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A randomized controlled trial for obesity and binge eating disorder: Low-energy-density dietary counseling and cognitive behavioral therapy

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Abstract

The present study examined a dietary approach – lowering energy density – for producing weight loss in obese patients with binge eating disorder (BED) who also received cognitive-behavioral therapy (CBT) to address binge eating. Fifty consecutive participants were randomly assigned to either a six-month individual treatment of CBT plus a low-Energy-Density diet (CBT+ED) or CBT plus General Nutrition counseling not related to weight loss (CBT+GN). Assessments occurred at six- and twelve-months. Eighty-six percent of participants completed treatment, and of these, 30% achieved at least a 5% weight loss with rates of binge remission ranging from 55–75%. The two treatments did not differ significantly in weight loss or binge remission outcomes. Significant improvements were found for key dietary and metabolic outcomes, with CBT+ED producing significantly better dietary outcomes on energy density, and fruit and vegetable consumption, than CBT+GN. Reductions in energy density and weight loss were significantly associated providing evidence for the specificity of the treatment effect. These favorable outcomes, and that CBT+ED was significantly better at reducing energy density and increasing fruit and vegetable consumption compared to CBT+GN, suggest that low-energy-density dietary counseling has promise as an effective method for enhancing CBT for obese individuals with BED.

Keywords

Obesity; overweight; weight loss; binge eating; eating disorders

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Disclosure

The authors declared no conflicts of interest.

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Introduction

Various health organizations now recommend a reduction in dietary energy density (kcal/g) for weight management (Centers for Disease Control and Prevention, 2008a, , 2008b; World Cancer Research Fund, 2007; World Health Organization, 2003). The main strategies for decreasing dietary energy density are to consume more water- and fiber-rich foods such as fruits and vegetables, and to decrease the proportion of fat (Duncan, Bacon, & Weinsier, 1983). Strategies for lowering dietary energy density allow for consumption of greater quantities of food while reducing energy intake and the associated reduction in hunger may for some individuals improve compliance with dietary recommendations. The purpose of the present research is to investigate the effects of a low-energy-density dietary approach in a population known to have difficulty with weight loss.

Binge eating disorder (BED) comprises a subset of overweight and obese individuals for whom weight loss in clinical trials has been an elusive goal. BED is characterized by recurrent binge eating, defined as eating an unusually large amount of food while experiencing a subjective sense of loss of control at least two days per week for at least a six month duration, and not engaging in compensatory behaviors characteristic of bulimia nervosa (American Psychiatric Association, 2000). While obesity is not a diagnostic criterion for BED the two are strongly associated such that most persons with BED who present for treatment are obese and at increased risk for medical and psychiatric morbidity (Hudson, Hiripi, Pope, & Kessler, 2007). A number of psychotherapies (Wilson, Grilo, & Vitousek, 2007) and pharmacotherapies (Reas & Grilo, 2008) have been shown to produce significant and substantial reductions in binge eating and BED related outcomes, but treatments tested to date have failed to produce significant or meaningful weight loss (Wilson et al., 2007). Cognitive behavior therapy (CBT) has emerged as the treatment of choice for BED, particularly because of its robust effects on reducing binge eating and improving the behavioral and psychological aspects of the disorder, despite its minimal effect on weight loss (Wilson et al., 2007).

A number of studies have directly compared CBT to behavioral weight loss treatments (BWLs) such as the *LEARN Program for Weight Management* (Brownell, 2000) and the National Institutes of Diabetes and Digestive and Kidney Diseases's Diabetes Prevention Program (Grilo, Masheb, & Wilson, 2005; Grilo, Masheb, Wilson, Gueorguieva, & White, in press; Munsch et al., 2007; Wilson, Wilfley, Agras, & Bryson, 2010). Collectively these studies have shown that CBT is superior to BWL in reducing and eliminating binge eating in BED. However, these studies have also reported minimal weight loss with BWL (Grilo & Masheb, 2005; Grilo et al., in press; Munsch et al., 2007) and any short-term weight loss advantage for BWL over CBT appears to be lost at two year follow-up (Wilson et al., 2010).

Studies have shown the effectiveness of lowering energy density for reducing energy intake in short-term laboratory studies (Bell, Castellanos, Pelkman, Thorwart, & Rolls, 1998; Bell & Rolls, 2001; Duncan et al., 1983; Rolls, Bell, Castellanos et al., 1999; Rolls, Bell, & Thorwart, 1999; Rolls, Hetherington, Stoner, & Andersen, 1997; Rolls, Roe, & Meengs, 2004), and more recently, for producing weight loss in longer-term efficacy (Ello-Martin, Roe, Ledikwe, Beach, & Rolls, 2007; Rolls, Roe, Beach, & Kris-Etherton, 2005) and effectiveness (Lowe et al., 2008) trials. Treatment with strategies to lower energy density, such as increased intake of vegetables and fruits, in combination with decreased fat intake, was shown to result in lower energy intake and less hunger than a diet which emphasized decreased fat intake only (Ello-Martin et al., 2007).

Given that obese individuals with BED have increased gastric capacity compared to obese individuals without binge eating (Geliebter & Hashim, 2001) it seems logical to test whether

such a dietary approach focused on greater food volume and lower caloric density might facilitate weight loss in this patient group. Preliminary support for this comes from a laboratory study that found individuals with BED reduced their energy intake with lower-energy-dense meals (Latner, Rosewall, & Chisholm, 2008) but this has not yet been tested as a clinical intervention. Thus, we performed a randomized, controlled trial to investigate a dietary approach – lowering energy density – for producing weight loss in obese patients with BED who also received CBT to address binge eating and BED related outcomes. We additionally aimed to determine whether improvements in binge eating and BED-related outcomes could be achieved and sustained with dieting added to CBT, and to be the first treatment study of obese individuals with BED to examine dietary and metabolic outcomes.

Methods and Procedures

Participants

Participants were adult patients who met DSM-IV-TR (American Psychiatric Association, 2000) criteria for BED, were recruited via print advertisements for treatment studies for binge eating and weight loss at a medical school, and were required to be aged 21 to 60, obese (body mass index (BMI) of 30 or greater) and available for the length of the treatment and follow-up at twelve-months. The study received full human subjects and ethics review, and approval by the University Institutional Review Board. The 50 consecutively randomized participants were aged 29 to 60 years ($M = 45.8$, $SD = 7.6$), 76% ($n = 38$) were female, and 84% ($n = 42$) attended or finished college. The participant group was 80% ($n = 40$) Caucasian, 18% ($n = 9$) African American, and 2% ($n = 1$) Hispanic American. Mean BMI was 39.1 ($SD = 6.6$).

