Health Behavior Research

Volume 6 | Number 1 Article 6

January 2023

Effects of Body Satisfaction and Emotional Eating on Obesity Treatment-Related Changes in Weight and Waist Circumference Over 2 Years: A Serial Multiple Mediation Analysis

James J. Annesi
Central Coast YMCA, jamesannesi@gmail.com

Francine A. Stewart
fstewart@mpusd.k12.ca.us

Recommended Citation

Annesi, James J. and Stewart, Francine A. (2023) "Effects of Body Satisfaction and Emotional Eating on Obesity Treatment-Related Changes in Weight and Waist Circumference Over 2 Years: A Serial Multiple Mediation Analysis," *Health Behavior Research*: Vol. 6: No. 1. https://doi.org/10.4148/2572-1836.1180

Effects of Body Satisfaction and Emotional Eating on Obesity Treatment-Related Changes in Weight and Waist Circumference Over 2 Years: A Serial Multiple Mediation Analysis

Abstract

Maintenance of lost weight beyond 6 months in adults with obesity remains problematic. To reliably impact obesity over the long term, an improved understanding of treatment-associated changes in psychosocial factors is required. Women are especially susceptible to body image concerns and emotional eating; however, associations among those variables within weight-management processes have been limited to either cross-sectional or short-term analyses. Women with obesity (M_{age} = 47.4 years, *SD* = 8.6) who participated in either a year-long YMCA-based cognitive-behavioral treatment emphasizing self-regulation of exercise and eating (*n* = 54), or a similar treatment that also included brief phone follow-ups of learned self-regulatory skills monthly during a second treatment year (*n* = 74), were assessed on weight and waist circumference changes over 6 and 24 months and changes in body satisfaction and emotional eating over 12 months. Improvements on all measures were significant with no time × group interaction. In aggregated analyses, there were significant direct relationships between changes in weight over 6 and 24 months, between changes in body satisfaction and emotional eating, and between those psychosocial changes and weight changes. Within serial multiple mediation models incorporating lagged variable analyses, only the path from changes in weight from baseline–Month 6→body satisfaction from baseline–Month 12→weight from baseline–Month 24 was significant. Results were similar when waist circumference was entered in place of weight. Findings suggest body satisfaction requires an increased focus within behavioral treatments for women with obesity to maximize their maintenance or extension of early reductions in weight and waist circumference.

Keywords

obesity, body satisfaction, emotional eating, treatment, weight, waist circumference

Obesity Treatment-related Changes in Weight and Waist Circumference over Two Years Based on Earlier Changes: Mediation by Body Satisfaction and its Association with Emotional Eating

James J. Annesi, PhD, FAAHB, FTOS, FAPA*
Francine A. Stewart, JD, PhD

Abstract

Maintenance of lost weight beyond 6 months in adults with obesity remains problematic. An improved understanding of the dynamic effect that treatment-associated changes in psychosocial factors is required to have a successful long-term impact on obesity. Women are especially susceptible to body image concerns and emotional eating; however, associations among those variables within weight-management processes have been limited to either cross-sectional or short-term analyses. Women with obesity (M_{age} = 47.4 years, SD = 8.6) who participated in either a year-long YMCA-based cognitive-behavioral treatment emphasizing self-regulation of exercise and eating (n = 54), or a similar treatment that also included brief telephone follow-ups of learned self-regulatory skills monthly during a second treatment year (n = 74), were assessed on weight and waist circumference changes over 6 and 24 months and changes in body satisfaction and emotional eating over 12 months. Improvements on all measures were significant with no time × group interaction. In aggregated analyses, there were significant direct relationships between changes in weight over 6 and 24 months, between changes in body satisfaction and emotional eating, and between those psychosocial changes and weight changes. Within serial multiple mediation models incorporating lagged variable analyses, only the path from changes in weight from baseline–Month 6→body satisfaction from baseline–Month 12→weight from baseline–Month 24 was statistically significant. Results were similar when waist circumference was entered in place of weight. Findings suggest body satisfaction requires an increased focus within behavioral treatments for women with obesity to maximize their maintenance or extension of early reductions in weight and waist circumference.

Keywords: obesity, body satisfaction, emotional eating, treatment, weight, waist circumference

*The corresponding author may be reached at: jamesannesi@gmail.com

Introduction

Maintenance of lost weight beyond the first several months of initiating a behavioral obesity treatment has remained problematic for many decades (Lazzeretti et al., 2015; Lemmens et al., 2008; Loveman et al., 2011). Although early weight loss has been related to reductions over several years (Nackers et al., 2010; Rössner et al., 2008), it is expected that a brief plateau will precipitate gain in weight beginning around Month 6 after treatment start, which persists (Jeffery et al., 2000; MacLean et al., 2015). For weight loss to be extended, or even maintained, an improved understanding of treatment-associated psychosocial factors within the dynamics of weight-management processes may be required (Sniehotta et al., 2014). Unfortunately, studies over a brief time frame that are often devoid of theory and executed through cross-sectional and/or retrospective research designs predominate.

Although sporadic, paradigms driven by behavioral theories have been proposed to direct obesity treatment architectures (Annesi et al., 2018; Gillison et al., 2015; Sniehotta et al., 2014). Under the umbrella of key tenets of social cognitive theory (e.g., effects of self-regulation on lifestyle barriers to goal-driven behavioral changes; Bandura, 1986, 2005) and the strength model of self-regulation (Vohs & Baumeister, 2016), participants' self-regulation, self-efficacy, and mood have appeared in both studies and predictive models, and explained a moderate portion of the variance in weight change (Annesi, 2012; Annesi & Walsh, 2021; Teixeira et al., 2004) – each of those variables making a significant and unique contribution when their change terms were incorporated (Annesi, 2012). Treatment foci on changes in self-regulation, self-efficacy, and mood, rather than on an atheoretical dependence on education to cause resilient changes in exercise and controlled eating, have been associated with enough sustained loss in weight to reduce health risks for most participants, i.e., ≥ 5% of baseline weight (Williamson et al., 2015), but have largely remained higher than considered to be within the healthy body mass index (BMI) range of 18.5-24.9 kg/m^2 (Jeffery et al., 2000; Nackers et al., 2010; Wing & Phelan, 2005). Some research suggests that weight circumference is a superior predictor of health risks than BMI or body weight, and thus, should be included in related analyses (Janssen et al., 2004).

