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Changes in Eating, Physical Activity, and Related Behaviors in a Primary-Care-Based Weight Loss Intervention

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Abstract

Objective—To examine changes in eating behaviors and physical activity, as well as predictors of weight loss success, in obese adults who participated in a 2-year behavioral weight loss intervention conducted in a primary care setting.

Design—A longitudinal, randomized-controlled, multi-site trial.

Subjects—390 obese (body mass index, 30 to 50 kg/m²) adults, 21 yr, in the Philadelphia region.

Methods—Participants were assigned to one of three interventions 1) Usual Care [Quarterly primary care provider (PCP) visits that included education on diet and exercise]; 2) Brief Lifestyle Counseling [quarterly PCP visits plus monthly Lifestyle Counseling (LC) sessions about behavioral weight control]; or 3) Enhanced Brief LC (the previous intervention with a choice of meal replacements or weight loss medication).

Results—At month 24, participants in both Brief LC and Enhanced Brief LC reported significantly greater improvements in mean ($\pm$ SE) dietary restraint than those in Usual Care (4.4 $\pm$ 0.5, 4.8 $\pm$ 0.5, and 2.8 $\pm$ 0.5, respectively; both ps 0.016). The percentage of calories from fat, along with fruit and vegetable consumption, did not differ significantly among the three groups.

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Conflict of Interest

Thomas Wadden serves on the advisory boards of Novo Nordisk and Orexigen Therapeutics, which are developing weight loss medications, as well as of Alere and the Cardiometabolic Support Network, which provide behavioral weight loss programs. David Sarwer discloses relationships with the following companies: Allergan, BaroNova, Enteromedics, Ethicon Endo-Surgery, and Galderma. The other authors declare no conflicts of interest.

The Brief LC and Enhanced Brief LC groups both reported significantly greater energy expenditure (kcal/week) at month 24 than Usual Care ($+593.4 \pm 175.9$, $+415.4 \pm 179.6$, and -70.4 ± 185.5 , respectively; both $p < 0.037$). The strongest predictor of weight loss at month 6 (partial $R^2 = 33.4\%$, $p < 0.0001$) and at month 24 (partial $R^2 = 19.3\%$, $p < 0.001$) was food records completed during the first 6 months. Participants who achieved a 5% weight loss at month 6 had 4.7 times greater odds of maintaining a 5% weight loss at month 24.

Conclusions—A behavioral weight loss intervention delivered in a primary care setting can result in significant weight loss, with corresponding improvements in eating restraint and energy expenditure. Moreover, completion of food records, along with weight loss at month 6, is a strong predictor of long-term weight loss.

Keywords

lifestyle intervention; weight loss; Eating Inventory; food intake; physical activity

Introduction

Investigators have recently begun to explore the feasibility of providing weight loss counseling to overweight and obese patients as part of routine care in primary care practice.¹ Counseling has employed the principles and techniques of behavioral weight control, as developed in academic medical centers. However, the frequency of treatment contacts in primary care generally has been limited to monthly or quarterly visits, as compared to weekly meetings in academically-based trials.¹ The limited number of visits likely has contributed to the generally modest weight losses observed in primary care interventions.²

Little is known about changes in appetite, eating, or activity behaviors that are produced by primary care weight loss interventions. Even less is known about possible predictors of long-term weight loss, such as patients' baseline characteristics or their early response to treatment.

The present study examined changes in eating and activity behaviors, as well as predictors of treatment success, in 390 obese patients who participated in a 2-year randomized controlled trial that was conducted in a primary care setting. Participants were randomly assigned to one of three interventions: 1) Usual Care [quarterly primary care provider (PCP) visits that included brief education on diet and exercise]; 2) Brief Lifestyle Counseling (quarterly PCP visits plus monthly behavioral counseling delivered by a trained auxiliary healthcare provider); or 3) Enhanced Brief Lifestyle Counseling (which included the previous intervention in combination with the participants' choice of using meal replacements or a weight loss medication). We hypothesized that greater improvements would be observed in self-reported measures of appetite control, dietary intake, and physical activity in the two groups that received lifestyle counseling, as compared with Usual Care. We further hypothesized that improvements in these measures, as well as frequency of treatment attendance during the first 6 months, would be associated with greater weight loss at months 6 and 24.

