1 The Weight-Related Eating Questionnaire offers a concise alternative to the Three-Factor Eating
2 Questionnaire for measuring eating behaviors related to weight loss

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Abstract

Objective: During a one-year weight loss trial, we compared the Three-Factor Eating Questionnaire (TFEQ), a valid 51-item measure of restraint, disinhibition, and hunger subscales, with the newer 16-item Weight-Related Eating Questionnaire (WREQ) measuring routine and compensatory restraint and external and emotional eating.

Methods: Both questionnaires were administered to women with overweight or obesity ($n = 186$, mean $\pm$ SD, age 50 ± 10.6 y, BMI 34 ± 4.2 kg/m²) at five time points. Completion rates were 100% at baseline and Month 1, 94% at Month 3, 83% at Month 6, and 76% at Month 12. Confirmatory factor analysis was conducted on baseline WREQ data and correlations were calculated between TFEQ and WREQ subscales. Multilevel models evaluated the relationship between each subscale and weight change over time.

Results: Factor analysis revealed a WREQ structure consistent with previous research, and corresponding subscales on the TFEQ and WREQ were correlated. Lower baseline TFEQ restraint predicted greater weight loss. Across five administrations, TFEQ and WREQ restraint scores were positively related to weight loss ($p < 0.01$) and TFEQ disinhibition and WREQ external and emotional eating scores were negatively related ($p < 0.001$). Thus, with one baseline administration, only TFEQ restraint was significantly related to weight change, but multiple administrations showed relationships between all TFEQ and WREQ subscales and weight change.

Conclusions: The WREQ offers a shorter alternative to the TFEQ when repeatedly assessing eating behaviors related to weight change.

Keywords: eating behaviors, weight loss, obesity treatment, adults

Introduction

The high prevalence of overweight and obesity in the United States (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016) indicates that many individuals have a history of energy imbalance that is likely related to eating behaviors. The cognitive and behavioral factors that drive energy intake are key components of energy balance regulation and have been shown to associate with weight change (Filiatrault, Chaput, Drapeau, & Tremblay, 2014; Teixeira, Going, Sardinha, & Lohman, 2005). Multiple questionnaires that measure eating behaviors, however, show inconsistent findings as to which factors have the greatest impact on weight and weight change, especially over the longer term (Bryant, King, & Blundell, 2007; Johnson, Pratt, & Wardle, 2012). Additionally, these questionnaires are often only administered once, precluding the investigation of behavior change over time and the relationship of that change to body weight. In order to support effective interventions, it is important to determine reliable measures of the eating behaviors and attitudes that influence weight change. In this study, two eating behavior questionnaires were administered repeatedly during a one-year weight loss trial (Rolls, Roe, James, & Sanchez, 2017) in order to identify correlates of weight change.

The Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) is a well-validated measure of three eating-related constructs: dietary restraint, disinhibition, and susceptibility to hunger. Dietary restraint refers to the tendency to consciously restrict food intake as a means of controlling weight, disinhibition refers to a tendency to overeat in response to negative emotional states or the presence of highly palatable foods, and the hunger subscale assesses susceptibility to feelings of hunger. Extensive research has been conducted with the TFEQ in relation to body weight (Bryant et al., 2007; Dykes, Brunner, Martikainen, & Wardle, 2004; Hays & Roberts, 2008; Thomas, Bond, Phelan, Hill, & Wing, 2014; Urbanek, Metzgar,

Hsiao, Piehowski, & Nickols-Richardson, 2015), although it has often examined only baseline levels or baseline and post-intervention. Some studies have reported that a greater increase in restraint during intervention relates to greater weight loss (Urbanek et al., 2015) and a decrease in restraint is a risk factor for weight regain (Thomas et al., 2014), but others have found that higher restraint at baseline correlates with weight gain (Drapeau et al., 2003; Stice, Cameron, Killen, Hayward, & Taylor; 1999). Higher disinhibition, more consistently than restraint, has been correlated with increased risk of weight gain and poorer weight loss outcomes (Hays & Roberts, 2008; JaKa et al., 2015; Bryant, Caudwell, Hopkins, King, & Blundell, 2012). The hunger subscale has received little attention in the literature and is rarely found to associate with weight change (Bryant et al., 2007).

