METABOLIC AND PSYCHOLOGICAL PREDICTORS OF WEIGHT REGAIN AMONG BEHAVIORAL WEIGHT LOSS PARTICIPANTS

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ABSTRACT

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Obesity may soon surpass smoking as the leading contributor to preventable death in the United States. While weight loss treatment outcomes have improved over time, weight loss maintenance following treatment is a significant problem. The present study explored metabolic, psychological and behavioral predictors of weight regain among 40 obese adults 6 months following completion of a 6-month behavioral weight loss program (BWLP). Predictor variables were assessed at pre-treatment, post-treatment, and the 6 month follow-up. Multiple regression analyses revealed statistical trends for higher post-treatment and follow-up resting metabolic rate (RMR) to be associated with superior weight loss maintenance from post-treatment to follow-up (but not from pre-treatment to follow-up) after controlling for fat-free mass (FFM) and fat-mass (FM). In addition, a higher follow-up RMR was significantly associated with superior weight loss maintenance after controlling for FFM, FM, and caloric intake. At follow-up, lower levels of dietary disinhibition and binge eating, greater levels of cognitive dietary restraint, greater internal locus of control, and less of a tendency to attribute weight to medical factors were all significantly correlated with superior weight loss maintenance. However, the psychological variables did not mediate the relationship between RMR and weight loss maintenance. Greater physical activity at post-treatment and follow-up was correlated with superior weight loss maintenance, but calorie and fat intake were not. The results suggest that RMR assessed at some point after a BWLP is generally associated with weight loss maintenance following treatment and that it is important to control for body size and caloric intake in such analyses. Therefore,
helping participants to find ways to maximize RMR following weight loss may be important for long-term success. Results also indicate that psychological variables assessed during active weight loss maintenance may be better predictors of weight maintenance outcomes compared to the same factors assessed at earlier times. Finally, maintaining high levels of dietary control and physical activity may be key to increasing weight loss maintenance success. Weight loss maintenance efforts may benefit from viewing obesity as a multifaceted health concern with metabolic, behavioral and psychological underpinnings.
In dedication to my parents who taught me the value of hard work and perseverance.
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CHAPTER 1. INTRODUCTION

Obesity may soon surpass smoking as the leading contributor to preventable death in the United States (McGinnis & Foege, 1993; Peeters et al., 2003). The prevalence of people who are overweight and obese has increased dramatically over the past several decades (Flegal, Carroll, Kuczmarski, & Johnson, 1998) with approximately two-thirds of American adults now considered to be overweight or obese (Flegal, Carroll, Ogden, & Johnson, 2002; Ogden, Carroll, Curtin, McDowell, Tabak, & Flegal, 2006). This upward trend is concerning from a public health perspective given that obesity is associated with a variety of health concerns, including mortality. The association between obesity and cardiovascular disease, hypertension, dyslipidemia, stroke, diabetes, osteoarthritis, gallstones, sleep apnea and some forms of cancer are well documented and robust (Corsica & Perri, 2003), and mortality rates increase significantly with body mass indices (BMI) greater than 30 compared to BMI’s in the normal range (Flegal, Graubard, Williamson, & Gail, 2005; Troiano, Frongillo, Sobal, & Levitsky, 1996). While non-surgical obesity treatment typically results in a 9% weight loss, which is sufficient to improve many health related problems, the poor maintenance of weight loss following treatment remains a significant obstacle for obesity treatment (Perri & Fuller, 1995).

Defining Obesity

Obesity is characterized by an unhealthy amount of body fat (greater than 30-35% for women and 20-25% for men; Lohman, 2002). While body fat can be measured by electrical impedance, skinfold measurements, hydrostatic weighing, and dual energy x-ray absorptiometry (i.e., DEXA scan), these measures can be cumbersome and unavailable. Therefore, obesity in adults is most commonly assessed indirectly in terms of weight in relation to height (i.e., BMI). Body mass index is defined as weight in kilograms divided by meters squared (kg/m²). The
National Institute of Health and the World Health Organization have established BMI criteria for normal weight, overweight, and obesity as, 18.5-24.9, 25-30, and $\geq 30$, respectively. BMI categories are based on comorbid conditions and mortality associated with the different BMI levels.

**Obesity Etiology**

Weight loss and regain is likely to be influenced, at least in part, by factors that contribute to the development of obesity (Nir & Neumann, 1995). Optimal treatment and prevention programs will be greatly enhanced by an increased understanding of the etiology of obesity. While obesity ultimately results from a positive energy imbalance (i.e., greater caloric intake compared to caloric expenditure), biological, behavioral, and environmental factors are likely to contribute to how easy or difficult it is for individuals to create or maintain a negative energy balance.

Biological contributions to obesity include genetics, rates of fat oxidation, and resting metabolic rate (RMR). It is estimated that 30-70% of total body fatness and fat distribution can be attributed to genetics (Steinbeck, 2002). A low rate of fat oxidation (i.e., a high respiratory quotient) reflects a reduced inclination for the body to use fat as fuel and is associated with poor weight maintenance (Tataranni & Ravusin, 2002). RMR, which accounts for 60-70% of total daily energy expenditure may be lower among obese people. Behavioral factors, such as excessive caloric consumption, binge eating, and insufficient physical activity, have also been associated with obesity. Finally, environmental factors such as unlimited access to high-calorie foods, large portion sizes, increased eating outside of the home, and technological advances that make physical activity unnecessary (e.g., less labor intensive occupations, labor saving devices such as cars, elevators, remote controls, and leisure activities that involve sedentary behavior
such as playing computer games and watching TV) have likely contributed to increased rates of obesity.

**Obesity Treatment**

Given the high rates of obesity and the well-known health consequences, many obese individuals attempt to lose weight (Corsica & Perri, 2003). Approximately 44% of women and 29% of men report that they are dieting to lose weight (Serdula et al., 1999). As mentioned earlier, a review of behavioral treatment outcome studies revealed that participants lose an average of 9% of their initial body weight over the course of treatment (Perri & Fuller, 1995). Maximum weight loss is usually reached approximately 6 months after the beginning of treatment (Jeffery et al., 2000). After 6 months, weight regain begins and continues until it stabilizes slightly below baseline levels.

Most individuals are unable to maintain their weight loss for longer than a few months to a year (Hill & Wyatt, 1999). During the first year following treatment, participants tend to regain 30% to 40% of the lost weight (Jeffery et al., 2000). A review by Anderson, Konz, Frederich, and Wood (2001) concluded that following structured weight loss programs, on average, a 3.2% body weight loss is maintained at 4 to 5 year follow-up assessments. However, the reported mean percent body weight loss may be misleading because only 13-22% of weight loss participants successfully maintain a weight loss of 5 kg (11 lb) or more 5 years post-treatment (Perri & Corsica, 2002). In other words, averaging across participants creates the impression that most people are maintaining some weight loss. However, actually only a small minority of participants are successful at maintaining at least a 10% loss of body weight, which is associated with substantial beneficial changes in health risk (National Heart, Lung, and Blood Institute [NHLBI] Obesity Education Initiative Expert Panel, 1998). After reviewing the treatment
outcome literature on obesity (excluding surgical procedures), the Institute of Medicine succinctly summarized the current state of obesity treatment by stating “…those who complete weight-loss programs lose approximately 10% of their body weight, only to regain two thirds of it back within one year and almost all of it back within 5 years” (Thomas, 1995, p. 1).

Despite these discouraging statistics, it is important to consider that success rates among individuals who try to lose weight through structured weight loss programs may be somewhat lower than those found among the general public. Compared to obese people who lose weight on their own, weight loss program members may represent people who experience greater difficulty losing and maintaining weight throughout their lives (Wing & Hill, 2001). For example, McGuire, Wing and Hill (1999) conducted a random-digit-dial telephone survey in a representative sample of 500 adults in the United States to explore weight patterns. Approximately 56% of the respondents reported having had a BMI of 27 or greater at some point in their life. Of these individuals, 20.6% reported that they had intentionally lost weight and maintained a weight loss of at least 10% for a minimum of 1 year. While weight loss maintenance outcomes of people losing weight on their own are modestly better than structured weight loss programs, these findings suggest that successful weight maintenance is nevertheless difficult for most people who lose a significant amount of weight.

While the percentage of individuals successful at weight loss maintenance may vary as a function of weight loss methods (e.g., structured behavioral weight loss program, pharmacology, very low calorie diet, or losing weight on one’s own), the definition of success (e.g., percentage of weight loss), and the length of follow-up, nearly all researchers agree that the failure to maintain long-term weight loss is a significant problem in the treatment of obesity. Furthermore,
research on the biological, psychological and behavioral predictors of long-term success is limited.

**Predictors of Weight Loss Maintenance**

Individuals who are ultimately successful at weight loss maintenance increase their caloric expenditure and decrease caloric intake, thus obtaining the energy balance necessary to maintain a given weight (McGuire, Wing, Klem, Lang, & Hill, 1999; Sarlio-Lahteenkorva & Rissanen, 1998; Wing & Hill, 2001). However, research on the metabolic and psychological predictors of successful weight loss maintenance has been limited and relatively inconclusive. Nevertheless, in some studies, weight loss maintenance has been associated with RMR, dietary disinhibition, binge-eating, hunger, cognitive dietary restraint, weight locus of control, and self-efficacy. The influence of these factors on weight loss maintenance will be discussed below.

**Resting Metabolic Rate**

RMR is the number of calories the body expends at rest, in the fasting state, over the course of 24 hours. RMR accounts for approximately 60-70% of the body’s total energy expenditure and thus, is the greatest factor in determining total caloric need (Tataranni & Ravussin, 2002). The other components of total daily energy expenditure are the calories used to digest food (i.e., thermic effect of food; 10-15%) and the calories expended during physical activity (20-30%). Fat-free mass (FFM), fat mass (FM), age, and sex account for approximately 80% of RMR’s variance, and family membership explains some of the remaining variance (Tataranni & Ravussin, 2002). The number one predictor of RMR is lean body mass or FFM; however, there can be large variations (up to 1,000 kcal/day) in RMR even among individuals of the same sex, age, and size (Wadden & Bell, 1990).
RMR and energy restriction. The study of RMR and weight loss and maintenance is complicated by the impact of energy restriction on RMR. For example, Weinsier et al. (2000) made RMR comparisons between energy restriction and energy balance states among 24 postmenopausal women. The participants had initial BMIs of 25-30, placing them in the overweight category. The study consisted of four 10-day phases: (1) the overweight state in energy balance, (2) the overweight state during energy restriction, (3) normal weight state during energy restriction, and (4) normal weight state in energy balance. Energy restriction was defined as consuming fewer calories (i.e., 800 kcal/day diet) than were being expended over a 24-hour period (i.e., approximately 1215 and 1108 kcal/day in phases 2 and 3, respectively), and energy balance was defined as equivalence between energy intake and energy expenditure over a 24-hour period. Participants in the energy restriction phase, in both the overweight and normal weight states, had a 5% lower RMR (adjusted for FFM and FM) compared to participants in the energy balanced phase in both the overweight and normal weight states. The authors concluded that energy restriction resulted in decreases in RMR that were independent of changes in body mass.

Other researchers also reported a decline in RMR during periods of energy restriction (e.g., Garrow, Durrant, Mann, Stalley, & Warwick, 1978; Steinbeck, 2002). Although not statistically significant, Garrow et al. (1978) measured RMR of 32 obese participants and found that those who reported having kept to a “reducing diet” 7 days prior to the initiation of a weight loss program had RMR’s 6% lower than those who reported overeating or normal eating even though there was no difference in their weight. It has been theorized that metabolic down regulation serves to protect against weight loss during times of starvation (Steinbeck, 2002).
When conducting research on RMR and weight, it is important to account for the state of energy restriction or balance of participants so that it is not a confounding factor.

Research into RMR’s role in the etiology of obesity has produced mixed results. Most studies have involved the following comparisons: (1) comparing RMR of obese or reduced-obese participants to never obese controls in attempt to determine if individuals with a history of obesity tend to have lower RMR compared to people who have never been obese, (2) comparing reduced weight participants’ RMR to their obese state RMR to determine if a larger than expected decline in RMR occurs after weight loss, making participants more vulnerable to weight regain, and/or (3) comparing the RMR of individuals who are more successful at weight loss maintenance to those who are less successful. In addition, there has been some research on the longitudinal relationship between RMR and naturalistic weight gain among American Indians.

*RMR of formerly obese or obese individuals compared to individuals who have never been obese.* Astrup et al. (1999) conducted a meta-analysis of 15 different studies conducted between 1983 to 1995 in order to compare RMR in 124 formerly obese participants to 121 control participants who had never been obese. The formerly obese participants had previously had a BMI ≥ 30 and had reduced their weight to a BMI ≤ 27 through non-surgical means. RMR in the formerly obese participants was 2.9% lower, even after controlling for FFM and FM, than the RMR in the control subjects. In addition, a larger portion of relatively low RMR’s (>1 SD below the mean of the control group) were found in formerly obese participants (15.3%) compared to the controls (3.3%). While the authors note that not all of the studies revealed a lower RMR among the formerly obese group, none of the studies found a higher RMR in formally obese participants compared to the control group. Therefore, the formally obese
participants in the 15 studies had either lower or equivalent RMR’s compared to the controls. The authors concluded that the relatively low RMR among formerly obese people compared to people who have never been obese may increase risk of weight regain. It may be worthwhile to note the studies’ samples (i.e., all formally obese) may not adequately represent obese people who are unable to lose a significant amount of weight or maintain the weight loss. These individuals could plausibly have a lower RMR relative to their successful peers.

In a separate study, Wyatt et al. (1999) compared RMR of 40 reduced-obese participants who were part of the National Weight Control Registry to weight-matched control participants who were within 5 lb of their lifetime maximum weight. After adjusting RMR for FFM, FM, age, and sex (variables found to be predictors of RMR in a stepwise multiple regression analysis), there was no difference in RMR between the two groups. However, membership in the National Weight Control Registry is contingent upon maintaining a weight loss of at least 30 lb (13.6 kg) for a minimum of one year. Again, National Weight Control Registry participants may not be representative of most individuals who lose weight. In other words, it is possible that this group of individuals who have maintained a substantial weight loss may have a higher RMR compared to people who are less successful at maintaining weight loss.

In summary, while not all individual studies have concluded that formerly obese participants have lower RMR than never obese participants, a meta-analysis concluded that a general trend for such findings exists (Astrup et al., 1999). Furthermore, the authors report that the studies that failed to find such an association did not have the statistical power necessary to detect meaningful group differences. It is also possible, as results from Wyatt et al.’s (1999) National Weight Control Registry study suggest, that sample characteristics associated with RMR may have contributed to the null findings from several studies.
RMR of reduced obese states (immediately following weight loss) compared to obese states. Weinsier et al. (1995) compared the RMR of 24 post-obese women to their pre-treatment RMR. The post-obese group began the study as obese and then underwent treatment on an 800 kcal diet in order to achieve a normal body weight (BMI ≤ 25). While the post-obese women’s RMR was below their pre-treatment RMR after controlling for FFM, the further addition of FM as a covariate eliminated the difference between pre and post-treatment RMR. Thus, even though FFM is the best predictor of RMR, FM may also need to be controlled when comparing RMR across time, particularly in individuals who experience a large weight loss. Results of the study indicate that weight loss did not reduce RMR beyond the anticipated reductions secondary to decreases in FFM and FM.

RMR as a predictor of successful weight loss maintenance. The first study known to compare the RMR of people who successfully maintained weight loss compared to those who regained weight examined 54 participants who were assigned to a diet or diet and exercise treatment for 12-14 weeks (Van Dale, Saris, & Hoor, 1990). Mean weight loss was 12.0 kg (26 lb) for the diet group and 16.5 kg (36 lb) for the diet and exercise group at post-treatment. Participants who maintained the most weight loss exercised more and experienced less of a RMR decline during treatment compared to participants who regained more weight. Furthermore, at follow-up assessments 24-31 months after treatment, the participants who best maintained their weight loss had higher RMR values than they did at post-treatment, despite minimal weight gain. On the other hand, the RMR of participants who had regained weight did not seem to increase proportionally to their weight. Thus, participants who maintained a relatively high RMR during treatment and the maintenance phase of the study were more successful at weight maintenance. The authors suggest that exercise may prevent a long-term reduction in RMR, although they did
not speculate on the proposed mechanism (e.g., perhaps the exercising participants were better at maintaining FFM, the best predictor of RMR).

Pasman, Saris, and Westerterp-Plantenga (1999) also found an association between RMR and weight maintenance in 34 obese women who lost weight on a 2-month very low calorie diet. Although it is unclear whether RMR was assessed during active weight loss or weight maintenance, the change in RMR from the beginning to the end of treatment (controlling for BMI) predicted weight gain during follow-up (14 months post-treatment). However, the change in body weight from baseline to post-treatment was not related to weight regain ($r = 0.17, p = 0.17$). Furthermore, the decrease in RMR cannot be explained solely by the decrease in FFM since the changes in both variables during treatment were not significantly correlated ($r = .21, p = .11$). In other words, participants who experienced more of a decline in RMR (controlled for BMI) from pre- to post treatment, tended to experience greater weight regain at follow-up independent of how much weight and FFM they lost during treatment. Therefore, a relative decrease in RMR during treatment appeared to make weight loss participants vulnerable to weight regain following treatment. The mechanism accounting for that decline is unknown.

While studies examining changes in RMR during weight loss interventions have generally found an association between changes in RMR and weight maintenance, studies examining RMR at a single time-point have generally not found evidence for an association between RMR and weight maintenance. For example, in the Weinsier et al. (1995) study discussed previously, correlations between RMR (both non-adjusted for and adjusted for FFM) in the weight-reduced state and weight gain at a 4-year follow-up assessment were not significant. In addition, a large ($n = 605$) treatment outcome study of obesity that examined the predictors of weight loss and maintenance with sibutramine (an anti-obesity agent that acts as a
serotonergic and adrenergic re-uptake inhibitor) failed to find an association between baseline RMR and long-term follow-up (Hansen et al., 2001). In that investigation, all participants received 10 mg of sibutramine daily and followed a low-calorie diet for the initial 6-months (Hansen et al., 2001). Although weight loss during that time was correlated with baseline RMR and body weight, multiple regression analyses simultaneously examining RMR and baseline weight revealed no significant relationship between RMR and weight loss during the first 6-months of treatment or at the end of the 2-year study. Thus, the association between baseline RMR and weight loss was likely due to the significant relationship between RMR and baseline body weight (FFM and FM). In other words, people who weighed more at baseline had higher RMR and tended to lose more weight. However, when baseline weight was controlled for, RMR did not independently predict weight loss.