Procedures

Social, psychiatric and medical histories were obtained, and two semi-structured interviews were administered. The Structured Clinical Interview for DSM-IV (SCID-I/P) (First, Spitzer, Gibbon, & Williams, 1996) was used to assess for BED, and Axis I psychiatric exclusions and co-morbidity. The BED diagnosis assessed with the SCID-I was confirmed on the semi-structured Eating Disorder Examination Interview – 12th Edition version (EDE) (Fairburn & Cooper, 1993). Laboratory testing included blood chemistry, blood count, serum electrolytes, thyroid function tests, and lipid profile analysis. After review of all of the above, potential participants were excluded if they (1) had co-existing psychiatric conditions requiring alternative treatments or hospitalization; (2) met criteria for current substance dependence; (3) were currently receiving psychiatric, psychological, behavioral, or pharmacologic treatment known to affect eating or weight; (4) had any physical conditions, such as diabetes, known to affect eating or weight; (5) had serious cardiac disease; (6) had serious neurologic illness; (7) had cognitive impairments that would interfere with being able to complete assessments and understand treatments; or (8) were pregnant, lactating or planning to become pregnant during the treatment period.

Figure 1 summarizes the recruitment and flow of participants throughout the study. Three hundred forty five individuals made telephone inquiries, 242 phone screens were completed, and 80 individuals were evaluated in person. Fifty individuals met all eligibility criteria, signed the informed consent, and were randomized to treatments from a computer-generated randomization schedule created by a data analyst and independent of the investigators, in the order they completed assessments. Treatments, delivered by doctoral-level research clinicians in psychology, included CBT plus a low-Energy-Density diet (CBT+ED) and CBT plus General Nutrition counseling not related to lowering energy density or weight loss (CBT+GN). Clinicians were experienced in treating patients with weight and eating

problems and with CBT methods, and received specialized training and reading in the treatments used in this study. Clinicians attended weekly group supervision with one of the investigators (RMM) to discuss cases and review audiotapes of sessions, and on-going consultation with the other investigators with regard to the dietary (BJR) and CBT (CMG) interventions was used.

Measures

In the present study, the primary outcomes were percentage of participants achieving at least a 5% weight loss (Rissanen, Lean, Rossner, Segal, & Sjostrom, 2003), binge remission, energy density, and servings of fruits and vegetables. Secondary outcomes included dimensional measures of weight, eating, diet and metabolism. Measures used to assess these outcomes are described below.

Weight Outcome

Body Mass Index (BMI; weight [kg] divided by height squared [m^2]) Weight and height were obtained using a medical balance beam scale. Participants were weighed without shoes or coats at each assessment point and treatment session.

BED-related Outcomes

Eating Disorder Examination-Interview 12th Edition (EDE) (Fairburn & Cooper, 1993) is a standardized semi-structured investigator-based interview that assesses the diagnoses and features of eating disorders including objective bulimic episodes (OBEs; binge eating defined as an unusually large amount of food coupled with a subjective sense of loss of control) for both the number of days and episodes on which these occurred in the past 28 days. The EDE is also comprised of four subscales (dietary restraint, eating concern, weight concern and shape concern) that reflect the attitudinal features of eating disorders. The EDE is a well-established assessment method for eating disorder psychopathology (Grilo, Masheb, & Wilson, 2001a, , 2001b) and has demonstrated good test-retest reliability (Grilo, Masheb, Lozano-Blanco, & Barry, 2004). The EDE interview was used at baseline, six-months and twelve-months.

Self-monitoring of Eating Behavior was used to prospectively assess overeating behavior, including OBEs, throughout the course of treatment. Each week patients were provided with a stapled packet of seven blank daily record sheets to monitor overeating behaviors. The definitions of overeating behaviors, based on the EDE definitions, were contained on the record and reviewed at the start of treatment. Records were reviewed for accuracy and completeness on a weekly basis.

Three Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985) is a 51-item self-report questionnaire that is a widely used and established measure of eating behaviors (Allison, Kalinsky, & Gorman, 1992), and has demonstrated clinical utility for treatment studies of overeating and obesity (Foster et al., 1998). The measure has three subscales: cognitive restraint, disinhibition, and hunger. The TFEQ was used at baseline, monthly during treatment, and at six-months and twelve-months.

Beck Depression Inventory (BDI) (Beck & Steer, 1987) 21-item version is a psychometrically sound, widely used measure for symptoms of depression and negative affect. The BDI was used at baseline, monthly during treatment, and at six-months and twelve-months.

Dietary Outcomes

24-Hour Random Dietary Recall Interviews. The Diet Assessment Center in the Department of Nutritional Sciences at The Pennsylvania State University collected, coded and calculated nutrition information. Two 24-hour dietary recall interviews were conducted on randomly selected days over a two-week period at baseline and again at six-months (post-treatment) with one interview being a weekday and the other a weekend given that adults have been shown to eat differently during these time periods (Bhargava, Forthofer, McPherson, & Nichaman, 1994). Interviewers, who were blind to treatment assignment, used the Nutrition Data System for Research (NDS-R, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN), an interactive interface that guides the interviewer through a series of structured prompts and probes to collect detailed dietary information over the telephone from midnight to midnight during the previous 24 hours. This method for collecting dietary data has been shown to be superior over food records (Buzzard et al., 1996). Food energy density was calculated as the ratio between total energy intake (kcal) and weight (g) of food and beverages combined. Data on fruit and vegetable servings, and fat intake were also collected.

Visual Analog Scales (VAS). 100-mm VAS were used to measure hunger (How hungry did you feel today?) and satiety (How full did you feel after consuming your meals today?) These items were completed 1.5 hours after the evening meal.

Metabolic Outcomes

Waist Circumference, a marker of obesity-related health risks, was obtained according to federal guidelines (Services, 2000). Blood Pressure and heart rate were measured with a digital blood pressure monitor by Life Source (model UB-401) and the average of the three measurements was calculated, at baseline, monthly during treatment, and at six-months and twelve-months. Lipid Profile Analysis was performed from blood samples drawn and analyzed at baseline and six-months (post-treatment) for total cholesterol, high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), and triglycerides.