Currently, the TFEQ is the standard for measuring eating behaviors. However, research aimed at identifying problematic eating behaviors has been hampered by the participant burden produced by repeatedly administering the 51-item TFEQ. The Weight-Related Eating Questionnaire (WREQ; Schembre, Greene, & Melanson, 2009) is a shorter, 16-item instrument that incorporates new findings in eating behavior research since the development of the TFEQ. The WREQ combines existing items from the TFEQ and the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien, Frijters, Bergers, & Defares, 1986) with several new questions in order to assess two types of restraint (routine and compensatory) and two types of disinhibition (external and emotional). External and emotional eating, while combined in the construct of disinhibition in the TFEQ, are separately assessed in the DEBQ and have been found to have independent associations with body weight (Wardle, 1987). Thus, the WREQ aims to combine the strengths of both questionnaires.

At present, data validating the WREQ are limited. A single administration of the instrument has been shown to distinguish the four subscales across different age groups and ethnicities, although most of these studies were conducted in college-aged samples (Byrd-Bredbenner, Quick, Koenings, Martin-Biggers, & Kattelman, 2016; Schembre & Geller, 2011; Schembre, Nigg, & Albright, 2011). It has also been administered in short-term weight loss studies (Bouhaidar et al., 2013) twice within a short time range, but results from these longitudinal analyses were not reported. Therefore, the utility of the WREQ in identifying eating behaviors related to weight loss has not been demonstrated in the longer term.

The present study explores whether the WREQ provides a valid alternative to the TFEQ, particularly in the context of a longer-term weight loss intervention. To provide additional validation for the WREQ, the first aim was to evaluate its psychometric properties in the previously untested setting of a year-long weight loss trial. The second aim was to use multilevel models to investigate how longitudinally measured TFEQ and WREQ scores were related to changes in body weight across the trial.

Methods

Study design

The Portion-Control Strategies Trial was a randomized controlled trial that investigated the effects of two portion-control interventions and standard dietary advice for weight loss. The trial examined weight change over a one-year period in women with obesity and overweight. An overview of trial participants and design is presented below. Further details of the trial design and main outcome data are presented elsewhere (Rolls, Roe, James, & Sanchez, 2017).

Participants

Eligible participants were women aged 20 – 65 y with a body mass index (BMI) of 28 – 45 kg/m². Potential participants were excluded if they had blood pressure >160/100 mm Hg, reported a weight change >4.5 kg in the past three months, had a medical condition that prevented participation or that limited physical activity, were following a special diet or weight-loss program, were pregnant or lactating, scored > 19 on the 26-item Eating Attitudes Test (Garner, Olmsted, Bohr, & Garfinkel, 1982), or > 25 on the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). To be enrolled in the trial, potential participants were required to complete three daily food and activity diaries and a two-week run-in period.

A total of 186 women with overweight and obesity were enrolled in the trial. Participants had mean ($\pm$ SEM) age of 50 $\pm$ 0.35 y, mean BMI of 34 $\pm$ 0.14 kg/m², and were predominantly white (98%). At baseline, participants reported a mean of 2.1 $\pm$ 0.2 attempts at weight loss in the previous year, thus they were experienced dieters. Table 1 provides additional demographic information. Participants provided signed informed consent and were financially compensated for their time. The trial protocol was reviewed and approved by the Office for Research Protections at The Pennsylvania State University.

Interventions

Participants were randomly assigned to one of three groups: a standard advice group (usual care) or one of two portion-control intervention groups. Participants in the Standard Advice group were instructed to follow dietary guidelines that emphasized eating less while making healthy choices from all food groups. Those in the Portion Selection group were instructed to choose food portions based on energy density and were given food scales and other portion-control tools. Participants in the Pre-portioned Foods group were taught to structure their

meals around pre-portioned foods and were given vouchers for single-serving main dishes. Participants in all groups received similar instruction on increasing physical activity, keeping records for self-monitoring, and managing behavior change.

