THE IMPACT OF RATE OF INITIAL WEIGHT LOSS ON LONG-TERM SUCCESS IN THE TREATMENT OF OBESITY: DOES SLOW AND STEADY WIN THE RACE?

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
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To my parents, who are my inspiration

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Controversy exists regarding rate of initial weight loss and long-term success in weight management. Some theorists contend that a rapid rate of initial loss may result in poorer long-term success and that a slow, gradual decrease may lead to better maintenance of lost weight and a superior long-term outcome. We examined this question in the context of a randomized trial of lifestyle treatment in which participants were encouraged to reduce their intake so as to achieve a weight loss of 0.45 to 0.91 kg/week (i.e. 1 to 2 lb/week). We classified participants based on their rate of weight loss during the first month of treatment as "FAST" ($\geq$ 0.68 kg/week [$\geq$ 1.5 lb/week], n = 55), "MODERATE" ($\geq$ 0.23 and < 0.68 kg/week [$\geq$ 0.5 and < 1.5 lb/week], n = 96) and "SLOW" (< 0.23 kg/week [< 0.5 lb/week], n = 79) losers. These groups were drawn from a sample of middle-aged (mean = 59.3 yr) obese women (mean BMI = 36.8) who participated in a six-month lifestyle intervention that was followed by one year of extended care. The three groups did not differ at baseline with respect to age, weight, BMI, fitness, nutritional intake, or physical activity patterns. The FAST, MODERATE, and SLOW groups differed significantly from each other with regard to net mean weight change at six months (-13.9, -9.6, and -5.9 kg, respectively, *p*s < .001) and at 18 months (-11.5, -7.8, and -4.8 kg, respectively, *p*s < .05). No significant differences in weight regain between 6 and 18 months were found among groups (2.5,

1.8, 1.1 kg, respectively). Odds ratios indicated the FAST group was 5.5 times more likely to achieve a 10% weight loss at 18 months than the SLOW group (58.2% vs. 20.3%), and the MODERATE group was 2.5 times more likely than the SLOW group (38.5% vs. 20.3%). Within the context of lifestyle treatment, these results suggest that there were both short- and long-term advantages to a fast rate of initial weight loss and that those who lost weight quickly were not more susceptible to relapse. These findings suggest that a high rate of initial weight loss is associated with long-term success in weight management.

CHAPTER 1
INTRODUCTION

Successful weight loss maintenance in obese individuals has been defined as a reduction of 10% or greater of initial body weight maintained for at least one year (National Heart, Lung, and Blood Institute, 1998; Wing & Hill, 2001). Research has demonstrated that lifestyle interventions consisting of 15 to 30 weekly group sessions result in an 8 to 10% reduction of initial body weight (Jeffery et al., 2000; Perri & Fuller, 1995; Wadden, Butryn, & Byrne, 2004); however, these beneficial losses are rarely maintained long-term (Perri, 1998; Wadden et al., 2004). Because weight regain has been shown to have an adverse impact on metabolic risk factors (Klein, 2001; Krebs et al., 2002; Moore et al., 2000), considerable efforts have been placed on identifying individual characteristics or behavioral factors that may be associated with long-term success in weight loss maintenance (Elfhag & Rössner, 2005; Vogels, Diepvens, & Westerterp-Plantenga, 2005; Wadden et al., 1992). Studies have shown that rate of initial weight loss, even within the first few weeks of treatment, may serve as a predictor of long-term success (Carels, Cacciapaglia, Douglass, Rydin, & O'Brien, 2003; Fogelholm, Kukkonen-Harjula, & Oja, 1999; Jeffery, Wing, & Mayer, 1998; Sbrocco, Nedegaard, Stone, & Lewis, 1999; Wadden et al., 1992), but controversy exists regarding the ideal initial rate of loss (Jeffery et al., 1998; Sbrocco et al., 1999; Wadden et al., 1992).

Losing weight at a slow, yet steady initial rate has been shown to result in continued weight loss, reduced risk for weight regain, and successful long-term weight loss maintenance (Sbrocco et al., 1999). Conversely, losing weight at a high initial rate has also been found to produce long-term success (Astrup & Rössner, 2000; Carels et al., 2003; Fogelholm et al., 1999; Jeffery et al., 1998), and degree of weight loss within the first month of intervention has been labeled as the best predictor of weight loss at post-treatment follow-up (Wadden et al., 1992).

While losing weight at a more rapid initial rate has been coupled with greater long-term weight loss, it is also associated with a greater amount of regain (Jeffery et al., 1998; Wadden, Foster, & Letizia, 1994). This finding suggests that a larger initial weight loss may actually serve as a risk factor for later weight regain (McGuire, Wing, Klem, Lang, & Hill, 1999; Weiss, Galuska, Kettel Khan, Gillespie, & Serdula, 2007; Wing & Hill, 2001). At present, controversy exists on how the degree of short-term weight loss affects long-term success. Thus, the current study examined the impact of rate of initial weight loss on long-term maintenance of lost weight.

Obesity

Prevalence

Over the past four decades, the prevalence of obesity (defined as a Body Mass Index, BMI, $\geq$ 30 kg/m^2) in the United States has increased markedly. Reports from the National Health and Nutrition Examination Survey (NHANES) illustrate that rates of obesity in adults rose from 12.8% in 1960-1962 (Flegal, Carroll, Kuczmarski, & Johnson, 1998) to 32.2% in 2003-2004 (Ogden et al., 2006). Trends suggest that by 2015, 41% of adults in the United States will be classified as obese (Wang & Beydoun, 2007). Certain sub-groups of the population are disproportionately affected, with those from low socio-economic status and inhabitants of rural areas exhibiting higher rates of obesity (Chang & Lauderdale, 2005; Flegal, Carroll, Ogden, & Johnson, 2002; Hedley et al., 2004; Patterson, Moore, Probst, & Shinogle, 2004). Similarly, higher rates are observed in older versus younger adults and in women versus men (Ogden et al., 2006).

Obesity-Related Health Conditions

The increasing prevalence of obesity has been directly linked with increased morbidity. Obesity is associated with increased risk cardiovascular for disease (Flegal, Graubard, Williamson, & Gail, 2007; Gregg et al., 2005; Wilson, D'Agostino, Sullivan, Parise, & Kannel,

2002), hypertension (Mokdad et al., 2003), hypercholesterolemia (Brown et al., 2000; Mokdad et al., 2003), type 2 diabetes (Flegal et al., 2007; Mokdad et al., 2003), asthma, arthritis (Mokdad et al., 2003), gallbladder disease (Field et al., 2001), sleep apnea (Vgontzas et al., 1994), renal disease (Flegal et al., 2007), and breast, pancreatic, and prostate cancers (Dumitrescu & Cotalra, 2005; Field et al., 2001; Freedland & Aronson, 2005). Obese individuals are also 2.75 times more likely to experience functional impairment (e.g. walking or lifting) than their normal weight counterparts (Alley & Chang, 2007). Based on the Medical Expenditure Panel Survey, it has been estimated that obese men and women in the United States lose 912,000 and 1.95 million health-related quality of life years, respectively, compared to those with a healthy BMI (Muennig, Lubetkin, Jia, & Franks, 2006).

Obesity is also related to an increased mortality and decreased life expectancy. Estimates of excess deaths per year attributable to obesity range from 111,909 (Flegal, Graubard, Williamson, & Gail, 2005) to as high as 414,000 (Mokdad, Marks, Stroup, & Gerberding, 2004). Additionally, results from the Framingham Heart Study suggest that BMI at ages 30 to 49 predicts mortality in future decades, with five to seven years of life lost in obese individuals (Peeters et al., 2003). Epidemiological estimates suggest that obesity leads to a reduction in quality-adjusted life expectancy by 4.4 to 7.2 years, indicating obese individuals will live fewer healthy, disease-free years than those of normal weight (Muennig et al., 2006).

In addition to adverse physical outcomes, obesity is also associated with negative psychosocial consequences. Recent studies have linked obesity to stigmatization in employment, education, and healthcare (Puhl & Brownell, 2001) and have found that close relationship partners (i.e. friends, parents, and spouses) serve as the worst sources of stigmatization (Puhl, Moss-Racusin, Schwartz, & Brownell, in press). Obese individuals experience lower quality of

life and higher levels of depression (Fontaine & Barofsky, 2001; Jia & Lubetkin, 2005; Wadden, Womble, Stunkard, & Anderson, 2002). Obese women are also at increased risk for suicidality (Carpenter, Hasin, Allison, & Faith, 2000).

Obesity-Related Economic Factors

The hazardous health consequences of obesity are accompanied by a significant financial burden. In the United States, 9.1% of healthcare expenditures are attributed to obesity, accounting for 78.5 billion dollars per year, a cost that rivals that associated with smoking (Finkelstein, Fiebelkorn, & Wang, 2003). These costs increase with both age and degree of obesity (Arterburn, Maciejewski, & Tsevat, 2005; Wee et al., 2005). In the year 2000, medical expenditures for the 5% of the population who were morbidly obese (BMI $\geq$ 40) surpassed 11 billion dollars, a cost that was 81% greater than health care costs for normal weight adults (Arterburn et al., 2005). It has been estimated that a sustained modest weight loss of 10% body weight would reduce expected lifetime medical care costs of diseases associated with excess weight by $2,200 to $5,300 per person (Oster, Thompson, Edelsberg, Bird, & Colditz, 1999).

