Original Article
CLINICAL TRIALS: BEHAVIOR, PHARMACOTHERAPY, DEVICES, SURGERY

Obesity

Eating Behaviors as Predictors of Weight Loss in a 6 Month Weight Loss Intervention

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Objective: To examine associations between eating behavior constructs and weight loss (WL) in a 6-month WL intervention in worksites.

Design and Methods: A cluster-randomized controlled trial of a group behavioral WL intervention versus wait-listed control was conducted at four worksites. Measures included body weight and the eating behavior constructs restraint, disinhibition, hunger, and their sub-constructs. Rates of intervention meeting attendance and weight self-monitoring were also quantified.

Results: WL was greater in intervention participants than controls ($\Delta I = -8.1 \pm 6.8$ kg, $\Delta C = +0.9 \pm 3.6$ kg, $P<0.001$). Between-group analyses showed that the intervention was associated with increased restraint ($\Delta I = 5.43 \pm 4.25$, $\Delta C = 0.29 \pm 3.80$, $P<0.001$), decreased disinhibition ($\Delta I = -2.5 \pm 3.63$, $\Delta C = 0.66 \pm 1.85$, $P < 0.001$) and decreased hunger ($\Delta I = -2.79 \pm 3.13$, $\Delta C = 0.56 \pm 2.63$, $P < 0.001$), and changes in all eating behavior subscales. Greater WL in intervention participants was correlated with higher baseline hunger ($r = -0.25$, $P = 0.03$), increased restraint ($r = -0.35$, $P=0.001$), decreased disinhibition ($r = 0.26$, $P = 0.02$), and decreased hunger ($r = 0.36$, $P = 0.001$). However, in a multiple regression model including rates of meeting attendance and self-monitoring, decreased hunger was the only eating behavior change that predicted weight loss ($R^2=0.57$, $P<0.001$).

Conclusion: Decreased hunger was the strongest predictor of WL in this intervention with relatively high mean WL. Further studies are needed to confirm the central role of hunger management in successful WL.

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Introduction

Overweight and obesity remain at epidemic levels and are associated with increased morbidity and mortality (1) as well as increased health care costs (2). Behavioral or lifestyle interventions are recommended for weight loss in obese individuals, but the widely suggested goal of 5-10% weight loss to achieve significant health benefits (3) is not routinely achieved even in intensive weight loss intervention studies (4). Identifying individual baseline characteristics and behavior changes that correlate with more successful weight loss in different types of interventions could potentially inform the development of more effective and sustainable interventions for weight control (5,6).

Previous studies have focused on program adherence variables and also on eating behaviors in short- and long-term weight loss in several environments such as research studies (7-9), clinic-based diets (6,10,11), and community programs (12,13). The eating behaviors most usually studied are restraint, which is the conscious restriction of food intake as a means of weight control; disinhibition, which is the tendency to overeat in response to different stimuli; and hunger, which is the tendency to eat in response to perceived physiological signal. Most of the studies have shown that greater weight loss is associated with higher baseline restraint and lower baseline disinhibition. In addition, greater increases in restraint and/or greater decreases in disinhibition over time were typically associated with

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greater weight loss in interventions that emphasized behavior changes related to increased restraint and decreased disinhibition (7,9). However, to date, there have been no studies examining predictors of weight loss in worksite weight loss interventions, although worksites are increasingly being suggested for weight management interventions to reduce the national obesity epidemic (14,15). Moreover, worksite weight management interventions reported to-date have generally reported smaller effect sizes than non-worksite programs or large research trials (15,16), which may alter the relative importance of different factors predicting weight loss success. Furthermore, worksites provide both a physical and social structure and opportunities for extended contact time, which may alter the relationship between eating behaviors and weight loss in comparison to non-worksite settings.