Treatment Fidelity

Treatment Credibility, using an adapted version of the Treatment Credibility Questionnaire (TCQ) (Borkovec & Nau, 1972) at the beginning and end of treatment, and Patient Satisfaction, rated at the end of treatment, included items rated on 11-point scales (0, lowest; 10, highest). Therapist Adherence was obtained by independent assessors who listened to randomly selected audio-tapes of the CBT+ED and CBT+GN sessions and rated them for compliance with session protocols.

Treatment Conditions

CBT+ED—One-half of participants received CBT+ED administered via 21 hourly individual sessions over a six-month treatment period. This included one-hour weekly individual sessions for weeks 1 to 16, and every other week for weeks 17 to 26. Sessions included 40 minutes devoted to CBT and 20 minutes devoted to energy density. Participants completed daily food diaries that were checked weekly by clinicians. In addition, participants were instructed in how to self-monitor episodes of binge eating and overeating in these diaries. CBT for BED (Fairburn, 1995) is a focal treatment consisting of three overlapping phases. The first phase involved the establishment of a collaborative therapeutic relationship while focusing on educating the patient about the nature of binge eating and the factors or processes thought to maintain the problem. Behavioral strategies, such as self-monitoring, were used to help patients identify problems with their eating, and other behavioral strategies, such as problem-solving and goal setting were used to assist the

patient in working towards a structured pattern of eating. The second phase integrated cognitive skills such that patients learned to identify and challenge maladaptive thoughts and triggers related to eating and weight/shape. Through this phase, continued attention to the normalization of eating patterns, and the associated behavioral goals, was maintained. The final phase focused on the maintenance of change and relapse prevention.

Additionally, participants in this condition received weekly dietary counseling for lowering energy density. In the first phase of this treatment, patients were: informed about the objective and science of energy density shown a food preparation demonstration for a breakfast differing in energy density ; shown photographs of meals differing in energy density ; and taught how to calculate energy density using nutrition facts labels, the energy density formula, and an energy density value food chart. In the second phase of this treatment, goals were set to increase the patient's consumption of low energy density foods which could be eaten in satisfying portions, and to exercise portion control over medium to high energy density foods. Weekly topics adapted from the manualized protocol by Ello-Martin and colleagues (Ello-Martin et al., 2007) were: water and energy density ; reducing fat and energy density ; volume and satiety; portion and serving sizes; carbohydrates and energy density ; protein and energy density ; calcium and energy density ; beverages, alcohol and desserts; meal planning and grocery shopping; dining out and energy density ; modifying recipes; overcoming obstacles to fruits and vegetables; cravings and variety; low energy density snacks and comfort foods; weight maintenance; and, holidays and celebrations. Clinicians reviewed the weekly topic with patients and problem-solved any obstacles to achieving goals for lowering energy density. Information was provided on sample meals, menus and recipes.

CBT+GN—One-half of participants received CBT+GN delivered similarly to CBT+ED (21 hourly individual sessions over a six-month treatment period, weekly for weeks 1 to 16 and every other week for weeks 17 to 26, with 40 minutes devoted to CBT and 20 minutes devoted to nutrition). Participants in this condition completed food diaries and self-monitoring, and received the same exact CBT described in Treatment 1 above.

Additionally, participants in this condition received weekly dietary counseling for health as opposed to reducing energy density or weight loss. A manual was specifically designed for this study so that the CBT+GN would serve as an active comparator to the CBT+ED treatment.¹ In the first phase of the dietary component of treatment patients were: informed about the objective of the general nutrition treatment and the science and definition of nutrients; taught the definition of calories; and informed about nutrition facts labels. In the second phase, each weekly topic was designed specifically as a control for the type and amount of dietary information provided in the energy density condition and included the following: My Pyramid.gov and your health; dietary fat and your health; fruits, vegetables and your health; portions, serving sizes and your health; carbohydrates and your health; protein and your health; calcium and your health; water and your health; meal planning, grocery shopping and your health; dining out and your health; added sugars and your health; herbs, spices and your health; consumer information and your health; sodium and your health; snacks, comfort foods and your health; vitamins, antioxidants and your health; and,

¹Here is an example to understand the specific difference between the dietary components of the CBT+GN and CBT+ED treatments. When discussing fruits, vegetables and your health the information provided by the clinician and in the CBT+GN manual focused on the health benefits of vitamins, minerals, fiber, antioxidants and phytochemicals needed to maintain good health and energy levels, protect against the effects of aging, and reduce the risk of cancer and heart disease. Definitions of antioxidants and phytochemicals were provided. In contrast the information provided by the clinician and the manual in the CBT+ED treatment focused on how to increase fruit and vegetable consumption as a way to lower the energy density of one's diet to reduce overall calorie intake and weight. Problem-solving and goal-setting was used to accomplish this.

tips for holidays and celebrations. Clinicians reviewed and discussed the weekly topic with patients, but no problem-solving or goal-setting was conducted in these sessions.

Overview of Analyses

Baseline analyses using analysis of variance (ANOVA) and chi-square were conducted to test for treatment-group differences on demographic variables. Descriptive summaries were presented in terms of means and standard deviations, and relative frequencies and percentages for continuous and discrete variables, respectively. To ensure that pretreatment random assignment was successful, ANOVA on baseline variables that were used for treatment outcome was conducted. All data were checked for normality prior to statistical analysis and transformations were applied as necessary. Chi-square analyses were used to examine the primary outcomes for percentage of participants who achieved at least a 5% weight loss and percentage who achieved binge remission. Mixed effects models were used to assess differences between the two treatments over time for the other primary and secondary dimensional outcomes. The fixed effects in all models were treatment (CBT+ED vs. CBT+GN), session (with all available time points for each measure) and the interaction between treatment and session. Time was considered as a categorical variable. The best-fitting variance-covariance matrix for each model was selected based on Schwartz-Bayesian criterion (BIC). Least square mean comparisons between groups at each time point and differences of least square means over time were performed to explain the significant effects in the model and to directly test a priori hypotheses. Of greatest interest was the comparison of the two treatment groups at the end of the study (twelve-months from the start of treatment) and for this comparison no correction for multiple tests was applied. Finally, correlation analysis and ANOVA were used to examine associations between weight loss and energy density from baseline to six-months (post- treatment).

Results

Randomization and Patient Characteristics

Demographic and clinical characteristics are summarized in Table 1. Participants in the CBT +ED treatment group were older than participants in the CBT+GN group ($M = 47.9$, $SD = 7.9$ vs. $M = 43.7$, $SD = 6.7$; $F(1, 49) = 4.13$, $p = 0.048$), but the two groups did not differ significantly on any other demographic (gender, ethnicity, education) or clinical characteristics. Baseline ANOVAs were performed on all of the outcome variables listed in Tables 2, 3 and 4, and the two treatment groups did not differ significantly on baseline levels of any of the clinical variables including BED-related, dietary, and metabolic outcomes.

