Appetite 69 (2013) 1–7

Contents lists available at SciVerse ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Research report

Relationship of cravings with weight loss and hunger. Results from a 6 month worksite weight loss intervention ☆

Payal Batra [a], Sai Krupa Das [a], Taylor Salinardi [a], Lisa Robinson [a,b], Edward Saltzman [a], Tammy Scott [a], Anastassios G. Pittas [c], Susan B. Roberts [a,*]

[a] *Energy Metabolism Laboratory, Jean Mayer USDA Human Nutrition Research Center on Aging, 711 Washington Street, Boston, MA 02111, United States*
[b] *New Balance Foundation Obesity Prevention Center, Boston Children's Hospital, Boston, MA, United States*
[c] *Division of Endocrinology, Diabetes, and Metabolism, Tufts Medical Center, Boston, MA, United States*

ARTICLE INFO

Article history:
Received 22 September 2012
Received in revised form 7 April 2013
Accepted 6 May 2013
Available online 16 May 2013

Keywords:
Obesity
Food cravings
Weight loss
Worksite
Hunger
Energy metabolism

ABSTRACT

We examined the association of food cravings with weight loss and eating behaviors in a lifestyle intervention for weight loss in worksites. This research was part of a randomized controlled trial of a 6-month weight loss intervention versus a wait-listed control in 4 Massachusetts worksites. The intervention emphasized reducing energy intake by adherence to portion-controlled menu suggestions, and assessments were obtained in 95 participants at baseline and 6 months including non-fasting body weight, food cravings (Craving Inventory and Food Craving Questionnaire for state and trait) and the eating behavior constructs restraint, disinhibition and hunger (Eating Inventory). There were statistically significant reductions in all craving variables in the intervention group compared to the controls. Within the intervention group, changes in craving-trait were significantly associated with weight loss after controlling for baseline weight, age, gender and worksite. However, in a multivariate model with craving-trait and eating behaviors (restraint, disinhibition and hunger), hunger was the only significant predictor of weight change. In contrast to some previous reports of increased food cravings with weight loss in lifestyle interventions, this study observed a broad reduction in cravings associated with weight loss. In addition, greater reductions in craving-trait were associated with greater weight change, but craving-trait was not a significant independent correlate of weight change when hunger was included in statistical models. Studies are needed to examine the effectiveness of hunger suppressing versus craving-suppressing strategies in lifestyle interventions for obesity.

Introduction

Food cravings are defined as intense desire for specific foods (Gendall, Joyce, & Abbott, 1999; Weingarten & Elston, 1990) and are experienced by 21–97% of the adult population (Christensen, 2007). Cravings are distinguished from hunger in that they usually focus on specific individual foods that are high in caloric density (Christensen, 2007; Gilhooly et al., 2007), whereas the state of hunger can be relieved by a diversity of foods (Martin, O'Neil, & Pawlow, 2006) that may differ in caloric density. Hunger, whether resulting from acute food deprivation or a desire to eat, is an innate phenomenon experienced almost universally by humans and other species (Zheng, Lenard, Shin, & Berthoud, 2009), whereas cravings are not a universal phenomenon and appear to be more prevalent in specific sub-populations (Christensen, 2007). In particular, the frequency and intensity of food cravings are known to be more prevalent and intense in obese individuals (Delahanty, Meigs, Hayden, Williamson, & Nathan, 2002; White, Whisenhunt, Williamson, Greenway, & Netemeyer, 2002) and have been suggested to play an important role in excess energy intake and weight gain (Forman et al., 2007; Moreno, RodrÃ-guez, Fernandez, Tamez, & Cepeda-Benito, 2008; Steel, Kemps, & Tiggemann, 2006), lack of success in weight loss (Forman et al., 2007; Hill, 2007; Jakubowicz, Froy, Wainstein, & Boaz, 2011; Lowe, 2003), and early drop-out from obesity treatment programs (Lim, Norman, Clifton, & Noakes, 2009; Moreno et al., 2008; Sitton, 1991). Currently, however, data to support a significant, causal role for cravings in weight regulation is lacking.