Behavioral Treatment for Obesity

With the increased prevalence and adverse outcomes associated with obesity comes an increased need for effective weight-loss treatments. Lifestyle, or behavioral, treatment programs utilize cognitive-behavioral strategies to modify eating and activity patterns to produce a negative energy balance necessary to lose weight (Wadden, Crerand, & Brock, 2005). This intervention applies classical learning theory to weight loss by identifying and modifying the antecedents and consequences that are associated with unhealthy eating patterns and low levels of physical activity and by altering the environment to increase and develop habits that promote healthy behaviors (Stuart, 1967; Wadden et al., 2005; Wing, 2002). Behavioral treatment utilizes self-monitoring through the use of daily food and physical activity records, calorie and activity

goal setting (e.g., a deficit of 500-1000 kcal/day combined with 30 min/day of physical activity), performance feedback and problem solving, reinforcement, stimulus control, and cognitive restructuring to achieve these goals (Wadden & Foster, 1992).

Reviews of randomized trials show that comprehensive behavioral modification programs, which typically include weekly group treatment sessions for four to six months, result in an 8% to 10% reduction of initial body weight, or an average loss of 0.5 kg (roughly 1 lb) per week (Jeffery et al., 2000; Perri & Fuller, 1995; Wadden, Butryn, & Byrne, 2004; Wadden et al., 2005). Weight losses of this magnitude have been associated with reductions in adverse health conditions and risk factors associated with obesity (National Heart, Lung, and Blood Institute, 1998). Unfortunately, long-term follow-up evaluations indicate that traditional behavioral treatment induced weight losses are not well maintained (Perri, 1998; Wadden et al., 2004). A recent review by Wadden et al. (2004) indicated that in the year following 20 to 30 weeks of group lifestyle modification treatment, patients regain 30% to 35% of their lost weight. After the first year, this weight regain slows, but 18 months following program entry, only about 50% of the initial lost weight is maintained (Jeffery et al., 2000). Five years after treatment, 50% or more of patients return to their initial body weight (Wadden, Sternberg, Letizia, Stunkard, & Foster, 1989). Another review found that only 13% to 22% of patients who initially lost $\geq$ 5 kg maintained this weight loss at five year follow-up (Wing & Hill, 2001). Thus, the pattern associated with behavioral treatment entails successful initial weight loss followed by a reliable regain of lost weight (Jeffery et al., 2000).

Impact of Weight Change on Disease Risk

Diabetes

Considerable evidence supports the notion that modest weight loss results in substantial improvements in glycemic control, thus reducing the risk for type 2 diabetes. The Diabetes

Prevention Program (DPP), a randomized clinical trial that involved 3200 obese individuals at high risk for developing type 2 diabetes, found that men and women receiving lifestyle intervention for weight loss experienced a 58% reduced risk of developing type 2 diabetes (Diabetes Prevention Program Research Group, 2002). Further analyses indicated that for every kilogram of weight lost, there was a 16% reduction in diabetes risk (Hamman et al., 2006). Similarly, the Finnish Diabetes Prevention Study, which randomized 522 middle-aged overweight participants with impaired glucose tolerance to either lifestyle intervention or control group, found that the intervention group lost an average 4.7% of initial body weight and experienced a 58% reduced risk of diabetes compared to the control group (Tuomilehto et al., 2001). A recent meta-analysis of nine randomized trials found a relative risk for one-year incidence of type 2 diabetes of 0.55 for participants receiving lifestyle intervention for weight loss compared to those in control groups (Yamaoka & Tango, 2005). Epidemiological estimates have calculated that a sustained modest weight loss would reduce the expected years of life with type 2 diabetes by 0.5 to 1.7 (Oster et al., 1999).

Weight regain has an adverse impact glycemic control. While participants in the DPP regained roughly one-third of their lost weight and still experienced reductions in diabetes risk (Diabetes Prevention Research Group, 2002), other reports indicate that those who regain lost weight experience no improvement in diabetes risk (Moore et al., 2000) or only experience improvement if net weight loss remains above 5% (Krebs et al., 2002).

Hypertension

Lifestyle interventions focused on achieving modest weight losses of 5% to 10% of initial body weight, even without dietary sodium reduction, have proven effective in reducing hypertension and the need for pharmacologic intervention regardless if the participant remains

obese (Mertens & Van Gall, 2000; Whelton et al., 1998). The Trials of Hypertension Prevention (TOHP) project, consisting of a three-year weight-loss intervention, showed that participants who lost approximately 5% of their initial body weight at six months and maintained this weight loss for 30 months experienced a relative risk for hypertension of 0.35 compared to those who did not achieve this weight loss (Stevens et al., 2001). A meta-analysis of 25 randomized trials suggested that blood pressure is reduced by 1.05 mm Hg (systolic) and 0.92 mm Hg (diastolic) per kilogram of weight loss (Neter, Stam, Kok, Grobbee, & Geleijnse, 2003). Expected years of life with hypertension would be reduced by an estimated 1.2 to 2.9 with successful weight loss (Oster et al., 1999). Conversely, results of the TOHP project demonstrate that much or full weight regain leads to a steady increase to baseline levels of blood pressure at 36 months (Stevens et al., 2001).

Hyperlipidemia

Weight loss has also been associated with a clinically significant reduction in lipid profile. Dattilo and Kris-Etherton's meta-analysis of 70 articles (1992) found that for each kilogram of weight lost, total cholesterol was reduced by 0.91 mg/dL, LDL cholesterol by 0.36 mg/dL, and triglycerides by 0.27 mg/dL. Similarly, it is expected that a weight loss of 4.5 kg (10 lbs) can reduce LDL cholesterol by 5% to 8% (Fletcher et al., 2005). Epidemiological estimates suggest that a modest weight loss would reduce the expected years of life with hypercholesterolemia by 0.3 to 0.8 (Oster et al., 1999). Degree of maintained weight loss may be a determinant of reduction in lipid profile benefits. Wadden, Anderson, and Foster (1999) found that a 5% sustained weight loss was necessary for decreases in triglyceride concentrations to remain significant, and a 10% maintained weight loss was necessary for LDL cholesterol to remain lowered.

Predictors of Long-Term Weight Loss Success

Over two decades ago, Brownell (1984) noted the usefulness of identifying predictors of success so that weight-loss programs could be tailored to those who are most likely to succeed. A recent meta-analysis by Teixeira, Going, Sardinha, and Lohman (2005) found, among a large number of baseline characteristics studied, only less previous dieting, fewer previous weight loss attempts, self-motivation, general efficacy, and autonomy held consistent evidence as predictors of successful weight-loss. Research has shown that, during weight management programs, both higher rates of attendance (Carels et al., 2003; Wadden et al., 1992) and higher rates of adherence, as measured by self-monitoring and recording daily dietary intake (Baker & Kirschenbaum, 1993; Boutelle & Kirschenbaum, 1998), have been correlated with long-term weight loss success. Studies have also indicated that rate of weight loss within the first few weeks of behavioral treatment may also serve as a predictor of long-term success (Carels et al., 2003; Fogelholm et al., 1999; Jeffery et al., 1998; Sbrocco et al., 1999; Wadden et al., 1992).

Slow Initial Rate of Weight Loss

Some theorists contend that losing weight at a slow initial rate may lead to superior long-term loss and lower risk for weight regain. Because it is often difficult to maintain the degree of caloric restriction promoted by traditional behavioral treatment programs for a prolonged period of time (Schlundt, Sbrocco, & Bell, 1989), Sbrocco and colleagues (Sbrocco et al., 1999) developed an alternate intervention called "behavioral choice treatment." Based upon a decision-making model (Sbrocco & Schlundt, 1998), behavioral choice treatment teaches participants to use mild caloric restriction, reducing caloric intake from an estimated 2500 kcal/day to 1800 kcal/day, and to make healthy decisions regarding eating choices without considering their eating patterns as dieting. Weight loss is therefore expected to be slower

initially, but continuous as participants maintain new decision making regarding healthy eating patterns. Sbrocco et al. (1999) conducted a 13-week randomized trial in which groups of obese women took part in either a traditional behavioral treatment that encouraged significant caloric reduction so as to achieve a substantial initial weight loss, or a behavioral choice treatment that promoted mild caloric restriction and a slow, yet steady weight loss. Results indicate that at both mid-treatment and post-treatment, those in the traditional behavioral treatment achieved significantly greater weight losses; however, at three-month follow-up, this difference was no longer apparent. The behavioral choice treatment group continued to lose weight and achieved significantly greater weight losses at both 6- and 12-month follow-up (-7.0 and -10.1 kg, respectively) than the traditional behavioral treatment group, which experienced continued weight regain from 6 to 12 months (-4.5 and -4.3 kg, respectively). Thus, a slow and steady initial weight loss may produce larger long-term weight loss that is not susceptible to regain, leading to successful weight loss maintenance.