Methods

Study Design

Practice-based Opportunities for Weight Reduction at the University of Pennsylvania (POWER-UP) was one of three clinical trials funded by the National Heart, Lung, and Blood Institute (NHLBI) to test novel interventions aimed at improving the treatment of obesity in primary care settings.^{3–5} The present 2-year, randomized controlled trial was conducted at six primary care practices in the Philadelphia area that are owned by the

University of Pennsylvania Health System. The study was approved by the University's Institutional Review Board, and all participants provided written informed consent. Randomization began January 2008, and final outcome assessments were completed February 2011. Detailed descriptions of the study design, interventions, and main results have been published elsewhere.^{5–9}

Participants were referred to the study by their PCP or were recruited in response to posters and brochures distributed throughout the practice sites. Individuals were eligible if they were 21 yr of age, had a body mass index (BMI) of 30–50 kg/m², and had at least two of five components of the metabolic syndrome.⁶ Major exclusion criteria included recent cardiovascular disease; other medical conditions contraindicating weight loss; blood pressure 160/100 mmHg; medications that substantially affect body weight (e.g., corticosteroids); substance abuse; severe psychiatric illness which could affect study adherence; bariatric surgery; weight loss 5% of weight in past 6 months; and pregnancy/lactation. Anti-depressant medications were permitted, except for those associated with marked weight gain (e.g., lithium).^{5,6}

Treatment Conditions

Participants were randomly assigned to one of three treatment groups: 1) Usual Care; 2) Brief Lifestyle Counseling (Brief LC); or 3) Enhanced Brief Lifestyle Counseling (Enhanced Brief LC). All participants received the same standardized, 5–7 minute, quarterly visits with their PCP and were prescribed identical diet and physical activity goals. Those who weighed <250 lb were prescribed a balanced diet of 1200–1500 kcal/d (with 1500–1800 kcal/d for participants 250 lb) based on the 2005 Dietary Guidelines for Americans.¹⁰ All participants were instructed to gradually increase their physical activity to 180 min/wk, and they received a pedometer (W4IQ6622, www.Walk4life.com), calorie-counting book,¹¹ and handouts from NHLBI's Aim for a Healthy Weight.¹²

In addition to quarterly visits with their PCPs, the Brief LC and Enhanced Brief LC participants met monthly with an auxiliary health care provider from the practice (typically a medical assistant) who instructed them in diet and activity modification during 10–15 minute sessions. As described previously,^{5,6} participants in the Enhanced Brief LC group, in consultation with their PCPs, also chose to receive either meal replacements or weight loss medication as part of their intervention.

At each lifestyle counseling session, participants were weighed, food and activity records were reviewed, and the treatment intervention was delivered by reviewing one of the 25 lessons adapted from the Diabetes Prevention Program.¹³ These lessons presented a variety of behavioral strategies, including self-monitoring, goal setting and problem solving, as described previously.^{5,6}

Treatment Delivery and Staff Certification

Prior to randomization of the first participant, all PCPs and lifestyle coaches received 6–8 hours of weight management training that was provided by the study staff, who included physicians, psychologists, and registered dietitians. Primary care providers and lifestyle coaches followed detailed treatment protocols and scripts that described the session topics and the manner in which they were to be covered. All treatment providers were certified at baseline and re-certified at 6-month intervals, according to methods described previously.^{5,6}

Measurements

The following data were collected at baseline and months 6 and 24.

Anthropometry—Certified staff measured weight in triplicate, to the nearest 0.1 kg, using a digital scale (Tanita BWB 800, Tanita Corp, Tokyo, Japan), with participants dressed in light clothing, without shoes. Height was measured in duplicate, to the nearest 0.1 cm, using a wall-mounted stadiometer (Seca Stadiometer 202, Seca, Hamburg, Germany).

