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A Randomized Controlled Trial of Lorcaserin and Lifestyle Counseling for Weight Loss Maintenance: Changes in Emotion- and Stress-Related Eating, Food Cravings, and Appetite

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Abstract

Antiobesity medication may help people maintain diet-induced reductions in appetite. The present exploratory analysis assessed the effects of lorcaserin on changes at 24 weeks post-randomization in emotion- and stress-related eating, food cravings, and other measures of appetite (i.e., binge eating, cognitive restraint, disinhibition, hunger, preoccupation with eating, and fullness). The parent study investigated the efficacy of combined lorcaserin and behavioral treatment in facilitating weight loss maintenance in 137 adults (mean age=46.1 years, 86.1% female, 68.6% black) who had lost ~5% of initial weight during a 14-week, low-calorie diet (LCD) run-in. Participants were randomly assigned to lorcaserin or placebo and provided group weight loss maintenance counseling sessions. Emotion- and stress-related eating, food cravings, and appetite were measured at the start of the LCD (week -14), randomization (0), and week 24. From randomization, lorcaserin-treated participants had significantly greater improvements in emotion- and stress-related eating compared to placebo-treated participants ($p=0.04$). Groups, however, did not differ significantly after randomization in changes in the frequency of food cravings, binge eating, or other measures of appetite ($p>0.05$). Compared to placebo, lorcaserin may improve emotion- and stress-related eating.

Keywords

Appetite; cravings; lorcaserin; obesity; weight loss

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Clinical trial registration:

Introduction

Serotonin (5-Hydroxytryptamine; 5-HT) is a monoamine neurotransmitter that has several known functions including appetite regulation and energy balance.¹ Low levels of serotonin are associated with: preference for carbohydrates;² emotion- and stress-related eating;³ binge eating;⁴ and increased appetite.⁵ Decreased levels of serotonin have also been implicated in carbohydrate cravings and obesity.^{2,6,7} There are at least 14 subtypes of 5-HT receptors that contribute to the various actions of serotonin.⁸ One type of serotonin receptor target, the 5-HT_{2c} receptor, is a key mediator of 5-HT's effect on appetite and is the target of the antiobesity medication, lorcaserin.^{9,10}

Lorcaserin is a selective 5-HT_{2c} agonist that was approved by the Food and Drug Administration (FDA) in 2012 for chronic weight management, when used as an adjunct to a reduced-calorie diet and increased physical activity. Lorcaserin, combined with diet and exercise, results in an additional weight loss of 3.2 kg compared to placebo.^{11–14} Relative to placebo, lorcaserin also improves cardiometabolic parameters.^{11–14} The medication is generally well tolerated, with a favorable side effect profile.¹²

The mechanisms underlying weight loss with lorcaserin are not clear, though the medication is believed to act centrally to reduce appetite. In a 56-day study, participants were randomized to either lorcaserin (10 mg twice a day) or placebo, combined with a healthy lifestyle program. Lorcaserin significantly reduced energy intake, appetite, and hunger compared to placebo.¹⁵ Change in food cravings, dietary restraint, disinhibition, energy expenditure, and physical activity did not differ significantly between groups. In a randomized controlled trial (RCT) that used functional magnetic resonance imaging, 1 week of lorcaserin treatment significantly reduced activity in the cuneus, precuneus, temporoparietal junction, and occipital cortex in response to highly palatable food cues compared to less palatable foods in a fasted state.¹⁶ However, results were attenuated at week 4. In a fed state, lorcaserin treatment for 4 weeks led to significant reductions in parietal cortex activation for all food images relative to non-food images. Taken together, these results suggest that lorcaserin may decrease food reward-related responses and appetite. However, the longer-term effects of lorcaserin on appetite have not been determined.