Amatruda, Statt and Welle (1993) examined 10 obese participants at pre-treatment and 18-34 months after achieving an ideal body weight to assess whether or not weight change was associated with the deviation between measured RMR (at ideal body weight) and predicted RMR. Stepwise multiple regression was used to generate the least squares linear multiple regression equation for predicting RMR. There was not a significant relationship between RMR (deviation from predicted and actual value) and weight gain after adjusting for the number of months between post-treatment and follow-up. Therefore, participants who possessed a below average RMR, after attaining their ideal body weight, were not more likely to regain weight over the course of the maintenance period (1.5 to almost 3 years post-treatment) compared to participants with average or above average RMR’s. Incidentally, the number of months post-treatment was highly correlated with weight gain ($r = 0.82$). However, this investigation may be limited by statistical power (small sample size) and sample selection. For example, none of the
participants had baseline BMIs greater than 35, all were able to reduce to an ideal body weight, and none of them had a RMR lower than their predicted RMR.

*Natural weight gain within subjects.* The American Indians are an important population to study when examining factors associated with obesity since they have higher prevalence rates of obesity than the general U.S. population (Story et al., 1999). For example, Pima Indians between 20 and 54 years old have obesity rates as high as 61-78% for men and 81-87% for women (Story et al., 1999). In one study with 126 American Indians, RMR varied considerably among individuals (1455 to 2059 kcal per day) even after adjusting for known covariates (e.g., FFM, FM, age and sex; Ravussin et al., 1998). In other words, participants with similar physical and demographic characteristics required quite different caloric intakes to maintain weight. Even more striking is that RMR at each yearly assessment predicted weight gain at the subsequent assessment period (between 1 – 4 years). At the 4 year assessment, the risk of gaining 10 kg (22 lb) was approximately eight times greater in participants with the lowest RMR (lower tertile) compared to participants with the highest RMR (higher tertile; Tataranni & Ravussin, 2002). Thus, in a longitudinal study of an obesity-prone population who was not actively trying to lose weight, low RMR was associated with weight gain.

*Summary of RMR and obesity.* The findings regarding the influence of RMR on obesity have been inconsistent. The mixed findings may, in part, be attributed to statistical power issues, different comparison groups, different operational definitions of RMR (e.g., change variable, deviation between predicted and measured), and varying assessment time points (e.g., baseline, post-treatment and/or at follow-up). However, relatively consistent findings include the tendency for formerly obese participants who lost weight via non-surgical procedures to have lower RMR’s compared to never obese control groups and for greater decreases in RMR between pre-
and post-treatment to be associated with poorer weight loss maintenance. Nevertheless, there is no evidence that an individual’s RMR differs in the obese state compared to the obesity-reduced state after controlling for FFM and FM. Therefore, it seems reasonable to assume that there is nothing about the weight loss process that makes individuals metabolically more vulnerable to weight regain. In addition, studies examining RMR at a single time-point have generally not found evidence for an association between RMR and weight loss maintenance. However, there are no known studies that have examined whether or not higher RMR at post-treatment or at a follow-up assessment predicts better weight loss maintenance in behavioral weight loss participants who begin and end treatment at very different weights. While Amatruda et al. (1993) examined the effect of post-treatment RMR on weight loss maintenance, none of the participants’ baseline BMIs were above 35 and all participants were at their ideal body weight at post-treatment.

*Psychological and Behavioral Variables*

In addition to RMR, other variables including dietary disinhibition, binge eating, hunger, dietary restriction, locus of control, beliefs about the causality of weight, and self-efficacy have been associated with weight loss maintenance. However, studies vary widely in their approach to examining these factors. For example, studies attempt to predict weight maintenance using: (1) pre-treatment/baseline factors, (2) post-treatment factors, (3) factors assessed during follow-up assessments, and (4) changes in factors from pre to post-treatment or from post-treatment to a follow-up assessment. The various approaches will be highlighted when discussed below.

*Dietary disinhibition, binge eating, hunger, and cognitive dietary restraint.* The related constructs of dietary disinhibition and binge eating have been associated with weight loss maintenance. Dietary disinhibition refers to a person’s reported loss of control while eating
(McGuire, Wing, Klem, Lang, et al., 1999) and is most often assessed using the Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985). Binge eating is defined as eating large amounts of food in a short amount of time with an accompanying feeling of loss of control (Sherwood, Jeffrey, & Wing, 1999). Dietary disinhibition, as measured by the TFEQ, has been correlated highly with binge eating status, as assessed by the Bulimic Inventory Test of Edinburgh (BITE; Henderson & Freeman, 1987; $r = .74$;) and the Binge Eating Scale (BES; Gormally, Black, Daston, & Rardin, 1982; $r = .61$), in two different studies of women seeking behavior treatment for obesity (Fogelholm, Kukkonen-Harjula & Oja, 1999; Marcus, Wing & Lamparski, 1985), suggesting some overlap between the constructs.

Obese individuals who experience frequent bouts of dietary disinhibition may have greater difficulty sustaining a reduced body weight particularly if they consume more calories than is necessary to sustain their body’s energy balance. In fact, dietary disinhibition has been found to be positively associated with caloric and fat intake (Fogelholm et al., 1999). Pasman et al. (1999) reported a significant correlation between greater dietary disinhibition and weight regain ($r = .26$, $p < .05$) at a 14-month follow-up assessment of 67 obese participants who had completed a 2-month low energy diet. In addition, in a study of 85 obese women treated with a low calorie diet, Fogelholm et al. (1999) concluded that higher dietary disinhibition assessed during the maintenance phase of treatment was the number one determinant of poor weight loss maintenance at a 40 week follow-up assessment. In a stepwise linear regression analysis, dietary disinhibition, assessed during the maintenance phase of treatment, predicted weight regain better than the change in weight during treatment, and indicators of dietary restraint, hunger, binge eating, and physical activity during maintenance. Similarly, in a study of 36 obese men who had participated in a very low calorie diet, Borg, Fogelholm, and Kukkonen-Harjula (2004) found
that higher post-treatment disinhibition (assessed at 8-months) was associated with higher body weight ($r = .74, p < .01$). Finally, McGuire, Wing, Klem, Lang, et al. (1999) examined whether baseline psychological factors were associated with continued weight maintenance among 714 individuals enrolled in the National Weight Control Registry (i.e., had lost at least 30 lb and maintained a suppressed weight for a year). At the one year follow-up, 248 individuals had gained more than 5 lb, 450 had maintained their weight ± 5 lb, and 46 had lost more than 5 lb. Higher levels of dietary disinhibition and binge eating were found among those who gained compared to those who maintained their weight during the year.

It has been estimated that more than half of all participants presenting for obesity treatment experience binge-eating episodes (Gormally et al., 1982; Marcus, Wing, & Lamparski, 1985; Spitzer et al., 1992). Therefore, understanding whether binge eating influences weight loss and maintenance is important. Similar to dietary disinhibition, binge eating reflects a perceived loss of control in regards to food consumption. In addition, binge eating is marked by greater food consumption than is typical for that individual within a relatively short period of time. Thus, the mechanism by which more severe binge eating may be associated with poor weight maintenance is also likely to be through increased caloric consumption. While not studied extensively, research suggests greater weight regain following weight loss among obese participants who engaged in episodes of binge eating at the beginning of treatment. For example, Marcus, Wing, and Hopkins (1988) compared 35 binge eaters and 33 nonbinge eaters, as determined by the Binge Eating Scale (BES) at baseline, who participated in a 12-week behavioral weight loss intervention on weight regain following treatment. They found that binge-eaters regained significantly more weight than nonbinge eaters at the 6-month follow-up assessment. Sherwood et al. (1999) also reported a trend for weight loss participants with greater
binge eating at baseline to have a smaller net weight loss at 18 months compared to participants with less binge eating (-6.4 lb versus -10.4 lb). In addition, an association between greater weight fluctuations and greater binge eating has also been reported (Sherwood et al., 1999; Spitzer et al., 1992).

Hunger, as assessed by the TFEQ, is another factor that may be associated with weight loss maintenance. TFEQ-hunger items include, “I am usually so hungry that I eat more than 3 times a day,” “Dieting is so hard for me because I just get too hungry,” and “I often feel so hungry that I just have to eat something.” Thus, it is plausible that higher hunger levels would be positively associated with poorer outcomes secondary to increased caloric intake. In fact, hunger has been found to be highly associated with disinhibition, which is associated with increased caloric intake (Fogelholm et al., 1999). In the Pasman et al. (1999) study discussed earlier, the baseline TFEQ-hunger score was a significant predictor of weight regain at a 14-month follow-up assessment in multiple regression analyses that included five other variables correlated with weight regain (e.g., BMI, RMR, prior diet history, TFEQ-disinhibition, and weight concern; $r^2 = .32, p < .05$). In another study discussed previously (Borg et al., 2004), higher body weight was associated with greater hunger at the 8-month follow-up assessment ($r = .32, p = .06$) with obese men who had completed a very low calorie diet. Similarly, in a study of 40 obese men who had completed a 6-week weight loss treatment, weight regain was correlated with increased hunger at the 8-week follow-up (Lejeune, Hokshorn, Saris, & Westerterp-Plantenga, 2003). Finally, McGuire, Wing, Klem, Lang et al. (1999) found hunger levels at a one-year follow-up assessment to be higher among National Weight Control registry members who had gained more than 5 lbs compared to those who had maintained their weight. Therefore, weight loss
participants who report greater hunger at baseline and following treatment are less likely to be successful at weight maintenance compared to those with lower hunger levels.

Several researchers have examined cognitive dietary restraint as a predictor of weight loss maintenance. Cognitive dietary restraint refers to consciously trying to resist eating in order to control body weight (Elfhag & Rossner, 2005), and it has been found to be inversely related to caloric intake (Allison, Kalinsky, & Gorman, 1992; Fogelholm et al., 1999). It is plausible that a greater ability to resist eating in order to control body weight would be associated with successful weight loss maintenance. In a study of 40 obese men, Lejeune, van Aggel-Leijssen, van Baak, and Westerterp-Plantenga (2003) found that higher dietary restraint change scores from pre- to post-treatment predicted better weight maintenance at the 40-week follow-up. Similarly, Westerterp-Plantenga, Kempen, and Saris (1998) found that increases in cognitive restraint from pre- to post-treatment were predictive of weight maintenance. In addition to restraint change scores, higher dietary restraint levels at the time of post-treatment and follow-up assessments have also been associated with improved weight loss maintenance. Lejeune, Hokshorn, et al. (2003) found that following a 6 week treatment, lower cognitive dietary restraint was associated with weight regain at the 8-week follow-up assessment. Finally, in a study with a longer, 7-year, maintenance period, cognitive dietary restraint was higher among weight loss participants who had successfully maintained their weight loss ($n = 9$) compared to obese controls ($n = 42$; Sarlio-Lahteenkorva & Rissanen, 1998).

Overall, research suggests that binge eating, dietary disinhibition and perceived hunger are negatively associated with weight loss maintenance, while dietary restraint is positively associated with weight-loss maintenance. In fact, Borg et al. (2004) found that dietary restraint increased and disinhibition and hunger decreased during treatment and that these changes
corresponded with weight loss. Conversely, following treatment, greater decreases in dietary restraint and greater increases in disinhibition and hunger tended to correspond with weight gain. In that investigation, participants maintained a 5% weight loss at the 20-month follow-up assessment. While dietary restraint scores were slightly higher at the follow-up assessment compared to baseline levels, disinhibition and hunger scores had returned to baseline levels. Thus, it seems that ultimate success with weight loss and weight loss maintenance may be associated with the ability to control disinhibition and hunger and maintain adequate dietary restraint.

**Locus of control and beliefs about causality of obesity.** Individuals’ beliefs about the amount of control they perceive in their own lives (i.e., locus of control, LOC) is another factor hypothesized to be related to weight loss. Internal LOC is defined as believing that one’s own actions are instrumental to goal attainment, while external LOC is defined as believing that luck, chance, fate or powerful others are responsible for the outcome. It has been speculated that the more an individual perceives control over a desired outcome, the more he or she will engage in behaviors necessary to achieve the goal. In other words, the more individuals believe that they can influence their weight, the more likely they will be to engage in behaviors known to affect weight (e.g., healthy eating and physical activity). On the other hand, if they believe their weight is due to circumstance beyond their control (e.g., genetics), they may be less likely to engage in behaviors known to affect weight.

Despite its intuitive appeal, research examining the role of LOC on weight loss and maintenance has been equivocal. While some studies have failed to find an association between weight loss and greater internal LOC (Rodin et al., 1977), others studies have provided evidence for more successful weight loss being associated with greater internal LOC (Balch & Ross, 1975;
Goldney & Cameron, 1981; Nir & Neumann, 1995). For example, in a study of 66 obese women who participated in a weight loss program, greater baseline internal LOC was associated with greater weight loss maintenance (15-47 month follow-up; Nir & Neumann, 1995). Similarly, a study with 41 obese participants enrolled in a weight loss program found that greater baseline internal LOC was associated with greater weight loss after 1 year (Adolfsson, Andersson, Elofsson, Rossner & Unden, 2005). Finally, in a 6-month self-help weight reduction program, Goldney and Cameron (1981) found that more of an internal LOC at baseline predicted greater weight loss post-treatment. Thus, the more participants felt in control of their own behaviors, the greater their success with weight loss and maintenance.

Similar to the concept of LOC, an individual’s beliefs about the causes of obesity have been shown to be associated with weight loss and maintenance (Ogden, 2000; Rodin et al., 1977). For example, if an individual believes that medical factors are to blame for their weight, they may be less likely to engage in behaviors known to affect weight, such as increased physical activity and decreased caloric intake. On the other hand, if they believe that a lack of physical activity and/or excess caloric intake is the ultimate cause of their weight problem, they may be more inclined to target those behaviors and ultimately be successful at losing and maintaining weight loss.

Ogden (2000) surveyed 142 members of a nationwide slimming club and divided the members into weight loss maintainers (i.e., originally obese [i.e., BMI ≥ 30], but then weight reduced to non-obese status for at least 3 years), weight loss re-gainers, or stable obese. Weight loss maintainers were more likely to endorse the belief that obesity was less related to medical factors compared to the weight loss re-gainers and the stable obese. The three groups rated diet, exercise, and psychological factors similarly in terms of their causality to obesity. Thus, re-
gainers endorsed more of a biological explanation for their weight than maintainers or stable obese. The authors suggest that understanding people’s beliefs about the cause of their obesity may help to identify individuals at risk for poor weight loss maintenance.

*Self-efficacy.* Self-efficacy is another variable associated with weight loss behaviors, weight loss, and maintenance (Bagozzi & Edwards, 2000; Foreyt et al., 1995; Kitsantas, 2000; Rodin, Elias, Silberstein, & Wagner, 1988). Self-efficacy refers to an individual’s beliefs that he or she can successfully execute specific behaviors required to produce desired outcomes (Bernier & Poser, 1984). In terms of weight loss, this means that those individuals who believe that they can successfully engage in caloric restriction and/or increased physical activity are likely to report higher self-efficacy for weight loss. Furthermore, it is plausible that higher self-efficacy for weight loss will be associated with more actual weight loss.

Self-efficacy has been associated with weight loss in obesity treatment studies. Leon and Rosenthal (1984) reported that pre-treatment self-efficacy scores were associated with the 8-month post-treatment follow-up weights, but not with weight immediately following the 12-week treatment. Bernier and Poser (1984) found that self-efficacy at post-treatment was predictive of weight loss maintenance at the 6-week and 6-month follow-up assessments, accounting for 10% and 11% of the total variation, respectively. They also examined self-efficacy change scores and found that changes in self-efficacy from post-treatment to both of the follow-up assessments were associated with weight changes during those times. In other words, participants who experienced less of a decrease in self-efficacy during the maintenance phase (despite struggling with the possibility of weight regain) were better able to maintain weight loss than people who experienced more of a decrease in self-efficacy. However, self-efficacy was once again unrelated to weight change during the 10-week treatment.
Self-efficacy appears to be more strongly associated with weight loss maintenance than with weight loss during treatment. Anecdotally, we have observed that people often report experiencing greater support and accountability for behavioral change during treatment. However, following treatment, as support and accountability decline, participant success may become more dependent on their own ability to successfully execute specific behaviors required to produce weight maintenance. Thus, self-efficacy may be particularly relevant during maintenance when people are likely to be struggling more to maintain their weight.

**Dietary intake and physical activity.** Individuals who are ultimately successful at weight loss or weight loss maintenance have commonly modified their energy balance through decreased caloric consumption and/or increased physical activity. Weight loss program research indicates that individuals most successful at weight loss report lower caloric intake, reduced portion sizes, reduced frequency of snacking, and lower consumption of calories from fat (Jeffery, Bjornson-Benson, Rosenthal, Lindquist, & Johnson, 1984; Wing & Hill, 2001). In fact, permanent dietary change is considered to be the core of successful weight loss maintenance (Borg, et al., 2004). For example, in a study of 27 obese women who participated in a weight management program, at the 3-year follow-up assessment, a greater percentage of caloric intake from fat was significantly associated with poor weight maintenance (Leser, Yanovski, & Yanovski, 2002). Thus, lower caloric intake and fat intake tend to be related to successful weight loss and maintenance.

Research unrelated to a particular weight loss program, also highlights the importance of caloric and fat intake in weight maintenance. Members of the National Weight Control Registry generally report diets low in calories and fat and high in carbohydrates (Wing & Hill, 2001). Their average caloric (1381 kcal/d; $SD = 526$) and fat (24% of daily caloric intake; $SD = 9$)
intake is considerably below the general dietary recommendations of 2,000-2,500 calories daily and less than 30% percent of intake from fat (Klem, Wing, McGuire, Seagle, & Hill, 1997). Finally, a random-digit telephone study of 500 adults in the United States also found that weight-loss maintainers (i.e., individuals who lost ≥ 10% of their weight and maintained it for at least a year) reported greater efforts in avoiding frying foods and substituting low-fat for high-fat foods than weight-loss regainers or weight-stable controls (McGuire, Wing, Klem, & Hill, 1999). The association between consumption of a low-fat diet and weight loss maintenance is a consistent finding among maintenance studies (McGuire, Wing, Klem, & Hill, 1999).

In addition to decreasing caloric and fat intake, increasing energy expenditure enhances the likelihood of successful weight loss maintenance. Correlational research consistently reveals an association between long-term weight loss and higher levels of physical activity (e.g., Anderson et al., 2001; Harris, French, Jeffery, McGovern, & Wing, 1994; Jeffery et al., 1984; Leser et al., 2002; McGuire, Wing, Klem, Lang et al., 1999; McGuire, Wing, Klem, & Hill, 1999; Sarlio-Lahteenkorva, Rissanen, & Kaprio, 2000; Sherwood, Jeffery & Wing, 1999; Wadden & Letizia, 1992; Wing, 1999; Wing & Klem, 2002). For example, a study of women who had previously been greater than 20% overweight, found that 90% who lost and remained average weight for at least two years exercised regularly (at least 3 times a week for at least 30 min) compared to only 34% of women who had lost but regained weight (Kayman, Bruvold, & Stern, 1990). The participants who maintained their weight loss were also engaging in significantly more leisure time physical activity. In a more recent study, Jeffery, Wing, Sherwood, and Tate (2003) found that overweight participants assigned to a high energy expenditure group (goal of 2,500 kcal/wk) lost more weight at 12 and 18 month follow-up
assessments compared to participants assigned to a lower energy expenditure group (goal of 1,000 kcal/wk), \( p = .07 \) and \( p = .04 \), respectively.

