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Long-term follow-up of an 8 week weight loss intervention: Impact of psychosocial factors

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Long-term follow-up of an 8 week weight loss intervention: Impact of psychosocial factors

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CHAPTER 1: INTRODUCTION

U.S. overweight and obesity rates have reached epidemic proportions. Since 1960 obesity rates have climbed 262% among adults over the age of 20 (CDC, 2010). Additionally, rates of overweight and obesity in industrialized nations across the globe are mimicking and even surpassing those of the U.S. with 50-97% of populations being effected (WHO, 2010). As Body Mass Index (BMI) increases, so too does the risk of developing a number of preventable chronic diseases such as: Type II Diabetes, hypertension, cardiovascular disease, and cancer. Of these conditions, heart disease, stroke, and diabetes contribute to over 50% of the top 10 leading causes of death. In addition, health related expenditures have skyrocketed to $147 Billion dollars per year (CDC, 2010). This translates to approximately 42% higher healthcare expenses for obese individuals compared with those of normal weight individuals (BMI 18-24.9 kg/m2) (CDC, 2010).

Effective interventions for the treatment of obesity are of vital importance to slow, stop, and potentially reverse the obesity epidemic. Unfortunately, there is no easy solution. In a very basic sense weight gain is caused by a positive energy balance, or consuming more calories than are expended through physical activity. However, obesity is a complex and multi-faceted condition that is also influenced by the interplay of genetic and environmental factors as well as a variety of complex social and cultural influences. Research has shown individuals respond differently to treatment (Ball et al., 2011), however, multi-level approaches that incorporate behavior modification techniques have been shown to be more effective than traditional low calorie diet prescription alone (Dansinger, Gleason, Griffith, Selker, & Schaefer, 2005). A fundamental challenge in this area of research is that successful weight loss treatments do not necessarily translate into successful long term weight maintenance. One study reported as few as 20% of participants maintain significant weight loss after one year (Toobert, Glasgow, Nettekoven, & Brown, 1998). Therefore, a critical need in obesity research is to identify factors that are important for long term weight maintenance. If identified, it may be possible to incorporate appropriate training and support needed to improve outcomes.

One strategy for determining key factors for weight loss maintenance is to determine what people who have successfully maintained significant weight loss long term have done previously. The National Weight Control Registry (NWCR) is one such resource. The registry reveals a diverse array of techniques used to lose weight by its members, but it has

also identified factors that appear to be consistently associated with successful weight maintenance (Phelan, Wing, Loria, Kim, & Lewis, 2010). These include self-monitoring food intake, eating breakfast, participating in regular physical activity, and limiting screen time. In an extensive review of literature, Elfhag and Rossner (2005) identified these same characteristics (physical activity, eating at regular intervals, selecting healthier foods, and self-monitoring), but they also emphasize psychological factors including successful stress coping strategies and a healthy concern for body weight and appearance.

The literature reveals many factors that may influence successful weight maintenance, but social support seems to play a particularly important role. Numerous studies have shown social support to have an overall positive impact on both weight loss and long-term weight loss maintenance (Elfhag & Rossner, 2005; Smith et al., 2009; Buclin-Thiebaud, Pataky, Bruchez, & Golay, 2010; Verheijeden, Bakx, van Weel, Koelen, & van Staveren, 2005; Gorin et al., 2005; Wing & Jeffery, 1999; Toobert, Glasgow, Nettekoven, & Brown, 1998; Leahey, Gokee LaRose, Fava, & Wing, 2010; Christakis & Fowler, 2007), while very few have demonstrated an inverse relationship or lack of effect (Svetkey et al., 2011; Napolitano & Hayes, 2011). In examining characteristic differences between those whom have successfully maintained weight loss and those whom have regained, maintainers demonstrate better adherence to weight control practices (Gorin et al., 2005; Paisley, Beanlands, Goldman, Evers, & Chappell, 2008; boutin-foster, 2005), have greater confidence in their ability to maintain weight, report higher levels of social support (Elfhag & Rossner, 2005), and are more likely to enlist social support (Gallagher, Jakicic, Napolitano, & Marcus, 2006). The literature also reveals social support is associated with lower attrition from weight loss interventions (Wing, Marcus, Epstein & Jawad, 1991, Verheijeden, Bakx, van Weel, Koelen, & van Staveren, 2005). In one study, completion rate at 10 month follow-up was as high as 95% for participants recruited with support partners compared to 76% of participants recruited alone (Wing & Jeffery, 1999).

In addition to better program retention, social support has been shown to facilitate weight loss and maintenance in research studies through a variety of mechanisms including group support (Gorin et al., 2005; Elfhag & Rossner, 2005), friend or spouse recruitment (Gorin et al., 2005; Paisley, Beanlands, Goldman, Evers, & Chappell, 2008), and through telephone (Smith et al., 2009), or in-person contact with health professionals (Buclin-Thiebaud, Pataky, Bruchez, & Golay, 2010; Van Dorsten & Lindley, 2008; Dansinger,

Gleason, Griffith, Selker, & Schaefer, 2005). Participants recruited with one or more support partners lost over one-third more weight and were more likely to keep the weight off than participants working alone (64% versus 24%) (Wing & Jeffery, 1999).

Self-efficacy has been widely accepted as an important factor in adherence to health behaviors, including those related to acute weight loss. For example, participants who had lost at least 10% of their baseline weight reported significantly higher levels of self-efficacy for physical activity than participants that lost less than 5% of baseline weight (Gallagher, Jakicic, Napolitano, & Marcus, 2006). Higher levels of self-efficacy for physical activity have also been shown to be a discriminating variable between women that lost versus gained weight during a print-media based intervention (Napolitano & Hayes, 2011). However, studies have shown self-efficacy for maintaining new eating and exercise habits decreases over time, as well as adherence to those behaviors (Linde, Rothman, Baldwin, & Jeffery, 2006), which can negatively impact weight control efforts. Therefore, in order to improve adherence to lifestyle changes promoting long term weight maintenance, it is important to identify strategies to improve self-efficacy beyond the intervention period.

Social support may be one approach for improving self-efficacy of health behaviors. Toobert, Glasgow, Nettekoven, and Brown (1998) observed post-intervention declines in self-efficacy for diet and exercise behaviors in both the intervention group, which encouraged social support, and the usual care control group. However, scores were significantly lower at 4 and 12 month follow-up periods in the usual care group. Another study demonstrated that positive social support was associated with higher levels of self-efficacy and this was associated with better performance during a golf tournament. However, the effect was only significant when performing under stress and rendered unimportant when stress levels were low (Rees & Freeman, 2009). This indicates that social support may be most crucial during challenging or stressful times. With regard to weight loss, social support may be most needed when will power is low or when faced with temporary setbacks.

Despite the importance, long term weight loss maintenance research is limited and often contains inconsistent methodologies or poor tracking of outcome variables such as weight, adherence to health behaviors, social support, or self-efficacy. In some cases, the use of financial incentives may confound any observed effects from social support (Wing &

Jeffery, 1999; Wing, Marcus, Epstein & Jawad, 1991). Maintenance research is also limited by insufficient power due to relatively small samples (Toobert, Glasgow, Nettekoven, & Brown, 1998). An additional limitation is that few studies have examined the impact of social support on long term weight maintenance following a multi-level weight loss intervention approaches (Svetkey et al., 2011). This type of research is needed to determine the relative effectiveness of different treatment approaches for promoting long-term weight maintenance.

Purpose

The purpose of this study was to evaluate the impact of self-efficacy and social support on the maintenance of weight loss in obese adults following a randomized, controlled weight loss trial. The study was conducted as a follow-up evaluation of a recently completed 8 week guided weight loss intervention conducted by researchers at the Nutrition and Wellness Research Center (NWRC). The modified Bon Sante Weight Loss program was a randomized 8 week clinical weight loss trial examining the relative effectiveness of 1) a guided behavior change program (modified Bon Sante curriculum) based on principles of motivational interviewing, 2) a self-monitoring program using the SenseWear™ Pro Mini-Fly Armband and associated online tracking software, and 3) a combined program including both the guided program and self-monitoring tools. A recent study examining clinical outcomes (Walsh, 2011), revealed that while all three groups lost weight, there was no statistically significant difference between the three groups. A follow-up study (Paulson, 2011), examined changes in psychosocial outcomes based on behavior constructs from Prochaska's Transtheoretical Model (stages of change). Participants in the guided behavior change program demonstrated higher levels of self-efficacy, suggesting the modified Bon Sante curriculum had a positive impact on their confidence in making healthier lifestyle choices. Comparison of initial pre-post data revealed psychosocial outcomes were only weakly associated with weight loss. Additional work is needed to examine the impact of behavioral skills and social support on long term weight maintenance.

The present study addresses this need by examining the maintenance of weight loss 4 months following completion of the intervention. The study addresses two main research questions:

1. *What is the impact of self-efficacy on maintenance of weight loss?* This question will be answered by examining whether increases in self-efficacy during the trial would be associated with maintenance of weight loss in the 6 month follow-up. The hypothesis is that higher levels of self-efficacy will be associated with greater weight maintenance (i.e. less weight re-gain) in the 6 month follow-up.

2. *What is the impact of social support on the maintenance of weight loss?* This question will be answered by collecting additional information about the degree of perceived social support that the participants had during the 6 month follow-up. The hypothesis is that individuals reporting favorable social support will have better weight maintenance (i.e.. less regain) in the 6 month follow-up.

The results of this study will help determine if self-efficacy and social support help individuals maintain or continue weight loss following guided and self-monitoring interventions. This information will help determine how to enhance the long term efficacy of weight loss studies. It will also directly determine the possible influence of social support on retention of weight loss in behavioral interventions.

CHAPTER 2: REVIEW OF LITERATURE

The purpose of this review is to provide background on obesity, current obesity treatments, their efficacy in long term weight loss maintenance, and an examination of psychosocial factors related to weight maintenance outcomes.

Obesity

Obesity has become one of the most important public health concerns in recent decades, posing significant long term health and economic risks. Currently, estimates suggest that approximately 30% of all Americans are obese (having a Body Mass Index (BMI) $\geq$ 30 Kg/m^2) (CDC, 2010). Obesity is associated with increased risks for chronic diseases such as Type II Diabetes, heart disease, hypertension, stroke, and reduced quality of life. Because of these associations, public health reports list obesity as the second leading cause of preventable death, just behind smoking (NICHD, 2006). The economic impact of obesity is alarming when considering that obese individuals incur 42% higher healthcare costs than someone of normal weight (BMI 18-24.9 Kg/m^2) over a lifetime (CDC, 2010).

Causes of overweight and obesity are complex and multi-factorial - involving the interplay of genetic, environmental, and behavioral factors. However, in a very basic sense, obesity is caused simply by a positive energy balance (more calories consumed than expended). Traditional weight loss approaches have focused on educating patients to reduce caloric intake and exercise regularly. However, traditional dietary prescriptions emphasizing only caloric or food restriction have typically been unsuccessful with individuals often returning to original energy intake following removal of the intervention (Dansinger, Gleason, Griffith, Selker & Schaefer, 2005). The purpose of this review is to examine the behavior modification approaches used in weight loss programs and to determine the factors that lead to more successful weight loss outcomes.

Components of Effective Weight Maintenance Programs

Weight regain is a significant issue following weight loss interventions (MacLean et al., 2009). Approximately one third of weight lost is regained the first year, and as much as 50% of those who have lost significant amounts of weight will return to original weight within five years (Von Dorsten & Lindley, 2008; MacLean et al., 2009). As previously discussed weight loss has been shown to produce positive changes in blood pressure, body composition, total cholesterol, and insulin sensitivity among others, (Riebe et al., 2005) however, these health benefits are only sustained with weight loss maintenance (Pasanisi et al., 2001). Therefore, it is important to

identify factors or treatment methods that predict successful weight maintenance. For the purposes of this review, weight maintenance will be considered weight stability following a loss of at least 5% of total body weight for at least one year (Von Dursten & Lindley, 2008), and treatment methods will be limited to lifestyle and behavioral approaches as opposed to surgical or pharmacological methods.

The factors contributing to the high incidence of weight regain are not fully understood, but some of the more commonly studied influences are metabolic rate and efficiency, hormonal response, adherence to weight control strategies, accountability, psychological effect of food, obesogenic environment, stress management, and depression (Von Dorsten & Lindley, 2008; Rolls, Roe, Meengs & Wall, 2004). Having a low baseline RMR has been associated with weight regain in some studies (Vogels, Diepvens, & Westerterp-Plantenga, 2005), but did not predict regain in others (Weinsier et al., 2000). At present, there are no models or mechanisms that explain or predict rates of weight regain. Other approaches may be needed to examine this issue since weight loss in only important if it can be maintained.

Individuals who have succeeded in maintaining weight loss may provide valuable insight into the most effective methods for keeping the weight off. The National Weight Control Registry, a database containing thousands of people whom have succeeded in long-term weight loss, has collected survey responses from its registrants for nearly two decades - in hopes of identifying factors consistent for long-term weight loss. Surprisingly, the registry reveals a diverse array of techniques used to initially lose weight, but has identified possible key factors associated with long term maintenance including self-monitoring food intake, eating breakfast, participating in physical activity, and limiting screen time (Raynor et al., 2006). In an extensive review of literature, Elfhag and Rossner (2005) identified these same characteristics (physical activity, eating at regular intervals, selecting healthier foods, and self-monitoring), but they also emphasized psychological factors including successful stress coping strategies and a healthy concern for body weight and appearance. Clearly, long-term behavior change is necessary for weight loss maintenance. Therefore, it is important to determine the most effective treatment methods to sustain behavior change.

Traditional dietary prescriptions emphasizing only caloric or food restriction to achieve long term weight loss have been largely unsuccessful as individuals often return to original energy intake following removal of the intervention (Dansinger, Gleason, Griffith, Selker & Schaefer, 2005). This suggests that weight maintenance requires consideration of the overall

energy balance relationship and contributions from both diet and physical activity. In a comprehensive meta-analysis, Wu, Gao, Chen, & van Dam (2009) examined the effectiveness of different intervention approaches on both acute and long-term weight loss. Using outcome measures of both weight and BMI, the researchers determined that diet and physical activity combined interventions are more effective for both acute and long-term weight loss. The long-term (2 year) results from combined programs were significantly better than those produced by diet only, but the degree of weight loss maintained was still low (1.64 kg on average).

While it is unrealistic to believe all weight maintenance programs will be successful, it is impossible for a program to succeed if no one is following it. Attrition and program adherence are major obstacles in weight loss maintenance research, but few studies have sought to specifically study the factors that explain maintenance of weight loss. Interventions incorporating techniques to elicit social support or direct involvement of social support partners have shown significant decreases in attrition (Verheijeden, Bakx, van Weel, Koelen, & van Staveren, 2005), and better adherence to eating and physical activity behaviors (Toobert, Glasgow, Nettekoven, & Brown, 1998). Until recently, studies examining long-term interventions or follow-up for weight maintenance were difficult to find. However, as rates of regain became more established, interventions began incorporating long-term follow-up or extended health professional contact (Gorin et al., 2005). While results often confirmed participant's gradual return to pre-intervention behaviors over time (Riebe et al., 2005), some studies are providing novel information, such as the relationship between weight loss partner success and weight maintenance (Gorin et al., 2005), which may become new weapons in the battle of the bulge. Another promising trend in weight maintenance research is the use of theory-based behavioral modification interventions.

Psychological Theories in Health Behavior Modification

Traditionally, health practitioners used authoritarian, informational, or scare tactic models to achieve behavior change (Rollnick, Miller, & Butler, 2008). Current research has emphasized theory-based approaches that take into account psychosocial factors influencing behavior change. It is widely believed there is a complex relationship between lifestyle behaviors and environment, socioeconomic status, psychosocial and interpersonal factors affecting weight loss and maintenance. Therefore, behavior modification strategies typically utilize psychological theories or models that help to explain or predict individual behavior. There is no consensus about the best method, but two of the most commonly studied approaches include the Transtheoretical Model (TTM) (DiClemente & Prochaska, 1982) and Social Cognitive Theory (SCT) (Bandura, 1986). Additional information will be provided about TTM, SCT since

constructs from these theories and measurement models were used to evaluate the weight loss intervention evaluated in the present study.

Transtheoretical Model

TTM, also referred to as Stages of Change (SOC), was developed by DiClemente and Prochaska (1982) to explain observed differences between smokers and successful quitters in tobacco cessation programs. Since its inception, application of TTM in clinical research has expanded to include alcohol and drug abuse, depression, eating disorders, high-fat diets, sedentary behavior, and obesity (Glanz, Rimer, & Viswanath, 2008). The core constructs of SOC are stages and processes of change, decisional balance, self-efficacy, and temptation. The model is made up of six stages including: 1) precontemplation (unaware of risks of their behavior, has no intention to change), 2) contemplation (aware of risks and benefits of their behavior, intend to change within next six months, but perceive significant barriers to change), 3) preparation (Intend to change behavior in very near future, have taken measures to seek help, information, or equipment to aid in behavior change), 4) action (has made one or more behavior changes within last six months), 5) maintenance (behavior changes have been adopted for at least six months, individuals are more confident about continuing new behaviors and are focused on preventing relapse), and 6) termination (behavior change has become automatic with no risk of temptation, but will not be discussed further as it is rarely used in research)(Glanz, Rimer, & Viswanath, 2008).