We previously reported the primary results of a RCT that tested the efficacy of lorcaserin (10 mg twice a day), combined with group weight loss maintenance (WLM) counseling, in facilitating the maintenance of a 5% or greater weight loss achieved with a prior 14-week low-calorie diet (LCD) that included meal-replacements.^{17,18} The LCD induced a mean $\pm$ standard error (SE) loss of $9.3 \pm 2.9\%$ of initial weight (10.7 ± 4.0 kg) in participants who were ultimately randomized. (Participants who lost $\geq 5\%$ in the 14-week program were eligible to enroll in the RCT.¹⁸) From randomization to week 24, participants assigned to lorcaserin lost 2.4 ± 0.8 kg, compared with a gain of 0.6 ± 0.1 kg for the placebo group ($p=0.01$). As assessed from the beginning of the 14-week LCD program, lorcaserin and placebo-treated participants maintained losses at week 24 of the RCT (week 38 overall) of $11.7 \pm 0.9\%$ and $8.4 \pm 0.9\%$ ($p=0.01$) (13.8 ± 0.9 and 9.4 ± 0.9 kg; $p=0.001$). Differences

between groups were no longer significant at week 52, possibly due to medication tolerance or suboptimal medication adherence.¹⁸

The present exploratory analysis examined the effects of lorcaserin on changes in emotion- and stress-related eating, food cravings, and appetite at 24 weeks post-randomization. Since maximal weight losses with lorcaserin are typically seen after approximately 24–36 weeks of treatment,¹² we selected week 24 for our analysis. We hypothesized that compared to placebo, lorcaserin-treated participants would report improvements in emotion- and stress-related eating, food cravings, and other aspects of appetite (i.e., cognitive restraint, disinhibition, hunger, preoccupation with eating, and fullness).

Materials and Methods

Study Design

Data for this study were collected as part of a two-phase study ([Clinical Trials.gov](https://clinicaltrials.gov)).¹⁷ Phase 1 consisted of a 14-week, non-randomized, group lifestyle intervention with a structured meal replacement diet. Participants who lost >5% of initial weight entered phase 2, a double-blind randomized controlled trial of lorcaserin versus placebo. All participants provided written informed consent. The study protocol was approved by the university's institutional review board, and a data and safety monitoring board oversaw the trial.

Participants

Participants were eligible for phase 1 if they were 21–65 years and had a body mass index (BMI) ≥ 33 kg/m² and ≤ 55 kg/m² (or ≥ 30 kg/m² with an obesity-related comorbidity). Major exclusion criteria were serious medical conditions (e.g., cancer), substance abuse, current major depression, active suicidal ideation, a history of suicide attempts, or psychiatric hospitalization within the past 6 months.¹⁷ Participants who did not lose $\geq 5\%$ of initial weight in phase 1 were excluded from phase 2.

Procedures

Phase 1: Weight loss induction.—Participants were provided 14 weekly, 90-minute group lifestyle modification sessions combined with a LCD. They were prescribed a 1000–1200 kcal/day structured diet that consisted of four liquid shakes, a prepackaged entrée, garden salad, and 1–2 servings of fruit. Participants were instructed to record their daily food intake and to gradually increase their physical activity to 175 minutes/week by week 14.

Phase 2: Weight loss maintenance.—Participants who completed the LCD program, lost $\geq 5\%$ of initial weight, and chose to participate were randomly assigned in a 1:1 ratio to lorcaserin or placebo. They began taking two doses daily of lorcaserin (10 mg) or placebo within a week of randomization. Participants were provided group WLM counseling every-other-week for the first 12 weeks (i.e., 6 sessions) and then once every 4 weeks using a combination of in-person visits and group conference calls. Participants were instructed during phase 2 to consume a diet of conventional foods based on current dietary guidelines, with calorie goals of 1200–1500 kcal/day if <250 lb and 1500–1800 kcal/day if ≥ 250 lb.

Measures

Questionnaires were administered at baseline (week -14), randomization (week 0), and week 24 of phase 2. The total frequency of food cravings was assessed using the Food Craving Inventory.¹⁹ The scale includes 28-items and asks participants to rate their cravings for particular foods (e.g., pizza, cake) in the past month on a scale ranging from 1 (never) to 5 (always). A total score is calculated by averaging the responses, with a possible range from 1 to 5. In the current sample, the Cronbach's alpha was 0.92. The subscale for emotion- and stress-related eating (of the Eating and Appraisal Due to Emotions and Stress Questionnaire) was used to measure how participants used food to cope with stress and emotions.²⁰ Participants select a response on a 5-point Likert scale from strongly disagree to strongly agree. The subscale includes 24 items, with a total score ranging from 24 to 120. Lower scores represent greater emotion- and stress-related eating. The Cronbach's alpha was 0.70. The Eating Inventory was used to evaluate eating-related cognitive restraint, disinhibition, and hunger.²¹ Participants select an answer of true or false for each statement. The cognitive restraint score ranges from 0 to 21, the disinhibition score from 0 to 16 and the hunger scale from 0 to 14. The Kuder-Richardson reliability coefficient was 0.73 for cognitive restraint scale, 0.74 for disinhibition, and 0.77 for hunger. Binge eating in the past 28 days was self-reported using the Eating Disorder Examination-Questionnaire.²² Visual analog scales were also used to ask participants, for the past 24 hours, how much they thought about wanting to eat (0=not at all to 100=constantly) and how full they felt after consuming their meals (0=not at all full to 100=very full). Height and weight were measured at screening and assessment visits.