Whereas variables such as body satisfaction (i.e., satisfaction with one's physical self) and emotional eating (i.e., propensity to eat in response to emotions) have been associated with weight and weight change (Chao, 2015; Frayn & Knäuper, 2018; Koenders & van Strien, 2011), especially in women (Péneau et al., 2013), they have not been well accounted for in either explanatory models or obesity treatment curricula even though there were suggestions to do so (Baker & Brownell, 2000; Lazzeretti et al., 2015; Teixeira et al., 2004). For many women within a social structure that highly values their thinness, as in most Western societies (Warren & Akoury, 2020), body satisfaction is of high importance and weight loss is a means to an improved self-perception of the body (Hawkins et al., 2004). Although the basis of emotional eating is unclear (Macht & Simons, 2011), suggestions of it being the most salient predictor of weight change has been supported (Koenders & van Strien, 2011). However, in one causal chain model based on treatment-driven findings (Annesi, 2020), the need for inclusion of emotional eating was questioned because associations of mood and eating were already incorporated. Thus, it might be redundant. However, subsequent research suggests that entry of emotional eating into analyses make a unique contribution in explaining weight change, and thus, warrant status as a distinct predictive factor (Annesi & Johnson, 2021).

Relationships between body satisfaction and emotional eating already have been supported cross-sectionally (Annesi, 2022; Carbonneau et al., 2020; Geller et al., 2020) and during the early months of obesity treatment (Annesi, 2022). Although increased body satisfaction over 3 months significantly predicted emotional eating change over 6 months (Annesi, 2022), a reciprocal relationship also was suggested in other research (Annesi & Mareno, 2015). However, whether changes in body satisfaction serve either to (1) impact emotional eating in the relation of short- and long-term weight loss (Olmsted & McFarlane, 2004), or (2) mediate associations between short- and long-term changes in weight by themselves is unclear. Resolution of this could be important to improve understanding of psychosocial correlates of weight loss and increase

explained variances in the prediction of weight change. As Sheeran et al. (2017) suggest, it also could provide guidance on where to target and prioritize future behavioral treatment content.

Thus, this report aimed to extend previous related research by accounting for the roles of changes in body satisfaction and emotional eating, and their interaction, in the prediction of long-term (baseline–Month 24) changes in weight via their shorter-term (baseline–Month 6) alterations. Based on research suggesting that body satisfaction affects emotional eating (Annesi, 2022; Carbonneau et al., 2020; Geller et al., 2020), body satisfaction was entered as the initial mediator of that relationship. Because of the additional value that measurement of weight circumference might have (Janssen et al., 2004), where weight was assessed, so was waist circumference. Year-long YMCA-based obesity treatments (one supplemented with brief telephone follow-ups and one without follow-ups) that were focused primarily on empowering women with obesity in self-regulatory skills (but not directly addressing body image or emotional eating) were incorporated to maximize generalizability of findings for "real-world" impacts. In addition to adding to the available research on psychosocial factors within behavioral weight-loss treatments, the present research could indicate whether *direct* attention on body image and/or emotional eating is warranted. Our specific hypotheses were:

In bivariate analyses, short-term change in weight will significantly predict both body satisfaction and emotional eating changes, and body satisfaction and emotional eating changes will significantly predict long-term change in weight.

Regression model paths from (1) early weight change→body satisfaction change→long-term weight change, and (2) early weight change→body satisfaction change→emotional eating change→long-term weight change, will be statistically significant.

As additional hypotheses, the above relationships also will be statistically significant when waist circumference is entered in place of body weight.

Methods

Participants

Participant data were from an ongoing research program in the United States which contrasts various behavioral treatment formats for their effects on weight. Volunteers were recruited through electronic and print media and informed that their weight-management methods would incorporate supports for both exercise and healthy eating. Although aspects of the data set were previously analyzed (Annesi et al., 2018), the present psychosocial variables and research foci are unique to this investigation. Inclusion requirements were self-identifying as female, a BMI of 30-40 kg/m^2 (Class 1 and 2 obesity), an average of < 20 minutes/week of exercise, no known contraindication for full participation (e.g., angina), no current/soon-planned pregnancy, and, if psychotropic medications were prescribed, no change in them during the previous 6 months. Based on the date of volunteering and their home/work location, participants were allocated by study staff to YMCA sites administering either a cognitive-behavioral treatment (CB group, n = 54) or the same

cognitive-behavioral treatment supplemented with brief telephone follow-ups of the comprised self-regulatory skills during the second year after treatment start (CB-Supplemented group, n = 74). Independent t and χ^2 tests indicated no statistically significant group difference in age ($M_{overall}$ = 47.4 years, SD = 8.6), BMI ($M_{overall}$ = 34.7 kg/m^2, SD = 3.2), or race/ethnicity (overall 69% White, 27% Black, 4% Hispanic). Nearly all participants were within a middle yearly household income range ($Mdn_{overall}$ = USD $63,000).

Measures

The Body Areas Satisfaction Scale of the Multidimensional Body-Self Relations Questionnaire (Cash, 2000, 2015) measured body satisfaction via 5 items. Response options for satisfaction with body areas (e.g., "lower torso," "mid torso") ranged from 0 (*very dissatisfied*) to 4 (*very satisfied*). Item scores were summed, with a higher score indicating a greater level of body satisfaction. Research suggests the adequacy of items being unweighted (Giovannelli et al., 2008). Internal consistencies for women (Cash, 2000), and women mostly post-bariatric surgery (de Zwaan et al., 2014), were reported as Cronbach's α = .73 and .75, respectively. Stability of the Body Areas Satisfaction Scale also was indicated through high degrees of response agreements over 2 weeks (Nevill et al., 2015). Test-retest reliability over 4 weeks was reported at .74 (Cash, 2000). Internal consistency (Cronbach's α) in the present sample from baseline values was .77.

The Emotional Eating Scale comprised of 15 items (Arnow et al., 1995) measured the extent to which feelings related to depression, anxiety, and anger/frustration lead to an urge to eat. Response options ranged from 0 (*no desire to eat*) to 4 (*an overwhelming urge to eat*) and were summed. A higher score indicated more emotional eating. In women with obesity, internal consistency was reported as Cronbach's α = .78, with test-retest reliability over 2 weeks at .79 (Arnow et al., 1995). Associations with validated scales of binge eating suggested convergent validity (Ricca et al., 2009). Adequate reliability and validity of the Emotional Eating Scale were found in adults with both disordered and non-disordered eating (Waller & Osman, 1998). Internal consistency in the present sample based on baseline values was Cronbach's α = .75.

Weight was measured to the nearest 0.1 kg by a calibrated, self-zeroing digital floor scale (Health-o-meter, Professional 800KL, McCook, IL). Participants first removed their shoes and any heavy outer-clothing. Waist circumference was measured to the nearest 0.1 cm at the midpoint between the last rib and iliac crest using a steel tape measure with minimal respiration of the participant. To maximize measurement accuracy, the measure of weight was the mean of two consecutive measurements made by the same study staff member. That was followed by the measure of waist circumference also derived by the mean of two consecutive measurements.

Procedures

Both the exercise- and eating-support components were based on key tenets of social cognitive theory (Bandura, 1986, 2005) and self-regulation theory (Vohs & Baumeister, 2016) which presume an ability of individuals to persevere with goal-directed behaviors through their use of self-regulation (which fosters feelings of competence associated with overcoming challenges and barriers, i.e., self-efficacy (Bandura, 1997). Because *existing* treatments were incorporated to evaluate effects on body satisfaction, emotional eating, and their relationships with weight loss within this

research, those psychological variables were not addressed explicitly in the protocols. All treatment processes were administered by existing staff members of the participating YMCAs. Each instructor possessed at least one national certification related to health/wellness instruction.