Eating behavior—Participants completed the Eating Inventory (EI),^{14,15} a 51-item questionnaire that assesses: cognitive restraint, the ability to restrain food intake; disinhibition, the tendency to lose control over food intake; and hunger. Higher scores reflect a greater degree of the measured trait. The inventory has been shown to be valid and reliable.^{14,15}

Dietary assessment—Participants completed two short validated dietary instruments developed by the National Cancer Institute (NCI). The Fruits and Vegetables Screener (FVS) is a 19-item questionnaire that assesses participants' intake of these foods over the past month.¹⁶ Participants recorded their usual monthly consumption of 10 categories of fruits and vegetables and chose the appropriate portion size based on the U.S. Department of Agriculture Pyramid defined servings. The screener provides an estimate of daily servings of fruits and vegetables.¹⁷ The second instrument, the 17-item Percentage from Fat Screener, assesses the approximate percentage of energy from fat. Participants reported the frequency with which they consumed specified high-fat foods over the past 12 months.^{18,19}

Participants in the Brief LC and Enhanced Brief LC groups also were asked to record their daily food and beverage intake for the first 6 months. Starting at week 2, they were instructed to record their calorie intake using a guide provided.¹¹ Food records were collected and reviewed with the participant at each monthly visit, and a new set was provided.

Physical activity—Physical activity was assessed using the Paffenbarger Physical Activity Survey.²⁰ Participants were instructed to answer questions based on their average daily physical activity habits for the past year, including the number of city blocks walked and flights of stairs climbed, as well as any sports, sporting leisure, or recreational activities in which they participated on a regular basis. This survey has excellent reliability and predictive validity.²¹ Statistical Analyses

Changes in body weight and other outcomes (i.e., appetite, physical activity, etc.) were examined using mixed effects linear regression models, fit with the between subject factor of treatment group and the within subject factor of time (i.e., changes from baseline to months 6 and 24). All mixed models were fit using an unstructured variance-covariance matrix and controlling for the *a priori* chosen covariates: site, gender, race, and baseline age. Pairwise comparisons were used to determine differences between treatment groups at months 6 and 24. P was set at 0.05 for all comparisons, except for body weight, the study's primary outcome (which was set at 0.025 for month 24, as described previously).⁵

We also assessed whether changes in appetite control, dietary intake, and physical activity at month 6, as well as the number of PCP visits completed, were associated with weight changes at months 6 and 24. (For Brief LC and Enhanced Brief LC participants, the number of food records kept and lifestyle coaching visits attended also were examined.) We fit separate ordinary least squares (OLS) regression models, adjusting for *a priori* covariates, defined as gender, race, baseline age, and primary care site. We examined both univariable and multivariable relationships and from the multivariable models report Beta (SE), percent of variation explained (R^2), and p-value for each covariate. For the multivariable models, we used the stepwise procedure, and all covariates with $\alpha < 0.20$ were retained in the final models. After inclusion of the *a priori* covariates, the following covariates were considered

in the OLS regression models: restraint, disinhibition, hunger, fruit/vegetable servings per day, percentage of energy from fat, energy expenditure, number of PCP visits, number of lifestyle coaching visit, and percentage of food diaries completed.

Logistic regression models were fit to examine the relationship between the achievement of a 5% weight loss at month 6 and at month 24. For all models (mixed, OLS, logistic), statistical residual analyses were performed to check for significant violations in the distribution, variance, and model assumptions. All analyses were performed using the statistical software package SAS, version 9.3 (SAS Institute, Cary, NC), and, unless otherwise specified, the alpha level was 0.05.

Results

Participants' Baseline Characteristics

Table 1 presents selected descriptive characteristics of the participants by treatment group. The 390 participants had a mean ($\pm$ SD) age of 51.5 ± 11.5 yr, weight of 107.7 ± 18.3 kg, and BMI of 38.5 ± 4.7 kg/m². The three groups did not differ significantly at baseline on these or other characteristics shown in Table 1.