Statistical Analyses

Paired t-tests and McNemar's tests were used to assess changes in variables during the LCD. Changes in appetite between the lorcaserin and placebo groups were compared using independent sample t-tests. Linear mixed models with restricted maximum likelihood estimation were used to compare the treatment groups in changes in appetite from randomization to week 24. All randomized participants were included in the primary intention-to-treat (ITT) analyses. Analyses controlled for change during the LCD in the outcome variable, as well as height, which differed between the lorcaserin and placebo groups at randomization. Analyses reported were exploratory and not adjusted for multiple comparisons.

Results

Participant Characteristics

The primary weight loss outcomes of this trial have been reported previously.¹⁸ In brief, 178 participants enrolled in the 14-week LCD and 143 lost ≥5% of initial weight and qualified for randomization. Six participants chose not to continue, resulting in 137 participants who were randomized in phase 2. At the beginning of phase 1, the 137 participants had a mean ± SD age of 46.1±10.1 years and BMI of 40.8±5.9 kg/m². The majority were female (86.1%) and black (68.6%; 24.1% were white, 2.9% Asian, and 4.4% multiracial/other). Overall, 86.1% (118/137) of participants attended the week-24 assessment, including 62 of 69 (89.9%) randomized to lorcaserin and 56 of 68 (82.4%) to placebo.

Overall Changes in Food Cravings, Binge Eating, and Appetite in Phase 1

At the end of the 14-week LCD program, the 137 participants reported significant improvements in emotion- and stress-related eating, food cravings, binge eating, cognitive restraint, disinhibition, hunger, and eating preoccupation (Table 1). Emotion- and stress-related eating improved by a mean±standard deviation (SD) of 5.2 ± 13.8 points and cognitive restraint improved by 4.7 ± 3.4 points. The total frequency of food cravings declined by 0.4 ± 0.6 points while specific types of food cravings declined by 0.3 ± 0.6 (high fats) to 0.5 ± 0.7 points (sweets). The average number of binge eating episodes decreased by 1.9 ± 5.6 . Disinhibition and hunger dropped by 1.6 ± 3.4 and 1.3 ± 3.3 points, respectively. Fullness did not change significantly during the LCD ($p=0.37$).

Comparisons by Treatment Condition

Phase 1 changes.—Prior to randomization, participants ultimately assigned to the lorcaserin and placebo groups did not differ significantly after the LCD program in improvements in emotion- and stress-related eating, binge eating, cognitive restraint, disinhibition, hunger, preoccupation with eating, fullness, and cravings for sweets and high fats ($ps>0.05$, Table 2). However, participants assigned to the lorcaserin group had a decline of 0.5 ± 0.6 points on Food Craving Inventory, which was significantly larger than the 0.3 ± 0.5 point decline in the placebo group ($p=0.01$). The lorcaserin group also had greater declines in cravings for complex carbohydrates/starches and fast-food fats ($ps=0.01$; Table 2). The difference between groups in change scores may have resulted from significant differences between groups on baseline values for these same measures (Table 2).

Phase 2.—Randomization values of appetite did not differ significantly between the lorcaserin- and placebo-treated participants ($ps>0.05$; Table 3). From randomization to week 24, lorcaserin-treated participants reported an improvement of a mean±SE of 2.7 ± 1.7 points in emotion- and stress-related eating, which was significantly different from the 2.4 ± 1.8 point decline reported by placebo-treated participants ($p=0.04$; Figure 1 and Table 4). Post-randomization changes in food cravings, binge eating episodes, cognitive dietary restraint, dietary disinhibition, hunger, eating preoccupation, and fullness did not differ significantly between groups ($ps>0.05$; Table 4). For example, the frequency of total food cravings declined by 0.01 points in both groups ($p=0.99$). Lorcaserin-treated participants had a 0.7 ± 0.4 point reduction on the hunger scale of the Eating Inventory, which did not differ significantly from the 0.03 ± 0.4 point reduction in placebo-treated participants ($p=0.20$). Both the lorcaserin group and placebo groups had improvements in fullness (5.1 ± 3.9 vs 7.5 ± 4.0 points, respectively, $p=0.66$).