Processes of Change are viewed as actions, experiences, attitudes, and beliefs that help people to move through the stages. According to the theory, there are ten distinct Processes of Change: 1) consciousness raising (increased awareness of consequences and treatment of behavior), 2) dramatic relief (emotional response which can be reduced or alleviated through action), 3) self-reevaluation (re-assessment of one's self-image in context of the behavior or absence of behavior), 4) environmental reevaluation (assessment of how one's actions can effect environment or persons in their environment) 5) self-liberation (confidence in the ability to change and commit to action), 6) social liberation (an increase in resources or opportunities that enable change), 7) counterconditioning (substituting healthier behavior for unhealthy behavior), 8) stimulus control (removal of negative cues to reduce unhealthy behaviors or adoption of positive cues to enable healthy behaviors), 9) contingency management (use of rewards or punishments), and 10) helping relationships (physical, cognitive, or emotional support enabling change)(Glanz, Rimer, & Viswanath, 2008).

Decision balance is an important construct within TTM. Decision balance is analogous to the concept of cost-benefit analysis, and relies on the pros and cons decision-making structure. Self-efficacy is another key construct and this refers to the confidence one has in performing or maintaining a specific behavior change. Self-efficacy and decision balance are constructs from SCT, but they were incorporated into TTM because they contribute understanding of the behavior change process.

Although originally designed for eliminating negative health behaviors (i.e. smoking) the TTM has been used successfully in the promotion of healthy behaviors, such as reducing dietary fat intake (Finckenor & Byrd-Bredbenner, 2000). In early studies, researchers compared the effectiveness of a pre-action stage intervention with pre-test/post-test, and post-test only control groups (also classified in pre-action stages at baseline). The intervention included a series of group-based lessons utilizing stage-matched processes of change over the course of 14 weeks. At post-test and one year follow-up, the treatment group demonstrated significant reduction in fat intake and progression through the SOC compared with control groups.

The use of the TTM framework in weight loss and maintenance interventions has demonstrated conflicting results. TTM was shown to promote significant weight loss and maintenance in a large randomized controlled study. Johnson et al. (2008) used a stage-matched multiple behavior change (healthy eating, exercise, and stress coping) weight loss intervention. Approximately 30% of the treatment group maintained at least 5% weight loss at 24 months, compared with 19% of the control group. However, Tuah et al. (2011) conducted a systematic review of literature examining randomized clinical trials utilizing the TTM framework for lifestyle modifications in the treatment of overweight and obesity. Their findings concluded that utilization of the TTM framework was inconsistent between trials and produced only minimal weight loss (no more than 2kg). The use of physical activity and dietary interventions in combination with TTM were more likely to produce significant outcomes, but they concluded there was insufficient evidence supporting the use of TTM in long term weight maintenance. These results indicate that lifestyle modification interventions based on the TTM framework, in conjunction with dietary and physical activity intervention techniques, can produce significant weight loss and maintenance. However, additional research is clearly needed to determine the most effective approach in using the TTM framework for lifestyle modification in a randomized controlled trial, for the treatment of obesity in adults.

Social Cognitive Theory

SCT was developed by Albert Bandura (1986) using principles of learning and information processing to explain human behavior (Glanz, Rimer, Viswanath, 2008). There are nine key concepts of SCT and these are grouped into five main categories: 1) psychological determinants of behavior, 2) observational learning, 3) environmental determinants of behavior, 4) self-regulation, and 5) moral disengagement (which will not be included in this review as this component is not applicable to weight control).

Psychological Determinants

Self-efficacy is the most widely known psychological construct of SCT. It is widely accepted as an important determinant of behavior change; so much so that researchers may be criticized for not including self-efficacy in studies examining factors in health behavior change. Outcome expectations are another key psychological construct in SCT. This is operationalized as the perceived value an individual places on a particular outcome (Glanz, Rimer, & Viswanath, 2008). It is common for those seeking to lose weight to have unrealistic weight loss goals, therefore researchers have sought to determine the importance of outcome expectations in weight loss maintenance.

In a review of literature by Elfhag and Rossner (2005), women were more likely to have unrealistic weight loss goals than men, and weight maintainers were more likely to have achieved their goal weight. Having a higher weight loss expectation was also associated with more long term weight loss, confidence and optimism in weight loss success. These results were supported by another review (Barte…2010) that suggested that weight retention was better in groups that lost more weight (>10% original body weight) rather than less weight loss (5-10% original body weight). The inability to achieve weight loss goals could also result in discouragement, perceived lack of weight control, and subsequent abandonment of weight loss efforts (Elfhag & Rossner, 2005).

Observational Learning

Observational learning refers to learning behaviors through modeling of family, peers, and media. According to Bandura (1997) the observation of others, who are similar to oneself, successfully performing a specific behavior increases confidence in one's own ability to perform the behavior. The literature did not reveal any studies using the observational learning construct for the treatment of weight loss or maintenance. However, it has been widely adopted in sports to aid in learning new skills and improving performance. Law and Hall (2009) found improvements in self-efficacy in the areas of skill achievement and mental self-regulation;

factors identified as important in weight loss maintenance (Elfhag & Rossner, 2005). According to SCT, observational learning is dependent on the perceived value of both the model and outcome of behavior. While the intervention was not based on SCT, Gorin et al. (2005) found that participants with support partners who lost weight were more likely to achieve greater weight loss than those with partners who did not lose weight. They also showed participants were likely to achieve the best weight loss if the support partner lost at least 10% of their original body weight. This study supports the observation that models may have greater influence over one's behavior if they are similar to the observer (Glanz, Rimer, & Viswanath, 2008).

Environmental Determinants of Behavior

The use of rewards or punishment (incentive motivation), is a key environmental determinant of behavior according to SCT. Incentives are widely used (generally very successful) to motivate behavior change in corporate wellness programs (Butterworth, Linden, & McClay, 2007). However, it has proven difficult to understand the impact of incentives when used in controlled weight loss studies. This is because the incentive may confound some of the underlying psychosocial mechanisms. For example, Wing, Marcus, Epstein and Jawad (1991) attempted to examine the effect of a family-based lifestyle intervention for weight loss in Type II Diabetics. They instituted a $150 deposit for all groups, which could be earned back through weight loss goals and attendance. However, without a non-financially supported control it is impossible to separate treatment effects of social support from a financial incentive.

Another key environmental influence is facilitation - provision of a service or materials which reduce barriers to behavior change. A study by Boutin-Foster (2005) examined the importance of different types of support in a sample of patients with coronary artery disease. Participants reported support for grocery shopping, preparation of food, and taking over specific daily responsibilities as most helpful for achieving new health behaviors. The concept of facilitation has been viewed as "social support" but the construct of social support may include other dimensions of influence. For example, numerous studies have shown positive effects from social support in weight loss interventions (Toobert, Glasgow, Nettekoven, & Brown, 1998; Verheijeden, Bakx, van Weel, Koelen, & van Staveren, 2005; Gorin et al., 2005; Wing & Jeffery, 1999; Wing, Marcus, Epstein, & Jawad, 1991), but it is unclear how much of the effects are the result of facilitation or other psychosocial factors. Regardless, these results indicate the importance of involving social support partners or teaching participants techniques to elicit social support for the facilitation of health behavior change. A broader discussion of social support is provided in a separate section since it forms the basis for the study.

Self-Regulation

Self-regulation is another key component in SCT that may be achieved through six strategies, 1) self-monitoring (observing one's own behavior), 2) goal-setting, 3) feedback, 4) self-reward (can include material or intangible rewards for one's own behavior), 5) self-instruction (technique of encouraging or coaching oneself before or during performance), 6) enlistment of social support (identifying and eliciting people that can encourage or facilitate behavior). Self-regulation has been identified as an integral component of weight loss and long-term weight maintenance, as successful maintenance requires adherence to weight control techniques (Elfhag & Rossner, 2005).

The most common types of self-monitoring in weight loss and maintenance are weighing oneself and recording food intake or physical activity. Webber, Tate, Ward & Bowling (2010) conducted a study examining the role of motivation in weight loss. They found high levels of motivation early in the weight loss intervention were strongly correlated to achieving $\geq$5% weight loss and greater adherence to self-monitoring. However, after analyzing the moderating effect of program adherence to self-monitoring versus motivation on weight loss, the authors found motivation was no longer significant. Self-monitoring of food intake and physical activity, however, was strongly correlated ($r = 0.66$; $P < .001$) with weight loss over 16 weeks. Likewise the National Weight Control Registry has identified self-monitoring of weight and food intake as characteristics of successful long-term weight maintenance (Klem, Wing, McGuire, Seagle, & O Hill, 1997). The various aspects of self-regulation are often emphasized as the basis of weight loss interventions since they can be actively taught.

Social Support

Although there appears to be some differences of opinion in the definition of social support (Verheijeden, Bakx, van Weel, Koelen, & van Staveren, 2005), it is generally recognized as the positive influence derived from the perception or realization of support from people within an individual's support network (spouse, family, friends, coworkers). In a review of social support interventions for weight loss spanning nearly two decades, researchers observed an overall positive effect of social support on weight loss outcomes when participants were recruited with support partners rather than as individuals. However, they also identified several weaknesses in the literature including: poor and inconsistent outcome measures, lack of SOC-based interventions, and a large number of interventions based on increasing social network size – which would not necessarily improve effectiveness or perception of social support.

Measuring Social Support in Weight Loss

The most commonly used tools to assess social support in studies examining adoption of healthy behaviors for weight loss are the Sallis, Grossman, Pinski, Patterson, and Nader (1987) Social Support and Eating Habits and Social Support and Exercise surveys (Svetkey, 2011; Napolitano & Hayes, 2011; Toobert, Glasgow, Nettekoven, & Brown, 1998; Wing & Jeffrey, 1999). The Eating Habits and Exercise surveys contain 10 and 13 statements, respectively, consisting of various positive and negative support behaviors related to eating or exercise. It is administered using a 5-point Likert scale ranging from 1 to 5 (1 = none, 5 = Very Often) with friends and family scored separately. Higher scores indicate higher perceived social support. Cronbach's alpha internal reliability coefficients for this survey ranged from 0.76 to 0.85 (Sallis, Grossman, Pinski, Patterson, & Nader, 1987).

Rieder and Ruderman (2007) developed a social support assessment tool specifically for use with weight management called the Weight Management Support Inventory (WMSI), but it has not been well supported in the literature as it has only been used in one other study, in modified form (Hwang et al., 2010). Therefore, it will not be included in this review.

Social Network Interventions

In order to examine the efficacy of utilizing social support networks for health behavior change, researchers have incorporated support partners such as spouses (Gorin et al., 2005; Paisley, Beanlands, Goldman, Evers, & Chappell, 2008; Toobert, Glasgow, Nettekoven, & Brown, 1998), and friends (Gorin et al., 2005, Paisley, Beanlands, Goldman, Evers, & Chappell, 2008) as part of interventions or relapse prevention. Toobert, Glasgow, Neetekoven, and Brown (1998) incorporated spouses into weekly participant dietary, exercise, stress management skills training and group support for two years, and found lower program attrition rates (attrition of participants 19%, spouses 29%) and significant improvements in health behaviors (lowered fat intake, lowered cholesterol intake, increased physical active), perceived positive social support, stress management, and coping strategies. These results indicate the involvement of a support partner may help participants adhere to weight control efforts - which are critical for weight maintenance.

In another study (Gorin et al., 2005), researchers encouraged participants to invite up to three friends to take part in a 6 month weight loss intervention, in order to determine whether the number of support partners influenced weight loss outcomes. There was no significant difference in participant weight loss between those recruited with friends or without friends, and the number of partners had no effect on participant weight loss outcomes. However, weight loss

was strongly correlated between the participant and their support partner, if that partner was successful at losing weight. The effect was observed post-intervention at 6 months, and again at 12 and 18 month follow-ups. Participant weight loss was greatest if one or more support partners lost at least 10% of their initial body weight during the initial 6 month intervention. This study supports the construct of vicarious experience, and demonstrates the importance of identifying factors that may predict weight loss outcomes in order to maximize participant weight maintenance success.

Smith et al. (2009) showed minimal weekly support (10 minute phone call) from a trained health professional resulted in better adherence to the prescribed eating plan ($P < 0.05$), increased participant motivation ($P < 0.0001$), greater satisfaction with the program ($P = 0.004$), and more weight loss ($P = 0.045$) than the treatment group receiving no weekly support. Physical activity, however, was not significantly different between the two groups. This study showed that even minimal support from a health professional can improve eating behaviors and motivation leading to greater weight loss. Unfortunately, this type or amount of support does not appear sufficient to increase physical activity which could help sustain weight loss over the long term.

Targeted Support

Holmes (1981) identified four modes of social support, including: 1) instrumental (babysitting so a friend can exercise), 2) emotional (empathizing with a loved one's situation), 3) informational (providing instruction in healthy cooking techniques), and 4) appraisal (sharing the belief that exercise is an important part of a healthy lifestyle). However, most social support outcome studies have analyzed perceived overall support, as opposed to identifying specific types of support perceived as most beneficial. This is likely due to variability in relationships and individual support needs, which could be difficult to measure or result in outcomes that may be ungeneralizable. For example, Marcoux, Trenkner, and Rosenstock (1990) recruited participants from a behavioral modification weight loss trial to attend a relapse prevention program with three month follow-up. Participants completed social support surveys based on five social contacts they perceived as important to their weight loss success. Responses to the survey questions indicated family and spouses were the top two categories for most and least helpful for weight control (based on categories of: family, spouse, friends, coworkers, neighbors, and other), with 40% of participants rating family and spouses in both categories. Participants also indicated "Others" in their support network as the top source of weight control interference, a category whose members were not identified in further detail by the authors.

Attempts to identify the most helpful form of social support were, likewise, inconclusive. Participants in Marcoux, Trenkner, and Rosenstock's (1990) study rated appraisal and emotional support as most helpful, with appraisal being strongly correlated with weight loss. Another study (Paisley, Beanlands, Goldman, Evers, & Chappell, 2008) identified behaviors of significant others perceived by participants as most helpful for maintaining prescribed dietary changes, including: preparing or buying food (instrumental), adopting dietary changes themselves, and providing motivation (appraisal). Interestingly, significant others who made major changes to their own eating habits were more likely to perceive those changes as critical to improving their partner's health, than significant others who made little or no change to their own diet. This may indicate the importance of not only involving social support partners in weight loss research, but also creating a sense of importance or urgency in their role and providing training to help them become an effective support member.

However, it seems, not all social support is created equal. For example, Wing, Marcus, Epstein and Jawad (1991) recruited couples in which at least one partner had Type II Diabetes Mellitis, and targeted either both spouses for behavior modification weight loss program or one spouse alone. They found significant improvement in all outcome variables including weight loss, blood glucose, HbA1C, and eating habits for both treatments. However, when comparing sexes by treatment and weight loss they found men experienced greater success when treated alone, and women greater results when treated with their spouse. Furthermore, after tracking the spread of obesity within social networks across 32 years researchers found the nature and strength of relationships were more predictive of obesity trends rather than proximity to the person (Christakis & Fowler, 2007). These findings may indicate further research is needed to assess type and strength of relationships with social support contacts perceived as important for weight control, as well as sex-specific social support needs or gender role differences that may impact long term weight maintenance.

While most social support research has demonstrated an overall positive effect on health behavior change, Svetkey et al. (2011) found participants reporting lower levels of social support at initiation of a weight loss program achieved greater success in maintaining weight loss long term, than those reporting higher levels of social support. However, as the authors pointed out, the Social Support and Exercise and Social Support and Eating Habits Survey (Sallis, Grossman, Pinski, Patterson, & Nader, 1987) may not have been sufficient for identifying modes of social interactions that influence long-term weight maintenance. For example,

reporting higher levels of social support may be indicative of participants relying more on external rather than internal motivators.

Additionally, it is not always clear if high levels of social support have a direct positive impact on adoption of health behaviors, or if the perception of social support is increased through improvements in psychosocial factors. For example, an intensive long-term intervention to improve healthy lifestyle behaviors for the treatment of coronary heart disease in women, found participants perceived significantly more positive social support from family and friends at 12 months (P = 0.012) than at 4 months (P = 0.097) (Toobert, Glasgow, Neetekoven, & Brown, 1998). Simultaneously, participants demonstrated significantly increased implementation of stress management techniques at 12 months (P = 0.012), but not at 4 months (P = 0.071),which could explain the perception of increased social support if participants acquired skills and experience to more effectively communicate with their support network and reduce stress. It has also been hypothesized that achievement of desired goals would improve mood and therefore may also increase the perception of social support, but this was not the case in one study that found depressive symptoms and self-efficacy as the only two differentiating factors between participants that lost weight versus those that maintained or gained weight in the treatment group (Napolitano & Hayes, 2011).