Treatment Completion Rates

Of the 50 randomized participants, 86% ($n=43$) were considered treatment completers and finished at least 2/3 of the treatment (at least 14 of the 21 treatment sessions) and either the six-month or twelve-month assessments, or both. The two treatment groups did not differ in completion rates (80%, $n=20$ for CBT+ED and 92%, $n=23$ for CBT+GN; $\chi^2(1)=1.50$, $p=.221$), or in the number of sessions completed ($M=16.8$, $SD=7.4$ for CBT+ED and $M=19.1$, $SD=3.1$ for CBT+GN; $F(1, 49)=2.03$, $p=0.161$). Treatment completers finished on average 20.1 sessions ($SD=1.7$) whereas dropouts completed on average 7.0 sessions ($SD=7.0$). Of the 50 randomized, six-month (post-treatment) assessment data was collected on 80% ($n=40$), and twelve-month assessment data was collected on 74% ($n=37$), of participants.

Weight Loss

The percent of all randomized participants who achieved at least a 5% six-month (post-treatment) weight loss was 26% ($n=13$), and this did not differ between treatment conditions

(32%, $n=8$ of 25 for CBT+ED, and 20%, $n=5$ of 25 for CBT+GN; $\chi^2(1) = 0.94$, $p=0.333$). The percent for twelve-month weight loss also 26% ($n=13$), and this did not differ between treatment conditions (28%, $n=7$ of 25 for CBT+ED and 24%, $n=6$ of 25 for CBT+GN; $\chi^2(1) = 0.10$, $p=0.747$). The percent of treatment completers ($n=43$) who achieved at least a 5% six-month (post-treatment) weight loss was 30.2% ($n=13$), and this rate did not differ between treatment conditions (40%, $n=8$ of 20 for CBT+ED, and 21.7%, $n=5$ of 23 for CBT+GN; $\chi^2(1) = 1.69$, $p=0.193$). The percent for twelve-month weight loss of treatment completers ($N=43$) was also 30.2% ($n=13$), and this did not differ between treatment conditions (35%, $n=7$ of 20 for CBT+ED and 26%, $n=6$ of 23 for CBT+GN; $\chi^2(1) = 0.40$, $p=0.526$).

Using mixed effects models, a significant increase in percent weight loss over time was found using the major assessment points (baseline, two-months, four-months, six-months and twelve-months) ($F(3, 95)=3.87$, $p=0.0117$) as well as weight data that were collected at every treatment session ($F(19, 716)=2.48$, $p=0.0005$). No significant interaction effects were observed with mixed effects modeling.

Figure 2 summarizes mean percent weight losses for all randomized participants with last observation carried forward (top half) and treatment completers (bottom half) for each treatment group at six-months and twelve-months. Mean percent weight losses for all randomized participants ($N=50$) were 3.1% ($SD=6.2$) for CBT+ED and 1.5% ($SD=4.2$) for CBT+GN at six-months and 2.8% ($SD=6.1$) for CBT+ED and 1.4% ($SD=7.6$) for CBT+GN at twelve-months. Mean percent weight losses for treatment completers ($n=43$) were 4.2% ($SD=6.5$) for CBT+ED and 1.6% ($SD=4.5$) for CBT+GN at six-months, and 3.6% ($SD=6.6$) for CBT+ED and 1.4% ($SD=7.9$) for CBT+GN at twelve-months. None of these comparisons in percent weight losses between treatments were significant.

BED Outcomes: Binge Remission

Binge remission was defined as zero binges for the 28 days prior to the end of treatment. Remission rates were calculated for completers and for all randomized patients using two sets of complementary intent-to-treat (ITT) analyses (prospective daily self-monitoring data and retrospective EDE interview data). For OBE data from the prospective self-monitoring, remission rates did not differ for completers ($X^2=0.04$, $p=0.846$) and were 72.2% ($n=13$ of 18) for CBT+ED and 75.0% ($n=15$ of 20) for CBT+GN. Remission rates also did not differ for ITT analysis using last observation carried forward (four consecutive weeks without OBEs prior to the last assessment point) ($X^2=0.80$, $p=0.370$) and were 60% ($n=15$ of 25) for CBT+ED and 72% ($n=18$ of 25) for CBT+GN. For OBE data obtained from the EDE Interview, remission rates did not differ for completers ($X^2=1.21$, $p=0.272$) and were 72.2% ($n=13$ of 18) for CBT+ED and 55% ($n=11$ of 20) for CBT+GN. Remission rates also did not differ for ITT analysis using baseline carried forward imputation ($X^2=0.32$, $p=0.571$) and were 52% ($n=13$ of 25) for CBT+ED and 44% ($n=11$ of 25) for CBT+GN.

BED Outcomes: Behavioral and Attitudinal Features of BED

Table 2 summarizes results of mixed effects models for dimensional measures used to assess features of BED. At twelve-months, participants reported significant improvements in the behavioral (fewer binge episodes, less disinhibition and hunger, and greater restraint) and attitudinal (concerns about weight, shape and eating concern) features of BED as well as symptoms of depression (all p 's < 0.001). No significant interaction effects were found for these same variables. Thus, both treatments produced similar improvements in BED-related outcomes.

Dietary Outcomes

Table 3 summarizes results of mixed effects models for the dietary outcomes. Participants reported significant reductions in dietary energy density and energy intake from baseline to six-months (post-treatment) based upon data collected from two random 24-hour dietary recall interviews (p 's<0.001). A significant interaction effect was found for energy density ($F(1, 35)=5.17$, $p=0.029$) such that greater reductions in energy density were found for CBT+ED than CBT+GN. No significant interaction effect was found for energy intake.

Significant increases in fruit and vegetable intake were reported ($F(1, 42)=9.17$, $p=0.004$), and these improvements were greater for the CBT+ED condition compared to the CBT+GN condition ($F(1, 44)=11.57$, $p=0.001$). Significant reductions in fat intake were also reported ($F(1, 31)=49.32$, $p<0.0001$), but the interaction effect was not significant. Similar to findings for hunger that were reported for the TFEQ subscale, hunger measured with visual analog scales suggested significant reductions from baseline to twelve-months ($F(4, 143)=4.99$, $p<0.001$), but no interaction effect.

