impact attendance, adherence and weight loss during the program (Kazdin, 1987).

Whether the effect of leader can be extended to weight maintenance is difficult to assess, especially in the present study where contact with the leaders was discontinued after the program ended. Most of the subjects who participated in the follow-up study expressed a desire for continued leader contact, regardless of which leader had led their program, indicating a feeling by the subjects that the support of the leaders was beneficial to them.

Food record completion

The number of times participants were contacted before they completed the three-day dietary records, a variable added during this study, proved to be significantly related to relative weight change. The more times a subject was called on the telephone to remind about completing his or her food record, the greater the amount of weight they had regained. This finding is interesting and merits further

study, because there is no literature to date addressing this concept.

Apparently the act of recording food eaten was very difficult for some subjects, with the difficulty increasing if the subject had regained weight. It was so difficult for some subjects to self record intake, that the primary investigator actually met with three subjects individually on three different days to obtain 24-hour recalls of food intake. This could be due to embarrassment at the prospect of having someone else read what they have eaten, or it could be that there is some sort of psychological barrier with actually recording the food eaten. This association is very interesting and it might mean that, if persons are encouraged to regularly record food intake during maintenance efforts, they may become more focused on their problems and it may benefit their efforts.

Limitations and Strengths.

There are some important limitations of this study that should be considered when evaluating data and results. First, the results obtained from this sample of Michigan State University weight control program participants, consisting of primarily faculty and staff, are generalizable only to groups with similar characteristics. The most obvious limitation, however, was the small size of the sample, 29 subjects. This was less than half the number of subjects that had been anticipated and made it difficult to

interpret results with the numerous predictive factors in the study.

In interpreting data with a small sample size, the possibility exists of not identifying associations that might be significant with a larger sample. For a given value of the parameter being tested, the power of the test of the hypotheses increases as the sample size increases (Glass and Hopkins, 1984). This relates to the concept of statistical significance versus practical significance. With a very large sample size, even a trivial difference may be large enough to be highly statistically significant. However, this does not mean that the findings are of practical significance.

Conversely, with a very small sample size, although findings may not always reach statistical significance, this does not automatically mean that the findings are not worthwhile or useful. Therefore in this study all p-values of $<.10$ were reported and trends observed were examined, in addition to simply reporting variables that were of statistical significance.

The use of three-day dietary records for obtaining food intake data was both a limitation and a strength. It was a limitation because many people were unwilling, for various reasons, to record their food intake for three days. This certainly was a factor in the reduced response rate. However, for those subjects for whom three-day records were

obtained, this information improved the food intake data available. Obtaining three-day records made it possible to obtain eating pattern information, such as caloric distribution throughout the day, in addition to nutrient intake information. The investigator is not aware of other weight maintenance studies on which food records were collected at follow-up measurement.

Another strength of this study was the attainment of actual height, weight and waist/hip ratio measures, both for subjects who came to the Nutrition Assessment Laboratory and for those who were measured at the worksite. All measurements and interviewing were done by the primary investigator, eliminating the possibility of inter-observer error and discrepancies in measurement technique. Conducting a pilot study provided time for evaluation of the procedures involved in measurement and questionnaire administration, and of the questionnaire itself.

Finally, a strength of this study was the benefit that subjects obtained from their participation, both those in the pilot and final studies. In addition to the dietary feedback subjects received, the act of following-up was a benefit to weight maintenance efforts. Subjects reflected on what they were doing and how they were doing with their weight control efforts. Many participants in the follow-up study indicated that they enjoyed participating, and perceived it as either a step towards "getting back on

track" or a check for themselves to verify that they were in fact "on the right track".

Directions for Future Research

Due to the current information regarding health risks of weight cycling (Goodrick and Foreyt, 1991; Wooley and Garner, 1991) more research is needed in this area, especially evaluating gender differences. It would also be interesting to examine obese, non-weight cyclers, if they exist, and whether these individuals are more likely to maintain weight losses than obese weight cyclers.

It is necessary in future research to examine waist/hip ratio information with pre, post and follow-up waist/hip ratio values, as this would be more informative than a single follow-up measurement. The relation of body fat distribution to weight loss and weight maintenance is still unclear.

Studies of the relation of modifiable lifestyle factors to weight maintenance with many more subjects is needed in the area of dietary intake, especially regarding diet beverage consumption. More work could be done with regard to meal and snack distribution and weight maintenance, perhaps using a sample consisting of a large and diverse population which would have many different eating patterns.

It would also be beneficial to examine work environments and success at weight maintenance, an area which was not addressed in the present study. Are the more

successful maintainers coming from more supportive environments, both with regards to coworkers but also considering the environment itself, such as space and available resources and time for exercise and availability of low fat snacks?

Finally, additional information on the effect of leadership and leadership quality would be useful in distinguishing between different levels of success at weight maintenance in programs that are similar in content but vary by program leader. Very little exists in the literature on impact of leader quality on weight loss and maintenance.

SUMMARY AND IMPLICATIONS

Factors contributing to weight maintenance success or failure over one to three year periods were examined for individuals who followed a six-month behaviorally oriented weight intervention program offered by Michigan State University's Healthy U Worksite Wellness Program. This study provided evidence that there are lifestyle factors which can improve an individual chances for successful weight maintenance and that there are some specific differences between individuals who maintain weight losses and those who regain. Individuals who were classified as maintainers were older when they became overweight, had fewer weight loss attempts and weight cycles, were more physically active and consumed less total fat than subjects who were classified as gainers.

The focus of this research was to identify modifiable variables, or those that might be altered by treatment, which play a role in weight maintenance. Due to the primary role that weight cycling plays in weight maintenance and the recent reports on the negative consequences of weight cycling (Goodrick and Foreyt, 1991; Wooley and Garner, 1991), weight cycling and the potential to enhance weight cycling cannot be dismissed by health professionals in weight control programs. Weight cycling, per se, is <u>not</u> a modifiable variable. The importance of weight cycling and

its association with failure at weight maintenance should lead to attempts to modify weight control intervention to decrease the number of weight cycles individuals have.

For some people it may actually be appropriate to counsel them not to diet or not to enter a weight loss program. For these individuals the health risks associated with weight cycling should be emphasized as well as the idea that they may be healthier just maintaining a heavier weight, if it is a weight at which they can remain stable. It might be difficult to convince people that there are actually benefits to remaining heavier, but it seems important based on the available information. For those individuals for caloric restriction may not be the answer, reduced fat intake and physical activity should still be encouraged, as long as their health permits.

For those individuals who have participated in many weight control programs, the lifestyle variables take on the most importance, because they are ones that people might be able to change. Weight loss interventions should promote regular physical activity and a low fat diet. This study provides supportive evidence that reducing fat intake is a step that should be encouraged in weight maintenance efforts. Recommendations to increase fruit and vegetable intake should be made with the caution not to increase fat intake as an adjunct to potato and salad consumption.

Because weight cycling has such a negative impact on

weight maintenance, regular exercise and low-fat diet should be targeted to individuals who do not yet have a weight history, specifically children and youth. If regular physical activity and low-fat eating can be learned early, children should come to adulthood with healthy behaviors already a part of their lifestyles. The idea that maintenance success seems to depend on a lifetime of physical activity and a low-fat diet should be stressed, rather than stressing that diet and exercise are important for weight loss. Every weight control program should be perceived by participants as the start of a healthier lifestyle, rather than a 16-week weight loss regimen. When programs are viewed for specific lengths of time only, this implies that after that specific time period the program is over. Our results show that this cannot be the mind-set, if success at weight loss maintenance is to be achieved.

GLOSSARY

GLOSSARY

INITIAL WEIGHT: Weight at the time of entry into the weight intervention program.

POST-TREATMENT WEIGHT: Weight measured at the end of the six month weight intervention program.

REFERENCE WEIGHT: The midpoint of the range of weights for height and gender using the 1983 data from the Metropolitan Life Insurance Company

RELATIVE WEIGHT: Relative weights were calculated for each subject at pre, post and follow-up as: Actual weight/Reference weight x 100.

WEIGHT LOSS MAINTENANCE: Follow-up relative weight that is within ± 5% of post-treatment relative weight.

"LOSER": Subjects whose follow-up relative weights were >5% below post-program relative weights.

"MAINTAINER": Subjects whose follow-up relative weights were within ±5% of post-program relative weight.

"GAINER": Subjects whose follow-up relative weights were >5% above post-program relative weights.