Social support may be an important factor in health behavior change as it relates to self-efficacy or one's confidence in the ability to perform a specific task when faced with barriers. According to Rees and Freeman (2009) social support increased self-efficacy during a stressful competitive golf tournament, and was associated with better performance. The effect, however, was only significant with high levels of stress; when stress levels were reduced social support had no effect on self-efficacy. These results demonstrate that social support may be a critical for success in weight maintenance during times of stress.

Relationship between Social Support and Self-Efficacy

Self-efficacy is the confidence in one's ability to perform a task when faced with barriers. As previously discussed, self-efficacy is a key component of Bandura's SCT, but has also been integrated into multiple behavior change theories including TTM, Theory of Planned Behavior, and the Health Belief Model. A popular and widely used construct for many behavior-based interventions, Bandura (1997) theorized self-efficacy to be the product of past performance, vicarious experiences, social persuasion, and physiological or emotional states. It is also directly related to or enhanced by social support.

Rodgers, Hall, Blanchard, McAuley, and Munroe (2002) proposed that the construct of self-efficacy should be expanded from task performance (i.e.. adherence to healthy eating and exercise behaviors) to modes of self-regulation (i.e.. confidence in the ability to overcome barriers or manage time effectively) that may enable the individual to perform the desired task. Statistical analyses supported the existence of two types of self-efficacy for exercise: 1) task and 2) scheduling. The researchers attempted to determine if one or both were related to exercise intention or behavior. They found task self-efficacy was significantly related to intention to exercise, while scheduling self-efficacy was strongly related to exercise behavior, even more so than intention. Results of this study indicate the importance of not only assessing participant self-efficacy for specific health behaviors, but also perceived control over time and ability to prioritize and plan specific positive health behaviors related to weight loss and long-term weight maintenance.

While self-efficacy is commonly associated with performing health behaviors (Napolitano & Hayes, 2011), high levels of self-efficacy have not been specifically associated with long-term weight maintenance. Linde, Rothman, Baldwin, and Jeffery (2006) observed that higher levels of self-efficacy for health behaviors (increased fruit and vegetable intake and physical activity, and decreased fat intake) were associated with increased performance of these health behaviors and weight loss. However, these effects were only observed during the 8 week intervention and immediately post-intervention. Self-efficacy and weight control behaviors during active treatment were not associated with weight change at 6 month follow-up. Therefore, it is important to determine factors that can improve long-term self-efficacy, and subsequent performance of health behaviors important for weight maintenance. According to a study conducted by Toobert, Glasgow, Nettekoven, and Brown (1998), social support may be a critical factor in maintaining long-term self-efficacy. In a two year study comparing usual care to a behaviorally based lifestyle intervention incorporating social support partners, researchers observed decreases in self-efficacy for dietary and exercise behaviors from 4 to 12 months in both groups. However, the behavioral intervention group experienced a smaller decrease in self-efficacy, and increased perception of positive social support when compared to the usual care group.

Currently, there is a lack of research examining the impact of social support on self-efficacy in weight loss maintenance. However, there are a few studies examining self-efficacy for behaviors related to weight control. In a study examining the effect of three print-based interventions to increase physical activity in women, researchers found two psychological

variables that could discriminate between women that lost weight, gained weight, or remained weight stable at the 12 month follow-up. These factors were depressed mood and physical activity self-efficacy. Interestingly, women who had lost or gained weight reported a mean change in self-efficacy of approximately 0.33, but for women who were weight stable there was no significant change. Although self-efficacy was not significantly different between women that lost or gained weight, there was a significant difference in the amount of physical activity reported (170 minutes versus 93 minutes, respectively). In addition, women that gained weight scored much higher for depressed mood (M = 4.47; SD = 1.58) compared with women who lost weight (M = 1.3; SD = .95) or remained stable (M = .47; SD = 0.66). These results indicate that self-efficacy was not a predictor of physical activity behavior, and also that future studies should screen for depressive symptoms. The present study will help to better understand possible associations between social support and self-efficacy as well as the subsequent influences of social support and self-efficacy on maintenance of weight loss.

Bon Sante Weight Loss Trial

The present study will evaluate the long-term weight loss outcomes resulting from a randomized controlled weight loss trial. The trial evaluated the effectiveness of a behaviorally-based weight loss program with and without the use of supplemental self-monitoring device designed to promote self-regulation of weight loss. A sample of 78 participants were randomized into 3 different conditions and followed for 8 weeks to examine differences in clinical and behavioral outcomes. Detailed summaries from the previous analyses conducted on the study are provided since they provide important context for the present study.

Clinical Outcomes

The primary outcome report (Walsh, 2011) from the trial examined the clinical outcomes and weight loss at the end of the study. Significant trial effects were observed for anthropometric measures (weight, body fat, and waist circumference) and various clinical outcomes (e.g. blood pressure and blood lipids). There was a significant trial effect for weight loss across the 8 week study period. (M = -4.21 kg; SD = 3.08; $p < 0.01$). There were also significant trial effects for improvements in body composition [percent body fat ($p = 0.01$) and waist circumference ($p < 0.01$)], diastolic blood pressure ($p < 0.01$), total cholesterol ($p < 0.01$), triglycerides ($p < 0.01$), and blood glucose ($p < 0.01$) following the 8 week intervention. There were non-significant group by trial interactions which indicated that all 3 groups had similar outcomes. Overall, the reported weight change (9.26 lbs or 4.21 kg) equates to an average loss of 1.16 lbs per week. These results are consistent with current recommendations for healthy

rate of weight loss (1-2 lbs per week). While there were no significant differences between the three treatments for either anthropometric or clinical outcomes, there was some evidence for larger effects for the guided weight loss plus self-monitoring tool intervention group. This is consistent with previous literature (Shuger et al., 2011; Polzien, Jakicic, Tate, & Otto, 2007) demonstrating greater weight loss when using the self-monitoring tool with behavior modification compared with behavior modification alone. The lack of statistical significance between treatment groups may have been due to insufficient power (n = 26 participants per treatment group).

The data were also analyzed for group interactions and effects of program compliance. Effect size analyses revealed only non-significant differences between treatment groups and group x gender interactions. Participant program compliance, determined by the average weekly Health Coach rating system, was moderately correlated with weight change (r = -0.37). These results support previous research showing higher program compliance has been associated with greater weight loss outcomes (Warziski & Sereika, 2008).

Behavioral Outcomes

A follow-up behavioral report (Paulson, 2011) from the trial reported on the changes in psychosocial outcomes from the study. Psychosocial outcome measures included constructs from SCT (self-efficacy) and TTM (stage of change, decisional balance, and cognitive and behavioral processes of change).

Participant self-efficacy was assessed using a 24 item questionnaire based on confidence in their own ability to overcome barriers to healthy eating and regular physical activity. It was administered using an 11-point Likert scale ranging from 0 “Not Confident” to 10 “Very Confident.” Self-efficacy improved across all groups over time for both eating (t = 3.99, p < 0.001) and physical activity (t = 3.37, p = 0.012). There were no significant differences in self-efficacy between treatment groups, but trend data showed larger effects for both eating and physical activity in treatment groups receiving weekly health coaching (guided and guided + self-monitoring groups), compared with self-monitoring alone. These results support previous research demonstrating an association between guided behavior change using motivational interviewing and improvements in self-efficacy for specific health behaviors (DiMarco, Klein, Clark, & Wilson, 2009; Hardcastle, Taylor, Bailey, & Castle, 2008).

Analysis of participant decisional balance (calculated difference between Pros and Cons of weight loss) demonstrated significant differences between treatment groups (p = 0.04) with

an increase in decisional balance for the combined treatment groups and decreases in the guided only and self-monitored only groups. An increase in decisional balance indicates participants perceived more benefits than consequences of weight loss efforts.

Significant trial effects were observed for cognitive processes of change ($p = 0.029$), and significant time effects were observed for behavioral processes of change ($p < 0.001$). Behavioral processes of change which increased significantly were: 1) counterconditioning, 2) interpersonal systems control (avoiding situations that can lead to undesired behavior), 3) reinforcement management, 4) self-liberation, and 5) stimulus control. Again, larger effects were found in groups receiving weekly health coaching (guided and combined groups). These results demonstrate the importance of the health coach-participant interaction in increasing participant use of behavior change techniques, a key factor in weight loss maintenance.

Behavioral Components of the Bon Sante Intervention

The present study examines the long term effects of the Bon Sante intervention. Additional detail is provided about the programming components to provide a justification for the hypothesized results and to facilitate interpretation of the results.

Bon Sante Weight Loss Program

The guided weight loss intervention utilized by the Nutrition and Wellness Research Center at Iowa State University in Ames, IA was adopted and modified, with permission, from the Bon Sante Weight Loss Program designed by Registered Dietitian Kathy Thames. The program was based on eliciting health behavior changes through weekly meetings with a health coach trained in Motivational Interviewing techniques. Meetings included, but were not limited to goal setting, problem solving, addressing skills identified as important for weight loss (i.e.. reading food labels, eating away from home, food cues, and social support), and reviewing participant motivation and progress towards behavior and weight loss goals. The key program components (Health Coaching, Nutrition, Physical Activity and Self-Monitoring) are described in greater detail below. This provides important context for the present study on long term weight loss outcomes and possible differences between groups.

Health Coaching

Health coaching is a relatively new technique in health behavior change. It has been defined by Butterworth, Linden, and McClay (2007) as “a behavioral health intervention that facilitates participants in establishing and attaining health-promoting goals in order to change lifestyle-related behaviors, with the intent of reducing health risks, improving self-management

of chronic conditions and increasing health-related quality of life." Currently, no health coach standardization of practice or credentialing currently exists; therefore, studies utilizing health coaching vary widely in their design and methodology. Health coaches can come from a wide variety of backgrounds ranging from health professionals with extensive education (Ball et al. 2011) and experience, to someone with little or no formal training. Intervention techniques can range from print-based models (Napolitano & Hayes, 2011) to comprehensive behavior modification therapy (Butterworth, Linden, & McClay, 2007).

Easily and effectively administered across a variety of modalities (one-on-one, groups, by telephone, internet, or a combination) and environments (workplace, community, clinical) along with the ability to address multiple health risk behaviors (smoking, diet, physical activity, medication adherence) Health Coaching is quickly gaining popularity in healthcare and corporate wellness. An additional benefit is cost-effectiveness, due to relatively low barriers to becoming a health coach, as opposed to professional therapists. Olsen and Nesbitt (2010) found three common factors in effective Health Coaching interventions: 1) goal setting 2) use of Motivational Interviewing, and 3) collaboration with primary care providers. It is important to note, Health coaching does not replace recommendations or treatment from primary care providers, and rather it is a complementary form of care to encourage health lifestyle behaviors.

Motivational Interviewing

Originally developed in 1983 for the treatment of alcoholism, Motivational Interviewing (MI) is a counseling technique used to help clients confront and overcome ambivalence towards change (Rollnick, Miller, & Butler, 2008). MI is different from traditional health models by incorporating multiple behavior change methods including the Health Belief Model, SCT, and the TTM to create a client-centered approach rather than authoritarian or educational models. Practitioners begin by building rapport, emphasizing the client is the expert in his or her own life, and, therefore, placing the responsibility for change in the client's own hands. Three principles of MI include: 1) collaboration, 2) evocation, and 3) protection of autonomy (Rollnick, Miller, & Butler, 2008). By creating a relationship based on valuation of the client's existing knowledge and skills, and protection of the client's freedom to make their own health decisions, resistance to change decreases. Since its inception, MI has been successful in improving a wide range of health behaviors: drug and smoking addiction, unprotected sex, poor diet, physical inactivity, weight loss, medication adherence (Martins & McNeil, 2009) (Butterworth, Linden, & McClay, 2007) and management of chronic diseases (Butterworth, Linden, & McClay, 2007).

In a review of MI, studies showed overall positive support for the use of MI in improving eating habits and exercise behaviors, with or without additional interventions (Martins & McNeil, 2009). Studies have shown MI is associated with increases in self-efficacy for eating (DiMarco, Klein, Clark, & Wilson, 2009) and physical activity behaviors (Hardcastle, Taylor, Bailey, & Castle, 2008), as well as improvements in BMI (DiMarco, Klein, Clark, & Wilson, 2009), cholesterol, and blood pressure (Hardcastle, Taylor, Bailey, & Castle, 2008). Unfortunately, many studies have poor tracking of eating or physical activity behavior and often lack sufficient power, making it difficult to draw any substantial conclusions.

One study (Ball et al. 2011), however, did not see significant differences in anthropometric or metabolic measures when comparing lifestyle change versus lifestyle change plus motivational interviewing, but had a number of potential sources of error including: adolescent participants, use of BMI, MI experience of clinicians, and use of clinic weight management services by control group. Adolescents are a particularly difficult population to use in weight loss studies as they can experience rapid fluctuations in height or weight which can affect BMI independently of body fat changes (Wells et al., 2010). While the study identifies the coaches as being experienced clinicians in areas of nutrition and exercise it does not mention extent of training or experience with MI which can impact effectiveness, particularly if clinicians have ambivalence in using MI. At the time of the study, the research hospital offered multiple services related to weight management including personal training, counseling, and nutrition programs available to all patients. The authors believe participants from the control group were using these services which could explain the lack of significant difference from the treatment group.

Dietary Intervention

The literature shows a variety of dietary approaches can be used to induce acute weight loss, with the overall goal of reducing caloric intake. Methods to achieve this goal have included: portion control, self-monitoring, meal replacements, modification of macronutrient ratios (i.e. high protein, low fat, low carbohydrate, etc.), reduction or elimination of sugar-sweetened beverages, and improvement in overall diet quality. The dietary portion of the Bon Sante Program was based on a high protein low-calorie diet, utilizing meal replacements to control calorie intake. Calorie recommendations included 1200-1400 Kcals per day with women at the lower end of the range, and men at the higher end of the range. The modified curriculum suggested the use of high protein meal replacements, but they were not required for the intervention and could be substituted with whole food options with similar caloric and protein

contents. The program also emphasized the importance of fiber, adequate hydration, portion sizes, nutrition facts label-reading, eating strategies for social functions, and cues to improve eating and physical activity.

Pre-packaged meals or meal replacements have become a popular method for weight management as foods are portion controlled, offer balanced nutrition, and can reduce the burden of food planning and preparation. Smith et al. (2009) conducted a randomized-controlled study using pre-packaged meals and shakes as part of a 12 week self-directed weight loss intervention. Participants were randomly assigned into one of two treatment groups or a control group. The treatment groups both received the same food, but one group received brief weekly follow-up via telephone from a trained health educator while the other did not. At the end of 12 weeks, 71% of participants in the weekly support treatment group lost more than 5% of total body weight, compared with 57% of participants in the no support treatment group. There was no significant weight loss in the control group. Significant differences were also noted between the treatment groups. The weekly support group, on average, met all of the daily nutrition requirements: two or more pre-packaged meals, three shakes, and five 1-cup servings of fruits and vegetables, but the second treatment group failed to meet any of the minimum nutrition requirements. Unfortunately, the study did not examine participant reasons for poor adherence, but instead attributed it to the absence of professional weekly support.

High protein diets have been shown to reduce perceptions of hunger, lower attrition rates, produce greater weight loss, and preserve more lean body mass when compared with normal protein diets (Leidy, Carnell, Mattes, & Campbell, 2007). This may be attributed to the satiating function of protein, which may be caused by the relative inefficiency of protein metabolism. Delbridge, Prendergast, Pritchard, and Proietto (2009) showed no significant difference between high protein and high carbohydrate iso-caloric diets in maintaining significant weight loss after one year. However, the high protein group experienced lower attrition compared with the high carbohydrate diet, which could lead to greater weight loss when combined with other weight control interventions.

While high protein diets appear to play a beneficial role in weight control, there is controversy surrounding possible safety concerns for long-term protein intake above the Acceptable Macronutrient Distribution Range (AMDR) of 10-35% of total energy intake. To test this theory, researchers fed pigs (whose physiology is similar enough to humans that they are often used in organ and tissue transplants) with either a normal or high protein diet (15% or 35%

of total energy) for four or eight months (Jia, Hwang, & House, 2010). The pigs fed a high protein diet showed significant enlargement and scarring of the kidneys at four and eight months compared with pigs fed the normal protein diet. However, a separate three month weight loss study comparing a very low calorie (750kcal/day) high protein (30% ~1.4g protein/kg body weight per day) or normal protein (18% ~0.8g protein/kg per day) diet in overweight and obese women did not significantly affect creatinine or glomerular filtration rate (GFR), clinical indicators of kidney disease risk (Leidy, Carnell, Mattes, & Campbell, 2007). Therefore, high protein diets below the upper range of 35% protein should be safe for treatment of obesity in otherwise healthy adults.