☆ *Acknowledgements*: *Funding/support*: This work was supported by the US Department of Agriculture agreement no. 58-1950-0-0014 with Tufts University and H15001-DAX023 by the Jean Mayer USDA Human Nutrition Research Center on Aging, Tufts University. Role of the Sponsor: The sponsors had no role in the design and conduct of the study; the collection, analysis, and interpretation of the data; or the preparation, review, or approval of the manuscript. *Disclaimer*: Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the US Department of Agriculture.

* Corresponding author.
E-mail address: susan.roberts@tufts.edu (S.B. Roberts).

0195-6663/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.appet.2013.05.002

Concerning cravings and weight loss, some recent studies reported increased cravings associated with dieting (Jakubowicz et al., 2011; Massey & Hill, 2012), which suggests that cravings could be a barrier to weight loss. However, other research found no change in the frequency or intensity of cravings with weight loss (Gilhooly et al., 2007) and there are also some reports of decreased cravings with weight loss (Alberts, Mulkens, Smeets, & Thewissen, 2010; Harvey, Wing, & Mullen, 1993; Jakubowicz et al., 2011; Lim et al., 2009; Martin et al., 2006). In addition, some researchers have suggested that a sense of deprivation may accentuate cravings and, thus, diet plans that restrict specific foods will be associated with increased cravings for restricted foods (Coelho, Polivy, & Herman, 2006; Gendall et al., 1999) while, conversely, reduced dietary variety during weight loss has been proposed as a potential mechanism for why cravings can decline during weight loss (Martin et al., 2006). Thus, there is no current consensus over whether weight loss is associated with increased or decreased food cravings, and whether interventions that successfully decrease cravings are associated with greater weight loss success on average.

The relationship between cravings and weight may also be mediated by hunger, which is hypothesized to vary between diets based on dietary composition (Eisenstein, Roberts, Dallal, & Saltzman, 2002; Howarth, Saltzman, & Roberts, 2001; Ludwig & Roberts, 2006; Rolls, 1995). Although food cravings can occur in the absence of hunger (Vander Wal, Johnston, & Dhurandhar, 2007), several studies unrelated to weight loss do show a significant relationship between hunger and food cravings (Alsene, Li, Chaverneff, & de Wit, 2003; Gibson & Desmond, 1999; Steel et al., 2006). Other factors such as mood state and operant conditioning also influence cravings (Hill, 2007), but do not necessarily invalidate a concomitant craving–hunger relationship (Christensen, 2007). We therefore examined the association between changes in hunger and changes in cravings with weight change in a worksite weight loss intervention that included dietary and behavioral components.

Methods and procedures

Worksites and participants

Study information was mailed to worksites with 100–1200 employees in Greater Boston, Massachusetts. Interested worksites were interviewed to confirm eligibility. The eligibility criteria included lack of any onsite weight loss program in the past 6 months, accessibility by public transportation, infrastructure to hold onsite group intervention sessions, and >50% employee response to an online employee survey for willingness to participate in one or more aspects of the study. The first 4 worksites completing all screening requirements were enrolled. The selected worksites were office-based and broadly classified as for-profit (2 sites) and non-profit (2 sites) companies.

Within each site, participants wishing to enroll in the onsite weight loss program were enrolled if age was $\geqslant$21 years, BMI was $\geqslant$25.0 kg/m^2, they gave written physician clearance, were not pregnant, and had no medical condition that would be expected to influence nutrient absorption or restrict adherence to the food-based program. The study was approved by the Institutional Review Board at Tufts Medical Center (Boston, MA) and all participants provided written informed consent. After baseline outcome assessments, the 4 sites were randomized to intervention sites or wait listed control sites. Each worksite was assigned a number and a random order of numbers was generated (SAS 9.2; SAS Institute Inc). The first 2 numbers in the output were assigned to the intervention, and the second 2 numbers were assigned to the control and there was one for profit and one non-profit site for each of the treatment arms. One worksite in the intervention group was substantially larger than the other worksites, resulting in a total employee size of 675 for intervention sites and 354 for controls sites. The wait-listed control sites completed outcome assessments during the 6 month period when the intervention sites received the weight loss program. To facilitate control worksite and employee retention, 2 informal social events that did not involve discussions on nutrition or weight control were hosted by the study team. At the end of the 6 month period, the control sites received a 2 month condensed weight loss intervention that employed the same principles as the 6 month intervention (data not shown).

