AMERICAN ACADEMY of HEALTH BEHAVIOR

Health Behavior Research

Volume 5 | Number 4

Article 4

July 2022

Early Effects of Improved Mood on Propensity for Emotional Eating During the Physical Activity-only Phase of a Community-Based Behavioral Treatment for Obesity in Women with High Mood Disturbance

James J. Annesi
University of Alabama at Birmingham and Central Coast YMCA, jamesannesi@gmail.com

Amelia A. Eberly

Recommended Citation

Annesi, James J. and Eberly, Amelia A. (2022) "Early Effects of Improved Mood on Propensity for Emotional Eating During the Physical Activity-only Phase of a Community-Based Behavioral Treatment for Obesity in Women with High Mood Disturbance," *Health Behavior Research*: Vol. 5: No. 4. https://doi.org/10.4148/2572-1836.1156

Early Effects of Improved Mood on Propensity for Emotional Eating During the Physical Activity-only Phase of a Community-Based Behavioral Treatment for Obesity in Women with High Mood Disturbance

Abstract

Weight loss beyond the short term is problematic for individuals with obesity. Especially for women, emotional eating is one of the greatest barriers and might require attention early in a behavioral weight-loss program. Physical activity-associated mood improvement may be associated with reduced emotional eating. Women with obesity volunteered for a community-based weight-management treatment. Effects associated with the initial 10 weeks, which focused on behavioral support of physical activity (prior to addressing eating behavior change), were assessed. Groups were designated based on whether participants' high total mood disturbance (TMD) scores reduced to a normal level (n = 45) or remained high (n = 27). Although significant overall improvements in emotional eating were found, $F(1, 70) = 22.80$, $p < .001$, its change scores did not significantly differ by group, $F(1, 70) = 0.82$, $p = .370$. Using aggregated data, the prediction of reduction in emotional eating by lowered TMD scores was not statistically significant. Adding change in self-efficacy for controlled eating into Step 2 of the regression model significantly increased the explained variance to $R^2 = .10$, $p = .014$, with group not being a significant contributor when added in Step 3. TMD reduction was significantly predicted by increase in physical activity, $\beta = -.23$, $p = .028$, and completion of at least 3 bouts/week, $r_{pb} = -.22$, $p = .015$. Because physical activity-related reductions in negative mood and increases in self-efficacy were associated with reduced emotional eating, viability for those behavioral factors as early treatment targets were signaled.

Keywords

mood, emotional eating, physical activity, obesity, treatment

Acknowledgements/Disclaimers/Disclosures

The authors have no conflicts of interest to declare, financial or otherwise.

Early Effects of Improved Mood on Propensity for Emotional Eating During the Physical Activity-only Phase of a Community-based Behavioral Treatment for Obesity in Women with High Mood Disturbance

James J. Annesi, PhD, FAAHB, FTOS, FAPA*
Amelia A. Eberly, BA

Abstract

Weight loss beyond the short term is problematic for individuals with obesity. Especially for women, emotional eating is one of the greatest barriers and might require attention early in a behavioral weight-loss program. Physical activity-associated mood improvement may be associated with reduced emotional eating. Women with obesity volunteered for a community-based weight-management treatment. Effects associated with the initial 10 weeks, which focused on behavioral support of physical activity (prior to addressing eating behavior change), were assessed. Groups were designated based on whether participants' high total mood disturbance (TMD) scores reduced to a normal level (n = 45) or remained high (n = 27). Although significant overall improvements in emotional eating were found, $F(1, 70) = 22.80$, $p < .001$, its change scores did not significantly differ by group, $F(1, 70) = 0.82$, $p = .370$. Using aggregated data, the prediction of reduction in emotional eating by lowered TMD scores was not statistically significant. Adding change in self-efficacy for controlled eating into Step 2 of the regression model significantly increased the explained variance to $R^2 = .10$, $p = .014$, with group not being a significant contributor when added in Step 3. TMD reduction was significantly predicted by increase in physical activity, $\beta = -.23$, $p = .028$, and completion of at least 3 bouts/week, $r_{pb} = -.22$, $p = .015$. Because physical activity-related reductions in negative mood and increases in self-efficacy were associated with reduced emotional eating, viability for those behavioral factors as early treatment targets were signaled.

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

Introduction

Weight loss beyond the short term has been *extremely* problematic in individuals with obesity using behavioral (non-surgical or non-pharmacological) processes (Lemmens et al., 2008; Loveman et al., 2011). An increased understanding of early effects of psychological and behavioral predictors of weight change might enable better treatment outcomes beyond an initial 6–9 months where most weight tends to begin its near-complete regain (MacLean et al., 2015; Mann et al., 2007). Early effects on eating behaviors have been deemed crucial for longer term weight loss (Burgess et al., 2017; Munsch et al., 2012). Especially in women (Péneau et al., 2013), emotional eating, or eating in response to negative mood, is one of the greatest barriers to weight-loss success (Koenders & van Strien, 2011). Emotional eating compromises planned improvements in eating behaviors through overwhelming one's confidence in dealing with lifestyle challenges such as high availabilities of unhealthy foods and feelings of discomfort (Leung et al., 2018).