Weight Loss

A total of 336 (86%) participants completed the study and had a final weight measured at month 24. As reported previously,⁵ mean ($\pm$ SE) weight losses at month 6 in the Usual Care, Brief LC, and Enhanced Brief LC groups were 2.0 ± 0.5 , 3.5 ± 0.5 , and 6.6 ± 0.5 kg, respectively. Weight loss differed significantly in both lifestyle groups, compared to Usual Care, as well as between the two lifestyle interventions ($p < 0.05$ for all comparisons, shown in Table 2). At month 24, participants in Usual Care, Brief LC, and Enhanced Brief LC lost 1.7 ± 0.7 , 2.9 ± 0.7 , and 4.6 ± 0.7 kg, respectively. Enhanced Brief LC produced significantly ($p = 0.003$) greater weight loss than Usual Care. There were no other significant differences in weight loss between the groups at month 24.

Eating Behavior

At month 6, participants in Enhanced Brief LC reported significantly greater increases in dietary restraint than those in Usual Care (4.9 ± 0.5 vs. 3.0 ± 0.5) and significantly greater reductions in disinhibition (-1.9 ± 0.3 vs. -0.6 ± 0.3) and hunger (-1.2 ± 0.3 vs. -0.5 ± 0.3) (see Table 2; $p < 0.05$ for all variables). At month 24, only the difference in restraint remained statistically significant (4.8 ± 0.5 vs. 2.8 ± 0.5 ; $p < 0.004$). Restraint scores also increased significantly more at month 24 in the Brief LC group than in Usual Care (4.4 ± 0.05 vs. 2.8 ± 0.05 ; $p = 0.016$), with no other significant differences among groups at any time.

Food Intake

There were no significant differences among treatment groups in changes in food intake at any time. Mean ($\pm$ SD) baseline fruit and vegetable intake was 5.8 ± 4.0 servings per day (across the three groups). At month 6, mean ($\pm$ SE) daily servings of fruits and vegetables increased modestly by 0.5 to 0.7 servings across the three groups, followed by smaller increases or declines at month 24. There were no significant differences among treatment groups at any time. At baseline, the mean ($\pm$ SD) percentage of energy from fat (across the three groups) was $32.9 \pm 5.4\%$. Percent fat intake decreased slightly at months 6 and 24 but there were no significant differences among the three groups.

Physical Activity

At baseline, participants across the three groups expended a mean ($\pm$ SD) of 1094.1 ± 1312.1 kcal/wk in moderately vigorous physical activity. As shown in Table 2, mean ($\pm$ SE) energy expenditure decreased in Usual Care participants at month 6, while increasing in Brief LC and Enhanced Brief LC participants (-49.6 ± 184.6 , $+113.7 \pm 187.4$, and $+624.2 \pm 182.0$ kcal/wk, respectively). Increases in energy expenditure were significantly greater in Enhanced Brief LC than the other two groups, and Brief LC was superior to Usual Care (see Table 2). A similar pattern of changes in energy expenditure was observed at month 24; both Enhanced Brief LC and Brief LC were superior to Usual Care, with no significant differences between the two lifestyle groups.

Treatment Adherence

Attendance at scheduled PCP and coaching visits has been reported previously.⁵ In brief, during the first 6 months, participants in Usual Care, Brief LC, and Enhanced Brief LC attended $88.2 \pm 21.8\%$, $87.0 \pm 22.5\%$, and $92.0 \pm 17.6\%$ of possible PCP visits, with no significant differences among groups. Attendance declined significantly ($p < 0.001$) in all three groups over the ensuing 18 months. Overall, 2-year attendance rates in the three groups were $69.0 \pm 29\%$, $71.8 \pm 28.6\%$, and $76.7 \pm 27\%$, respectively, with no significant difference among groups.

During the first 6 months, participants in Brief LC and Enhanced Brief LC attended $78.0 \pm 24.0\%$ and $86.3 \pm 20.0\%$ of possible lifestyle counseling visits, respectively (with no significant differences between groups). Over the full 24 months, the percentage of lifestyle counseling visits attended was significantly higher in the Enhanced Brief LC group than in Brief LC ($64.7 \pm 25.8\%$ vs. $56.1 \pm 28.8\%$; $p = 0.013$). During the first 6 months, participants in Enhanced Brief LC also completed significantly more food records than those in Brief LC ($57.97 \pm 35.0\%$ vs. $46.64 \pm 36.1\%$; $p = 0.012$).