Intervention

The weight loss intervention used an approach based on Social Cognitive Theory and Cognitive Behavioral Theory and goals for behavior change were based on a published weight loss book (Roberts & Sargent, 2010). The primary goal of the intervention was reducing energy intake to achieve 0.5–1 kg/week weight loss facilitated by use of portion controlled menus that were low in glycemic load, low in energy density, and contained $\geqslant$40 g/day dietary fiber. Dietary recommendations for macronutrients (26% protein, 26% fat and 48% low glycemic index carbohydrate) were within Acceptable Macronutrient Distribution Ranges of the Dietary Reference Intakes (Institue of Medicine., 2006) and the dietary fiber recommendation was greater than its current Recommended Dietary Allowance but similar to recent studies testing higher fiber diets for reduction in cardiometabolic risk factors (Jenkins et al., 2011). There were a total of up to 19 group sessions (15 consecutive sessions followed by biweekly sessions), each including a 60-min interactive educational session led by nutritionists with experience in behavior modification. The sessions addressed a variety of topics such as problem solving around barriers to reducing energy intake, and management of hunger and food cravings by adherence to provided menus, stimulus control and acceptance-based strategies (Forman et al., 2007). Other topics included portion control, self-monitoring, self efficacy, dietary variety, holidays, eating outside the home, social support, goal setting and strategies for weight maintenance. In addition to group sessions, participants received a weekly email from their counselor for individual support and a weekly email requesting weight self-monitoring data. At the intervention sites, there was also a monthly general nutrition and health seminar that could be attended by all worksite employees including those enrolled in the weight loss group.

Measures

Questionnaires that subjects completed online were used to assess demographic data, cravings and eating behaviors. Both intervention and control participants were requested to complete these assessments at baseline and 6 months.

Food cravings were measured using the Food Craving Questionnaire (FCQ) and Food Craving Inventory (FCI). The reliability and validity of the FCQ (Cepeda-Benito, Gleaves, Williams, & Erath, 2000; Moreno et al., 2008) and FCI (White & Grilo, 2005) have been reported and these instruments are generally recognized as the best measures of food cravings currently available (Christensen, 2007). The FCQ assesses 9 trait (T, general susceptibility to craving) and 5 state (S, strength of craving at the moment of administration) dimensions of food craving (Cepeda-Benito et al., 2000). The FCI (White et al., 2002) is a 28-item assessment for capturing subjective experience and frequency of specific food craving across 28 different foods over the past month, consisting of four scales (high fats, sweets, carbohydrates/starches and fast food fats).

The Eating Inventory, previously known as the three factor eating questionnaire is a validated 51 item questionnaire (Stunkard & Messick, 1985) that assesses cognitive restraint (21 items to assess conscious attempts to monitor and regulate intake), disinhibition (16 items to assess tendency to overeat in response to cognitive or emotional cues) and hunger (14 items to assess feeling and perception of hunger). Some of these questionnaires had missing data and, in these cases, we used a previously developed algorithm for calculating proportional scores for each construct (Hays et al., 2002). Specifically when ⩽15% of the scale's questions were unanswered, proportional scales were calculated, while when >15% of the scale's questions were unanswered, a score was not calculated and data for the particular construct or subscale was set to missing. As a result of this adjustment, the sample size for constructs varied between 71 and 74 subjects.

Weight was measured in the non-fasting state wearing light clothing and indoor shoes. The same calibrated digital scales were used at each time-point (UC-321PL Precision Health Scale, A&D Medical; San Jose, California) at all sites and were accurate to 0.05 kg. Height was measured on a single occasion using a portable stadiometer (Model HM200P, Portstad Portable Stadiometer; Quick Medical, Washington).