In a meta-analysis including six studies on exercise and long-term weight loss maintenance, the weight loss groups reporting higher levels of exercise were significantly more successful at maintaining their weight loss compared to groups with less exercise at follow-up periods of 2 to 3.3 years (Anderson et al., 2001). The groups participating in higher exercise achieved a 54% weight loss maintenance ([initial body weight – body weight at follow-up / average initial weight loss] \( \times \) 100) compared to a 27% weight loss maintenance for the lower exercise groups. One of the studies included in the meta-analysis found that participants who exercised over 210 minutes per week, the median exercise duration, lost twice as much weight at a 3.3 year follow-up assessment compared to participants who exercised less (Holden et al., 1992). In a review of physical activity in the treatment of obesity, Wing (1999) examined six studies that included maintenance periods of at least 1 year and compared diet only groups to diet plus exercise groups. Although only two of the studies showed significantly better maintenance for the diet plus exercise group compared to the diet only group, all of the studies at least reported better maintenance trends for the groups that included physical activity in addition to diet.

Several population studies (McGuire, Wing, Klem, & Hill, 1999), as well as publications with National Weight Control Registry members, (Klem et al., 1997; McGuire, Wing, Klem, Seagle, & Hill, 1998; Wing & Hill, 2001) also indicate that regular exercise is essential to weight loss maintenance. For example, Wing and Hill (2001) reported that only 9% of the National Weight Control Registry members claim to maintain their weight loss without regular physical activity. In fact, female and male members reported expending an average of 2,545 kcal and
3,293 kcal per week, respectively, in physical activity. This level of caloric expenditure is well above the American College Sports Medicine recommended goal of 1,000 kcal per week for people who want to lose weight. Therefore, actual weight loss maintenance seems to be associated with more physical activity than is often prescribed for weight loss.

In the McGuire, Wing, Klem, and Hill (1999) study discussed previously, weight loss maintainers in the general US population reported engaging in more physical activity (especially strenuous activities such as running, weight lifting and aerobics) than weight loss re-gainers or weight stable controls. The weight loss maintainers reported engaging in 8.4 episodes per week of mild, moderate, strenuous and sweat producing activities compared to 5.5 for the re-gainers and 5.8 for the never-obese controls. In addition, maintainers engaged in 78% and 52% more weekly episodes of vigorous activity (i.e., strenuous and sweat producing physical activity) than re-gainers and controls, respectively. Clearly, increased physical activity is an important distinguishing factor for those who are able to maintain a reduced weight. The mechanism by which physical activity leads to improved weight loss maintenance is likely due to psychological (e.g., improved self-efficacy, self-esteem and stress management) and physiological (e.g., direct increases in caloric expenditure, preservation of lean body mass, and possibly minimizing the reduction in RMR that is associated with caloric restriction) factors (Foreyt & Goodrick, 1994).

While not all randomized clinical trials assigning participants to weight loss programs with and without exercise have shown a consistent relationship between increased physical activity and weight loss maintenance, most programs that evidence successful weight loss maintenance include exercise (Corsica & Perri, 2003; Wing, 1999). However, as Wing (1999) indicates, short treatment duration and insufficient dose (i.e., low levels of exercise prescriptions) may partially account for the null findings or the modest effects of exercise on weight loss.
maintenance. In addition, problems with treatment adherence and integrity are another possible explanation for inconsistent findings (Corsica & Perri, 2003). Many weight loss studies do not consistently assess exercise adherence or the relationship between adherence and successful weight loss or maintenance.

RMR’s Association with Psychological and Behavioral Factors and Weight Loss Maintenance

In a study of psychological and behavioral correlates of baseline BMI in the Diabetes Prevention Program, Delahanty, Meigs, Hayden, Williamson, and Nathan (1992) concluded that it is important to examine the associations among different variables associated with weight loss in order to develop a more comprehensive understanding of treatment success and failure. In a more recent review, Elfhag and Rossner (2005) state, “A combination of psychology and physiology may…give us more understanding of the mechanisms in weight loss maintenance” (p. 75). Despite these urgings, studies commonly assess the influence of metabolic, psychological, or behavioral factors on weight loss and weight loss maintenance individually. To my knowledge there are no known studies that examine the association between the metabolic factors, such as RMR, and psychological factors. While any proposed associations between RMR and psychological factors are speculative, it seems worthwhile to consider that such relationships may exist and have important implications for effective weight loss interventions.

The Learned Helplessness theory and the Health Belief Model (HBM) could plausibly suggest an association between RMR and psychological or behavioral factors. For example, LOC, beliefs about causes of weight, and self-efficacy are constructs designed to assess the degree to which participants believe they can exert control over their weight or behaviors that influence weight. Both the Learned Helplessness theory and the HBM propose that people’s perceptions of their ability to control or change a situation impacts whether or not they make
attempts to do so. For example, learned helplessness refers to the belief that outcomes are not controlled or influenced by responses (Seligman, 1975), and is thought to result from a lack of contingency between past efforts to change one’s situation and the outcomes associated with those efforts. It can lead to a general acceptance of a negative situation such that an individual may no longer try to change the situation for the better because they do not expect those efforts to make a difference.

Locus of control refers to the degree to which individuals perceive events in their lives as being a consequence of their own behavior, and thereby controllable (internal control), or as being unrelated to their own actions, and therefore beyond personal control (external control) (Lefcourt, 1976). People’s attributions for their weight similarly assesses the degree to which people attribute their weight to medical (i.e., external) factors. The Learned Helplessness theory suggests that LOC and weight attributions are likely to be influenced by experiences with weight loss success and failure.

RMR may be one factor affecting the contingency between weight loss efforts and weight loss. Participants with a lower RMR may experience less rewarding outcomes for engaging in weight loss behaviors (i.e., caloric restriction and exercise) compared to people with a higher RMR. In other words, people with a lower RMR may believe they have to work harder compared to others to lose weight, and these repeated struggles may lead to feelings of hopelessness related to one’s ability to lose weight. This in turn could results in more of an external LOC and a greater tendency to attribute weight to medical factors.

The link between RMR and self-efficacy would likely be through a similar mechanism. If BWLP participants have not been rewarded for their efforts at weight reduction with actual weight loss, they may come to doubt the value of the behaviors thought to be associated with
weight loss and their ability to carry out such behaviors. Thus, participants with a lower RMR may have decreased self-efficacy for eating and exercising compared to participants with a higher RMR. Thus, the Learned Helplessness theory suggests a plausible link between RMR-related experiences and psychological constructs such as LOC and self-efficacy.

The HBM was originally developed to explain and predict why people engage in certain preventative health behaviors (Becker, 1974; Janz & Becker, 1984; Rosenstock, 1966; Rosenstock, 1974). In essence, the theory suggests that behavior can be predicted from the value of the outcome of an action and from the expectation that the action will prevent or ameliorate the health problem. The core components of the HBM are: (1) the perception of the degree of an individual’s susceptibility to an illness, (2) the perceived severity of the illness, (3) perception of whether or not intended action would reduce susceptibility and/or severity (i.e., the efficacy of a behavior), and (4) a cue or stimulus that triggers the positive health action. It seems plausible that a lower RMR may be connected to the third component of this model, one’s perception of the efficacy of a behavior. If an individual has a lower RMR and thus, their weight is not as responsive to restrictions in caloric intake and increased exercise, the efficacy of those behaviors may be questioned. This doubt in the efficacy of behaviors directly explains the rationale for the link between the HBM, RMR, and lower eating and exercising efficacy. Furthermore, because weight LOC and attributions of weight assess beliefs about one’s ability to exert personal control on body weight and a low RMR may minimize the link between weight loss efforts and weight loss, it follows that a lower RMR may be associated with more of an external LOC and a greater tendency to attribute weight to medical factors.

In terms of behavioral factors, successful weight loss participants with relatively low RMR’s may have to expend more and/or consume fewer calories when compared to participants
with average or higher RMR’s. In terms of dietary disinhibition and restraint, again weight loss participants with relatively low RMR’s may need to possess superior dietary restraint and decreased dietary disinhibition to compensate for their low RMR. These plausible relationships between RMR and psychological and behavioral factors are explored in this investigation.

Goals and Hypotheses of the Study

Given the prevalence of obesity and its relationship to increased morbidity and mortality, finding ways to improve weight loss maintenance is extremely important from a public health perspective. To accomplish this goal it will be important to develop a better understanding of why most people regain lost weight. The present study will examine metabolic, behavioral, and psychological predictors of weight loss maintenance. In addition, the relationships among the various predictors will be explored.

Hypotheses:

1. RMR and weight maintenance

Research on the effects of RMR on weight loss and weight loss maintenance is inconclusive. Some researchers have found RMR to be related to weight loss maintenance (Astrup et al., 1999; Pasman et al., 1999; Ravussin et al., 1988; Van Dale et al., 1990) and others have not found such an association (Amatruda et al., 1993; Hansen et al., 2001; Nelson et al., 1992; Weinsier et al., 1995; Wyatt et al., 1999). In general, formerly obese individuals have lower RMR’s, even after adjusting for body size, compared to individuals who have never been obese. Furthermore, a smaller decline in RMR during treatment is predictive of superior weight loss maintenance. However, there are no known studies that have examined whether or not higher RMR at post-treatment or at a follow-up assessment predicts better weight loss maintenance in a group of heterogeneous participants (in terms of pre- and post-treatment
weights) undergoing a behavioral weight loss program. The association between the change in RMR from post-treatment to follow-up and weight loss maintenance has also not been examined. In the present study, it is predicted that greater increases in RMR from post-treatment to follow-up and higher RMR at post-treatment and follow-up, after adjustment for FFM and FM, will be associated with superior weight loss maintenance at the 6-month follow-up assessment.

2. Dietary disinhibition and weight maintenance

Some evidence suggests that weight loss participants with increased dietary disinhibition at post-treatment and at follow-up assessments experience more weight regain following treatment compared to participants with lower dietary disinhibition (Borg et al., 2004; Fogelholm et al., 1999; McGuire, Wing, Klem, Lang, et al., 1999; Pasman et al., 1999). Thus, it is predicted that greater dietary disinhibition at post-treatment and the 6-month follow-up will be associated with greater weight regain.

3. Binge eating and weight maintenance

Binge eating has repeatedly been found to be associated with poor weight loss maintenance (Marcus et al., 1988; McGuire, Wing, Klem, Lang, et al., 1999; Sherwood et al., 1999, Spitzer, 1992). Therefore, it is predicted that more extreme binge eating at pre-treatment, post-treatment, and at the follow-up assessment will be associated with poorer weight loss maintenance at the 6-month follow-up assessment.

4. Perceived hunger and weight maintenance

Greater hunger has been found to be associated with weight regain following treatment (Borg et al., 2004; Lejeune, Hokshorn, et al., 2003; McGuire, Wing, Klem, Lang, et al., 1999; Pasman et al., 1999). Thus, it is hypothesized that greater hunger at pre-treatment, post-
treatment, and at the follow-up assessment will be associated with poor weight loss maintenance at the 6-month follow-up assessment.

5. Cognitive dietary restraint and weight maintenance

Higher levels of cognitive dietary restraint and greater increases in restraint from pre- to post-treatment have been found to be associated with greater weight maintenance (Lejeune, van Aggel-Leijssen, et al., 2003; Lejeune, Hokshorn, et al., 2003; Sarlio-Lahteenkorva & Rissanen, 1998; Westerterp-Plantenga et al., 1998). Thus, it is hypothesized that increased cognitive dietary restraint from pre- to post-treatment and higher restraint at post-treatment and at the follow-up assessment will be associated with better weight maintenance at the 6-month follow-up assessment.

6. Locus of control and weight maintenance

Some studies indicate that weight loss participants with an internal LOC are more successful at losing weight and maintaining weight loss (Balch & Ross, 1975; Nir & Neumann, 1995; Adolfsson et al., 2005). Therefore, in the present study, it is predicted that greater internal weight LOC at post-treatment and at the follow-up assessment will be associated with better weight loss maintenance at the 6-month follow-up assessment.

7. Beliefs about causality of obesity and weight maintenance

Individuals’ beliefs about the causes of obesity have been linked to weight loss and maintenance (Ogden, 2000; Rodin et al., 1977). It is predicted that a greater likelihood to attribute weight to medical factors (e.g., genetics, hormones or gland condition, slow metabolism) at post-treatment and at the follow-up assessment will be associated with poor weight loss maintenance.

8. Self-efficacy and weight maintenance
There is prior support for the link between greater self-efficacy and increases in self-efficacy and weight loss maintenance (Bernier & Poser, 1984; Foreyt et al., 1995; Leon & Rosenthal, 1984). Therefore, it is predicted that greater self-efficacy at pre-treatment, post-treatment and at the follow-up assessment, in addition to a greater increase in self-efficacy from post-treatment to the follow-up assessment, will be associated with better weight loss maintenance at the 6-month follow-up assessment.

9. Dietary intake and weight maintenance

Decreased caloric intake is generally assumed to be associated with weight loss maintenance, and individuals successful at weight loss and weight loss maintenance tend to report lower caloric intake compared to individuals who are less successful (Jeffery et al., 1984; Klem et al., 1997; Wing & Hill, 2001). Therefore, it is hypothesized that lower caloric intake at post-treatment and at the follow-up assessment will be associated with greater weight loss maintenance at the 6-month follow-up assessment.

10. Fat intake and weight maintenance

Several researchers have reported an association between decreased fat intake and weight loss maintenance (Jeffery et al., 1984; Klem et al., 1997; Leser et al., 2002; McGuire, Wing, Klem & Hill, 1999; Wing & Hill, 2001). Therefore, it is predicted that less dietary fat intake at post-treatment and at the 6-month follow-up assessment will be associated with greater weight loss maintenance.

11. Physical activity and weight maintenance

Many researchers have found an association between increased physical activity and long-term weight loss (Anderson et al., 2001; Corsica & Perri, 2003; Harris et al., 1994; Holden et al., 1992; Jeffery et al., 1984; Jeffery et al., 2003; Kayman et al., 1990; Leser et al., 2002;
McGuire et al., 1998; McGuire, Wing, Klem, & Hill, 1999; McGuire, Wing, Klem, Lang, et al., 1999; Sarlio-Lahteenkorva et al., 2000; Sherwood et al., 1999; Wadden & Letizia, 1992; Wing, 1999; Wing & Klem, 2002). Thus, it is predicted that greater physical activity at post-treatment and at the follow-up assessment will be associated with more successful weight loss maintenance at the 6-month follow-up assessment.

12. Relationship between RMR and psychological/behavioral factors

This study examines the potential relationship between RMR and psychological (e.g., dietary disinhibition, binge eating, hunger, dietary restraint, LOC, self-efficacy) and behavioral (e.g., physical activity and dietary intake) variables. For example, if someone with relatively low RMR has repeatedly experienced difficulty in maintaining weight loss, they may evidence decreased weight loss self-efficacy. They may also need to engage in more dietary restraint and physical activity and evidence less dietary disinhibition in order to create a caloric deficit compared to someone with a relatively higher RMR. Potential associations between post-treatment RMR and psychological and behavioral factors are explored in the present study.

It is possible that psychological and/or behavioral factors might mediate the association between RMR and weight loss maintenance. If all the necessary conditions are met for a mediational analysis, psychological and behavioral factors will be examined as potential mediators of the relationship between RMR and weight loss maintenance. For example, if RMR and self-efficacy are both significantly associated with weight loss maintenance and RMR is associated with self-efficacy, self-efficacy will be examined as a mediator between RMR and weight loss maintenance.
CHAPTER 2. METHODS

Participants

Fifty-five obese, sedentary adults were randomly assigned to a 6-month behavioral weight loss program (BWLP) or to a BWLP + stepped care (BWLP + SC) condition. Participants were originally recruited through local advertisements and campus email at a Midwestern university and were included in the study if they were: (a) obese (BMI ≥ 30 kg/m²), (b) sedentary (exercising less that two times per week for a 20 minute duration), (c) non-smokers, and (d) approved for participation by their physician. Exclusion criteria included: (a) a history of cardiovascular disease, (b) a history of insulin-dependent diabetes, (c) musculoskeletal complications that would prevent moderate levels of physical activity, (d) resting blood pressure of 160/100 mmHg or greater during screening, and (e) life threatening or serious medical conditions such as cancer, renal dysfunction, hepatic dysfunction, and dementia.

Forty participants remained in the study at the 6-month follow-up assessment point (i.e., had maintenance weights). Of the participants that remained in the study until follow-up, 35 completed an RMR assessment at post-treatment and 38 completed it at follow-up. The mean age of the participants was 49.0 (SD = 8.9) and 87.5% of them were women. Ninety percent identified as Caucasian and 75% as married (see Table 1 for demographics).

Study Design

The data collected for this study was part of a weight loss treatment outcome study in which participants were randomly assigned to a BWLP or a BWLP + SC (Carels et al., 2005). At pre-treatment participants completed assessments of height, body weight, percentage of body fat, physical activity, nutrition, and a variety of psychological variables (e.g., dietary disinhibition, binge eating, dietary restraint, hunger, self-efficacy). At post-treatment and follow-up, all of the
variables assessed at pre-treatment were assessed again in addition to RMR, weight LOC and beliefs about causes of obesity.

**Intervention**

The 6-month BWLP (20 weekly sessions over the course of 24 weeks due to holidays) was based on the LEARN program, a comprehensive, lifestyle approach to weight management with five primary components: lifestyle, exercise, attitudes, relationships, and nutrition (Brownell, 2004). The 75-minute weekly sessions were lead by two advanced clinical psychology graduate students or by one graduate student and a clinical health psychologist. The groups had 6-12 participants and all participants were weighed at the end of each session. The overall goal of the LEARN program is to commit to lifestyle changes resulting in increased physical activity and decreased caloric intake, ultimately leading to gradual weight loss. The program emphasizes: (a) self-monitoring of eating behavior, (b) stimulus control, (c) physical activity, (d) nutrition education, (e) modifying self-defeating thoughts and emotions associated with poor body image and dieting, (f) setting realistic goals, (g) relationships, and (h) relapse prevention and weight maintenance. Additional information about the LEARN program can be found at: [www.thelifestylecompany.com](http://www.thelifestylecompany.com).

