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Contribution of Behavior Intervention Components to 24-Month Weight Loss

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Abstract

Sustaining weight loss long-term is difficult.

Purpose—To examine if eating behaviors, physical activity levels, and program participation influence ones ability to achieve $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss over a period of 24 months.

Methods—Data from 170 overweight and obese women ($BMI = 32.7 \pm 4.2 \text{ kg/m}^2$) were analyzed in this study. All women followed a standard 24-month behavioral weight loss program in which they were instructed to decrease caloric intake and increase physical activity levels. Eating behaviors, body weight, and physical activity levels were assessed at baseline, 6 and 24 months. Program participation was evaluated by the percentage of group meetings attended and the percentage of telephone calls completed with an interventionist. Three separate step-wise linear regression analyses were performed to identify variables that were predictive of $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss at 24 months.

Results—The percentage of telephone calls completed and change in weight loss eating behaviors predicted $\geq 5\%$ ($r^2 = 0.16$), $\geq 7\%$ ($r^2 = 0.14$), and $\geq 10\%$ weight loss ($r^2 = 0.10$) at 24 months. However, the change in physical activity levels from baseline to 24 months was only predictive of weight losses $\geq 10\%$ ($r^2 = 0.11$).

Conclusion—Behavioral factors, such as adopting healthy eating behaviors and telephone contact time, are important components that assist individuals in achieving weight losses $\geq 5\%$. However, high levels of physical activity play a more prominent role in sustaining weight losses of $\geq 10\%$. Therefore, innovative strategies to enhance long-term exercise adherence should be developed.

Keywords

Weight reduction; physical activity; eating behaviors; body weight; obesity

INTRODUCTION

Obesity is a health problem that plagues millions of Americans, with over 65% of adults in the United States classified as overweight ($BMI \geq 25.0 \text{ kg/m}^2$) and over 30% classified as obese ($BMI \geq 30 \text{ kg/m}^2$) (3). Despite short-term success of initiatives to reduce body weight (8,10,23), the maintenance of weight loss is more difficult to achieve (24,29). Wing and

Phelan estimated that 20% of individuals who attempt weight loss successfully maintain a significant weight loss using the criteria of a weight loss $\geq 10\%$ of initial body weight that was maintained for ≥ 1 year (28). To improve the prevalence of successful weight loss it is important to identify specific behaviors that are associated with weight loss maintenance.

Behavioral weight loss programs have previously been shown to be successful in reducing body weight among overweight and obese individuals (1,8,10). On average, participants of such programs lose approximately 10% of their initial body weight within the initial 6 months of a behavioral intervention (22). However, weight regain of approximately 33% of initial weight loss typically takes place within the subsequent 12 months (22). These data suggest that despite initial success of behavioral weight loss interventions, weight regain is common and there is a need to better understand factors that contribute to successful long-term weight loss maintenance.

Jakicic et al. (8) have concluded that there is a constellation of behaviors that contribute to long-term weight loss, which include changes in diet, physical activity, and ongoing contact with weight loss specialists. Data from the National Weight Control Registry (NWCR), which is a registry of individuals who have maintained a weight loss of at least 30 pounds for at least one-year, indicates that individuals who have been successful in long-term weight maintenance consume diets low in fat, have high physical activity levels, and they frequently monitor their food intake and body weight (26). Randomized controlled trials have reported significant correlations between long-term weight control and high levels of physical activity (12,24) and low dietary fat intake (12). However, it is unknown if these variables differentially impact the ability for one to achieve different levels of long-term weight loss.

Clinically significant weight loss is defined using different criteria, with the magnitude of weight loss needed to significantly improve long-term health defined as $\geq 5\%$ (5,21), $\geq 7\%$ (6,25) or $\geq 10\%$ (7,14,26) of initial body weight. Therefore, the aim of this paper is to determine whether eating behaviors, physical activity patterns, or program participation differentially impact 24-month weight loss when different weight loss criteria are applied to the data.

METHODS

Study Design

This study involves secondary analysis of data collected as part of a 24-month weight loss intervention study. Primary outcomes from this study have previously been published (8,9). All subjects participated in a 24-month weight loss study that included both a reduction in energy intake via dietary modification and an increase in physical activity, with randomization based on the dose and intensity of the physical activity prescription. These intervention components are described in detail below. For the purpose of this study, the data collected at the 0, 6, and 24-month assessment periods were used for analysis, with intervention contact across the 24-month period also considered in the analysis. The assessments components are described in detail below.