Metabolic Outcomes

Table 4 summarizes results of mixed effects models for physical and health-related outcomes. Significant improvements in total cholesterol $F(1, 31)=5.78$, $p=0.022$), but not HDL and LDL cholesterol or triglycerides, were observed from baseline to six-months (post-treatment). Significant reductions in waist circumference ($F(4, 144)=3.39$, $p=0.011$), and systolic ($F(4, 146)=7.77$, $p<0.001$) and diastolic ($F(4, 146)=8.45$, $p<0.001$) blood pressure were observed from baseline to twelve-months. No significant interaction effects were found for any of the metabolic outcomes.

Associations Among Change in BMI and Change in Energy Density

Change in BMI was calculated for each session attended by subtracting the session BMI from the baseline BMI. Mean changes in BMI were not significantly different between the treatment conditions. Mean changes in BMI units for all randomized participants ($N=50$) were 1.34 ($SD=2.65$) for CBT+ED and 0.53 ($SD=1.59$) for CBT+GN at six-months and 1.24 ($SD=2.65$) for CBT+ED and 0.50 ($SD=3.0$) for CBT+GN at twelve-months. Mean changes in BMI units for treatment completers ($n=43$) were 1.77 ($SD=2.80$) for CBT+ED and 0.55 ($SD=1.65$) for CBT+GN at six-months, and 1.59 ($SD=2.86$) for CBT+ED and 0.52 ($SD=3.13$) for CBT+GN at twelve-months.

A partial correlation analysis was performed for associations between change in BMI and change in energy density from baseline to six months (post-treatment) using baseline weight as a covariate. For treatment completers, change in BMI from baseline to six-months was significantly related to change in energy density ($r=0.31$, $p=0.045$). For ITT analyses, change in BMI was also significantly related to change in energy density ($r=0.34$, $p=0.018$).

Treatment Fidelity

At the end of treatment, no differences were found for patient satisfaction between the two treatments ($t=-0.45$, $p=0.655$). Treatment credibility was significantly greater at the end of treatment compared to the beginning ($F(1, 41)=12.26$, $p=0.001$), but no significant interaction effect was found suggesting that the treatments were equally credible. In a random sample of 31 tapes, therapist adherence was 100% for three core elements (reviewing self-monitoring of eating behavior, reviewing daily food diaries, and completing the CBT portion of the session), 84% for setting the agenda, and 81% for completing the dietary counseling portion of the session.

Discussion

The present study evaluated the efficacy of two dietary counseling approaches, when combined with CBT, to investigate binge eating, dietary and metabolic outcomes in a randomized clinical trial for BED. Eighty-six percent of randomized participants completed treatment, and of these, 30% achieved at least a 5% weight loss with rates of binge remission ranging from 55–75%. Dietary outcomes improved by the end of the study such that significant reductions were found for energy density, and calorie and fat intake, as well as significant increases in fruit and vegetable consumption. In addition, participants reported significant reductions in binge eating, hunger, waist circumference, blood pressure and cholesterol. There was some evidence for the specificity of weight loss changes in CBT+ED, as participants in that treatment condition reported significantly greater reductions in energy density and significantly greater increases in fruit and vegetable consumption.

The two treatment conditions did not differ significantly in either the frequencies of participants achieving at least 5% weight loss or in percent weight losses. At the end of treatment, treatment completers who received CBT+ED achieved an average 4.2% weight loss compared to those who received CBT+GN and achieved an average 1.6% weight loss. Forty percent (40%) of treatment completers who received CBT+ED, and 22% of treatment completers who received CBT+GN, achieved at least a 5% post-treatment weight loss. For context, we note that our intent-to-treat rate of 20% achieving 5% weight loss at six-months in the CBT-GN condition was similar to the 15% rate reported by Wilson and colleagues (2010) for guided-self-help CBT, whereas our 32% rate of 5% weight loss by the CBT+ED condition was higher and closer to 41% rate for BWL reported by Wilson et al (2011).

Our power analysis was based on one of our previous trials (Grilo & Masheb, 2005) suggesting 8% of participants in the CBT+GN condition would have achieved at least a 5% weight loss. With the present sample size only large effect sizes would be detected given that this study was adequately powered (80% power) for differences of 40% versus 8% and higher at two-sided alpha level of 0.05. While the sample size made it difficult to detect statistically significant differences in weight loss outcomes between the groups, we did, however, find evidence for the specificity of the CBT+ED treatment as changes in energy density were significantly related to changes in BMI, a finding that is consistent with a previous trial of low-energy-density in obese women (Ello-Martin et al., 2007; Ledikwe et al., 2006). In addition, while both groups had significant reductions in energy density, energy intake and fat, and significant increases in fruit and vegetable consumption, improvements for energy density and fruit and vegetable consumption were greater in the CBT+ED condition. It is important to note that these two treatment groups only differed in two ways, i.e., the type of dietary information received, and that the CBT+ED group received goals to increase the consumption of low energy dense foods and the CBT+GN group did not.

Remission from binge eating is typically the primary outcome for BED trials. In the present study, using binge eating data from two complementary assessment methods - prospective self-monitoring and the EDE interview - we found that remission rates did not differ between groups and ranged from 52% to 72% for CBT+ED and from 44% to 75% for CBT+GN. These remission rates for individual CBT combined with dietary counseling compare favorably to rates reported by previous RCTs of CBT delivered via individual (Devlin et al., 2005; Grilo, Masheb, & Wilson, 2005), guided self-help CBT (Grilo & Masheb, 2005; Grilo, Masheb, & Salant, 2005; Wilson et al., 2010), and group methods (Grilo et al., in press; Wilfley et al., 2002). Our findings here represent strong evidence against clinical lore that dietary interventions might be contraindicated for binge eating.

Treatments in the present study also produced similar improvements in other BED-related outcomes. By twelve-months, participants reported significant improvements in the behavioral and attitudinal features of BED as well as symptoms of depression. While these latter findings are not surprising for CBT, in the present study they suggest that dietary strategies can be combined with CBT treatment without concern about a lack of improvement, or worsening, in eating disorder pathology.

This is the first randomized controlled trial for BED that has reported significant improvements in metabolic outcomes. Both treatments produced similar and significant reductions in waist circumference and blood pressure, and improvements in total cholesterol. This is clinically meaningful given that adiposity and high blood pressure are two of the criteria for metabolic syndrome, a major risk factor for cardiovascular disease, type II diabetes and all-cause mortality, and high cholesterol is one of the major controllable risk factors for coronary heart disease, heart attack and stroke (Lakka et al., 2002; NCEP, 2001). These positive findings may be a consequence of the dietary changes, weight loss or a combination of both.