All participants met individually with trained interventionists weekly during Month 1, biweekly during Months 2-6, then monthly during Months 7-12. In addition to 19 instructional sessions, there were assessment sessions at baseline and Months 1, 3, 6, and 12. At the five assessment sessions, weight was measured to the closest 0.1 kg and participants completed computer-administered questionnaires including the Three-Factor Eating Questionnaire (TFEQ) and the Weight-Related Eating Questionnaire (WREQ).

Measures

Table 2 provides an overview of the eating behavior constructs measured by the two questionnaires. The TFEQ assesses restraint, disinhibition, and hunger. The WREQ assesses two types of restraint: routine and compensatory, and two eating behaviors associated with disinhibition: external eating and emotional eating. TFEQ subscale scores are sums of the item scores of 0 or 1, while WREQ subscale scores are averages of the item scores on a 5-point Likert scale, and thus have a range of 1-5. Questionnaire completion rates were 100% at baseline and Month 1, 94% at Month 3, 83% at Month 6, and 76% at Month 12.

Statistical Analysis

To assess the fit of the WREQ structure, confirmatory factor analysis was applied to the baseline data. Standard cutoffs for acceptability in goodness-of-fit indices were used: standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), comparative fit index (CFI), and normed fit index (NFI) (Hu & Bentler, 1999; Smith, 2015). Cronbach's alpha levels were used to determine internal consistency within each WREQ

factor at baseline. To establish concurrent validity, Pearson correlation coefficients were calculated between the baseline values of the three TFEQ subscales and the four WREQ subscales.

Relationships with weight loss over the five assessment time points of the trial were analyzed for all randomized participants by multilevel models using maximum likelihood to handle missing data. Individual trajectories were modeled for all randomized subjects using the available data. The trajectory of weight change was modeled by including linear and quadratic effects of time (trial week) as fixed factors, and all models were controlled for group assignment and baseline BMI and age. The time effects were also included as random effects to model the individual trajectories. Separate models were run with each of the TFEQ and WREQ subscales as a covariate, in order to determine their individual impact on the weight change trajectory. Each subscale was tested both as the baseline level alone and as a time-varying covariate. The data were analyzed using SAS software (version 9.4, 2013, SAS Institute Inc., Cary, NC).

Results

On average, participants in all groups lost weight during the first six months of intervention and maintained most of this loss at the end of the trial. As previously reported, however, there were significant differences in weight loss trajectories across groups (Rolls et al., 2016). Between Months 1 and 4, the Pre-portioned Foods group lost weight at a greater rate and then regained weight at a faster rate. As a result, there were no significant differences in mean ($\pm$ SEM) weight loss across groups at Month 6 (5.2 ± 0.4 kg) or Month 12 (4.5 ± 0.5 kg).

Table 3 reports mean WREQ and TFEQ subscale scores for the five assessment time points of the trial. Mean scores for TFEQ restraint and WREQ routine and compensatory

restraint increased from baseline during intervention; in contrast, scores for TFEQ disinhibition and WREQ external and emotional eating decreased. TFEQ hunger also decreased. For both TFEQ and WREQ subscales, all significant changes occurred in the first 3 months of the trial. There was no further change in mean subscale scores at Months 6 or 12, and none had returned to baseline levels at Month 12.

WREQ Confirmatory Factor Analysis

The four-factor structure of the WREQ was reproduced in the confirmatory factor analysis of the baseline data (Table 4). The model fit was acceptable (SRMR: 0.05, RMSEA: 0.07, CFI: 0.95, NFI: 0.89). Further analyses showed some minor misfit on the restraint subscales: one routine restraint item (Item 1) loaded with the compensatory restraint items, and Item 3 had a weak loading (< 0.50). When constrained to three factors, all restraint items loaded onto a single factor, and the model fit indices were comparable (SRMR: 0.06, RMSEA: 0.07, CFI: 0.94, NFI: 0.88). For both models, fit indices were within or approaching the thresholds for acceptable fit.