Because initiating regular exercise/ physical activity reliably predicts both improved mood (Arent et al., 2020) and sustained weight loss (Loveman et al., 2011), it was proposed that physical activity-related mood change positively affects emotional eating (Annesi & Eberly, 2022). This was indirectly reinforced through research indicating that weight loss cannot be directly accounted for through the minor caloric expenditures found in adults with obesity who are initiating physical activity regimens (Annesi, 2019; Donnelly et al., 2009). Although the influence of physical activity on overall mood might be predominantly through either biochemical changes in the brain or behavioral changes (e.g., feelings of mastery over an important and challenging health behavior; Arent et al., 2020), social cognitive theory (Bandura, 1986) emphasizes the reinforcement properties of improved mood on goal-driven behavioral changes such as controlling one's eating. However, the proposed relationships between physical activity, mood, and emotional eating have not been sufficiently assessed in the high number of women with both obesity and elevated levels of depression, anxiety, and/or mood disturbance who might have the most problems adhering to regular physical activity (Burgess et al., 2017).

Although research indicates that less than 4% of U.S. adults complete the minimum recommended amount of moderate-intensity physical activity for health benefits (i.e., ≥ 150 minutes/week; Piercy et al., 2018) (Troiano et al., 2008), other studies suggest that approximately half that amount (i.e., ~3 moderate bouts/week) is needed for significant improvements in mood (Annesi, 2022). This could have implications for individuals with obesity who avoid high amounts of exercise because of physical discomforts, but would benefit from associated changes in negative mood (Ekkekakis et al., 2016). Changes in emotional eating could also vary in strength based on one's degree of treatment-related improvement in mood disturbance – which has been assessed as an aggregate of measured anxiety, depression, fatigue, anger, confusion, and vigor (McNair & Heuchert, 2005).

Although self-efficacy theory (Bandura, 1997) and social cognitive theory (Bandura, 1986) support a relationship between improved mood and behavioral changes such as that of emotional eating, improvements in self-efficacy (i.e., feelings of competence) might also be an important predictor of emotional eating change (Annesi, 2020). Self-efficacy increases both goal striving and the effort required for behavioral changes (Bandura, 1997; Mann et al., 2013). Thus, recent theoretically driven obesity treatments have demonstrated promise in first focusing on the support of physical activity (in advance of addressing eating behavior changes) to build self-regulatory skills, which foster feelings of early success, along with improved mood (Annesi et al., 2018). It was thought that early success at negotiating the weight-loss behavior of physical activity would carry over to increased feelings of self-efficacy for controlled eating (Annesi, 2020; Mata et al., 2009). However, emotional eating was not well accounted for in much of that intervention-related inquiry, and that shortcoming was acknowledged as a gap in the extant research (Litwin et al., 2017). Recent research on coaction, or improvements in one behavior inducing a proportional improvement in a second behavior (Johnson et al., 2014), suggests that increased physical activity leads to improved eating via increases in self-efficacy to control one's behaviors (Annesi, 2021).

Thus, this research focused on the initial 10 weeks of a cognitive-behavioral treatment for obesity intended for field settings. Because of their heightened response to emotional eating (Péneau et al., 2013), women with both obesity and disturbed mood were participants. Hypotheses are as follows:

- The group of participants with normalized mood scores will have significantly greater improvements in

DOI: 10.4148/2572-1836.1156

emotional eating, self-efficacy for controlled eating, and physical activity than the group whose negative mood remained high.

- Reduction in emotional eating will be significantly predicted by reduction in mood disturbance, with the addition of self-efficacy significantly increasing the explained variance.
- Increase in physical activity, and the completion of (the equivalent of) three moderate bouts of physical activity/ week, will significantly predict reduction in mood disturbance.

Method

Participants

The present data set from 2018–2020 was from longitudinal field research on behavioral weight-loss treatments held within community health promotion settings in the United States. Participants were recruited from local paper and electronic advertisements. Overwhelmingly, either their residence and/or workplace was within the same community/city as the treatment location. The goals of that continuing field research project were different from those of the present short-term investigation which also required an initial Profile of Mood States-Brief (McNair & Heuchert, 2005) total mood disturbance (TMD) score ≥ 1.0 *SD* above the reported normative mean for women (score ≥ 23; highest 16%; Nyenhuis et al., 1999). Based on reference material (Lovibond & Lovibond, 1995), previous research classified that score range as "disturbed mood" (Annesi, in press). Other inclusion criteria were BMI of 30–40 kg/m^2 (i.e., Class 1–2 obesity); self-identification as female ≥ 21 years-of-age; and no present or soon-planned pregnancy, change in psychotropic medication during the previous year, or known contraindication for safe participation. All were enrolled in the same cognitive-behavioral weight-management treatment (outlined in the Procedures section below). Out of an initial 129 participants fulfilling all inclusion criteria except for that of TMD score, 72 (56%) also had a TMD score ≥ 23 at baseline. Of that overall sample for this study ($N = 72$), participants were then designated as groups of Normalized Mood ($n = 45$) and Non-normalized Mood ($n = 27$) based on whether their TMD score at Week 10 reduced to ≤ 0.5 *SD* above the normative mean (i.e., ≤ 16) or not. One-way ANOVA and χ^2 analyses indicated no significant group difference ($ps > .30$) in age ($M_{\text{overall}} = 46.8$ years, $SD = 8.8$), BMI ($M_{\text{overall}} = 34.7$ kg/m^2, $SD = 3.3$), or race/ethnicity (overall, 79% white, 15% black, 4% Hispanic, and 2% other). Almost all participants had a middle family income (*Mdn* = US$76,000/year). Institutional review board (IRB) approval and IRB-approved written informed consent was acquired from all participants prior to study start. Ethical requirements of the Declaration of Helsinki and American Psychological Association were maintained throughout.