All participants were given identical weight loss percentage goals and took part in four pre-established assessments throughout treatment (Week 4, 8, 16), including a total body weight loss of at least 10% at the end of treatment (Week 24). They also participated in follow-up assessments at 1-month, 2-months, and 4-months post-treatment, during which they were encouraged to gain no more than 1% of their post-treatment weight. The final follow-up assessment for this study was 6-months post-treatment.
Participants in the BWLP + SC condition received additional treatment (i.e., motivational interviewing; Miller and Rollnick, 2002) if they failed to meet their goals at any of the 7 assessment points during and post-treatment. Motivation interviewing, as developed by Miller and Rollnick (2002), is a client-centered approach designed to reduce ambivalence and encourage action toward behavior change. The motivational interviewing treatment consisted of meeting with a clinical psychology graduate student approximately once a week for a 45 minute session until the participant achieved their weight loss goal at an assessment period or requested termination of stepped care. A detailed description of the treatment can be provided upon request (Carels et al., 2005).

Measures

Body weight, height, and body composition. Body weight was measured using a digital scale (BF-350e; Tanita, Arlington Heights, IL) to the closest 0.1 lb. and height was measured to the closest 0.5 inch using a standard balance beam scale height rod. The percentage of body fat (i.e., FM) was obtained using leg-to-leg bioelectrical impedance (BF-350e; Tanita, Arlington Heights, IL) and was converted into pounds. Leg-to-leg bioelectrical impedance measurements correlated highly with the gold standards of body composition, the underwater weighing method ($r = .83$) and the dual energy X-ray absorptiometry method (DEXA; $r = .89$) within an obese sample (Nunez et al., 1997). Other studies found similar results with obese and elderly samples (Rubiano, Nunez, Gallagher & Haymsfield, 1999; Utter, Nieman, Ward & Butterworth, 1999). FFM was calculated by subtracting FM from the total body weight.

Resting Metabolic Rate. RMR was assessed at the end of the 6-month treatment and at the end of the 6-month follow-up in the morning after an overnight food, caffeine, water, and exercise fast (at least 8 hours). Participants were also asked not to use nicotine for at least 2
hours prior to their appointment. The MedGem Analyzer (Healthetech, Golden, Colorado) is a handheld, portable indirect calorimeter that measures oxygen consumption (VO₂) and calculates RMR by using the Weir Equation and a constant Respiratory Quotient (i.e., VCO₂/VO₂) value of 0.85 (RMR = 6.931xVO₂). The MedGem has been clinically validated against the gold standard technique, the Douglas Bag, to ensure accurate measurement of VO₂ and determination of RMR within 1% (ActiveOptions, 2003). St-Onge, Rubiano, Jones, and Heymsfield, (2004) assessed the validity and reliability of the MedGem and found that it compared favorably to the Delta-Trac, a conventional indirect calorimetry system.

**Paffenbarger Physical Activity Questionnaire.** The Paffenbarger Physical Activity Questionnaire (PPAQ; Paffenbarger, Wing, & Hyde, 1978) is used to assess calories expended from leisure-time physical activity (see Appendix A). It assesses stairs climbed, blocks walked, and recreation and sports play through open-ended questions concerning frequency and duration of activity. The PPAQ has been used extensively to assess physical activity (Pereira et al., 1997). It has been shown to have high test-retest reliability (Paffenbarger et al., 1978; Washburn, Smith, Goldfield, & McKinlay, 1991), and to be significantly correlated with measures of cardiovascular fitness (Siconolfi, Lasater, Snow, & Carleton, 1985).

**Caloric intake.** Participants completed a food diary for 4 days (2 weekdays and 2 weekend days) at pre-treatment, post-treatment, and at the follow-up assessment. They received verbal and written instructions on how to accurately complete the diary (e.g., record type of food, brand name if known, portion sizes, condiments, etc.). Research has shown that 4-day food diaries can provide reliable group estimates of caloric intake (Gay, 2000; Schlundt, 1988). Nutribase 2001 Professional Nutrition software (Phoenix, Arizona) was used to derive total daily caloric intake and calories from fat.
Three Factor Eating Questionnaire. The Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) is a 51-item scale with three factors: cognitive dietary restraint (21 items), disinhibition of eating (16 items), and perceived hunger (14 items; see Appendix B). The TFEQ is the most common measure of eating behaviors (Elfhag & Rossner, 2005). The first part of the scale is 36 true and false items and the second half is 15 Likert-scale items. All of the Likert items are on a 4-point scale with different anchors except for one item that uses a 6-point scale. The total scale score can range from 0 to 51. Coefficient alphas for the three factors were 0.93, 0.91, and 0.85, respectively, with a sample of dieters and non-dieters. In the current study, they were 0.82, 0.79 and .83 at pre-treatment, respectively. Allison et al. (1992) reported a test-retest coefficient of .93 for the total scale in an unpublished study by Ganley. In terms of construct validity, the cognitive restraint and disinhibition scores discriminated between dieters and non-dieters, although there was not a difference between the two groups on perceived hunger (Stunkard & Messick, 1985). Furthermore, the restraint scale has been found to be inversely related to caloric intake (Laessle, Tuschl, Kotthaus, & Pirke, 1989).

Binge eating. The Binge Eating Scale (BES; Gormally et al., 1982) is a 16-item questionnaire designed to assess behavioral (8 items), and emotional and cognitive (8 items) aspects of binge-eating (see Appendix C). For each item, participants choose one of three or four responses that best describes them. Total scores can range from 0 to 46, and more pathological responses receive higher scores. The internal reliability coefficient was 0.89 (Gormally et al., 1982 and in the current study at baseline), and test-retest reliability was $r = .87$ over a 2 week time interval (Timmerman, 1999). The BES was associated with the severity of binging, as assessed by a 28-day food diary, in a sample of 56 binge eaters ($r = .39-.40$; Timmerman, 1999).
However, BES scores were not associated with total caloric intake, suggesting that the scale measures the severity of uncontrolled eating episodes and not the number of calories consumed.

*Weight Locus of Control Scale.* The Weight Locus of Control scale (WLOC; Saltzer, 1982) is a 4-item scale designed to assess internal versus external locus of control as it pertains to personal weight (see Appendix D). The scale has two internally worded items and two externally worded items that utilize a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The total scale score can range from 4 to 24 with lower scores indicating more of an internal orientation and higher scores indicating more of an external orientation. The internal reliability coefficient was found to be 0.56-0.58 and the test-retest reliability was $r = .67$ (Saltzer, 1982). In the current study, the reliability coefficient at post-treatment was 0.36. The low internal consistency may be partly due to the fact that the scale only contains 4 items.

*Beliefs about causes of obesity.* In a questionnaire created for this study, participants were asked to “rate the degree to which you believe the stated reasons contribute to YOUR weight” on a 7-point Likert scale ranging from 1 (not at all responsible for my weight) to 7 (totally responsible for my weight; see Appendix E). The eight items included eating habits, genetics, hormones or gland condition, slow metabolism, physical activity or exercise habits, psychological factors and environmental factors. There were also two blank lines provided for participants to write in other attributes for their weight. A factor analysis revealed a construct for external attributions (i.e., genetics, hormones or gland condition, slow metabolism, and psychological factors). The scores for the three attributions referring to medical factors were added together to derive a medical attributions’ scale, and the total score could range from 3 to 21. The Cronbach’s alpha for the medical attributions’ scale was 0.75 at the post-treatment assessment.
Self-efficacy. Self-efficacy was assessed by the Exercise Self-Efficacy Scale (ESS; Bandura, 1997) and the Eating Self-Efficacy Scale (ESES; Glynn & Ruderman, 1986). The ESS is an 18-item scale designed to assess participants’ confidence that they will be able to exercise under a variety of conditions (e.g., “when I am tired,” “when I am feeling anxious,” “after a vacation”; see Appendix F). Participants rate the items on a scale from 0 (cannot exercise) to 100 (certain I can do exercise). Total scores can range from 0 to 1,800 with higher scores reflecting greater exercise self-efficacy. The internal reliability among a sample of adults with chronic illness was $\alpha = .94$, and the test-retest reliability with a two-week time period was $r = .77$ (Shin, Jang, & Pender, 2001). The internal reliability for the current study was 0.93 at pre-treatment.

The ESES is a 25-item scale designed to assess participants’ perceived control regarding overeating in a variety of situations (e.g., “after work or school,” “when angry,” “when tempting food is in front of you”; see Appendix G). Participants rate the items on a 7-point Likert scale from 1 (no difficulty controlling eating) to 7 (most difficulty controlling eating). Total scores can range from 25 to 175 with lower scores indicating greater eating self-efficacy. Factor analyses revealed two subscales: difficulty controlling overeating when (1) experiencing negative affect and (2) in socially acceptable situations, such as a dinner party or around holiday time. The internal reliability among a sample of 484 female undergraduates was .92 for the total scale, .94 for the negative affect subscale and .85 for the socially acceptable situations subscale. The test-retest reliability was acceptable over a 7-week period ($r = .70, p < .01$). The internal reliability of the total scale for the current study was 0.94 at pre-treatment. In terms of predictive validity, a study of 32 participants enrolled in a weight loss program found that weight loss was significantly correlated with increases in eating self-efficacy (Glynn & Ruderman, 1986).
Data Analysis

Correlational analyses and analyses of variance (ANOVAs) were used to examine associations between demographic characteristics (e.g., age, sex, race, income, and education) and weight loss maintenance. Because participants in this study were participating in a treatment outcome study in which they were assigned to a BWLP or a BWLP + SC, the effect of treatment condition on weight loss maintenance was also examined.

While there were no specific hypotheses regarding possible associations among psychological variables, behavioral factors, and RMR, correlations among the various independent variables are presented to highlight significant associations among variables. The dependent variable, weight loss maintenance, was calculated in several ways: (1) pre-treatment body weight – body weight at the 6-month follow-up assessment, and (2) the previous number expressed as a percent of pre-treatment weight, as done in previous research (Anderson et al., 2001). Weight loss maintenance was also calculated to highlight the time between the end of treatment and the follow-up assessment: (1) post-treatment weight – 6-month follow-up weight, and (2) the previous number expressed as a percentage of post-treatment body weight. The calculations highlight different aspects of weight loss maintenance. Although absolute change in body weight is commonly used to measure weight loss success, weight loss expressed as a percentage of initial body weight controls for baseline differences in body weight, thus reducing the likelihood that heavier participants will be categorized as more successful while losing a smaller percentage of their total body weight than lighter participants. Therefore, both absolute weight loss and percentage of pre-treatment/post-treatment body weight are presented in this investigation. Furthermore, it is important to measure weight loss maintenance from the beginning of a weight loss intervention in order to assess whether or not the intervention resulted
in significant improvements from baseline. Examining weight maintenance from the end of treatment to a follow-up assessment is important in order to examine how a period of minimal or no treatment contact effects weight change (i.e., to what degree the changes implemented during the treatment period can be sustained).

Separate analyses were conducted to determine if the following variables are predictive of weight loss maintenance: (1) post-treatment, follow-up, and post-treatment to follow-up changes in RMR (controlled for FFM and FM via regression analyses), (2) pre-treatment levels of binge eating, hunger, and self-efficacy for eating and exercise, (3) post-treatment and 6-month follow-up levels of dietary disinhibition, binge eating, hunger, cognitive dietary restraint, weight LOC, beliefs about causality of obesity, self-efficacy for eating and exercise, daily caloric consumption, percentage of daily caloric intake composed of fat, and calories expended by physical activity (i.e., PPAQ), (4) pre-to post-treatment changes in dietary restraint, and (5) post-treatment to follow-up changes in self-efficacy.

In addition, three separate multiple regression analyses were conducted with the various independent variables at pre-treatment, post-treatment and the 6-month follow-up assessment in order to explore which variables, at specified time points, have the greatest impact on maintenance.

Mediational analyses were proposed to examine the possibility of specified psychological variables mediating the relationship between RMR and weight loss maintenance if all necessary mediational analysis conditions were met. According to Baron and Kenny (1986), necessary conditions would include finding a significant association between weight loss maintenance and RMR, between weight loss maintenance and a specific psychological variable, and between RMR and a specified psychological or behavioral variable.
Due to the small sample size (i.e., limited statistical power) in the current investigation, and the lack of variables found to be associated with weight loss maintenance in prior research, attempts were made to reduce type II statistical error (i.e., failing to detect a significant effect when it exists). Thus, findings will be noted when they reach the standard statistical significance level of $p < .05$ and a “trend” will be reported when $p < .10$. One-tailed tests of significance were used to examine all relationships hypothesized a priori.
CHAPTER 3. RESULTS

Weight Loss Maintenance Across Demographic and Treatment Groups

Correlational analyses and analyses of variance revealed that weight loss maintenance did not vary as a function of demographic variables such as gender, age, marital status, race, income level, education or the presence of a thyroid condition. Independent samples t-tests revealed that participants in the SC group ($n = 19$) did not differ on any indices of weight loss maintenance compared to those in the control group ($n = 21$). There was also no difference in weight loss maintenance between those who were eligible to receive SC following the intervention in the treatment group ($n = 8$) versus those who failed to meet weight loss maintenance goals in the control group ($n = 8$). Finally, there was no difference in weight loss between those who were eligible to receive SC and chose to receive counseling in the treatment group ($n = 6$; two participants in the treatment group declined additional counseling following the intervention) compared to those who failed to meet weight loss maintenance goals in the control group. Because the treatment condition and post-treatment SC did not have significant effects on weight loss maintenance, data from both treatment groups were combined and the relationships between various independent variables and weight loss maintenance were examined with Pearson correlations and multiple regression analyses, unless otherwise stated.

Weight Loss Maintenance

Weight loss maintenance was calculated to indicate change in weight from pre-treatment to the 6-month follow-up assessment and from post-treatment to the follow-up assessment: (1) pre-treatment weight minus the 6-month follow-up weight (i.e., PRE-MAINTENANCE), (2) the previous number expressed as a percentage of pre-treatment weight (PRE-MAINTENANCE %), (3) post-treatment weight minus the 6-month follow-up weight (POST-MAINTENANCE), and
(4) the previous number expressed as a percentage of post-treatment weight (POST-MAINTENANCE %). On average, participants lost 11.9 lbs ($SD = 13.5$; Range = -10.6 - 44.0) from the beginning of treatment to the follow-up assessment (i.e., PRE-MAINTENANCE) or 6.0 % ($SD = 6.8$; Range = -4.0 – 24.0 %) of their pre-treatment weight (i.e., PRE-MAINTENANCE %). They gained an average of 1.3 lbs ($SD = 7.4$; Range = -18.4 – 15.6) from the end of treatment to the follow-up assessment (i.e., POST-MAINTENANCE) or 0.6 % ($SD = 4.2$; Range = -12 – 9 %) of their post-treatment weight (POST-MAINTENANCE %). The mean and standard deviation of the physiological, psychological and behavioral variables at the three assessment points are presented in Table 2.

**Body Size Indices and Weight Loss Maintenance**

Participants’ weight and FM at post-treatment and follow-up were significantly associated with weight loss maintenance from pre-treatment to the follow-up (see Table 3). Those who weighed less and had less FM at post-treatment and at the follow-up experienced more successful weight loss maintenance from pre-treatment to the follow-up assessment (PRE-MAINTENANCE and PRE-MAINTENANCE %). However, when weight loss maintenance was examined from post-treatment to the follow-up, weight and FM were not significantly associated with weight loss maintenance. These findings suggest that weight and FM were more strongly associated with weight loss during treatment than weight maintenance following treatment. Furthermore, FFM was not significantly associated with any indices of weight loss maintenance (see Table 3).

**Covariates of RMR and Weight Loss Maintenance**

When examining the relationship between RMR and weight loss maintenance, FFM and FM were proposed as important covariates. As expected, body size indices were correlated with
RMR (see Table 4), in addition to weight loss maintenance. Post-treatment and follow-up weight, FFM, and FM were all significantly correlated with RMR at the respective assessments. Multiple regression analyses were conducted to examine the relationship between RMR and weight loss maintenance after controlling for FFM and FM together.

In addition, post hoc analyses indicated that greater post-treatment caloric intake was strongly associated with higher post-treatment RMR, $r = .58, p < .01$, and an increase in caloric consumption from post-treatment to follow-up was significantly associated with an increase in RMR during the same period, $r = .40, p < .05$. Furthermore, greater decreases in caloric consumption from pre-treatment to the follow-up assessment (POST-MAINTENANCE, $r = .52, p < .01$; POST-MAINTENANCE %, $r = .49, p < .01$) and from post-treatment to the follow-up assessment were associated with superior weight loss maintenance (POST-MAINTENANCE, $r = .47, p < .01$; POST-MAINTENANCE %, $r = .42, p < .05$). Given the significant relationships between caloric intake and RMR and the changes in caloric intake and weight loss maintenance, additional analyses were conducted to examine the effect of RMR on weight loss maintenance after controlling for caloric intake.

Post-treatment RMR and Weight Loss Maintenance

The average post-treatment RMR ($M = 1535; SD = 235$) was significantly lower than that predicted with the Harris-Benedict equation (1612), $t(34) = 2.73, p < .05$. However, post-treatment RMR was not significantly correlated with any indices of weight loss maintenance. Additional analyses were conducted to examine the relationship between post-treatment RMR and weight loss maintenance after controlling for: (1) FFM and FM, and (2) caloric intake, FFM and FM.
Post-treatment RMR controlled for FFM and FM. The overall multiple regression models including post-treatment RMR, FFM, and FM significantly predicted weight loss maintenance from pre-treatment to follow-up. While less FM was associated with superior weight loss maintenance from pre-treatment to follow-up in these models, RMR and FFM were not (see Table 5). When maintenance was calculated from post-treatment to follow-up, the overall regression models were not significantly associated with weight loss maintenance. However, there was a trend \( p < .10 \) for RMR to be associated with absolute weight loss maintenance in this model (POST-MAINTENANCE; see Table 5). Thus, after controlling for FFM and FM, participants with a higher RMR at post-treatment tended to experience better weight loss maintenance from post-treatment to the follow-up assessment.

Post-treatment RMR controlled for caloric intake, FFM, and FM. Post-treatment caloric intake alone was not significantly associated with any indices of weight loss maintenance (see Table 3). The overall regression models including post-treatment RMR, caloric intake, FFM and FM significantly predicted weight loss maintenance from pre-treatment to follow-up. However, while having less FM was associated with superior weight loss maintenance in these models, post-treatment RMR, FFM and caloric intake were not associated with weight loss maintenance (see Table 5). The overall regression models including post-treatment RMR, caloric intake, FFM and FM were not significantly associated with weight loss maintenance from post-treatment to follow-up, and post-treatment RMR was not associated with weight loss maintenance in these models (see Table 5).