Predicting 6-Month Weight Loss

No significant relationships were observed between 6-month weight loss and any of the baseline measures of diet, physical activity, and eating behavior (data not shown). In the multivariable step-wise regression analysis, the *a priori* covariates (gender, race, baseline age, site) accounted for 9.4% of the variance in weight loss at 6 months, with both race and site contributing significantly ($p < 0.001$ and $p = 0.046$, respectively) (see Table 3). The addition of the 6-month changes in restraint (partial $R^2 = 9.4\%$; $p < .0003$) and hunger (partial $R^2 = 4.1\%$; $p = 0.03$), as well as total number of PCP visits during the first 6 months (partial $R^2 = 2.6\%$; $p = 0.005$), significantly increased the total variance explained to 25.51%. (Changes in disinhibition and physical activity did not significantly increase the total variance explained.) In a separate model that examined only participants in the Enhanced Brief LC and Brief LC groups, both race and site continued to be significant ($p < 0.001$, $p = 0.009$), with all *a priori* baseline characteristics accounting for 12.3% of the variance in weight change at month 6 (see Table 4). The percentage of food diaries completed (partial $R^2 = 33.4\%$; $p < .0001$) and percentage of lifestyle counseling visits attended (partial $R^2 = 3.3\%$; $p = 0.009$) increased the variance explained to 45.7% and 49.0%, respectively. (The remaining variables shown in Table 4 did not contribute significantly.)

Predicting 24-Month Weight Loss

There were no significant associations between 24-month weight loss and any of the baseline measures of diet, physical activity, or eating behavior (data not shown). The multivariable step-wise regression analyses that included all participants revealed that baseline characteristics of gender, race, age, and site accounted for 9.5% of the variance in

weight loss at month 24, with only race contributing significantly ($p < .0001$). The addition of change in hunger at month 6 (partial $R^2 = 2.9$; $p = 0.038$) increased the total variance explained to 12.4%. Changes in restraint and disinhibition at month 6, as well as measures of food intake, physical activity, and number of PCP visits, did not significantly increase the variance explained in 24-month weight loss (see Table 5). When examining only the Enhanced Brief LC and Brief LC groups by multivariable stepwise regression analysis, baseline characteristics accounted for 8.4% of the variance, and the addition of the percentage of food diaries completed at month 6 (partial $R^2 = 19.3$, $p < .0001$) increased the variance explained to 27.7% (see Table 5). No other variables contributed significantly in the multivariable model.

Relationship of Early and Late Weight Loss

Of the 124 (31.8%) participants across the three groups who lost $\geq 5\%$ of initial weight at month 6, 50.8% of these maintained a weight loss of at least 5% at month 24. Of the 266 (68.2%) participants who did not lose $\geq 5\%$ at month 6, only 16.5% of these proceeded to do so at month 24. When adjusting for site, baseline age, race, and sex, the odds of losing 5% or more weight at month 24 were 4.7 times greater (95% CI: 2.83, 7.77) for participants who lost $\geq 5\%$ of their weight at month 6, as compared to those who did not achieve a 5% weight loss at this time.

Discussion

The main finding of this study was that primary care providers, in collaboration with auxiliary healthcare professionals, successfully delivered a behavioral lifestyle intervention in a primary care setting, which resulted in significant weight loss, improved eating behaviors, and increased physical activity. Obese patients in the Brief LC and Enhanced Brief LC groups lost 2.9 and 4.6 kg, respectively, at month 24, compared to 1.7 kg in Usual Care. The addition of meal replacements or weight loss medication to lifestyle coaching significantly increased the mean weight loss in the Enhanced group by 2.9 kg, compared with Usual Care.

Participants in the Enhanced Brief LC group also reported greater improvements in dietary restraint and physical activity at month 24 than those in Usual Care. Although individuals in the Brief LC group also reported more favorable long-term improvements in these variables than Usual Care participants, these changes were not sufficient to translate into significantly greater weight loss at 24 months. None of the three groups reported substantial changes in hunger, which was surprising for the Enhanced Brief LC group, given some participants' use of the weight loss medication sibutramine.