Subjects

As previously reported, 201 overweight and obese women were randomized to participate in this 24-month behavioral weight loss program. Subjects ranged from 21–45 years of age, had a BMI between 27 and 41 kg/m², and reported having been sedentary prior to the start of the study defined as exercising less than 20 min/day, 3 days/week over the previous six months. Exclusionary criteria included the following: 1) a history of significant heart disease (i.e., myocardial infarction, 2) taking medications that could alter heart rate during exercise

(i.e., beta blockers) or medications that may affect metabolism (i.e., Synthroid), 3) current treatment for any psychological disorder (i.e., depression), 4) having any other medical condition that may affect metabolism (i.e., diabetes), 5) having a medical condition that would prohibit participation in the dietary or physical activity components of the intervention. Furthermore, females who were currently pregnant, had been pregnant in the past 6 months, and those who were planning on becoming pregnant during the study period were excluded from this study.

Prior to study participation, subjects provided written consent, completed a medical history and physical activity readiness questionnaire, and provided written medical clearance from their physician. All procedures for this study were approved by the Institutional Review Board of the Miriam Hospital (Providence, RI) and the University of Pittsburgh (Pittsburgh, PA).

Intervention

Intervention Contact—Subjects participated in a 24-month behavioral weight loss program, which included both a dietary and exercise component. The details of this intervention have been previously published (8,9) and are briefly described below. During the initial 6 months, participants attended weekly group intervention meetings that focused on specific behavioral strategies to adopt and maintain the recommended eating and physical activity components. From months 7 to 12 participants were to attend bi-weekly meetings, with the frequency of these meetings reduced to monthly during months 13 to 18, and these meetings no longer offered during months 19 to 24.

The group intervention meetings were complimented with brief individualized telephone contacts between months 7 to 24. The frequency of these telephone contacts was bi-weekly during months 7–12, monthly during months 13 to 18, and bi-weekly during months 19 to 24. Phone calls were scheduled for a period of up to 10 minutes; however, the weight loss counselor could extend the call beyond the 10 minute period if deemed necessary. All calls followed a structured script, and calls were prescheduled to facilitate the ability of the subject to participate in this call.

Dietary Intervention—Subjects were instructed to reduce caloric intake to 1200 or 1500 kcal/d based on baseline body weight. In addition, subjects were instructed to reduce dietary fat to 20% to 30% of their daily energy intake. Subjects were provided with structured meal plans and recipes to facilitate compliance with these dietary recommendations. Subjects were instructed to monitor and record their dietary intake in a weekly diary that was reviewed by an interventionist and returned to the participant with written feedback.

Exercise Intervention—As previously described (8) subjects were randomized into one of four exercise groups that differed according to exercise intensity (moderate vs. vigorous) and weekly energy expenditure (1000 kcal/wk vs. 2000 kcal/wk). Thus, randomization was to 1) vigorous intensity and high volume (2000 kcal/wk), 2) moderate intensity and high volume (2000 kcal/wk), 3) moderate intensity and moderate volume (1000 kcal/wk), or 4) vigorous intensity and moderate volume (1000 kcal/wk). Moderate intensity was prescribed as 50–65% of age-predicted maximal heart rate or a perceived exertion rating (RPE) of 10–12 on the Borg 15-category scale, with vigorous intensity prescribed as 70–85% of age-predicted maximal heart rate or a RPE of 13–15 on the Borg 15-category scale. Exercise was prescribed at 5 d/wk with walking or other structured activities similar to brisk walking encouraged as the primary mode of exercise. The exercise progression to the prescribed levels of exercise has previously been reported (8). Subjects were instructed to record their

daily exercise mode, duration, and intensity in a weekly diary that was reviewed by an interventionist and returned the subject with written feedback.

Assessments

For the purpose of this study, the assessment data collected at 0, 6, and 24 months for body weight, body mass index (BMI), physical activity, and eating behaviors were used for analysis. The specific methods of assessment for each of these outcomes are described below.

Body Weight, Height, and BMI—Body weight was measured to the nearest 0.25 pounds using a calibrated balance beam scale with subjects wearing a lightweight hospital gown. Height was assessed using a wall-mounted stadiometer and was measured to the nearest 0.1 cm. Body mass index was calculated using measured weight and height and expressed as kg/m².

Physical Activity Levels—Physical activity was assessed using the questionnaire proposed by Paffenbarger et al (17). This questionnaire was modified to examine only purposeful physical activity and queried subjects about the amount of walking as well as any participation in sports, fitness, or recreational activities performed over the previous week for the purpose of exercise. Questions included: 1) How many city blocks or their equivalent you walked on average each day in this past week? Only include walking done outdoors and walking done indoors for the sole purpose of exercise, but do not include walking done around the house or at work, and 2) Were there any sports, fitness, or recreational activities in which you participated during the past week? Physical activity was expressed as minutes per week (min/wk) and kcal/wk of moderate-to-vigorous intensity physical activity as previously described (9).