WEIGHT HISTORY: Includes age of onset of overweight, number of weight changes over time, number of weight loss attempts, and number of weight programs in which subject participated.

WEIGHT LOSS ATTEMPT: Self reported attempt to reduce body weight by caloric restriction, increased activity, program enrollment or other means.

WEIGHT CYCLE: A self-reported gain or loss of more than five pounds (± 5 lb).

WEIGHT PROGRAM: Any supervised program focusing on weight loss for which a fee was required for participation, either individual or in a group setting.

BREAKFAST: A meal before noon that contained at least one food or beverage that had nutritive value. Coffee or tea alone was not considered breakfast.

CALORIC DISTRIBUTION: The percentage of calories consumed in a 24 hour period at meals and as snacks, and combinations of meals and snacks.

DIET QUALITY: Diet quality for this study was assessed using two indices, the nutritional density of the diet and the nutritional adequacy of the diet.

NUTRITIONAL DENSITY: Refers to the consumption of selected nutrients, per 1000 kilocalories of a subjects' daily dietary intake. Nutritional density for this study was assessed using the Index of Nutritional Quality (INQ) summated for six nutrients.

INDEX OF NUTRITIONAL QUALITY (INQ): A nutrient density ratio which can be used to compare actual nutrient density per 1000 kcal of daily dietary intake to the recommended nutrient density per 1000 kcal of dietary intake based on age and sex specific Recommended Dietary Allowances and Recommended Energy Intake.

NUTRITIONAL ADEQUACY: Refers to the intake of a nutrient as compared to the RDA for that nutrient. Nutritional adequacy for this study was assessed using the Mean Adequacy Ratio (MAR) summated for six nutrients.

MEAN ADEQUACY RATIO (MAR): The average of selected Nutrient Adequacy Ratios, calculated by dividing the actual intake of a nutrient by that nutrients' RDA and multiplying by 100.

ACTIVITY: Includes a) an intentional exercise session, such as aerobic dance or jogging; b) leisure-time activities, such as gardening or bowling, and c) activities of daily life, such as housework, shopping, sleeping and fidgeting.

"AT RISK": A waist/hip ratio >0.8 for women and >1.0 for men.

"NOT AT RISK": Waist/hip ratio values falling below the cut-offs for "at risk".

APPENDICES

APPENDIX A

APPENDIX A

Example outline for weight control program

Session Number	Topic
1	Physiology of weight loss
2	Identifying behavioral problems
3	Nutrition Education
4	Food Exchanges
5	Contracting for behavioral change
6	Social Support
7	Exercise
8	Self-esteem and self-image
9	Behavior chains
10	Eating styles
11	Coping with problem situations
12	Sabotage
13	Preventing relapse
14	Eating out
15	Final Session

APPENDIX B

WORKSITE WELLNESS
B416 West Fee Hall (517) 353-3734
Michigan State University
East Lansing, MI

May 5, 1991

Dear Program Participant:

We would like you to participate in a study conducted by Gail Haus R.D., under the supervision of Sharon Hoerr R.D., Ph.D. from the Department of Food Science and Human Nutrition and Brian Mavis, Ph.D. of the Worksite Wellness Project. The purpose of this study is to assess factors which may contribute to successful weight loss maintenance, and to evaluate the long term results of participants in Healthy U Worksite Wellness weight control programs.

You have been identified as a subject because of your previous interest and participation in these programs. Any information gathered as part of this study is confidential. All results will be reported as aggregate data and no individuals will be identified.

The study involves a dietary analysis of a 3-day food record as well as the completion of a survey questionnaire and physical measurements such as height and weight. We would like to schedule an appointment with you at the Nutrition Assessment Laboratory on the MSU campus. At that time you will receive a free dietary consultation with a Registered Dietitian and feedback on your dietary information (a $30 value) in appreciation for your participation. If you are unable to visit the Nutrition Assessment Laboratory, all assessments can be made confidentially at your place of work.

This study is important to the future of Healthy U's Worksite Wellness program, and in the identification of possible factors that will assist other participants in achieving successful maintenance of their weight loss. Your participation is vital to the success of our study.

Attached you will find a list of meeting dates and times. The purpose of these meetings is to explain the study in detail and set up times for you to visit the nutrition assessment laboratory. Several meetings have been arranged in an effort to accommodate your schedule. Please attend the meeting at the time and/or location most convenient for you.

You will be contacted in the next week to check if you are able to attend one of these meetings, as well as to answer any questions you may have about the study.

Thank-you for your assistance!!

Sincerely,

Gail J. Haus, R.D.
Home phone: 351-1771
Work phone: 355-3360

Brian Mavis, Ph.D.
Project Coordinator
Worksite Wellness

APPENDIX C

APPENDIX C

MEETING TIMES AND LOCATIONS

This is a list of the meetings that have been set up for the week of May 6-May 10, 1991. The purpose of these meetings is to explain the study in detail, and to arrange an additional appointment with each of you.

Please attend any meeting that is convenient for you. You need only to attend one meeting and you are welcome to attend a meeting that is not in your building if the time is more convenient for you. The meetings should last about 45 minutes and you are welcome to bring your lunch.

I will be attempting to contact each of you this week to make sure you are able to attend one of these meetings. If you are unable to attend any of the scheduled times, I will be happy to meet with you individually to explain the study.

I look forward to meeting with each of you!

MONDAY MAY 6

12:00 pm	Room 103	Anthony Hall

TUESDAY MAY 7

4:00 pm	Room 271	Plant and Soil Science Building

WEDNESDAY MAY 8

12:00 pm	Room 322	Chemistry Building

THURSDAY MAY 9

5:00 pm	Room 322	Chemistry Building

FRIDAY MAY 10

12:00 pm	Room 271	Plant and Soil Science Building

APPENDIX D

MICHIGAN STATE UNIVERSITY

OFFICE OF VICE PRESIDENT FOR RESEARCH
AND DEAN OF THE GRADUATE SCHOOL

EAST LANSING • MICHIGAN • 48824-1046

March 14, 1991

Gail Haus
Food Science and Human Nutrition
165 S. Anthony Hall

RE: FACTORS AFFECTING SUCCESS AT WEIGHT LOSS MAINTENANCE, IRB#91-094

Dear Ms. Haus:

I am pleased to advise that because of the nature of the proposed research, it was eligible for expedited review. This process has been completed, the rights and welfare of the human subjects appear to be adequately protected, and your project is therefore approved.

You are reminded that UCRIHS approval is valid for one calendar year. If you plan to continue this project beyond one year, please make provisions for obtaining appropriate UCRIHS approval prior to March 6, 1992.

Any changes in procedures involving human subjects must be reviewed by the UCRIHS prior to initiation of the change. UCRIHS must also be notified promptly of any problems (unexpected side effects, complaints, etc.) involving human subjects during the course of the work.

Thank you for bringing this project to our attention. If we can be of any future help, please do not hesitate to let us know.

Sincerely,

David E. Wright, Ph.D., Chair
University Committee on Research
Involving Human Subjects (UCRIHS)

DEW/deo

cc: Dr. Sharon Hoerr

APPENDIX E

FSHN Food Science and Human Nutrition
Michigan State University East Lansing, Michigan 48824-1224

INFORMED CONSENT FORM

You are being asked to participate in a study being conducted by Gail Haus, RD and Sharon Hoerr, RD, PhD from the Department of Food Science and Human Nutrition at Michigan State University. The purpose of this study is to assess factors that contribute to successful weight loss maintenance and to evaluate the longterm results of participants in Healthy U Worksite Wellness weight control programs. You and your responses to questions in this study will not be identified in any way. All results of the study will be reported as aggregate data and all information collected is strictly confidential and protected to the extent provided under the law.

You will be completing a record of food intake for three days and will then be asked to visit the Nutrition Assessment Laboratory on the MSU campus to complete the remainder of the assessments. Your visit to the laboratory will take a maximum of one hour. The questionnaire you will complete at the laboratory will assess your weight history, physical activity and social support for weight control. Measurements will include heights, weights and waist/hip ratios which are simple body circumferences obtained using a tape measure. The Nutrition Assessment Laboratory is a private setting and all measurements will be done individually and confidentially. If you are unable to visit the laboratory, measurements can be taken at your place of work where a room will be reserved and a privacy screen used. In appreciation for your participation in this study you will receive a free dietary consultation with a Registered Dietitian (a $30 value). This consultation is intended to cover general dietary concepts, and specific medical problems will be referred elsewhere.