Discussion

Results of the present trial demonstrated that the combination of lorcaserin and weight loss maintenance counseling improved emotion- and stress-related eating at 24 weeks post-randomization, compared with placebo, among adults who had lost 5% of their initial body weight during a 14-week LCD. Lorcaserin-treated participants continued to show modest improvements in emotion- and stress-related eating whereas the placebo-treated participants had a slight worsening on this measure, though the clinical significance of these changes is

uncertain. While the differences between groups were small, this study supports previous neuroimaging data that suggest that lorcaserin decreases the emotional significance of highly desirable food cues.¹⁶ The present trial is the first to report behavioral data demonstrating these improvements with lorcaserin.

Scores on the hunger scale of the Eating Inventory did not differ between lorcaserin-treated participants and placebo-treated participants. In contrast, Martin et al. (2010) reported that weight loss induction using lorcaserin produced an average reduction of 2.4 points on the hunger scale of the Eating Inventory, compared to a reduction of 0.4 points in the placebo group at 56 days ($p=0.008$).¹⁵ The discrepancy between our results and those of Martin et al. (2010) is likely due to differences in follow-up duration as well as in the studies' designs. Similar to other trials that used a LCD run-in to assess subsequent weight loss maintenance,^{23,24} in the present trial the largest weight losses occurred during the initial diet run-in program.¹⁸ Paralleling the findings with weight loss, participants reported the largest changes in hunger at the end of the 14-week LCD. The significant decline in hunger and weight during the LCD may have masked the potential effects of lorcaserin on hunger, other aspects of appetite, and weight¹⁸ during the subsequent weight maintenance program.

Contrary to our hypothesis, lorcaserin-treated participants did not have additional reductions in the frequency of food cravings beyond those achieved during the reduced-calorie diet. Martin et al. (2010) also found no differences between lorcaserin and placebo in the frequency of food cravings during weight loss induction.¹⁵ While it is possible that lorcaserin does not have significant effects on the frequency of food cravings, the lack of differences in the current study could be a result of floor effects. The Food Craving Inventory (FCI) total score ranges from 1 to 5. Overall, FCI scores declined from 2.2 to 1.9 during the LCD run-in, which may have restricted our ability to test differences between groups during the weight loss maintenance trial. It is also possible that lorcaserin reduces food craving intensity and/or the consumption of food in response to cravings, variables which were not assessed in the present study. This study does support previous findings that the frequency of food cravings decreases during caloric restriction,²⁵ and extends the literature to show that at 24 weeks after acute weight loss, these declines can be preserved with weight loss maintenance counseling.

Lorcaserin did not significantly reduce self-reported binge eating behavior. These results are inconsistent with preclinical research indicating that lorcaserin may decrease binge eating behavior.⁴ There are several possible explanations. First, there may be floor effects due to the overall low frequency of binge eating behavior at randomization (sample average of 1.2 episodes in the past 28 days). Second, we used a self-report measure to assess binge eating behavior at each assessment. Inconsistencies between self-reported versus interview-assessed binge eating behavior have been reported, and interview assessments are typically considered to be more accurate.²⁶ Third, as we reported previously,²⁷ only 3.4% of participants who began LCD met full diagnostic criteria for binge eating disorder, so we were not able to assess the effect of lorcaserin on binge eating disorder in this sample.

Strengths of the present study include the high retention rate and use of a placebo control. The sample comprised primarily of black and female participants, who have not been well

represented in previous studies. However, this limits the generalizability of our findings. There are possible floor effects in some measures, resulting from the instruments used in the study. This study is also limited due to the exploratory nature of these analyses. Results were not adjusted for multiple comparisons and need to be replicated in future studies. A larger sample size would have provided greater power to assess changes in these measures.

Conclusion

In this sample of predominantly black and female participants with obesity, a 14-week LCD improved emotion- and stress-related eating, food cravings, binge eating, cognitive restraint, disinhibition, hunger, and preoccupation with eating. Lorcaserin did not produce additional changes in food cravings, binge eating, and appetite beyond those achieved with the prior LCD. However, lorcaserin combined with weight loss maintenance counseling improved emotion- and stress-related eating relative to placebo.