Summary of post-treatment RMR and weight loss maintenance. Controlling for post-treatment FFM and FM resulted in a positive association between post-treatment RMR and the number of pounds lost from post-treatment to the follow-up assessment. Thus, superior weight
loss maintenance following treatment was associated with higher post-treatment RMRs after controlling for FFM and FM. However, with no covariates or after controlling for caloric intake in addition to body size, there was not a significant relationship between post-treatment RMR and weight loss maintenance. Furthermore, none of the analyses revealed a significant association between post-treatment RMR and weight loss maintenance from pre-treatment to follow-up. See Table 6 for a quick summary highlighting the relationship between post-treatment RMR and weight loss maintenance.

**Follow-up RMR and Weight Loss Maintenance**

The average follow-up RMR for all participants ($M = 1681; SD = 271$) was significantly greater than that predicted with the Harris-Benedict equation (1628), $t(37) = -2.24, p < .05$. Interestingly, a post-hoc analysis revealed that participants taking thyroid medication ($n = 7$) had lower RMRs at follow-up (but not at post-treatment) compared to those not taking thyroid medication even after controlling for weight, $F(2,36) = 5.39, p < .05$. However, unlike the whole group, the average follow-up RMR of participants taking thyroid medication was not significantly different than that predicted by the Harris-Benedict equation.

Surprisingly, *higher* RMR at the 6-month follow-up assessment was associated with *poorer* weight loss maintenance from pre-treatment to the follow-up, and there was not a significant association between follow-up RMR and weight loss maintenance from post-treatment to the follow-up (see Table 5). Additional analyses were conducted to examine the relationship between follow-up RMR and weight loss maintenance after controlling for: (1) FFM and FM, and (2) caloric intake, FFM, and FM.

*Follow-up RMR controlled for FFM and FM.* The overall regression models including follow-up RMR, FFM, and FM significantly predicted weight loss maintenance from pre-
treatment to follow-up. However, while having less FM was significantly associated with superior weight loss maintenance in these models, RMR and FFM were not (see Table 5). The two overall regression models including follow-up RMR, FFM, and FM were not significantly associated with weight loss maintenance from post-treatment to follow-up. However, there were trends ($p < .10$) for the association between higher RMR and superior weight loss maintenance within these models. Again, having less FM was significantly associated with superior weight loss maintenance (see Table 5).

**Follow-up RMR controlled for caloric intake FFM, and FM.** Follow-up caloric intake was not significantly associated with any indices of weight loss maintenance (see Table 3). The overall regression models including follow-up RMR, caloric intake, FFM and FM significantly predicted weight loss maintenance from pre-treatment to follow-up. However, while having less FM was significantly associated with weight loss maintenance in these models, RMR, caloric intake, and FFM were not (see Table 5). There was a trend for the overall regression model including follow-up RMR, caloric intake, FFM, and FM to predict absolute weight loss maintenance from post-treatment to follow-up (POST-MAINTENANCE). Higher RMR was associated with superior weight loss maintenance from post-treatment to follow-up after controlling for caloric intake, FFM and FM in these models. Furthermore, having less FM was significantly associated with superior weight loss maintenance in these models (see Table 5).

**Summary of follow-up RMR and weight loss maintenance.** The association between follow-up RMR and weight loss maintenance was significantly influenced by whether or not body size was controlled for and how weight loss maintenance was defined. For example, after controlling for body size alone or with caloric intake, higher RMR was associated with superior weight loss maintenance from post-treatment to the follow-up. However, when not controlling
for body size or caloric intake, higher RMR was associated with poorer weight loss maintenance from pre-treatment to the follow-up. See Table 6 for a summary of the findings with follow-up RMR and weight loss maintenance.

*Change in RMR and Weight Loss Maintenance*

The change in RMR from post-treatment to the follow-up assessment was also examined as a potential predictor of weight loss maintenance both when examined alone and after controlling for: (1) post-treatment FFM and FM, and (2) change in caloric intake, post-treatment FFM, and post-treatment FM. The increase in RMR from post-treatment to the follow-up alone ($M = +145, SD = 419$) was not significantly associated with any indices of weight loss maintenance.

*Change in RMR controlled for post-treatment FFM and FM.* The overall regression models including the change in RMR from post-treatment to follow-up, post-treatment FFM, and post-treatment FM significantly predicted weight loss maintenance from pre-treatment to follow-up. While less FM was significantly associated with superior weight loss maintenance from pre-treatment to follow-up, the change in RMR was not significantly associated with weight loss maintenance in these models (see Table 5). The overall regression models including the change in RMR from post-treatment to follow-up, post-treatment FFM, and post-treatment FM were not significantly associated with weight loss maintenance from post-treatment to follow-up, and the change in RMR was not associated with weight loss maintenance in these models (see Table 5).

*Change in RMR controlled for change in caloric intake, post-treatment FFM, and post-treatment FM.* A greater decrease in caloric intake from post-treatment to follow-up was significantly associated with superior weight loss maintenance from post-treatment to follow-up,
(but not from pre-treatment to follow-up; POST-MAINTENANCE, \( r = .47, p < .01 \); POST-MAINTENANCE \%, \( r = .42, p < .05 \)).

The overall regression models including the change in RMR, change in caloric intake, post-treatment FFM, and post-treatment FM together predicted weight loss maintenance from pre-treatment to follow-up. However, while having less FM was associated with superior weight loss maintenance in these models, the change in RMR, change in caloric intake, and post-treatment FFM were not significantly associated with success (see Table 5). The overall regression models including the change in RMR, change in caloric intake, post-treatment FFM, and post-treatment FM did not predict weight loss maintenance from post-treatment to follow-up. Furthermore, the change in RMR was not significantly associated with weight loss maintenance in these models (see Table 5).

Summary of change in RMR and weight loss maintenance. No association was found between the change in RMR and weight loss maintenance after controlling for body size or body size and the change in caloric intake. See Table 6 for a summary of the findings with the change in RMR and weight loss maintenance.

Dietary Disinhibition and Weight Maintenance

Consistent with previous research (Borg et al., 2004; Fogelholm et al., 1999), scores on dietary disinhibition, as assessed by the TFEQ, decreased over the course of the weight loss intervention (see Table 2). The dietary disinhibition mean scores in the present study at pre-treatment (M = 11.7), post-treatment (M = 8.7), and at the follow-up assessment (M = 8.9) were similar to those reported in a previous weight loss maintenance study (Fogelholm et al., 1999).

Contrary to expectations, post-treatment dietary disinhibition was not associated with weight loss maintenance. However, greater dietary disinhibition at the follow-up assessment was
significantly associated with poorer weight loss maintenance from post-treatment to follow-up (see Table 3).

**Binge Eating and Weight Maintenance**

Consistent with previous research (Fogelholm et al., 1999), binge eating (i.e., BES) decreased over the course of the weight loss program: pre-treatment \( M = 17.4 \), post-treatment \( M = 11.1 \) and follow-up assessment \( M = 12.2 \). The BES mean pre-treatment score in the present study is nearly identical to that reported in a study with 444 BWLP participants \( M = 17.2, SD = 7.7; \) Sherwood et al., 1999), but somewhat lower than another previously reported average for weight loss participants \( M = 21.4, SD = 9.2; \) Gormally et al., 1982).

Pre-treatment and post-treatment binge eating were not associated with weight loss maintenance. However, binge eating at the follow-up assessment was significantly associated with all indices of weight loss maintenance (see Table 3). Thus, as predicted, increased binging behavior at the follow-up assessment was associated with poorer weight loss maintenance.

**Perceived Hunger and Weight Maintenance**

Consistent with previous research (Borg et al., 2004; Fogelholm, et al., 1999), perceived hunger, as assessed by the TFEQ, decreased over the course of the weight loss intervention: pre-treatment \( M = 7.2 \), post-treatment \( M = 5.1 \) and follow-up assessment \( M = 4.8 \). The pre-treatment mean score in the present study is nearly identical to those of “free eaters”/non-dieters \( M = 7.0 \) and “dieters” \( M = 7.2 \) reported previously (Stunkard & Messick, 1985). Hunger levels at pre-treatment, post-treatment and the 6-month follow-up assessment were not associated with any indices of weight loss maintenance.

**Cognitive Dietary Restraint and Weight Maintenance**
Consistent with previous research (Borg et al., 2004; Fogelholm, et al., 1999), dietary restraint, as assessed by the TFEQ, increased after the intervention: pre-treatment ($M = 9.0$), post-treatment ($M = 15.8$) and follow-up assessment ($M = 13.8$). The pre-treatment dietary restraint mean score was comparable to an average reported for dieters and non-dieters combined ($M = 10.5$), while the scores at post-treatment and the follow-up assessment are more similar to an average previously reported for dieters ($M = 14.3$; Stunkard & Messick, 1985).

Dietary restraint at post-treatment was not significantly associated with weight loss maintenance. However, greater dietary restraint at the follow-up was positively associated with all indices of weight loss maintenance (see Table 3). In addition, a greater increase in dietary restraint from pre-to-post treatment was significantly associated with better maintenance from pre-treatment to follow-up (see Table 7).

**Locus of Control and Weight Maintenance**

Participants’ average scores on the WLOC at post-treatment ($M = 5.7$) and at the follow-up assessment ($M = 6.3$) were indicative of slightly more of an internal WLOC compared to another group of women beginning a weight control intervention ($M = 7.0$, $SD = 2.8$; Saltzer, 1982).

There was a trend for greater internal post-treatment WLOC to be associated with superior weight loss maintenance from pre-treatment to follow-up, $r = -.24, p = .09$ (PRE-MAINTENANCE %). When assessed at follow-up, WLOC was significantly associated with weight loss maintenance from pre-treatment to follow-up (see Table 3), and there was also a trend for the association between follow-up WLOC and weight loss maintenance from post-treatment to follow-up, $r = -.21, p = .09$ (POST-MAINTENANCE). Thus, more of an internal
WLOC (versus external) at post-treatment and follow-up was associated with greater weight loss maintenance.

**Beliefs about Causality of Obesity and Weight Maintenance**

On a questionnaire designed for the purpose of this study, participants generally indicated that medical factors were “moderately responsible for my weight” at post-treatment ($M = 9.6$) and at the follow-up assessment ($M = 10.1$). At post-treatment, a greater likelihood of attributing weight to medical factors was not associated with weight loss maintenance. However, at the follow-up assessment, a greater tendency to attribute weight to medical factors was significantly associated with poorer weight loss maintenance from post-treatment to follow-up (see Table 3).

**Self-efficacy and Weight Maintenance**

Mean eating self-efficacy scores (i.e., ESES) at pre-treatment ($M = 106.5$), post-treatment ($M = 92.7$) and the follow-up assessment ($M = 91.0$) fell within the range of previously reported scores for a sample of dieters (range = 33-148, $M = 87.2$) and non-dieters (range = 25-155, $M = 74.1$) even though the means were slightly higher and indicative of somewhat poorer eating self-efficacy (Glynn & Ruderman, 1986). Mean scores on exercise self-efficacy, as assessed by the ESS ($M = 820.7$, 1083.9, and 985.6) were generally higher and indicative of better exercise self-efficacy compared to a sample of Korean adults with chronic diseases ($M = 688.0$, $SD = 364.1$; Shin et al., 2001).

Pre-treatment and post-treatment exercise and eating self-efficacy were not significantly associated with weight loss maintenance. However, at the follow-up assessment, there were trends for greater eating self-efficacy to be associated with better weight loss maintenance from post-treatment to follow-up, $r = -.25, p = .06$ (POST-MAINTENANCE) and $r = -.24, p = .07$ (POST-MAINTENANCE %). The change in eating self-efficacy from post-treatment to the
follow-up assessment was not significantly associated with weight loss maintenance (see Table 7). Thus, experiencing less of a decline in eating self-efficacy following treatment was not associated with better weight loss maintenance.

There was a trend for greater exercise self-efficacy at the follow-up assessment to be associated with superior weight loss maintenance from pre-treatment to follow-up, $r = .21, p = .10$ (PRE-MAINTENANCE %) and from post-treatment to follow-up, $r = .21, p = .10$ (POST-MAINTENANCE %). In addition, there was a significant relationship between the change in exercise self-efficacy from post-treatment to the follow-up assessment and weight loss maintenance from post-treatment to follow-up (see Table 7). Participants who experienced less of a decrease in exercise self-efficacy from the end of treatment to the follow-up assessment were more successful at weight loss maintenance.

**Dietary Intake and Weight Maintenance**

Participants completed 4-day food diaries at the three assessment points. The average calories consumed per day were 2001, 1626, and 1719 at pre-treatment, post-treatment and follow-up, respectively. The pre-treatment level of calories consumed was comparable to that of another group of 202 weight loss participants at baseline ($M = 2032, SD = 785$; Raynor, Jeffery, Tate, & Wing, 2004). Follow-up analyses found that caloric intake decreased significantly from pre-treatment to post-treatment, $t (37) = 4.88, p < .01$ and increased significantly from post-treatment to follow-up, $t (34) = -2.04, p < .05$.

Self-reported caloric intake at post-treatment and at the follow-up assessment were not associated with any indices of weight loss maintenance. However, as stated previously, post-hoc analyses revealed that greater decreases in caloric consumption from pre-treatment to the follow-up assessment (POST-MAINTENANCE, $r = .52, p < .01$; POST-MAINTENANCE %, $r = .49, p$
< .01) and from post-treatment to the follow-up assessment were associated with superior weight loss maintenance (POST-MAINTENANCE, \( r = .47, p < .01 \); POST-MAINTENANCE %, \( r = .42, p < .05 \)).

**Fat Intake and Weight Maintenance**

Nutrient analyses revealed that participants consumed an average of 35.9%, 32.9% and 33.5% of their total daily caloric intake from fat at pre-treatment, post-treatment, and at follow-up, respectively. Another study cited above found nearly identical levels of fat consumption at baseline within a weight loss sample (\( M = 35.8 \%, SD = 7.1 \); Raynor et al., 2004). At post-treatment, participants who consumed a smaller percentage of their total calories from fat tended to maintain weight loss from pre-treatment to follow-up more successfully compared to those who consumed a greater percentage of their caloric intake from fat, \( r = -.24, p = .07 \) (PRE-MAINTENANCE) and \( r = -.26, p = .07 \) (PRE-MAINTENANCE %). Fat intake at the follow-up assessment was not associated with weight loss success (see Table 3).

**Physical Activity and Weight Maintenance**

The mean number of calories expended per week on physical activity, as assessed by the PPAQ, were 821.2, 2007.2, and 2087.3 at the pre-treatment, post-treatment, and follow-up assessment, respectively. The pre-treatment mean is comparable, although somewhat lower, to that reported in another study involving 444 BWLP participants at baseline (\( M = 921.3, SD = 921.4 \); Sherwood et al., 1999). The number of post-treatment calories expended via physical activity was significantly associated with weight loss maintenance from post-treatment to follow-up (see Table 3). In addition, there were trends for the association between post-treatment physical activity and weight loss maintenance from pre-treatment to follow-up, \( r = .24, p = .07 \) (PRE-MAINTENANCE) and \( r = .22, p = .09 \) (PRE-MAINTENANCE %).
At the follow-up assessment, the PPAQ was significantly associated with maintenance from pre-treatment to follow-up (see Table 3), and there were trends when maintenance was calculated from post-treatment to follow-up, $r = .24$, $p = .07$ (POST-MAINTENANCE) and $r = .23$, $p = .08$ (POST-MAINTENANCE). Thus, greater physical activity levels at post-treatment and follow-up were associated with superior weight loss maintenance.

**Overall Multiple Regression Models at Pre-treatment, Post-treatment, and Follow-up**

Multiple regression analyses were conducted for each time point (pre-treatment, post-treatment, and the 6-month follow-up assessment) to examine the aggregate effect of the independent variables on the different indices of weight loss maintenance. The overall regression models examining the association between pre-treatment variables (binge eating, hunger, eating self-efficacy, and exercise self-efficacy) and different indices of weight loss maintenance were not statistically significant. However, within the overall models, baseline hunger, $t(34) = 2.48$, $p < .01$ (PRE-MAINTENANCE) and $t(34) = 2.35$, $p < .05$ (PRE-MAINTENANCE %), and exercise self-efficacy, $t(34) = 1.71$, $p < .05$ (PRE-MAINTENANCE) were significantly associated with weight loss maintenance from pre-treatment to follow-up.

The overall multiple regression models revealed that variables assessed together at post-treatment [binge eating, hunger, eating self-efficacy, exercise self-efficacy, dietary restraint, dietary disinhibition, calories expended though physical activity, calories consumed, percentage of calories consumed from fat, WLOC, weight loss attributions associated with medical factors (e.g., genetics, hormonal or gland condition, slow metabolism), RMR, and FFM] were not significantly associated with weight loss maintenance. Individual variables that were predictive of weight loss maintenance within the overall models were hunger, $t(15) = 2.19$, $p < .05$ (POST-MAINTENANCE) and $t(15) = 2.11$, $p = .05$ (POST-MAINTENANCE %), and binge eating, $t(15)$
The overall multiple regression models revealed that the variables assessed together at the follow-up assessment (same as those assessed at post-treatment) were not significantly associated with weight loss maintenance. Within the overall models, dietary restraint was the only individual variable at the follow-up assessment that was predictive of weight loss maintenance, \( t(20) = 2.22, p < .05 \) (POST-MAINTENANCE) and \( t(20) = 2.08, p < .05 \) (POST-MAINTENANCE %). Perhaps the associations between predictor variables and weight loss maintenance often differed between correlational and multiple regression analyses because of the multiple predictor variables in the regression analyses and the correlations between the variables (see Table 8).

**Relationship Between RMR and Psychological/Behavioral Variables**

Partial correlations were conducted to examine whether or not the various psychological and behavioral variables were associated with RMR after partialling out FFM and body weight in separate analyses (see Table 9). Post-treatment fat intake was the only variable significantly correlated with RMR after controlling for body size. However, it was not significantly associated with weight loss maintenance and thus, could not mediate the relationship between RMR and weight loss maintenance. Therefore, none of the examined variables mediate the relationship between RMR and weight loss maintenance.

Although not statistically significant, there were moderate correlations between the tendency to attribute weight to medical factors and RMR at follow-up (after controlling for FFM; \( r = -.30, p = .09 \)), and between calories consumed and RMR at post-treatment (after controlling for weight; \( r = .33, p = .08 \)). In other words, participants with a higher RMR at follow-up tended
to attribute their weight to medical factors to a lesser degree compared to people with lower RMRs, and participants who consumed more calories at post-treatment were likely to have a higher RMR compared to those who consumed fewer calories.
CHAPTER 4. DISCUSSION

**RMR and Weight Loss Maintenance**

It was hypothesized that post-treatment RMR, follow-up RMR, and the change in RMR from post-treatment to follow-up would be associated with weight loss maintenance. While higher post-treatment and follow-up RMR were associated with superior weight loss maintenance under certain conditions, the change in RMR was not significantly associated with weight loss maintenance.