As part of a new weight loss intervention in worksites, we examined predictors of weight loss success that have been reported to be significant in non-worksite trials, including baseline and change scores for eating behavior constructs and sub-constructs determined using the Eating Inventory (17,18), weight self-monitoring (19,20), and rates of meeting attendance (6,8,13).

Methods

Participants and procedures

The Healthy Weight for Life (HWL) study was a 6-month randomized controlled trial of a new worksite weight loss intervention. Change in weight was the primary outcome and changes in behavioral and psychological factors were included as secondary outcomes. Four worksites in the Greater Boston area with 80-800 employees were recruited for the study. The worksites were identified through a multi-stage screening process, and eligibility of sites was defined as the absence of a formal onsite weight loss program during the previous 6 months, accessibility by public transportation, employee interest in participating in one or more program components as gauged by an online survey, and adequate infrastructure and logistical support from human resources. The companies enrolled in the study were broadly categorized as for-profit (two sites) and non-profit (two sites) office-based companies. After obtaining agreement from each of the worksites, employees were invited to enroll in a cost-free weight loss program, which would be a 6-month program beginning immediately after baseline assessments if their worksite was randomized to the intervention (two sites) or a 2-month intervention starting after the main 6-month study period if their worksite was randomized to the wait-listed control (two sites). The wait listed control sites completed outcome assessments during the main 6-month study period. The intervention program provided to intervention worksites was a moderate-intensity group weight loss program based on a published book (21). The eligibility criteria for employees to enroll in the weight loss program were interest in participating, BMI during screening $\geq$25 kg/m^2, age $\geq$ 21 years, and a written clearance for participation in the study and the absence of significant co-morbidities from their primary care physician.

Baseline outcome assessments were obtained prior to worksite-level randomization to either intervention or control. For the randomization, one number was assigned to each worksite and a random order of the numbers was generated (SAS 9.2, SAS Institute, Cary, North Carolina). The first two numbers in the output were assigned to the intervention (one for-profit and one non-profit worksite) and the second two were assigned to the control (one for-profit and one non-profit worksite).

Employees who enrolled in the weight loss program at the intervention sites received a lifestyle intervention program with the goal of reducing energy intake sufficient to achieve a weight loss of 0.5-1.0 kg/week. Groups of up to 20 employees met with their interventionist weekly for the first 15 weeks and then semimonthly for the remainder of the 6-month program with a total of 19 possible group meetings that could be attended. These group meetings included an educational component as well as providing a forum for discussion and social support. Caloric restriction was based on the participant's baseline weight. Macronutrient targets were 26% protein, 26% fat, and 48% low glycemic index carbohydrate (22), and dietary fiber target was $\geq$ 40 g/day. All macronutrient recommendations were within Acceptable Macronutrient Distribution Ranges of the Dietary Reference Intakes (23) and dietary fiber was higher than its DRI (24). Factors such as dietary composition, meal timing, and high fiber intake were specifically combined and translated in a practical menu-based approach to facilitate adherence and hunger management (25,26). Craving control was addressed by a combination of control-based strategies (such as problem solving around how to cognitively restructure urge-related thoughts and cues to mentally distract from food stimuli) and acceptance-based strategies aimed at increasing mindfulness of internal experiences (27). Examples of practical behavior changes facilitated by the program included meal planning, grocery shopping, social support, differentiating between hunger and non-hunger stimuli, promoting dietary restraint and decreasing disinhibition, hunger, cravings, and practical strategies for social situations such as holiday eating and restaurant eating. Self-monitoring of daily home weights, and food intake using food logs on an as-needed basis, was also encouraged. Since our approach was menu-based and emphasis was placed on meal planning, we did not suggest that subjects keep food logs regularly and reserved this step for when participants did not show weight loss. Group meetings were led by nutritionists with experience in lifestyle approaches to weight control. In addition to support groups for weight control, intervention sites also received a monthly seminar and handouts that were open to all worksite employees.

Control sites received no intervention during the 6-month study period. To facilitate control worksite and employee retention, two informal social events that did not involve discussions on nutrition or weight control were hosted by the study team.