WREQ Reliability

The baseline administration of the WREQ demonstrated good internal consistency for the four-subscale model: Cronbach's alpha values were 0.82 for external eating, 0.93 for emotional eating, 0.61 for routine restraint, and 0.80 for compensatory restraint. Combining the two restraint subscales into one subscale produced an alpha value of 0.78 for overall restraint.

WREQ Validity

Baseline correlations between WREQ and TFEQ subscales. Correlations between the WREQ and TFEQ subscales at baseline are presented in Table 5. The two restraint subscales on the WREQ correlated as expected with the TFEQ restraint score; for example, WREQ routine

restraint correlated positively with TFEQ restraint ($r = 0.66$, $p < 0.0001$). Both external and emotional eating on the WREQ correlated strongly with TFEQ disinhibition as well as marginally with TFEQ hunger.

Correlations with weight change across the year. Table 6 shows the coefficients of the model using polynomial effects of time to characterize weight change and controlling for group assignment and baseline BMI and age. The trajectory had a significant positive linear coefficient (0.57 kg/week, $p < 0.001$) and a negative quadratic coefficient (-0.01 kg/week^2 , $p < 0.001$), corresponding to weight loss in the initial months of the trial and some weight regain in the latter months. Baseline BMI positively influenced weight loss; participants with higher initial BMI tended to lose weight at a faster rate during the trial. Group assignment was not related to the trajectory of weight loss across the five assessment time points, unlike the finding for all 23 time points in the trial (Rolls et al., 2016). Lower baseline TFEQ restraint predicted greater weight change over the year (regression coefficient -0.01 , $p < 0.05$). Baseline levels for all other subscales were not significantly related to weight change over one year.

Examining multiple administrations of the questionnaires revealed that subscales from both the TFEQ and the WREQ were related to weight change during the trial (Table 6). For the WREQ, routine restraint and compensatory restraint were both positively related to weight loss (both $p < 0.001$), indicating that on average across all time points, individuals with higher scores on these restraint subscales had greater weight loss. Conversely, WREQ external eating and WREQ emotional eating were negatively related to weight loss across time (both $p < 0.01$), with lower levels of these eating behaviors correlating with greater weight loss. For the TFEQ, restraint was positively related to greater weight loss across 12 months while disinhibition was

negatively related to these outcomes (both $p < 0.0001$), showing the same pattern as the WREQ. TFEQ hunger was also negatively related to weight loss ($p < 0.0001$).

Discussion

This study evaluated repeated administrations of two eating behavior questionnaires, the Three-Factor Eating Questionnaire (TFEQ) and the Weight-Related Eating Questionnaire (WREQ), in the context of a year-long weight loss trial. Using data collected at baseline, the factor structure of the newer WREQ was confirmed, and strong correlations with the subscales of the standard TFEQ were demonstrated, specifically between WREQ and TFEQ restraint scales and between WREQ eating scales and TFEQ disinhibition. In addition, both external and emotional eating on the WREQ correlated with TFEQ hunger, demonstrating that higher levels of behaviors associated with overeating are also related to greater overall feelings of hunger in general. Longitudinal analyses found consistent correlations with weight change for the related subscales on the two questionnaires. This is the first study to analyze how weight change over a year relates to multiple measurements of the WREQ subscales, and these analyses provide support for the use of the WREQ as an alternative to the TFEQ.

Analyses of the reliability and validity of the WREQ showed that the psychometric properties of the questionnaire were consistent with previous research demonstrating strong internal consistency for the subscales (Schembre & Geller, 2011; Schembre et al., 2009); these previous findings were extended by demonstrating robust concurrent correlations with the TFEQ subscales. Confirmatory factor analysis showed an acceptable fit for the original four-factor structure of the WREQ. Since the WREQ subscales of routine and compensatory restraint appear to measure a very similar construct, combining those items into one subscale could create a stronger factor structure; alternatively, adding items to each subscale could improve the ability to

discriminate between different aspects of dietary restraint. Notably, the internal consistency shown for the two restraint scales in these findings are comparable to those found in participants with overweight or obesity in the previous validation paper (Schembre & Geller, 2011). However, internal consistency for the two restraint scales was considerably higher in the normal weight participants in that study. Therefore, additional work is needed to determine how weight status affects how individuals interpret and respond to the restraint items.