Eating Behaviors—The Eating Behavior Inventory Questionnaire (EBI) (15) was used to assess changes in eating behaviors as a result of the intervention program. This 26-item questionnaire asks individuals to rate both positive and negative weight management eating behaviors on a 5-point scale that ranges from “never or hardly ever” to “always or almost always.” Examples of the types of statements include the following: “I shop from a list”, “I leave food on my plate”, “I eat when I am really not hungry”, or “I keep a graph of my weight.” Negative statements are reverse scored thus a higher score is indicative of more behaviors that are favorable to weight loss. Both individual questions and the questionnaire as a whole were previously reported as being valid and test-retest reliability has proven to be satisfactory (15). Furthermore, the EBI Questionnaire has consistently been shown to be sensitive to behaviorally based weight loss interventions (16).

Energy Intake and Macronutrient Composition—Energy intake and macronutrient composition was assessed using the 1998 version of the Block Food Frequency Questionnaire (2). Energy intake was reported as kcal/d with macronutrient composition for carbohydrates, proteins, and fats calculated and expressed as grams per day (gm/d) and as a percentage of total daily energy intake.

Statistical Analysis

A total of 201 subjects were enrolled in this study. Of those subjects, only those with complete data at baseline, 6, and 24 months for each variable examined were included in the secondary analysis. Thus, 170 subjects provided valid weight data at 0, 6 and 24 months and were considered for the analyses present. However, specific analyses for physical activity, dietary intake, and eating behaviors varied slightly from this N=170 due to incomplete data for some of these measures.

Intervention groups were collapsed and subjects were grouped into one of four groups according to their weight loss achieved at 6 and 24 months. Separate categories were established using $\geq 5\%$ (5,21), $\geq 7\%$ (6,25), or $\geq 10\%$ (7,14,26) as the criterion weight loss. Thus, the following categories were established for each criterion weight loss: 1) MAINTAIN (\geq criterion weight loss at both 6 and 24 months), 2) NON-MAINTAIN (\geq criterion weight loss at 6 months but $<$ criterion weight loss at 24 months), 3) NON-ADOPT ($<$ criterion weight loss at both 6 and 24 months), and 4) LATE-ADOPT ($<$ criterion weight loss at 6 months but \geq criterion weight loss at 24 months).

A series of two-factor (time X group) repeated measures analysis of variance (ANOVA) were performed to assess for potential differences between the defined groups (MAINTAIN, NON-MAINTAIN, NON-ADOPT) based on achievement of the predefined weight loss criteria ($\geq 5\%$, $\geq 7\%$, $\geq 10\%$) over time for physical activity, eating behavior, and dietary intake. Separate one-way ANOVAs were also performed to examine whether attendance at group intervention sessions and completion of telephone intervention calls were different among groups. Due to the limited number of subjects in the LATE-ADOPT group defined using the criteria of $\geq 5\%$ (N=2), $\geq 7\%$ (N=4), and $\geq 10\%$ (N=6) weight loss, this group was not included in the repeated measures ANOVA procedures. If the assumption of sphericity was not met, the Greenhouse-Geisser adjustment was used for these analyses.

Change values from baseline to 24 months were computed for each variable by subtracting the baseline data from the 24-month data. Bivariate correlation coefficients were computed to determine if the change in any of these variables (i.e., physical activity, eating behavior, dietary intake, attendance at group sessions, completion of intervention telephone calls) were associated with a change in body weight from baseline to 24 months. Variables significantly correlated with the change in body weight were considered in a multivariate logistic stepwise regression analyses, with separate regression analyses performed to predict achievement of $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss.

RESULTS

Of the 170 subjects whose data was analyzed, participants ranged in age from 23 to 45 years old with a mean age of 38.3 ± 5.4 years. The majority of the subjects were white (79.9%) and 8.3% were African American and 9.5% Hispanic or Latino. The mean height of the participants was 163.5 ± 6.3 cm (range: 140.5 – 180.9 cm) and the mean baseline weight was 87.5 ± 13.2 kg (range: 62.1 – 119.8 kg). All subjects entering the study had a BMI between 25 and 41 kg/m² with the initial mean BMI being 32.7 ± 4.2 kg/m².

Forty-eight percent of participants sustained at least a 5% weight loss at 24 months, 38% sustained at least a 7% weight loss at 24 months, and 24% of individuals sustained a 10% weight loss at this time period. However, 34%, 33%, and 25% of participants who lost $\geq 5\%$, $\geq 7\%$, or $\geq 10\%$ of initial body weight at 6 months were unable to maintain this magnitude of weight loss at 24 months. By definition, the MAINTAIN group had a significantly higher percentage of weight loss at 24 months compared to either the NON-MAINTAIN or NON-ADOPT groups for all weight loss classifications ($p < 0.001$). At 6 months, the mean percentage of weight loss was significantly different between all groups for $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss categories ($p < 0.001$; see Table 1).