Measures

Weight and Height. Weight was measured in the non-fasting state while subjects were wearing light clothing and indoor shoes. Measurements were made at baseline and at 6 months in both groups and also at 2.5 months in the intervention group. A calibrated digital scale was used at each time-point (UC-321PL Precision Health Scale, A&D Medical; San Jose, California) at all sites and two measurements that were within 2% were obtained. Height was measured on a single occasion during the study period using a portable stadiometer (Model HM200P, Portstad Portable Stadiometer; Quick Medical, Washington).

Online Questionnaires. These were administered for demographics and eating behaviors at baseline and for eating behaviors also at 6 months in both the intervention and control participants, with an additional time point at 2.5 months in the intervention participants.

Eating behavior was measured by using the 51-item Eating Inventory (previously known as the three factor eating questionnaire or

TABLE 1 Baseline characteristics

	Intervention $n = 74$ Mean ± SD	Control $n = 21$ Mean ± SD
Age	49.09 ± 10.12	49.84 ± 10.98
Height (cms)	167.77 ± 9.68	163.25 ± 7.50
Weight (kg)	94.51 ± 21.93	92.91 ± 22.41
BMI (kg/m^2)	33.48 ± 6.47	33.12 ± 6.61
Gender		
Male, *n* (%)	20 (27)	3 (14)
Female *n* (%)	54 (73)	18 (86)

TFEQ) (17). Within this questionnaire, three sets of questions are used to calculate cognitive restraint (21 items to assess conscious attempts to monitor and regulate intake, scale 0-21); disinhibition (16 items to assess disruption of eating in response to cognitive or emotional cues, scale 0-16); and hunger (14 items to assess feeling and perception of hunger, scale 0-14). The scale consists of 36 true/false items and 15 forced-choice format questions. Higher scores reflect a proportionately greater tendency to exhibit that particular eating behavior characteristic. The Eating Inventory is a valid and reliable instrument (17) and has been successfully used online (28). Since the development of the questionnaire, subscales for each of the three constructs has also been proposed (18). Subscales for restraint include strategic dieting behavior (behaviors that might be used to control weight, for example, deliberately taking small helpings), attitude to self-regulation (overarching perspective on eating and weight control, e.g., feeling that life is too short to worry about dieting), and avoidance of fattening foods (dieting behavior which limits calorie-dense foods). Disinhibition subscales include habitual susceptibility (recurrent disinhibition triggered by routine circumstances), emotional susceptibility (associated with negative affective states), and situational susceptibility (disinhibition initiated by specific environmental cues, e.g. social occasions). Subscales for hunger include internal locus of hunger (hunger that is interpreted and regulated internally) and external locus of hunger (hunger that is triggered by external cues). The investigation of these subscales is relevant since it may provide a more detailed understanding of eating behaviors (29), and all scales and subscales were analyzed in this study. When the Eating Inventory questionnaire was returned with some missing data, we used a previously developed algorithm for calculating proportional scores of scales and subscales (30). Specifically when $\leq$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 subscales varied between 71 and 74 subjects.

Attendance and Adherence. Attendance was recorded at each support group meeting, and each individual's percent attendance for the 6-month intervention period was calculated. Participants were requested to send their daily self-weighing records to the counselor once every week; these weekly submissions were used to calculate percent weight self-monitoring (percent of records for weights that were sent on weekly request to the counselor).