Measures

TMD was measured by the Profile of Mood States-Brief (McNair & Heuchert, 2005). Its 30 items required recall of feelings "during the past week, including today." Responses ranging from 0 (*not at all*) to 4 (*extremely*) to items associated with depression (e.g., "sad"), fatigue (e.g., "weary"), anger (e.g., "annoyed"), anxiety (e.g., "nervous"), confusion (e.g., "confused"), and reversed scores on vigor (e.g., "energetic") were summed, with a possible score range of -20–100. A higher score indicated a greater level of disturbed mood. Internal consistencies across factors in samples of women were Cronbach's αs = .76–.87, and test-retest reliability over an average of 3 weeks that was .70 (McNair & Heuchert, 2005). Concurrent validity was previously indicated through score correspondences with accepted, but lengthier, scales such the Manifest Anxiety Scale, Minnesota Multiphasic Personality Inventory-2, and Beck Depression Inventory (McNair et al., 1992). Internal consistencies in this study's sample averaged Cronbach's α = .80. Correspondences between the present and full 65-item Profile of Mood States were high at *r*s = .93 – .98 (Jackson & Jackson, 1997).

Emotional eating (EE) was measured by the Emotional Eating Scale (Arnow et al., 1995). Its 15 items required reactions to "the extent the following feelings presently lead you to feel an urge to eat." Responses ranging from 0 (*no desire to eat*) to 4 (*an overwhelming urge to eat*) to items associated with sensations of depression (e.g., "blue"), anxiety (e.g., "on edge"), and anger/frustration (e.g., "irritated") were summed, with a possible score range of 0–60. A higher score indicated more EE. In women with obesity, Cronbach's α = .77, and test-retest reliability over 2 weeks averaged .79 (Arnow et al., 1995). Concurrent validity was previously indicated through score correspondences with accepted scales of binge eating (Ricca et al., 2009). Internal consistency in this study's sample was Cronbach's α = .75.

Self-efficacy related to confidence in dealing with challenges to controlled eating (SE-eating) was measured by the Weight Efficacy Lifestyle Scale (Clark et al., 1991). Its 20 items required responses ranging from 0 (*not confident*) to 9 (*very confident*) to items associated with physical discomforts (e.g., "I can resist eating when I am uncomfortable"), positive activities (e.g., "I can resist eating when I am watching TV"), negative emotions (e.g., "I can resist eating when I am depressed (or feeling down)"), high food availabilities (e.g., "I can resist eating even when high-calorie foods are available"), and social pressure (e.g., "I can resist eating even when others are pressuring me to eat"). The responses were summed, with a possible score range of 0 – 180. A higher score indicated a greater amount of self-efficacy. Internal consistencies within item groupings were reported at Cronbach's αs = .76 – .82 (Clark et al., 1991). Predictive validity was previously indicated when Weight Efficacy Lifestyle Scale scores were significantly higher in adults with obesity vs. their counterparts with a normal weight (Mehar et al., 2018). Internal consistencies in this study's sample averaged Cronbach's α = .75.

The number of bouts of physical activity/exercise (PA) of at least 15 minutes completed in the previous 7 days was recalled using the Godin-Shephard Leisure-time Physical Activity Questionnaire (Godin, 2011). Response options were: "mild exercise (minimal exertion)," "moderate exercise (heartbeat faster than resting, but not exhausting)," and "strenuous exercise (heart beats rapidly)." They were coded 3, 5, and 9 metabolic equivalents (METs, a measure of physical intensity/energy expenditure; Jetté et al., 1990), respectively, and multiplied by the number of corresponding bouts reported during the past week. Those were then summed. For example, 3 bouts of moderate exercise (3 × 5 METs) and 1 bout of strenuous exercise (1 × 9 METs) would be summed to equal a score of 24. Concurrent validity of scores on the Godin-Shephard Leisure-time Physical Activity Questionnaire was previously indicated through correspondences with $VO_{2\ max}$ stress testing, accelerometry, and body fat scores in adults (Amireault & Godin, 2015; Amireault et al., 2015; Jacobs et al., 1993; Miller et al., 1994; Pereira et al., 1997). Test-retest reliability over 2 weeks was reported to be .74 (Pereira et al., 1997).

Procedure

Instructors were existing staff members of the community health promotion sites where the treatment was administered. Each had a national health education certification (e.g., American Council on Exercise, American College of Sports Medicine) and completed 6 hours of additional training on the present protocol which was reinforced by a manual for their ongoing reference. Although processes addressing eating behavior changes were planned through other instructors beginning 10 weeks after treatment start (leveraging self-regulation skills used for adhering to physical activity), based on the goals of this investigation on early treatment effects, only the initial 10 weeks comprising exclusively PA support was assessed. The treatment contained four 40-minute, one-on-one sessions at baseline and Weeks 2, 6, and 10, conducted within a private office, which consisted of counseling rather than actual completion of PA. Access to an exercise facility was included for each participant for the duration of the study. However, participants were encouraged to complete PA in any location of their choosing using their preferred modalities. A record of accessing the facility was not kept. Participants were urged to record their PA on their own for later discussion within their one-on-one sessions. However, this record was not retained by the instructor.