There was a significant main effect of time ($p < 0.001$) for physical activity, EBI score, and dietary intake across all weight loss classifications (see Tables 2 & 3). Physical activity, EBI score, percent dietary carbohydrate intake, and percent dietary protein intake were greater at 24 months compared to baseline ($p < 0.001$). Total energy intake, dietary carbohydrate intake, dietary fat intake, dietary protein intake, and percent dietary fat were decreased at 24 months

compared to baseline ($p < 0.001$). For all 3 weight loss classification criteria ($\geq 5\%$, $\geq 7\%$, $\geq 10\%$), there was a significant group by time interaction for body weight ($p < 0.001$) and EBI score ($p < 0.001$). There was an additional group by time interaction effect for % dietary fat intake ($p < 0.01$) using $\geq 7\%$ and $\geq 10\%$ weight loss criteria.

There was a significant group by time interaction for physical activity ($p < 0.01$) using a $\geq 10\%$ weight loss but not $\geq 5\%$ or $\geq 7\%$ (see Table 2). A post-hoc analysis using the Bonferroni adjustment indicated that the pattern of change in physical activity between the NON-ADOPT and MAINTAIN groups was significantly different across time. Physical activity levels (kcal/wk) stratified by weight loss groups using $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss cut-off criteria and plotted against time are shown in Figure 1, 2, and 3 respectively.

Telephone contact time, expressed as the percentage of telephone calls completed, was significantly greater ($p < 0.001$) using the $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss criteria, in the MAINTAIN group (79.4%, 79.5%, 83.6%, respectively) compared with the NON-MAINTAIN (69.3%, 70.6%, 68.4%, respectively) and NON-ADOPT (64.4%, 67.7%, 69.6%, respectively) groups. There was no significant difference in participant session attendance between groups for any of the weight loss criteria.

Correlational Analyses

Significant correlations were found between percent change in body weight from 0–24 months and the changes in physical activity levels ($r = -0.33$), EBI scores ($r = -0.38$), percent dietary fat intake ($r = 0.19$), percent carbohydrate intake ($r = -0.20$), and the percentage of telephone calls completed ($r = -0.40$). There were also significant associations found for each of these variables and absolute change in body weight ($p < 0.05$). Change in total caloric intake from baseline to 24 months, dietary fat intake, carbohydrate intake, protein intake, and the percentage of telephone calls completed were not significantly correlated with either the change in body weight or the percent change in body weight from 0–24 months.

Logistic Stepwise Regression

All variables that were significantly correlated with change in body weight were included in three separate logistic stepwise regression analyses, with achievement of $\geq 5\%$, $\geq 7\%$ or $\geq 10\%$ weight loss at 24 months considered as the dependent variables in these analyses. Indicator variables were used for the dependent variable to indicate whether a subject satisfied the specified weight loss criteria at 24 months. The results from these regression analyses are shown in Table 4. The percentage of telephone calls completed and change in EBI score significantly predicted a $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss at 24 months ($p < 0.01$). While physical activity was not included in the regression models for $\geq 5\%$ or $\geq 7\%$ weight loss criteria, the change in physical activity from baseline to 24 months arose as the first predictor variable for $\geq 10\%$ weight loss over a 24-month period, explaining 11% of the variance.

DISCUSSION

This paper explored whether several factors (eating behaviors, participant contact time, and physical activity levels) differentially impact one's ability to achieve different levels of weight loss over a 24-month period. To our knowledge, no other studies have analyzed their data in a manner that would identify the influence of these factors for inducing different levels of clinically significant weight losses defined as greater than 5% (5,21), 7% (6,25), or 10% (7,14,26) of initial body weight. Regression analyses showed that interventionist/

participant telephone contact time and the adoption of eating behaviors related to successful weight loss were the only two factors examined that significantly predicted weight loss outcomes of $\geq 5\%$ or $\geq 7\%$ of initial body weight. Both telephone contact time and the adoption of healthy eating behaviors also were predictive of $\geq 10\%$ weight loss; however, physical activity was also predictive of this level of weight loss and explained more of the variance in weight loss than any of the other variables considered in the regression models (see Table 4). Thus, if an individual's goal is to maximize weight loss and to achieve the 10% weight loss at 24 months as recommended by the National Heart, Lung and Blood Institute (14), sufficient levels of physical activity must be performed in addition to adopting healthy eating behaviors and maintaining contact with a weight loss specialist.

When subjects were grouped into one of three categories (MAINTAIN, NON-MAINTAIN, or NON-ADOPT), depending upon their achievement of specified weight loss criteria at 6 months ($\geq 5\%$, $\geq 7\%$, or $\geq 10\%$) and their maintenance of these weight losses at 24 months, no group by time interaction for physical activity levels was seen using a $\geq 5\%$ weight loss criteria. There was a trend towards a significant interaction effect ($p=0.09$) using a $\geq 7\%$ criteria. However, when using a $\geq 10\%$ weight loss criteria, there was a significant group by time interaction for physical activity levels (see Table 2). Thus, these data demonstrate that high levels of physical activity may have the greatest impact on those individuals who successfully achieve and maintain at least a 10% weight loss.