Statistical analyses

Comparisons in this study are for participants at the intervention sites versus those enrolled in the wait-listed weight loss program at the control sites. Analyses were performed using Statistical Analysis System version 9.2 (SAS Institute, North Carolina), and statistical significance for all variables was set at a two-sided P value of $<$ .05. Comparisons of baseline differences between the intervention and control groups were 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 constructs measured by the Eating Inventory was assessed by comparing mean change in scores of these variables between the intervention and control participants by ANCOVA models controlling for age, sex, and baseline values. Pearson correlation coefficients were generated for baseline and change scores in relation to change in weight. Fisher's z transformation was used to assess site differences in the Pearson correlation coefficients. We investigated association of both baseline and change scores of the Eating Inventory variables as well as attendance and adherence with weight change ($\text{Weight}_{6\ \text{months}} - \text{Weight}_{\text{baseline}}$) by multiple regressions, with overall models per construct and individual models of the sub-scales within each construct. To focus on eating behavior, attendance and adherence as predictors of weight loss beyond the contribution attributable to gender, initial weight, and age, these three variables were forced into all regression models. Additionally, worksite as a covariate was also included to adjust for site-to-site variability. ''All possible regressions'' was used to derive the best fitting overall model based on the coefficient of multiple determination (R^2). This approach of model selection is favored over stepwise approaches since the final model is selected based on all possible subsets of explanatory variables. Due to the limits on subject-parameter ratio, only main effects were entered for all possible regression; interactions were beyond the scope of the current analysis.

Results

Baseline and 6-month measurements were completed by 89.4% of participants (84 out of 94) at the intervention sites and 87.2% (34 out of 39) at the control sites. Reasons stated for not completing the trial included time conflicts ($n = 7$), change in job ($n = 3$), lost to follow-up ($n = 3$), and drop out for unrelated health issues ($n = 2$). Table 1 summarizes the baseline demographics for intervention participants who completed online questionnaires at all time points ($n = 74$ intervention and $n = 21$ controls). At baseline, there were no statistically significant differences in weight, BMI, age, or other demographic or behavioral variables between the intervention and control participants.

Table 2 shows the eating behavior and body weight values at baseline and 6 months for intervention and control groups. Mean weight change for individuals in this study during the 6 month was -8.1 ± 6.8 kg in intervention participants and $+0.9\pm3.6$ kg in control participants. The mean % weight loss was -8.8% in the intervention participants and +0.6% in the control participants. Intervention versus control differences analyzed by ANCOVA controlling for the baseline scores, age and sex showed that there were significant increases in dietary restraint and subscales for dietary restraint, and decreases in disinhibition, hunger, and subscales for these constructs in the participants at the intervention sites compared to the wait-listed controls. When ANCOVA models included company

TABLE 2 Changes in eating inventory constructs for control and intervention groups

	Intervention			Control			Between group difference for change over time
	$n = 74$			$n = 21$			
	Baseline	6-month		Baseline	6-month		
	Mean ± SD	Mean ± SD	Δ	Mean ± SD	Mean ± SD	Δ	*P*
Weight (kg)	94.51 ± 21.93	85.93 ± 19.28	−8.1 ± 6.8	91.59 ± 24.41	92.54 ± 26.93	0.9 ± 3.6	<0.0001
Eating inventory							
Restraint (0–21)	8.96 ± 4.02	14.39 ± 3.24	5.43 ± 4.25	8.74 ± 5.52	9.02 ± 5.37	0.28 ± 3.80	<0.0001
Strategic dieting behavior	1.27 ± 1.25	2.32 ± 1.32	1.04 ± 1.63	1.00 ± 1.45	1.44 ± 1.16	0.44 ± 1.36	0.0214[a]
Attitude to self regulation	2.43 ± 1.22	3.97 ± 1.05	1.54 ± 1.27	2.38 ± 1.47	2.36 ± 1.68	−0.02 ± 1.16	<0.0001[a]
Avoidance of fatty foods	2.45 ± 1.10	3.66 ± 0.65	1.21 ± 1.11	2.74 ± 1.34	2.46 ± 1.44	−0.28 ± 1.03	<0.0001
Disinhibition (0–16)	8.78 ± 4.22	6.27 ± 3.14	−2.51 ± 3.63	8.93 ± 4.25	9.59 ± 4.37	0.66 ± 1.85	<0.0001
Habitual susceptibility	2.19 ± 1.73	1.34 ± 1.06	−0.84 ± 1.61	2.33 ± 1.46	2.73 ± 1.84	0.39 ± 0.84	<0.0001
Emotional susceptibility	1.58 ± 1.25	0.87 ± 1.06	−0.72 ± 1.15	1.68 ± 1.34	1.52 ± 1.29	−0.16 ± 1.31	0.0039
Situational susceptibility	3.11 ± 1.63	2.17 ± 1.48	−0.91 ± 1.47	2.95 ± 1.72	3.05 ± 1.60	0.09 ± 1.14	0.0018
Hunger (0–14)	6.35 ± 3.59	3.55 ± 2.75	−2.79 ± 3.13	5.66 ± 3.48	6.23 ± 3.68	0.56 ± 2.63	<0.0001[b]
Internal locus for hunger	2.32 ± 1.94	1.04 ± 1.40	−1.32 ± 1.78	2.14 ± 1.82	2.44 ± 2.06	0.29 ± 1.68	<0.0001[a]
External locus for hunger	2.21 ± 1.42	1.15 ± 1.23	−1.05 ± 1.21	1.71 ± 1.42	2.33 ± 1.71	0.62 ± 1.39	<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 for models accounting for group randomized nature of the study; [a]P<0.05, [b]P<0.01 Δ = 24 week baseline values.