If you decide to participate, you may refuse to answer any questions and you are free to withdraw consent and discontinue participation at any time. You indicate your voluntary agreement to participate by signing this consent form. If you would like a copy of this consent form, one will be provided for you. If you have any questions regarding this study, you may call 351-1771. **THANK YOU!!**

DATE _____

Participant's signature _____

Investigator's signature _____

APPENDIX F

APPENDIX F

THREE DAY FOOD RECORD

DIRECTIONS FOR RECORDING YOUR FOOD INTAKE:

It is very important that food intake records be filled out as accurately and completely as possible. To ensure the accuracy of your dietary analysis, it is essential that you list all of the foods and beverages consumed for any meal or snack. Along with each type of food, record the amount of food, how it was prepared, and a complete description. For example: one, large fried egg; one slice of whole wheat bread; one tsp. corn oil margarine; one cup Cheerios.

Record the food eaten on two (2) nonconsecutive weekdays and one (1) weekend day. Please record typical days of food intake. If you are sick one day, or have a day of unusually high intake, use the next day's intake, unless it is a common occurrence for example, a big Sunday night dinner.

It is very important to record where and when the food was eaten. For example; at home, at a restaurant, in the car. Carry your daily record with you and fill out the record after you have eaten. Memory is not perfect; if you forget your record, jot down the information on a slip of paper or even on a paper napkin and transfer the information to your record as soon as possible.

***If you have questions, please give us a call at (517) 355-7701 (from 8am to 5pm) or 351-1771 (after office hours).

DO NOT FORGET TO RECORD:

soft drinks	gravies	nuts
butter	sauces	jams
margarine	ketchup	jellies
chips	dressings	preserves
popcorn	cream	candy/gum
sugar	relish	alcoholic drinks

BE SURE TO THOROUGHLY DESCRIBE EACH FOOD

HOW TO RECORD PORTION SIZES:

Record in ounces or cups:
beverages

Record in cups or tablespoons:
potatoes, rice, noodles
fruits and vegetables (cooked, canned, sweetened, unsweetened)
cereals (dry or cooked)
soups
casserole dishes

Record in teaspoons or tablespoons:
jelly, jam
sugar, syrup
sauces, gravies
salad dressings
butter, margarine, mayonnaise

Record by number, size, and description:
bread, rolls, crackers, coffee cake
raw fruits and vegetables
meat such as beef, chicken, pork, frankfurters, shellfish
snack items, nuts, candy
pie, cake
pizza

NOTE: You can measure the size of the glasses and bowls you use at home with a standard measuring cup and use the same amount each time you record your food intake.

Standard Abbreviations:

Tablespoon--Tbsp.
Teaspoon--tsp.
Ounce--oz.
Cup--c.
Slice--sl.

Equivalent Measures:

3 teaspoons = 1 Tablespoon
16 Tablespoons = 1 cup
1 ounce = 2 Tablespoons
8 ounces = 1 cup
16 ounces = 1 pound

DESCRIPTION OF MIXED DISHES:

For mixed dishes, such as stew, casseroles, etc., record the total amount eaten. Please write any recipes for mixed dishes in the back of this booklet. Indicate how much or how many servings the total recipe makes.

For sandwiches, all ingredients should be recorded separately. Example:

Ham Sandwich--
2 slices whole wheat bread
2 ounces ham, trimmed
1 leaf lettuce
1 tsp. mayonnaise

Meatloaf--(makes 6 servings)
1.5 pounds ground beef
3/4 c. quick cooking oats
1 egg
1 c. milk
1/4 c. chopped onion
1 Tbsp Worcestershire sauce
1 tsp salt
1/2 tsp dry mustard
1/4 tsp pepper

SAMPLE PAGE

Remember to list each item on a separate line along with it portion size.

Day: Tuesday
Date: November 28, 1989

Time	What you ate and How much	Where you ate
8:00 a.m.	1/2 c. orange juice	
	1 c. oatmeal	at home
	1/2 c. whole milk	
	2 tsp. sugar	
	1 sweet roll	
	1 tsp butter	
	1 tsp. jelly	
	1 cup hot chocolate, mix	
10:00 a.m.	2 sweetened canned pear halves	
	2 Tbsp. liquid	at office
	4 vanilla wafers	
	1 c. whole milk	
12:30 p.m.	2 sl. white bread	
	1 sl. bologna	
	1 tsp butter	at office
	1 apple 3" diameter	
	2 gingersnaps (homemade)	
	1 c. whole milk	
5:30 p.m.	2 fried pork chops (3"long, 1/2"thick)	
	1/2 c. mashed potatoes, homemade with butter and milk	
	2 Tbsp. gravy	
	1/2 c. corn, canned	at home
	1-2"square of chocolate cake with icing	
	1 c. whole milk	
	1 c. coffee	
	1 tsp. sugar	
9:00	20 stick pretzels	
	12 oz Coke	at movie theater

Name:_____ Phone:_____
Day:_____
Date:_____

Time	What you ate and How much	Where you ate

Name:_____ Phone:_____
Day:_____
Date:_____

Time	What you ate and How much	Where you ate

Name:_____ Phone:_____
Day:_____
Date:_____

Time	What you ate and How much	Where you ate

RECIPES/MIXED DISHES

APPENDIX G

APPENDIX G

FOOD FREQUENCY FOR BEVERAGES AND ALCOHOL

Directions: Please fill in your average use, during the past year, of each specified beverage.

Consider the serving size as one 12-ounce glass, bottle or can for these beverages. If consuming 16-ounce bottles, please indicate this in the margins, and adjustments will be made.

	Never or less than once	1-3 per mo.	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-5 per day	6+ per day
CARBONATED BEVERAGES									
Low calorie cola, with caffeine									
Low calorie, caffeine-free cola									
Regular cola, caffeinated									
Regular cola, caffeine-free									
Other carbonated beverages (7-Up,etc)									
OTHER BEVERAGES									
Hawaiian punch, lemonade, koolaid									
Decaffeinated coffee									
Regular coffee									
Tea									
ALCOHOL									
Beer (12 Oz)									
Red Wine (4 oz glass)									
White wine (4 oz glass)									
Liquor (e.g. whiskey, gin, etc. 1 oz)									

APPENDIX H

APPENDIX H

DEMOGRAPHIC INFORMATION

*From Gladys Block National Cancer Institute

TODAYS DATE _____ _____ _____
month day year

NAME _____ _____ _____
last first middle initial

ADDRESS _____
street

_____ _____ _____
city state zip

TELEPHONE (_____) - _____ - _____

1) When were you born? _____ _____ _____
month day year

2) How old are you? _____ years

3) Sex: _____ male _____ female

4) Race or ethnic background:

1 ____ White, not of hispanic origin
2 ____ Black, not of hispanic origin
3 ____ Hispanic
4 ____ American Indian/Alaskan native
5 ____ Asian
6 ____ Pacific Islander

5) Please circle the highest grade of school you have completed:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17+

6) How tall are you? ____ feet _____ inches

7) How much do you weigh? _____ pounds

8) Do you smoke cigarettes now? 1 ___ no 2 ___ yes

IF YES: On the average, about how many cigarettes a day do you smoke now? _____ cigarettes

APPENDIX I

APPENDIX I

PERSONAL WEIGHT HISTORY

1) How long have you been at your present weight? _____ months
_____ years

2) Are you trying to lose weight now? _____ yes (1)
_____ no (2)

3) As a child (before puberty) were you:

_____ thin (1)
_____ average (2)
_____ overweight (3)

4) As a teen (after puberty) were you:

_____ thin (1)
_____ average (2)
_____ overweight (3)

5) If you consider yourself overweight, at weight age did you first become overweight?

_____ years

6) Describe your previous attempts to lose weight:

How many times have you tried to lose weight? (either on your own with any methods or in a supervised program)? _____

How many weight control programs have you enrolled in? _____

How many weight control programs have you completed? _____

* By "weight control program" I mean any supervised session for which a fee was required for participation.

7) How many times (as an adult) do you think you have lost and then regained weight (at least 5-8 pounds) irrespective of pregnancies? _____

8) How many pregnancies into the second or third trimester have you had? _____

9) Since the end of the MSU weight control program, how often do you weigh yourself?

_____ never
_____ day
_____ week
_____ month or
_____ year

10) Since the end of the MSU weight control program, how often do you count calories (record foods eaten).

_____ never
_____ day
_____ week or
_____ month
_____ year

11) How many weight control programs have you completed since the MSU program?

_____

12) How many other types of health promotion intervention have you completed since the MSU program (i.e. smoking cessation, stress management)?