Physical Activity

Increasing physical activity, both through lifestyle changes and planned exercise, is considered an integral component of weight loss and maintenance (Phelan, Wing, Loria, Kim, & Lewis, 2010; Elfhag & Rossner, 2005). Although participation in exercise was not included as part of the intervention, physical activity was included as a health behavior goal. During the intervention participants worked with health coaches to identify internal motivation and barriers to physical activity. Emphasis was placed on increasing lifestyle physical activity, and establishing a regular exercise routine rather than a specific prescription for exercise in accordance with SDT.

In one study, participants whom successfully lost additional weight 12 months post-intervention completed 74 minutes more physical activity (170 minutes/week total) than those who maintained (96 minutes/week) or gained weight (93 minutes/week) (Napolitano & Hayes, 2011). The primary mechanism of physical activity in producing weight loss is production of a negative energy balance, or more calories expended through activity than eaten. However, physical activity may also influence long term weight loss in multiple dimensions of health: physiological (BMR, body composition, appetite) and psychological (body image, depression, self-efficacy) (Mata et al., 2009). In one study participants that lost weight reported fewer depressive symptoms and higher self-efficacy for physical activity (Napolitano & Hayes, 2011).

Self-Monitoring

Participants in the guided weight loss group tracked their weekly food and physical activity using forms created for the Bon Sante Program. These included check boxes for daily ½ cup servings of fruits and vegetables, meal replacement bars or shakes, water, and physical activity.

Sensewear Pro Minifly Armband

Self-monitoring may play several roles in weight control by providing personal accountability in the absence of a health coach or other health professional, and, particularly with online self-monitoring tools, provide immediate feedback about problematic food and physical activity behaviors or energy balance. Traditional self-monitoring techniques have included pencil and paper logs, pedometers, and more recently online food and physical activity tracking programs and activity monitors such as the Sensewear Pro Minifly armband (SWA).

For this study two treatment groups 1) self-monitoring tool with web-based self-management program and 2) guided weight loss with self-monitoring tool and web-based self-management program received the SWA to monitor their physical activity, sleep, and eating habits over the 8 week treatment period. The armband contains multiple sensors to collect information about the user, including: motion (via accelerometers), steps, galvanic skin response (electrical conductivity of skin in relation to sweat and other physiological responses), skin temperature, and heat production. The information collected from these sensors is then used to estimate energy expenditure of the user, which can be displayed instantaneously on a watchband interface, or uploaded to a personal computer or smartphone. The associated self-management program includes a modifiable food database to facilitate self-reporting of eating habits. This online interface allows the user to observe their energy balance (comparison of calories eaten versus calories expended through activity) in real-time, as opposed to using traditional energy expenditure estimate calculations which were complicated and relied heavily on the user's recall of daily or weekly activities.

Studies examining the use of the SWA for weight loss have demonstrated that participants lost more weight when using the armband in combination with behavior modification when compared to a traditional self-directed print-based intervention (Shuger et al., 2011) or behavioral intervention alone (Polzien, Jakicic, Tate, & Otto, 2007). Polzien, Jakicic, Tate, and Otto (2007) also indicated that the armband must be used continuously throughout the intervention period, as opposed to intermittent use, to maximize weight loss effectiveness.

CHAPTER 3: METHODS

The data for this study were collected as a follow-up to a recently completed randomized clinical weight loss trial (Walsh, 2011; Paulson, 2011). In the study, participants were recruited in two cohorts (Fall 2010 and Spring 2011) and randomized into one of three 8 week treatment programs: guided weight loss support, a behaviorally based self-monitoring tool, or a combination of support with self-monitoring tool. Anthropometric and psychosocial measures were completed at baseline, immediately post-intervention, and at 6 month follow-up (4 months post-intervention). The study (including follow-up assessments) was approved by the Iowa State University Institutional Review Board. Participants provided signed informed consent and physician approval forms (if needed) prior to entry into the study and prior to randomization.

Participants

Participants were eligible if they were over the age of 18 years, non-smoking, weight stable at $\pm$ 10lbs for 3 months prior to the study, and had a Body Mass Index (BMI) of 30 kg/m^2 or greater. Exclusion criteria included major surgery and/or bariatric surgery within 3 months prior to the study, active disease conditions: thrombophlebitis (DVT/PE), cancer, diabetes (fasting glucose >126mg/dl), fasting triglycerides >500mg/dl, severe hypertension (average >160 mmHg systolic pressure and/or >100 mmHg diastolic pressure), severe liver, kidney or peptic ulcer disease, recent or recurrent strokes or mini-strokes, heart attack or unstable angina, severe psychiatric conditions including eating disorders, medications including corticosteroids (>20 mg/d), lithium, or other medications in which physical activity, dietary changes, or weight loss would affect dosage, pregnancy/lactation, or currently participating in another weight loss program or study. 89 participants were randomized into the study and 78 participants (32 males and 46 females) completed the 8 week intervention, with an attrition rate of 12%. Participants in the study had a mean Body Mass Index (BMI) value of 36.72 kg/m^2 (*SD* = 5.48) and a mean age 39 years (*SD* = 14.0) (range 18-72 y). Fifty-three participants (19 males, 34 females) returned for the 6 month follow-up assessment, an attrition rate of 32%. (See Participant Flow Chart in Appendix B)

Measurements

The study utilized clinical outcomes, psychosocial outcomes, and process data obtained during the course of the intervention.

Participant Characteristics

Height, weight, waist circumference, body fat percentage, and blood pressure measures were taken following a 10 hour fast at screening (baseline), post-intervention (8 weeks), and 4 month follow-up. Measures were collected by a trained laboratory technician, as well as graduate and undergraduate students. Participant height was recorded as an average of two measurements, in sock feet, using an Ayrton Model S100 stadiometer. Weight was measured in sock feet using a Cardinal Detecto digital medical scale. Waist circumference was determined as the average of two tape measure readings (within 0.2 mm difference) around the umbilicus. Body fat was measured via bioelectric impedance analysis (BIA) using the Omron Fat Loss Monitor HBF-306 for both the first and second cohorts. Body composition was also measured in a subsample of participants (second cohort) via air displacement plethysmography using the Bod Pod GS which has been previously validated for use in evaluation of obese weight loss participants (Plasqui, Soenen, Westerterp-Plantenga & Westerterp, 2011). Resting blood pressure was taken as an average of two consecutive seated measurements using the Omron Digital Blood Pressure Monitor HEM-907XL. To achieve approximate resting blood pressure readings participants were isolated in a dimly lit room with relaxation music for 10 minutes prior to each measurement.

Analyses of baseline anthropometrics and socioeconomic characteristics (age, marital status, education, and race) were used to help determine if there were any differences between participants. Separate descriptive statistics were run for baseline characteristics overall, between groups, and between those who completed the 6 month follow-up and those that did not complete the 6 month follow-up. Differences between 8 week self-efficacy for those that completed the 6 month follow-up and those that did not complete 6 month follow-up were also reported.

Clinical Outcomes

A previous study on this intervention (Walsh, 2011) did not detect differences between the treatment groups, but it is important to also check for any differences in the retention of weight loss. To examine this we computed changes in key anthropometric variables from baseline to 8 weeks, baseline to 6 months (4 months post-intervention), as well as from 8 weeks to 6 months. Separate three-way (cohort x group x gender) ANOVAs were run for weight loss outcomes at 8 weeks and at 6 months. To test for possible post-intervention effects a similar three-way ANOVA was run for weight loss outcomes from 8 weeks to 6 months. Main effects and interactions were examined for each set of analyses. Effect sizes were calculated using

Cohen's d (difference of two means over pooled variance) and reported for differences between the combined and guided treatment groups, and between the combined and self-monitored groups at 8 weeks and 6 months. Two additional outcome measures were computed to examine weight retention and maintenance:

Weight Loss Retention

Weight loss retention is an important consideration in evaluating weight loss programs since the intervention can only be considered successful if participants can keep the weight off. To examine weight loss retention in more detail, participants were divided into two categories based on weight change between the end of the intervention program (8 weeks) and the end of the follow up period (6 months): 1) Retention and 2) Regain. Categorization was determined by calculating the difference in weight outcomes (6 months – 8 weeks). Zero (no weight change) or negative (additional weight loss) values were categorized as Retention, while positive values were categorized as Regain. Weight retention frequencies were reported to observe any possible patterns related to cohort, group, or gender effects following the re-categorization.

Clinically Relevant Weight Maintenance

The magnitude of weight loss is important for evaluating the clinical significance of a weight loss program. This has generally been defined in the literature as a weight loss greater than 5% of baseline body weight. To examine the clinical significance of the weight loss outcomes, participants were divided into two categories based on weight change from baseline to 6 months: 1) Clinically Relevant weight maintenance and 2) Clinically Non-relevant weight maintenance. Individuals that maintained a weight loss of more than 5% of baseline weight were categorized into the Clinically Relevant group while those that did not achieve or maintain this weight loss were categorized into the Clinically Non-relevant group. Weight relevance frequencies were reported to observe any possible patterns related to cohort, group, or gender effects following the re-categorization.

Psychosocial Outcomes

The primary goals of this study focus on the psychosocial factors that influence weight loss maintenance. The measures used for these analyses are described below:

Self-Efficacy

Participant self-efficacy in maintaining healthy eating habits and regular physical activity was assessed using questionnaires created specifically for this study. The questionnaire consisted of 24 items asking participants to rate their confidence eating healthfully or being physically active when confronted with barriers such as: social gatherings, busy schedules, or

periods of emotional distress. It was administered using a 10-point Likert scale ranging from 0 "Not Confident" to 10 "Very Confident." Higher scores indicated higher perceived barriers. The scales used for this study have been previously described in greater detail (Paulson, 2011). Internal reliability for diet and physical activity social support surveys were calculated and reported for this study using Cronbach's Alpha internal reliability coefficient.

Social Support

Social support during the 4 month post-intervention period was measured using the Social Support and Eating Habits and Exercise surveys developed by Sallis, Grossman, Pinski, Patterson, and Nader (1987). The questionnaire consists of 23 items assessing social support from family and friends through participation (i.e. "Offered me food I'm trying not to eat") or encouragement/discouragement (i.e. "Complained about the time I spend exercising") of specific eating and exercise behaviors. It was administered using a 5-point Likert scale ranging from 1 ("None") to 5 ("Very Often"). Family and friends are scored separately. Higher scores indicate higher perceived social support. Cronbach's alpha internal reliability coefficients for this survey previously ranged from 0.76 to 0.85 (Sallis, Grossman, Pinski, Patterson, & Nader, 1987). Internal reliability for Social Support and Eating Habits and Exercise surveys were calculated and reported for this study using Cronbach's Alpha internal reliability coefficient.

Process Data

Program Adherence

Program adherence and motivation during the 8 week intervention was assessed using a Health Coach Rating (HCR) score. Each week health coaches rated their individual participants on a scale of 0-2 based on the level of program adherence (meeting attendance, participation, completion of food records, and progress towards goals). A rating of 0 indicates failure to attend coaching session, little or no participation in coaching session, no or insufficient progress toward self-selected goals, incomplete food or physical activity records, or failure to respond to coach communications. A rating of 2 denotes attendance and full participation in coaching session, sufficient progress towards goals, record keeping and task completion, active communication with health coach. A rating of 1 includes a combination of: 1a) regular attendance or 1b) irregular attendance and 2a) sufficient progress towards goals or 2b) insufficient progress towards goals, and 3a) completion of records and assignments or 3b) incomplete records or assignments. Walsh (2011) reported significant mean differences in weight loss between participants that received the highest HCR (>1.75) over the 8 week intervention compared with those who were less compliant or willing to make lifestyle changes ($p < 0.0001$). This indicates

those whom were more compliant with the health coaching intervention achieved greater weight loss than those whom were less compliant.

Exit Interviews

Participants provided feedback about their experience with the program during a structured exit interview at the end of the 8 week intervention and the 6 month follow-up. A questionnaire containing 10 items designed to explore participant satisfaction or dissatisfaction with the program and goal attainment was administered. An additional 22 items explored the aspects or skills most or least beneficial to the participant, changes in overall diet or physical activity habits, relationship with health coach, armband use, and the presence or absence of an accountability partner. Interviews were administered by either project staff or graduate students. Interviewers had no formal training in providing exit interviews.

Data Analysis

The focus of the study was to examine whether psychosocial factors influenced retention of weight loss. Before these analyses could be completed it was important to directly examine (and quantify) the retention of weight loss and to compare outcomes across treatment groups. Therefore, initial analyses were conducted to determine the effectiveness of guided, self-monitored, or guided plus self-monitored interventions on anthropometric outcomes. Descriptive statistics (mean and standard deviations) were used to characterize samples based on differences in anthropometric outcomes at 8 weeks (8 weeks - baseline) and 6 months (6 months - baseline). Effect sizes from 8 weeks to 6 months were also calculated to reveal the magnitude of anthropometric changes. Effect sizes were calculated based on the difference of means at 8 weeks and 6 months divided by pooled standard deviation.

A series of separate three-way (cohort x group x gender) Analyses of Variance (ANOVA) were used to examine group differences. Separate analyses were run for the 8 week outcomes, the 6 month outcomes and the differences or changes between the 8 week and 6 month period. These analyses were used to determine if there were differences between cohorts, groups or gender in the outcomes of the study. Based on previous analyses (Walsh, 2011), no differences were expected but it was important to test differences for the longer term outcomes. If no differences are detected between groups data could be combined to increase the sample sizes for evaluation of psychosocial outcomes.

Two key outcomes in the study were weight retention and clinically significant weight maintenance. These outcomes were used to further characterize the retention of weight loss

and whether it varied by cohorts, groups and gender. These analyses were primarily descriptive in nature.

The primary focus of the study was to examine possible relationships between psychosocial factors and weight maintenance. Internal reliability of the psychosocial surveys was determined using Cronbach's Alpha.

Correlation analyses were conducted to examine possible relationships within and between psychosocial factors. Correlations were used to identify possible relationships within self-efficacy subscales (diet, physical activity) and within types of social support (diet, physical activity, family and friends). Relationships were also examined between levels of self-efficacy and levels of social support. Correlation analyses were also used to examine possible relationships between weight outcomes at 8 weeks and 6 months as well as to examine possible relationships between weight outcomes and psychosocial factors (self-efficacy and social support).

Supplemental analyses were conducted to examine the relationships between psychosocial factors and weight maintenance in more detail. A series of one-way ANOVAs were run to analyze the differences in psychosocial factors between the two retention groups (Retain: those that kept the weight off; Regain: those that regained some or all of their weight loss) and the two weight relevance groups (Clinically Relevant: those that maintained clinically relevant weight loss; Clinically Non-Relevant: those that did not maintain clinically relevant weight loss). Effect sizes were calculated to indicate the impact of psychosocial factors between weight maintenance groups. Effect sizes were calculated using Cohen's d (difference of two means over pooled variance).

Additional exploratory analyses were conducted to help explain weight change. One-way ANOVAs were used to determine if the 8 week health coach rating (HCR) (a method for assessing program adherence during the 8 week intervention) could explain differences between the two weight retention groups or the two weight relevance groups.

CHAPTER 4: RESULTS

Participant Characteristics

Seventy-eight participants (31 males, 47 females) completed the 8 week intervention. There were equal numbers of participants (*n* = 26) in each of the 3 treatment groups: Guided: guided support only; Self-Monitored: self-monitoring tool; and Combined: guided support and self-monitoring tool. Participants, on average, weighed 109.9 kg (*SD* = 20.6), had a BMI of 36.7 kg/m^2 (*SD* = 5.5), had 38.2% (*SD* = 6.4) body fat, and a waist circumference of 120.1 cm (*SD* = 13.8). The average age was 39 years (*SD* = 13.1), with an age range of 18 – 72 years. Participants were primarily Caucasian (94.9%), married (56.4%), and well-educated (76.9% had obtained a college or graduate degree), representative of the Ames, Iowa and surrounding communities, from which they were recruited. Baseline characteristics for the three treatment groups are shown in Table 1a. Participants were guided through the intervention in two successive cohorts (one started in Fall and on in the Spring), each cohort contained thirty-nine participants. There were no significant differences in baseline measures between cohorts.

Fifty-three participants (19 males, 34 females) returned for the 6 month follow-up assessment, an attrition rate of 32%. Table 1b shows the characteristics of the participants who completed the 6 month follow-up 39.6% were from the Guided group, 28.3% from the Self-Monitored group, and 32.1% from the Combined group. The percentage of participants returning for the follow-up were similar for cohort 1 (-64.1%) and cohort 2 (-71.8%). At baseline, on average, participants weighed 109.4 kg (*SD* = 20.7), had a BMI of 36.7 kg/m^2 (*SD* = 5.5), had 38.9% (*SD* = 6.1) body fat, and a waist circumference of 119.8 cm (*SD* = 14.3). The average age was 42 years (*SD* = 14.5), with an age range of 21 – 54 years, compared with those that did not complete the 6 month follow-up (average age: 33 years (*SD* = 11.1), [F(1,76) = 6.77, p = .01]). Non-completers were also more likely to be single (64.0%)[F(1,76) = 1.53, p = .01]. There were no statistically significant differences in baseline anthropometric measures between completers and non-completers [$F(4,72) = .65$, $p = .63$], nor did they differ by 8 week weight change [F(65,12) = .76, p = .77]. Table 1c shows non-completers did, however, differ from those who returned for the 6 month follow-up by having significantly lower diet self-efficacy [$F(1,76) = 9.26$, $p < .01$], physical activity self-efficacy [$F(1,75) = 4.94$, $p = .03$], and combined self-efficacy [$F(1,76) = 8.00$, $p < .01$] at 8 weeks. Forty-nine participants returned at least one follow-up survey.