**Assessed Versus Predicted RMR.** On average, participants’ post-treatment and follow-up RMRs were significantly different than those predicted by the Harris-Benedict equation. While the average RMR at post-treatment was below the predicted value (-77 kcal), the average at follow-up RMR was higher than the predicted value (+53 kcal). The lower than expected RMR at post-treatment may be secondary to the caloric restriction during active treatment. Participants reported consuming, on average, 19% fewer calories at post-treatment compared to at pre-treatment and 5% fewer calories at post-treatment compared to at follow-up. In fact, lower caloric intake at post-treatment and smaller increases in caloric intake between post-treatment and follow-up were significantly associated with lower RMRs. These findings are consistent with previous research which has documented a significant association between caloric restriction and RMR suppression during weight loss (Elliot, Goldberg, Kuehl, & Bennett, 1989; Heilbronn, Jonge, Frisard, DeLany, Larson-Meyer, Rood, et al., 2006; Mole, 1990; Weinsier et al., 2000).

The higher than predicted RMR at follow-up was unexpected and may not be clinically significant. However, it does suggest that the BWLP participants were not at a metabolic disadvantage at follow-up. While many participants may believe that their weight struggles are
secondary to an abnormally low RMR, the mean RMR in the current investigation was in the normal range (or above normal) at follow-up. BWLP participants may benefit from being informed of their RMRs to dispel misconceptions about possessing a low RMR. Furthermore, they might also benefit from being educated about the potential suppression in RMR that can accompany caloric restriction.

In the following sub-sections, the overall findings for the relationship between RMR and weight loss maintenance will be discussed in light of the timing of the RMR assessment, the definition of weight loss maintenance, and the use of various statistical covariates (i.e., FFM, FM, or caloric intake).

*Timing of RMR assessment and weight loss maintenance.* When RMR was assessed at post-treatment, there was only a statistical trend for higher RMR to be associated with absolute weight loss maintenance from post-treatment to follow-up after controlling for body size. None of the other findings (i.e., with different covariates or definitions of weight loss maintenance) with post-treatment RMR and weight loss maintenance were significant. These results suggest that RMR assessed immediately following a weight loss intervention (i.e., at post-treatment) and presumably at the time of maximum weight loss may not be a reliable predictor of weight loss maintenance. Research suggests that RMR decreases as a function of weight loss and caloric restriction (e.g., Heilbronn et al., 2006; Leibel, 1995; Weinsier et al., 2000; Wing & Hill, 2001). Therefore, it is possible that RMR immediately following treatment may differ significantly from the individual’s nonrestrictive RMR, yielding a less reliable predictor of treatment outcomes.

Compared to the post-treatment assessment of RMR, RMR assessed at follow-up was more likely to be associated with weight loss maintenance. It was associated with both the absolute and percentage of body weight indices of weight loss maintenance from post-treatment
to follow-up after controlling for body size or body size and caloric intake. As suggested above, RMR at follow-up may more accurately reflect a participant’s stable RMR. Follow-up RMR was a superior predictor of weight loss maintenance in this investigation.

In addition to examining the effect of RMR assessed at one point in time on weight loss maintenance, the effect of the change in RMR from post-treatment to follow-up on weight loss maintenance was also explored. The change in RMR was not associated with superior weight loss maintenance regardless of the statistical covariates entered into the analyses. While previous research has not explored the relationship between weight loss maintenance and the change in RMR from post-treatment to follow-up, significant associations have been reported between superior weight loss maintenance and smaller decreases in RMR from pre-treatment to post-treatment (Pasman et al., 1999; Van Dale et al., 1990).

These findings along with the findings of previous researchers suggest that the timing of the RMR assessment(s) is likely to greatly influence the observed relationship between RMR and weight loss maintenance. In contrast to previous research findings (Amatruda et al., 1993; Hansen et al., 2001; Weinsier et al., 1995), this investigation indicates that RMR assessed at a single point in time may be significantly associated with weight loss maintenance (especially when examined among weight loss participants who begin and end treatment at very different weights). Future studies aimed at exploring the best times in which to assess RMR or the change in RMR in order to predict weight loss maintenance are likely to be useful. Furthermore, if a low RMR at some point in time following treatment is consistently identified as a risk factor for weight regain, future research may explore whether informing participants of their RMRs and educating them on ways to counteract the effects of a low RMR would enhance treatment
outcomes. For example, educating weight loss participants on how to preserve their RMR, such as through strength training, may result in better long-term weight loss outcomes.

Definition of weight loss maintenance and weight loss maintenance. Interestingly, the results for all of the analyses were nearly the same whether weight loss maintenance was calculated as absolute weight loss (lbs) or as a percentage of weight loss. However, the results differed significantly when maintenance was calculated with different time periods. When maintenance was calculated as weight change from the end of treatment to the follow-up assessment, a higher RMR at post-treatment and follow-up was associated with better weight loss maintenance after controlling for body size. However, when maintenance was calculated as weight change from the beginning of treatment to the follow-up assessment, a higher RMR or less of a decrease in RMR from post-treatment to follow-up was not associated with superior weight loss maintenance after controlling for body size.

These findings suggest that RMR may not have the same impact on weight loss during active treatment compared to weight maintenance during the 6 month post-treatment period. From a weight maintenance perspective, the two time periods are quite distinct. The period from pre-treatment to the 6 month follow-up includes 6 months of active treatment during which most weight loss occurs. However, the period from post-treatment to the 6 month follow-up does not include a period of active treatment. Factors other than RMR may have a greater impact on weight loss during active treatment (e.g., significant increases in dietary restraint and energy expenditure). On the other hand, biological factors, such as RMR, may have a greater effect on weight loss maintenance when it is defined exclusively as the time period following treatment. Perhaps this is because behaviors such as increased dietary restraint and physical activity have somewhat stabilized during this time.
Interestingly, most studies that have examined RMR as a potential predictor of weight loss maintenance have considered weight loss maintenance as the time between post-treatment and the follow-up assessment (Armatruda et al., 1993; Pasman et al., 1999; Van Dale et al., 1990; Weinsier et al., 1995). This computation ignores the amount of weight lost during treatment that could plausibly have a considerable impact on long-term outcomes. In addition, the time intervals between post-treatment and follow-up weight assessments have varied greatly between studies. For example, Pasman et al.’s (1999) follow-up assessment was 14 months after treatment, while Weinsier et al.’s (1995) follow-up assessment was 4 years after treatment. Consistent definitions of weight loss maintenance, including comparable follow-up assessments, might yield greater reliability among findings across studies.

*Body size and caloric intake as covariates of weight loss maintenance.* As expected, the use of different covariates had a significant impact on the associations between RMR and weight loss maintenance. For example, after controlling for FM and FFM, higher post-treatment and follow-up RMR was associated with superior weight loss maintenance from post-treatment to follow-up. However, the results were opposite of what was expected when examining the relationship between follow-up RMR and weight loss maintenance from pre-treatment to follow-up when not controlling for FFM and FM. In other words, lower follow-up RMR was associated with superior weight loss maintenance from pre-treatment to follow-up when not controlling for body size.

It is possible that the reason there was an inverse relationship between RMR and weight loss maintenance when not controlling for body size is that people who were lighter and had less FM at follow-up were more successful at weight loss maintenance from pre-treatment to follow-up. Previous research has also reported a significant relationship between being lighter and
successful weight loss maintenance (e.g., Ogden, 2000). Because participants who weighed less had lower RMRs, as would be expected, it appeared that participants who had lower RMRs were more successful at weight loss maintenance from pretreatment to follow-up until FFM and FM were controlled for in the analyses. These findings generally suggest that lower weight, rather than lower RMR, was associated with superior weight loss treatment outcomes from pre-treatment to follow-up. As previous researchers have consistently noted (e.g., Astrup et al., 1999; Weinsier et al., 2000), controlling for body size appears to be critical when examining the relationship between RMR and weight loss maintenance.

Interestingly, there was an insignificant relationship between FFM and weight loss maintenance in the current investigation. In fact, when examining the impact of FM, FFM, and RMR together on weight loss maintenance from pre-treatment to follow-up, FM was the only variable significantly associated with weight loss maintenance. Therefore, FM may be a more important covariate than FFM when assessing weight loss maintenance among the obese or formerly obese. In prior research, Weinsier et al. (1995) also found that FM was an important covariate in addition to FFM when examining the relationship between RMR and weight maintenance in a group of formerly obese participants. These findings demonstrate the importance of examining the associations between various indices of body size, RMR, and weight loss maintenance, particularly among overweight/obese participants.

In addition to controlling for indices of body size, the relationship between RMR and weight loss maintenance was also examined after controlling for caloric intake. Adding caloric intake as an additional covariate along with FFM and FM did not affect the non-significant relationship between the change in RMR and weight loss maintenance. However, the positive statistical trend for the relationship between higher post-treatment RMR and superior absolute
weight loss maintenance from post-treatment to follow-up became non-significant after adding caloric intake as a covariate. This is likely secondary to the association between lower caloric intake at post-treatment and lower RMR. Therefore, once the influence of caloric restriction was controlled for, post-treatment RMR was not significantly associated with weight loss maintenance. As mentioned earlier, previous researchers have documented an association between caloric restriction and decreased RMR during weight loss (Elliot et al., 1989; Mole, 1990; Weinsier et al., 2000). On the other hand, including caloric intake as an additional covariate along with FFM and FM strengthened the relationship between follow-up RMR and absolute weight loss maintenance from post-treatment to follow-up. Perhaps this is due to a reduction in error variance associated with the additional predictor variable (i.e., caloric intake).

In future studies, it may be important to consider the impact of caloric intake on RMR and on the relationship between RMR and weight loss maintenance. Furthermore, this study suggests that BWLP participants may benefit from being encouraged to create a moderate, rather than a severe, caloric restriction since there was a positive association between calories consumed at post-treatment and the number of calories participants expended while at rest (i.e., RMR) after controlling for weight.

Psychological and Behavioral Variables and Weight Loss Maintenance

There were no significant associations between weight loss maintenance and pre-treatment (BES, hunger, exercise and eating self-efficacy) or post-treatment (BES, dietary disinhibition, cognitive dietary restraint, hunger, weight attributions, exercise and eating self-efficacy) psychological variables when examined individually. There are several possible explanations for the null findings. First, none of the psychological variables (except post-treatment exercise self-efficacy) were related to physical activity, and in this investigation
physical activity, but not energy intake, was associated with weight loss maintenance. Second, it is possible that the psychological variables as assessed at pre-treatment and post-treatment in the current study are truly not related to weight loss maintenance. Again, other pre-treatment and post-treatment factors may be more important predictors of weight loss maintenance (i.e., energy expenditure). Third, it is plausible that psychological variables are associated with weight loss maintenance, but that pre-treatment and post-treatment are not optimal time points in which to assess these variables in order to detect their impact on weight loss maintenance. As discussed below, psychological factors assessed at follow-up were more strongly associated with weight loss maintenance.

Finally, there is a precedent for individuals with greater psychological struggles and distress to drop out of treatment (Sherwood et al., 1990; Balch and Ross, 1975) and thus create range restrictions on the variables that might potentially be associated with treatment outcomes. However, the findings in the current study do not fully support this explanation. There was not a statistically significant difference in scores on psychological variables at pre-treatment between program completers (n = 40) and non-completers (n = 7). However, the small number of program non-completers limits the statistical power of these analyses. For example, even though the mean pre-treatment binge eating score was not statistically different for program non-completers (M = 21.7, SD = 10.8) and completers (M = 17.4, SD = 7.7), the non-completers’ mean score was higher and the effect size was moderate (Cohens d = .54). While program non-completers also reported slightly greater pre-treatment hunger and lower self-efficacy than program completers, these effect sizes were smaller (.14-.31). Therefore, in most but not all instances, treatment non-completion did not contribute to range restrictions in the psychological variables.
Nearly all of the psychological variables at the 6-month follow-up assessment were associated with weight loss maintenance when examined separately. Participants with greater dietary restraint and less binge eating at follow-up experienced superior weight loss from pre-treatment to follow-up and from post-treatment to follow-up. Having more of an internal WLOC was associated with superior weight loss maintenance from pre-treatment to follow-up, and participants with less dietary disinhibition and less of a tendency to attribute weight to medical factors experienced better weight loss maintenance from post-treatment to follow-up. Those with greater exercise and eating self-efficacy also tended to experience superior weight loss maintenance. In other words, participants who exerted more dietary control and believed that they could control their weight at follow-up were more successful with weight loss maintenance from pre-treatment to follow-up and from post-treatment to follow-up. Hunger was the only follow-up psychological variable not significantly associated with weight loss maintenance, even though the correlation was in the predicted direction. While previous researchers have generally found hunger assessed at some point following treatment to be negatively associated with weight loss maintenance (Borg et al., 2004; McGuire, Wing, Klem, Lang et al., 1999), other researchers have not found a significant association between follow-up hunger and weight loss maintenance (Pasman et al., 1999).

In summary, none of the pre-treatment and post-treatment psychological variables were significantly correlated with weight loss maintenance. However, many of the psychological variables assessed at follow-up were correlated with weight loss maintenance. The mean scores on these variables changed throughout the BWLP, and perhaps psychological variables assessed during active weight loss maintenance more accurately portray individuals’ weight loss maintenance psychological states. In other words, there may be a timing effect such that
psychological functioning and behaviors during maintenance may be more relevant for predicting successful weight loss maintenance than earlier levels of functioning. Of course, it is also possible that weight loss outcomes were actually influencing psychological functioning. For example, perhaps greater weight loss and/or weight loss maintenance leads to superior self-efficacy or more of an internal LOC. The directionality of the relationship between psychological variables and weight loss maintenance cannot be determined from the current investigation.

In addition to examining the associations between psychological variables assessed at one point in time and weight loss maintenance, the effects of the changes in dietary restraint, eating self-efficacy and exercise self-efficacy on weight loss maintenance were also explored. Participants who experienced greater increases in dietary restraint from the beginning to the end of treatment were more successful with weight loss maintenance from pre-treatment to the follow-up assessment. While it would be logical to suspect that the increase in dietary restraint as assessed by the TFEQ might be related to weight loss maintenance secondary to reduced caloric intake, the change in dietary restraint from pre-to-post treatment was not significantly associated with the change in caloric intake during that time (even though the relationship was in the expected direction; $r = -.21, p = .24$). Also, dietary restraint was not significantly associated with the change in calories expended via physical activity. Therefore, the mechanism accounting for the relationship between the change in dietary restraint and weight loss maintenance is uncertain.

Changes in eating and exercise self-efficacy from post-treatment to follow-up revealed different findings in terms of their relationships with weight loss maintenance. There was not a significant association between the change in eating self-efficacy and weight loss maintenance. However, participants who experienced less of a drop in exercise self-efficacy were more successful at weight loss maintenance. The findings in the current investigation emphasize the
importance of sustained self-efficacy for physical activity and actual physical activity (i.e., calories expended) on weight loss maintenance. In fact, continued motivation to be physically active has been sited as an essential factor in long-term weight management (Teixeira, Going, Houtkooper, Cussler, Metcalfe, Blew, Sardinha, & Lohman, 2004).

In terms of behavioral variables, more physical activity at post-treatment and the follow-up assessment was associated with superior weight loss maintenance from pre-treatment to follow-up and from post-treatment to follow-up, and there was a trend for a lower percentage of calories consumed from fat at post-treatment to be associated with better maintenance from pre-treatment to follow-up. The relationship between high levels of physical activity and weight loss maintenance is well documented (Anderson et al., 2001; Corsica & Perri, 2003; Harris et al., 1994; Holden et al., 1992; Jeffery et al., 1984; Jeffery et al., 2003; Kayman et al., 1990; Leser et al., 2002; McGuire et al., 1998; McGuire, Wing, Klem, & Hill, 1999; McGuire, Wing, Klem, Lang, et al., 1999; Sarlio-Lahteenkorva et al., 2000; Sherwood et al., 1999; Wadden & Letizia, 1992; Wing, 1999; Wing & Klem, 2002). The association between lower fat consumption and weight loss maintenance has also been reported previously (Jeffery et al., 1984; Klem et al., 1997; Leser et al., 2002; McGuire, Wing, Klem & Hill, 1999; Wing & Hill, 2001) and is likely partially due to the association between post-treatment fat intake and caloric consumption ($r = .45$, $p < .01$).

While, post-treatment and follow-up caloric intake was not related to weight loss maintenance, greater decreases in caloric intake from pre-treatment and post-treatment to the follow-up assessment were associated with weight loss maintenance. Thus, within subject change in caloric intake appears to be a more meaningful predictor of weight loss maintenance than the level of absolute caloric intake. In addition, the absolute level of physical activity seems
to be a better predictor than caloric intake in the current investigation. This finding is consistent with previous researchers’ suggestion that physical activity may be a stronger determinant of weight regain than caloric intake (McGuire, Wing, Klem, Lang & Hill, 1999).

Simultaneous Examination of All Predictor Variables at Pre-treatment, Post-treatment, and Follow-up

Individual multiple regression analyses including all of the predictor variables were conducted at each of the three assessment points in order to explore which variables had the greatest impact on weight loss maintenance. While none of the overall models were significant, some variables within the models were significant at each time point. At pre-treatment, multiple regression analyses revealed that greater hunger and exercise self-efficacy (the two pre-treatment variables most strongly correlated with weight loss maintenance) were associated with superior absolute weight loss maintenance from pre-treatment to follow-up after controlling for the effects of binge eating and eating self-efficacy. At post-treatment, greater hunger and less binge eating were associated with superior weight loss maintenance from post-treatment to follow-up after statistically controlling for the other predictor variables in multiple regression analyses. Therefore, while weight loss maintenance was not associated with pre-treatment and post-treatment variables within the correlational analyses, several pre-treatment and post-treatment variables were significantly related to weight loss maintenance during multiple regression analyses. These findings may be secondary to the use of additional covariates in the regression analyses and the change in error variance associated with multiple predictors.

When multiple regression analyses were conducted with all of the follow-up variables, dietary restraint was the only variable significantly associated with weight loss maintenance within the models. The reason that it was the only follow-up variable significantly associated
with weight loss maintenance in the multiple regression analyses is likely because it had the strongest correlation with weight loss maintenance and was significantly correlated with nearly all of the follow-up variables.

Interestingly, some of the variables that were significantly associated with weight loss maintenance when examined with correlational analyses (e.g., calories expended at post-treatment and follow-up) and simpler multiple regression analyses (RMR at post-treatment and follow-up) were not significantly related to weight loss maintenance when examined in the overall regression analyses with all of the predictor variables. Again, these inconsistent findings may partially be due to having multiple predictor variables in the regression analyses and the correlations between the predictor variables. However, they also indicate that predicting weight loss maintenance is a complex endeavor. Future studies may be needed in order to clarify the uniqueness of different predictor variables and to determine what constructs are best related to weight loss outcomes.