Within the sessions and consistent with self-efficacy theory (Bandura, 1997), social cognitive theory (Bandura, 1986), and proposed models of associations of physical activity and eating behavior change through psychosocial channels (Annesi, 2020), treatment emphases were placed on the instruction and rehearsal of learned self-regulatory skills (e.g., proximal goal setting and progress tracking, relapse prevention, cognitive restructuring, stimulus control) to effectively counter behavioral challenges and thus increase self-efficacy (a correlate of adherence to exercise; Trost et al., 2002) (Mann et al., 2013). Because depression, anxiety, and overall disturbed mood is common in women with obesity (van der Merwe, 2007), the PA-support process also included methods to individualize programs to maximize associated mood improvements and counter negative effects of over-exertion/discomfort (Trost et al., 2002). For example, instruction on testing PA bouts to ensure post-session feelings were more favorable than pre-session feelings was provided to participants (Annesi et al., 2011). Governmental recommendations of 150 minutes/week of moderate PA for health (Piercy et al., 2018) were mentioned; however, participants were free to choose their own types and amounts of PA. The treatment protocol did not specifically address emotional eating, and protocol processes have been explained more fully elsewhere (Annesi et al., 2011).

Study staff not involved in instruction conducted structured protocol fidelity checks on 10% of treatment sessions that assessed instructors' adherence to the prescribed: (a) within-session timelines, (b) goal-setting processes, and (c) self-regulatory skills training. Compliance was determined to be strong with minor breaches easily handled via concise staff-instructor interactions. The same study staff also administered measurements in a private area at baseline and Week 10.

Data Analyses

Analyses were completed in 2022. The 11% of missing scores (all at Week 10) met the criteria for no systematic bias in their missingness (White et al., 2011) enabling use of the expectation-maximization algorithm for imputation (Ding & Song, 2016; Little & Rubin, 2014; Schafer & Graham, 2002). Thus, the desired intention-to-treat format (Gupta, 2011) was supported. For the primary hierarchical multiple regression analysis, an overall sample size of 68 was required to detect a moderate effect of f^2 = .15 at the statistical power of .80, α = .05 (Cohen, 1988; Cohen et al., 2002). Variance inflation factors of < 2.0 denoted acceptable multicollinearity in the data. SPSS Version 28 (IBM, Armonk, NY) was used for the analyses.

A mixed-model repeated measures ANOVA first assessed difference in gain (change) scores on EE, overall, and between the groups of Normalized Mood and Non-normalized Mood. Similar ANOVAs assessed changes over 10 weeks in SE-eating, PA, and TMD. Effect sizes were calculated as partial eta-squared (η^2_p; 0.01, 0.06, 0.14 = small, moderate, and large effects, respectively). Follow-up tests determined effect sizes for within-group changes using Cohen's *d* (0.20, 0.50, 0.80 = small, moderate, and large effects, respectively).

The planned hierarchical multiple regression analysis was next conducted predicting change in EE by entering change in TMD in its Step 1 (Model 1), then adding SE-eating change in Step 2 (Model 2). To assess effects of group (coded: 1 = Non-normalized Mood, 2 = Normalized Mood), that coding was entered into Step 3 (Model 3). Based on suggestions (Glymour et al., 2005), change scores were unadjusted for their baseline value. For each predictor, the unstandardized beta (B), standardized beta (β), and change in R^2 values are reported. Because directionalities of change scores and their relationships were previously established (Annesi & Eberly, 2022), significance was set at $\alpha \leq .05$ (one-tailed), where appropriate. Because the primary treatment target was increased PA, sensitivity analyses was also conducted to assess the prediction of TMD change by (a) change in PA, and (b) completion of an average of (the equivalent of) at least 3 moderate bouts of PA/week (PA score ≥ 15; coded 1 = no, 2 = yes).

Results

There were significant overall improvements (*df*s = 1, 70; *p*s < .001) in EE, F = 22.80, η^2_p = 0.25; SE-eating, F = 42.84, η^2_p = 0.38; PA, F = 126.79, η^2_p = 0.64; and TMD F = 138.26, η^2_p = 0.66. Improvements (*df*s = 1, 70) were significantly greater on SE-eating in the Non-normalized Mood group, F = 4.91, p = .030, η^2_p = 0.07; and significantly greater on TMD in the Normalized Mood group, F = 42.59, p < .001, η^2_p = 0.38. There was no significant time × group interaction on EE, F = 0.82, p = .370, η^2_p = 0.01; and PA, F = 0.04, p = .838, η^2_p = 0.001. Descriptive statistics and effect sizes for within-group changes are given in Table 1.

In hierarchical multiple regression Model 1, the prediction of change in EE by TMD change did not reach statistical significance (p = .06). With the entry of SE-eating change in Model 2, statistical significance was observed. Entry of group into Model 3 did not affect the findings. Results and associated beta values are given in Table 2.