Clinical Outcomes

In order to determine treatment effectiveness, we evaluated anthropometric changes from baseline to 8 weeks, and baseline to 6 months (4 months post-intervention). The 8 week anthropometric changes were as follows: weight loss = 4.21 kg (*SD* = 3.08), BMI decrease = 1.39 kg/m^2 (*SD* = 1.01), body fat decrease = 0.97% (*SD* = 1.54), and waist circumference decrease = 4.27 cm (*SD* = 3.58). On average, the participants were successful in maintaining the positive changes as the average weight change between 8 weeks and 6 months was -.19 kg (SD = 3.67). The average 6 month values for each of the 6 month anthropometric variables were also more favorable than the corresponding 8 week values: weight loss = 4.82 kg (*SD* = 4.83), BMI decrease = 1.58 kg/m^2 (*SD* = 1.59), body fat decrease = 1.15 % (*SD* = 2.09), and waist circumference decrease = 4.64 cm (*SD* = 4.69) (see results in Table 2a).

Participants in cohort 2 experienced 47% greater weight loss than cohort 1 at 8 weeks. A similar pattern emerged at 6 months, with cohort 2 achieving 79% greater weight loss than cohort 1. A three-way ANOVA (cohort x group x gender) was run to test for possible differences in weight loss outcome at 8 weeks. The overall multivariate F test was not significant for the 8 week weight loss outcome [F(11,66) = 1.57, p = .13]. However, a significant cohort main effect was observed for weight change [$F(1,66) = 5.61$, $p = 0.02$] with larger weight loss evident for cohort 2 (-5.0 kg) compared to cohort 1 (-3.41 kg). Similar results were obtained with a second three-way ANOVA to test for differences at 6 months. The overall multivariate F test was not significant [F(10, 42) = .94, p = .50], but the cohort main effect was again significant [F(1,42) = 4.76, p = .03]. Mean weight loss was significantly greater in cohort 2 (*M* = 6.09 kg, *SD* = 4.77) than cohort 1(*M* = 3.40 kg, *SD* = 4.59). These results are consistent with previous observations of greater mean weight loss in cohort 2 at 8 weeks (Paulson, 2011). Changes in anthropometric outcomes for each cohort at 8 weeks and 6 months are shown in Table 2b.

These changes reflect overall differences but additional analyses were run to test if participants in cohort 2 had better weight retention in the 4 months following completion of the intervention. The three-way ANOVA yielded a non-significant F test [F(10,42) = .79, p = .64. The cohort effect was not significant [F(1,42) = 2.02, p = .10], but effects were clearly more favorable for cohort 2 which had a mean weight loss of about .76 kg compared to a mean weight gain of approximately .42 kg. The improved outcomes for cohort 2 could be due to improved effectiveness of the intervention, but they may also be due to the timing of the interventions. Cohort 1 finished the 8 week intervention prior to the winter holiday season (with 4 month follow-up occurring over the winter) while cohort 2 finished in the Spring (with 4 month follow-up in the

summer). While the weight loss outcomes were different we observed no significant cohort interaction effects with group or gender. This suggests that the intervention worked similarly in both cohorts (just with greater impact in cohort 2). The main effect for gender was not significant for both 8 weeks [$F(1,66) = .91$, $p = .35$] and 6 months [$F(1,42) = 1.41$, $p = .24$]. This suggests that the intervention worked similarly for males and females. The main effect for groups was also not significant for both 8 weeks [$F(1,66) = .36$, $p = .70$] and 6 months [$F(2,42) = .07$, $p = .93$] suggesting no significant differences between groups. The cohort effect was viewed as an artifact and was not further analyzed; however, additional consideration was given to possible differences between groups since the treatments may differentially impact retention of weight loss.

As previously shown (Paulson, 2011), the group effect was not significant, but participants in the Combined treatment group demonstrated the greatest overall improvement in anthropometric outcomes including losing the most weight (M = 5.57 kg, SD = 5.18). In contrast, participants in the Guided group showed the least improvement in all anthropometric outcomes at 8 weeks and 6 months. Effect sizes were computed to compare weight loss outcomes among the groups. The effect sizes for 8 weeks were moderate for comparisons between group 3 and group 1 [(d = .38, CI_{95} (-0.85, 1.59)] and small between group 3 and group 2 [(d = .28, CI_{95} (-0.96, 1.38)]. The corresponding effect sizes for the 6 month outcomes were [d = .36, CI_{95} (-2.11, 2.20)], and [d = .07, CI_{95} (-2.39, 2.73)], respectively. Changes in weight loss, BMI, body fat, and waist circumference outcomes for each group at 8 weeks 6 months are shown in Table 2c.

To examine factors that may have affected post-intervention (8 weeks – 6 months) weight loss retention differently from clinically relevant weight maintenance ($\geq$5% loss of baseline body weight at 6 months) the variables: A) Weight loss Retention and B) Clinically Relevant weight maintenance were examined separately and in greater detail, below.

Weight Loss Retention

To examine post-intervention (8 weeks to 6 months) effects in more detail, participants were divided into two categories based on weight change: 1) Retention and 2) Regain. These categories were determined by calculating the difference between 6 months and 8 weeks weight outcomes. Zero or negative values were categorized as retention, while positive values were categorized as regain. Slightly less than half (45.3%) of all participants retained their weight loss from post-intervention to 6 month follow-up. (See Figure 1). Retention was similar between males (42.1%) and females (47.1%). Additional comparisons were made to evaluate retention

between cohorts and groups. Figure 2 shows that retention was slightly higher for cohort 2 (50%) than cohort 1 (40%). Figure 3 shows that retention was highest for the Self-Monitored group (53.3%), followed by the Guided group (47.6%) and the Combined group (35.3%).

Clinically Relevant Weight Maintenance

Consistent with clinical guidelines, relevant weight maintenance was defined in this study as ≥5% loss of baseline body weight maintained for at least 6 months. To examine the treatment effectiveness in more detail, participants were categorized into two groups based on the degree of weight loss: 1) Clinically relevant weight loss (≥5% loss of baseline body weight maintained for at least 6 months) or 2) Non-relevant weight loss or regain. Figure 4 shows that slightly less than half (47.2%) of all participants maintained clinically relevant weight loss by 6 months, and males (52.6%) had slightly better maintenance than females (44.1%). Figure 5 shows a greater number of participants in cohort 2 (57.1%) achieved clinically relevant weight maintenance versus cohort 1 (36.0%). Figure 6 shows a greater number of participants in the Self-Monitored group (56.3%) achieved clinically relevant weight maintenance, followed by the Guided group (45.0%) and the Combined group (41.2%).

Psychosocial Outcomes

The primary goals of the study focused on the psychosocial factors influencing weight loss maintenance.

Internal Reliability of Psychosocial Measures

Cronbach's Alpha was used as a measure of internal reliability for the Self-efficacy and Social Support multi-item Likert-type scales used in this study. These reliability coefficients were determined based on the summation of items related to a single behavior, such as diet or physical activity, and are reported in Table 3. Both the diet (12 items; $\alpha = .94$) and physical activity (12 items; $\alpha = .93$) self-efficacy scales demonstrated excellent internal reliability. The social support scales for family (13 items; $\alpha = .86$) and friends (10 items; $\alpha = .87$) also showed good internal reliability for exercise. Social support for eating habits from family and friends scales had internal reliability coefficients of .72 (acceptable) and .61 (questionable), respectively (strength of reliability coefficient categories based on recommendations by Gliem & Gliem (2003).

Relationship Among Psychosocial Factors

Correlation analyses were conducted to examine possible relationships within and between psychosocial factors (self-efficacy and social support) between 8 weeks and 6 months.

Analyses of the correlation matrix revealed several relationships. The strongest relationships were found between diet self-efficacy (SED) and activity self-efficacy (SEA) at 8 weeks [$r(77) = .70$, $p < .01$] and 6 months [$r(52) = .69$, $p < .001$], indicating participants with higher self-efficacy for diet also tended to have higher self-efficacy for physical activity (See Table 4). There was another moderately-strong correlation between self-efficacy for combined diet and activity self-efficacy (SEC) at 8 weeks and 6 months [$r(54) = .60$, $p < .001$], revealing that participants with higher self-efficacy at 8 weeks had a tendency to have higher self-efficacy at 6 months.

Social support from family had moderately-strong correlations with social support for both eating [$r(50) = .70$, $p < .001$] and physical activity, [$r(45) = .69$, $p < .001$] . Social support from friends was also moderately correlated with social support for both eating [$r(50) = .67$, $p < .001$] and physical activity, [$r(45) = .65$, $p < .001$] (See Table 4). These results indicate participants who perceive higher levels of social support from family or friends are more likely to report higher levels of social support for weight control behaviors. Social support between family and friends was moderately correlated, [$r(50) = .45$, $p < .001$] indicating participants who perceive greater social support from family are more likely to perceive greater social support from friends. There was a relationship between higher levels of social support for eating and physical activity, but it was weak [$r(45) = .22$, $p = .15$].

When examining the relationships between self-efficacy and social support, several strong correlations emerged. Self-efficacy for physical activity at 8 weeks was moderately associated with social support for diet, $r(50) = .46$, $p < .001$, from friends, $r(50) = .38$, $p < .001$, and from family, $r(50) = .30$, $p < .001$, at 6 months. This reveals participants with higher self-efficacy for maintaining regular physical activity at 8 weeks were more likely to perceive higher levels of social support for eating, as well as social support from friends and family over the following 4 months. Self-efficacy for activity at 6 months was moderately associated with social support for physical activity, [$r(44) = .42$, $p < .01$] , and from friends, [$r(49) = .43$, $p < .01$] at 6 months, indicating participants with higher self-efficacy for maintaining regular physical activity were more likely to perceive higher levels of social support for physical activity and social support from friends. Combined diet and physical activity self-efficacy at 6 months were weakly correlated with both social support for physical activity, [$r(44) = .39$, $p = .01$] and social support from friends, $r(49) = .37$, $p = .01$] at 6 months. This relationship indicates participants with higher total self-efficacy are more likely to perceive greater social support for physical activity and from friends. The relationship between self-efficacy for activity at 8 weeks and social support for physical activity at 6 months was non-significant.

Relationships between Psychosocial Factors and Weight Outcomes

There was a moderate correlation between weight change at 8 weeks and 6 months [$r(53) = .65$), $p < .001$], indicating participants who achieved greater weight loss at 8 weeks were also likely to achieve more weight loss at 6 months (See Table 4). Self-efficacy for diet at 8 weeks was weakly correlated with weight change at 8 weeks [$r(78) = -.27$, $p = .02$]. Although non-significant, weight change was negatively associated with combined self-efficacy at 8 weeks [r(78) = -.20, p = .09] and 6 months [r(54) = -.07, p = .59] and 6 month social support for diet [r(49) = -.07, p = .62], physical activity [r(44) = -.08, p = .62] family [r(49) = -.06, p = .69] and friends [r(49) = -.03, p = .86], supporting the hypothesis that higher levels of self-efficacy and social support would be related to greater weight loss. Although weak, the relationship indicates that participants with greater confidence in overcoming barriers to healthy eating were more likely to achieve greater weight loss. Although correlations were found between psychosocial factors and weight change, it does not necessarily mean one causes the other. Statistical significance means the relationship is not likely to have occurred by chance, but still does not explain why the association exists.

Factors Influencing Weight Loss Maintenance

In order to examine the relationships between psychosocial factors and weight maintenance in more detail, supplemental analyses were conducted. A series of one-way ANOVAs were run to analyze the differences in self-efficacy between the two retention groups (those that kept weight off versus those that regained) and the two weight relevance groups (those that maintained relevant weight loss and those that did not).

Table 5 shows differences in self-efficacy values for the two weight retention groups at 8 weeks and 6 months. The ANOVA analyses for 8 weeks revealed non-significant differences, and no effect or small effect sizes, were found for diet self-efficacy [$F(1,51) = .03$, $p = .87$, $d = .04$, CI_{95} (-.68, .40)], physical activity self-efficacy [$F(1,51) = 1.14$, $p = .29$, $d = .30$, CI_{95} (-.45, .76)], and combined self-efficacy [$F(1,51) = .50$, $p = .48$, $d = .20$, CI_{95} (-.50, .53)]. While there were no significant differences, the group achieving weight loss retention had higher self-efficacy values than the group that regained weight (See Figure 7).

The ANOVA analyses for 6 months revealed a significant difference between the weight retention groups for diet self-efficacy [$F(1,50) = 5.37$, $p = .03$, $d = -.65$, CI_{95} (-1.10, -.05)]. Participants with more confidence in their abilities to maintain healthy eating habits at follow-up retained their weight loss. While there were no significant differences, the group achieving

weight loss retention had higher physical activity self-efficacy [$F(1,51) = 2.13$, $p = .15$, $d = -.40$, CI_{95} (-.89,.45)] and combined self-efficacy [$F(1,49) = 1.10$, $p = .30$, $d = -.56$, CI_{95} (-.99, .09)] values than the group that regained weight. As with the 8 week effect, the group achieving weight loss retention had higher self-efficacy values than the group that regained weight (See Figure 7).

Table 6 shows differences in social support values among weight retention groups at 6 months. The ANOVA analyses revealed non-significant differences in social support for diet [$F(1,47) = .61$, $p = .44$, $d = -.17$, CI_{95} (-.65, .24)], physical activity [$F(1,42) = .12$, $p = .73$, $d = -.08$, CI_{95} (-.60, .31)], from family [$F(1,45) = 1.56$, $p = .22$, $d = -.01$, CI_{95} (-.30, .40)], or from friends [$F(1,45) = .83$, $p = .37$, $d = -.52$, CI_{95} (-.74, -.17)] for weight retention groups. Although differences were not significant, social support was slightly higher in the group that regained weight. Plots showing the differences between weight retention groups for social support are shown in Figure 8.

Table 7 shows differences in self-efficacy values for the two weight maintenance groups at 8 weeks and 6 months. Non-significant differences, and small effect sizes, were found in 8 week diet self-efficacy [$F(1,51) = 1.82$, $p = .18$, $d = .37$, CI_{95} (-.30,.75)], physical activity self-efficacy [$F(1,51) = 2.10$, $p = .15$, $d = .40$, CI_{95} (-.22,.97)], and combined self-efficacy [$F(1,51) = 2.42$, $p = .13$, $d = .42$, CI_{95} (-.19,.82)]. While there were no significant differences, the group achieving clinically relevant weight loss had higher self-efficacy values than the group that did not achieve clinically relevant weight loss (See Figure 9).

The ANOVA analyses at 6 months revealed significant differences, and a medium effect size, for diet self-efficacy [$F(1,50) = 5.70$, $p = .02$, $d = .66$, CI_{95} (.11,1.14)]. While there were no significant differences for physical activity self-efficacy [$F(1.51) = 1.63$, $p = .21$, $d = .34$, CI_{95} (-.44, .88)], the group achieving relevant weight loss had higher self-efficacy values, and a small effect size. These results indicate participants who maintained $\geq$ 5% weight loss reported more confidence in maintaining healthy eating habits, but confidence in maintaining physical activity was not different between groups (See Table 7 and Figure 9).

Table 8 shows differences in social support values among weight maintenance groups at 6 months. The ANOVA analyses revealed non-significant differences in social support for diet [$F(1,42) = 1.13$, $p = .20$], physical activity [$F(1,42) = .32$, $p = .58$], family [$F(1,42) = .55$, $p = .38$], and friends [$F(1,42) = 1.23$, $p = .27$]. While differences were not significant, social support values were higher in the group that achieved clinically relevant weight loss compared with the

group that did not achieve clinically relevant weight loss. Plots showing differences between weight relevant groups are shown in Figure 10.

Additional exploratory analyses were conducted to explain weight change. One analyses included one-way ANOVAs to determine if the health coach rating (HCR; a method for assessing program adherence during the 8 week intervention) could explain differences in weight retention or clinically relevant weight maintenance. There were no significant differences in HCRs between weight retention groups [$F(10,53) = .53$, $p = .86$] or weight maintenance groups [$F(10,53) = 1.25$, $p = .29$] or. Program adherence did not influence weight retention or maintenance (data not shown).