Statistical analyses

Comparisons were made for participants at the intervention sites vs. those enrolled as wait-listed controls at the control sites. Comparisons of baseline differences between the intervention and control groups were also made, using Student's *t* test for independent samples for continuous variables and Fisher exact test for categorical variables. The impact of the intervention on cravings was assessed by comparing mean change in scores of the subscales and global scores on the 3 craving instruments between the intervention and control groups by ANCOVA models controlling for age, sex and baseline value of the respective variable. The same sets of models were run accounting for differences by worksite within each group. Pearson correlation coefficients were generated for baseline and change scores on cravings in relation to changes in weight and eating behavior constructs. Fisher's *z* transformation was used to assess by site differences in the Pearson correlation coefficients. We investigated the association of baseline scores as well change in cravings with weight change over 6 months ($Weight_{6months}$–$Weight_{baseline}$) by multiple regressions with and without inclusion of eating behavior variables. To focus on cravings as predictors and correlates of weight change over and above the contribution attributable to gender, initial weight, age and worksite, these variables were forced into all regression models. Analyses were performed using SAS version 9.2 (SAS Institute, Inc., North Carolina) and statistical significance for all variables was set at a 2-sided *P* value of <.05.

Results

Subject characteristics

Table 1 summarizes the subject characteristics at baseline for the intervention and control groups. Data is reported here for a subset of completers who provided all outcome measures, representing 79% of intervention participants and 54% of control participants. Details of the recruitment and participant flow have been reported by Salinardi et al., 2013 (Salinardi et al., 2013). At baseline, there were no statistically significant differences in weight, BMI, age, or other demographic, physical activity as measured by IPAQ-short (Ekelund et al., 2006) or behavioral variables between the intervention and control groups. The intervention was well received at the intervention sites with an 89% of intervention participants completing the 6 month program and an 84% attendance at group sessions.

Table 1
Baseline characteristics.

	Intervention *n* = 74 Mean ± SD	Control *n* = 21 Mean ± SD
Age	49.1 ± 10.1	49.8 ± 10.9
Height (cm)	167.8 ± 9.7	163.2 ± 7.5
Weight (kg)	94.5 ± 21.9	91.6 ± 24.4
BMI (kg/m^2)	33.5 ± 6.5	33.1 ± 6.6
Gender		
Male, *n* (%)	20 (27)	3 (14)
Female *n* (%)	54 (73)	18 (86)

At baseline, 66% of the participants reported food cravings ranging from sometimes to daily in the past month, and 34% reported that they rarely experienced cravings in the past month. 79% of females and 21% of males reported cravings. Cravers reported cravings for fatty foods (54%), sweets (90%), carbohydrates (84%) and fast food (86%) over the past month. There was a significant correlation between BMI at baseline and the frequency of cravings as measured by the FCI ($r = 0.21$, $p = 0.046$) and the intensity of cravings as measured by FCQ-T ($r = 0.29$, $p = 0.006$). Of the eating inventory variables, only disinhibition showed a significant correlation with BMI at baseline ($r = 0.30$, $p = 0.009$).

Change in cravings

Table 2 shows the baseline and 6 month values for body weight, craving, and eating behavior variables for intervention and control groups. Net weight change for individuals in this study was −8.1 ± 6.8 kg (mean ± SD) in intervention participants and +0.9 ± 3.6 kg in control participants. There were significant decreases in all craving scores in the intervention group compared to the control group as determined by ANCOVA models controlling for the baseline scores, age and sex. When ANCOVA models included a nested (worksite within group) covariate was added to the model, total FCQ-S and FCQ-T scores, and some of the subscales remained significant as summarized in Table 2.

Craving variables as correlates of weight change and Eating Inventory variables

Pearson's correlations for associations between the weight change and both baseline and change values for craving variables were not significantly different between the 2 intervention sites. Further, neither the baseline nor the change scores of FCI and FCQ-S showed associations with weight change and were not included in further analyses. The correlation between FCQ-T and weight change are presented in Table 3. Baseline FCQ-T and most of its subscales were negatively correlated with weight change; in other words, participants with greater scores on FCQ-T at baseline showed smaller subsequent weight change. Changes in FCQ-T variables were positively correlated with weight change such that greater reductions in FCQ-T were associated with greater weight change. Significant positive correlations were also observed between the baseline and change scores for hunger and disinhibition and FCQ-T variables. Decreases in all FCQ-T variables over 6 months were positively correlated with decreases in hunger susceptibility and disinhibition as shown in Fig. 1. There was also a significant negative correlation between change in restraint and change in total FCQ-T score.