TABLE 3 Pearson correlations between weight change and baseline and 6-month changes in Eating Inventory variables

	Baseline *r*	Change score *r*
Restraint	0.146	−0.359[b]
Strategic dieting behavior	0.148	−0.373[b]
Attitude to self regulation	0.011	−0.235[a]
Avoidance of fatty foods	0.156	−0.222
Disinhibition	−0.187	0.266[a]
Habitual susceptibility	−0.157	0.235[a]
Emotional susceptibility	−0.124	0.203
Situational susceptibility	−0.147	0.189
Hunger	−0.251[a]	0.362[b]
Internal locus for hunger	−0.237[a]	0.359[b]
External locus for hunger	−0.208[a]	0.265[a]
Attendance/adherence		
% Session attendance		−0.403[c]
% Self-monitoring		−0.353[b]

n=71-74; [a]P<0.05, [b]P<0.01, [c]P<0.001

type as a variable in the model (non-profit versus for-profit), strategic dieting behavior-restraint, attitude to self-regulation-restraint, hunger, and internal locus of hunger-retained significance.

Correlations between weight change and eating behavior constructs

Baseline scores for hunger and both external and internal loci of hunger showed significant negative correlations with weight change; in other words, higher baseline hunger was associated with higher weight loss over time (Table 3). Change in weight was also strongly associated with increased total restraint and subscales of restraint, as well as decrease in disinhibition and habitual susceptibility to disinhibition, a decrease in hunger and subscales, and attendance and weight self-monitoring. The significant correlations were in the range of 0.21 to 0.46, which are considered moderate to strong associations for behavioral variables (31). The correlations between eating behavior and weight change were not significantly different between the two intervention sites and were calculated by combining participants in the two intervention sites. Results from within-group multiple regressions are presented below; all models were adjusted for baseline weight, site, gender, and age.

Models for baseline eating behaviors as predictors of weight change

In a model containing baseline scores of restraint, disinhibition, and hunger, only baseline hunger scores predicted greater weight change (R^2=0.39, P=0.0356) (Table 4) and participants who scored higher on baseline scores of hunger (R^2=0.39, P=0.01), internal locus of hunger (R^2=0.38, P=0.024), and external locus of hunger (R^2=0.38, P=0.023) lost more weight over 0-6 months.