There are some limitations to the present study. First, while CBT+GN was designed to be a credible comparison for the CBT+ED, there are a number of factors that may have led to the attenuation of findings. For example, it is unknown whether the absence of statistically significant differences in weight loss was due to insufficient power or similarities between the two treatments. For example, the use of food diaries and a manual with nutrition information may have resulted in the weight loss observed in the CBT+GN condition. Even the use of doctoral-level psychologists to administer interventions typically delivered by dietitians may have played a role in attenuating findings as we found greater therapist adherence to the CBT portion of the sessions compared to the dietary counseling portion of the sessions.

There were a number of strengths and weaknesses to the use of 24-hour Dietary Recall interviews in the present study. These in-depth interviews by trained interviewers who assess eating during a recent, discrete period of time utilize prompts from computer-based software designed specifically for dietary intake have demonstrated superiority over food records (Buzzard et al., 1996). Three 24-hour recalls taken at each assessment point has been shown to be optimal for estimating energy intake in comparison to doubly labeled water (Ma et al., 2009). In the present study, only two recalls were taken at each assessment point and dietary data were collected only at baseline and six-months (post-treatment). Even if three recalls had been taken and data collected at twelve-months, these interviews were still reliant upon self-report, and self-report of food intake has consistently been shown to be biased toward underreporting of intake. Nevertheless, it is unlikely that participants in one condition were more biased in reporting than the other, and thus it is reasonable to assume that reported differences in energy density and fruit and vegetable intake reflect actual intakes.

The demographic and clinical characteristics of this study group are quite similar to those of other CBT trials (Grilo, Masheb, & Salant, 2005; Grilo, Masheb, & Wilson, 2005; Wilson et al., 2010). However, findings may not generalize to BED patients who seek treatment at different types of clinics, who seek different types of treatments, or who have a different demographic composition from, or clinical presentation than, this sample. It is also unknown if treatment improvements will persist beyond twelve-months. A recent study has shown substantial relapse in weight loss at two-year follow-up for behavioral weight loss treatment for BED (Wilson et al., 2010).

With over 30% of the sample achieving statistically and clinically significant weight losses, significant improvements in dietary and metabolic outcomes, the high completion rate, ratings of patient satisfaction, and comparable rates of binge remission and improvements in dimensional BED outcomes to other BED clinical trials, this study provides strong evidence that dietary counseling can be successfully combined with CBT for obese patients with BED. These favorable outcomes, and the superiority of CBT+ED over CBT+GN for reducing dietary energy density and increasing fruit and vegetable consumption, suggest that low-energy-density dietary counseling has promise as an effective method for enhancing CBT for obese individuals with BED.

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References

- Allison DB, Kalinsky LB, Gorman BS. A comparison of the psychometric properties of three measures of dietary restraint. *Psychological Assessment*. 1992; 4(3):391–398.
- American Psychiatric Association. *Diagnostic and Statistical Manual - Text Revision*. Washington, DC: American Psychiatric Association; 2000.
- Beck, AT.; Steer, R. *Manual for Revised Beck Depression Inventory*. New York: Psychological Corporation; 1987.
- Bell EA, Castellanos VH, Pelkman CL, Thorwart ML, Rolls BJ. Energy density of foods affects energy intake in normal-weight women. *Am J Clin Nutr*. 1998; 67(3):412–420. [PubMed: 9497184]
- Bell EA, Rolls BJ. Energy density of foods affects energy intake across multiple levels of fat content in lean and obese women. *Am J Clin Nutr*. 2001; 73(6):1010–1018. [PubMed: 11382653]
- Bhargava A, Forthofer R, McPherson S, Nichaman M. Estimating the variations and autocorrelations in dietary intakes on weekdays and weekends. *Stat Med*. 1994; 13(2):113–126. [PubMed: 8122048]
- Borkovec T, Nau C. Credibility of analogue therapy rationales. *Journal of Behavior Therapy and Experimental Psychiatry*. 1972; 3:257–260.
- Brownell, K. *The LEARN program for weight management 2000*. Dallas, TX: American Health; 2000.
- Buzzard IM, Faucett CL, Jeffery RW, McBane L, McGovern P, Baxter JS, et al. Monitoring dietary change in a low-fat diet intervention study: advantages of using 24-hour dietary recalls vs food records. *J Am Diet Assoc*. 1996; 96(6):574–579. [PubMed: 8655904]
- Centers for Disease Control and Prevention. *Eat more, weigh less?*. Atlanta, GA: CDC; 2008a.
- Centers for Disease Control and Prevention. *Low-energy-dense foods and weight management: cutting calories while controlling hunger*. Atlanta, GA: CDC; 2008b.
- Devlin MJ, Goldfein JA, Petkova E, Jiang H, Raizman PS, Wolk S, et al. Cognitive behavioral therapy and fluoxetine as adjuncts to group behavioral therapy for binge eating disorder. *Obes Res*. 2005; 13(6):1077–1088. [PubMed: 15976151]
- Duncan KH, Bacon JA, Weinsier RL. The effects of high and low energy density diets on satiety, energy intake, and eating time of obese and nonobese subjects. *Am J Clin Nutr*. 1983; 37(5):763–767. [PubMed: 6303104]
- Ello-Martin JA, Roe LS, Ledikwe JH, Beach AM, Rolls BJ. Dietary energy density in the treatment of obesity: a year-long trial comparing 2 weight-loss diets. *Am J Clin Nutr*. 2007; 85(6):1465–1477. [PubMed: 17556681]
- Fairburn, CG. *Overcoming binge eating*. New York: Guilford Press; 1995.
- Fairburn, CG.; Cooper, Z. *The Eating Disorder Examination*. In: Fairburn, CG.; Wilson, GT., editors. *Binge eating: nature, assessment, and treatment*. 12. New York: Guilford Press; 1993. p. 317–360.