Previous prospective (19) and retrospective (11) studies also indicate that high levels of physical activity are needed to maintain significant weight losses over time. According to data from the current study, those women in the MAINTAIN group who achieved and maintained at least a 10% weight loss at 24 months (average weight loss $-17.2 \pm 6.3\%$) were expending an average of 2259 kcals/week through exercise. This is approximately 1100 kcals/week more than those women in the NON-MAINTAIN (average weight loss $-3.2 \pm 5.1\%$) and NON-ADOPT (average weight loss $-0.30 \pm 4.9\%$) groups who were unsuccessful in achieving a weight loss $\geq 10\%$ of initial body weight at the conclusion of the study (see Table 2). The energy expenditure of those in the MAINTAIN group is similar to that reported by those women in the National Weight Control Registry (average weight loss = 28kg) who expended an average of 2545 kcals/week (11). Interestingly, when successful weight loss was defined as $\geq 5\%$ or $\geq 7\%$ of initial body weight at 24 months, those women in the MAINTAIN group averaged 1770 and 1825 kcals/week respectively, in leisure time physical activity. Thus, it appears that less physical activity is performed when weight loss $< 10\%$ of initial body weight is achieved and maintained.

These findings are relevant since the majority of individuals entering a weight loss program have very high weight loss expectations, with weight loss goals exceeding 25% of initial body weight in many instances (4). While previous research suggests that average weight losses achieved through behavioral intervention programs are about 10% of initial body weight (22), most individuals are seeking to exceed these averages. In fact, data from the present study demonstrated that for individuals achieving $\geq 10\%$ weight loss at 24 months, the actual weight loss was approximately 17% of initial body weight (see Table 1). Based on the results of this study, physical activity was a key factor in the ability to achieve this magnitude of weight loss when used in combination with improved eating behaviors and sufficient contact with the intervention staff (see Table 4). Thus, innovative strategies that would promote the adoption and maintenance of sufficient doses of physical activity are needed, and this may facilitate the achievement of larger magnitudes of long-term weight loss.

Participants who effectively maintained each of the weight loss criteria ($\geq 5\%$, $\geq 7\%$, $\geq 10\%$) over the 24-month period exhibited more favorable eating behaviors as illustrated through

the Eating Behavior Inventory Questionnaire, compared to those who did not meet these weight loss criteria (see Table 4). Interestingly, neither total caloric intake nor macronutrient composition significantly predicted weight loss success. Unlike previous studies, which have demonstrated that reductions in dietary fat and total daily energy intake are necessary for sustained weight loss (20), this was not the case in our sample. One possible justification for this finding may be explained through the method of measurement. This study utilized a food frequency questionnaire to assess calorie intake and macronutrient composition. However, this assessment methodology may not have been sensitive to distinguish between individuals achieving the various weight loss criteria. Thus, future studies may need to examine total daily energy intake and macronutrient composition using other assessment methodology such as random 24-hour dietary recalls.

The frequency of telephone contact between the participant and intervention staff significantly contributed to the prediction of all levels of weight loss at 24 months (see Table 4). Thus, the more telephone contact an individual had with a weight loss specialist, the greater their weight loss success. Interestingly, participant attendance at group sessions did not arise as a significant predictor of 24-month weight maintenance. It is likely that the design of this particular study may explain this finding. In the current study, the majority of group meetings took place at the start of the program while during the last 12 months of the study telephone calls were more prevalent. Since the regression analyses examined 24-month weight maintenance and not initial weight loss at 6 months, the type of contact that occurred more proximal to the 24-month outcome assessment may have been more influential than contact that occurred earlier in the intervention. Past studies have reported that continued contact improves long-term weight loss (18). However, similar to Wing et al. (27), our results indicate that non-face-to-face contact may be effective for successful weight maintenance. Thus, long-term intervention programs that utilize monthly or bimonthly telephone calls may be a viable and low cost alternative to aid individuals struggling to maintain their initial weight loss. Future studies should examine the feasibility of such telephone interventions.

A potential limitation to this study is that dietary intake and physical activity were assessed using self-reported measures. Physical activity and dietary intake measures were assessed by questionnaires and were not objectively measured. Since previous research has found that individuals tend to overestimate physical activity levels and underestimate total energy intake (13), future studies should be conducted using objective measures of physical activity and dietary intake to confirm the findings from this current study.

Another possible limitation to this study was that the variables examined (eating behaviors, participant contact time, and physical activity levels) only explain a small portion of the variance seen between those who are successful with long-term weight maintenance and those who are not. It is possible that other factors that were not measured in the current study (ie – social support networks, self-efficacy for physical activity and weight maintenance, motivational factors, or changes in environmental factors that are indicative of healthy lifestyle behaviors) also predict successful long-term weight maintenance. Thus, future studies should further explore these factors.