The exercise support component consisted of six 30- to 45-minute one-on-one sessions (baseline and Weeks 2, 6, 10, 18, 26) where self-regulatory skills such as proximal goal setting/incremental progress tracking, relapse prevention, cognitive restructuring, stimulus control, and dissociation from discomfort were developed and rehearsed. Although recommended amounts of exercise for health (Piercy et al., 2018) were mentioned, the emphasis was on building regularity of exercise behaviors based on preferences related to both modality and intensity/duration. Walking was, however, the primary selected modality. Assessment of pre- to post-feeling state changes were incorporated to help regulate exercise duration/intensity.

After food logging methods were developed during Weeks 9-10, group eating behavior-change sessions of 50-60 minutes were held every 2 weeks with one instructor leading 10-15 participants. Self-regulatory skills previously directed at adherence to exercise were adapted for eating-behavior changes. Emphases were on fruit/vegetable consumption, a proxy of the health effects of a diet as a whole, (Rolls et al., 2004) and daily self-recording of energy intake which was to range from 1200-1500 kcal/day, based on current weight. Targets for participants were weight loss until Week 28, when goals of maintaining lost weight next persisted until Week 36. At that point, further weight loss could be sought. Meetings terminated at Week 56. Self-weighing was required weekly. Separate manuals supported instructors' administration of both the exercise- and eating-support components.

The CB group completed only the above processes, whereas the CB-Supplemented group had the additional element of five 10- to 15-minute telephone calls to each participant at Weeks 64, 72, 80, 88, and 96 to reinforce learned self-regulatory skills. Study staff not involved in treatment administration completed structured fidelity checks on 15% of sessions. Protocol compliance was strong, and deviations were easily corrected through individual staff-to-instructor interactions, where indicated. Study staff also administered the present measures to participants in a private room, the results of which were kept confidential.

Data Analysis

The present data were primarily from previous research on weight-loss treatment effects that did not address the present variables of interest (Annesi et al., 2018). Based on fully missing data on those measures and some additional data becoming available after completion of that research, five of the original participants were removed and four were added (all fulfilling inclusion requirements). After final establishment of the study's data set, there were 10% missing cases overall resulting from measurements beyond baseline. Because there was no systematic bias in their missingness as set forth through criteria suggested by White et al. (2011), the expectation maximization algorithm was used for imputation (Little & Rubin, 2014; Schafer & Graham, 2002). This facilitated the desired intention-to-treat analytic approach (Gupta, 2011). Variance inflation factor scores of < 2.0 indicated acceptable multicollinearity in the data. For the primary analysis incorporating six predictors of the dependent measure (including the three planned covariates), to detect the moderate effect of $f^2 = .15$ at the statistical power of .90, 123 total participants were required.

As proposed for the present context of longitudinal health-related research (Glymour et al., 2005), and time-series analyses more generally (Kim & Steiner, 2021), gain (change) scores were unadjusted for their baseline value. Temporal intervals of the mediators were established based on tenets of lagged variable analyses (e.g., change over a longer duration predicted by change over a previous period; Cromwell et al., 1994). For weight and waist circumference, intervals were baseline–Month 6 (designated here as short-term change) and baseline–Month 24 (designated here as long-term change). For body satisfaction and emotional eating, the interval was baseline–Month 12. The incorporated expectation maximization algorithm had been deemed appropriate for use with such lagged variable analyses (Ding & Song, 2016). Statistical significance was set at $\alpha < .05$ (two-tailed), throughout. Based on suggestions for theory-driven analyses (Perneger, 1998), there was no adjustment to α for multiple tests. Where bootstrap resamples (20,000 resamples using the percentile method) were incorporated, a 95% confidence interval (95% CI) assessed significance (Hayes, 2018). SPSS Version 28 (IBM, Armonk, NY) was used incorporating the PROCESS macroinstruction software Version 3.5 Model 6 for serial multiple mediation (Hayes, 2018).

Mixed-model repeated measures ANOVAs first assessed significance of change in the study variables, then evaluated whether that change significantly differed by group. Effect sizes are given as partial eta-squared ($\eta^2_{partial} = SS_{Effect}/[SS_{Effect} + SS_{Error}]$) where 0.01, 0.09, and 0.25 are small, moderate, and large effects, respectively. Intercorrelations of change scores were next derived using aggregated data. Finally, serial multiple mediation of the prediction of weight change from baseline–Month 24 by weight change from baseline–Month 6, through baseline–Month 12 change in body satisfaction→baseline–Month 12 change in emotional eating, was calculated. Treatment group, age, and ethnicity were entered as covariates. Waist circumference change was then substituted for weight change in an additional, otherwise identical, serial multiple mediation model.

Results

Treatment-associated Score Changes

Table 1 shows score changes by group. Overall, there were statistically significant (*df*s = 1, 126, *p*s < .001) reductions in weight from baseline–Month 6, $F = 222.57$, $\eta^2_{partial} = 0.64$; weight from baseline–Month 24, $F = 74.14$, $\eta^2_{partial} = 0.37$; waist circumference from baseline–Month 6, $F = 205.59$, $\eta^2_{partial} = 0.62$; waist circumference from baseline–Month 24, $F = 47.11$, $\eta^2_{partial} = 0.27$; a statistically significant increase in body satisfaction from baseline–Month 12, $F = 159.97$, $\eta^2_{partial} = 0.56$; and a statistically significant reduction in emotional eating from baseline–Month 12, $F = 62.80$, $\eta^2_{partial} = 0.33$. However, there was no significant time × group interaction (*df*s = 1, 126) in weight from baseline–Month 6, $F = 0.38$, $p = .848$, $\eta^2_{partial} = 0.00$; weight from baseline–Month 24, $F = 0.86$, $p = .356$, $\eta^2_{partial} = 0.01$; waist circumference from baseline–Month 6, $F = 0.96$, $p = .328$, $\eta^2_{partial} = 0.01$; waist circumference from baseline–Month 24, $F = 0.13$, $p = .716$, $\eta^2_{partial} = 0.00$; body satisfaction from baseline–Month 12, $F = 1.86$, $p = .175$, $\eta^2_{partial} = 0.02$; or in emotional eating from baseline–Month 12, $F = 3.24$, $p = .074$, $\eta^2_{partial} = 0.03$.