- First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JBW. Structured clinical interview for DSM-IV Axis I Disorders - Patient Version (SCID-I, Version 2.0). New York: New York State Psychiatric Institute; 1996.
- Foster GD, Wadden TA, Swain RM, Stunkard AJ, Platte P, Vogt RA. The Eating Inventory in obese women: clinical correlates and relationship to weight loss. *Int J Obes Relat Metab Disord*. 1998; 22(8):778–785. [PubMed: 9725638]
- Geliebter A, Hashim SA. Gastric capacity in normal, obese, and bulimic women. *Physiol Behav*. 2001; 74(4–5):743–746. [PubMed: 11790438]
- Grilo CM, Masheb RM. A randomized controlled comparison of guided self-help cognitive behavioral therapy and behavioral weight loss for binge eating disorder. *Behav Res Ther*. 2005; 43(11):1509–1525. [PubMed: 16159592]
- Grilo CM, Masheb RM, Lozano-Blanco C, Barry DT. Reliability of the Eating Disorder Examination in patients with binge eating disorder. *Int J Eat Disord*. 2004; 35(1):80–85. [PubMed: 14705160]
- Grilo CM, Masheb RM, Salant SL. Cognitive behavioral therapy guided self-help and orlistat for the treatment of binge eating disorder: a randomized, double-blind, placebo-controlled trial. *Biol Psychiatry*. 2005; 57(10):1193–1201. [PubMed: 15866560]
- Grilo CM, Masheb RM, Wilson GT. A comparison of different methods for assessing the features of eating disorders in patients with binge eating disorder. *J Consult Clin Psychol*. 2001a; 69(2):317–322. [PubMed: 11393608]
- Grilo CM, Masheb RM, Wilson GT. Different methods for assessing the features of eating disorders in patients with binge eating disorder: a replication. *Obes Res*. 2001b; 9(7):418–422. [PubMed: 11445665]
- Grilo CM, Masheb RM, Wilson GT. Efficacy of cognitive behavioral therapy and fluoxetine for the treatment of binge eating disorder: a randomized double-blind placebo-controlled comparison. *Biol Psychiatry*. 2005; 57(3):301–309. [PubMed: 15691532]
- Grilo CM, Masheb RM, Wilson GT, Gueorguieva R, White MA. Cognitive-behavioral therapy, behavioral weight loss, and sequential treatment for obese patients with binge eating disorder: a randomized controlled trial. *Journal of Consulting and Clinical Psychology*. in press.
- Hudson JI, Hiripi E, Pope HG Jr, Kessler RC. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. *Biol Psychiatry*. 2007; 61(3):348–358. [PubMed: 16815322]
- Lakka H, Laaksonen D, Lakka T, Niskanen L, Kumpusalo E, Tuomilehto J, et al. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. *JAMA*. 2002; 21:2709–2716. [PubMed: 12460094]
- Latner JD, Rosewall JK, Chisholm AM. Energy density effects on food intake, appetite ratings, and loss of control in women with binge eating disorder and weight-matched controls. *Eat Behav*. 2008; 9(3):257–266. [PubMed: 18549984]
- Ledikwe JH, Blanck HM, Kettel Khan L, Serdula MK, Seymour JD, Tohill BC, et al. Dietary energy density is associated with energy intake and weight status in US adults. *Am J Clin Nutr*. 2006; 83(6):1362–1368. [PubMed: 16762948]
- Lowe MR, Tappe KA, Annunziato RA, Riddell LJ, Coletta MC, Crerand CE, et al. The effect of training in reduced energy density eating and food self-monitoring accuracy on weight loss maintenance. *Obesity (Silver Spring)*. 2008; 16(9):2016–2023. [PubMed: 18483475]
- Ma Y, Olendzki BC, Pagoto SL, Hurley TG, Magner RP, Ockene IS, et al. Number of 24-hour diet recalls needed to estimate energy intake. *Ann Epidemiol*. 2009; 19(8):553–559. [PubMed: 19576535]
- Munsch S, Biedert E, Meyer A, Michael T, Schlup B, Tuch A, et al. A randomized comparison of cognitive behavioral therapy and behavioral weight loss treatment for overweight individuals with binge eating disorder. *Int J Eat Disord*. 2007; 40(2):102–113. [PubMed: 17089420]
- NCEP. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. 2001.
- Reas DL, Grilo CM. Review and meta-analysis of pharmacotherapy for binge-eating disorder. *Obesity (Silver Spring)*. 2008; 16(9):2024–2038. [PubMed: 19186327]

- Rissanen A, Lean M, Rossner S, Segal KR, Sjostrom L. Predictive value of early weight loss in obesity management with orlistat: an evidence-based assessment of prescribing guidelines. *Int J Obes Relat Metab Disord.* 2003; 27(1):103–109. [PubMed: 12532161]
- Rolls BJ, Bell EA, Castellanos VH, Chow M, Pelkman CL, Thorwart ML. Energy density but not fat content of foods affected energy intake in lean and obese women. *Am J Clin Nutr.* 1999; 69(5): 863–871. [PubMed: 10232624]
- Rolls BJ, Bell EA, Thorwart ML. Water incorporated into a food but not served with a food decreases energy intake in lean women. *Am J Clin Nutr.* 1999; 70(4):448–455. [PubMed: 10500012]
- Rolls BJ, Hetherington MM, Stoner SA, Andersen AE. Effects of preloads of differing energy and macronutrient content on eating behavior in bulimia nervosa. *Appetite.* 1997; 29(3):353–367. [PubMed: 9468765]
- Rolls BJ, Roe LS, Beach AM, Kris-Etherton PM. Provision of foods differing in energy density affects long-term weight loss. *Obes Res.* 2005; 13(6):1052–1060. [PubMed: 15976148]
- Rolls BJ, Roe LS, Meengs JS. Salad and satiety: energy density and portion size of a first-course salad affect energy intake at lunch. *J Am Diet Assoc.* 2004; 104(10):1570–1576. [PubMed: 15389416]
- Services, U. S. D. o. H. a. H. With Understanding and Improving Health and Objectives for Improving Health. 2. Washington, DC: U.S. Government Printing Office; 2000. Healthy People 2010.
- Stunkard AJ, Messick S. The three factor eating questionnaire to measure dietary restraint, disinhibition, and hunger. *Journal of Psychosomatic Research.* 1985; 29:71–81. [PubMed: 3981480]
- Wilfley DE, Welch RR, Stein RI, Spurrell EB, Cohen LR, Saelens BE, et al. A randomized comparison of group cognitive-behavioral therapy and group interpersonal psychotherapy for the treatment of overweight individuals with binge-eating disorder. *Arch Gen Psychiatry.* 2002; 59(8): 713–721. [PubMed: 12150647]
- Wilson GT, Grilo CM, Vitousek KM. Psychological treatments of eating disorders. *American Psychologist.* 2007; 62:199–216. [PubMed: 17469898]
- Wilson GT, Wilfley DE, Agras WS, Bryson SW. Psychological treatments of binge eating disorder. *Arch Gen Psychiatry.* 2010; 67(1):94–101. [PubMed: 20048227]
- World Cancer Research Fund, A. I. f. C. R. Determinants of weight gain, overweight, and obesity. Washington, DC: AICR; 2007.
- World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Geneva, Switzerland: 2003.