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Conflicts of Interest:

AMC reports grant funding, outside the current work, from Shire Pharmaceuticals. TAW discloses serving on advisory boards for Novo Nordisk and Weight Watchers, as well as receiving grant support, on behalf of the University of Pennsylvania, from Eisai Co and Novo Nordisk. RLP discloses serving as a consultant for Weight Watchers. NA discloses serving as a consultant for Novo Nordisk. RIB discloses serving as a consultant to Eisai Co. RIB also is receiving research support from Eisai Inc., on behalf of The Children's Hospital of Philadelphia. JST discloses serving as a consultant for Novo Nordisk. None of the other authors declares any conflicts.

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What is already known about this subject?

- Lorcaserin is a selective 5-HT_{2C} receptor agonist that is approved for chronic weight management, when used as an adjunct to a reduced-calorie diet and increased physical activity.
- Lorcaserin may help people maintain diet-induced reductions in energy intake, hunger, and other aspects of appetite.
- However, few studies have investigated the effects of lorcaserin on appetite.

What this study adds?

- Compared to placebo, lorcaserin helped to maintain improvements in emotion- and stress-related eating achieved with a low-calorie diet.
- Lorcaserin and placebo participants did not differ in changes in food cravings, binge eating, and appetite at 24 weeks post-randomization.

Figure 1.

Mean change (error bars are SEM) in emotion- and stress-related eating from week -14 (start of low-calorie diet program) to week 24. *=within-group change differed significantly from zero ($p<0.05$). Brackets identify whether change from time point to time point differed significantly by treatment group.

Table 1.

Food craving, binge eating, and appetite scores at baseline and after the 14-week low-calorie diet program for participants who qualified for randomization (N = 137)

Variable	Baseline	Randomization	Change from Baseline to Randomization	p-value
Emotion- and stress-related eating	81.38±19.62	86.60±16.83	+5.21±13.77	<0.001
Food cravings ^a				
Total	2.24±0.66	1.87±0.55	-0.37±0.57	<0.001
Complex carbohydrates/starches	2.09±0.76	1.69±0.63	-0.40±0.65	<0.001
Sweets	2.31±0.84	1.85±0.69	-0.46±0.70	<0.001
High fats	2.06±0.71	1.80±0.63	-0.26±0.62	<0.001
Fast-food fats	2.64±0.81	2.31±0.76	-0.34±0.74	<0.001
Binge eating ^b				
Number of episodes	3.03±5.38	1.17±1.97	-1.86±5.59	<0.001
% Endorsing any	46.1%	43.0%	-3.1%	0.68
Cognitive restraint	9.87±3.76	14.51±3.40	+4.65±3.35	<0.001
Disinhibition	8.33±3.37	6.74±3.23	-1.59±3.41	<0.001
Hunger	5.61±3.35	4.31±3.06	-1.29±3.32	<0.001
Preoccupation with eating ^c	47.63±24.12	40.77±23.95	-6.86±28.34	0.01
Fullness ^c	70.42±21.66	67.99±23.57	-2.43±29.43	0.37

Note. Values shown are the mean±standard deviation or percent. Due to missing data, Ns ranged from 119–131

^aRefers to food cravings in the past month.

^bRefers to binge eating in the past 28 days.

^cRefers to feelings over the past 24 hours.

Table 2.

Baseline and mean changes in appetite from baseline to randomization to lorcaserin plus weight loss maintenance (WLM; n=69) counseling or placebo + WLM (n=68)