Fast Initial Rate of Weight Loss

Other researchers purport that weight loss occurring at a high initial rate leads to better long-term outcomes. Recent reviews of weight loss patterns have concluded that the greater the initial weight loss in obese patients, the larger the total weight loss retention at long-term follow-up (Astrup & Rössner, 2000; Elfhag & Rössner, 2005). Fogelholm et al. (1999) conducted a 12-week weight reduction program followed by a 40-week maintenance period and found that weight loss during the initial 12-week treatment served as the strongest positive predictor of further weight change during the subsequent period. Similar predictive results have been shown when assessing weight loss within the initial six weeks (Carels et al., 2003) and within the first month of traditional behavioral treatment programs (Wadden et al., 1992). Jeffery et al. (1998)

conducted a randomized trial in which 130 men and women participated in an 18-month weight-loss treatment program with an additional 12-month follow-up. Participants were then categorized into tertiles according to the maximum amount of weight loss. Those participants in the highest maximum weight-loss category lost weight at more than twice the initial rate of those in the lowest tertile. The results indicated that 23% of those participants who achieved the highest initial weight loss (i.e. highest tertile of maximum weight loss [average loss of 0.68 kg/week]) attained a clinically significant 10% reduction in body weight at 30 months compared to only 9% of those who lost a moderate initial amount (i.e. middle tertile [average loss of 0.58 kg/week]) and 2% who lost the least initially (i.e. lowest tertile [average loss of 0.29 kg/week]). However, the results also demonstrated that those who had the largest initial losses experienced larger and more rapid weight regain than those who initially had smaller losses. Similar findings have documented that a large initial weight loss is a risk factor for weight regain (McGuire et al., 1999; Sbrocco et al., 1999; Wadden, Foster, & Letizia, 1994; Weiss et al., 2007; Wing & Hill, 2001).

In sum, many behavioral treatment programs have proven effective in promoting clinically significant weight losses, but long-term weight reduction is difficult to maintain. Therefore, predictors of success in weight-loss programs have been examined. There is evidence to suggest that initial rate of weight loss, assessed in as few as four weeks of treatment, is associated with both greater long-term success and higher rates of weight regain. Thus, it remains unclear whether there exists an optimal initial rate of weight loss for effective long-term weight management.

Specific Aims and Hypotheses

The present study examined the effects of rate of weight loss within the first month of a six-month lifestyle intervention on long-term (18-month) weight reduction in a group of women

ages 50-75 years. Women who lost weight at a SLOW rate (< 0.23 kg/week [< 0.5 lb/week]) were compared to women who achieved MODERATE (≥ 0.23 to < 0.68 kg/week [≥ 0.5 to <1.5 lb/week]) and FAST (≥ 0.68 kg/week [≥ 1.5 lb/week]) rates of weight loss within the first month of intervention. The first aim of this study was to determine if a SLOW rate of initial weight loss was better associated with weight loss at 6 and 18 months and less weight regain from 6 to 18 months than a MODERATE or FAST rate of loss. We tested the hypothesis that those women who lost at a SLOW rate would experience greater short- and long-term weight losses and lesser weight regain. In conjunction with the definition of successful weight loss maintenance, the second aim of the present study was to assess if a SLOW rate of initial weight loss was associated with a greater likelihood of achieving a 10% weight reduction at 18 months than a MODERATE or FAST rate of loss. We tested the hypothesis that women who lost at a SLOW initial rate would be more likely to achieve a 10% weight loss at 18 months.

A secondary aim of this study was to evaluate if overall rate of weight loss at one month was associated with weight reductions at both 6 and 18 months and weight regain from 6 to 18 months. We expected that weight loss at one month would be related to weight loss at both 6 and 18 months as well as weight regain between these two time points. Additionally, we sought to determine if rate of attendance and rate of adherence, as assessed by the number of program sessions attended and self-monitoring daily dietary records completed, respectively, during the first month of treatment were associated with weight loss at 1, 6, and 18 months, as well as with weight regain from 6 to 18 months. We hypothesized that both rate of attendance and rate of adherence within the first month of lifestyle treatment would be related to greater weight loss at 1, 6, and 18 months, but not with weight regain from 6 to 18 months. A final exploratory aim was to examine the rate of initial weight loss on both short- and long-term changes in blood

pressure (systolic), lipid profile (LDL-cholesterol and triglycerides), and glycemic control (HbA1c).

CHAPTER 2
MATERIALS AND METHODS

Research Methods and Procedures

The present study was a secondary analysis that utilized data collected in the TOURS (Treatment of Obesity in Underserved Rural Settings) project. TOURS was a randomized controlled weight-loss trial of behavioral interventions in six medically underserved rural counties in Northern Florida (Perri et al., 2005).

Participants

Participants were 298 obese women between the ages of 50 to 75 years (*M* = 59.3, *SD* = 6.2 years) with a mean baseline weight of 96.5 kg (*SD* = 14.9 kg) and Body Mass Index (BMI) of 36.8 kg/m^2 (*SD* = 5.0 kg/m^2). The majority of participants classified themselves as Caucasian (75.5%) followed by African American, (20.5%), Other (2.3%), and Hispanic/Latino (1.7%). The sample was well-educated, with 53.7% attending some college or receiving a college degree, and 9.7% achieving a postgraduate degree; the remaining 36.6% reported completing less than 12 years of education. Additional baseline demographic characteristics can be found in Table 2-1.

No upper limit was placed on BMI; however, the use of a standard balance beam scale required exclusion of women who weighed greater than 159 kg (350 lbs). Women were also excluded if they lost an excess of 4.5 kg (10 lbs) within the preceding six months. Additional exclusion criteria include cancer within the previous five years (except non-melanoma skin cancer), serious infectious disease, myocardial infarction, cerebrovascular accident or unstable angina within the past six months, congestive heart failure, chronic hepatitis, cirrhosis, chronic malabsorption syndrome, chronic pancreatitis, irritable bowel syndrome, previous bariatric surgery, history of solid organ transplantation, history of musculo-skeletal conditions that limit

walking, chronic lung diseases limiting physical activity, serum creatinin >1.5 mg/dL, anemia (hemoglobin <10 g/dL), or any additional condition likely to limit five-year life expectancy or interfere with lifestyle intervention. Diabetic women receiving active treatment were included with the approval of their primary provider, but women whose fasting blood glucose was >125 mg/dL at screening were not allowed to participate if they were not known to have diabetes. Regardless of medication treatment, women with fasting serum triglycerides >400 mg/dL and resting blood pressure >140/90 mmHg at screening were excluded. Use of antipsychotic agents, monoamine oxidase inhibitors, systemic corticosteroids, human immunodeficiency virus or tuberculosis antibiotics, chemotherapeutic drugs, or weight-loss drugs also was exclusionary. Women who indicated a major psychiatric disorder or excessive alcohol intake, and those who were unwilling or unable to provide informed consent, unable to read English at a fifth grade level, participating in another randomized research project, or unwilling to accept random assignment were also not allowed to enroll.

Procedure

Participants in the TOURS study were recruited through direct mailings, newspaper announcements, and presentations at community centers and events. Telephone screenings were conducted with prospective participants, and those that passed the initial eligibility screening were scheduled for an in-person baseline visit. At this visit, eligible women received a detailed explanation of the study and provided their informed consent. Additionally, participants completed questionnaires on demographic information, medical history, current medication inventory, dietary intake, physical activity, health-related quality of life, depressive symptoms, and problem-solving skills. Assessments of height, weight, and abdominal girth as well as resting heart rate, blood pressure, and blood-draw for serum analysis were taken. To determine functional mobility, the 6 Minute Walk Test (6MWT) was administered. Within two weeks of

the first group session, participants completed a pre-start visit to ensure weight stability prior to treatment and to repeat the 6MWT. Only the results from the second walk test were used to reduce the potential impact of practice. An additional blood-draw was conducted on those women who had gained or lost greater than 4.5 kg to ensure their metabolic profile had not changed from baseline. All measures were repeated after six months of the intervention and at study conclusion after a total of 18 months.

The TOURS Intervention

The TOURS lifestyle modification intervention consisted of two phases. Phase I included 24 weekly group intervention sessions (10 to 15 participants per group) held at Cooperative Extension Offices in six rural counties in Northern Florida. Each session lasted 90 minutes and was designed to decrease caloric intake and increase moderate intensity physical activity to facilitate a weight loss of approximately 0.4 kg/week. Dietary goals involved reducing energy intake by 500 to 1000 kcal per day, maintaining a balanced diet consisting of 25% to 30% total kcal from fat, 15% from protein, and the remaining 60 to 65% from carbohydrates. Participants were also encouraged to increase fruit and vegetable consumption to five servings per day and whole grains to three or more servings per day. Physical activity goals focused on attaining 180 minutes of moderate intensity exercise per week, or 30 minutes per day for six days per week. Pedometers were supplied and participants were encouraged to add 3000 or more steps per day above baseline levels. Participants were also instructed to maintain detailed daily written records of their dietary intake and physical activity.