CHAPTER 5: DISCUSSION

This study evaluated the effectiveness of three behaviorally based weight loss treatments on long term (6 month) weight maintenance following an 8 week intervention. Overall, participants experienced positive changes in anthropometric outcomes from 8 weeks (post-intervention) to 6 months, but there were no significant differences between cohorts, treatment groups, or genders. The main focus of the study was on the impact of psychosocial factors (self-efficacy and social support) on long-term weight maintenance. The specific goals were to examine the influences of perceived self-efficacy and social support on maintaining healthy diet and physical activity habits related to long-term weight maintenance. Our hypotheses were: 1) higher levels of self-efficacy would be associated with greater weight maintenance, and 2) higher levels of perceived social support would be associated with greater weight maintenance.

Overall, there was good retention of weight loss with average weight loss retention of 4.82 kg (*SD* = 4.83) over the 6 months. Approximately half (47%) of the participants were able to maintain weight loss over the 6 month follow-up. The statistical comparisons revealed a significant cohort effect for weight loss outcomes with better effects noted for Cohort 2. Weight loss retention was also higher in Cohort 2 compared to Cohort 1 suggesting that the intervention might have been more effectively implemented the second time. However, it is also possible that this effect was due purely to the timing of the interventions and the additional challenges of maintaining weight loss during the winter/holiday season.

The group effects were not significant, but lack of significance may have been due to small sample size. Therefore, we have included some discussion of non-significant trends. Participants in the combined treatment group (Guided and Self-Monitored) had larger weight loss at 8 weeks and 6 months. Although the combined treatment group had larger mean weight loss, the self-monitored group had the greatest percentage of participants that achieved weight loss retention (53.3%) and relevant weight maintenance (56.3%). These results indicate the combined treatment produced a lower magnitude of weight loss in a greater number of people, while the self-monitored treatment appeared to have produced a greater magnitude of weight loss in fewer participants. One possible explanation for this difference could be related to the purchase of the self-monitoring tool following the study, by some individuals. This would have resulted in an increased likelihood of continuing self-monitoring practices for individuals with the self-monitoring tool compared with those that did not purchase the tool. While there were some

differences between cohorts and groups the primary analyses focused on whether the psychosocial variables were related to weight loss outcomes.

Correlations between self-efficacy and weight outcomes did not achieve statistical significance at the $p < .05$ level, but they approached significance and were deemed noteworthy in the analyses. Although not significant, self-efficacy was found to be negatively correlated with weight loss, but the magnitudes of the correlations were weak. Additional analyses evaluated differences in self-efficacy between groups that had better retention and maintenance of weight loss. There were significant differences in self-efficacy for maintaining healthy eating behaviors between the weight maintenance groups which suggests that this variable might contribute to the different weight loss outcomes. This effect only occurred for diet self-efficacy at 6 months but it is consistent with previous research (Linde, Rothman, Baldwin & Jeffery, 2006).

It is interesting that diet self-efficacy, but not physical activity self-efficacy, had a significant relationship with weight change in our study. This may have been due, in part, to the larger focus on diet modification (i.e. reducing caloric intake, eating smaller meals and snacks, and incorporating higher protein content) and eating related behaviors (i.e. eating at special events, reading nutrition labels) in the behavioral intervention. Participants were encouraged to set goals and increase lifestyle physical activity, but were not given an exercise prescription or instruction for creating an exercise program. Diet and activity behaviors were not assessed, so it is not possible to evaluate how self-efficacy may have directly or indirectly impacted health behaviors.

Findings for social support were less clear than those for self-efficacy. For the purposes of our study we examined the relationships between perceived social support and self-efficacy with the expectation that positive social support may impact weight maintenance by affecting health behaviors, or indirectly influencing health behaviors through promotion of self-efficacy. This expectation was based on Bandura's (1997) Social Cognitive Theory which emphasized that social persuasion or "support" (i.e. encouragement or discouragement is one of four factors which can influence self-efficacy. In the present study, although the associations between social support and weight maintenance were not statistically significant, these relationships may be important. Social support, for physical activity and from friends, was moderately correlated with self-efficacy for diet at 6 months (which was significantly related to weight maintenance), and significantly correlated with self-efficacy for physical activity at 8 weeks and 6 months.

There was no assessment of eating or exercise behaviors in our study, so it is not possible to evaluate how social support may have directly or indirectly impacted health behaviors. One difficulty with research on social support in weight maintenance has been inconsistency in the literature. Wing and Jeffery (1999) demonstrated greatly reduced attrition (5%) and increased weight maintenance at 6 months (66%) by recruiting participants with support partners, however, there were also financial incentives based on weight loss and completion of follow-ups. Toobert, Glasgow, Nettekoven and Brown (1998) observed increases in perceived social support at 12 months for women in a 2 year intensive lifestyle change program (including 4 hour weekly meetings for 15 months where support partner was encouraged to attend) compared with a usual-care control group. Marcoux, Trenkner, and Rosenstock (1990) found a strong positive correlation between appraisal support and weight outcomes, through examination of different aspects of social support (i.e. instrumental, appraisal, and affective support). Overall, the relationship between social support and weight maintenance appears to be positive, but in need of more consistent research methodologies to identify possible mechanisms of influence.

Several reviews (Elfhag & Rossner, 2005; Klem, Wing, McGuire, Seagle, & O Hill, 1997) have reported self-monitoring as integral to successful weight maintenance. Following removal of the self-monitoring tool, we therefore, expected a lower incidence of weight retention for participants in the self-monitored group, with better outcomes in the guided and combined treatment groups which had received guided support. Instead, the self-monitored group had the highest prevalence of weight retention (53.3%), and the combined group had the lowest (35.3%) retention from 8 weeks to 6 months. Although differences were not significant, these results may still be important. The self-monitored group may have developed better self-reliance or intrinsic motivation, compared with the combined group which may have relied more heavily on external motivation or support from the armband and health coach. This is an important consideration as external support has been shown to have a negative impact on intrinsic motivation (Deci, Koestner & Ryan, 1999). Another explanation for the lack of difference between groups could be that participants were directly motivated due to: 1) self-selection into a weight loss program, or 2) a feeling of obligation to produce positive outcomes for the research study. Treatment effect may be confounded by a highly motivated sample. However, in a study (Webber, Tate, Ward & Bowling (2010) examining the relationship between motivation and adherence to self-monitoring and previous weight loss, adherence to self-monitoring was a mediating factor in weight loss rather than motivation.

Although the attrition rate for the initial 8 week intervention was very low (12.4%), only 68% of participants returned for the 6 month follow-up, similar to the average attrition rate for social support interventions (35%) (Verheijeden, Bakx, van Weel, Koelen, & van Staveren, 2005). Those who did not complete the 6 month follow-up were similar at baseline to those who completed the study, except that they were more likely to be single, or older. Those who did not return for 6 month follow-ups did report significantly lower self-efficacy at 8 weeks compared with completers.

Study Strengths and Limitations

There were several key strengths to this study. The most significant is the evaluation of long term outcomes (4 months after the intervention was completed). A number of studies have evaluated retention of weight loss but few have systematically evaluated the psychological factors that may influence retention of weight loss. The findings support the importance of both self-efficacy and social support but it proved difficult to isolate any specific factor as being important for retention of weight loss. The obese population is at high risk of comorbidities such as Type 2 diabetes, hypertension, and hyperlipidemia if significant weight loss is not maintained. Long-term weight maintenance is the primary goal of weight loss interventions, as health benefits of weight loss are reversed if weight is regained. Therefore, more research is needed to determine the most effective treatment methods for long-term weight maintenance.

A unique advantage of the study is that the intervention did not provide any incentive outside of anthropometric and clinical results testing. Studies which provided monetary incentive based on weight loss outcomes or completion of the program may indirectly influence efficacy by shifting motivation from intrinsic to extrinsic. This can bias the results and it also limits the generalizability of any findings to other settings. The present study was more ecologically valid and this allows it to contribute to the body of literature on weight loss retention.

There were also several limitations for this study including: insufficient statistical power, lack of data, measurement scales, self-reported data, health coach experience. The small sample size (8 weeks: n =78; 6 months: n = 53) reduced statistical power and made it difficult to detect significant relationships between groups. There was also a discrepancy in distributions of males within the study due to our randomization process (i.e. the guided group only had 3 males, compared with self-monitored (n = 13) and combined (n = 15) treatment groups). This made it difficult to place confidence in some of the gender comparisons.

Due to a conflict with timing of IRB approvals and data collection periods, participants from the first cohort received psychosocial surveys in the mail rather than in-person at follow-up, which affected psychosocial data collection. This also meant there was no repeated measure of social support. Therefore, we could not evaluate how social support may have changed over time and how that change related to anthropometric outcomes at different time points. Additionally, the first participants only completed half of the social support survey, so it was not possible to evaluate this for the entire sample. There was also no consistent measure of diet or physical activity to compare between the three treatments, which potentially may have helped determine if specific diet or physical activity behaviors associated with, or explain differences in, long-term weight maintenance. Participants that did not complete the 6 month follow-up were not used in the analyses of 6 month measures, meaning we did not carry 8 week anthropometric measures forward nor made the assumption of no further change in outcomes.

The social support surveys were based on participant reflection of perceived social support from family and friends over the previous four months. This is a limitation as self-reported data is made less reliable by selective memory, telescoping memory, attribution, and exaggeration. Internal reliability coefficients for the social support scales revealed one questionable alpha for perceived support from friends (eating habits). In retrospect, the internal consistency of the scale may have been improved by modifying the scale prior to distribution.

The use of trained graduate students with limited experience in Motivational Interviewing techniques and health coaching, and some inconsistency of graduate students between cohorts may have been two factors in explaining anthropometric differences observed between cohorts 1 and 2. Only 3 of 6 health coaches were present for both cohorts, the other 3 were replaced by new coaches for the second cohort. Therefore, outcomes may have been affected by skill improvement for coaches who remained for both cohorts, or there may have been a difference in coaching skill level between new and preceding coaches. To reduce, or control for, some of the variance caused by inexperienced health coaches it may be advisable to evaluate Motivational Interviewing skills with a tool such as the Motivational Interviewing Treatment Integrity scale.

Conclusions and Recommendations for Future Research

In conclusion, the interventions seemed reasonably effective as the majority of participants were able to retain weight lost during the intervention. There were no significant differences in outcomes between treatment groups and it also proved difficult to detect any

specific behavioral processes that influenced the retention of weight loss. The results show that both self-efficacy and social support were associated with weight change. The results also reveal some tendency for self-efficacy and social support to be higher among participants with more successful retention of weight loss. These results support the importance of these psychosocial constructs for weight loss programs.

A unique finding was that there were significant relationships between social support and self-efficacy for long-term weight maintenance behaviors. Self-efficacy has been consistently shown to be a key factor in weight loss and long-term weight maintenance. The associations with social support suggest that this may be a promising target to help promote self-efficacy for weight loss. More research is needed to determine the effects on specific weight related behaviors and self-efficacy for weight related behaviors. Future interventions for the obese population should be based on psychological theory, encourage healthy eating habits, incorporate diet and physical activity monitoring, and assess a variety of psychosocial variables in order to better understand behavioral factors influencing weight loss.

APPENDIX A - SURVEYS

SOCIAL SUPPORT AND EXERCISE SURVEY

Below is a list of things people might do or say to someone who is trying to exercise regularly. If you are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question.

Please rate each question twice. Under family, rate how often anyone living in your household has said or done what is described during the last four months. Under friends, rate how often your friends, acquaintances, or coworkers have said or done what is described during the last four months.

Please write one number from the following rating scale in each space:

None	Rarely	A Few Times	Often	Very Often	Does Not Apply
1	2	3	4	5	8

During the past four months, my family (or members of my household) or friends:

	Family	Friends
11. Exercised with me.		
12. Offered to exercise with me.		
13. Gave me helpful reminders to exercise (“Are you going to exercise tonight?”)		
14. Gave me encouragement to stick with my exercise program.		
15. Changed their schedule so we could exercise together.		
16. Discussed exercise with me.		
17. Complained about the time I spend exercising.		
18. Criticized me or made fun of me for exercising.		
19. Gave me rewards for exercising (bought me something or gave me something I like).		
20. Planned for exercise on recreational outings.		
21. Helped plan activities around my exercise.		
22. Asked me for ideas on how they can get more exercise.		
23. Talked about how much they like to exercise.		

SOCIAL SUPPORT AND EATING HABITS SURVEY

Below is a list of things people might do or say to someone who is trying to improve their eating habits. Please rate each question twice. Under family, rate how often anyone living in your household has said or done what is described during the last four months. Under friends, rate how often your friends, acquaintances, or coworkers have said or done what is described during the last four months.

Please write one number from the following rating scale in each space:

SAMPLE:

If my family rarely makes fun of the foods I eat, and my friends very often do, I would answer like this:

	Family	Friends
A. Made fun of the foods I eat SAMPLE:	2	5

None	Rarely	A Few Times	Often	Very Often	Does Not Apply
1	2	3	4	5	8

During the past four months, my family (or members of my household) or friends:

	Family	Friends
1. Encouraged me not to eat "unhealthy foods" (cake, salted chips) when I'm tempted to do so.		
2. Discussed my eating habit changes with me (asked me how I'm doing with my eating changes).		
3. Reminded me not to eat high fat, high salt foods.		
4. Complimented me on changing my eating habits ("Keep it up", "We are proud of you ")		
5. Commented if I went back to my old eating habits.		
6. Ate high fat or high salt foods in front of me.		
7. Refused to eat the same foods I eat.		
8. Brought home foods I'm trying not to eat.		
9. Got angry when I encouraged them to eat low salt, low fat foods.		
10. Offered me food I'm trying not to eat.		

Self-Efficacy for Physical Activity Survey

Please provide honest answers. The knowledge provided from your responses will increase the understanding and development of programs that are designed to help people manage life situations with which they have to cope.

10 items are listed below that may influence your choice to **be physically active**.

Please rate your confidence that you can be **physically active on a regular basis** using the scale: 0 = not confident to 10 = very confident.

How confident am I that I can be physically active:	**Please circle your response** **Not Confident Moderate Very Confident**
When I am anxious (nervous)	0 1 2 3 4 5 6 7 8 9 10
During the winter	0 1 2 3 4 5 6 7 8 9 10
When I am angry (or irritable)	0 1 2 3 4 5 6 7 8 9 10
During holiday seasons	0 1 2 3 4 5 6 7 8 9 10
When I experience family problems	0 1 2 3 4 5 6 7 8 9 10
When I am tired	0 1 2 3 4 5 6 7 8 9 10
When I am depressed (or down)	0 1 2 3 4 5 6 7 8 9 10
When I am exceptionally busy	0 1 2 3 4 5 6 7 8 9 10
When I am travelling or on vacation	0 1 2 3 4 5 6 7 8 9 10
When I am stressed	0 1 2 3 4 5 6 7 8 9 10
When visitors are present	0 1 2 3 4 5 6 7 8 9 10
When I am recovering from illness or injury	0 1 2 3 4 5 6 7 8 9 10

Self-Efficacy for Diet Survey

Please provide honest answers. The knowledge provided from your responses will increase the understanding and development of programs that are designed to help people manage life situations with which they have to cope.

10 items are listed below that may influence your choice to **practice a healthy diet**.

Please rate your confidence that you can eat a **healthy diet on a regular basis** using the scale: 0 = not confident to 10 = very confident.