TMD change was significantly predicted by change in PA, B = -.21, SE_B = .11, β = -.23, $F(1, 70)$ = 3.77, p = .028, 95% CI [-.39, -.03]; and completion of (the equivalent of) ≥ 3 moderate bouts of PA/week, r_{pb} (N = 72) = -.22, p = .015, 95% CI [-.40, -.03].

Discussion

The overall significant improvements in EE, TMD, SE-eating, and PA during the 10-week physical activity-only phase of the behavioral intervention substantiated the first hypothesis. It "set the stage" for a similarly focused treatment component addressing

DOI: 10.4148/2572-1836.1156

eating behavior change and its psychosocial correlates. Specifically, effects on EE were moderate to large whether participants' high TMD score was normalized or not. Thus, receptivity to ensuing changes in eating behaviors might be enhanced for both conditions. The finding that the Non-normalized Mood group had significantly greater self-efficacy improvements, although in opposition to the associated hypothesis here, is consistent with earlier laboratory work that concluded, "Negative mood, then, by lowering the evaluation of prospective outcomes, would raise the level of performance that ultimately is judged as satisfactory …" (Cervone et al., 1994, p. 508).

In corroboration of the second hypothesis, while EE reduction was predicted by improvement in mood at a marginally significant level, the addition of change in SE-eating substantially strengthened that model's predictive strength. This supports the importance of the proposed role of self-efficacy in maximizing goal striving and effort toward positive change (Bandura, 1997; Mann et al., 2013). Thus, considerable treatment attention is warranted there. However, because only 10% of the variance in EE change was accounted for, additional theory-driven psychosocial predictors should also be evaluated in extensions of this research. Although self-regulation improve-

Table 1

Baseline, Week 10, Gain (Change) Scores, and Associated Effect Sizes of Study Variables, by Group

Measure	Baseline		Week 10		ΔBaseline–Week 10		
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*d*
Emotional eating (EE)							
Normalized mood	28.84	10.96	22.11	10.62	-6.73	10.64	0.63
Non-normalized mood	28.07	9.28	23.48	8.42	-4.59	7.99	0.58
Group data aggregated	28.56	10.30	22.63	9.81	-5.93	9.73	0.61
Total mood disturbance (TMD)							
Normalized mood	33.60	11.17	3.69	9.11	-29.91	15.74	1.90
Non-normalized mood	36.22	9.82	24.56	11.42	-11.67	12.19	0.96
Group data aggregated	34.58	10.69	11.51	14.24	-23.07	16.95	1.36
Self-efficacy for controlled eating (SE-eating)							
Normalized mood	39.84	20.68	64.20	19.09	24.36	24.28	1.00
Non-normalized mood	51.22	20.02	63.26	18.76	12.04	20.17	0.60
Group data aggregated	44.11	21.04	63.85	18.81	19.74	23.46	0.84
Physical activity/exercise (PA)							
Normalized mood	6.32	7.34	32.13	18.01	25.81	17.21	1.49
Non-normalized mood	6.19	6.55	31.07	18.87	24.89	20.49	1.22
Group data aggregated	6.27	7.00	31.74	18.21	25.47	18.37	1.37

Note. Normalized Mood group $n = 45$. Non-normalized Mood group $n = 27$. Groups aggregated $N = 72$. Δ = change during 10 weeks. d = Cohen's measure of within-group effect size for score change.

Table 2

Results of Hierarchical Multiple Regression Analyses for the Prediction of Change in Emotional Eating Over 10 Weeks (N = 72)

Measure	R^2	ΔR^2	B	SE_B	β	*p*	95% CI
Model 1	.03					.063	
ΔTotal mood disturbance			0.11	0.07	.18	.063	[-.01, .22]
Model 2	.10	.07				.014	
ΔTotal mood disturbance			0.05	0.07	.08	.257	[-.07, .16]
ΔSelf-efficacy for controlled eating			-0.11	0.05	-.28	.015	[-.20, -.03]
Model 3	.10	.00				.034	
ΔTotal mood disturbance			0.05	0.08	.09	.275	[-.09, .18]
ΔSelf-efficacy for controlled eating			-0.11	0.05	-.28	.015	[-.20, -.03]
Group			0.16	2.71	.01	.477	[-4.36, 4.67]

Note. Δ = change in score from baseline – Week 10. 95% CI = 95% confidence interval. Entry of ΔSelf-efficacy for controlled eating into Model 2 was planned based on theory. In Model 3, group was coded: 1 = Non-normalized Mood, 2 = Normalized Mood. Model 1 $F(1, 70) = 2.42$. Model 2 $F(2, 69) = 3.77$. Model 3 $F(3, 68) = 2.48$.

ment was a key component of the present treatment, it was considered here as an unmeasured correlate of self-efficacy change. Change in self-regulation has been entered as a separate predictor of eating behavior changes in previous research on general (rather than emotional) eating (Annesi, 2019). Thus, it should be evaluated as an independent variable in the future. Other possible variables suggested for inclusion as predictors of EE changes include body image and self-concept (Frayn & Knäuper, 2018). Findings of such multivariate models could alter indications for early treatment emphases.