https://newprairiepress.org/hbr/vol6/iss1/6
DOI: 10.4148/2572-1836.1180

Table 1
Changes in Study Measures, by Group

Measure Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*d*
	Baseline		Month 6		ΔBaseline–Month 6		
Weight (kg)							
Cognitive-Behavioral	94.84	11.52	89.00	11.57	-5.84	3.75	1.56
Cognitive-Behavioral-Supplemented	94.77	12.19	88.77	12.26	-6.00	4.87	1.23
Aggregated data	94.80	11.86	88.87	11.93	-5.93	4.42	1.34
	Baseline		Month 24		ΔBaseline–Month 24		
Weight (kg)							
Cognitive-Behavioral	94.84	11.52	90.47	12.88	-4.37	6.29	0.70
Cognitive-Behavioral-Supplemented	94.77	12.19	89.35	12.62	-5.43	6.41	0.85
Aggregated data	94.80	11.86	89.82	12.69	-4.98	6.36	0.78
	Baseline		Month 6		ΔBaseline–Month 6		
Waist circumference (cm)							
Cognitive-Behavioral	106.86	9.17	100.18	9.90	-6.68	5.05	1.32
Cognitive-Behavioral-Supplemented	101.53	9.50	95.70	8.67	-5.82	4.74	1.23
Aggregated data	103.78	9.69	97.59	9.54	-6.18	4.87	1.27
	Baseline		Month 24		ΔBaseline–Month 24		
Waist circumference (cm)							
Cognitive-Behavioral	106.86	9.17	102.02	11.04	-4.83	7.31	0.66
Cognitive-Behavioral-Supplemented	101.53	9.50	97.18	10.06	-4.35	7.59	0.57
Aggregated data	103.78	9.69	99.22	10.71	-4.55	7.45	0.61
	Baseline		Month 12		ΔBaseline–Month 12		
Body satisfaction							
Cognitive-Behavioral	5.31	2.09	8.30	2.84	2.98	2.47	1.21
Cognitive-Behavioral-Supplemented	5.61	2.45	9.26	3.46	3.65	3.73	0.98
Aggregated data	5.48	2.30	8.85	3.24	3.37	3.26	1.03
	Baseline		Month 12		ΔBaseline–Month 12		
Emotional eating							
Cognitive-Behavioral	24.74	10.47	19.07	10.84	-8.67	10.41	0.83
Cognitive-Behavioral-Supplemented	22.73	11.57	17.27	11.27	-5.46	9.62	0.57
Aggregated data	24.84	11.35	18.03	11.08	-6.81	10.05	0.68

Note. Cognitive-Behavioral group $n = 54$. Cognitive-Behavioral-Supplemented group $n = 74$. Aggregated data. $N = 128$. d = Cohen's measure of effect size for within-group change where 0.20, 0.50, and 0.80 are small, moderate, and la rge effects, respectively.

Bivariate Relations

Incorporating aggregate data, intercorrelations of study variables are given in Table 2. There were statistically significant direct relationships between changes in weight from baseline–Month 6 and baseline–Month 24, and waist circumference from baseline–Month 6 and baseline–Month 24. Hypothesized relationships between short-term changes in weight and waist circumference and body satisfaction, but not emotional eating, were statistically significant. As expected, change in both body satisfaction and emotional eating were significantly associated with long-term changes in weight and waist circumference. There was also a statistically significant bivariate association between 12-month changes in body satisfaction and emotional eating.

Table 2
Intercorrelations of Study Measures (N = 128)

Measure	1	2	3	4	5	6
1. ΔWeight baseline–Month 6	---					
2. ΔWeight baseline–Month 24	.67**	---				
3. ΔWaist circumference baseline–Month 6	.60**	.41**	---			
4. ΔWaist circumference baseline–Month 24	.45**	.63**	.57**	---		
5. ΔBody satisfaction baseline–Month 12	-.39**	-.46**	-.31**	-.34**	---	
6. ΔEmotional eating baseline–Month 12	.14	.19*	.10	.19*	-.40**	---

Note. A positive correlation indicates an association among variable pairs that are in the same direction (i.e., *increase* in one variable associated with *increase* in the second variable, or *decrease* in one variable associated with *decrease* in the second variable). A negative correlation indicates an association among variable pairs that are in a different direction (i.e., *increase* in one variable associated with *decrease* in the second variable [or the reverse]).

*$p < .05$. **$p < .001$ (two-tailed tests).

Serial Multiple Mediation Analyses

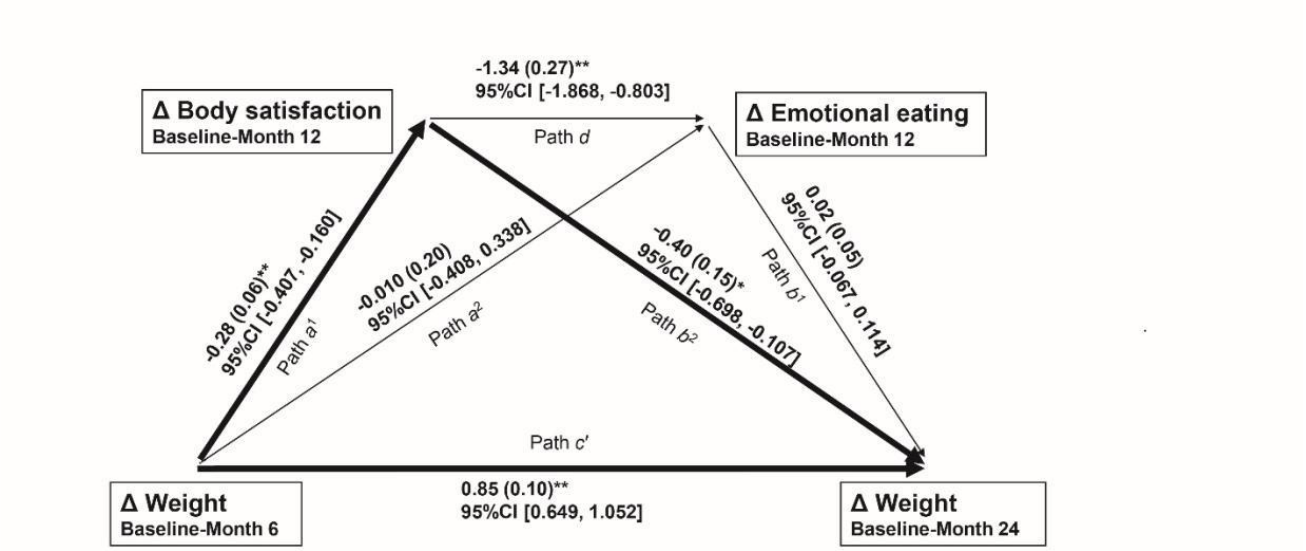
Relationships among variables within the serial multiple mediation models are given as B (SE_B) [95% CI]. For the prediction of weight change from baseline–Month 24 (Figure 1), along with a statistically significant direct effect between the independent and dependent variables (Path *c*′), only the hypothesized path from changes in weight from baseline–Month 6→body satisfaction from baseline–Month 12→weight from baseline–Month 24, was statistically significant, B = .11, SE_B = .05, 95% CI [.028, .228]. Similarly, for the prediction of waist circumference change from baseline–Month 24 (Figure 2), along with a statistically significant direct effect between the independent and dependent variables (Path *c*′), only the path from changes in waist circumference from baseline–Month 6→body satisfaction from baseline–Month 12→waist circumference from baseline–Month 24 was significant, B = .08, SE_B = .04, 95% CI [.001, .171]. Treatment group, age, and ethnicity were not statistically significant covariates in the prediction of changes in weight (*p*s > .25) or waist circumference (*p*s > .35). Within both overall models, only treatment group was a statistically significant covariate, and only of change in emotional eating (*p*s = .012). That finding indicated greater effects on reduced emotional eating in the CB-Supplemented group.