Models for association between change in eating behavior and weight change

In a multivariate model containing scores for changes in restraint, disinhibition, and hunger, only the decrease in hunger was significantly associated with weight change (R^2=0.43, P=0.018) (Table 4). The partial correlation plot for change in hunger and weight change is shown in Figure 1. The subscales of hunger, internal hunger (R^2=0.37, P = 0.038) and external hunger (R^2=0.40, P = 0.006), were also significant predictors of weight change over 6 months. When separated into early (0-3 months) and late (4-6 months) study periods, reduction in the internal locus of hunger was a significant independent correlate for early weight change (0-3 months) (partial

TABLE 4 Regression models identifying predictors of weight loss from 0–6 months

	Coefficients			Model summary		
	Beta ± SE	*T*	*P*	R^2	adj R^2	*P*
Baseline eating inventory						
Restraint	−0.04 ± 0.38	−0.12	0.908	0.39	0.32	<0.0001
Disinhibition	−0.16 ± 0.42	−0.39	0.696			
Hunger	−1.03 ± 0.48	−2.14	0.035			
Change in eating inventory						
Δ Restraint	−0.30 ± 0.38	−0.77	0.443	0.43	0.36	<0.0001
Δ Disinhibition	0.18 ± 0.47	0.37	0.710			
Δ Hunger	1.32 ± 0.55	2.41	0.018			
Attendance/adherence						
% Session attendance	−0.28 ± 0.09	−2.99	0.003	0.51	0.49	<0.0001
% Self-monitoring	−0.15 ± 0.06	−2.22	0.029			
Overall model						
Δ Hunger	1.39 ± 0.45	3.05	0.003	0.57	0.52	<0.0001
% Session attendance	−0.27 ± 0.10	−2.56	0.013			
% Self monitoring	−0.17 ± 0.07	−2.15	0.016			

n=71-74; all models were adjusted for baseline weight, age, sex, and worksite.

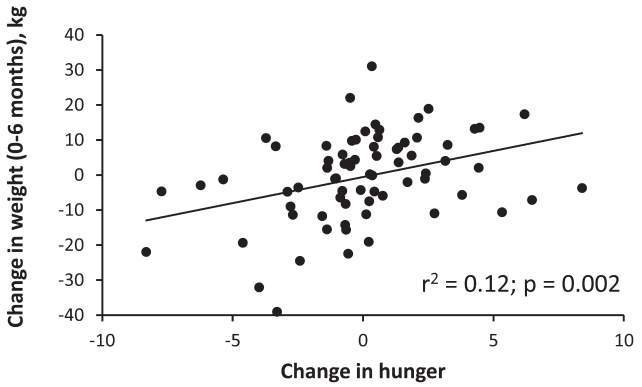

FIGURE 1 Partial correlation plot of change in hunger and weight change from 0-6 months; Plot is adjusted for baseline weight, age, sex and site. Change scores for weight and hunger calculated as 6 month-baseline.

R^2=0.09, P=0.009) and reduction in the external locus of hunger was a significant independent correlate for later weight change (4-6 months) (partial R^2=0.09, P=0.010) (Figure 2).

Attendance and self-monitoring

The mean attendance at group meetings was 83.8±15.2% for participants at the intervention sites during the 6-month intervention. Over the course of the intervention, participants submitted weekly weight self-monitoring logs 76.8±23.7% of time. As shown in Table 3, both attendance and weight self-monitoring correlated with weight change and remained significant in a multiple linear regression model. Together attendance (P=0.003) and self-monitoring (P=0.029) accounted for 51% of the variability in weight change (Table 4).

Combination model

We ran all possible regressions starting with the changes in eating behavior and adherence measures that showed a significant correlation with weight change (Table 3). The two competing models were a fourpredictor model (reduced hunger, increased restraint, % attendance, and % self-monitoring) and a three-predictor model (reduced hunger, % attendance, and % self-monitoring). In the four-predictor model, increased restraint did not have a significant coefficient, and when it was dropped, there was no drop in the adjusted R^2. The final overall model, the three-predictor model, is presented in Table 4. As shown, reductions in hunger, high attendance, and high self-monitoring together accounted for 57% variability in weight change.