List all that apply: _____
_____
_____
_____

APPENDIX J

APPENDIX J

PART I

PHYSICAL ACTIVITY

Instructions:

This set of questions asks about your leisure time physical activity. Please respond to each question by placing a mark on the appropriate line.

1) Do you participate in one of the following activities?

a) **jog or run?** Yes _____ No _____

If Yes, how many times? _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

b) **ride a bike or exercise bike?** Yes _____ No _____

If Yes, how many times? _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

c) **swim?** Yes _____ No _____

If Yes, how many times? _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

d) **do aerobics or aerobic dancing?** Yes _____ No ____

If Yes, how many times? _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

e) **do other dancing?** Yes _____ No _____

<u>If Yes, how many times?</u> _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

f) **do calisthenics or exercises?** Yes _____ No _____

<u>If Yes, how many times?</u> _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

g) **lift weights?** Yes _____ No _____

<u>If Yes, how many times?</u> _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

2) In the past month, did you walk a mile or more at a time without stopping?

Yes _____ No _____

<u>If Yes, how many times?</u> _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

3) In the past month, have you done any other exercises, sports or physically active hobbies not mentioned yet?

Yes _____ No _____

If Yes, what was it? _____

How many times? _____ time (s) ___ per day
___ per week
___ per month

Each time (typically) for _____ minutes

Any other activities? _____

4) During the past month, were you more active, less active, or about the same compared to your physical activity for the past 12 months?

_____ more active
_____ less active
_____ about the same
_____ don't know

5) Compared to most people your age and sex would you say that you are more active, less active or about the same?

_____ more active
_____ less active
_____ about the same
_____ don't know

PART II

PHYSICAL ACTIVITY

Instructions:

This set of questions asks about the repetitiveness of your formal exercise and your lifestyle changes in physical activity. Please respond to each question by checking all responses that apply. When the term 'exercise' is used, this means physical activity of at least 30 minutes duration.

1) How would you describe your typical pattern of physical activity? Would you say you:

__Exercise both on weekdays and weekends

__Exercise only on weekdays (Monday through Friday)

__Exercise only on weekends (Saturday and/or Sunday)

__Exercise only during specific seasons of the year.

(Please check all that apply)

___ Summer ___ Winter

___ Fall ___ Spring

__Do not routinely exercise

__Other (please explain):

_____

_____

2) If you exercise, what time of day do you typically exercise?

Would you say you: (Please choose the one most usual time)

__Do not exercise

__Usually exercise first thing in the morning.

__Usually exercise after work, before a meal.

__Usually exercise in the evening, after a meal.

__Exercise on your noon hour.

__Do not have a 'usual pattern', exercise at different times depending on the day.

__Other (please explain):

_____

_____

3) Have you made any changes in routine physical activity during or since completing the MSU weight control program?

(Please check all that apply)

__Have not made any changes in physical activity

__Take the stairs instead of the elevator

__Park your car farther away so you have to walk farther

__Take walks on your lunch hour

__Walk or ride a bike to the store or work instead of driving

__Watch less television

__Other (please explain):

_____

5) On the average, how much time in a 24 hour period during a typical weekday do you spend in the following activities?

Please break down a 24 hour day so your responses add up to 24.

___ sleep

___ reading, relaxing, watching TV, sitting at a desk.

___ light activity (standing, shopping,walking slowly).

___ moderate/high activity (running, swimming, dancing, bicycling, doing aerobics, brisk walking, etc.)

6) On the average, how much time in a 24 hour period during a typical weekend day do you spend in the following activities?

Please break down a 24 hour day so your responses add up to 24.

___ sleep

___ reading, relaxing, watching TV, sitting at a desk

___ light activity (standing, shopping,walking slowly).

___ moderate/high activity (running, swimming, dancing, bicycling, doing aerobics, brisk walking, etc.)

6) Is there anything else you would like us to know about changes in your physical activities since participating in the intervention program? If so, please explain.

_____

_____

APPENDIX K

APPENDIX K

SOCIAL SUPPORT**

When people try to diet, the people around them can sometimes help and sometimes make things harder, even if they don't realize it.

Please circle the answers below which best indicate how helpful these people were in your weight maintainence efforts.

	Not at all helpful	A little helpful	Usually helpful	Completely helpful	Does not apply
Spouse/Significant Other	1	2	3	4	0
Children*	1	2	3	4	0
Other relatives	1	2	3	4	0
Friends	1	2	3	4	0
Coworkers	1	2	3	4	0

* If more than one child, please rate the most helpful one.

** Adapted from:

Funch DP, Marshall JR, Gebhardt GP. Assessment of a short scale to measure social support. Soc Sci Med 1986;23:337-344.

APPENDIX L

APPENDIX L

Frame Size Approximation
Metropolitan Life Insurance Co., 1983

Height in 1" heels	Elbow Breadth
Men	
5'2" - 5'3"	2 1/2" - 2 7/8"
5'4" - 5'7"	2 5/8" - 2 7/8"
5'8" - 5'11"	2 3/4" - 3"
6'0" - 6'3"	2 3/4" - 3 1/8"
6'4"	2 7/8" - 3 1/4"

Height in 1" heels	Elbow Breadth
Women	
4'10" - 4'11"	2 1/4" - 2 1/2"
5'0" - 5'3"	2 1/4" - 2 1/2"
5'4" - 5'7"	2 3/8" - 2 5/8"
5'8" - 5'11"	2 3/8" - 2 5/8"
6'0"	2 1/2" - 2 3/4"

2 3/8" = 60mm

Method: Extend arm and bend forearm upward at 90 degree angle. Keep fingers straight and turn the inside of wrist toward the body. Use the caliper to measure the space between the two prominent bones on either side of the elbow. Compare this measurement with the tables above. Measurements lower than those listed indicate a small frame, and higher measurements indicate a large frame.

APPENDIX M

APPENDIX M

1983 METROPOLITAN HEIGHT AND WEIGHT TABLES
Metropolitan Life Insurance Company
Health and Safety Education Division

MEN

Height Feet	Height Inches	Small Frame	Medium Frame	Large Frame
5	2	128-134	131-141	138-150
5	3	130-136	133-143	140-153
5	4	132-138	135-145	142-156
5	5	134-140	137-148	144-160
5	6	136-142	139-151	146-164
5	7	138-145	142-154	149-168
5	8	140-148	145-157	152-172
5	9	142-151	148-160	155-176
5	10	144-154	151-163	158-180
5	11	146-157	154-166	161-184
6	0	149-160	157-170	164-188
6	1	152-164	160-174	168-192
6	2	155-168	164-178	172-197
6	3	158-172	167-182	176-202
6	4	162-176	171-187	181-207

1983 METROPOLITAN HEIGHT AND WEIGHT TABLES
Metropolitan Life Insurance Company
Health and Safety Education Division

WOMEN

Height		Small	Medium	Large
Feet	Inches	Frame	Frame	Frame
4	10	102-111	109-121	118-131
4	11	103-113	111-123	120-134
5	0	104-115	113-126	122-137
5	1	106-118	115-129	125-140
5	2	108-121	118-132	128-143
5	3	111-124	121-135	131-147
5	4	114-127	124-138	134-151
5	5	117-130	127-141	137-155
5	6	120-133	130-144	140-159
5	7	123-136	133-147	143-163
5	8	126-139	136-150	146-167
5	9	129-142	139-153	149-170
5	10	132-145	142-156	152-173
5	11	135-148	145-159	155-176
6	0	138-151	148-162	158-179

APPENDIX N

APPENDIX N

CODEBOOK

VARIABLE NAME	ITEM DESCRIPTION	CODING SCHEME
RECRD	client record number	
LEADER	weight program leader	#1 Robison #2 Mavis #3 Carlson
L	employee level	#1 Staff #2 Faculty #3 Grad student #4 Other
AG	age of participant	
S	sex of participant	
TOTAL	total amount of money refunded at program end	
D	dropout status	#1 Non-dropout #2 Dropout
HT	height of participant	
STARTDAT	program starting date	
FOLLUP	follow-up time (months since program end)	
BLD	building where program was held	#1 PSS #2 CHE #3 ANT #4 DPS
POSTMSU	number of subsequent weight control programs	
OTHERHP	number of other subsequent health promotion programs	
SOCSUP	mean social support score	