*Relationship Between RMR and Psychological/Behavioral Variables*

While specific hypotheses were not made for the relationships between RMR and the various psychological variables assessed, the relationships were explored with the primary goal of identifying any variables that might be functioning as mediators between RMR and weight loss maintenance. None of the psychological variables were significantly associated with RMR after controlling for body size. However, there was a moderate correlation and a statistical trend in the expected direction between RMR and the tendency to attribute weight to medical factors at the follow-up assessment after controlling for body size. It seems plausible that people with a lower RMR may have learned that they are not as in control of their weight compared to people with a higher RMR and therefore, they may be more likely to attribute weight to medical factors.
It is also possible that people with a lower RMR truly experienced more gland or hormone conditions that would affect weight loss maintenance. In fact, in the current study, participants who indicated being on medication for a thyroid condition did have lower RMRs at follow-up, even after controlling for weight, compared to participants not on thyroid medication. However, participants with a thyroid condition did not endorse more of an external LOC compared to participants without a thyroid condition, and weight loss maintenance for participants with a thyroid condition did not differ from those without a thyroid condition in the current investigation.

**Limitations to Study**

There are several notable limitations to this study. First, the sample size was small and thus, the statistical power may be limited. Second, the results may not be generalizable to the population as a whole given that the sample consisted of all BWLP participants, more females than males, and was relatively homogeneous in regards to race. For example, the psychological and metabolic results may not be generalizable to all people attempting to maintain weight loss since it is likely a unique group of people who are qualified and elect to join a BWLP. Third, the reliability of self-reported caloric intake is questionable and may be influenced by factors such as body weight, depression, and social desirability (Herbert, Patterson, Gorfin, Ebbeling, Jeor, & Chlebowski, 2003; Johnson, Friedman, Harvey-Berino, Gold, & McKenzie, 2005; Kretsch, Fong, & Green, 1999). Additionally, the energy state (restrictive versus non-restrictive) of participants at post-treatment and follow-up is unknown. For example, it cannot be determined which participants were in a state of energy balance (i.e., caloric intake = caloric expenditure) and which participants were in a state of energy restriction (i.e., caloric intake < caloric expenditure) at the assessments.
Summary, Future Studies, and Conclusions

Despite the study’s limitations, it does contribute to the body of research that is attempting to identify factors related to weight loss maintenance. It is one of the first studies to find a significant association between RMR and weight loss maintenance in a sample of BWLP participants with varying degrees of obesity at pre-treatment and success with weight loss at post-treatment. Furthermore, this study is the first to examine the relationship between physiological (RMR) and psychological factors (e.g., WLOC) that may impact weight loss maintenance. Perhaps one of the reasons that research has not consistently identified factors associated with weight loss maintenance is because physiological variables, such as RMR, are not explored along with other variables. Future studies might benefit from continued examination of the interaction between physiological and psychological variables and weight loss maintenance.

Findings from the current investigation suggest the importance of communicating to BWLP participants (or perhaps anyone who wishes to sustain a reduced weight) the significance of maintaining RMR during and following weight loss. Maintaining FFM, with weight bearing physical activity, may be one way to reduce a decline in RMR since FFM and RMR are highly correlated. Education on the effects of caloric restriction on RMR may also be important. In addition, this study confirms the importance of physical activity and dietary control on weight maintenance, and thus, BWLP participants should continue to be informed of their extreme importance following weight loss.

Future research could examine the effects of informing BWLP participants of their RMRs. It may be beneficial to provide participants with this information since being able to accurately calculate caloric expenditure (at rest and from physical activity) and caloric intake are
key tools for weight loss and maintenance. Furthermore, participants’ mean RMR in this investigation was normal for their body size at follow-up. Correcting the misperception that their obesity is secondary to an abnormally low RMR may lead to greater internal LOC, more health promoting behaviors, and superior weight loss maintenance. However, even if some participants do have relatively low RMRs, they might benefit from knowing that a higher RMR was not associated with weight loss maintenance from pre-treatment to follow-up in this investigation. Nevertheless, participants with lower RMRs may need to exercise greater vigilance in their weight maintenance efforts (i.e., continue to engage in behaviors that lead to weight loss) following treatment since that was the time in which weight loss maintenance was influenced by RMR.

This study also demonstrates that the timing in the assessment of both the independent (RMR, psychological and behavioral variables) and dependent variables (weight loss maintenance) may significantly impact their relationship. Thus, it would be beneficial for future researchers to include multiple assessment points and clearly operationalize change variables, such as weight loss maintenance, so that it is obvious to other researchers at what point in time various factors’ associations with weight loss maintenance were examined and how maintenance was being defined.

Finally, the area of obesity research would continue to benefit from further exploration of factors that may be associated with weight loss outcomes and the mechanisms by which various factors may impact weight loss maintenance. Surprisingly, few studies examine whether or not self-reported physical activity and caloric intake are associated with weight loss maintenance even though the relationships are often assumed. Furthermore, there seems to be even less research exploring how psychological factors such as binge eating and self-efficacy affect weight
loss maintenance and whether or not these factors are unique constructs (i.e., different from one another and behavioral variables such as caloric intake and expenditure). While it is assumed that psychological factors exert their effects via behavior changes that influence energy intake and expenditure, the mechanisms have yet to be consistently documented. In addition, before the casual pathways could be identified, reliable and valid measurements for assessing energy intake and expenditure will be essential.

In summary, this investigation suggests an association between lower RMR assessed at some point following treatment and weight regain following a weight loss intervention. It also highlights the different findings that may result from defining weight loss maintenance in different ways, assessing RMR at different times, and statistically controlling for various covariates (e.g., FFF, FM, and caloric intake). For example, it seems that RMR assessed at some later point following treatment is a better predictor of weight loss maintenance than when assessed immediately following treatment, that RMR may predict weight loss maintenance from the end of treatment to a follow-up but not from the beginning of treatment to a follow-up, and that FM and caloric intake influence weight loss maintenance and RMR. Finally, this study confirms previous research that has documented the importance of continued dietary control and physical activity in order to maintain weight loss. While the long-term outcomes of weight loss interventions have been poor, better weight loss treatment outcomes may be possible if the view of obesity as a behavioral problem is replaced with a more holistic understanding of the interactions between behavioral, psychological, and physiological factors.
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Kayman, S., Bruvold, W., & Stern, J. S. (1990). Maintenance and relapse after weight loss in


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*Journal of the American Dietetic Association, 102*, 1252-1256.


Appendix A. Paffenbarger Physical Activity Questionnaire

*Please think of the past week when you answer these questions:*

1. How many city blocks or their equivalent do you normally walk each day? ____ blocks/day. (Let 12 blocks = 1 mile)

2. How many flights of stairs do you climb up each day? ___ flights per day (Let 1 flight = 10 steps)

3. List any sports or recreation you have actively participated in during the past week.

<table>
<thead>
<tr>
<th>Time/Episode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sport, Recreation, or Other Physical Activity</td>
</tr>
<tr>
<td>a.</td>
</tr>
<tr>
<td>b.</td>
</tr>
<tr>
<td>c.</td>
</tr>
<tr>
<td>d.</td>
</tr>
<tr>
<td>e.</td>
</tr>
<tr>
<td>f.</td>
</tr>
</tbody>
</table>
Appendix B. Three Factor Eating Questionnaire

Part I
Please circle “T” if the statement is mostly true for you or “F” if it is mostly false.

1. When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. T F
2. I usually eat too much at social occasions, like parties and picnics. T F
3. I am usually so hungry that I eat more than three times a day. T F
4. When I have eaten my quota of calories, I am usually good about not eating anymore. T F
5. Dieting is so hard for me because I just get too hungry. T F
6. I deliberately take small helpings as a means of controlling my weight. T F
7. Sometimes things just taste so good that I keep on eating when I am no longer hungry. T F
8. Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat. T F
9. When I feel anxious, I find myself eating. T F
10. Life is too short to worry about dieting. T F
11. Since my weight goes up and down, I have gone on reducing diets more than once. T F
12. I often feel so hungry that I just have to eat something. T F
13. When I am with someone who is overeating, I usually overeat too. T F
14. I have a pretty good idea of the number of calories in common food. T F
15. Sometimes when I start eating, I just can’t seem to stop. T F
16. It is not difficult for me to leave something on my plate. T F
17. At certain times of the day, I get hungry because I have gotten used to eating then. T F
18. While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. T F

19. Being with someone who is eating often makes me hungry enough to eat also. T F

20. When I feel blue, I often overeat. T F

21. I enjoy eating too much to spoil it by counting calories or watching my weight. T F

22. When I see a real delicacy, I often get so hungry that I have to eat right away. T F

23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat. T F

24. I get so hungry that my stomach often seems like a bottomless pit. T F

25. My weight has hardly changed at all in the last ten years. T F

26. I am always hungry so it is hard for me to stop eating before I finish the food on my plate. T F

27. When I feel lonely, I console myself by eating. T F

28. I consciously hold back at meals in order not to gain weight. T F

29. I sometimes get very hungry late in the evening or at night. T F

30. I eat anything I want, any time I want. T F

31. Without even thinking about it, I take a long time to eat. T F

32. I count calories as a conscious means of controlling my weight. T F

33. I do not eat some foods because they make me fat. T F

34. I am always hungry enough to eat at any time. T F

35. I pay a great deal of attention to changes in my figure. T F

36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. T F
Part II

Directions: Please answer the following questions by circling the number above the response that is appropriate to you.

37. How often are you dieting in a conscious effort to control your weight?
   1   2   3   4
   rarely   sometimes   usually   always

38. Would a weight fluctuation of 5 lbs. affect the way that you live your life?
   1   2   3   4
   not at all   slightly   moderately   very much

39. How often do you feel hungry?
   1   2   3   4
   only at meal times   sometimes between meals   often between meals   almost always

40. Do your feelings of guilt about overeating help you to control your food intake?
   1   2   3   4
   never   rarely   often   always

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?
   1   2   3   4
   easy   slightly difficult   moderately difficult   very difficult

42. How conscious are you of what you are eating?
   1   2   3   4
   not at all   slightly   moderately   extremely

43. How frequently do you avoid “stocking up” on tempting foods?
   1   2   3   4
   almost never   seldom   usually   almost always

44. How likely are you to shop for low calorie foods?
   1   2   3   4
   unlikely   slightly unlikely   moderately likely   very likely

45. Do you eat sensibly in front of others and splurge alone?
   1   2   3   4
   never   rarely   often   always

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?
   1   2   3   4
   unlikely   slightly likely   moderately likely   very likely
47. How frequently do you skip dessert because you are no longer hungry?
1 almost never 2 seldom 3 at least once a week 4 almost every day

48. How likely are you to consciously eat less than you want?
1 unlikely 2 slightly likely 3 moderately likely 4 very likely

49. Do you go on eating binges though you are not hungry?
1 never 2 rarely 3 sometimes 4 at least once a week

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, when ever you want it) and 5 means total restraint (constantly limiting your food intake and never ‘giving in’), what number would you give yourself?

0 eat whatever you want, whenever you want it

1 usually eat whatever you want, whenever you want it

2 often eat whatever you want, when ever you want it

3 often limit food intake, but often ‘give in’

4 usually limit food intake, rarely ‘give in’

5 constantly limiting food intake, never ‘giving in’

51. To what extent does this statement describe your eating behaviors? ‘I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow.’
1 not like me 2 little like me 3 pretty good 4 describes me

description of me perfectly
Appendix C. Binge Eating Scale

Please make a check mark in the box next to the one sentence that you feel best describes you.

#1
- I don’t feel self-conscious about my weight or body size when I’m with others.
- I feel concerned about how I look to others, but it normally doesn’t make me feel disappointed with myself.
- I do get self-conscious about my appearance and weight which makes me feel disappointed in myself.
- I feel very self-conscious about my weight and frequently, I feel intense shame and disgust for myself. I try to avoid social contacts because of my self-consciousness.

#2
- I don’t have any difficulty eating slowly in the proper manner.
- Although I seem to “gobble down” foods, I don’t end up feeling stuffed because of eating too much.
- At times, I tend to eat quickly and then, I feel uncomfortably full afterwards.
- I have the habit of bolting down my food, without really chewing it. When this happens, I usually feel uncomfortably stuffed because I’ve eaten too much.

#3
- I feel capable of controlling my eating urges when I want to.
- I feel like I have failed to control my eating more than the average person.
- I feel utterly helpless when it comes to feeling in control of my eating urges.
- Because I feel so helpless about controlling my eating, I have become very desperate about trying to get in control.

#4
- I don’t have the habit of eating when I’m bored.
- I sometimes eat when I’m bored, but often I’m able to become busy and get my mind off food.
- I have a regular habit of eating when I’m bored, but occasionally, I can use some other activity to get my mind off eating.
- I have a strong habit of eating when I’m bored. Nothing seems to help me break the habit.

#5
- I’m usually physically hungry when I eat something.
- Occasionally, I eat something on impulse even though I really am not hungry.
- I have the regular habit of eating foods, that I might not really enjoy, to satisfy a hungry feeling even though physically, I don’t need the food.
- Even though I’m not physically hungry, I get a hungry feeling in my mouth that only seems to be satisfied when I eat a food, like a sandwich, that fills my mouth. Sometimes, when I eat the food to satisfy my mouth hunger, then I spit the food out so I won’t gain weight.

#6
- I don’t feel any guilt or self-hate after I overeat.
- After I overeat, occasionally I feel guilt or self-hate.
- Almost all the time I experience strong guilt or self-hate after I overeat.

#7
- I don’t lose total control of my eating when dieting even after periods when I overeat.
- Sometimes when I eat a “forbidden food” on a diet, I feel like “I blew it” and eat even more.
- Frequently, I have the habit of saying to myself, “I’ve blown it anyway, why not go all the way” when I overeat on a diet.
| #8 | I rarely eat so much food that I feel uncomfortably stuffed afterwards.  
    | Usually about once a month, I eat such a quantity of food, I end up feeling very stuffed.  
    | I have regular periods during the month when I eat large amounts of food, either at meal times or at snacks.  
    | I eat so much food that I regularly feel quite uncomfortable after eating and sometimes a bit nauseous.  |
| #9 | I usually am able to stop eating when I want to. I know when “enough is enough.”  
    | Every so often, I experience a compulsion to eat which I can’t seem to control.  
    | Frequently, I experience strong urges to eat which I seem unable to control, but at other times I can control my eating urges.  
    | I feel incapable of controlling urges to eat. I have a fear of not being able to stop eating voluntarily.  |
| #10 | I don’t have any problem stopping eating when I feel full.  
     | I usually can stop eating when I feel full but occasionally overeat leaving me feeling uncomfortably stuffed.  
     | I have a problem stopping eating once I start and I usually feel uncomfortably stuffed after I eat a meal.  
     | Because I have a problem not being able to stop eating when I want, I sometimes have to induce vomiting to relieve my stuffed feeling.  |
| #11 | I seem to eat just as much when I’m with others (family, social gatherings) as when I’m by myself.  
     | Sometimes, when I’m with other persons, I don’t eat as much as I want to eat because I’m self-conscious about my eating.  
     | Frequently, I eat only a small amount of food when others are present, because I’m very embarrassed about my eating.  
     | I feel so ashamed about overeating that I pick times when I know no one will see me. I feel like “closet eating.”  |
| #12 | I eat three meals a day with only an occasional between-meal snack.  
     | I eat three meals a day but I also normally snack between meals.  
     | When I am snacking heavily, I get in the habit of skipping regular meals.  
     | There are regular periods when I seem to be continually eating, with no planned meals.  |
| #13 | I don’t think much about trying to control unwanted eating urges.  
     | At least some of the time, I feel my thoughts are pre-occupied with trying to control my eating urges.  
     | I feel that frequently I spend much time thinking about how much I ate or about trying not to eat anymore.  
     | It seems to me that most of my waking hours, I am pre-occupied with thoughts about eating or not eating. I feel like I’m constantly struggling not to eat.  |
| #14 | I don’t think about food a great deal.  
     | I have strong cravings for food but they last only for brief periods of time.  
     | I have days when I can’t seem to think about anything else but food.  
     | Most of my days seem to be pre-occupied with thoughts about food. I feel like I live to eat.  |
| #15 | I usually know whether or not I’m physically hungry. I take the right portion of food to satisfy me.  
     | Occasionally, I feel uncertain about knowing whether or not I’m physically hungry. At these times it’s hard to know how much food I should take to satisfy me.  
     | Even though I might know how many calories I eat, I don’t have any idea what is a “normal” amount of food for me.  |
| #16 | My level of calorie intake does not go up very high or go down very low on a regular basis.  
     | Sometimes after I overeat, I will try to reduce my caloric intake to almost nothing to compensate for the excess
calories I have eaten.

I have a regular habit of overeating during the night. It seems that my routine is not to be hungry in the morning but overeat in the evening.

In my adult years, I have had week-long periods where I practically starve myself. This follows periods when I overeat. It seems I live a life of either “feast or famine.”
Appendix D. Weight Locus of Control Scale

Please respond to the items using the following scale

1  2  3  4  5  6
Strongly Disagree Strongly Agree

1. _____ Whether I gain, lose, or maintain my weight is entirely up to me.

2. _____ Being the right weight is largely a matter of good fortune.

3. _____ No matter what I intend to do, if I gain or lose weight, or stay the same in the near future, it is just going to happen.

4. _____ If I eat properly, and get enough exercise and rest, I can control my weight in the way I desire.
Appendix E. Beliefs about the Causes of Weight

Please rate the degree to which you believe the stated reasons contribute to YOUR weight using the following scale.

Not at all responsible for my weight  Moderately responsible for my weight  Totally responsible for my weight
1  2  3  4  5  6  7

1. ____Eating habits
2. ____Genetics
3. ____Hormone or gland condition
4. ____Slow metabolism
5. ____Physical activity or exercise habits
6. ____Psychological factors
7. ____Family history of obesity
8. ____Environmental factors (fast food, snack machines, large servings of food, etc.)
9. ____Other: ___________________________________________________________________
10. ____Other: ___________________________________________________________________
Appendix F. Exercise Self-Efficacy Scale

Instructions: Please indicate how certain you are you can exercise under each of the following conditions.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
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<tr>
<td></td>
<td>Cannot</td>
<td>I can do</td>
<td>I can do</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I can exercise……

1. ____ When I am feeling tired
2. ____ When I am feeling under pressure for work
3. ____ During bad weather
4. ____ After recovering from an injury that caused me to stop exercising
5. ____ During or after experiencing personal problems
6. ____ When I am feeling depressed
7. ____ When I am feeling anxious
8. ____ After recovering from an illness that cause me to stop exercising
9. ____ When I feel physical discomfort when I exercise
10. ____ After a vacation
11. ____ When I have too much work to do at home
12. ____ When visitors are present
13. ____ When there are other interesting things to do
14. ____ If I don’t reach my exercise goals
15. ____ Without support from my family or friends
16. ____ During a vacation
17. ____ When I have other time commitments
18. ____ After experiencing family problems
Appendix G. Eating Self-Efficacy Scale

For numbers 1-25 you should rate the likelihood that you would have difficulty controlling your overeating in each of the situations listed, using this scale:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>No difficulty controlling eating</td>
<td>Moderate difficulty controlling eating</td>
<td>Most difficulty controlling eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How difficult is it to control your……..