How confident am I that I can eat a healthy diet…	**Please circle your response** **Not Confident Moderate Very Confident**
When I am anxious (nervous)	0 1 2 3 4 5 6 7 8 9 10
During the winter	0 1 2 3 4 5 6 7 8 9 10
When I am angry (or irritable)	0 1 2 3 4 5 6 7 8 9 10
During holiday seasons	0 1 2 3 4 5 6 7 8 9 10
When I experience family problems	0 1 2 3 4 5 6 7 8 9 10
When I am tired	0 1 2 3 4 5 6 7 8 9 10
When I am depressed (or down)	0 1 2 3 4 5 6 7 8 9 10
When I am exceptionally busy	0 1 2 3 4 5 6 7 8 9 10
When I am travelling or on vacation	0 1 2 3 4 5 6 7 8 9 10
When I am stressed	0 1 2 3 4 5 6 7 8 9 10
When visitors are present	0 1 2 3 4 5 6 7 8 9 10
When I am recovering from illness or injury	0 1 2 3 4 5 6 7 8 9 10

APPENDIX B – TABLES AND FIGURES

Participant Flow Chart

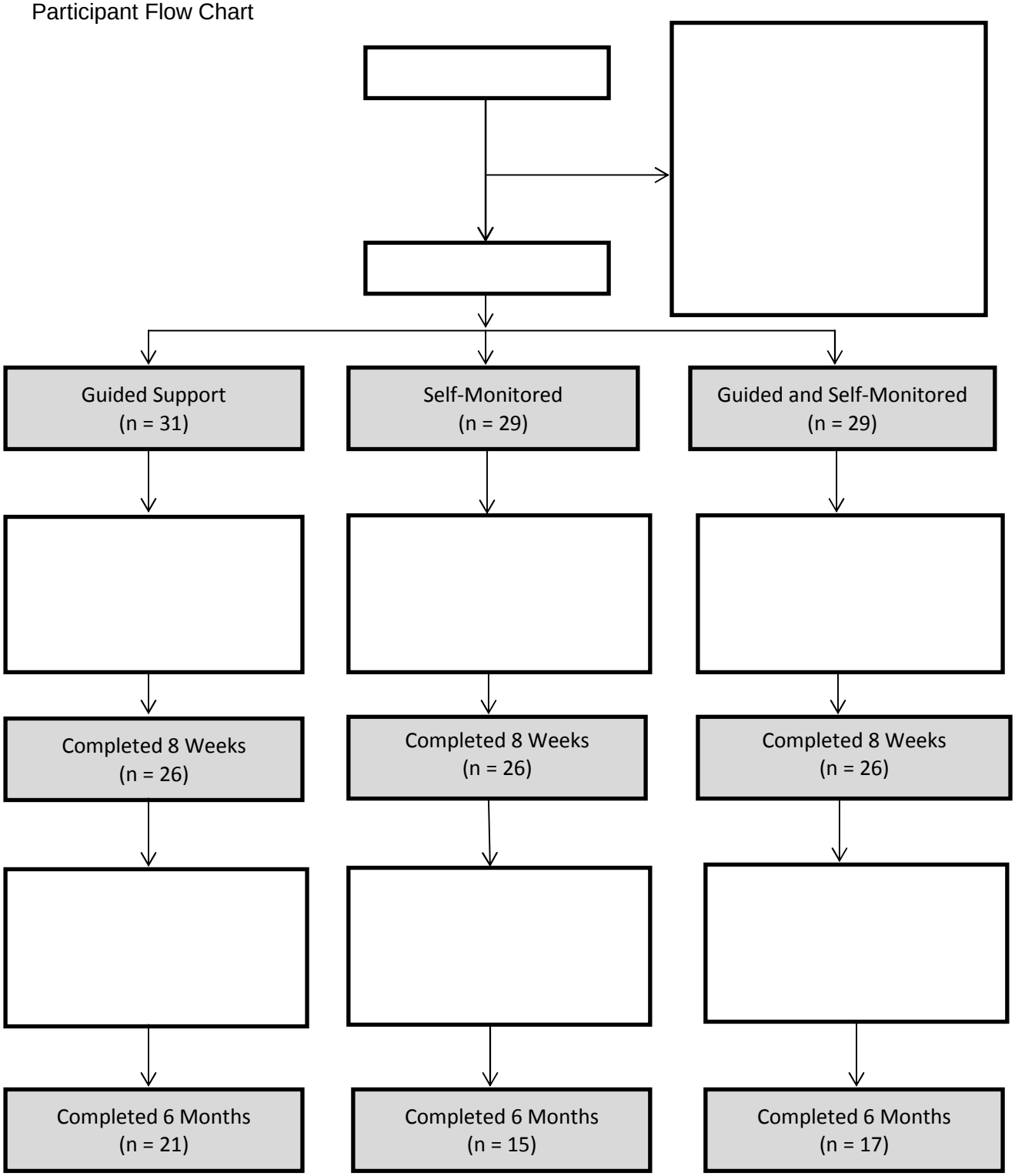


Table 1a Baseline Characteristics Based on 8 Week Completion

		Treatment Group		
Characteristic	**All**	**Guided**	**Self-Monitored**	**Combined**
N (male:female)	78 (31:47)	26 (3:23)	26 (13:13)	26 (15:11)
Age (years)[a]	38.6±14.1	41.0±14.6	38.6±14.7	37.9±13.1
Range	18-72	19-65	18-72	19-67
Weight (kg) [a]	109.9±20.6	103.8±15.5	111.9±20.0	114.1±24.6
BMI (kg/m^2) [a]	36.7±5.5	36.8±5.3	36.4±5.3	37.0±6.0
Body Fat (%)[a]	38.2±6.4	41.1±5.2	37.0±7.0	36.6±6.2
Waist Circumference (cm) [a]	120.1±13.8	119.9±13.9	120.6±13.0	119.8±14.8
Education (N[%])				
High School	1[1.3]	0[0.0]	1[3.9]	0[0.0]
Some College	17[21.8]	7[26.9]	5[19.2]	5[19.2]
College or Graduate Degree	60[76.9]	19[73.1]	20[76.9]	21[80.8]
Marital Status (N[%])				
Single	34[43.6]	10[38.5]	12[46.2]	12[46.2]
Married	44[56.4]	16[61.5]	14[53.9]	14[53.9]
Race (N[%])				
Caucasian	74[94.9]	25[96.2]	25[96.2]	24[92.3]
Black	3[3.8]	1[3.9]	1[3.9]	1[3.9]
Asian	1[1.2]	0[0.0]	0[0.0]	1[3.9]

Note. BMI = Body Mass Index;

[a] Mean ± Standard Deviations

Table 1b Baseline Characteristics Based on 6 Month Follow-up

		6 Month Follow-up Status	
	All	**Completed**	**Not Completed**
Characteristic	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
N (male:female)	78 (31:47)	53 (19:34)	25 (12:13)
Cohort (N_1:N_2)	(39:39)	(25:28)	(14:11)
Group (N[%])			
Guided	26[33.3]	21[39.6]	5[20.0]
Self-Monitored	26[33.3]	15[28.3]	11[44.0]
Combined	26[33.3]	17[32.1]	9[36.0]
Age (years)	38.6±14.1	41.9±14.5[a]	33.4±11.1[a]
Range	18-72	18-72	21-54
Weight (kg)	109.9±20.6	109.4±20.7	110.9±20.7
BMI (kg/m^2)	36.7±5.5	36.7±5.5	36.7±5.6
Body Fat (%)	38.2±6.4	38.9±6.1	37.0±7.0
Waist Circumference (cm) [a]	120.1±13.8	119.8±14.3	120.6±12.7
Education (N[%])			
High School	1[1.3]	1[1.9]	0[0.0]
Some College	17[21.8]	12[22.6]	5[20.0]
College or Graduate Degree	60[76.9]	40[75.5]	20[80.0]
Marital Status (N[%])			
Single	34[43.6]	18[44.0][b]	16[64.0][b]
Married	44[56.4]	35[66.0][c]	9[36.0][c]
Race (N[%])			
Caucasian	74[94.9]	49[92.5]	25[100.0]
Black	3[3.8]	3[5.7]	0[0.0]
Asian	1[1.2]	1[1.9]	0[0.0]

Note. BMI = Body Mass Index;

(M+SD) = Mean ± Standard Deviations;

[a-c] values with the same letter are significantly different ($p < .05$)

Table 1c Self-Efficacy by Completion Status

	6 Month Follow-up					
	Completed			Not Completed		
	N	Mean	SD	N	Mean	SD
Self-Efficacy (8 Weeks)						
Diet	53	7.37[a]	1.41	25	6.33[a]	1.39
Physical Activity	53	6.63[b]	1.57	24	5.77[b]	1.56
Combined	53	7.00[c]	1.35	25	6.07[c]	1.37

[a-c] Values with same letter are significantly different ($p < .05$)

Table 2a Changes in Anthropometric Outcomes Between Treatment Groups at 8 Weeks and 6 Months

			Guided				Self-Monitored				Combined			
	All		Male		Female		Male		Female		Male		Female	
N (8Wk,6M)	(78,53)		(3,2)		(23,19)		(13,7)		(13,8)		(15,10)		(11,7)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Weight (Kg)														
8 week	-4.21	3.08	-4.20	6.03	-3.63	2.81	-4.31	3.13	-3.80	2.69	-5.71	2.46	-3.75	3.86
6 month	-4.82	4.83	-7.70	3.25	-3.55	4.28	-5.29	5.25	-5.13	5.61	-6.49	5.49	-4.27	4.80
BMI (kg/m2)														
8 week	-1.39	1.01	-1.30	1.97	-1.28	0.95	-1.29	0.94	-1.32	0.91	-1.73	0.81	-1.36	1.40
6 month	-1.58	1.59	-2.70	0.57	-1.25	1.52	-1.56	1.53	-1.83	1.71	-1.88	1.73	-1.46	1.90
Body Fat (%)														
8 week	-0.97	1.54	-0.57	1.03	-0.76	2.46	-0.82	1.05	-0.88	0.64	-1.27	0.72	-1.40	1.24
6 month	-1.15	2.09	-2.20	0.00	-0.27	2.07	-1.24	1.78	-1.20	1.34	-2.11	2.70	-1.85	2.00
Waist (cm)														
8 week	-4.27	3.58	-4.50	2.38	-3.45	3.99	-4.45	2.61	-5.60	4.02	-4.09	1.82	-4.35	5.15
6 month	-4.64	4.69	-8.50	4.73	-2.67	4.64	-4.46	3.05	-7.87	5.57	-4.84	4.81	-5.05	3.83

Note. BMI = Body Mass Index

Table 2b Anthropometric Changes by Cohort

	Cohort 1			Cohort 2		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**
Weight Change						
8 week	39	-3.41[a]	2.89	39	-5.00[a]	3.09
6 month	25	-3.40[b]	4.59	28	-6.09[b]	4.77
BMI Change						
8 week	39	-1.14	0.97	39	-1.63	1.01
6 month	25	-1.15	1.57	28	-1.96	1.53
BF Change						
8 week	38	-0.76	0.91	39	-1.17	1.95
6 month	24	-0.85	1.50	28	-1.41	2.49
Waist Change						
8 week	39	-3.54	3.97	39	-4.99	3.04
6 month	25	-3.73	5.20	28	-5.44	4.11

Note. BMI = Body Mass Index; BF = Body fat;
[a-b]: values with same letter are significantly different; $p < .05$

Table 2c Anthropometric Changes by Group

	Guided			Self-Monitored			Combined		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Weight Change									
8 week	26	-3.69	3.14	26	-4.05	2.87	26	-4.88	3.21
6 month	21	-3.94	4.31	15	-5.20	5.25	17	-5.57	5.18
BMI Change									
8 week	26	-1.28	1.05	26	-1.30	0.91	26	-1.58	1.09
6 month	21	-1.39	1.51	15	-1.70	1.57	17	-1.71	1.76
BF Change									
8 week	26	-0.73	2.32	26	-0.85	0.85	25	-1.32	0.94
6 month	21	-0.45	2.05	15	-1.22	1.50	16	-2.01	2.39
Waist Change									
8 week	26	-3.57	3.82	26	-5.03	3.37	26	-4.20	3.54
6 month	21	-3.23	4.73	15	-6.28	4.75	17	-4.93	4.30

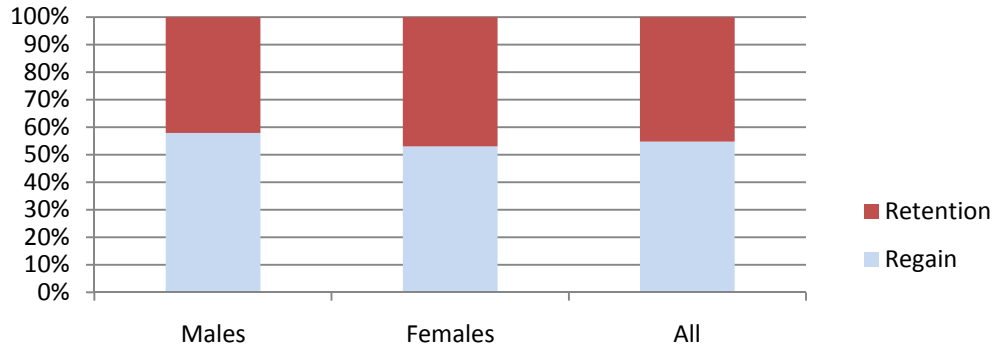
Note. BMI = Body Mass Index; BF = Body fat; Cohen's d: effect size, CI = Confidence Interval (95%).

Table 2d Anthropometric Changes by Gender

	Male			Female		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**
Weight Change						
8 week	31	-4.97	3.11	47	-3.70	2.99
6 month	19	-6.17	5.05	34	-4.07	4.61
BMI Change						
8 week	31	-1.51	0.98	47	-1.31	1.04
6 month	19	-1.85	1.55	34	-1.43	1.61
BF Change						
8 week	31	-1.02	0.91	46	-0.93	1.85
6 month	19	-1.80	2.21	33	-0.78	1.96
Waist Change						
8 week	31	-4.28	2.17	47	-4.25	4.29
6 month	19	-5.09	4.02	34	-4.39	5.07

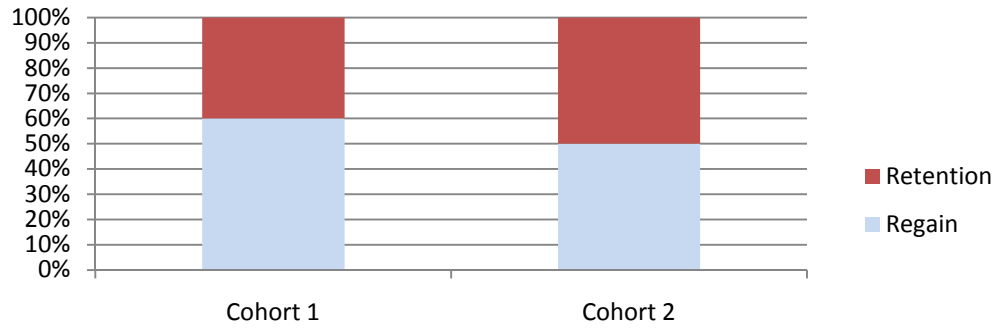
Note. BMI = Body Mass Index; BF = Body fat; Cohen's d = Effect size, CI = Confidence Interval (95%) (upper limit, lower limit).

Figure 1 Weight Retention Versus Regain by Gender (8 weeks to 6 months)



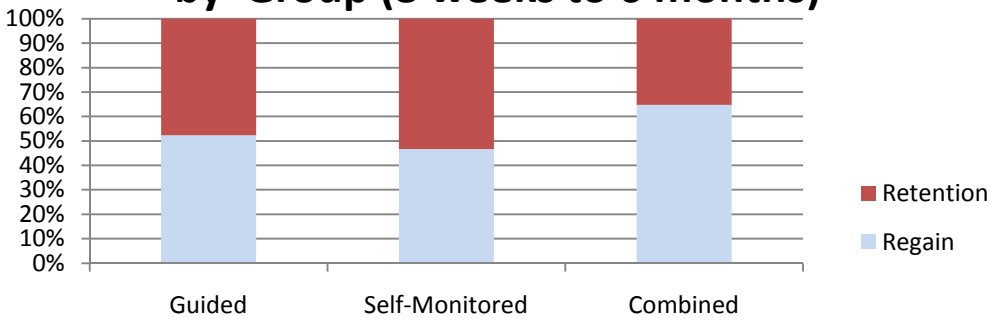
Note. Retention/Regain categories based on difference of weight outcomes (6 months - 8 weeks) ; Retention = zero (no weight change) or negative difference (additional weight loss); Regain = positive difference.

Figure 2 Weight Retention Versus Regain by Cohort (8 weeks to 6 months)



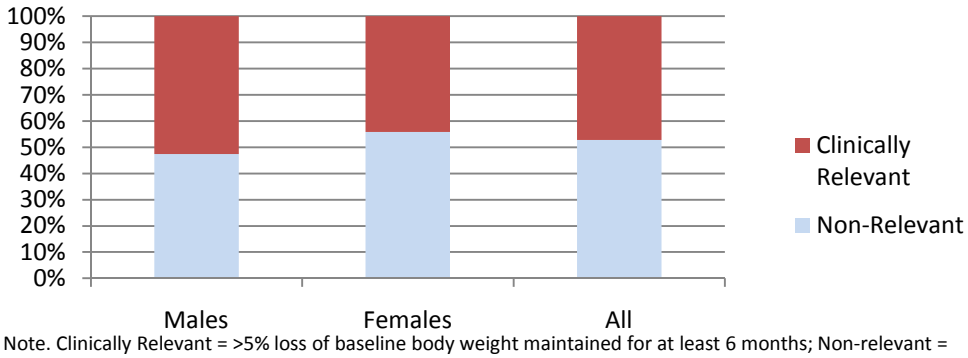
Note. Retention/Regain categories based on difference of weight outcomes (6 months - 8 weeks) ; Retention = zero (no weight change) or negative difference (additional weight loss); Regain = positive difference.

Figure 3 Weight Retention Versus Regain by Group (8 weeks to 6 months)



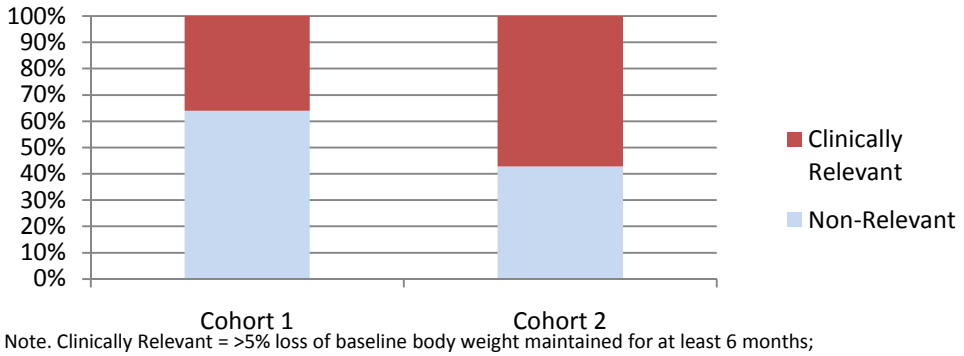
Note. Retention/Regain categories based on difference of weight outcomes (6 months - 8 weeks) ; Retention = zero (no weight change) or negative difference (additional weight loss); Regain = positive difference.