In addressing the third hypothesis, although the dose-response relationship between PA and TMD changes was supported, so were benefits for completing only 3 moderate bouts per week. This seemingly manageable amount might be useful for those with obesity who are likely to be challenged adhering to the PA volume recommended for health (Burgess et al., 2017). Findings were congruent with path analyses indicating relationships of changes in PA → mood → emotional eating (Annesi & Eberly, 2022), and on coaction between increases in PA and reductions in uncontrolled eating (Heredia et al., 2020). Although dose-response relationships between PA and mood changes have been questioned (Arent et al., 2020), the 3 bout/week dosage found here was also indicated for significant effects on high depression and anxiety scores in other research (Annesi, 2022).

Strengths/Limitations

A strength of this research was its applicable findings that supported the use of self-regulation training to reinforce PA and mitigate EE within the initial 10 weeks of a behavioral obesity treatment. It also helped define a role for eating-related self-efficacy, and targeting treatment there. Additionally, the research was conducted using a time-series design in a field setting that enabled results to be rapidly generalized to real-world settings (Green et al., 2013). Such analysis of change is more advantageous than typical cross-sectional designs because it accounts for dynamic changes and their interrelations associated with weight management processes. However, limitations should also be acknowledged. For example, it is not known to what extent expectation or social effects impacted outcomes. This is a common shortcoming in field-based research (Price et al., 2008). The use of a no-treatment or usual care control condition would help with that issue in extensions of this research. Measurement of social supports and enjoyment with PA over time was not accounted for and could have also affected findings. Moreover, although short-term change in EE is an important predictor of longer-term eating and weight changes in women (Stotland & Larocque, 2005), direct measurement over longer periods will be required to increase confidence under the present conditions. Evaluation of findings across samples of men, individuals with higher levels of obesity (e.g., BMI ≥ 40 kg/m^2; Class 3/severe obesity), and those with other medical disorders (e.g., Type 2 diabetes) is additionally required. Results where treatment is focused on eating and/or EE early in in its curriculum should also be contrasted with the present intervention format of PA support first. Although predicting change in EE simultaneously via two related statistical methodologies increased the chance of a Type I error, it was deemed justified here. More specifically, although treating TMD change as a dichotomous variable (i.e., Normalized/Non-normalized Mood – within the ANOVA analysis) risked some loss of data, its designation as a continuous variable (i.e., TMD change – within the regression analysis) failed to account for the previously identified diminishment of effect after substantial reduction in negative mood is realized (e.g., floor effect; Annesi et al., 2018). Also, score cut points (available through the dichotomous designation) present opportunities for conveniently applied usages for the high proportion of individuals with both obesity and mood disturbance.

Implications for Health Behavior Theory

Findings generally supported tenets of self-efficacy theory (Bandura, 1997), social cognitive theory (Bandura, 1986), and theory- and related research-based relationships between PA and eating behaviors via psychosocial channels when goals center around weight loss (Frayn & Knäuper, 2018). However, the somewhat low percentage of explained variance in EE change found here requires a more comprehensive inclusion of variables associated with those theories in extensions of this study. It is recommended that health behavior research continue to shape interventions that can be applied to many individuals through community-based venues utilizing strong behavioral theories. As with the present investigation, hypothesized mechanisms can then be scrutinized for their effects, and treatment revisions may follow from those findings.

While the present research suggested the need for longitudinal analyses of impacts on EE, the current findings suggested: (a) the viability of moderate amounts of PA for improving negative mood, (b) the need to support adherence to such PA practices through theory-based cognitive-behavioral methods that have the potential of carrying over to positive psychosocial changes related to improved eating behaviors, and (c) reshaping recommendations for PA amounts to foster increased self-efficacy and mood improvement rather than challenge tolerances for greater amounts (as is typical). Ongoing and systematic extensions of applied research such as this will provide the best chance of building methods for success in endeavors such as long-term weight loss (Baranowski et al., 2009). Certainly, the public requires disciplines that address health promotion to carefully attend to behavior change processes rather than continue their reliance on atheoretical methods of simply providing education on *what to do* (without sufficient consideration of how to circumvent persistent lifestyle barriers to the accomplishment of those required behaviors).

Discussion Questions

1. What theory-based considerations should be contemplated when constructing and evaluating an intervention to address emotional eating?
2. Can that process be effectively adapted for community-based venues so that all in need, including the underserved, may benefit?

Ethical Approval Statement

Institutional review board (IRB) approval for the study protocol was received. An IRB-approved written informed consent form was reviewed and signed by all participants prior to study start. Ethical requirements of the Declaration of Helsinki and American Psychological Association were maintained throughout study processes.

Acknowledgments

The authors have no conflicts of interest to declare, financial or otherwise.