Phase I also included cognitive and behavioral skills training for weight loss that consisted of self-monitoring, goal-setting, self-reinforcement, stimulus control, cognitive restructuring, and increasing social support. Weekly sessions included a private weigh-in, a review of participants' progress toward goals, a discussion of nutrition and exercise, feedback

and encouragement from group leaders and other group members, and skills training related to the behavioral strategies for weight loss.

Because these interventions were conducted in rural counties, they were also tailored to special issues of rural southern women and included cooking demonstrations every other session to illustrate low-fat, low-calorie food preparation, with special focus on Southern Cooking. Additionally, sessions included stress and depression coping strategies and techniques for eating away from home. The specific dietary objectives of the TOURS intervention were derived from the Therapeutic Lifestyle Changes recommended in the Adult Treatment Panel III Report of the National Cholesterol Education Program (2001). The physical activity goals and methods are based on recommendations of the Surgeon General (US Department of Health and Human Services, 1996) and the American College of Sports Medicine (2001).

Phase II consisted of an extended care 12-month follow-up program in which participants were encouraged to maintain the new eating and exercise habits learned during the Phase I intervention. Participants were encouraged to continue monitoring dietary intake and physical activity through the use of record logs. At the beginning of Phase II, participants were randomized to one of three extended-care programs: an office-based (in-person) maintenance program, a telephone-based maintenance program, or an educational (mail) control condition. All participants received contact twice per month in the form of group sessions, telephone contact, or biweekly newsletters, respectively.

Measures

Body weight. Weight was measured to the nearest 0.1 kilogram using a certified balance beam scale. Participants were weighed at weekly group sessions and at assessments at Month 0, 6, and 18 while wearing light indoor clothing, without shoes, and with empty pockets. Weight

change scores were calculated by subtracting participants' weight at 6 and 18 months from Month 0 and by subtracting weight at 18 months from six months.

Blood pressure. A Registered Nurse (RN) obtained participants' resting systolic and diastolic blood pressure using a standardized protocol (Chobanian et al., 2003). Three blood pressure readings, spaced one minute apart, were taken, and the last two readings were averaged for the analysis. If a large discrepancy was observed between the last two readings, an additional reading was taken and the median for the final three readings was used. For the present study, only systolic blood pressure was examined because of its relation to cardiovascular disease risk (Prospective Studies Collaboration, 2002; Vasan et al., 2001). It has been estimated that a three mm Hg reduction in systolic blood pressure leads to reductions of 8% in stroke mortality and 5% in coronary heart disease mortality (Stamler, 1991).

Blood analyses: LDL-cholesterol, triglycerides, HbA1c. The study RN drew blood samples, which were sent to Quest Diagnostics Clinical Laboratories for metabolic and lipid profile analysis. From the metabolic profile, Hemoglobin A1c (HbA1c), which is a more durable measure than fasting glucose (Centers for Disease Control and Prevention, 2001), was used to measure glycemic control. Glycemic control has been highly related to diabetes risk (American Diabetes Association, 2001). From the lipid profile, LDL-cholesterol and triglycerides were used to assess cardiovascular disease risk. Triglycerides and LDL-cholesterol each constitutes independent components of overall lipid control (Tanne, Koren-Morag, Graff, & Goldbourt, 2001), and each contributes independently to cardiovascular risk (National Cholesterol Education Program, 2001). Lowering LDL-cholesterol and triglycerides can significantly reduce the risk of stroke, coronary events, coronary artery procedures, and mortality (National Cholesterol Education Program, 2001).

Caloric intake. The Block 95 Food Frequency Questionnaire, a revised version of a previously validated survey (Block et al., 1986), asks respondents to estimate consumption of a wide variety of foods. Scoring yields estimates of daily caloric intake, macro- and micro-nutrient intake and intake by specific food groups (e.g. fruits, vegetables, grains, etc.). The Block has been strongly correlated with four-day food records (Subar et al., 2001). Estimated daily caloric intake was taken for Month 0. Caloric intake within the first month was assessed according to daily written food records kept by each participant.

Physical fitness. Participants completed the 6 Minute Walk Test (6MWT), a performance-based measure of physical fitness used in populations with low exercise capacity (e.g., elderly persons, those with functional limitations) and for whom rigorous fitness tests like treadmill exercise tests would be inappropriate (Peeters & Mets, 1996). Participants walked for six minutes along a clearly marked indoor course and were asked to cover as much ground as possible. Distance walked was measured to the nearest foot. The 6MWT was completed twice during a screening visit, and the first results were discarded due to known practice effects. The 6MWT has been shown to be highly reliable in populations with low exercise capacity (Kervio, Carre, & Ville, 2003) and to have convergent validity, as suggested by a strong correlation with peak oxygen uptake during maximal exercise testing (r = .68; Zugck et al., 2000). Physical fitness within the first month of treatment was assessed according to the number of steps recorded by participants on pedometers.

Attendance. Session attendance was recorded if the participant arrived at the treatment session and was weighed by a staff member.

Adherence. Because self-monitoring of dietary intake and physical activity has been considered a critical aspect of behavioral treatment programs (Baker & Kirschenbaum, 1993;

Boutelle & Kirschenbaum, 1998; Brownell, 2000; Wing, 1998), participants were asked to complete food and activity records daily throughout Phase I and at least three times per week during Phase II of the study. The total number of food records maintained serves as a better predictor of successful weight loss than actual content (Streit, Stevens, Stevens, & Rössner, 1991). For the present study, the total number of daily records completed was used as a measure of adherence to the intervention. Because participants did not return food diaries during the first week of the treatment program, adherence was calculated according to the number of food records kept between weeks two and four.

Statistical Analyses

Weight-Change Categories

Participants were classified according to their rate of weight loss during the first month of the intervention. Change scores were calculated by subtracting Month 1 weight values from Month 0 values. These numbers were then divided by four to achieve an average weekly rate of weight loss. Participants were then categorized as "FAST" ($\geq$ 0.68 kg/week [$\geq$ 1.5 lb/week]), "MODERATE" ($\geq$ 0.23 and < 0.68 kg/week [$\geq$ 0.5 and < 1.5 lb/week]) and "SLOW" (< 0.23 kg/week [< 0.5 lb/week]) weight losers. Only those women (n = 230) that had values at Month 0, 1, 6, and 18 were included in the present study.

Primary Aims

Weight change scores (kg) were calculated to establish both short-term (Month 6 values – Month 0 values) and long-term weight reduction (Month 18 values – Month 0 values) and weight regain (Month 18 values – Month 6 values). To determine if a SLOW rate of initial weight loss is better associated with weight loss than a MODERATE or FAST rate, we conducted one-way ANOVAs utilizing the aforementioned weight change scores as outcome variables. Family-wise

error was constrained to α = .05, *r* was calculated to measure effect size of associations, and Bonferroni corrections were applied to control the risk of type I error.

To assess whether those in the SLOW group were more likely than the MODERATE or FAST groups to achieve a 10% weight reduction at 18 months, percent change scores were calculated ([Month 18 values – Month 0 values]/ Month 0 values * 100), and Pearson's chi-square tests were conducted. Cramer's *V* was utilized to determine strength of associations. Family-wise error was once again constrained to α = .05. Odds ratios were also calculated to measure effect size of associations.

Secondary Aims

To evaluate our secondary aims of whether overall weight loss, attendance, and adherence at one month of treatment were associated with weight change scores both short- and long-term, Pearson's correlation analyses were conducted utilizing α = .05. Change scores were calculated as defined above using values at Months 0, 6, and 18 for systolic blood pressure (mm Hg), LDL-cholesterol (mg/dL), triglycerides (mg/dL), and HbA1c (%). One-way ANOVAs were conducted to examine whether those in the SLOW group attained greater reductions in metabolic risk factors at 6 and 18 months. Family-wise error was again constrained to α = .05, *r* was calculated to measure effect size of associations, and Bonferroni corrections were applied to control the risk of type I error.

All statistical analyses were conducted using SPSS statistical software (version 15.0).

Table 2-1. Baseline demographic characteristics of the sample of 298 women

	M	*SD*
Age (years)	59.3	6.2
Weight (kg)	96.5	14.9
BMI (kg/m²)	36.8	5.0
	n	%
Race/ethnicity (%)		
Caucasian	225	75.5
African American	61	20.5
Hispanic American	5	1.7
Other	7	2.3
Education		
≤ 12 years	109	36.6
Some college/college degree	160	53.7
Post-college	29	9.7
Total income		
< $20,000	66	22.1
$20,000–34,999	73	24.5
$35,000–49,999	62	20.8
$50,000–74,999	57	19.1
$75,000–99,999	24	8.1
> $99,999	10	3.4
Do not know/Did not report	6	2.0

CHAPTER 3
RESULTS

Weight-Loss Groups

Of the original 298 TOURS participants, 36 were excluded because they did not have a recorded weight at one month. Additionally, one participant had no recorded weight at six months and 31 did not have recorded weights at 18 months and thus were excluded from the present study. Therefore, the sample was composed of 230 obese women and categorized according to amount of weight loss at Month 1. The average weekly weight loss for the FAST, MODERATE, and SLOW group were -1.0, -0.5, and -0.0 kg, respectively.