The TFEQ may be preferable to the WREQ in some situations because it includes a larger number of items, thus providing a better measure of the different facets of these eating behaviors as well as the variability between individuals. The use of the TFEQ also allows direct comparison with the large number of weight loss trials in which it has been administered. However, the original four-factor structure of the WREQ provides a useful assessment of eating behavior constructs, and in settings where a less burdensome measure is required, the WREQ offers an efficacious alternative to the TFEQ.

Associations with weight change during the trial were found with only one of the baseline subscale scores, TFEQ restraint. The finding that lower baseline restraint predicted greater weight loss likely reflects a greater opportunity to increase the restrained eating behaviors that affect weight. Previous research in women with obesity showed a similar pattern in which lower baseline restraint predicted greater weight loss, while baseline disinhibition and hunger were not related to weight change (Foster et al., 1998). The results from the present trial also support the literature showing higher baseline restraint is associated with increased risk of weight gain (Drapeau et al., 2003; Hill, 2004; Stice, et al., 1999). In contrast, data evaluating the WREQ in relation to weight are limited. One past study using a single administration of the WREQ found that routine restraint and emotional eating were associated with self-reported, retrospective

weight change (Schembre & Geller, 2011). However, we did not replicate those findings with baseline WREQ scores when weight change was measured in a population of experienced dieters during intervention.

Repeated administration of the questionnaires revealed a stronger pattern of correlation between eating behaviors and weight change than a single administration at baseline. The relationships found between weight change and the TFEQ subscales are consistent with previous literature showing that increases in dietary restraint and decreases in disinhibition are associated with greater weight loss (Dalle Grave, Calugi, Corica, Di Domizio, & Marchesini, 2009; Johnson et al., 2012; Pliner & Saunders, 2008). The finding that the relationship between restraint and weight change was negative at baseline and was positive when examined over time indicates that both lower initial restraint and increases in restraint during intervention can promote weight loss. Multiple assessments of the WREQ, as in previous findings with the TFEQ (Pliner & Saunders, 2008; Schur et al., 2010), were also more strongly related to weight change than a single baseline measurement, adding further support for its validity as a measure of weight-related eating behaviors when administered repeatedly.

Based on the findings of this study, it is advisable to administer either the TFEQ or the WREQ at least twice over the course of an intervention. If one administration is the only option, it is preferable to use the TFEQ if it is not too burdensome to participants. However, in the context of an intervention, administering these measures only at baseline may have limited utility for predicting weight change. Data from this trial show the value in frequent, early measurement for evaluating these eating behaviors. The greatest magnitude of change in mean eating behavior scores occurred in the first three months, suggesting not only that repeat assessment is important but that frequent measurement at early time points may be key for capturing behavior change.

Additional work could inform its longitudinal validity in samples not represented here, such as men or those individuals with conditions such as an eating disorder or depression. Since these eating behaviors are related to weight change, a future direction could be to intervene early in an intervention based on these subscale scores to help benefit longer-term weight outcomes.

It should be noted that shorter versions of the original 51-item TFEQ have been proposed and have data supporting their validation. They comprise an initial 18-item version measuring restraint, emotional eating, and uncontrolled eating (Karlsson, Persson, Sjöström, & Sullivan, 2000); a 21-item version adding three additional emotional eating items (Tholin, Rasmussen, Tynelius, & Karlsson, 2005); and a final 18-item version that removes three of the restraint items (Cappelleri et al., 2009). The utility of these shorter versions of the TFEQ in comparison to the WREQ cannot be assessed with the trial data presented here, but they may offer an equally efficacious alternative since they address some criticisms of the original TFEQ such as the limited range of responses. Other weaknesses remain in these shorter versions, however, including a tendency toward floor and ceiling effects in the subscales with fewer items (Cappelleri et al., 2009). There is also a lack of consensus on which shorter version to use; as a result, there is limited literature assessing the validity of any specific version (Cappelleri et al., 2009; Tholin et al., 2005). The WREQ offers an alternative that combines the strengths of the TFEQ with the more specific external and emotional eating assessment of the DEBQ in a shorter, updated form that is simple to administer.