RACE	race of subject	#1 white #2 black #3 hispanic #4 american indian #5 asian #6 pacific islander
SCHOOL	years of school completed	
SMOKE	smoking of cigarettes	#1 no #2 yes
NOCIGGS	number of cigarettes smoked per day	
SELFREP	was weight self-reported	#1 yes #2 no
GENDER	gender of subject	#1 male #2 female

Behavioral variables

ATT	participant attendance (percent of classes)
ADH	adherence to program goals (percent)
SCALE	number of times weigh oneself per month
COUNT	frequency of counting calories
RECORD	frequency of recording foods eaten
FRCOMP	number of times called for completed food record

Weight variables

WTLOSS	amount of weight loss during program
PREWT	pre-program participant weight

INREL	initial relative weight	
POSTREL	post-program relative weight	
FOLLREL	follow-up relative weight	
RELCHG	change in relative weight	
WTCAT	weight category	#1 loser #2 maintainer #3 gainer
FOLLWT	weight of subject at follow-up	
REFWT	reference weight of subject	
RATIO	waist/hip ratio	
SHAPE	whether or not subject is "at risk"	#1 not at risk #2 at risk
SIZE	subject frame size	#1 small #2 medium #3 large

Weight history variables

MAINT	weeks maintained current weight	
LOSENOW	is subject trying to lose weight now	#1 yes #2 no
CHILDWT	weight as a child (before puberty)	#1 thin #2 average #3 overweight
TEENWT	weight as a teen	#1 thin #2 average #3 overweight
AGEOVWT	age of onset of overweight	

LOSSATT	number of weight loss attempts		
WTPROGEN	number of weight programs enrolled in		
WTPROGCP	number of weight programs completed		
WTCYCLE	number of times weight lost and regained		
PREG	number of pregnancies		

Food and Beverage variables

ALCOHOL	subject alcohol consumption	#1 #2	yes no
ALCMO	number of alcoholic drinks per month		
REGBEV	number of regular or sweetened beverages per month		
DIETBEV	number of diet beverages per month		
COFFEE	cups of regular coffee per month		
FAT	percentage of calories consumed as fat		
FATGM	total grams of fat		
CARBOS	percentage of calories consumed as carbohydrate		
PROTEIN	percentage of calories consumed as protein		
INQ	Inq 1000-6		
MAR	Mean adequacy ratio		
EATOCC	number of eating occasions		
FRUIT	number of servings of fruits and vegetables		

FIBER	grams of fiber per day	
JUICE	ounces of juice per day	

Activity variables

PALEVEL	level of physical activity	#1 inactive #2 moderate #3 high
PHYSMIN	minutes spent in physical activity per week	
PHYSPAT wkend	pattern of physical activity	#1 wkday and #2 weekday only #3 weekend only #4 specific times #5 no routine #6 other
PHYSTIME	time of physical activity	#1 do not exercise #2 morning #3 before dinner #4 after dinner #5 at noon #6 no pattern #7 other
PHYSCHG	number of changes made in activity	
SLEEPHRS	hours spent sleeping per day	
RELAXHRS	hours spent relaxing per day	
LTHOURS	hours spent in light activity per day	
ACTHOURS	hours spent in moderate or high activity	

Eating pattern variables

BREAKPER	percentage of calories consumed at breakfast
LUNCHPER	percentage of calories consumed at lunch
DINPER	percentage of calories consumed at dinner
SNACKPER	percentage of calories consumed as snacks
AFTPER	percentage of calories as afternoon snacks
EVEPER	percentage of calories as evening snacks

APPENDIX O

APPENDIX O

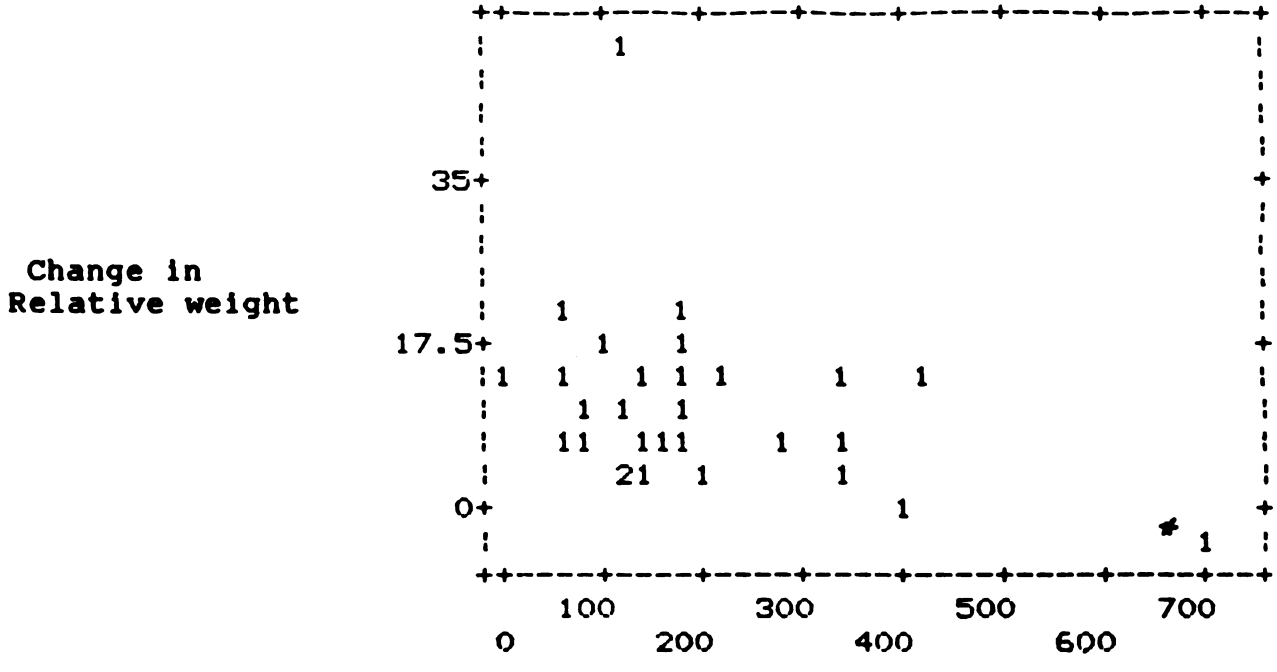
Table 7.1 Demographic information by site on all program participants (n=78).

Variable	Site				
	PSS	CHE	ANT	DPS	Total
			Gender		
Male	17	10	2	4	33
Female	18	12	5	10	45
			Occupation		
Faculty	9	2	1	0	12
Staff	18	17	6	13	54
Grad Student	7	2	0	0	9
Other	1	1	0	1	3

APPENDIX P

APPENDIX P

Scatterplot of relative weight change with minutes spent in physical activity.

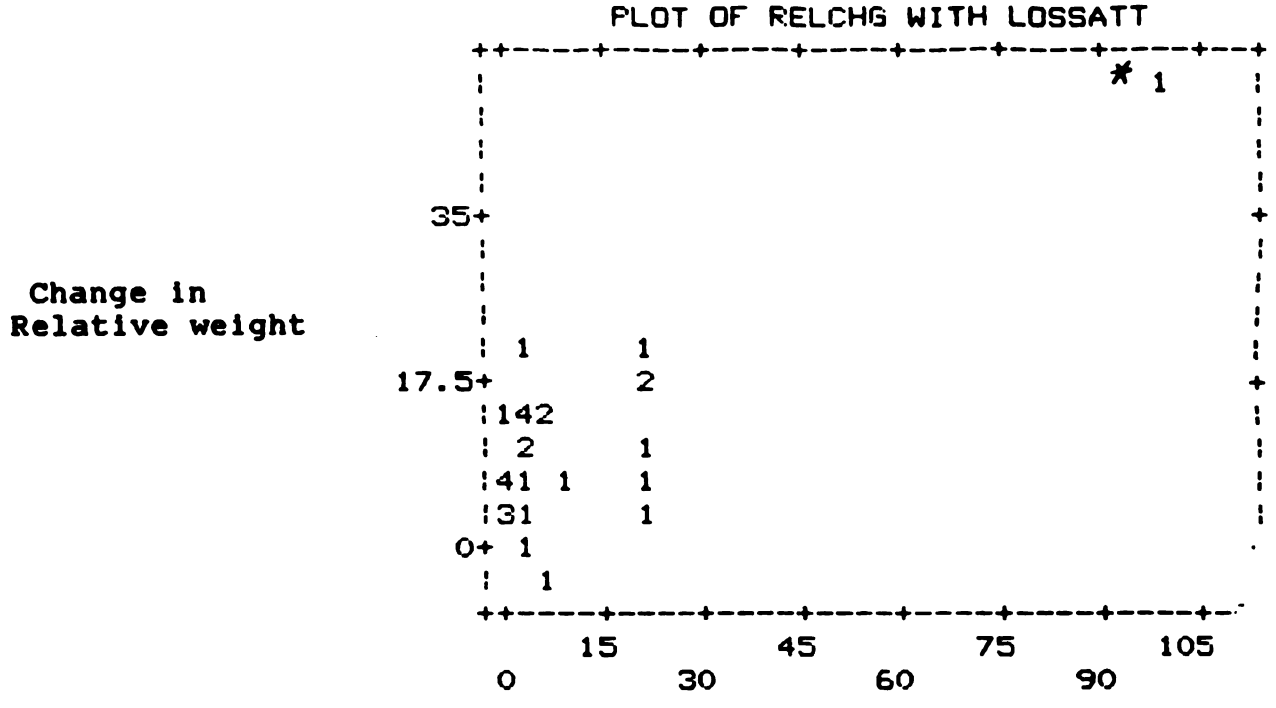


* Outlier

APPENDIX Q

APPENDIX Q

Scatterplot of relative weight change with average number of weight loss attempts