Table 2
Changes in cravings and eating inventory for intervention and control groups.

	Intervention n = 74		Control n = 21		Between group difference for change over time
	Baseline Mean ± SD	6-month Mean ± SD	Baseline Mean ± SD	6-month Mean ± SD	p
Weight (kg)	94.5 ± 21.9	85.9 ± 19.2	91.6 ± 24.4	92.5 ± 26.9	<0.0001
Craving inventory					
Fats (1–5)	1.92 ± 0.60	1.44 ± 0.45	1.88 ± 0.72	1.77 ± 0.60	0.0020
Sweets (1–5)	2.48 ± 0.75	1.68 ± 0.60	2.56 ± 0.99	2.30 ± 0.95	<0.0001
Carbohydrates (1–5)	2.26 ± 0.69	1.69 ± 0.55	2.11 ± 0.78	2.01 ± 0.65	0.0033
Fast food fats (1–5)	2.51 ± 0.78	1.95 ± 0.77	2.46 ± 0.78	2.40 ± 0.82	0.0027
Total craving Inventory score (1–5)	2.25 ± 0.56	1.66 ± 0.47	2.22 ± 0.59	2.07 ± 0.48	<0.0001
Craving-state					
Intense desire to eat (3–15)	8.53 ± 3.32	6.45 ± 2.95	9.04 ± 3.47	9.76 ± 3.66	<0.0001[a]
Anticipation of positive reinforcement (3–15)	7.91 ± 3.15	5.92 ± 2.61	7.61 ± 2.36	8.10 ± 3.79	0.0016
Anticipation of relief from negative state (3–15)	7.50 ± 2.84	5.92 ± 2.60	6.47 ± 2.73	7.52 ± 2.79	0.0021[b]
Lack of control over eating (3–15)	7.81 ± 3.14	5.82 ± 2.58	8.42 ± 3.08	8.52 ± 4.00	0.0004[a]
Hunger (3–15)	7.89 ± 3.02	5.63 ± 2.41	7.57 ± 2.83	7.38 ± 3.01	0.0035[a]
Total craving-state score (15–75)	39.60 ± 11.8	29.7 ± 10.9	39.1 ± 7.3	41.3 ± 11.6	<0.0001[b]
Craving-trait					
Plans to consume food (3–18)	9.20 ± 3.68	6.62 ± 3.06	9.52 ± 4.37	9.90 ± 4.64	<0.0001[b]
Anticipation of positive reinforcement (5–30)	13.49 ± 4.94	10.57 ± 4.02	14.1 ± 5.66	14.61 ± 6.34	0.0002
Anticipation of relief from negative state (3–18)	7.71 ± 3.03	5.83 ± 2.38	7.619 ± 3.77	8.10 ± 4.64	0.0009
Lack of control over eating (6–36)	17.23 ± 7.53	13.12 ± 5.68	18.19 ± 8.86	18.4 ± 9.9	0.0007
Preoccupation with food (7–42)	16.25 ± 8.05	12.38 ± 4.82	16.68 ± 7.95	18.7 ± 9.3	<0.0001
Hunger (4–24)	11.91 ± 4.07	9.24 ± 3.69	11.68 ± 4.47	12.3 ± 4.30	<0.0001
Emotions experienced before or during food cravings (4–24)	11.91 ± 5.76	8.98 ± 3.87	12.71 ± 7.34	13.7 ± 7.09	<0.0001
Cues that trigger craving (4–24)	13.82 ± 4.75	10.52 ± 4.17	13.57 ± 4.80	12.9 ± 4.92	0.0038
Guilt from cravings (3–18)	9.66 ± 4.36	7.51 ± 3.25	10.14 ± 3.81	9.64 ± 3.82	0.0091[a]
Total craving-trait score (39–234)	111.2 ± 38.8	84.30 ± 29.4	114.3 ± 41.5	118. ± 46.3	<0.0001[a]
Eating inventory					
Hunger (0–14)	6.35 ± 3.59	3.55 ± 2.75	5.66 ± 3.48	6.23 ± 3.68	<0.0001[b]
Disinhibition (0–16)	8.78 ± 4.22	6.27 ± 3.14	8.93 ± 4.25	9.59 ± 4.37	<0.0001
Restraint (0–21)	8.96 ± 4.02	14.39 ± 3.24	8.74 ± 5.52	9.02 ± 5.37	<0.0001