Overall, the WREQ in its current form demonstrates utility for identifying cognitive and behavioral correlates of weight change in a long-term weight loss trial. Combining its restraint items into one subscale or adding additional items could strengthen its utility to accurately assess

335 restraint across time. In a context where minimizing participant burden is important, the WREQ
336 provides an acceptable alternative for measuring eating behavior.

337

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342 Table 1: Baseline characteristics of women in The Portion-Control Strategies Trial

Characteristic	(n = 186)
Age (y)	50.0 (10.6)
Body weight (kg)	91.2 (12.7)
Body mass index (kg/m ²)	34.0 (4.2)
Weight loss attempts in past year, n	2.1 (2.5)
Race, n (%)	
White	184 (98%)
African-American	2 (1%)
More than one race	1 (1%)
Ethnicity, n (%)	
Not Hispanic	184 (99%)
Hispanic	2 (1%)
Education, n (%)	
High school graduate	27 (15%)
Some college education	56 (30%)
College degree	57 (31%)
Professional or graduate degree	25 (27%)
Employment, n (%)	
Employed full-time	114 (61%)
Employed part-time	32 (17%)
Not employed	40 (22%)

343 Values are mean (SD) unless otherwise noted.

344 Table 2: Definition of TFEQ and WREQ subscales with related subscales displayed in the same
 345 row

Three-Factor Eating Questionnaire (TFEQ)*		Weight-Related Eating Questionnaire (WREQ)**	
<u>Restraint</u> (21 items, Range 0-21)	Restriction of food intake as a means of controlling weight	<u>Routine Restraint</u> (3 items, Range 1-5)	Perceived restriction of energy intake as a way to manage weight; more rigid overall
		<u>Compensatory Restraint</u> (3 items, Range 1-5)	Perceived overconsumption followed by a restrained period to compensate; more flexible overall
<u>Disinhibition</u> (16 items, Range 0-16)	Removal of eating inhibition in response to environmental or emotional states	<u>External Eating</u> (5 items, Range 1-5)	Eating in response to external cues such as the smell or sight of food regardless of any internal hunger or satiety cues
	Heightened response to food cues	<u>Emotional Eating</u> (5 items, Range 1-5)	Eating in response to negative emotions
<u>Hunger</u> (14 items, Range 0-14)	Susceptibility to feeling hungry in general	[No corresponding subscale]	

346 *TFEQ scoring: Item responses are scored as 0 or 1 and summed for each subscale.

347 **WREQ scoring: Item responses are scored as 1 to 5 and averaged for each subscale.

348 Table 3: TFEQ and WREQ subscale scores at the 5 assessment time points of the trial

Subscale	Baseline (n = 186)	Month 1 (n = 186)	Month 3 (n = 175)	Month 6 (n = 154)	Month 12 (n = 142)
TFEQ Restraint	8.90 (0.27) ^a	13.44 (0.25) ^b	14.09 (0.28) ^{b,c}	14.47 (0.28) ^c	14.29 (0.31) ^c
TFEQ Disinhibition	9.74 (0.26) ^a	8.54 (0.27) ^b	7.84 (0.27) ^c	8.01 (0.30) ^{b,c}	7.75 (0.33) ^{b,c}
TFEQ Hunger	6.20 (0.25) ^a	5.44 (0.25) ^b	5.08 (0.25) ^b	5.19 (0.28) ^b	5.09 (0.29) ^b
WREQ Routine Restraint	1.83 (0.04) ^a	2.37 (0.06) ^b	2.50 (0.06) ^b	2.48 (0.06) ^b	2.37 (0.06) ^b
WREQ Compensatory Restraint	2.30 (0.06) ^a	2.66 (0.06) ^b	2.78 (0.07) ^b	2.82 (0.08) ^b	2.78 (0.08) ^b
WREQ External Eating	2.98 (0.07) ^a	2.61 (0.07) ^b	2.51 (0.07) ^{b,c}	2.50 (0.08) ^{b,c}	2.48 (0.08) ^c
WREQ Emotional Eating	2.92 (0.09) ^a	2.59 (0.09) ^b	2.49 (0.09) ^b	2.51 (0.10) ^b	2.44 (0.11) ^b