There were no significant differences among the three groups at months 6 or 24 in changes in fruit and vegetable intake or in the percentage of calories consumed from fat. However, the lack of change may have been attributable to our participants' high reported baseline consumption of fruits and vegetables (~ 5.8 servings), relative to the average daily servings consumed by U. S. adults (~ 2.7 servings).²² Likewise, our participants' reported baseline estimates of percent energy intake from fat (32.9%) were within the 20–35% of calories range recommended by the Dietary Guidelines for Americans.²³ Our participants may well have overestimated their initial fruit and vegetable intake, thus, attenuating estimates of change at months 6 and 24.

The present results add to prior efforts to identify predictors or correlates of weight loss. The baseline values of selected measures, such as cognitive restraint, disinhibition and hunger, were not successful in predicting weight loss and indicate that clinicians should not use these or similar measures to screen patients for weight loss. By contrast, the change in

cognitive restraint from baseline to month 6 correlated with weight loss at this time, indicating (as expected) that as participants increased efforts to restrict their food intake, they lost more weight. Change in hunger also contributed modestly to weight loss at this time, as did participants attendance of PCP visits. Greater attendance was associated with greater weight loss, although these variables were only weakly related in the stepwise, multivariable model.

When examining the two lifestyle interventions together (excluding Usual Care), participants' completion of their food records during the first 6 months proved to be by far the strongest correlate of weight loss during this time, accounting for 33.4% of the variance. The greater the percentage of records participants completed, the more weight they lost, as demonstrated in several prior studies,^{24–27} and as summarized in a recent systematic review by Burke *et al.*²⁸ Moreover, completion of food records during the first 6 months was the strongest predictor of weight change at month 24, explaining 19.3% of the variance in this variable. Milsom *et al.* similarly reported that increased frequency of record keeping (7.1 versus 2.7 days per month) during the first 6 months was associated with greater weight loss maintenance at 3.5 years.²⁹ Collectively, these findings underscore the importance of ensuring the participants record their food intake regularly during the initial months of a behavioral weight loss program. Participants who only marginally complete – or do not complete – diaries during the first 2 weeks should receive additional counseling to help them master this behavior, given its strong relationship to short- and long-term weight loss.

Early weight loss is also a known predictor of subsequent weight loss.^{30–32} In the current analysis, participants who achieved a 5% weight loss at 6 months had 4.7 times greater odds of maintaining a 5% weight loss at 24 months. These findings replicate prior studies which found initial weight loss was a predictor of better weight loss maintenance.^{33,34}

Strengths of this study include the successful provision of treatment by primary care providers and auxiliary health professionals within their own practice sites (as opposed to interventions delivered by highly specialized personnel at academic-based institutions). This has significant implications for the delivery of behavioral interventions in primary care settings. Second, the study population was diverse and included patients at both urban and suburban practice sites, which further extends our findings to the general primary care population. Third, outcome measures were collected by trained and certified staff members using calibrated equipment, standardized procedures, and validated questionnaires.

The study also had several limitations. Numerous factors that influence eating and activity behaviors, as well as weight loss (e.g., treatment acceptability, motivation to change) were not examined in this study. In addition, the measurement of usual dietary intake or physical activity often relies on self-reported instruments, which may be cognitively difficult for respondents and are vulnerable to measurement error (depending on the time period considered, the ease of the instrument, and the characteristics of the respondents).

Findings from our study and others^{3,4} have important clinical implications, as several organizations have recently endorsed the use of lifestyle counseling in routine clinical practice. In November 2011, the Center for Medicare and Medicaid services announced that it will cover intensive behavioral interventions delivered in primary care practice to obese Medicare beneficiaries.³⁵ This includes weekly face-to-face visits with the primary care provider for the first month, followed by bi-monthly face-to-face visits for months 2–6, and then monthly visits for months 7–12 (provided the patient loses ≥ 3 kg in the first 6 months). Additionally, the U.S. Preventive Services Task Force recently published new clinical guidelines recommending that clinicians screen adults for obesity and offer or refer patients

with a body mass index $\geq 30 \text{ kg/m}^2$ to intensive, multicomponent behavioral interventions (Grade B recommendation).³⁶

Results of our study indicate that a primary care-based lifestyle intervention delivered by primary care providers, with the assistance of auxiliary health care workers, can result in clinically meaningful weight loss in some patients, with corresponding improvements in eating restraint and energy expenditure. Moreover, treatment adherence and weight loss at month 6 were strong predictors of long-term weight loss (24 months). These findings offer PCPs new methods to assist their obese patients with weight management.