References

Amireault, S., & Godin, G. (2015). The Godin-Shephard Leisure-time Physical Activity Questionnaire: Validity evidence supporting its use for classifying healthy adults into active and insufficiently active categories. *Perceptual and Motor Skills, 120*(2), 604–622. http://doi.org/10.2466/03.27.PMS.120v19x7

Amireault, S., Godin, G., Lacombe, J., & Sabiston, C. M. (2015). Validation of the Godin-Shephard Leisure-time Physical Activity Questionnaire classification coding system using accelerometer assessment among breast cancer survivors. *Journal of Cancer Survivorship, 9*(3), 532–540. http://doi.org/10.1007/s11764-015-0430-6

Annesi, J. J. (2019). Relations of change in fruit and vegetable intake with overall energy reduction and physical activity with weight change: Assessing theory-based psychosocial mediators. *Journal of Sport and Health Science, 8*(4), 394–399. https://doi.org/10.1016/j.jshs.2018.08.005

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.

Annesi, J. J. (2021). Psychological mechanisms of interactions between improvements in exercise and healthy eating behaviors (coaction) within a community-based obesity treatment setting. *Behavioral Medicine*. Advance online publication. https://doi.org/10.1080/08964289.2021.1940821

Annesi, J. J. (2022). Longitudinal effects of supported exercise on elevated anxiety and depression scores in formerly sedentary adults with severe obesity. *Journal of Prevention and Health Promotion, 3*(1), 53–67. https://doi.org/10.1177/26320770211056858

Annesi, J. J. (in press). Coaction of exercise and eating improvements within a behavioral obesity treatment: Directionality and psychological mechanisms. *Research Quarterly for Exercise and Sport.* https://doi.org/10.1080/02701367.2022.2057904

Annesi, J. J., & Eberly, A. A. (2022). Sequential mediation of the relation of increased physical activity and weight loss by mood and emotional eating changes: Community-based obesity treatment development guided by behavioral theory. *Family and Community Health*, 45(3), 187–194. https://doi.org/10.1097/FCH.0000000000000331

Annesi, J. J., Unruh, J. L., Marti, N. C., Gorjala, S., & Tennant, G. (2011). Effects of the Coach Approach intervention on adherence to exercise in obese women: Assessing mediation of social cognitive theory factors. *Research Quarterly for Exercise and Sport, 82*(1), 99–108. https://doi.org/10.1080/02701367.2011.10599726

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

Arent, S. M., Walker, A. J., & Arent, M. A. (2020). The effects of exercise on anxiety and depression. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of Sport Psychology* (4th ed.), (pp. 872–890). Wiley.

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

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.

Baranowski, T., Cerin, E., & Baranowski, J. (2009). Steps in the design, development and formative evaluation of obesity prevention-related behavior change trials. *International Journal of Behavioral Nutrition and Physical Activity, 6*, Article 6. https://doi.org/10.1186/1479-5868-6-6

Burgess, E., Hassmén, P., & Pumpa, K. L. (2017). Determinants of adherence to lifestyle intervention in adults with obesity: A systematic review. *Clinical Obesity*, *7*(3), 123–135. https://doi.org/10.1111/cob.12183

Cervone, D., Kopp, D. A., Schaumann, L., & Scott, W. D. (1994). Mood, self-efficacy, and performance standards: Lower moods induce higher standards for performance. *Journal of Personality and Social Psychology, 67*(3), 499-512. https://doi.org/10.1037/0022-3514.67.3.499

Clark, M. M., Abrams, D. B., Niaura, R. S., Eaton, C. A., & Rossi, J. S. (1991). Self-efficacy in weight management. *Journal* *of Consulting and Clinical Psychology, 59*(5), 739–744. https://doi.org/10.1037/0022-006X.59.5.739

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2002). *Applied multiple regression/ correlation analysis for the behavioral sciences* (2nd ed.). Earlbaum.

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

Donnelly, J. E., Blair, S. N., Jakicic, J. M., Manore, M. M., Rankin, J. W., & Smith, B. K. (2009). Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Medicine & Science in Sport & Exercise, 41*(2), 459–471. https://doi.org/10.1249/MSS.0b013e3181949333

Ekkekakis, P., Vazou, S., Bixby, W. R., & Georgiadis, E. (2016). The mysterious case of the public health guideline that is (almost) entirely ignored: Call for a research agenda on the causes of the extreme avoidance of physical activity in obesity. *Obesity Reviews*, *17*(4), 313–329. https://doi.org/10.1111/obr.12369

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

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

Godin, G. (2011). The Godin-Shephard Leisure-time Physical Activity Questionnaire. *The Health & Fitness Journal of Canada, 4*(1), 18–22. https://doi.org/10.14288/hfjc.v4i1.82

Green, L. W., Sim, L., & Breiner, H. (Eds.) (2013). *Evaluating obesity prevention efforts: A plan for measuring progress*. National Academies Press.

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

Heredia, N. I., Fernandez, M. E., van den Berg, A. E., Durand, C. P., Kohl, H. W., Reininger, B. M., Hwang, K. O., & McNeill, L. H. (2020). Coaction between physical activity and fruit and vegetable intake in racially diverse, obese adults. *American Journal of Health Promotion*, *34*(3), 238–246. https://doi.org/10.1177/0890117119884479

Jackson, C. W., & Jackson, C. (1997). Which mood state assessments? Cross validation of short mood measurement techniques. *Medicine & Science in Sports & Exercise*, *29*(Suppl. 5), S188.