Figure 4 Clinically Relevant Weight Maintenance by Gender



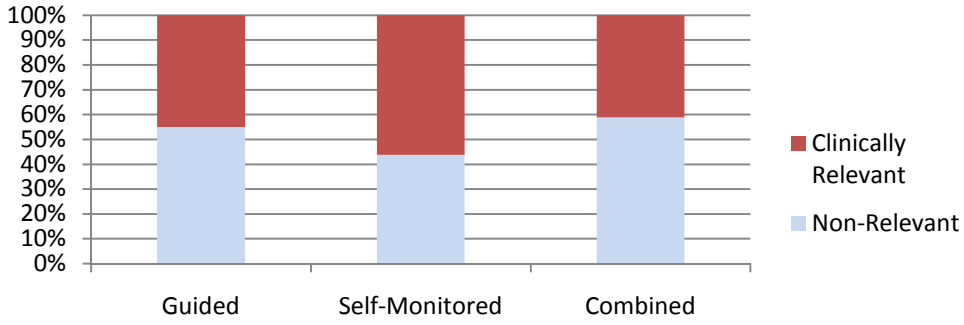
Note. Clinically Relevant = >5% loss of baseline body weight maintained for at least 6 months; Non-relevant = <5% weight loss maintained, or regain occurred.

Figure 5 Clinically Relevant Weight Maintenance by Cohort



Note. Clinically Relevant = >5% loss of baseline body weight maintained for at least 6 months; Non-relevant = <5% weight loss maintained, or regain occurred.

Figure 6 Clinically Relevant Weight Maintenance by Group



Note. Clinically Relevant = >5% loss of baseline body weight maintained for at least 6 months; Non-relevant = <5% weight loss maintained, or regain occurred.

Table 3 Internal Reliability for Self-Efficacy and Social Support Surveys

Survey	Cronbach's Alpha	Item Sample
Self-Efficacy		
Diet	0.94	How confident am I that I can eat a healthy diet when I am stressed
Physical Activity	0.93	How confident am I that I can be physically active when I am stressed
Social Support (Family)		
Eating Habits	0.72	During the past 4 months, my family (or members of my household) offered me foods I'm trying not to eat.
Exercise	0.86	During the past 4 months, my family (or members of my household) exercised with me.
Social Support (Friends)		
Eating Habits	0.61	During the past 4 months, my friends offered me foods I'm trying not to eat.
Exercise	0.87	During the past 4 months, my friends exercised with me.

Note: Strength of internal reliability coefficient interpreted as follows: $\geq$ .9 = Excellent, > .8 = Good, > .7 = Acceptable, > .6 = Questionable, > .5 = Poor, and < .5 = Unacceptable (Gliem & Gliem, 2003).

Table 4 Correlations between Self-Efficacy, Social Support, and Weight Change

	SED 8W	SEA 8W	SEC 8W	SED 6M	SEA 6M	SEC 6M	SSEat 6M	SSPA 6M	SSFam 6M	SSFri 6M	WtChg 8W	WtChg 6M
SED 8W	_	.70**	.91**	.52**	.42**	.49**	.12	.12	.12	.06	-.27*	-.21
SEA 8W		_	.93**	.47**	.61**	.59**	.46**	.21	. 30*	. 38**	-.11	-.18
SEC 8W			_	.55**	.58**	.60**	.32*	.18	.23	.25	-.20	-.21
SED 6M				_	.69**	.90**	.05	.30	.09	.24	-.15	-.26
SEA 6M					_	.94**	. 29*	. 42**	. 28*	. 43**	-.02	-.09
SEC 6M						_	.19	.39**	.21	.37**	-.07	-.18
SSEat 6M							_	.22	.70**	.67**	-.03	-.07
SSPA 6M								_	.69**	.65**	-.01	-.08
SSFam 6M									_	.45**	-.02	-.06
SSFri 6M										_	.12	-.03
WtChg 8W											_	.65**
WtChg 6M												_

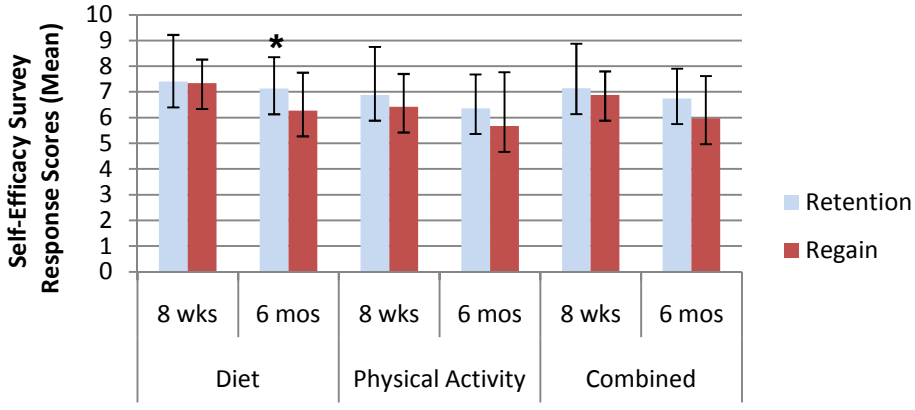
Note. Pearson correlation indicating strength of linear relationships between psychosocial factors and weight change. SED/A/C: Self-Efficacy Diet/Activity/Combined; SSEat/PA/Fam/Fri: Social Support Eating Habits/Physical Activity/Family/Friends. WtChg: Weight Change; 8W: 8 Weeks; 6M: 6 Months. * $p < 0.05$; **$p < 0.01$.

Table 5 Self-Efficacy by Weight Retention (8 Weeks to 6 Months)

	Retention			Regain			Effect Size	
	N	Mean	SD	N	Mean	SD	d	CI 95%
Self-Efficacy (8 Weeks)								
Diet	24	7.40	1.82	29	7.34	0.97	0.04	-.68, .40
Physical Activity	24	6.88	1.87	29	6.42	1.28	0.30	-.45, .76
Combined	24	7.14	1.74	29	6.88	0.92	0.20	-.50, .53
Self-Efficacy (6 Months)								
Diet	23	7.13*	1.48	29	6.27*	1.22	0.65	-1.10, -.05
Physical Activity	24	6.36	2.1	29	5.67	1.32	0.40	-.89, .45
Combined	24	6.75	1.65	29	5.97	1.15	0.56	-.99, .09

Note. Retention/Regain based on difference between 6 month and 8 week weight measurements (6 month – 8 week), zero or negative value = retention, positive value = regain. d = Cohen's d, CI = confidence interval (95%) upper limit, lower limit. *Values are significantly different p = 0.03.

Figure 7 Self-Efficacy by Weight Loss Retention

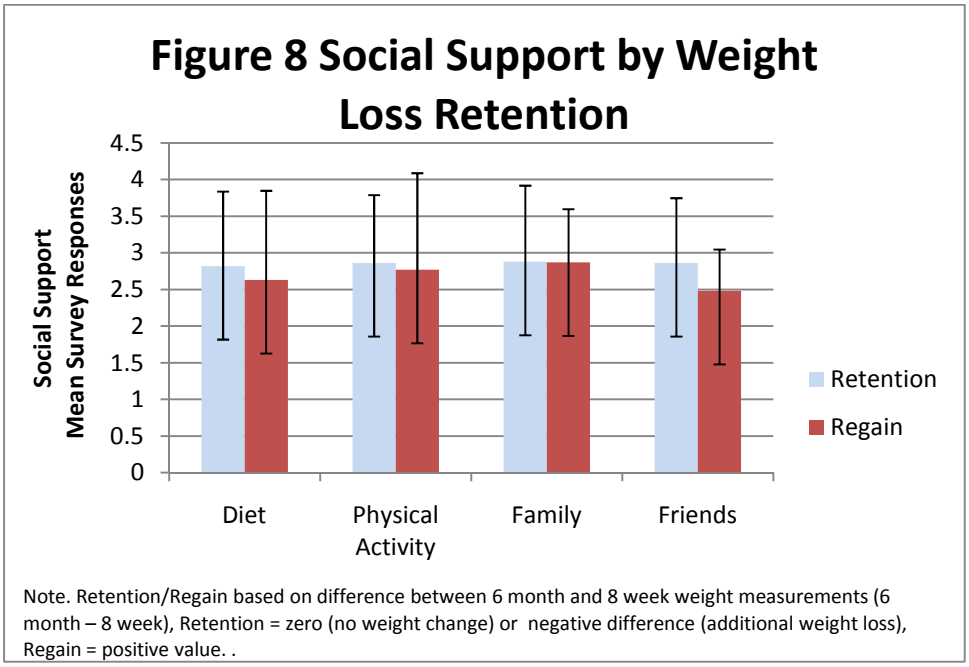


Note. Retention/Regain based on difference between 6 month and 8 week weight measurements (6 month – 8 week), Retention = zero (no weight change) or negative difference (additional weight loss), Regain = positive value. * Value was significantly different p = 0.03

Table 6 Social Support by Weight Retention (8 Weeks to 6 Months)

	Retention			Regain			Effect Size	
	N	Mean	SD	N	Mean	SD	d	CI 95%
Eating	25	2.63	1.22	24	2.82	1.02	-0.17	-.65, .24
Physical Activity	22	2.77	1.32	22	2.86	0.93	-0.08	-.60, .31
Family	25	2.87	0.73	24	2.88	1.04	-0.01	-.30, .40
Friends	25	2.48	0.57	24	2.86	0.89	-0.52	-.74, -.17

Note. Retention/Regain based on difference between 6 month and 8 week weight measurements (6 month – 8 week), zero or negative value = retention, positive value = regain. d = Cohen's d, CI = confidence interval (95%) upper limit, lower limit.

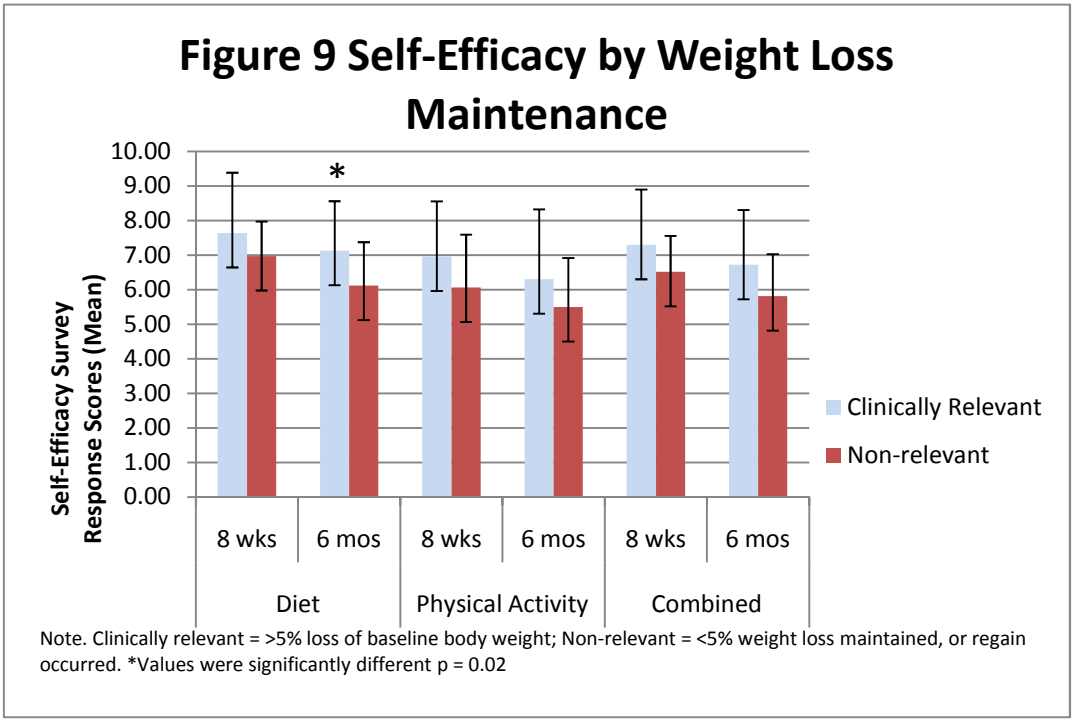


Note. Retention/Regain based on difference between 6 month and 8 week weight measurements (6 month – 8 week), Retention = zero (no weight change) or negative difference (additional weight loss), Regain = positive value. .

Table 7 Self-Efficacy by Weight Maintenance

	Clinically Relevant			Non-Clinically Relevant			Effect Size	
	N	Mean	SD	N	Mean	SD	d	CI 95%
Self-Efficacy (8 Weeks)								
Diet	25	7.64	1.74	28	7.12	0.99	.37	-.30,.75
Physical Activity	25	6.96	1.60	28	6.34	1.52	.40	-.22,.97
Combined	25	7.30	1.60	28	6.73	1.03	.42	-.19,.82
Self-Efficacy (6 Months)								
Diet	24	7.13*	1.43	28	6.24*	1.25	.66	.11,1.14
Physical Activity	25	6.30	2.02	28	5.70	1.41	.34	-.44,.88
Combined	25	6.72	1.58	28	5.97	1.22	.53	-.14,1.07

Note: Clinically relevant: >5% loss of baseline body weight maintained at least 6 months; non-clinicallyrelevant: <5% loss maintained or regain. d = Cohen's d; CI = confidence interval (95%) upper limit, lower limit. *Values are significantly different p = 0.02.

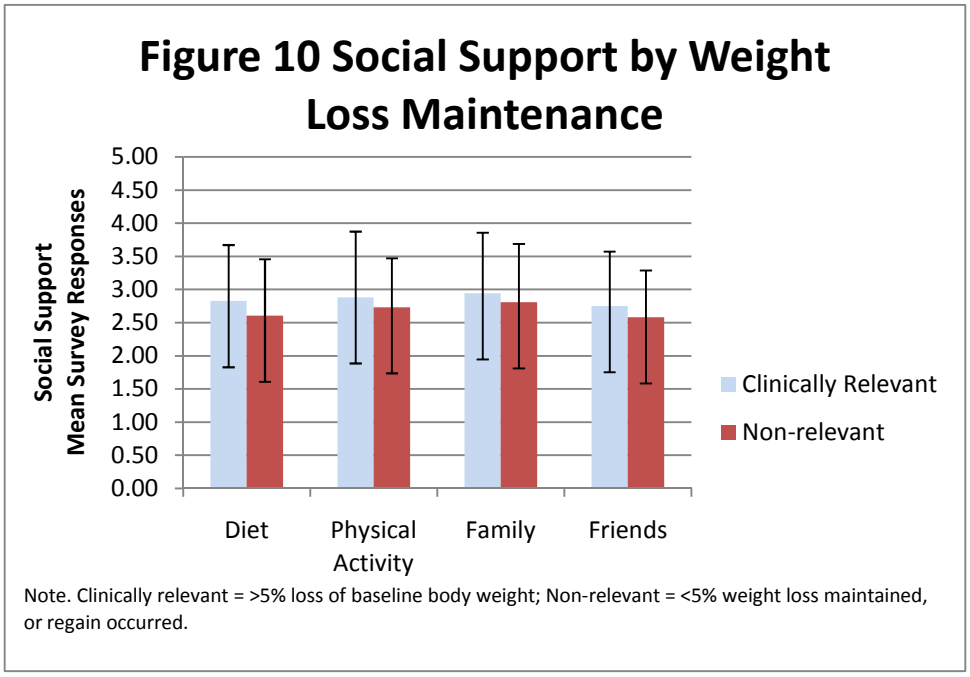


Note. Clinically relevant = >5% loss of baseline body weight; Non-relevant = <5% weight loss maintained, or regain occurred. *Values were significantly different p = 0.02

Table 8 Social Support by Weight Maintenance

	Clinically Relevant			Non-Clinically Relevant			Effect Size	
	N	Mean	SD	N	Mean	SD	d	CI (95%)
Eating	25	2.83	0.84	24	2.61	0.85	.26	-.06, .61
Physical Activity	24	2.88	0.99	20	2.73	0.73	.17	-.22, .49
Family	25	2.94	0.91	24	2.81	0.88	.15	-.21, .50
Friends	25	2.75	0.82	24	2.58	0.70	.22	-.09, .51

Note: Clinically relevant: >5% loss of baseline body weight maintained at least 6 months; non-clinically relevant: <5% loss maintained or regain. d = Cohen's d. CI = confidence interval (95%) upper limit, lower limit



Note. Clinically relevant = >5% loss of baseline body weight; Non-relevant = <5% weight loss maintained, or regain occurred.

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