Discussion

This study examined the effects of a 6-month weight loss intervention conducted in worksites on eating behavior and measures of program adherence and evaluated these variables as predictors of weight loss over time. As anticipated based on the previous reports (6,8,13,19,20,32,33), a higher frequency of self-monitoring and a higher frequency of group meeting attendance were significant predictors of weight loss success. In addition, and in contrast to the

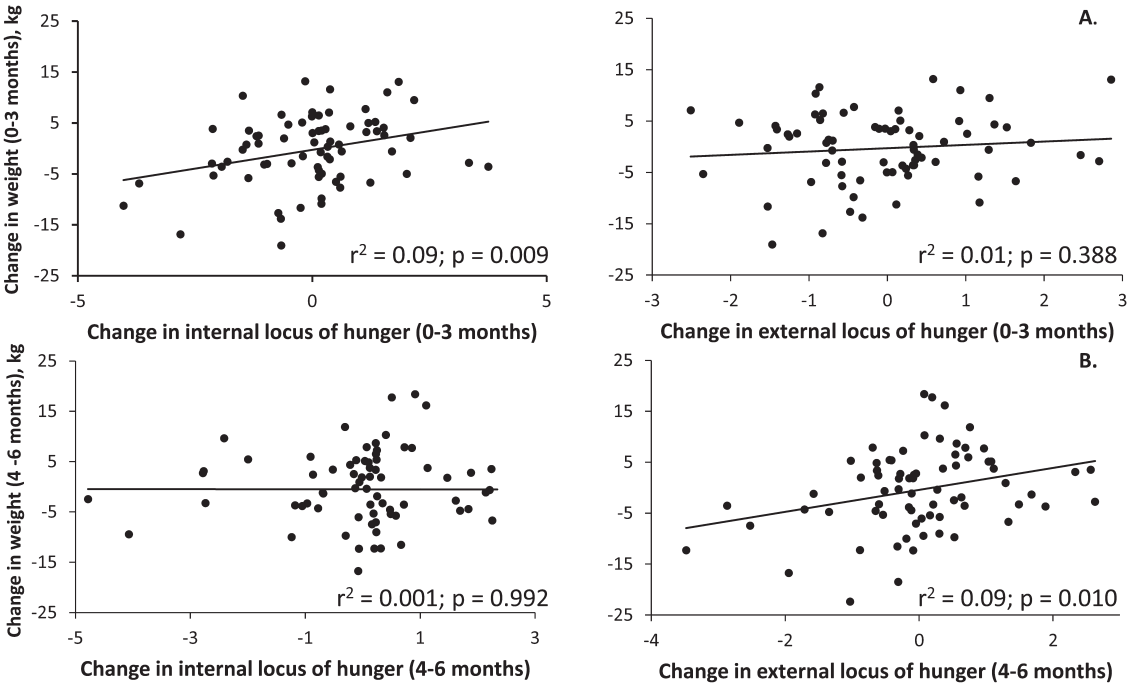

FIGURE 2 Partial correlation plots between change in hunger subscales and weight change; Panel **A**: Decreases in hunger subscales and weight change over 0-3 months. Change scores for weight and hunger subscales calculated as 3 month-baseline; Panel **B**: Decreases in hunger subscales weight change over 4-6 months. Change scores for weight and hunger subscales calculated as 6 month-3 month; n = 71-74; Plots are adjusted for baseline weight, age, sex and site.

most previous studies evaluating eating behavior variables as predictors of weight loss, we identified a decrease in hunger as a significant predictor of successful weight loss. Specifically among the constructs captured by the Eating Inventory, we found that high hunger at baseline and a decrease in hunger during the intervention were significant predictors of the magnitude of weight loss when all eating behavior variables were included in the same model. Although hunger is a basic drive indicating the need for food, in the context of weight loss, hunger suppression is beneficial. The finding that reduced hunger is a significant predictor of success both at baseline and change over time has implications for the design of interventions for weight control in both, worksites and other settings. In particular, these findings suggest the prioritization of hunger suppression, which in this study was achieved by focusing on meal timing and nutrient composition (high fiber, moderately high protein, moderately low glycemic load, and high volume), as well as techniques such as appetite awareness training. Further studies addressing this suggestion are now needed.