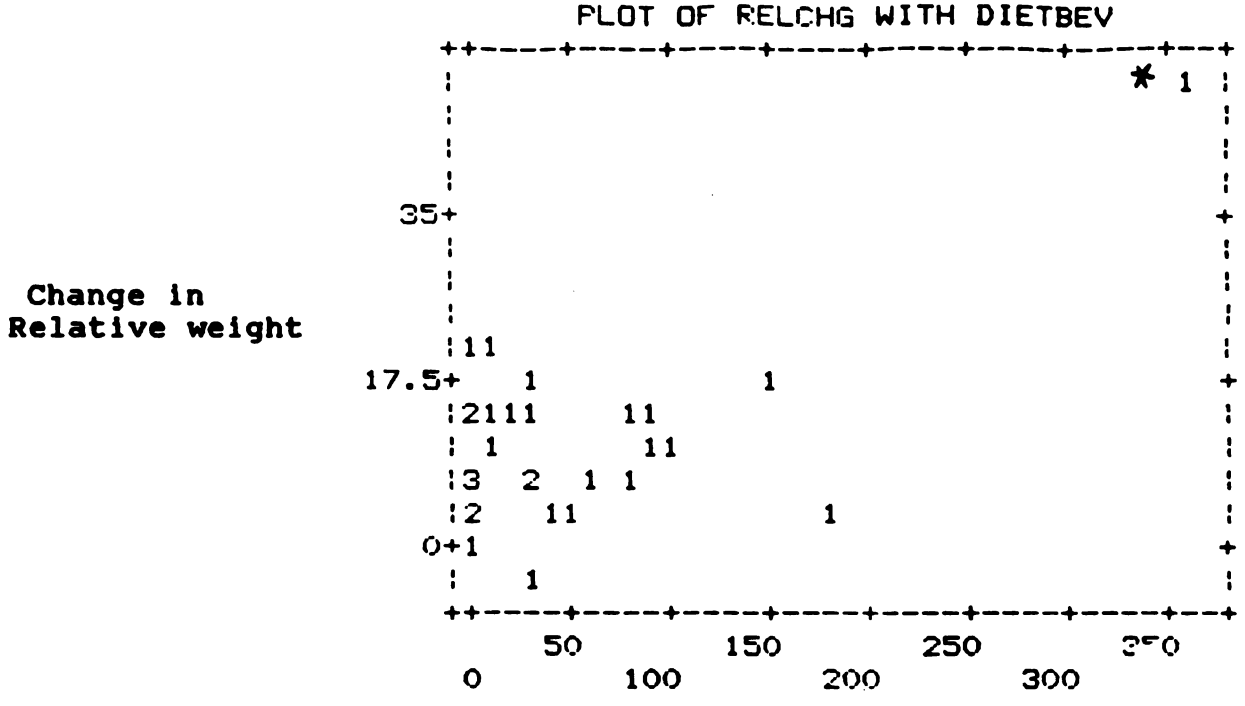


* Outlier

APPENDIX R

APPENDIX R

Scatterplot of relative weight change with average monthly diet beverage consumption



* Outlier

REFERENCES

American Diabetes Association. Exchange lists for meal planning. New York: American Diabetes Association, 1986.

Ballor DL, McCarthy JP, Wilterdink EJ. Exercise intensity does not affect the composition of diet and exercise induced body mass loss. Am J Clin Nutr 1990;51:142-6.

Bellisle F, Rolland-Cachera MF, Deheeger M, Guilloud-Bataille M. Obesity and food intake in children: evidence for a role of metabolic and/or behavioral daily rhythms. Appetite 1988;11:111-118.

Blackburn GL, Wilson GT, Kanders BS, Stein LJ, Lavin PT, Adler J, Brownell KD. Weight cycling: the experience of human dieters. Am J Clin Nutr 1989;49:1105-9.

Blair D, Buskirk ER. Habitual daily energy expenditure and activity levels of lean and adult-onset and child-onset obese women. Am J Clin Nutr 1987;45:540-50.

Blair D, Habict JP, Sims EA, Sylvester D, Abraham S. Evidence for an increased risk for hypertension with centrally located body fat and the effect of race and sex on this risk. Am J Epidemiol 1984;119:526-540.

Blair S, Kohl H, Paffenberger R, Clark D, Cooper K, Gibbon L. Physical fitness and all-cause mortality: a prospective study of healthy men and women. J Amer Medical Assoc 1989;262:2395-2401.

Block G, Rosenberger WF, Patterson BH. Calories, fat and cholesterol: Intake patterns in the US population by race, sex and age. Am J Public Health 1988;78:115-1155.

Bolocofsky DN, Coulthard-Morris L, Spinler D. Prediction of successful weight management from personality and demographic data. Psych Reports 1984;55:795-802.

Brandon JE. Differences is self-reported eating and exercise behaviors and actual-ideal self-concept congruence between obese and nonobese individuals. Health Values 1987;11:22-33.

Bray GA., ed. Obesity in America. Dept. of Health, Education and Welfare; National Institute of Health, 1979.

Bray GA. Complications of Obesity. Ann Int Med 1985; 103:1052-1062.

Brooks GA, Fahey TD. Exercise Physiology: Human Bioenergetics and Its Applications. New York: Macmillan, 1985.

Brownell KD, Greenwood MRC, Stellar E, Schrager EE. The effects of repeated cycles of weight loss and regain in rats. Physiol Behav 1986; 38: 459-464.

Brownell KD, Heckerman CL, Westlake RJ, Hayes SC, Manti PM. The effect of couples training and partner cooperativeness in the behavioral treatment of obesity. Behav Res and Therapy 1978;16:323-33.

Colditz GA, Willett WC, Stampfer MJ, London SJ, Segal MR, Speizer FE. Patterns of weight change and their relation to diet in a cohort of healthy women. Am J Clin Nutr 1990;51:1100-5.

Cooke CJ, Meyers A. The role of predictor variables in the behavioral treatment of obesity. Behav Assess 1980;2:59-69.

Dannenberg AL, Keller JB, Wilson PWF, Castelli WP. Leisure time physical activity in the Framingham offspring study. Am J Epidemiol 1989;129:76.

de Castro JM, Orozco S. Moderate alcohol intake and spontaneous eating patterns of humans: evidence of unregulated supplementation. Am J Clin Nutr 1990;52:246-53.

de Groot L, van Es A, van Raaij J, Vogt J, Hautvast J. Energy metabolism of overweight women 1 mo and 1 y after an 8-wk slimming period. Am J Clin Nutr 1990;51:578-83.

Dietz WH, Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. Pediatrics 1985;75:807-812.

Dillman DA. Mail and telephone surveys: the total design method. New York: John Wiley, 1978.

Dougherty RM, Fong AKH, Iacono JM. Nutrient content of the diet when the fat is reduced. Am J Clin Nutr 1988;48:970-9.

Dreon DM, Frey-Hewitt B, Ellsworth N, Williams PT, Terry RB, Wood PD. Dietary fat:carbohydrate ratio and obesity in middle-aged men. Am J Clin Nutr 1988;47:995-1000.

Drewnowski A, Greenwood MRC. Cream and sugar: human preferences for high-fat foods. Physiology & Behavior 1983;30:629-633.