Sensitivity Analyses

Although the research literature suggests that body satisfaction is a predictor of emotional eating, rather than the reverse, (Annesi, 2022; Carbonneau et al., 2020; Geller et al., 2020), directionality (or reciprocality) has not been well tested. Therefore, to account for directionality of the relationships of the mediators within the serial multiple mediation analyses, models were fit where change in emotional eating was entered as the first mediator, predicting change in body satisfaction (as the second mediator). Because only paths from changes in weight from baseline–Month 6→body satisfaction from baseline–Month 12→weight from baseline–Month 24, B =

Figure 1

Serial Multiple Mediation Model Predicting Change in Weight Baseline–Month 24 from Weight Change Baseline–Month 6 through Changes in Body Satisfaction, then Emotional Eating



Note. Δ = change during the designated temporal interval. Data concerning each bivariate path within the model are given as unstandardized beta (and the corresponding *SE*), with the 95% confidence interval (95% CI) in brackets. Heavy lines denote a statistically significant path toward change in weight from baseline–Month 24.

*$p < .01$. **$p < .001$ (two-tailed tests).

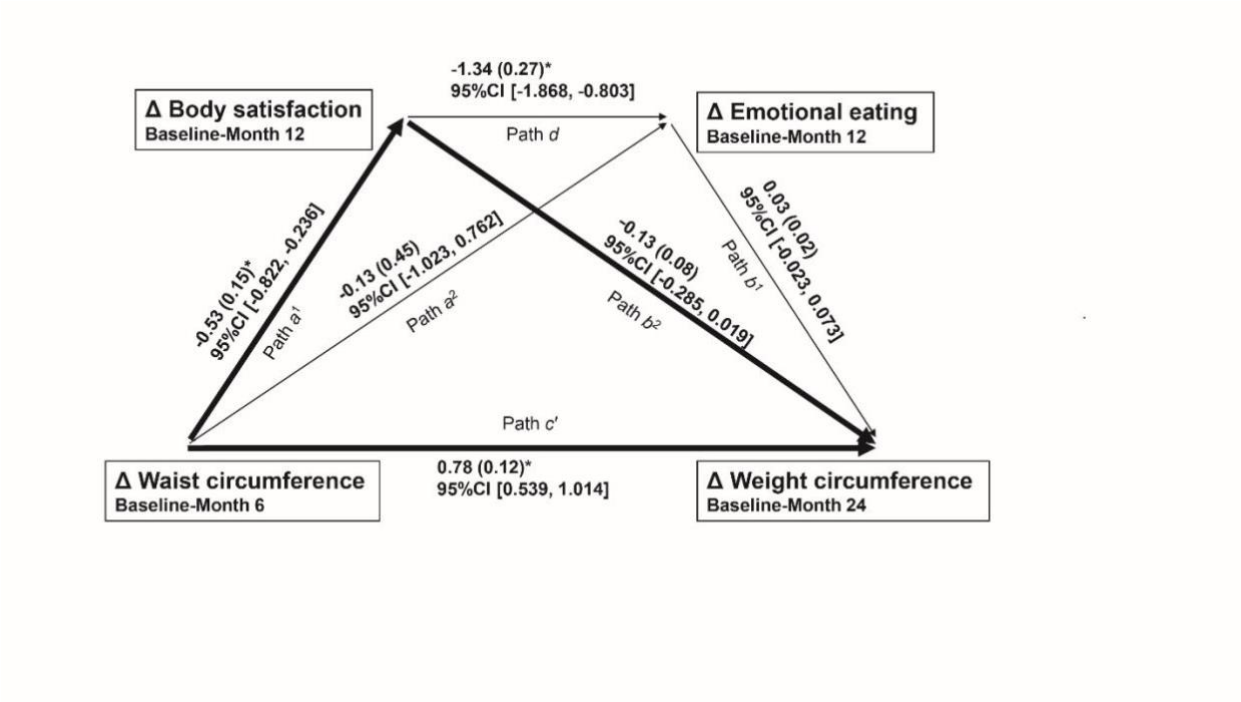
.10, SE_B = .05, 95% CI [.021, .196], and changes in waist circumference from baseline–Month 6→body satisfaction from baseline–Month 12→waist circumference from baseline–Month 24, B = .06, SE_B = .04, 95% CI [.0001, .152], were again statistically significant, and other embedded relationships and impacts of covariates were similar to the results in the original models (Figures 1 and 2), it was suggested that directionality of the mediators did not impact the identified role of body satisfaction change in the prediction of long-term change in weight and waist circumference.

Discussion

Findings indicated that the present behavioral treatments were associated with improvements in measures of short- and long-term weight and waist circumference, body satisfaction, and emotional eating. The additional brief telephone contacts made in the second year in the CB-Supplemented treatment group were not associated with any statistically significant additional improvement in those variables. An increased treatment dosage and/or focus in the second year will likely be required for

Figure 2

Serial Multiple Mediation Model Predicting Change in Weight Baseline–Month 24 from Weight Change Baseline–Month 6 through Changes in Body Satisfaction, then Emotional Eating



Note. Δ = change during the designated temporal interval. Data concerning each bivariate path within the model are given as unstandardized beta (and the corresponding *SE*), with the 95% confidence interval (95% CI) in brackets. Heavy lines denote a statistically significant path toward change in weight from baseline–Month 24.

*$p < .01$. **$p < .001$ (two-tailed tests).

additional effects. Although obesity is a chronic disorder with high levels of relapse, participants often rebuff long-term, multi-year interventions because of the immediacy of expectations, and unrealistic promises made by the popular media (Karasu, 2012). Innovative research, possibly incorporating electronic and virtual components, require further testing to increase acceptability of elongated behavioral treatments.

Direct bivariate relationships between short- and long-term changes in weight and waist circumference and changes in body satisfaction and emotional eating were found. In affirmation of the hypotheses, short-term change in weight and waist circumference predicted body satisfaction, and changes in both body satisfaction and emotional eating significantly predicted long-term changes in weight and waist circumference. However, those associations were not assessed for what have been termed their "underlying mechanisms" (Fairchild & McDaniel, 2017). Thus, as suggested (Fairchild & McDaniel, 2017), the present incorporation of serial multiple mediation analyses, using theoretically driven time-series and lagged variable analytic approaches, were more instructive in that regard. As Sheeran et al. (2017) suggest, those regression models were

structured in a manner where treatment targets and emphases could be suggested based on their results – in the present case, applicable to women with obesity.