In summary, this study reaffirms the importance of adopting healthy eating behaviors and telephone contact time with a weight loss specialist for enhancing long-term weight loss success. Additionally, data from the current study indicate that sufficient levels of physical activity in combination with appropriate eating behaviors and maintaining contact with a weight loss specialist are important predictors of $\geq 10\%$ weight loss at 24 months, which is the level of weight loss recommended by the National Heart, Lung and Blood Institute (14). Therefore, to assist overweight and obese individuals in achieving and maintaining weight

losses $\geq 10\%$ of initial body weight, innovative strategies that would enhance long-term adherence to appropriate exercise and eating behaviors, and that facilitate continued contact with a weight loss specialist should implemented.

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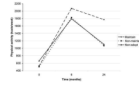


Figure 1. Physical activity levels based on achieving and maintaining a $\geq 5\%$ weight loss at 6 and 24 months

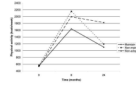


Figure 2. Physical activity levels based on achieving and maintaining a $\geq 7\%$ weight loss at 6 and 24 months

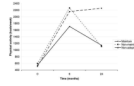


Figure 3. Physical activity levels based on achieving and maintaining a 10% weight loss at 6 and 24 months

Table 1

Mean percentage of weight loss defined as $\geq 5\%$ (N=168*), $\geq 7\%$ (N=166*), and $\geq 10\%$ (N=164*) of initial body weight

	n	0-6 Months	Group (0-6)	0-24 Months	Group (0-24)
Maintain ($\geq 5\%$)	81	-13.5 \pm 4.1%	<0.001 A,B,C	-12.8 \pm 6.7%	<0.001 A,B
Non-maintain ($\geq 5\%$)	57	-9.3 \pm 3.4%		0.73 \pm 3.9%	
Non-adopt ($\geq 5\%$)	30	-2.8 \pm 1.7%		2.2 \pm 3.6%	
Maintain ($\geq 7\%$)	64	-14.2 \pm 4.0%	<0.001 A,B,C	-14.5 \pm 6.6%	<0.001 A,B
Non-maintain ($\geq 7\%$)	56	-11.0 \pm 3.1%		-1.9 \pm 3.9%	
Non-adopt ($\geq 7\%$)	46	-3.8 \pm 2.1%		2.7 \pm 3.8%	
Maintain ($\geq 10\%$)	41	-16.2 \pm 3.2%	<0.001 A,B,C	-17.2 \pm 6.3%	<0.001 A,B
Non-maintain ($\geq 10\%$)	42	-12.9 \pm 2.4%		-3.2 \pm 5.1%	
Non-adopt ($\geq 10\%$)	81	-5.8 \pm 2.8%		-0.31 \pm 4.9%	

All values are expressed as mean \pm standard deviation; Maintain: met weight loss criteria at 6 and 24 months; Non-maintain: met weight loss criteria at 6 months and < weight loss criteria at 24 months; Non-adopt: met weight loss criteria at 6 and 24 months.

^A Maintain group significantly different than non-maintain group ($p < 0.001$)

^B Maintain group significantly different than non-adopt group ($p < 0.001$)

^C Non-maintain group significantly different than non-adopt group ($p < 0.001$)

* Subjects in Late-adopt not included in these analyses

TABLE 2

Physical activity levels from 0–24 months defined by $\geq 5\%$ (N=158*), $\geq 7\%$ (N=157*), and $\geq 10\%$ (N=154*) weight loss criteria

	Baseline	6 months	24 months	Time	Group	Time x Group
$\geq 5\%$ weight loss criteria						
Physical activity (kcal/wk)				<0.001	0.08	0.19
Maintain (n = 76)	533.4 \pm 531.9	2073.7 \pm 1488.3	1770.4 \pm 1271.9			
Non-maintain (n = 53)	507.4 \pm 944.6	1827.4 \pm 1503.6	1069.5 \pm 1031.7			
Non-adopt (n = 29)	663.0 \pm 730.1	1793.3 \pm 3215.7	1108.3 \pm 961.5			
$\geq 7\%$ weight loss criteria						
Physical activity (kcal/wk)				<0.001	0.13	0.09
Maintain (n = 61)	532.9 \pm 505.3	1995.8 \pm 1382.4	1824.5 \pm 1326.7			
Non-maintain (n = 52)	572.0 \pm 981.6	2154.3 \pm 1689.4	1193.6 \pm 1047.1			
Non-adopt (n = 44)	554.0 \pm 651.6	1641.1 \pm 2672.1	1103.6 \pm 996.0			
$\geq 10\%$ weight loss criteria						
Physical activity (kcal/wk)				<0.001	0.01 ^A	<0.01
Maintain (n = 39)	509.5 \pm 471.8	2157.1 \pm 1303.5	2259.4 \pm 1359.7			
Non-maintain (n = 41)	599.6 \pm 973.8	2265.0 \pm 1755.1	1108.9 \pm 1099.7			
Non-adopt (n = 74)	546.5 \pm 694.4	1710.9 \pm 2256.3	1143.5 \pm 941.1			

^A Maintain group significantly different than non-adopt group ($p < 0.05$); All values are expressed as mean \pm standard deviation; Maintain: met weight loss criteria at 6 and 24 months; Non-maintain: met weight loss criteria at 6 months and < weight loss criteria at 24 months; Non-adopt: met weight loss criteria at 6 and 24 months.