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Figure 1. Physical activity energy expenditure at three different times for participants assigned to Usual Care (UC), Brief Lifestyle Counseling (Brief LC), and Enhanced Brief Lifestyle Counseling (Enhanced Brief LC).

Table 1

Baseline characteristics of participants in POWER-UP.

Variable	Total (N=390)	Usual Care (N=130)	Brief LC (N=131)	Enhanced Brief LC (N=129)
Age (yr)	51.5 ± 11.5 [†]	51.7 ± 12.1	52.0 ± 12.2	51.0 ± 10.1
Body weight (kg)	107.7 ± 18.3	111.2 ± 20.0	106.3 ± 17.3	105.4 ± 17.2
BMI (kg/m ²)	38.5 ± 4.7	39.0 ± 4.8	38.5 ± 4.6	37.8 ± 4.7
Restraint ^a	8.87 ± 4.0	8.85 ± 4.0	8.92 ± 3.9	8.84 ± 4.2
Disinhibition ^a	8.85 ± 3.8	8.81 ± 3.7	9.02 ± 3.9	8.72 ± 3.8
Hunger ^a	5.97 ± 3.6	6.34 ± 3.6	6.05 ± 3.8	5.50 ± 3.2
Servings/day of fruits and vegetables ^b	5.82 ± 4.0	5.61 ± 4.1	6.06 ± 3.9	5.79 ± 4.23
Percentage of energy from fat ^c	32.9 ± 5.4	34.1 ± 6.6	32.16 ± 4.0	32.45 ± 5.0
Energy expenditure kcal/wk ^d	1094.1 ± 1312.1	1153.4 ± 1536.4	1074.9 ± 1070.7	1057.14 ± 1309.5

[†]Note: Values shown are means ± SD.^aEating Inventory (EI) subscale^bNational Cancer Institute (NCI) Fruit/Vegetable Screener (FVS)^cNCI Percentage of Energy from Fat Screener (PFat)^dPaffenbarger Physical Activity Questionnaire

Table 2

Changes in weight and other variables by treatment group over time.*

Variable	Usual Care (UC)			Brief LC			Enhanced Brief LC			P-Value Month 24		
	Month 6	Month 24	Month 6	Month 6	Month 24	Month 6	Month 24	Month 6	Month 24	Enhanced Brief LC vs Usual Care	Enhanced Brief LC vs Brief LC	Enhanced Brief LC vs Brief LC
Body weight (kg)	-2.0 ± 0.5	-1.7 ± 0.7	-3.5 ± 0.5	-2.9 ± 0.7	-2.9 ± 0.7	-6.6 ± 0.5	-4.6 ± 0.7	0.220 [†]	0.003 [†]	0.003 [†]	0.080 [†]	0.080 [†]
Restraint ^a	3.0 ± 0.5	2.8 ± 0.5	4.0 ± 0.5	4.4 ± 0.5	4.4 ± 0.5	4.9 ± 0.5	4.8 ± 0.5	0.016	0.004 [†]	0.004 [†]	0.623	0.623
Disinhibition ^a	-0.6 ± 0.3	-1.2 ± 0.4	-1.2 ± 0.3	-2.0 ± 0.4	-2.0 ± 0.4	-1.9 ± 0.3	-1.9 ± 0.4	0.093	0.154 [†]	0.154 [†]	0.788	0.788
Hunger ^a	-0.5 ± 0.3	-1.2 ± 0.4	-0.9 ± 0.3	-1.3 ± 0.3	-1.3 ± 0.3	-1.2 ± 0.3	-1.1 ± 0.3	0.808	0.757 [†]	0.757 [†]	0.577	0.577
Servings/day of fruits and veg ^b	0.5 ± 0.5	0.3 ± 0.5	0.7 ± 0.5	-0.6 ± 0.5	-0.6 ± 0.5	0.6 ± 0.5	-0.3 ± 0.5	0.195	0.352	0.352	0.703	0.703
Percentage of energy from fat ^c	-1.8 ± 0.5	-1.8 ± 0.6	-1.4 ± 0.5	-1.5 ± 0.6	-1.5 ± 0.6	-1.2 ± 0.5	-1.8 ± 0.6	0.738	0.936	0.936	0.675	0.675
Energy Expenditure kcal/wk ^d	-49.6 ± 185	-70.4 ± 186	113.7 ± 187	415.4 ± 180	415.4 ± 180	624.2 ± 182	593.4 ± 176	0.037	.004 [†]	.004 [†]	0.426 [†]	0.426 [†]