Hypotheses related to those serial multiple mediation analyses were partially supported as change in body satisfaction, but not *additionally* emotional eating, significantly mediated the short- to long-term weight and waist circumference change relationships (although the *direct* relationship between changes in body satisfaction and emotional eating were indicated in bivariate analyses (Table 2) and within the serial multiple mediation analyses (Figures 1 and 2, Paths *d*). Unlike in the present treatments, findings suggest intervention time should be specifically allocated to improve participants' body satisfaction. This might include instruction in corrective thinking, addressing unproductive assumptions, use of emotion control/desensitization, and understanding possible bases for an unfavorable body image (Cash & Smolak, 2011). Although the variance in long-term weight and waist circumference reduction explained by improved body satisfaction was small, its significant mediation (while accounting for emotional eating) warrants such intervention considerations. When body satisfaction is added to the already-established factors of self-regulation, self-efficacy, and mood change (Annesi, 2020; Teixeira et al., 2015), that grouping should then be tested to determine relative amounts of attention warranted within behavioral obesity programs with their bases in social cognitive theory (Bandura, 1986, 2005). Considering earlier research, self-regulation might still remain the primary treatment focus (Annesi, 2020; Teixeira et al., 2015).

Although accounting for interactions across these and other psychosocial correlates of short- and long-term weight loss could prove useful for refining treatment content, investigation of how changes in body satisfaction interact with self-efficacy (through increased feelings of accomplishment) might be particularly productive. Self-efficacy has been a robust predictor of consistency with health-related behavioral changes such as exercise and controlled eating (Luszczynska & Schwarzer, 2005). Also, even though emotional eating was not particularly relevant in the present serial multiple mediation analyses, the extant research literature still suggests it warrants treatment attention (Annesi & Johnson, 2021). It will require considerable additional research to *comprehensively* delineate the role of specific psychosocial predictors in the transfer of earlier- to longer-term weight loss so that treatment attention can best be allocated. Even then, individual participant characteristics might require consideration regarding the uptake of specific methodologies (Johnson et al., 2010).

Our investigation both filled a gap in the available related research and followed suggested methodologies where predictive models and accumulated evidence can be utilized for refining intervention curricula (Sheeran et al., 2017). The findings extended already-identified relationships among body satisfaction, emotional eating, and weight change that was mostly limited to short-term analyses, prior to expected regains in weight beyond 6 months, (Jeffery et al., 2000; MacLean et al., 2015) and on a cross-sectional level (Annesi, 2022; Annesi & Mareno, 2015; Carbonneau et al., 2020; Chao, 2015; Frayn & Knäuper, 2018; Geller et al., 2020; Koenders & van Strien, 2011).

Although relevant findings were gained, there were limitations that should be acknowledged. On a participant level, effects of age, sex, race/ethnicity, degree of obesity (e.g., Class 3 [morbid] obesity), additional disorders (e.g., diabetes), and numbers of previous attempts at weight loss should be considered more extensively. Also, success with maintaining exercise and reduced

energy eating over the length of the investigation should be attended to in extensions of this research. Initial propensities for emotional eating and a positive/negative body image also should be addressed, as well as limitations based on a dependency on self-report measures and responses possibly influenced by social support/expectancy effects from instructors and fellow participants (Rosnow, 2002). The addition of a control condition will be useful to enhance confidence in reported changes in the psychosocial measures. Finally, the association of weight and waist circumference change from baseline–Month 6 and baseline–Month 24 had overlap that could have elevated their association. Although such shortcomings should be considered, it is hoped that extensions of this research also incorporate longitudinal designs emanating from field-based data so that large-scale dissemination of methodologies capable of fostering reliable long-term reductions in health risks can be realized.

Implications for Health Behavior Research

This research extended the existing knowledge base on effects of psychological factors in short- and long-term weight loss. Findings suggest practitioners incorporate evidence-based methods to address body satisfaction in the behavioral treatment of women with obesity (Cash & Smolak, 2011). Because success with both short- and long-term improvements in body composition is largely dependent on treatment-associated psychosocial changes that empower required improvements in eating and exercise, the medical, dietetic, exercise science, educational, as well as psychological disciplines should collaborate in the use of the most current behavior-change methods for the benefits of their patients/clients. Research indicates that simply providing education or prescribing changes, which is often still depended upon, is insufficient (Phelan et al., 2009). Ultimately, studies such as the present investigation will cumulatively serve to build theory-based methodologies to improve the persistent problem of long-term weight loss and reliably empower reductions in associated health risks.

Discussion Question

How does body satisfaction and emotional eating play a part in explaining the relationship between short- and long-term weight change?

Ethical Approval Statement

Institutional review board (IRB) approval and IRB-approved written informed consent was obtained from all participants prior to the start of study processes. Ethical obligations of the World Medical Association Declaration of Helsinki and the American Psychological Association were followed throughout.

Potential Author Conflicts

The authors have no conflicts of interest to declare.

References

Annesi, J. J. (2012). Supported exercise improves controlled eating and weight through its effects on psychosocial factors: Extending a systematic research program toward treatment development. *Permanente Journal, 16*(1), 7-18. https://doi.org/10.7812/TPP/11-136

Annesi, J. J. (2020). Sequential changes advancing from exercise-induced psychological improvements to controlled eating and sustained weight loss: A treatment-focused causal chain model. *Permanente Journal, 24*(3), Article 19.235. https://doi.org/10.7812/TPP/19.235

Annesi, J. J. (2022). Relation of changes in body satisfaction with propensities for emotional eating within a community-delivered obesity treatment for women: Theory-based mediators. *Health Behavior Research, 5*(1), Article 2. https://doi.org/10.4148/2572-1836.1113

Annesi, J. J., & Johnson, P. H. (2021). Emotional eating: A treatment-worthy construct, or artifact of relations between mood, eating behaviors, and age in women with obesity. *Scandinavian Journal of Psychology, 62*(2), 193-202. https://doi.org/10.1111/SJOP.12685

Annesi, J. J., & Mareno, N. (2015). Improvement in emotional eating associated with an enhanced body image: Mediation by weight-management treatments' effects on self-efficacy to resist emotional cues to eating. *Journal of Advanced Nursing*, *71*(12), 2923-2935. https://doi.org/10.1111/jan.12766

Annesi, J. J., Unruh-Rewkowski, J. L., & Mareno, N. (2018). Replication and extension of the Weight Loss For Life community-based treatment protocol. *Behavioral Medicine, 44*(1), 54-61. https://doi.org/10.1080/08964289.2016.1232241

Annesi, J. J., & Walsh, S. M. (2021). Evaluation of a new causal chain model for predicting embedded psychosocial and behavioral relationships in a community-based obesity treatment seeking maintained weight loss. *Scandinavian Journal of Psychology, 62*(4), 574-585. https://doi.org/10.1111/sjop.12741