Figure 1.
Flow of participants throughout the study

Figure 2. Mean percent weight loss for all participants randomized (N=50; top) and treatment completers (n=43; bottom).
Note: No significant differences between treatment conditions.

Table 1

Characteristics of participants randomized to treatment conditions

	Overall (N=50)	CBT+ED (n=25)	CBT+GN (n=25)	F or χ^2	P
BMI (kg/m ²) (<i>M, SD</i>)	39.1 (6.6)	39.2 (6.9)	39.0 (6.5)	0.01	0.930
Age (<i>M, SD</i>)	45.8 (7.6)	47.9 (7.9)	43.7 (6.7)	4.13	0.048
Gender, female (<i>n, %</i>)	38 (76%)	20 (80%)	18 (72%)	0.44	0.508
Ethnicity (<i>n, %</i>)				2.40	0.301
Caucasian	40 (80%)	18 (72%)	22 (88%)		
African-American	9 (18%)	6 (24%)	3 (12%)		
Hispanic-American	1 (2%)	1 (4%)	0 (0%)		
Education (<i>n, %</i>)				3.23	0.358
Some high school	1 (2%)	1 (4%)	0 (0%)		
High school graduate	7 (14%)	5 (20%)	2 (8%)		
Some college	13 (26%)	7 (28%)	6 (24%)		
College graduate	29 (58%)	12 (48%)	17 (68%)		
DSM-IV Lifetime Psychiatric Disorder (<i>n, %</i>)					
Any Axis I disorder	43 (86%)	21 (84%)	22 (88%)	0.17	0.684
Any mood disorder	36 (72%)	19 (76%)	17 (68%)	0.40	0.529
Any anxiety disorder	29 (58%)	14 (56%)	15 (60%)	0.08	0.774
Any substance use disorder	18 (36%)	9 (36%)	9 (36%)	0.00	1.000
Age onset BED (<i>M, SD</i>)	24.3 (11.8)	25.4 (12.2)	23.1 (11.6)	0.48	0.490

Table 2

BED-related outcomes for treatment effects by time and treatment condition

Domains and variables	Baseline				Twelve-months				Time		Time x Treatment	
	CBT+ED		CBT+GN		CBT+ED		CBT+GN		F	p	F	p
	EMM	SE	EMM	SE	EMM	SE	EMM	SE				
BED Outcomes: Behavioral features												
Binge eating per month (EDE) ^a	2.3	0.2	2.4	0.2	0.7	0.3	0.0	0.2	48.23	.000	1.92	0.110
Disinhibition (TFEQ)	12.9	0.5	12.5	0.5	8.6	0.9	7.6	0.8	19.93	.000	0.90	0.467
Restraint (TFEQ)	7.7	0.8	7.5	0.8	11.2	0.9	9.7	0.8	12.41	.000	0.64	0.634
Hunger (TFEQ)	8.7	0.7	9.9	0.7	4.6	0.8	6.8	0.8	11.97	.000	0.40	0.806
BED Outcomes: Attitudinal features												
Weight concern (EDE)	3.8	0.2	4.4	0.2	2.1	0.3	2.6	0.2	20.60	.000	1.38	0.242
Shape concern (EDE)	4.3	0.2	4.7	0.2	2.8	0.3	2.8	0.3	21.29	.000	0.37	0.829
Eating concern (EDE)	3.1	0.3	3.5	0.3	1.4	0.3	1.1	0.3	32.14	.000	0.53	0.715
Total score (EDE)	3.3	0.2	3.6	0.2	1.9	0.2	2.1	0.2	26.84	.000	1.68	0.159
Depression (BDI) ^a	2.6	0.1	2.8	0.1	1.9	0.2	1.8	0.2	11.60	.000	1.58	0.187

^aVariable was log-transformed to better approximate normality.

Note: EDE=Eating Disorder Examination-Interview; TFEQ=Three Factor Eating Questionnaire; BDI=Beck Depression Inventory.

Table 3

Dietary outcomes for treatment effects by time and treatment condition

Dietary Outcomes	Baseline			Six-months			Time		Time x Treatment	
	CBT+ED	CBT+GN	EMM	CBT+ED	CBT+GN	EMM	F	p	F	p
Energy density	1.2	0.1	1.2	0.1	0.8	0.1	38.38	.000	5.17	0.029
Energy intake (kcal)	2844	259	2950	128	1674	1912	42.49	.000	0.15	0.700
Fruit & vegetable servings	3.7	0.5	5.2	0.6	7.0	5.0	9.17	.004	11.57	0.001
Fat intake	120.9	11.0	131.2	12.2	62.0	65.9	49.32	.000	0.13	0.721
Twelve-months										
Hunger (Visual Analog Scale)	54.2	4.4	55.8	4.4	38.6	5.0	4.99	.000	1.07	0.376
Satiety (Visual Analog Scale)	55.4	3.9	59.4	3.9	60.9	4.4	1.86	.120	1.06	0.378

Table 4

Metabolic outcomes for treatment effects by time and treatment condition

Metabolic Outcomes	Baseline				Six-months				Time		Time x Treatment		
	CBT+ED		CBT+GN		CBT+ED		CBT+GN		F	p	F	p	p
	EMM	SE	EMM	SE	EMM	SE	EMM	SE					
Total cholesterol	201	6.3	193	6.3	183	7.8	188	7.3	5.78	.022	2.14	0.154	
HDL	58	3.3	57	3.3	56	3.4	56	3.4	2.37	.134	0.71	0.408	
LDL	119	5.4	110	5.4	102	6.3	110	5.8	3.36	.076	3.70	0.063	
Triglycerides ^a	4.7	0.1	4.8	0.1	4.8	0.1	4.7	0.1	0.01	.926	3.66	0.065	
Twelve-months													
Waist circumference (inches)	45.7	1.4	47.2	1.4	44.2	1.5	46.4	1.4	3.39	.011	0.91	0.461	
Systolic blood pressure	136	2.9	134	2.9	126	3.6	122	3.2	7.77	.000	0.71	0.588	
Diastolic blood pressure	85	2.0	84	2.0	79	2.6	78	2.3	8.45	.000	0.85	0.495	

^aVariable was log-transformed to better approximate normality.