Characteristics by Weight-Loss Group

Women in the FAST group (n = 55) were more likely to be Caucasian than those in the MODERATE group (n = 96; χ^2 (1) = 7.6, $p < .01$, Cramer's $V = 0.27$) and SLOW group (n = 79; χ^2 (1) = 17.2, $p < .001$, Cramer's $V = 0.37$). No additional baseline demographic differences were found among groups on age, BMI, weight, or education (Table 3-1). As assessed by the Block 95 Food Frequency questionnaire and the 6MWT, the weight-loss groups did not differ on baseline measurements of caloric intake and physical fitness. Participants in each group also did not vary on any metabolic risk factor at pre-treatment. Pre-treatment levels for each weight-loss group can be seen in Table 3-2. At the conclusion of six-month behavioral treatment, women were randomized to a Phase II follow-up program involving in-person, telephone, or mail contacts. No significant differences in Phase II assignment were found among weight-loss groups, χ^2 (4) = 2.1, $p = .71$, Cramer's $V = 0.07$.

Primary Aims

Initial Rate of Weight Loss and Weight Outcomes

Weight outcomes (means and standard errors) for all groups at Month 0, 6, and 18 are illustrated in Figure 3-1.

Month 0 to Month 6

Of the variables examined in the study, race/ethnicity and attendance rate within the first month of behavioral treatment were found to be related to net change in weight at Month 6 (ps < .05), thus an ANCOVA was conducted to assess group differences. At the conclusion of active treatment, the FAST, MODERATE, and SLOW groups differed significantly from each other with regard to net mean weight changes (-13.9, -9.6, and -5.9 kg, respectively; $F(2, 225) = 33.91$, $p < .001$, $r = 0.45$). Bonferroni-corrected comparisons showed that women in the SLOW group lost significantly less weight than those in the FAST and MODERATE groups (ps < .001).

An additional retrospective ANCOVA was conducted to assess if group differences in net mean weight change at six months remained when only the Caucasian participants (n = 178) were analyzed. Attendance rate within the first month was once again found to be a covariate ($p < .01$). Results indicate that the FAST, MODERATE, and SLOW group differences in net change in weight at six months remained significant when the sample was limited to Caucasians ($F(2, 174) = 20.98$, $p < .001$, $r = 0.43$). Bonferroni-corrected comparisons indicate that Caucasian women in the FAST and MODERATE groups lost significantly more weight at six months than Caucasian women in the SLOW group ($p < .001$ and $p < .05$, respectively)

Month 6 to Month 18

From conclusion of behavioral treatment to 18-month follow-up, amount of weight regain was assessed among groups. Results of a one-way ANOVA indicate the FAST, MODERATE,

and SLOW groups did not significantly differ in net weight regain (2.5, 1.8, and 1.1 kg, respectively; $F(2,227) = 0.77$, $p = .46$, $r = 0.08$).

Month 0 to Month 18

With regards to change in weight from pre-treatment to 18-month follow-up, results of a one-way ANOVA show significant differences existed among FAST, MODERATE, and SLOW weight loss groups (-11.5, -7.8, and -4.8 kg, respectively; $F(2, 227) = 11.05$, $p < .001$, $r = 0.30$). Bonferroni-corrected comparisons indicated that women in the SLOW group lost significantly less weight overall than those in the FAST ($p < .001$) and MODERATE ($p < .05$) groups.

10% Weight Loss at Month 18

As successful weight loss maintenance is often defined as $\geq$ 10% reduction in body weight maintained for at least one year, a chi-square analysis was conducted to assess whether the SLOW group was superior at attaining this goal at 18-months. Results (Figure 3-2) indicate that the FAST group was more likely to achieve a 10% body weight reduction at Month 18 than was the SLOW group (58.2% vs. 20.3%, respectively; χ^2 (1) = 20.29, $p < .001$, Cramer's V = 0.39). Similarly, the MODERATE group was superior in reaching this goal when compared to the SLOW group (38.5% vs. 20.3%, respectively; χ^2 (1) = 6.87, $p < .01$, Cramer's V = 0.20). Odds ratios indicate that those who, within the first month of behavioral treatment, lost weight at a FAST rate were 5.5 times more likely to achieve successful weight loss maintenance at 18-months than those who lost at a SLOW rate. Those who were categorized as MODERATE were 2.5 times more likely to attain a 10% reduction at 18-months than those in the SLOW group.

Secondary Aims

Initial Weight Loss, Attendance, Adherence and Weight Outcomes

Results of Pearson's correlation analysis indicate that initial weight loss occurring within the first month of the behavioral treatment program proved to be significantly related to net

weight change at both 6 and 18 months (*p*s < .001). No correlation was found between initial change in weight during Month 1 and weight regain between Months 6 and 18 (Table 3-3). Similarly, number of weekly sessions attended and adherence within the first month of treatment were examined in relation to net weight change at Months 1, 6, and 18 and also weight change between Months 6 and 18. First month attendance was significantly correlated to net weight change at both one and six months ($p < .05$ and $p < .001$, respectively), but not to18 months or change between 6 and 18 months (Table 3-3). Similar results were found for first month adherence rate (*p*s < .001; Table 3-3).

Initial Rate of Weight Loss and Metabolic Risk Factors

At both 6 and 18 months, no significant differences among the FAST, MODERATE, and SLOW weight loss groups were found in changes of triglycerides, LDL-cholesterol, systolic blood pressure, and HbA1c levels (all *p*s > .05; Figure 3-3). As a retrospective analysis, Pearson's correlation coefficients were calculated to assess whether initial weight loss occurring within the first month of treatment was significantly related with net change in any of the metabolic risk factors at both 6 and 18 months. Results indicate that only initial rate of weight loss and change in HbA1c from Months 0 to 6 were significantly correlated ($r = 0.16$, $p < .05$).

Initial Rate of Weight Loss, Attendance, Adherence, Caloric Intake, and Physical Activity

Additional retrospective analyses were conducted to assess whether first-month attendance and adherence were significantly different among weight-loss groups. Similarly, one-way ANOVAs were also performed to assess whether the FAST, MODERATE, and SLOW groups differed according to self-reported average daily steps (calculated by individual pedometers) and caloric intake within the first month of treatment. The homogeneity of variance assumption was violated for both first-month attendance and adherence (*p*s < .001) and caloric

intake ($p < .05$); therefore, the Brown-Forsythe F-ratio is reported. Both attendance and adherence within the first month of behavioral treatment were found to be significantly different among weight-loss groups ($F(2, 205) = 3.78$, $p < .05$, $r = .17$ and $F(2, 123.1) = 19.13$, $p < .001$, $r = .37$, respectively; Table 3-4). Bonferroni-corrected comparisons indicate that differences in first-month attendance approached significance for the SLOW versus FAST groups ($p = .052$). With regards to adherence, post-hoc analyses indicated that the SLOW group completed significantly fewer food records than did women in both the FAST and MODERATE groups, and the MODERATE group completed significantly fewer records than the FAST group (ps < .001).

No significant differences were found among the groups on average daily caloric intake ($p = .32$) or average number of daily steps ($p = .07$) within the first month of treatment (Table 3-4). However, results of one-way ANOVAs assessing differences among the FAST, MODERATE, and SLOW groups in caloric intake and steps solely during the fourth week of treatment indicate groups did begin to diverge. Both caloric intake and steps at Week 4 were significantly different among groups ($F(2, 183.8) = 10.42$, $p < .001$, $r = .29$ and $F(2, 220) = 3.26$, $p < .05$, $r = .17$, respectively, Table 3-5). Bonferroni-corrected comparisons indicate the SLOW group took in significantly more calories than both the FAST and MODERATE groups (ps <.001).