Jacobs, D. R., Ainsworth, B. E., Hartman, T. J., & Leon, A. S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine &*

Science in Sports & Exercise, 25(1), 81–91. https://doi.org/10.1249/00005768-199301000-00012

Jetté, M., Sidney, K., & Blümchen, G. (1990). Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clinical Cardiology, 13*(8), 555–565. https://doi.org/10.1002/clc.4960130809

Johnson, S. S., Paiva, A. L., Mauriello, L., Prochaska, J. O., Redding, C., & Velicer, W. F. (2014). Coaction in multiple behavior change interventions: Consistency across multiple studies on weight management and obesity prevention. *Health Psychology*, *33*(5), 475–480. https://doi.org/10.1037/a0034215

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

Lemmens, V. E. P. P., 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

Leung, S. L., Barber, J. A., Burger, A., & Barnes, R. D. (2018). Factors associated with healthy and unhealthy workplace eating behaviours in individuals with overweight/obesity with and without binge eating disorder. *Obesity Science & Practice*, *4*(2), 109–118. https://doi.org/10.1002/osp4.151

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

Litwin, R., Goldbacher, E. M., Cardaciotto, L., & Gambrel, L. E. (2017). Negative emotions and emotional eating: The mediating role of experiential avoidance. *Eating and Weight Disorders, 22*(1), 97–104. https://doi.org/10.1007/s40519-016-0301-9

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), 1–82. https://doi.org/10.3310/hta15020

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the depression anxiety stress scales* (2nd ed.). Psychology Foundation of Australia.

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

Mann, T., de Ridder, D., & Fujita, K. (2013). Self-regulation of health behavior: Social psychological approaches to goal setting and goal striving. *Health Psychology, 32*(5), 487–498. https://doi.org/10.1037/a0028533

Mann, T., Tomiyama, A. J., Westling, E., Lew, A. -M., Samuels, B., & Chatman, J. (2007). Medicare's search for effective obesity treatments: Diets are not the answer. *American Psychologist, 62*(3), 220–233. https://doi.org/10.1037/0003-066X.62.3.220

Mata, J., Silva, M. N., Vieira, P. N., Carraça, E. V., Andrade, A. M., Coutinho, S. R., Sardinha, L. B., & Teixeira, P. J. (2009). Motivational "spill-over" during weight control: Increased self-determination and exercise intrinsic motivation predict eating self-regulation. *Health Psychology, 28*(6), 709–716. https://doi.org/10.1037/a0016764

McNair, D. M., & Heuchert, J. W. P. (2005). *Profile of Mood States technical update*. Multi-health Systems.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). *Revised manual for the Profile of Mood States*. Education and Industrial Testing Services.

Mehar, H., Srivastava, S., Tiwari, R. (2018). Psychological well-being and weight efficacy lifestyle of adults with obesity. *Open Journal of Psychiatry & Allied Sciences, 9*(1), 51-54. https://doi.org/10.5958/2394-2061.2018.00010.1

Miller, D. J., Freedson, P. S., & Kline, G. M. (1994). Comparison of activity levels using Caltrac accelerometer and five questionnaires. *Medicine & Science in Sports & Exercise, 26*(3), 376–382.

Munsch, S., Meyer, A. H., & Biedert, E. (2012). Efficacy and predictors of long-term treatment success for Cognitive-Behavioral Treatment and Behavioral Weight-Loss-Treatment in overweight individuals with binge eating disorder. *Behaviour Research and Therapy*, *50*(12), 775–785. https://doi.org/10.1016/j.brat.2012.08.009

Nyenhuis, D. L., Yamamoto, C., Luchetta, T., Terrien, A., & Parmentier, A. (1999). Adult and geriatric normative data and validation of the Profile of Mood States. *Journal of Clinical Psychology, 55*(1), 79–86. https://doi.org/10.1002/(SICI)1097-4679(199901)55:1<79::AID-JCLP8>3.0.CO;2-7

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

Pereira, M. A., FitzGerald, S. J., Gregg, E. W., Joswiak, M. L., Ryan, W. J., Suminski, R. R., Utter, A. C., & Zmuda, J. M. (1997). A collection of physical activity questionnaires for health-related research. *Medicine and Science in Sports and Exercise, 29*(Suppl. 6), S1–S205.

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

Price, D. D., Finniss, D. G., & Benedetti, F. (2008). A comprehensive review of the placebo effect: Recent advances and current thought. *Annual Review of Psychology, 59,* 565–590 https://doi.org/10.1146/annurev.psych.59.113006.095941

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

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

Stotland, S. C., & Larocque, M. (2005). Early treatment response as a predictor of ongoing weight loss in obesity treatment. *British Journal of Health Psychology, 10*(Part 4), 601-614. https://doi.org/10.1348/13591070505X43750.

Troiano, R. P., Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine & Science in Sports & Exercise, 40*(1), 181–188. https://doi.org/10.1249/mss.0b013e31815a51b3

Trost, S. G., Owen, N., Bauman, A. E., Sallis, J. F., & Brown, W. (2002). Correlates of adults' participation in physical activity: Review and update. *Medicine & Science in Sports & Exercise*, *34*(12), 1996–2001. https://doi.org/10.1097/00005768-200212000-00020

van der Merwe, M. -T. (2007). Psychological correlates of obesity in women. *International Journal of Obesity, 31* (Suppl. 2), S14–S18. https://doi.org/10.1038/sj.ijo.0803731

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