1. ____ Overeating after work or school
2. ____ Overeating when you feel restless
3. ____ Overeating around holiday time
4. ____ Overeating when you feel upset
5. ____ Overeating when tense
6. ____ Overeating with friends
7. ____ Overeating when preparing food
8. ____ Overeating when irritable
9. ____ Overeating as part of a social occasion dealing with food--- like at a restaurant or dinner party
10. ____ Overeating with family members
11. ____ Overeating when annoyed
12. ____ Overeating when angry
13. ____ Overeating when you are angry at yourself
14. ____ Overeating when depressed
15. ____ Overeating when you feel impatient
16. ____ Overeating when you want to sit back and enjoy some food
17. ____ Overeating after an argument
18. ____ Overeating when you feel frustrated
19. ____ Overeating when tempting food is in front of you
20. ____ Overeating when you want to cheer up
21. ____ Overeating when there is a lot of food available to you (refrigerator is full)
22. ____ Overeating when you feel overly sensitive
23. ____ Overeating when nervous
24. ____ Overeating when hungry
25. ____ Overeating when anxious or worried
Table 1

*Demographic Characteristics*

<table>
<thead>
<tr>
<th>Demographics</th>
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<tr>
<td>Race (Caucasian)</td>
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<td>Income &lt; $30,000</td>
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<td>College degree</td>
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<td>Married</td>
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<table>
<thead>
<tr>
<th>M</th>
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<tbody>
<tr>
<td>Age</td>
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*N = 40*
Table 2

Scores of Physiological, Psychological, and Behavioral Variables Across Time

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<th>Post-treatment</th>
<th>Follow-up</th>
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<tr>
<td></td>
<td>Treatment Stage</td>
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</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Range</td>
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<tr>
<td>Body Size Indices</td>
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<td>163.4-369.2</td>
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<td>Psych Variables</td>
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### Treatment Stage

<table>
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</table>

Note: FFM = Fat Free Mass, FM = Fat Mass, RMR = Resting Metabolic Rate, Disinhib. = TFEQ Dietary Disinhibition, BES = Binge Eating Scale, Hunger = TFEQ Hunger, Restraint = TFEQ Cognitive Dietary Restraint, WLOC = Weight Locus of Control, Attribut. = Attributing Weight to Medical Factors, ESES = Eating Self-Efficacy, ESS = Exercise Self-Efficacy, Cals fat (%) = percentage of consumed calories from fat, Cals expended = calories expended via physical activity in a week as assessed by the Paffenbarger Physical Activity Questionnaire.
Table 3

**Correlations Between Predictor Variables and Multiple Indices of Weight Loss Maintenance**

<table>
<thead>
<tr>
<th></th>
<th>WLM1</th>
<th>WLM2</th>
<th>WLM3</th>
<th>WLM4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Follow-up</td>
<td>Pre</td>
</tr>
<tr>
<td><strong>Body Size Indices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (lb)</td>
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<td>-.41**</td>
<td>-.47**</td>
<td>-.27</td>
</tr>
<tr>
<td>FFM (lb)</td>
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<td>-.06</td>
<td>-.07</td>
<td>-.09</td>
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<tr>
<td>FM (lb)</td>
<td>-.29</td>
<td>-.52**</td>
<td>-.55**</td>
<td>-.31*</td>
</tr>
<tr>
<td><strong>Psych Variables</strong></td>
<td></td>
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<tr>
<td>Disinhib.</td>
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<td>-.15</td>
<td>-.02</td>
<td>-.14</td>
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<td>BES</td>
<td>.03</td>
<td>-.02</td>
<td>-.28*</td>
<td>.01</td>
</tr>
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<td>Hunger</td>
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<td>.09</td>
<td>.07</td>
<td>.24</td>
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<td>Restraint</td>
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<td>.21</td>
<td>.39**</td>
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<td>WLOC</td>
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<td>-.35*</td>
<td>-.24</td>
<td>-.34*</td>
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<td>Attribut.</td>
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<td>.15</td>
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<td>.11</td>
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<td>Behavior Variables</td>
<td>Pre</td>
<td>Post</td>
<td>Follow-up</td>
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<td>--------------------</td>
<td>-----</td>
<td>------</td>
<td>-----------</td>
<td>-----</td>
</tr>
<tr>
<td>Cals consumed (kcal/day)</td>
<td>.05</td>
<td>.13</td>
<td>-.02</td>
<td>.03</td>
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<tr>
<td>Cals fat (%)</td>
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<td>.06</td>
<td>-.26</td>
<td>.08</td>
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<tr>
<td>Cals expended</td>
<td>.24</td>
<td>.41**</td>
<td>.22</td>
<td>.41**</td>
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</table>

Notes: (1) Restraint = WLM1 = PRE-MAINTENANCE, WLM2 = PRE-MAINTENANCE %, WLM3 = POST-MAINTENANCE, WLM4 = POST-MAINTENANCE %; FFM = Fat Free Mass, FM = Fat Mass, Disinhib. = TFEQ Dietary Disinhibition, BES = Binge Eating Scale, Hunger = TFEQ Hunger, Restraint = TFEQ Cognitive Dietary Restraint, WLOC = Weight Locus of Control, Attribut. = Attributing Weight to Medical Factors, ESES = Eating Self-Efficacy, ESS = Exercise Self-Efficacy, Cals fat (%) = percentage of calories consumed from fat, Cals expended = calories expended via physical activity in a week as assessed by the Paffenbarger Physical Activity Questionnaire, (2) A blank space indicates that the variable was not predicted to be associated with weight loss maintenance.

* = p < .05 one tailed test of significance

** = p < .01 one tailed test of significance
Table 4

*Correlations Between RMR and Indices of Body Size at Post-treatment and Follow-up*

<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
<th>FFM</th>
<th>FM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post RMR</strong></td>
<td>.60**</td>
<td>.69**</td>
<td>.36*</td>
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<tr>
<td><strong>Follow RMR</strong></td>
<td>.77**</td>
<td>.74**</td>
<td>.61**</td>
</tr>
</tbody>
</table>

Note. RRM = Resting Metabolic Rate, FFM = Fat Free Mass, FM = Fat Mass

* = $p < .05$ two tailed test of significance
** = $p < .01$ two tailed test of significance
Table 5

*Simultaneous Regression Analyses for RMR and Covariates Predicting Multiple Indices of Weight Loss Maintenance*

<table>
<thead>
<tr>
<th>Variable/s (N)</th>
<th>WLM1</th>
<th>WLM2</th>
<th>WLM3</th>
<th>WLM4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>$R^2$ (F)</td>
<td>B</td>
<td>$R^2$ (F)</td>
</tr>
<tr>
<td>Post RMR N=35</td>
<td>-0.16</td>
<td>-0.00 (0.91)</td>
<td>-0.22</td>
<td>0.02 (1.79)</td>
</tr>
<tr>
<td>Post RMR</td>
<td>0.32 (6.41**)</td>
<td>0.29 (5.67**)</td>
<td>0.03 (1.36)</td>
<td>-0.03 (0.66)</td>
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<tr>
<td>Post FFM</td>
<td>-0.15</td>
<td>-0.15</td>
<td>0.35</td>
<td>0.24</td>
</tr>
<tr>
<td>Post FM</td>
<td>0.31</td>
<td>0.21</td>
<td>-0.10</td>
<td>-0.07</td>
</tr>
<tr>
<td>N=35</td>
<td>-0.63**</td>
<td>-0.59**</td>
<td>-0.28</td>
<td>-0.21</td>
</tr>
<tr>
<td>Post RMR</td>
<td>0.30 (4.72**)</td>
<td>0.29 (4.20**)</td>
<td>0.02 (1.15)</td>
<td>-0.06 (0.55)</td>
</tr>
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<td>Post Calories</td>
<td>-0.12</td>
<td>-0.13</td>
<td>0.30</td>
<td>0.21</td>
</tr>
<tr>
<td>Post FFM</td>
<td>-0.07</td>
<td>-0.09</td>
<td>0.17</td>
<td>0.11</td>
</tr>
<tr>
<td>Post FM</td>
<td>0.34</td>
<td>0.24</td>
<td>-0.17</td>
<td>-0.12</td>
</tr>
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<td>N=35</td>
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<td>-0.62**</td>
<td>-0.22</td>
<td>-0.17</td>
</tr>
<tr>
<td>Variable/s (N)</td>
<td><strong>WLM1</strong></td>
<td></td>
<td><strong>WLM2</strong></td>
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<tr>
<td>---------------</td>
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<td>------------------</td>
<td>----------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>$R^2$ (F)</td>
<td>B</td>
<td>$R^2$ (F)</td>
</tr>
<tr>
<td>Follow-up RMR</td>
<td>-0.30</td>
<td>0.07 (3.68 T)</td>
<td>-0.37</td>
<td>0.12 (5.95*)</td>
</tr>
<tr>
<td>N = 38</td>
<td>0.27</td>
<td>0.28 (5.81**)</td>
<td>0.37</td>
<td>0.07 (1.99)</td>
</tr>
<tr>
<td>Follow-up RMR</td>
<td>-0.20</td>
<td>-0.22</td>
<td>0.37</td>
<td>-0.16</td>
</tr>
<tr>
<td>Follow-up FFM</td>
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<td>0.15</td>
<td>-0.16</td>
<td>-0.37</td>
</tr>
<tr>
<td>Follow-up FM</td>
<td>-0.52**</td>
<td>-0.49**</td>
<td>-0.46*</td>
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<tr>
<td>N = 38</td>
<td>0.28</td>
<td>0.29 (4.39**)</td>
<td>0.16</td>
<td>0.06 (1.51)</td>
</tr>
<tr>
<td>Follow-up RMR</td>
<td>-0.24</td>
<td>-0.26</td>
<td>0.49*</td>
<td>0.42 T</td>
</tr>
<tr>
<td>Follow-up Calories</td>
<td>0.31 T</td>
<td>0.25</td>
<td>-0.06</td>
<td></td>
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<tr>
<td>Follow-up FFM</td>
<td>0.08</td>
<td>0.01</td>
<td>-0.19</td>
<td></td>
</tr>
<tr>
<td>Follow-up FM</td>
<td>-0.48*</td>
<td>-0.46*</td>
<td>-0.62**</td>
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</tr>
<tr>
<td>N = 34</td>
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<tr>
<td>Variable/s (N)</td>
<td>WLM1</td>
<td>WLM2</td>
<td>WLM3</td>
<td>WLM4</td>
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<tr>
<td>---------------</td>
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<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>$B$</td>
<td>$R^2 (F)$</td>
<td>$B$</td>
<td>$R^2 (F)$</td>
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<tr>
<td>Change RMR</td>
<td>0.18</td>
<td>0.00 (1.04)</td>
<td>0.19</td>
<td>0.01 (1.21)</td>
</tr>
<tr>
<td>$N = 34$</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Change RMR</td>
<td>0.30</td>
<td>(5.75**)</td>
<td>0.26</td>
<td>(5.06**)</td>
</tr>
<tr>
<td>Post FFM</td>
<td>0.09</td>
<td></td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Post FM</td>
<td>-0.62</td>
<td>**</td>
<td>-0.58</td>
<td>**</td>
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<tr>
<td>$N = 34$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Change RMR</td>
<td>0.22</td>
<td>(3.06*)</td>
<td>0.19</td>
<td>(2.79*)</td>
</tr>
<tr>
<td>Change Calories</td>
<td>-0.19</td>
<td></td>
<td>-0.16</td>
<td></td>
</tr>
<tr>
<td>Post FFM</td>
<td>0.18</td>
<td></td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Post FM</td>
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<td>*</td>
<td>-0.51</td>
<td>*</td>
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<tr>
<td>$N = 30$</td>
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</table>

Note: $R^2 = $ Adjusted R squared; $B = $ Standardized beta; WLM1 = PRE-MAINTENANCE, WLM2 = PRE-MAINTENANCE %, WLM3 = POST-MAINTENANCE, WLM4 = POST-MAINTENANCE %; RMR = Resting Metabolic Rate, FFM = Fat Free Mass, FM = Fat Mass; Change = change in respective variables from post-treatment to follow-up.

** = $p < .01$

* = $p < .05$

T = $p < .10$
Table 6

*Significant Associations Between Weight Loss Maintenance and RMR at Different Times after Controlling for Body Size and Caloric Intake*

<table>
<thead>
<tr>
<th>Timing of assessment and covariates</th>
<th>Definition of Weight Loss Maintenance</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>WLM1</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>Post-treatment</strong></td>
<td></td>
</tr>
<tr>
<td>RMR-no covariates</td>
<td></td>
</tr>
<tr>
<td>FFM &amp; FM</td>
<td></td>
</tr>
<tr>
<td>Caloric intake, FFM &amp; FM</td>
<td></td>
</tr>
<tr>
<td><strong>Follow-up</strong></td>
<td></td>
</tr>
<tr>
<td>RMR-no covariates</td>
<td></td>
</tr>
<tr>
<td>FFM &amp; FM</td>
<td>T_+</td>
</tr>
<tr>
<td>Caloric intake, FFM &amp; FM</td>
<td></td>
</tr>
<tr>
<td><strong>Change post-treatment to follow-up</strong></td>
<td></td>
</tr>
<tr>
<td>Change RMR-no covariates</td>
<td></td>
</tr>
<tr>
<td>Post FFM &amp; FM</td>
<td></td>
</tr>
<tr>
<td>Change caloric intake, Post FFM, &amp; FM</td>
<td></td>
</tr>
</tbody>
</table>

Note: WLM1 = PRE-MAINTENANCE, WLM2 = PRE-MAINTENANCE %, WLM3 = POST-MAINTENANCE, WLM4 = POST-MAINTENANCE %; RMR = Resting Metabolic Rate, FFM = Fat Free Mass, FM = Fat Mass; Change = change in variables from post-treatment to follow-up

+ = positive association between RMR and weight loss maintenance
- = negative association between RMR and weight loss maintenance
* = $p < .05$
\( \text{\^{T}} = p < .10 \)
Table 7

*Correlations Between Change Variables and Weight Loss Maintenance*

<table>
<thead>
<tr>
<th></th>
<th>WLM1</th>
<th>WLM2</th>
<th>WLM3</th>
<th>WLM4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restraint pre-to-post</td>
<td>.35*</td>
<td>.38*</td>
<td>-.01</td>
<td>.01</td>
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<tr>
<td>ESES post-to-follow up</td>
<td>.03</td>
<td>.04</td>
<td>.20</td>
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</tr>
<tr>
<td>ESS post-to-follow up</td>
<td>.06</td>
<td>.04</td>
<td>-.25</td>
<td>-.28*</td>
</tr>
</tbody>
</table>

Note: WLM1 = PRE-MAINTENANCE, WLM2 = PRE-MAINTENANCE %, WLM3 = POST-MAINTENANCE, WLM4 = POST-MAINTENANCE %; Restraint = TFEQ Cognitive Dietary Restraint, ESES = Eating Self-Efficacy, ESS = Exercise Self-Efficacy

* = p < .05 one tailed test of significance
Table 8

**Correlations Between Psychological and Behavioral Variables at Pre-Treatment, Post-Treatment and Follow-up**

<table>
<thead>
<tr>
<th></th>
<th>Restraint</th>
<th>Disinhib.</th>
<th>Hunger</th>
<th>BES</th>
<th>ESES</th>
<th>ESS</th>
<th>WLOC</th>
<th>Attribut.</th>
<th>Cals expended</th>
<th>Cals consumed (kcal/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Restraint</strong></td>
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<td></td>
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<td>-.21</td>
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<td>-</td>
<td>-.19</td>
<td>-.14</td>
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<tr>
<td>Post</td>
<td>-.55**</td>
<td>-.72**</td>
<td>-.50**</td>
<td>-.65**</td>
<td>.41*</td>
<td>-.49**</td>
<td>.00</td>
<td>.12</td>
<td>-.19</td>
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<td>Follow-up</td>
<td>-.47**</td>
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<td>-.52**</td>
<td>-.44**</td>
<td>.39*</td>
<td>-.42**</td>
<td>-.19</td>
<td>.40*</td>
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<td><strong>Disinhib.</strong></td>
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</tr>
<tr>
<td>Pre</td>
<td>.31*</td>
<td>.46**</td>
<td>.73**</td>
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<td>-</td>
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<td>Post</td>
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<td>.72**</td>
<td>.73**</td>
<td>-.32*</td>
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</tr>
<tr>
<td>Pre</td>
<td>.34*</td>
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<tr>
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<td>.68**</td>
<td>-.38*</td>
<td>-.10</td>
<td>.29</td>
<td>-.18</td>
<td>.41*</td>
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<td>Pre</td>
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<td>-.44**</td>
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<tr>
<td>Follow-up</td>
<td>.72**</td>
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<td>.15</td>
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<td>-.21</td>
<td>.40*</td>
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<tr>
<td>Pre</td>
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<td>.04</td>
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<td>.04</td>
<td>.39*</td>
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<td>Follow-up</td>
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<td>.08</td>
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<td>Post</td>
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Note: Restraint = TFEQ Dietary Restraint, Disinhib. = TFEQ Dietary Disinhibition, Hunger = TFEQ Hunger, BES = Binge Eating Scale, ESES = Eating Self-Efficacy, ESS = Exercise Self-Efficacy, WLOC = Weight Locus of Control, Attribut. = Attributing Weight to Medical Factors, Cals expended = weekly calories expended via physical activity (Paffenbarger Physical Activity Questionnaire)

* = $p < .05$ two tailed test of significance
** = $p < .01$ two tailed tests of significance
Table 9

Correlations Between RMR and Psychological and Behavioral Variables at Post-Treatment and Follow-up

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<td>Cals expended</td>
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Note: RMR = Resting Metabolic Rate, FFM = Fat Free Mass, Disinhib. = TFEQ Dietary Disinhibition, BES = Binge Eating Scale, Hunger = TFEQ Hunger, Restraint = TFEQ Cognitive Dietary Restraint, WLOC = Weight Locus of Control, Attribut. = Attributing Weight to Medical Factors, ESES = Eating Self-Efficacy, ESS = Exercise Self-Efficacy, Cals fat (%) = percentage of consumed calories from fat, Cals expended = calories expended via physical activity in a week as assessed by the Paffenbarger Physical Activity Questionnaire

T = p < .10 two tailed test of significance

** = p < .01 two tailed test of significance