Table 3-1. Baseline demographic characteristics of participants in FAST, MODERATE, and SLOW groups

	FAST *n* = 55		MODERATE *n* = 96		SLOW *n* = 79	
	M	*SD*	*M*	*SD*	*M*	*SD*
Age (years)	59.4	6.2	59.1	6.4	58.9	6.2
Weight (kg)	97.2	15.1	96.1	15.0	96.2	15.0
BMI (kg/m²)	37.0	4.7	36.8	5.1	36.6	4.9
	n	%	n	%	n	%
Race/ethnicity						
Caucasian	51	92.7	74	77.1*	53	67.1**
African American	1	1.8	19	19.8	24	30.4
Hispanic American	2	3.6	1	1.0	2	2.5
Other	1	1.8	2	2.1	0	0.0
Education						
≤ 12 years	25	45.5	35	36.5	27	34.2
Some college/ college degree	27	49.1	53	55.2	42	53.2
Post-college	3	5.5	8	8.3	10	12.7

Note: * $p < .01$, ** $p < .001$

Table 3-2. Pretreatment caloric intake, physical fitness, and metabolic risk factor levels for FAST, MODERATE, and SLOW groups

	FAST *n* = 55		MODERATE *n* = 96		SLOW *n* = 79	
	M	*SD*	*M*	*SD*	*M*	*SD*
Caloric intake (kcal)	1802.6	662.1	1708.0	676.1	1726.3	617.7
Physical fitness (ft)	1419.5	177.2	1395.4	186.5	1413.7	186.8
Systolic blood pressure (mm Hg)	125.7	10.2	126.1	8.9	124.9	8.9
Triglycerides (mg/dL)	148.8	59.0	148.0	62.3	139.0	65.6
LDL-cholesterol (mg/dL)	124.0	26.8	124.5	30.6	118.2	29.9
HbA1c (%)	5.9	0.5	5.9	0.7	6.0	0.8

Table 3-3. Behavioral correlates of weight loss

		Month 0 to 1 (kg)	Month 0 to 6 (kg)	Month 0 to 18 (kg)	Month 6 to 18 (kg)
	M ± *SD*	*r*	*r*	*r*	*r*
Month 0 to 1 (kg)	-1.8 ± 1.6		0.58**	0.31**	-0.11
First month attendance	3.8 ± 0.5	-0.14*	-0.23**	-0.07	0.11
First month adherence	19.0 ± 3.9	-0.34**	-0.27**	-0.09	0.13

Note: * $p < .05$, ** $p < .001$

Table 3-4. First month attendance and adherence rates for FAST, MODERATE, and SLOW groups

	FAST *n* = 55		MODERATE *n* = 96		SLOW *n* = 79	
	M	*SD*	*M*	*SD*	*M*	*SD*
Attendance	3.9*	0.4	3.8	0.4	3.6	0.6
Adherence	20.6**	1.3	19.7**	2.7	17.1**	5.4
Calories (kcal)	1444.9	612.4	1391.1	217.0	1496.0	378.1
Steps	4704.0	2133.5	4720.8	2292.5	4006.0	2076.7

Note: *$p = .052$ for FAST vs. SLOW, **$p < .001$ for FAST vs. SLOW, FAST vs. MODERATE, and MODERATE vs. SLOW

Table 3-5. Week 4 average caloric intake and steps for FAST, MODERATE, and SLOW groups

	FAST *n* = 55		MODERATE *n* = 96		SLOW *n* = 79	
	M	*SD*	*M*	*SD*	*M*	*SD*
Calories (kcal)	1192.7**	196.0	1241.6**	224.1	1378.9	309.3
Steps	5499.6	2410.6	5419.8	2474.1	4580.5	2257.8

Note: **$p < .001$ for FAST vs. SLOW and MODERATE vs. SLOW

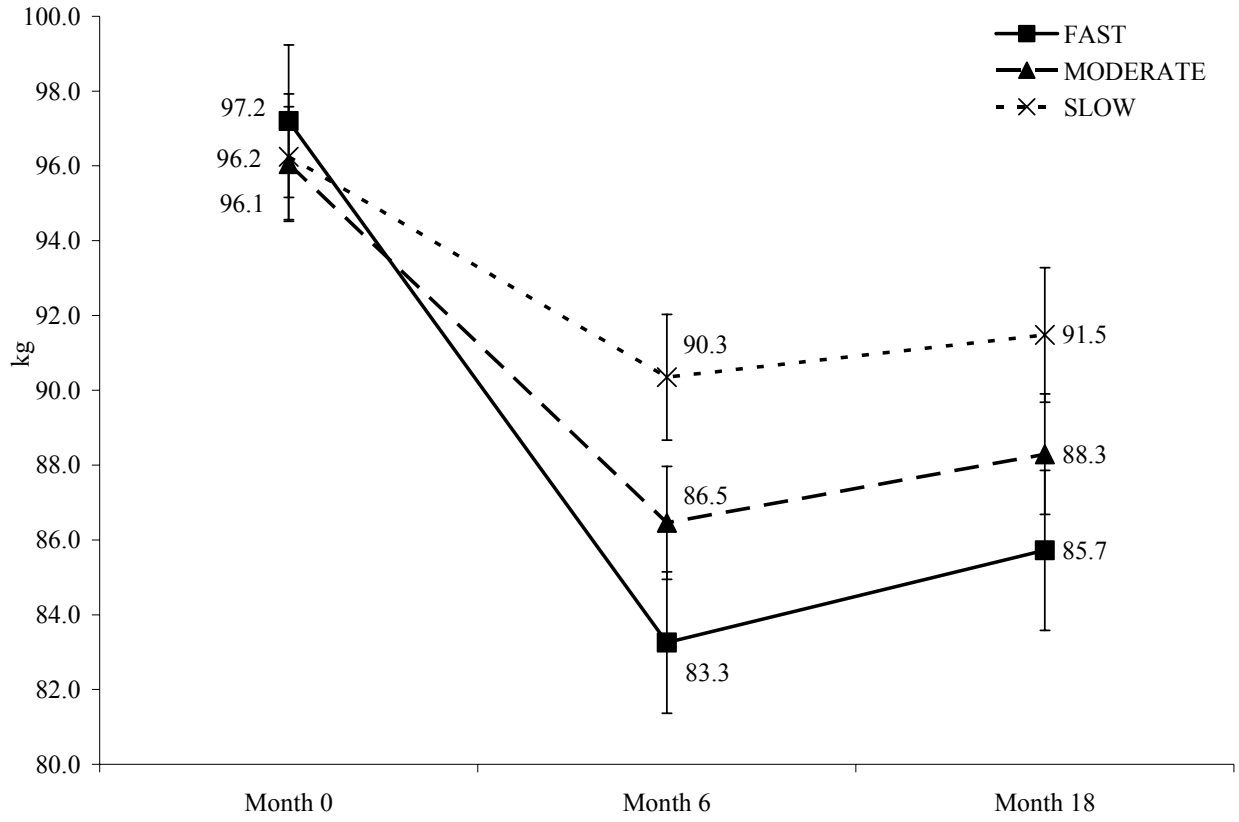

Figure 3-1. Weight changes according to weight-loss group. (Means and Standard Errors) Significant within-group changes were observed from Month 0 to 6 and from Month 0 to 18, *p*s < .001.

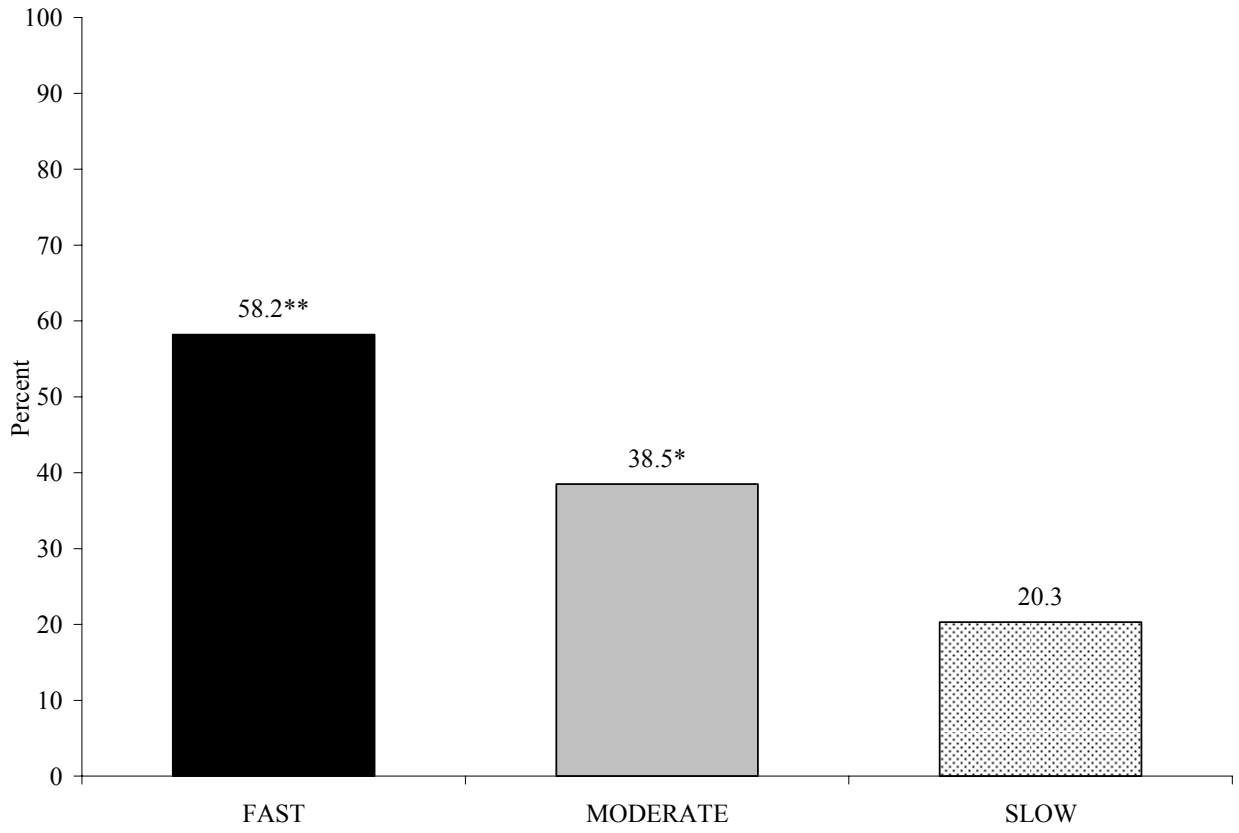

Figure 3-2. Percentage of weight-loss groups attaining a 10% reduction at Month 18. Both the FAST and MODERATE groups were significantly different from the SLOW group. Note: *$p < .01$, **$p < .001$.