349 TFEQ, Three-Factor Eating Questionnaire; WREQ, Weight-Related Eating Questionnaire.

350 All values are mean scores (SEM).

351 ^{a,b,c} Means for the same subscale with different letters are significantly different ($p < 0.05$).

352 Table 4: Confirmatory factor analysis of the WREQ using baseline data from the trial (n = 186)

Subscale	Item #	Factor 1	Factor 2	Factor 3	Factor 4
External Eating	5	0.60			
	8	0.72			
	9	0.83			
	11	0.52			
	13	0.80			
Emotional Eating	2		0.83		
	4		0.82		
	6		0.90		
	14		0.84		
	15		0.87		
Routine Restraint	1			0.71	
	3			0.50	
	7			0.48	
Compensatory Restraint	10				0.68
	12				0.87
	16				0.71

353 All values are standardize regression weights representing factor loadings.

354 WREQ, Weight-Related Eating Questionnaire.

355 Table 5: Correlations between TFEQ and WREQ subscales at baseline of the trial (n = 186)

Subscale	TFEQ Restraint	TFEQ Disinhibition	TFEQ Hunger	WREQ Routine Restraint	WREQ Compensatory Restraint	WREQ External Eating	WREQ Emotional Eating
TFEQ Restraint	1.00						
TFEQ Disinhibition	0.02	1.00					
TFEQ Hunger	0.01	0.51*	1.00				
WREQ Routine Restraint	0.66*	0.10	-0.03	1.00			
WREQ Compensatory Restraint	0.39*	0.08	-0.17	0.50*	1.00		
WREQ External Eating	0.02	0.71*	0.49*	0.08	0.13	1.00	
WREQ Emotional Eating	0.06	0.68*	0.30*	0.18	0.17	0.44*	1.00

356 TFEQ, Three-Factor Eating Questionnaire; WREQ, Weight-Related Eating Questionnaire.

357 All values are Pearson correlation coefficients ranging from -1 to 1.

358 *p < 0.0001.

359 Table 6: Characteristics of random coefficients models of the relationship between TFEQ and
360 WREQ subscales and weight loss (kg) during the trial.

Variable	Base model coefficient (SEM)	Fixed effect coefficient (SEM)
Fixed effects included in all models		
Time, linear (week)	0.57* (0.05)	
Time, quadratic (week*week)	-0.01* (0.00)	
Baseline BMI (kg/m ²)	0.005 (0.006)	
Baseline Age (years)	0.00 (0.00)	
Fixed effects tested individually		
TFEQ Restraint Score		0.30* (0.05)
TFEQ Disinhibition Score		-0.25* (0.05)
TFEQ Hunger Score		-0.28* (0.05)
WREQ Routine Restraint Score		0.88* (0.23)
WREQ Compensatory Restraint Score		0.70* (0.20)
WREQ External Eating Score		-0.77* (0.21)
WREQ Emotional Eating Score		-0.49* (0.17)

361 *p < 0.01

362 BMI: body mass index; TFEQ: Three-Factor Eating Questionnaire; WREQ: Weight-Related Eating
363 Questionnaire.

364
365 Base model coefficients were included in all models. Fixed effects listed in the last column were each modeled
366 separately to determine their individual impact on weight change.

367
368 Coefficients for the TFEQ and WREQ subscales represent average change in body weight per unit change in
369 subscale score. The TFEQ and WREQ coefficients are not directly comparable due to different scoring
370 metrics.

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