Arnow, B., Kenardy J., & Agras, W. S. (1995). The Emotional Eating Scale: The development of a measure to assess coping with negative affect by eating. *International Journal of Eating Disorders, 18*(1), 79-90. https://doi.org/10.1002/1098-108x(199507)18:1<79::aid-eat2260180109>3.0.co;2-v

Baker, C. W., & Brownell, K. D. (2000). Physical activity and maintenance of weight loss: Physiological and psychological mechanisms. In C. Bouchard (Ed.), *Physical activity and obesity* (pp. 311-328). Human Kinetics.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Bandura, A. (2005). The primacy of self-regulation in health promotion. *Applied Psychology, 54*(2), 245-254. https://doi.org/10.1111/j.1464-0597.2005.00208.x

Carbonneau, N., Goodman, L. C., Roberts, L. T., Bégin, C., Lussier, Y., & Musher-Eizenman, D. R. (2020). A look at the intergenerational associations between self-compassion, body esteem, and emotional eating within dyads of mothers and their adult daughters. *Body Image, 33,* 106-114. https://doi.org/10.1016/j.bodyim.2020.02.007

Cash, T. F. (2000). Multidimensional Body-Self Relations Questionnaire users' manual (3rd ed.). Body Images Research.

Cash, T. F. (2015). Multidimensional Body-Self Relations Questionnaire (MBSRQ). In T. Wade (Ed.), *Encyclopedia of feeding and eating disorders*. Springer. https://doi.org/10.1007/978-981-287-087-2_3-1

Cash, T. F., & Smolak, L. (2011). *Body image* (2nd ed.). Guilford.

Chao, H. L. (2015). Body image change in obese and overweight persons enrolled in weight loss intervention programs: A systematic review and meta-analysis. *PLoS ONE*, *10*(5), Article e0124036. https://doi.org/10.1371/journal.pone.0124036

Cromwell, J. B., Hannan, M. J., Labys, W. C., & Terraza, M. (1994). *Multivariate tests for time series models*. Sage.

de Zwaan, M., Georgiadou, E., Stroh, C. E., Teufel, M., Köhler, H., Tengler, M., & Müller, A. (2014). Body image and quality of life in patients with and without body contouring surgery following bariatric surgery: A comparison of pre- and post-surgery groups. *Frontiers in Psychology*, *5*, Article 1310. https://doi.org/10.3389/fpsyg.2014.01310

Ding, W., & Song, P. X. K. (2016). EM algorithm in Gaussian copula with missing data. *Computational Statistics and Data Analysis*, *101*, 1-11. https://doi.org/10.1016/j.csda.2016.01.008

Fairchild, A. J., & McDaniel, H. L. (2017). Best (but oft-forgotten) practices: Mediation analysis. *American Journal of Clinical Nutrition*, *105*(6), 1259-1271. https://doi.org/10.3945/ajcn.117.152546

Frayn, M., & Knäuper, B. (2018). Emotional eating and weight in adults: A review. *Current Psychology, 37*(4), 924-933. https://doi.org/10.1007/s12144-017-9577-9

Geller, S., Levy, S., Hyman, O., Jenkins, P. L., Abu-Abeid, S., & Goldzweig, G. (2020). Body image, emotional eating and psychological distress among bariatric surgery candidates in Israel and the United States. *Nutrients*, *12*(2), 490. https://doi.org/10.3390/nu12020490

Giovannelli, T. S., Cash, T. F., Henson, J. M., & Engle, E. K. (2008). The measurement of body-image dissatisfaction-satisfaction: Is rating importance important? *Body Image, 5*(2), 216-223. https://doi.org/10.1016/j.bodyim.2008.01.001

Gillison, F., Stathi, A., Reddy, P., Perry, R., Taylor, G., Bennett, P., Dunbar, J., & Greaves, C. (2015). Processes of behavior change and weight loss in a theory-based weight loss intervention program: A test of the process model for lifestyle behavior change. *International Journal of Behavioral Nutrition and Physical Activity*, *12*, Article 2. https://doi.org/10.1186/s12966-014-0160-6

Glymour, M. M., Weuve, J., Berkman, L. F., Kawachi, I., & Robins, J. M. (2005). When is baseline adjustment useful in analyses of change? An example with education and cognitive change. *American Journal of Epidemiology, 162*(3), 267-278. https://doi.org/10.1093/aje/kwi187

Gupta, S. K. (2011). Intention-to-treat concept: A review. *Perspectives in Clinical Research*, *2*(3), 109-112. https://doi.org/10.4103/2229-3485.83221

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional*

process analysis: A regression-based approach (2nd ed.). Guilford.

Hawkins, N., Richards, P. S., Granley, H. M., & Stein, D. M. (2004). The impact of exposure to the thin-ideal media image on women. *Eating Disorders, 12*(1), 35-50. https://doi.org/10.1080/10640260490267751

Janssen, I., Katzmarzyk, P. T., & Ross, R. (2004). Waist circumference and not body mass index explains obesity-related health risk. *American Journal of Clinical Nutrition*, *79*(3), 379-384. https://doi.org/10.1093/ajcn/79.3.379

Karasu, S. R. (2012). Of mind and matter: Psychological dimensions in obesity. *American Journal of Psychotherapy*, *66*(2), 111-128. https://doi.org/10.1176/appi.psychotherapy.2012.66.2.111

Kim, Y., & Steiner, P. M. (2021). Gain scores revisited: A graphical models perspective. *Sociological Methods and Research, 50*(3), 1353-1375. https://doi.org/10.1177/0049124119826155

Jeffery, R. W., Drewnowski, A., Epstein, L. H., Stunkard, A. J., Wilson, G. T., Wing, R. R., & Hill, D. R. (2000). Long-term maintenance of weight loss: Current status. *Health Psychology, 19*(Suppl. 1), 5-16. https://doi.org/10.1037/0278-6133.19.Suppl1.5

Johnson, B. T., Scott-Sheldon, L. A. J., & Carey, M. P. (2010). Meta-synthesis of health behavior change: Meta-analyses. *American Journal of Public Health, 100*(11), 2193-2198. https://doi.org/10.2105/AJPH.2008.155200

Koenders, P. G., & van Strien, T. (2011). Emotional eating, rather than lifestyle behavior, drives weight gain in a prospective study in 1562 employees. *Journal of Occupational and Environmental Medicine, 53*(11), 1287-1293. https://doi.org/10.1097/JOM.0b013e31823078a2

Lazzeretti, L., Rotella, F., Pala, L., & Rotella, C. M. (2015). Assessment of psychological predictors of weight loss: How and what for? *World Journal of Psychiatry*, *5*(1), 56-67. https://doi.org/10.5498/wjp.v5.i1.56

Lemmens, V. E., Oenema, A., Klepp, K. I., Henriksen, H. B., & Brug, J. (2008). A systematic review of the evidence regarding efficacy of obesity prevention interventions among adults. *Obesity Reviews, 9*(5), 446-455. https://doi.org/10.1111/j.1467-789X.2008.00468.x

Little, R. J., & Rubin, D. B. (2014). *Statistical analysis with missing data* (2nd ed.). Wiley.