Note: Values are means ± SE.

* Adjusted for site, gender, race, and age;

[†] Significant at p<0.05 at Month 6;

^a Eating Inventory (EI) subscale;

^b National Cancer Institute (NCI) Fruit/Vegetable Screener (FVS);

^c NCI Percentage of Energy from Fat Screener (PFat);

^d Paffenbarger Physical Activity Questionnaire

Table 3

Multivariable association between weight loss at month 6 and 6-month change in study variables for the whole sample.*

Variable	Beta (SE)	Partial R ²	Cumulative R ²	P-value
Baseline covariants ^a		9.42	9.42	0.0003
Restraint ^b	−0.29 (0.08)	9.42	18.84	0.0003
Hunger ^b	0.25 (0.11)	4.07	22.91	0.030
PCP visits during the first 6 M of treatment	−0.08 (0.03)	2.60	25.51	0.005
Disinhibition ^a	0.15 (0.11)	0.60	26.11	0.187

^aBaseline covariants: gender, race, site, and baseline age

^bEating Inventory (EI) subscale

* Selection criteria for stepwise regression: $p < 0.20$

Table 4

Multivariable association between weight loss at month 6 and 6-month change in study variables for participants in Brief LC and Enhanced Brief LC combined. *

Variable	Beta (SE)	Partial R ²	Cumulative R ²	P-value
Baseline Covariants ^a		12.27	12.27	0.002
% Food diaries completed ^b	−0.07 (0.1)	33.44	45.71	<.0001
LC visits during first 6 M of treatment ^b	−0.1 (0.04)	3.29	49.00	0.009
Hunger	0.2 (0.1)	1.92	50.92	0.186
PCP visits during the first 6 M of treatment	0.1 (0.1)	1.00	51.92	0.157
Restraint	−0.1 (0.1)	1.00	52.97	0.166

* Selection criteria for stepwise regression: $p < 0.20$

^a Baseline covariants: gender, race, site, and baseline age

^b Brief Lifestyle Counseling and Enhanced Lifestyle Counseling Groups only

LC = lifestyle counseling; PCP = primary care provider

Table 5

Multivariable association between weight loss at month 24 and 6-month change in study variables for the whole group and for Brief LC and Enhanced Brief LC groups only.*

Variable	Beta (SE)	Partial R ²	Cumulative R ²	P-value
<i>All groups</i>				
Baseline covariants ^a		9.53	9.53	<0.001
Hunger ^b	0.3 (0.1)	2.89	12.42	0.038
Restraint ^b	-0.2 (0.1)	0.75	13.71	0.163
<i>Brief LC and Enhanced brief LC groups only</i>				
Baseline covariants		8.44	8.44	0.05
% Food diaries completed months 0–6 ^c	-0.1 (0.1)	19.30	27.74	<.0001
PCP visits during months 0–6	0.1 (0.1)	1.80	29.54	0.07
Hunger	0.3 (0.2)	1.38	30.92	0.13

* Selection criteria for stepwise regression: $p < 0.20$

^a Baseline covariants: gender, race, site, and baseline age

^b Eating Inventory subscale

^c Brief Lifestyle Counseling and Enhanced Lifestyle Counseling Groups only

PCP = primary care provider