Between group differences measured by GLM (general linear model) adjusting for baseline score of the variable, age and sex. Superscripted *p* values are presented for models including a nested (worksite within group) covariate.
[a] $p < 0.05$,
[b] $p < 0.01$.

Table 3
Pearson correlations between weight change and craving trait variables.

	Weight change and baseline craving score r	Weight change and craving change score r
Craving-trait		
Plans to consume food	−0.301[b]	0.365[b]
Anticipation of positive reinforcement	−0.215	0.169
Anticipation of relief from negative state	−0.328[b]	0.462[c]
Lack of control over eating	−0.238[a]	0.344[b]
Preoccupation with food	−0.256[a]	0.284[a]
Hunger	−0.194	0.271[a]
Emotions experienced before or during food cravings	−0.126	0.146
Cues that trigger craving	−0.105	0.158
Guilt from cravings	−0.075	0.047
Total craving-trait score	−0.241[a]	0.334[a]

Change scores for weight and craving trait variables are calculated as 6 month – baseline value.
[a] $p < 0.05$,
[b] $p < 0.01$,
[c] $p < 0.001$.

Craving variables as predictors of weight change

Multiple regression analyses were performed on FCQ-T variables to explore predictors of weight change over 6 months of the intervention. These models were controlled for baseline weight, age, sex and worksite. Baseline scores on FCQ-T subscales or total score were not significant predictors of subsequent weight change. Using all the change scores of FCQ-T subscales in one model, decreases in ‘plans to consume food’ ($p = 0.022$) and ‘anticipation of relief from negative state’ ($p = 0.024$) were associated with weight change (model $R^2 = 0.58$, $p = <0.0001$). Change in total FCQ-T score (Model 1, Table 4) showed a significant association with weight change from 0 to 6 months (model $R^2 = 0.39$, $p = 0.01$). However, in the presence of the eating inventory constructs, restraint, disinhibition and hunger, neither total FCQ-T or the subscales of FCQ-T retained significance (Model 2, Table 4). In this overall model, change in hunger was the only significant variable (model $R^2 = 0.44$, $p = 0.0025$). The results were the same even when eating inventory and craving scores were transformed into percentages and entered in the model.

Discussion

Food cravings are suggested to be both an impediment to weight loss and a promoter of recidivism after weight loss. (Forman et al., 2007; Moreno et al., 2008; Sitton, 1991). Specific techniques for reducing food cravings are included in some behavioral programs for weight control including the present study. However, there has been limited experimental data to support a significant relationship between cravings and weight loss, and thus the role of cravings in successful weight management remains uncertain. In common with most previous studies of food cravings and obesity (Christensen, 2007; Delahanty et al., 2002) we found that the majority of our population experienced food cravings at baseline,