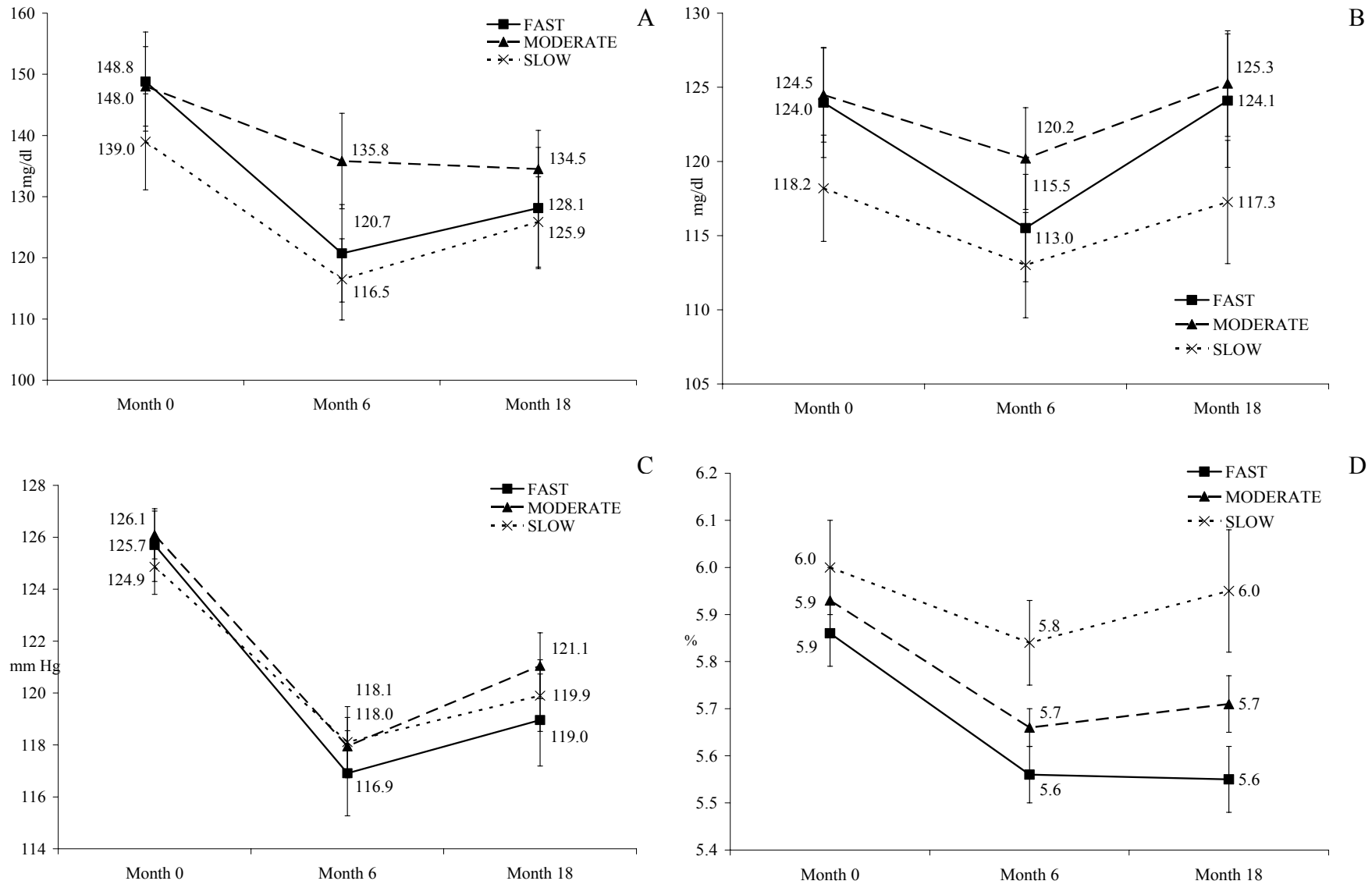

Figure 3-3. Net changes in metabolic risk factors (Means and Standard Errors). A) Triglycerides. B) LDL-cholesterol. C) Systolic Blood Pressure. D) HbA1c.

CHAPTER 4
DISCUSSION

Primary Aims

The present study examined the effect of rate of weight loss during the first month of a six-month behavioral treatment program on long-term (18-month) success in weight management in obese women ages 50-75. With regards to our primary aims, there were 3 key findings. First, women who lost at FAST ($\geq$ 0.68 kg/week [$\geq$ 1.5 lb/week]) and MODERATE (< 0.68 and $\geq$ 0.23 kg/week [< 1.5 and $\geq$ 0.5 lb/week]) rates during the first four weeks of treatment achieved significantly greater net changes in weight at both 6 and 18 months than women who lost weight at a SLOW rate (< 0.23 kg/week [< 0.5 lb/week]). These findings are consistent with previous research demonstrating that larger initial weight losses are associated with greater long-term weight loss success (Astrup & Rössner, 2000; Carels et al., 2003; Elfhag & Rössner, 2004; Fogelholm et al., 1999; Jeffery et al.,1998; Stotland & Larocque, 2005; Wadden et al., 1992). Specifically, Jeffery et al. (1998) separated a sample of 130 men and women into tertiles of maximum achieved weight loss. Those in the highest tertile lost an average 0.68 kg/week while those in the middle and low tertiles lost at slower rates (0.58 and 0.29 kg/week, respectively). These rates are comparable to those used in the present study, illustrating that weight outcomes favor those who initially lose the most weight. Racial differences were observed, with those in the FAST group more likely to be Caucasian than those in the MODERATE and SLOW groups. Race/ethnicity was also significantly related to net weight change at six months, but not 18 months, of treatment. These results are consistent with previous findings in which African Americans tend to lose weight at a slower initial rate, but equalize with their Caucasian counterparts later in treatment (Kumanyika et al., 2002; Newton & Perri, 1997; Wing & Anglin, 1996; Yanovski, Gormally, Lesser, Gwirtsman, & Yanovski, 1994).

Second, it has been well documented that weight loss usually slows following six months of behavioral treatment (Jeffery et al., 2000; Wing, 2002), and weight regain begins (Perri, 1998; Wadden et al., 2004). Contrary to the research completed by Jeffery et al. (1998) and others (Sbrocco et al., 1999), participants in the present study who lost at a greater initial rate did not experience greater amounts of weight regain from end of treatment at six months to 18-month follow-up. This effect could be explained with the present study design's incorporation of a year-long extended care regimen where participants received continuing contact. Extended care has been shown to enhance long-term progress (Perri & Corsica, 2002), and it is believed that continuing contact may provide the "overlearning" that is necessary for long-term habit changes to become fully ingrained for long-term weight loss success (Latner et al., 2000). Other studies that have demonstrated greater weight regain in participants who lose more initially did not incorporate a continuous care model. Because those who lose larger amounts of weight are more susceptible to regain (McGuire et al., 1999; Weiss et al., 2007; Wing & Hill, 2001), our results support the notion that "overlearning" long-term habit changes through extended care is necessary to maintain large initial weight losses.

Third, as the National Heart, Lung, and Blood Institute (1998) defined successful weight loss maintenance, the present study examined whether women who lost weight at a SLOW initial rate were more likely to achieve a 10% weight reduction at 18 month follow-up than those who lost at MODERATE and FAST initial rates. Only 20.3% of the SLOW group attained a 10% weight loss in the year following active behavioral treatment compared to 38.5% of the MODERATE group and 58.2% of the FAST group. These results do not support the hypothesis that the SLOW group was more likely than the MODERATE or FAST group to achieve a 10% weight reduction at 18 months. Additionally, odds ratios indicate that those women who lost at

FAST and MODERATE rates were 5.5 and 2.5 times more likely than the SLOW weight losers to achieve a successful 10% weight loss long-term.

Taken together, these results do not support the slow weight loss hypothesis. Losing weight at a SLOW initial rate does not appear to lead to greater long-term weight loss and/or to lesser amounts of weight regain. Losing at a slow initial rate may be less reinforcing to participants than losing at a moderate or fast initial rate. For example, Carels et al. (2003) assessed quality of life factors, such as general appearance and body image, physical mobility, energy, and perceived health, during the fourth week of a weight loss treatment program and found that improvement on these variables were positively associated with weight loss at end of treatment. Therefore, satisfactory early initial weight loss and the related positive quality of life changes may serve as reinforcers/motivators, increasing healthy behaviors and healthy habit learning, and leading to successful weight loss maintenance. Conversely, unsatisfactory early weight loss has been associated with poor treatment outcomes (Carels et al., 2003; Wadden & Letizia, 1992). This suggests that when the shaping of healthy behavior occurs slowly, the changes may be too small, and therefore the reinforcement value may not be great enough to promote learning and long-term habit change.