Drewnowski A, Brunzell JD, Sande K, Iverius PH. Sweet tooth reconsidered: taste responsiveness in human obesity. Physiology & Behavior 1985;35:617-622.

Drewnowski A, Shrager EE, Lipsky C, Stellar E, Greenwood MRC. Sugar and fat: sensory and hedonic evaluation of liquid and solid foods. Physiology & Behavior 1989;45:177-183.

Flatt JP, Ravussin E, Acheson KJ, Jequier E. Effects of dietary fat on postprandial substrate oxidation and on carbohydrate and fat balances. J Clin Invest 1985;76:1019-24.

Foreyt JP, Mitchell RE, Garner DT, Gee M, Scott LW, Gotto AM. Behavioral treatment of obesity: results and limitations. Behavior Therapy 1982;13:153-161.

Foreyt JP. Issues in the assessment and treatment of obesity. J Consult Clin Psych 1987;55:677-684.

Forster JL, Jeffery RW, Snell MK. One year follow-up study to a worksite weight control program. Prev Med 1988;17:129-133.

Fricker J, Giroux S, Fumeron F, Apfelbaum M. Circadian rhythm of energy intake and corpulence status in adults. Int J Obes 1990;14:387-393.

Funch DP, Marshall JR, Gebhardt GP. Assessment of a short scale to measure social support. Soc Sci Med 1986;23:337-344.

Garner DM, Garfinkle PE (eds) Handbook of Psychotherapy for Anorexia Nervosa and Bulimia. New York, NY: Guilford Publications Inc., 1985.

Glass G, Hopkins K. Statistical Methods in Education and Psychology. Englewood Cliffs, New Jersey: Prentice Hall, 1984.

Goodrick GK, Foreyt JP. Why treatments for obesity don't last. J Amer Diet Assoc 1991;91:1243-1247.

Gorbach SL, Morrill-LaBrode A, Woods MN, Dwyer JT, Selles WD, Henderson M, Insull W, Goldman S, Thompson D, Clifford C, Sheppard L. Changes in food patterns during a low-fat dietary intervention in women. J Amer Diet Assoc 1990;90:803-809.

Gormally J, Rardin D. Weight loss and maintenance and changes in diet and exercise for behavioral counseling and nutrition education. J Counseling Psych 1981;28:295-304.

Gortmaker SL, Dietz WH, Cheung LWY. Inactivity, diet and the fattening of America. J Amer Diet Assoc 1990;90:1247-52.

Graham LE, Taylor CB, Hovell MF, Siegel W. Five-year follow-up to a behavioral weight-loss program. J Consult Clin Psych 1983;51:322-323.

Gray DS, Fisler JS, Bray G. Effects of repeated weight loss and regain on body composition in obese rats. Am J Clin Nutr 1988;47:393-9.

Griffiths RA, Holliday J. An evaluation and follow-up investigation of a behavioral group treatment programme for obesity. Psychother Psychosom 1987;48:157-164.

Haffner SM, Stern MP, Hazuda HP, Pugh J, Pattersen JK. Do upper-body and centralized adiposity measure different aspects of regional body fat distribution? Relationship to non-insulin- dependent diabetes mellitus, lipids and lipoproteins. Diabetes 1987;36:43-51.

Hansen GR, Wyse BW. Expression of nutrient allowances per 1000 kilocalories. J Am Diet Assoc 1980;76:223-227.

Hart J, Einav C, Weingarten MA, Stein M. The importance of family support in a behavior modification weight loss program. J Am Diet Assoc 1990;90:1270.

Hill JO, Schlundt DG, Sbrocco T, Sharp T, Pope-Cerdle J, Stetson B, Kaler M, Heim C. Evaluation of an alternating-calorie diet with and without exercise in the treatment of obesity. Am J Clin Nutr 1989;50:248-54.

Hoerr S. "Weight Status of Michigan Adults" Michigan Department of Public Health. Spectrum: Winter, 1989.

Hoiberg A, Berard S, Watten RH, Caine C. Correlates of weight loss in treatment and at follow-up. Int J Obes 1984;8:457-465.

Hovell MF, Koch A, Hofstetter CR, Sipan C, Faucher P, Dellinger A, Borok G, Forsythe A, Felitti VJ. Long-term weight loss maintenance: assessment of a behavioral and supplemented fasting regimen. Am J Pub Health 1988;78:663-666.

Human Nutrition Information Service, United States Department of Agriculture. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans 1990. U.S. Government Printing Office: 1990.

Kahn HS, Williamson DF. The contributions of income, education and changing marital status to weight change among US men. Int J Obes 1990;14:1057-1068.

Kahn HS, Williamson DF, Stevens JA. Race and weight change in US women: the roles of socioeconomic and marital status. Am J Pub Health 1991;81:319-323.

Kaplan BH, Cassel JC, Gore S. Social support and health. Medical Care 1977;5:47.

Kayman S, Bruvold W, Stern JS. Maintenance and relapse after weight loss in women: behavioral aspects. Am J Clin Nutr 1990;52:800-7.

Kazdin AE. Behavior Modification in Applied Settings. Belmont, CA: Wadsworth Inc.,1989.

Keim NL, Barberi TF, Belko AZ. The effect of exercise on energy intake and body composition in overweight women. Int J Obes 1990;14:335-346.

Kendall A, Levitsky DA, Strupp BJ, Lissner L. Weight loss on a low-fat diet: consequences of the imprecison of the control of food intake in humans. Am J Clin Nutr 1991;53:1124-29.

Kissileff HR, Pi-Sunyer FX, Segal K, Meltzer S, Foelsch PA. Acute effects of exercise on food intake in obese and nonobese women. Am J Clin Nutr 1990;52:240-5.

Kraemer HC, Berkowitz RI, Hammer LD. Methodological difficulties in studies of obesity. I. Measurement issues. Annals of Behavioral Medicine 1990;12:112-118.

Kramer FM, Jeffery RW, Forster JL, Snell MK. Long-term follow-up of behavioral treatment for obesity: patterns of weight regain among men and women. Int J Obes 1989;13:123-136.

Kramer FM, Jeffery RW, Snell MK, Forster JL. Maintenance of successful weight loss over one year: effects of financial contracts for weight maintenance or participation in skills training. Behav Therapy 1986;17:295-301.

Lanska DJ, Lanska MJ, Hartz AJ, Kalkhoff RK, Rupley D, Rimm AA. A prospective study of body fat distribution and weight loss. Int J Obes 1985;9:241-246.

Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Bjorntorp P, Tibblin G. Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow-up of participants in the study of men born in 1913. Br Med J 1984;288:1401-1404.

Lavery MA, Loewy JW, Kapadia AS, Nichaman MZ, Foreyt JP, Gee M. Long-term follow-up of weight status of subjects in a behavioral weight control program. J Am Diet Assoc 1989;89:1259-1264.

Leon GR, Sternberg B. Prognostic indicators of success or relapse in weight reduction. Int J Eat Dis 1984;3:15.

Lissner L, Odell PM, D'Agostino RB, Stokes J, Kreger BE, Belanger AJ, Brownell KD. Variability of body weight and health outcomes in the Framingham population. N Engl J Med 1991;324:1839-44.

Lohman T, Roche A, Martorell R (Eds.) Anthropometric Standardized Reference Manual. Human Kinetics Books, 1988.

Madden JP, Yoder MD. Program evaluation: food stamps and commodity distribution in rural areas of central Pennsylvania. Ag Exp Station Res Bull #780. The Penn St University, University Park PA, 1972.

MarketData Enterprises, U.S. Weight Loss and Diet Control Market. Lynbrook NY, 1989.

McClaren DM. Motivational factors affecting patient attrition in a weight reduction program. J Am Coll Health 1986;41:765-82.

McNett S. Social support, threat and coping responses and effectiveness in the functionally disabled. Nursing Research 1986;36:98.

Mela DJ, Sacchetti DA. Sensory preferences for fats: relationships with diet and body composition. Am J Clin Nutr 1991;53:908-15.

Metropolitan Insurance Company. Metropolitan height and weight tables. New York, 1983.

Michigan Department of Public Health. Coordination of high blood pressure control in Michigan. Center for Health Promotion. MDPH: Lansing, MI:1987.

Michigan Department of Public Health. Health Risk Behaviors 1987. Center for Health Promotion. MDPH: Lansing, MI:1988.

Michigan Department of Public Health. Safe Weight Loss Guidelines. MDPH: Lansing, Mi: 1990.