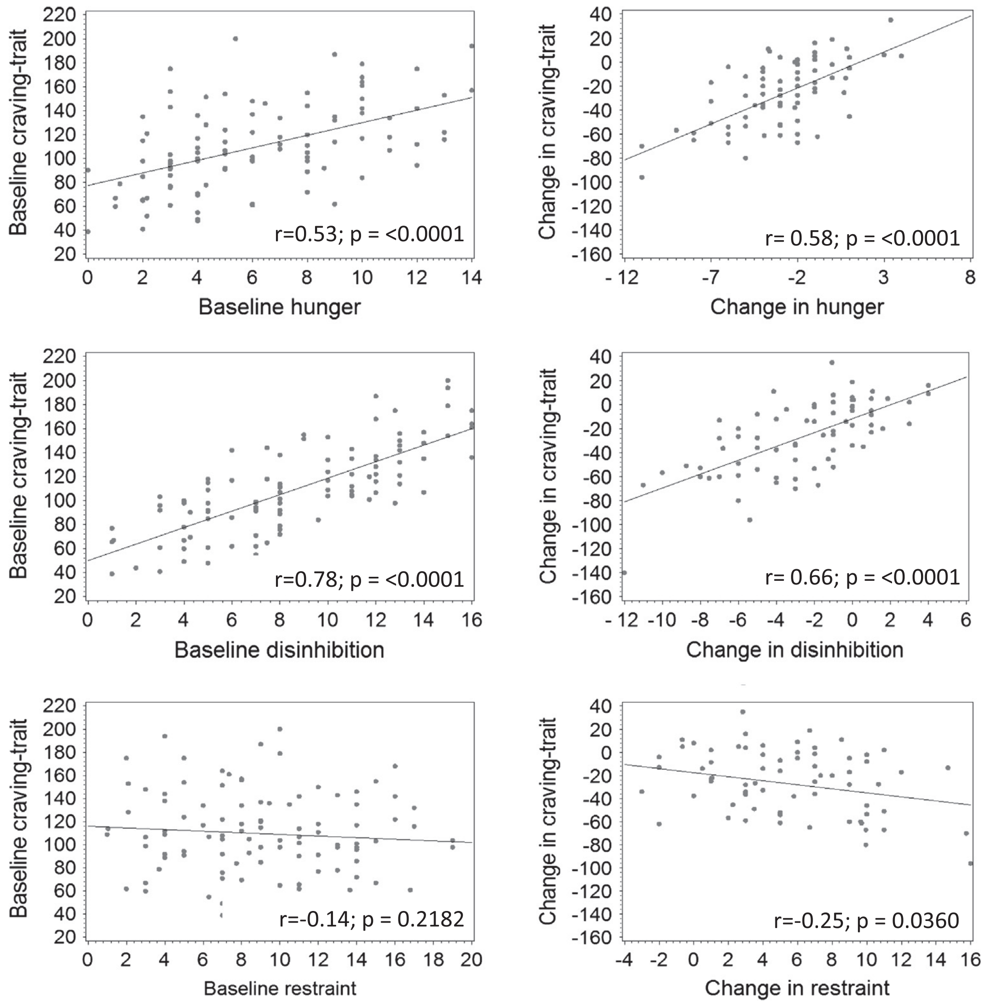

Fig. 1. Relationship between Craving-Trait and Hunger, Disinhibition and Restraint. Pearson's correlation coefficients shown for relationships between hunger, restraint and disinhibition from the Eating Inventory and total craving-trait at baseline and after 6 months of intervention.

Table 4
Regression models identifying predictors of weight loss from 0 to 6 months.

	Coefficients				Model summary		
	Beta ± SE	t	p	Partial r^2	r^2	adj r^2	p
Model 1: craving-trait total score							
ΔTotal craving-trait score	0.12 ± 0.05	2.5	0.0150	0.087	0.39	0.33	<0.0001
Model 2: craving-trait and eating Inventory							
ΔHunger	1.45 ± 0.62	2.34	0.0225	0.081	0.44	0.36	<0.0001
ΔRestraint	−0.30 ± 0.39	−0.76	0.4480	0.009			
ΔDisinhibition	0.10 ± 0.57	0.18	0.8597	0.004			
ΔTotal craving-trait score	0.03 ± 0.07	0.43	0.6715	0.002			

$n = 71$; the models were adjusted for baseline weight, age, sex and site.

and cravings were typically for sweets, carbohydrates and fast food fats. In addition, higher BMI at baseline was associated with greater severity and frequency of cravings, a finding that appears to support a role for cravings in the maintenance of obesity. However, the severity and frequency of cravings declined substantially during weight loss in this population of adult men and women enrolled in a worksite weight loss program. Even though cravings declined during weight change, in our analyses no craving variable was significantly associated with weight change independent of hunger. Combined, these findings indicate that frequent, intense cravings are usually associated with obesity but that cravings are susceptible to change using techniques such as reduction to exposure to the palatable foods that evoke cravings and are not a barrier to embarking on a program for successful weight loss.