Secondary Aims

Attendance and Adherence

With regards to our secondary aims, weekly attendance during the first month of the weight-loss treatment was found to be related to net weight change at both one and six months. These findings support results from previous studies, suggesting that good attendance within the first few weeks of treatment is associated with better weight loss outcomes at the end of the treatment period (Carels et al., 2003; Wadden et al., 1992). However, we did not find that

attendance within the first month of treatment correlated with weight maintenance at 18 months. When assessing attendance throughout the entirety of treatment programs, others have shown that percentage of sessions attended serves as a good predictor of success at one-year follow-up (Wadden et al., 1992). This suggests that, for the present study, assessing attendance within the initial four weeks of the six-month program may not have been a sufficient time period to predict 18-month weight loss.

Adherence, as measured by number of completed self-monitoring daily food records, during the first month of active treatment was also associated with net weight change at both one and six months. Results are consistent with the argument that self-monitoring of caloric intake is one of the most critical components of behavioral weight-loss treatment (Baker & Kirschenbaum, 1993; Boutelle & Kirschenbaum, 1998; Brownell, 2000; Wing, 1998). Participants who lost weight at a SLOW initial rate turned in significantly fewer food records during the first month of treatment than did women in the FAST and MODERATE weight loss groups, highlighting the importance of this behavior. However, this could also be related to attendance in that those who were absent did not turn in food records. As with attendance, adherence during the first month of treatment was not related to 18-month net weight change, once again suggesting that four weeks may not serve as a sufficient time period for this variable to predict long-term success.

Additionally, daily average number of steps and calories within the first month of treatment did not differ among groups; however, an assessment of these variables solely during Week 4 of the treatment program indicated that the groups did begin to diverge, with the FAST and MODERATE groups taking in significantly fewer calories and recording a higher average number of steps than the SLOW group. Together, results of attendance, adherence, caloric

intake, and steps suggest that women who lost weight at a SLOW initial rate may have been less motivated to make large behavioral changes than those who lost at both MODERATE and FAST initial rates.

Metabolic Risk Factors

Finally, the present study also explored whether differences exist among our weight loss groups with regards to metabolic parameters. At both 6 and 18 months, we found no difference in triglycerides, LDL-cholesterol, systolic blood pressure, and HbA1c among the FAST, MODERATE, and SLOW groups. Additionally, we found that rate of weight loss within the first month of treatment correlated only with net change in HbA1c at six months. No other correlations between rate of weight loss within the first month and net change in metabolic risk factors existed at either 6 or 18 months. Others have found similar results in that weight loss during an initial four week period did not influence two year changes in cardiovascular risk factors (Rissanen, Lean, Rössner, Segal, & Sjöström, 2003). While large randomized clinical trials like the DPP (Diabetes Prevention Program Research Group, 2002) and TOHP (Stevens et al., 2001) showed that modest weight changes can result in beneficial changes in health related parameters, our results suggest that four weeks may not be sufficient in predicting long-term changes in metabolic risk factors.

Limitations

There are four potential limitations to the present study. First, this study did not employ a prospective, randomized design to assign participants to the FAST, MODERATE, and SLOW weight-loss categories. Our results are consistent with previous studies that indicate a greater initial rate of weight loss leads to long-term success (Astrup & Rössner, 2000; Carels et al., 2003; Elfhag & Rössner, 2004; Fogelholm et al., 1999; Jeffery et al.,1998; Stotland & Larocque, 2005; Wadden et al., 1992). However, there is some evidence that prescribing faster initial rates

of weight loss may not produce better long-term outcomes. For example, Toubro and Astrup (1997) prospectively randomized one group of obese women to eight weeks of low energy diet (500 kcal/day) and another group to 17 weeks of a conventional hypocaloric diet (1200 kcal/day) so as to achieve similar weight losses at varying rates. Those on the low energy diet experienced weight loss at approximately twice the rate of the conventional dieters, but groups did not significantly differ in weight maintenance measured at one year follow-up. Similarly, Wadden and colleagues (1994) randomly assigned women to either a balanced deficit diet (1200 kcal/day) condition for 52 weeks of a behavioral treatment program or to a very-low-calorie diet (420 kcal/day) for the initial 16 weeks and a balanced deficit diet thereafter. At six months, women on the very-low-calorie diet experienced nearly twice the initial weight loss as those on the balanced deficit diet; however, during the following year of extended care, women who were prescribed the very-low-calorie diet regained significantly more weight. At 18 month follow-up, the groups no longer differed with regards to net weight loss. These results suggest that utilizing methods to attain fast initial weight losses may not lead to successful long-term weight maintenance.

A second limitation of the current study involved its limited assessment of how the weight-loss groups achieved their initial rates of weight loss. While associations were found between one-month rate of weight loss and both one-month attendance and adherence, and significant differences were discovered among groups in both caloric intake and steps at Week 4, other factors that constitute significant components for weight-loss lifestyle interventions, such as nutritional content (National Cholesterol Education Program, 2001), were not formally assessed.

Third, intrinsic motivators, such as change in general appearance, improvement in body image, increased energy, and perceived enhancement of health within the first month of behavioral treatment have previously been linked to long-term weight loss success (Carels et al., 2003), but also were not measured in the present study. Therefore it is not possible to separate these additional factors that may affect weight loss within the first month of behavioral treatment from rate of weight loss. Future studies that prospectively assign initial rates of weight loss and assess modalities of achieving this weight loss are warranted.

Finally, the study is also limited by the population assessed; namely, only women between the ages of 50 and 75 were included in our sample. Generalizability therefore is limited by the exclusion of men and individuals of younger age groups. Additionally, those with serious health conditions, such as hypertension or uncontrolled diabetes, were excluded from study participation, causing a truncated range of values for metabolic risk factors. This may lead to a floor effect by which participants with less severe metabolic impairment can achieve only incremental reductions and individuals with more significantly elevated risk factors experience greater improvements.

Clinical Implications

Our study has important clinical implications with regards to behavioral treatments for weight loss. While traditional behavioral treatment programs for obesity often result in a reduction of body weight that is associated with clinically significant benefits in health-related parameters, weight regain is considered "the single greatest challenge in the long-term management of obesity" (Perri, 1998). As Brownell (1984) suggested, identifying early predictors of long-term weight loss success could assist in tailoring programs so as to enhance treatment outcomes, but research thus far has illustrated that few of these predictors exist (Teixeira et al., 2005). Results from our study support the notion that losing weight at a fast rate

(≥ 0.68 kg/week [≥ 1.5 lb/week]) early in treatment is a strong predictor for long-term weight loss, and that losing at a slow initial rate (< 0.23 kg/week [< 0.5 lb/week]) may be associated with a lower long-term weight loss. Additionally, this study provides unique evidence that suggests, within the context of lifestyle treatment where energy intake exceeds 1000 kcal/day, the amount of weight regain does not differ based upon early rates of weight loss. Losing weight at a fast initial rate was not associated with greater relapse following active treatment when compared to those who lost lesser weight at a slower initial rate. It is therefore suggested that substantial efforts be focused on the first few weeks of behavioral weight-loss treatment programs.

Because small behavioral changes early in treatment may not provide enough reinforcement value (i.e. slow weight loss) to result in long-term habit change, leaders of lifestyle interventions should encourage and motivate participants to make significant behavioral and environmental changes within the first month of the program so as to induce high rates of weight loss. The experience of observing a rapid change in body weight may serve as a reinforcer, resulting in a faster rate of habit change and greater long-term weight loss. Participants should also be reinforced for attendance and adherence as those two variables were found to be related to first month weight change. In sum, these findings suggest that, within the context of a lifestyle treatment, a high rate of initial weight loss is associated with long-term success in weight management.

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BIOGRAPHICAL SKETCH

Lisa Marie Nackers was born on February 11, 1982 in Appleton, Wisconsin. Her family owned a farm in Wrightstown, Wisconsin, where she worked while growing up with both an older and younger brother. She graduated from Wrightstown High School in 2000. She attended college at the University of Wisconsin—Eau Claire and took the opportunity to study abroad for a semester in Dalkeith, Scotland. In 2004, Lisa graduated summa cum laude with a B.A. in psychology and accepted an Intramural Research Training Award fellowship at the National Institute of Diabetes and Digestive and Kidney Diseases within the National Institutes of Health (NIH). She conducted basic research on the metabolic functions of the $G_s\alpha$ protein in mice for one year before accepting another NIH fellowship at the National Center for Complementary and Alternative Medicine. Here, she spent one year assessing neuroendocrine function in men with osteoarthritis pain. In fall 2006, Lisa entered the doctorate program in clinical & health psychology at the University of Florida and is currently researching weight loss interventions for obesity. In conjunction with pursuing her Ph.D., Lisa is also working toward her master's in public health at the University of Florida.