* Subjects in Late-adopt not included in these analyses and only subjects with complete weight and physical activity data included in the analysis.

TABLE 3

Eating behaviors from 0–24 months defined by $\geq 5\%$, $\geq 7\%$, and $\geq 10\%$ weight loss criteria

	Baseline	6 months	24 months	Time	Group	Group x Time
$\geq 5\%$ weight loss criteria						
EBI score				<0.001	<0.01 ^{A,B}	<0.001
Maintain (n = 76)	71.2 \pm 8.3	92.9 \pm 9.1	83.6 \pm 11.3			
Non-maintain (n = 49)	69.3 \pm 11.1	91.1 \pm 10.2	75.2 \pm 10.6			
Non-adopt (n = 23)	68.7 \pm 9.8	84.0 \pm 13.6	77.4 \pm 11.1			
Total energy intake (kcal/day)				<0.001	0.03	0.16
Maintain (n = 72)	2112.2 \pm 716.9	1388.8 \pm 454.3	1407.4 \pm 570.2			
Non-maintain (n = 48)	2427.3 \pm 1075.0	1549.7 \pm 548.1	1872.4 \pm 1126.7			
Non-adopt (n = 21)	2173.0 \pm 768.6	1571.4 \pm 757.7	1444.6 \pm 806.8			
% dietary carbohydrate intake				<0.001	0.67	0.36
Maintain (n = 72)	45.9 \pm 6.0	55.0 \pm 6.8	51.4 \pm 7.8			
Non-maintain (n = 48)	46.3 \pm 6.9	54.3 \pm 6.9	49.1 \pm 6.2			
Non-adopt (n = 21)	46.3 \pm 8.3	54.3 \pm 7.5	49.6 \pm 6.6			
% dietary fat intake				<0.001	0.24	0.94
Maintain (n = 72)	39.0 \pm 5.3	27.7 \pm 4.6	32.2 \pm 6.2			
Non-maintain (n = 48)	38.7 \pm 7.1	29.1 \pm 6.3	35.0 \pm 5.9			
Non-adopt (n = 21)	38.1 \pm 5.5	29.6 \pm 5.3	34.2 \pm 5.8			
% dietary protein intake				<0.001	0.64	0.66
Maintain (n = 72)	14.5 \pm 3.0	17.1 \pm 3.3	16.1 \pm 3.4			
Non-maintain (n = 48)	15.2 \pm 3.0	17.5 \pm 2.7	16.3 \pm 2.8			
Non-adopt (n = 21)	15.6 \pm 4.1	17.0 \pm 3.8	16.3 \pm 3.6			
$\geq 7\%$ weight loss criteria						
EBI score				<0.001	0.03 ^A	<0.001
Maintain (n = 61)	70.6 \pm 8.1	92.1 \pm 8.7	84.0 \pm 11.6			
Non-maintain (n = 46)	69.7 \pm 11.6	93.1 \pm 9.6	76.8 \pm 11.4			
Non-adopt (n = 39)	70.1 \pm 9.3	86.5 \pm 13.3	76.6 \pm 10.0			
Total energy intake (kcal/day)				<0.001	0.34	0.23
Maintain (n = 58)	2182.8 \pm 738.5	1423.1 \pm 451.5	1418.6 \pm 600.9			