Previous studies have reported widely divergent changes in cravings with weight loss, with some reports of increased cravings (Massey & Hill, 2012), other reports of no change (Gilhooly et al., 2007; Massey & Hill, 2012), or, as in this study, a decrease (Harvey et al., 1993; Lim et al., 2009; Martin et al., 2006). Possible explanations proposed for the different findings have been the different types of dietary prescriptions, different intervention components, different study duration and different instruments used to assess cravings. In addition, several of the previous studies of cravings and weight loss used liquid calorie or high protein diets with restricted variety (Harvey et al., 1993; Jakubowicz et al., 2011; Martin et al., 2006), thus making it difficult to separate the effects of consuming a restricted-variety diet versus weight loss on cravings. To our knowledge this is the first study that showed a decline in food cravings in association with weight loss when a diet consisting of regularly available foods and typical dietary patterns was recommended.

It is noteworthy that we achieved consistent significant associations between weight change and cravings with the FCQ-T subscale. Although reductions in FCQ-S were also significant in the intervention group compared to the control group, these changes did not associate with weight change and did not correlate with changes in hunger and disinhibition. State-craving has been shown to respond to particular events whereas trait-craving typically manifest across times and situations (for example, chocolate craving after last meal of the day vs. chocolate craving over the 6 month intervention period) (Moreno et al., 2008), which may make it more relevant to studies relating to weight loss, as in this investigation. Moreover, as proposed by Vander Wal et al. (2007)), overweight and obese individuals may not be sensitive to FCQ-S.

Cravings have been hypothesized to be a conditioned expression of hunger that is acquired by repeated experience of eating the craved food in a hungry state (Gibson & Desmond, 1999; Gilhooly et al., 2007; Steel et al., 2006). Support for the role of hunger in the development and maintenance of cravings can be seen in those reports of cravings declining acutely after food consumption (Hill & Heaton-Brown, 1994; Steel et al., 2006) and increasing acutely after food deprivation or in a hungry state (Alsene et al., 2003). However, this is the first study that supports the hypothesis with data obtained during weight loss, and notably cravings and hunger both declined with weight loss, and weight loss and hunger were also significantly associated both at baseline and at the end of the 6-month weight loss program. These associations suggest that cravings, hunger and disinhibition track each other during changes in energy balance. However, when eating behavior variables were included in models along with FCQ-T, only hunger showed significant associations with weight change. Further studies are needed to investigate whether hunger control may be a more central factor determining success or failure in weight loss, and if so whether cravings and disinhibited eating behavior are associated with hunger levels rather than independent factors influencing weight control.

Important features of this study included the use of a randomized prospective design including features of both hunger and craving control, low attrition rates, and the use of psychometrically robust questionnaires for assessment of cravings (Christensen, 2007; Vander Wal et al., 2007). The findings should also be viewed in light of some limitations. In particular, the study findings provide associations which need to be confirmed in intervention studies designed to selectively address hunger versus craving reduction during weight loss. Another limitation is that data on smoking status, which may influence hunger and cravings, was not collected. Although we accounted for different worksites in regression models, it was a pilot group-randomized study and lacked statistical power to conduct cluster-randomized analyses. We speculate that due to this lack of statistical power, many of the between group differences for FCI, FCQ-S and FCQ-T dissipated when a nested covariate was included in the models. Nevertheless, to our knowledge, this is the first study to investigate cravings and its interrelationships with hunger and weight loss in worksites, which are increasingly being endorsed as potentially important locations for implementing public health measures for reducing the obesity epidemic.

In conclusion, this 6 month study provides the first data on cravings from a worksite weight loss program and confirms that food cravings are widespread in obese and overweight adults. Both the intensity and frequency of cravings decreased with weight change, but neither baseline nor change in scores for cravings showed associations with weight change when included in models with hunger. These results suggest that a reduction in hunger may be a more important determinant of successful weight control than reduction in cravings. Further research is needed to compare the relative importance of reducing hunger versus reducing cravings in interventions for long-term weight control.

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