Loveman, E., Frampton, G. K., Shepherd, J., Picot, J., Cooper, K., Bryant, J., Welch, K., & Clegg, A. (2011). The clinical effectiveness and cost-effectiveness of long-term weight management schemes for adults: A systematic review. *Health Technology Assessment, 15*(2), 1-182. https://doi.org/10.3310/hta15020

Luszczynska, A., & Schwarzer, R. (2005). The role of self-efficacy in health self-regulation. In W. Greve, K. Rothermund, & D. Wentura (Eds.), *The adaptive self: Personal continuity and intentional self-development* (pp. 137-152). Hogrefe & Huber.

Macht, M., & Simons, G. (2011). Emotional eating. In I. Nyklíček, A. Vingerhoets, & M. Zeelenberg (Eds.), *Emotion regulation and well-being* (pp. 281-295). Springer.

MacLean, P. S., Wing, R. R., Davidson, T., Epstein, L., Goodpaster, B., Hall, K. D., Levin, B. E., Perri, M. G., Rolls, B. J., Rosenbaum, M., Rothman, A. J., & Ryan, D. (2015). NIH working group report: Innovative research to improve maintenance of weight loss. *Obesity, 23*(1), 7-15. https://doi.org/10.1002/oby.20967

Nackers, L. M., Ross, K. M., & Perri, M. G. (2010). The association between rate of initial weight loss and long-term success in obesity treatment: Does slow and steady win the race? *International Journal of Behavioral Medicine*, *17*(3), 161-167. https://doi.org/10.1007/s12529-010-9092-y

Nevill, A., Lane, A., & Duncan, M. (2015). Are the Multidimensional Body Self-Relations Questionnaire scales stable or transient? *Journal of Sports Sciences, 33*(18), 1-9. https://doi.org/10.1080/02640414.2015.1018930

Olmsted, M. P., & McFarlane, T. (2004). Body weight and body image. *BMC Women's Health*, *4*(Suppl. 1), Article S5. https://doi.org/10.1186/1472-6874-4-S1-S5

Péneau, S., Ménard, E., Méjean, C., Bellisle, F., & Hercberg, S. (2013). Sex and dieting modify the association between emotional eating and weight status. *American Journal of Clinical Nutrition*, *97*(6), 1307-1313. https://doi.org/10.3945/ajcn.112.054916

Perneger, T. V. (1998). What's wrong with Bonferroni adjustments. *British Medical Journal, 316*(7139), 1236-1238. https://doi.org/10.1136/bmj.316.7139.1236

Phelan, S., Nallari, M., Darroch, F. E., & Wing, R. R. (2009). What do physicians recommend to their overweight and obese patients? *Journal of the American Board of Family Medicine*, *22*(2), 115-122. https://doi.org/10.3122/jabfm.2009.02.080081

Piercy, K. L., Troiano, R. P., Ballard, R. M., Carlson, S. A., Fulton, J. E., Galuska, D. A., George, S. M., & Olson, R. D. (2018). The physical activity guidelines for Americans. *Journal of the American Medical Association*, *320*(19), 2020-2028. https://doi.org/10.1001/jama.2018.14854

Ricca, V., Castellini, G., Lo Sauro, C., Ravaldi, C., Lapi, F., Mannucci, E., Rotella, C. M., & Faravelli, C. (2009). Correlations between binge eating and emotional eating in a sample of overweight subjects. *Appetite*, *53*(3), 418-421. https://doi.org/10.1016/j.appet.2009.07.008

Rolls, B. J., Ello-Martin, J. A., & Tohill, B. C. (2004). What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutrition Reviews, 62*(1), 1-17. https://doi.org/10.1111/j.1753-4887.2004.tb00001.x

Rosnow, R. L. (2002). The nature and role of demand characteristics in scientific inquiry *Prevention and Treatment, 5*(1), Article 37. https://doi.org/10.1037/1522-3736.5.1.537c

Rössner, S., Hammarstrand, M., Hemmingsson, E., Neovius, M., & Johansson, K. (2008). Long-term weight loss and weight-loss maintenance strategies. *Obesity Reviews*, *9*(6), 624-630. https://doi.org/10.1111/j.1467-789X.2008.00516.x

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art.

Psychological Methods, 7(2), 147-177. https://doi.org/10.1037/1082-989X.7.2.147

Sheeran, P., Klein, W. M. P., & Rothman, A. J. (2017). Health behavior change: Moving from observation to intervention. *Annual Review of Psychology, 68,* 573-600. https://doi.org/10.1146/annurev-psych-010416-044007

Sniehotta, F. F., Simpson, S. A., & Greaves, C. J. (2014). Weight loss maintenance: An agenda for health psychology. *British Journal of Health Psychology, 19*(3), 459-464. https://doi.org/10.1111/bjhp.12107

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J. M., De Bourdeaudhuij, I., Lakerveld, J., & Brug, J. (2015). Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators. *BMC Medicine, 13*, Article 84. https://doi.org/10.1186/s12916-015-0323-6

Teixeira, P. J., Palmeira, A. L., Branco, T. L., Martins, S. S., Minderico, C. S., Barata, J. T., Silva, A. M., & Sardinha, L. B. (2004). Who will lose weight? A reexamination of predictors of weight loss in women. *International Journal of Behavioral Nutrition and Physical Activity, 1,* Article 12. https://doi.org/10.1186/1479-5868-1-12

Vohs, K. D., & Baumeister, R. F. (Eds.). (2016). *Handbook of self-regulation: Research, theory, and application* (3rd ed.). Guilford.

Waller, G., & Osman, S. (1998). Emotional eating and eating psychopathology among non-eating-disordered women. *International Journal of Eating Disorders, 23*(4), 419-424. https://doi.org/10.1002/(sici)1098-108x(199805)23:4<419::aid-eat9>3.0.co;2-l

Warren, C. S., & Akoury, L. M. (2020). Emphasizing the "cultural" in sociocultural: A systematic review of research on thin-ideal internalization, acculturation, and eating pathology in US ethnic minorities. *Psychology Research and Behavior Management*, *13*, 319-330. https://doi.org/10.2147/PRBM.S204274

White, I. R., Horton, N. J., Carpenter, J., & Pocock, S. J. (2011). Strategy for intention to treat data in randomized trials with missing outcome data. *British Medical Journal, 342*, Article d40. https://doi.org/10.1136/bmj.d40

Williamson, D. A., Bray, G. A., & Ryan, D. H. (2015). Is 5% weight loss a satisfactory criterion to define clinically significant weight loss? *Obesity, 23*(12), 2319-2320. https://doi.org/10.1002/oby.21358

Wing, R. R., & Phelan, S. (2005). Long-term weight loss maintenance. *American Journal of Clinical Nutrition*, *82*(Suppl. 1), S222-S225. https://doi.org/10.1093/ajcn/82.1.222S