	Baseline	6 months	24 months	Time	Group	Group x Time
Non-maintain (n = 45)	2355.1 ± 1080.1	1470.3 ± 546.4	1750.3 ± 972.6			
Non-adopt (n = 36)	2155.8 ± 769.3	1555.0 ± 677.3	1596.1 ± 1032.8	<0.001	0.65	0.09
% dietary carbohydrate intake						
Maintain (n = 58)	45.6 ± 6.0	55.5 ± 7.0	51.6 ± 8.4			
Non-maintain (n = 45)	46.2 ± 5.4	54.9 ± 5.6	49.2 ± 5.6			
Non-adopt (n = 36)	46.9 ± 8.9	53.2 ± 8.2	49.8 ± 6.9			
% dietary fat intake						
Maintain (n = 58)	39.4 ± 5.1	27.7 ± 4.7	32.2 ± 6.5	<0.001	0.51	<0.01
Non-maintain (n = 45)	38.8 ± 5.5	28.1 ± 4.1	34.9 ± 5.3			
Non-adopt (n = 36)	37.7 ± 7.7	30.3 ± 7.3	33.8 ± 6.5			
% dietary protein intake						
Maintain (n = 58)	14.5 ± 3.2	17.1 ± 3.5	16.1 ± 3.7	<0.001	0.63	0.64
Non-maintain (n = 45)	14.9 ± 3.0	17.4 ± 2.5	16.0 ± 2.4			
Non-adopt (n = 36)	15.5 ± 3.6	17.2 ± 3.5	16.5 ± 3.4			
≥ 10% weight loss criteria						
EBI score						
Maintain (n = 39)	70.3 ± 8.8	93.6 ± 8.9	86.1 ± 11.7	<0.001	0.03 ^A	<0.001
Non-maintain (n = 35)	70.0 ± 11.4	92.9 ± 8.9	74.8 ± 11.1			
Non-adopt (n = 70)	70.2 ± 9.2	88.3 ± 12.1	78.5 ± 10.1			
Total energy intake (kcal/day)						
Maintain (n = 39)	2099.4 ± 773.9	1371.9 ± 442.9	1394.2 ± 482.2	<0.001	0.18	0.16
Non-maintain (n = 34)	2448.1 ± 897.1	1438.3 ± 543.2	1808.9 ± 1102.7			
Non-adopt (n = 65)	2198.1 ± 904.1	1533.4 ± 601.1	1557.6 ± 878.8			
% dietary carbohydrate intake						
Maintain (n = 39)	46.4 ± 5.4	56.3 ± 7.2	52.7 ± 8.6	<0.001	0.06	0.08
Non-Maintain (n = 34)	44.8 ± 5.4	54.2 ± 6.0	47.6 ± 6.2			
Non-adopt (n = 65)	46.7 ± 7.8	53.9 ± 7.0	50.5 ± 6.3			
% dietary fat intake						
Maintain (n = 39)	38.8 ± 4.5	26.6 ± 4.4	31.2 ± 6.6	<0.001	0.06	<0.01
Non-maintain (n = 34)	39.9 ± 5.0	27.8 ± 4.3	35.3 ± 4.9			
Non-adopt (n = 65)	38.1 ± 7.0	30.0 ± 6.0	33.7 ± 6.1			

	Baseline	6 months	24 months	Time	Group	Group x Time
% dietary protein intake				<0.001	0.80	0.27
Maintain (n = 39)	14.3 ± 3.3	17.4 ± 3.8	16.2 ± 4.1			
Non-maintain (n = 34)	15.0 ± 2.7	17.8 ± 2.3	16.3 ± 2.5			
Non-adopt (n = 65)	15.2 ± 3.5	16.9 ± 3.1	16.2 ± 3.0			

All values are expressed as mean ± standard deviation. Maintain: met weight loss criteria at 6 and 24 months; Non-maintain: met weight loss criteria at 6 months and < weight loss criteria at 24 months; Non-adopt: met weight loss criteria at 6 and 24 months.

^A Maintain group significantly different than non-adopt group ($p < 0.05$)

^B Maintain group significantly different than non-maintain group ($p < 0.05$)

* Subjects in Late-adopt not included in these analyses and only subjects with complete data included in the analysis.

TABLE 4

Stepwise logistic regression analysis to predict $\geq 5\%$, $\geq 7\%$, or $\geq 10\%$ weight loss at 24 months

Dependent variable	Independent Variable ¹	Intercept	Beta Coefficient	SE	P	R ²
$\geq 5\%$ weight loss						
Model 1		1.248		0.473	<0.001	0.12
	% telephone calls completed		-0.010	0.002	<0.001	
Model 2		1.293		0.463	<0.01	0.16
	% telephone calls completed		-0.010	0.002	<0.001	
	Change in EBI score (0-24 months)		-0.009	0.003	<0.01	
$\geq 7\%$ weight loss						
Model 1		0.698		0.476	<0.001	0.08
	Change in EBI score (0-24 months)		-0.012	0.003	<0.001	
Model 2		1.228		0.462	<0.01	0.14
	Change in EBI score (0-24 months)		-0.011	0.003	<0.01	
	% telephone calls completed		-0.007	0.002	<0.01	
$\geq 10\%$ weight loss						
Model 1		0.803		0.435	<0.001	0.11
	Change in physical activity (0-24 months)		-0.000117	0.000	<0.001	
Model 2		0.876		0.423	<0.01	0.16
	Change in physical activity (0-24 months)		-0.0000898	0.000	<0.01	
	Change in EBI score (0-24 months)		-0.10	0.003	<0.01	
Model 3		1.298		0.413	<0.01	0.21
	Change in physical activity (0-24 months)		-0.0000774	0.000	<0.01	
	Change in EBI score (0-24 months)		-0.009	0.003	<0.01	

Variables excluded from the models: % of sessions attended, change in % carbohydrate intake from 0-24 months, change in % fat intake from 0-24 months.

¹ Only those variables predictive of $\geq 5\%$, $\geq 7\%$, or $\geq 10\%$ weight loss were included in one of the models