Changes in eating behavior variables have been shown to accompany intentional weight loss in several studies (7,12,33-35), but most previous investigations have shown significant associations between weight loss and increased restraint and/or decreased disinhibition (7,9,11,12,34) and have not demonstrated significant associations of weight loss with change in hunger. Similarly, high restraint at baseline has also been reported as a significant predictor of weight loss success (but not disinhibition) (7,12) and high baseline hunger has not predicted weight loss. In our analysis, consistent with the previous studies we also found an increase in restraint and a decrease in disinhibition with weight loss, and these changes were correlated with weight loss. However, in multiple regression models including all eating behavior variables, the only eating behavior construct that significantly correlated with weight loss was change in hunger, and the change scores for disinhibition and restraint were not significant. These findings are consistent with one report of decreases in hunger showing associations with weight loss (36), but most studies have found no association between hunger and weight loss (7,9,37,38). The reasons for why hunger was a more significant predictor of weight loss in this study is not known but several possibilities may be relevant. In particular, this study achieved greater mean weight loss than is typical in weight loss interventions, which must have entailed longer periods and/or a greater magnitude of negative energy balance. Since hunger is a negative sensation typically, leading to food consumption (39), participants who had the greatest decrease in hunger may well have been the ones who were able to withstand negative energy balance for a more sustained period of time. This hypothesis is consistent with the previous reports of associations between low hunger scores determined using the Eating Inventory and low reported energy intake (40). The reasons for the relatively large weight loss in this trial is not known but may be related to the specific features of the intervention or the use of specific types of worksites. Further trials are needed to examine the extent to which reduced hunger is an important feature of interventions with relatively large weight loss and the relationship between hunger and weight loss.

To our knowledge, this study was also the first to examine subscales of eating behavior constructs as predictors of intentional weight loss. Both the internal locus of hunger and the external locus of hunger significantly correlated with weight loss from 0 to 6 months, and when separated into early (0-3) and late (4-6) month study periods, reduction in internal locus of hunger was a significant correlate for early weight loss (0-3 months) and reduction in external locus of hunger was a significant correlate for later weight loss (4-6 months). These results suggest the potential importance of managing the internal locus of hunger, that is, hunger that is interpreted and regulated internally, early on in a weight management program followed by managing hunger that is triggered by external cues for subsequent sustainability of weight loss.

There are several strengths and some potential limitations in this study. A particular strength of this randomized controlled trial was that 89% of the participants were retained in the intervention through the 6-month study period. An additional strength was the considerable variation in weight loss (+1.36 to −35.5 kg), providing a suitable dataset for studying correlates of weight loss. One limitation of the current study is that it was a group-randomized pilot study that was not powered for weight loss when a site effect was included. However, we did control for site effects in our regression analysis, to account for the fact that employees at any given site were exposed to the same intervention and obtained significance. The large number of regression models may have increased Type I error but all significant associations were strong and in the expected direction, providing additional suggestive evidence that the observed relationships are not due to chance alone.

In conclusion, this evaluation of eating behavior and adherence suggests that hunger management is an important factor contributing to successful weight loss. The study also found that the eating behavior constructs restraint and disinhibition, which have previously been suggested to predict weight loss, were not significant in this worksite weight loss intervention when included in multiple regression models with hunger. Further examination of the role of hunger control in successful weight management is warranted because these results suggest that greater focus on hunger management could lead to improved effectiveness of weight loss interventions in worksites and other settings. O

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