Variable	Lorcaserin + WLM (n = 69)	Placebo + WLM (n = 68)	p-value
Emotion- and stress-related eating			
Baseline	79.04±20.45	83.84±18.42	0.16
Change	+5.98±14.59	+4.42±12.95	0.52
Food cravings ^a			
Total			
Baseline	2.36±0.71	2.08±0.55	0.01
Change	-0.49±0.62	-0.25±0.49	0.01
Complex carbohydrates/starches			
Baseline	2.20±0.85	1.97±0.64	0.08
Change	-0.55±0.71	-0.25±0.54	0.01
Sweets			
Baseline	2.46±0.93	2.16±0.71	0.04
Change	-0.55±0.74	-0.37±0.64	0.12
High fats			
Baseline	2.19±0.77	1.93±0.63	0.04
Change	-0.36±0.67	-0.16±0.55	0.07
Fast-food fats			
Baseline	2.82±0.82	2.47±0.78	0.02
Change	-0.52±0.75	-0.15±0.70	0.01
Binge eating, number of episodes ^b			
Baseline	3.06±5.74	2.71±5.25	0.71
Change	-2.09±5.57	-1.61±5.64	0.63
Cognitive restraint			
Baseline	9.39±3.76	10.43±3.73	0.11
Change	+5.07±3.65	+4.20±2.97	0.14
Disinhibition			
Baseline	8.80±3.03	7.90±3.60	0.12
Change	-1.98±3.08	-1.18±3.70	0.18
Hunger			
Baseline	6.03±3.35	5.04±3.24	0.09
Change	-1.61±3.41	-0.95±3.22	0.25
Preoccupation with eating ^c			
Baseline	47.22±23.71	48.20±23.79	0.82
Change	-5.62±29.40	-8.12±27.41	0.64
Fullness ^c			
Baseline	70.60±21.11	70.49±21.99	0.98
Change	-0.03±30.41	-4.71±28.51	0.39

Note. Values shown are the mean ± SD.

^aRefers to food cravings in the past month.

^bRefers to binge eating in the past 28 days.

^cRefers to feelings over the past 24 hours.

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Table 3.

Participants' food craving, binge eating, and appetite scores at the time of randomization to lorcaserin plus weight loss maintenance (WLM) counseling or placebo + WLM

Variable	Lorcaserin + WLM (n=69)	Placebo + WLM (n=68)	p-value
Emotion and stress-related eating	84.72±15.51	89.05±18.31	0.14
Food cravings ^a			
Total	1.87±0.53	1.83±0.55	0.61
Complex carbohydrates/starches	1.65±0.66	1.72±0.59	0.53
Sweets	1.92±0.69	1.78±0.67	0.22
High fats	1.84±0.61	1.75±0.65	0.43
Fast-food fats	2.28±0.73	2.28±0.80	0.96
Binge eating ^b			
Number of episodes	0.90±1.33	1.03±1.48	0.59
% Endorsing at least 1 episode in the past 28 days	28 (49.1%)	29 (50.9%)	0.81
Cognitive restraint	14.49±3.08	14.49±3.66	0.99
Disinhibition	6.84±3.02	6.51±3.51	0.56
Hunger	4.41±3.10	4.06±3.02	0.51
Preoccupation with eating ^c	41.09±23.13	39.33±24.94	0.68
Fullness ^c	68.45±23.02	66.32±24.72	0.61

Note. Values shown are the mean ± SD. Ns range from 125–137 due to missing data.

^aRefers to food cravings in the past month.

^bRefers to binge eating in the past 28 days.

^cRefers to feelings over the past 24 hours.

Table 4.

Changes in eating-related measures from randomization to week 24 in participants assigned to lorcaserin + weight loss maintenance (WLM) or placebo +WLM

	Lorcaserin + WLM (n=69)	Placebo + WLM (n=68)	p-value
Emotion- and stress-related eating	+2.66±1.65	-2.42±1.83	0.04
Food cravings ^a			
Total	-0.01±0.05	-0.01±0.06	0.99
Complex carbohydrates/starches	-0.02±0.07	-0.05±0.08	0.75
Sweets	+0.05±0.06	+0.10±0.07	0.60
High fats	-0.04±0.06	-0.07±0.07	0.73
Fast-food fats	-0.02±0.09	-0.08±0.10	0.71
Binge eating episodes ^b	+1.29±0.66	+1.15±0.73	0.89
Cognitive restraint	-0.04±0.42	+0.16±0.47	0.76
Disinhibition	-0.31±0.32	+0.48±0.36	0.11
Hunger	-0.74±0.37	-0.03±0.41	0.20
Eating preoccupation ^c	-2.75±3.23	+2.27±3.39	0.29
Fullness ^c	+5.09±3.89	+7.53±4.02	0.66

Note. Values shown are the mean ± standard error using an intention-to-treat sample. Values were estimated adjusting for baseline differences in height between the lorcaserin and placebo groups, as well as change in the respective measure during the low-calorie diet run-in.

^aRefers to food cravings in the past month.

^bRefers to binge eating in the past 28 days.

^cRefers to feelings over the past 24 hours.