Miller WC, Lindeman AK, Wallace J, Niederpruem M. Diet composition, energy intake and exercise in relation to body fat in men and women. Am J Clin Nutr 1990;52:426-30.

Morgan KJ, Zabik ME, Stampley GL. The role of breakfast in diet adequacy of the U.S. adult population. J Am Coll Nutr 1986;5:551-563.

MSU Nutriguide; dietary analysis software. Version 1.3. MSU Department of Food Science and Human Nutrition, Michigan State University; 1988.

National Center for Health Statistics, Carroll MD, Abraham S, Dresser CM. Dietary intake source data: United States, 1976-80. Vital and Health Statistics, series 11-No.231.

National Research Council. Diet and Health: Implications for Reducing Chronic Disease Risk.1989; Washington D.C.: National Academy Press.

O'Reilly P. Methodological issues in social support and social network research. Soc Sci Med 1988;26:863-873.

Pavlou KN, Krey S, Steffee WP. Exercise as an adjunct to weight loss and maintenance in moderately obese subjects. Am J Clin Nutr 1989a;49:1115-23.

Pavlou KN, Whatley JE, Jannace PW, Di Bartolomeo JJ, Burrows BA, Duthie EAM, Lerman RH. Physical activity as a supplement to a weight loss dietary regimen. Am J Clin Nutr 1989b;49:1110-14.

Perri MG, Nezu AM, Patti ET, McCann KL. Effect of length of treatment on weight loss. J Consult Clin Psych 1989b;57:450-452.

Perri MG, Nezu AM, McAllister DA, Gange JJ, Jordan RC, McAdoo WG. Effects of four maintenance programs on the long-term management of obesity. J Consult Clin Psych 1988;56:529-534.

Perri MG, Lauer JB, McAdoo WG, McAllister DA, Yancey DZ. Enhancing the efficacy of behavior therapy for obesity: effects of aerobic exercise and a multicomponent maintenance program. J Consult Clin Psych 1986;54:670-675.

Perri MG, Lauer JB, Yancey DZ, McAdoo WG, McAllister DA, Jordan RC, Nezu AM. Effects of peer support and therapist contact on long-term weight loss. J Consult Clin Psych 1987;55:615-617.

Pi-Sunyer FX. Health implications of obesity. Am J Clin Nutr 1991;53:1595-1603.

Pratt CA. A conceptual model for studying attrition in weight reduction programs. J Nutr Ed 1990;22:177.

Read MH, Fisher KA, Bhalla VJ, Bendel R, Brock MA, Harrill I, Mitchell M, Schutz H, Sheehan E, Standal B. Dietary fat intake: demographics. J Am Diet Assoc 1990;90:830-31.

Rodin J, Radke-Sharpe N, Rebuffe-Scrive M, Greenwood MRC. Weight cycling and fat distribution. Int J Obes 1990;14:303-310.

Rosenthal B, Allen GJ, Winter CL. Husbands involvement in the behavioral treatment of overweight women: Initial effects and long-term follow-up. Int J Obes 1980;4:165-7.

Rowland ML. Self-reported weight and height. Am J Clin Nutr 1990;52:1125-33.

Saris WHM. Physiological aspects of exercise in weight cycling. Am J Clin Nutr 1989;49:1099-108.

Schaefer C, Coyne JC, Lazarus RS. The health-related functions of social support. J Behav Med 1981:4:381.

Schectman G, McKinney P, Pleuss J, Hoffman RG. Dietary intake of Americans reporting adherence to a low cholesterol diet (NHANES II). Am J Public Health 1990;80:698-703.

Schlundt DG, Hill JO, Sbrocco T, Pope-Cordle J, Kasser T. Obesity: A bioenergetic or behavioral problem.

Schutz Y, Flatt JP, Jequier E. Failure of dietary fat intake to promote fat oxidation: a factor favoring the development of obesity. Am J Clin Nutr 1989;50:307-14.

Stanton JL, Keast DR. Serum cholesterol, fat intake, and breakfast consumption in the United States adult population. J Am Coll Nutr 1989;8:567-572.

Statistical Package for the Social Sciences (SPSS/PC+ V4.0). Chicago, IL:SPSS Inc., 1990.

Stephen AM, Wald NJ. Trends in individual consumption of dietary fat in the United States, 1920-1984. Am J Clin Nutr 1990;52:457-69.

Stern M, Haffner S. Body fat distribution and hyperinsulinemia as risk factors for diabetes and cardiovascular disease. Arteriosclerosis 1986;6:123-130.

Stuart RB. Weight loss and beyond: are they taking it off and keeping it off? In Davidson PO and Davidson SM (eds), Behavioral Medicine: changing health lifestyles. New York: Brunner/Mazel, Inc., 1980.

Stunkard AJ, Berthold HC. What is behavior therapy? A very short description of behavioral weight control. Am J Clin Nutr 1985;41:821.

Stunkard AJ, Cohen RY, Felix MRJ. Weight loss competitions at the worksite: how they work and how well. Prev Med 1989;18:460-474.

Teufel NI, Dufour DL. Patterns of food use and nutrient intake of obese and non-obese Hualapai Indian women of Arizona. J Amer Diet Assoc 1990;90:1229-1235.

Tremblay A, Plourde G, Despres JP, Bouchard C. Impact of dietary fat oxidation on energy intake in humans. Am J Clin Nutr 1989;49:799-805.

Tremblay A, Lavallee N, Almeras N, Allard L, Despres JP, Bouchard C. Nutritional determinants of the increase in energy intake associated with a high-fat diet. Am J Clin Nutr 1991;53:1134-37.

United States Department of Agriculture, Human Nutrition Information Service, Nationwide Food Consumption Survey, Continuing Survey of Food Intake of Individuals. Washington D.C., U.S. Government Printing Office.

United States Department of Health and Human Services, National Center for Health Statistics, National Health and Nutrition Examination Survey (NHANES II).

USDA/HNIS. Catalog of Data files on nutrition and food composition. 1989.

U.S. Department of Agriculture: Nutrient Intakes: Individuals in 48 States, Year 1977-78. Nationwide Food Consumption Survey, 1977-78, Report No. 1-2, 1984 Hyattsville, MD:HNIS/USDA.

U.S. Department of Health and Human Services; Public Health Service. Promoting Health/ Preventing Disease: Year 2000 Objectives for the Nation. 1989.

U.S. Surgeon General. Report on Nutrition and Health. U.S. Department of Health and Human Services; Public Health Service, Publication No. 88-50210, 1988.

Van Dale D, Saris WHM, Tenhoor F. Weight maintenance and resting metabolic rate 18-40 months after a diet/exercise treatment. Int J Obes 1990;14:347-359.

Van Dale D, Saris WHM. Repetitive weight loss and weight regain: effects on weight reduction, resting metabolic rate, and lipolytic activity before and after exercise and/or diet treatment. Am J Clin Nutr 1989;49:409-16.

Vansant G, Den Besten C, Weststrate J, Deurenberg P. Body fat distribution and the prognosis for weight reduction: preliminary observations. Int J Obes 1988;12:133-140.

Wadden TA, Stunkard AJ, Johnston FE, Wang J, Pierson RN, Van Itallie TB, Costello E, Pena M. Body fat deposition in adult obese women. II Changes in fat distribution accompanying weight reduction. Am J Clin Nutr 1988; 47:229-34.

Welin L, Svardsudd K, Wilhelmsen L, Larsson B, Tibblin G. Analysis of risk factors for stroke in a cohort of men born in 1913. N Engl J Med 1987;317:521-526.

Willett W. Short-term dietary recall and recording methods. In: Nutritional Epidemiology. New York; Oxford University Press, 1990.

Windham CT, Wyse BW, Hansen RG. Alcohol consumption and nutrient density of diets in the Nationwide Food Consumption Survey. J Amer Diet Assoc 1983;82:364-373.

Wing RR, Shoemaker M, Marcus MD, McDermott M, Gooding W. Variables associated with weight loss and improvements in glycemic control in Type II diabetic patients in behavioral weight control programs. Int J Obes 1990;14:495-503.

Wood ER. Weight loss maintenance one year after individual counseling. J Am Diet Assoc 1990;90:1256-1260.

Wooley SC, Garner DG. Obesity treatment: the high cost of false hope. J Amer Diet Assoc 1991;91:1248-1251.

Yang M, Presta E, Bjorntorp P. Refeeding after fasting in rats: effects of duration of starvation and refeeding on food efficiency in diet-induced obesity. Am J Clin Nutr 1990;51:970-8.