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## Research paper

# Effects of mood change on self-regulatory skill usage and subsequent impacts on physical activity and eating changes within the weight-loss phase of differing behavioral obesity treatment types: A retrospective cohort study

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## ABSTRACT

**Introduction:** Previous research suggests the value of self-regulation for facilitating weight-loss behaviors. This study aimed to determine if improved mood has a facilitative effect on the self-regulation of healthy eating and exercise outputs associated within behavioral obesity treatments.

**Methods:** Data were from women with obesity (mean age = 47.1 ± 8.4 years; mean BMI = 35.0 ± 3.2 kg/m<sup>2</sup>) who previously participated in one of two community-based weight-loss treatment types over 6 months. One supported manual-based education on the need for healthy eating and increased exercise (*n* = 127). The other focused on self-regulation skills applied first to exercise, then eating behaviors (*n* = 107). Changes in exercise- and eating-related self-regulation, negative mood, exercise and eating behaviors, and weight were assessed.

**Results:** For both the psychological, exercise, and eating changes, effect sizes for within-group improvements were uniformly larger in the self-regulation group. Weight loss was 2.1% in the education group, and 6.3% in the self-regulation group. Based on 95% confidence intervals, changes in self-regulation over 3 months significantly mediated the prediction of changes in exercise, fruit/vegetable intake, and sweets consumption over 6 months by treatment type. Change over 3 months in mood significantly moderated (*p*-values ≤ 0.01) the above-indicated association of treatment type with self-regulation change. Mood score at month 3 was also a significant moderator (*p*-values < 0.05) in the models predicting eating changes. Increased fruit/vegetable intake significantly predicted reduced weight (*p* = 0.009), and reduced sweets, bread products, and dairy (*p*-values ≤ 0.01).

**Conclusion:** Findings clarified benefits for targeting self-regulation and mood within behavioral weight-loss treatments that go well-beyond typical processes of providing education on desirable behaviors.

## 1. Introduction

In the developed countries, obesity is a considerable health risk with up to 38% of adults presently affected [1]. Although improving one's diet and increasing exercise will reliably reduce weight, attempts at inducing such behavioral changes have typically failed beyond the very short term [2,3], and obesity rates are projected to continue their escalation [1]. Most weight-management interventions are atheoretical, and incorrectly assume that informing individuals about the need to eat in a healthy manner and exercise regularly, and how to do so, will foster sustained changes [2]. Although only just marginally more successful [4], treatments based on accepted theories of behavior change have been advocated as preferable [5]. An often-cited problem with research on such theory-based interventions, however, is that their effects are not decomposed in a manner that allows for an adequate understanding

of salient treatment targets [6]. Although some such work has begun [7,8], behavioral treatments remain in need of more informed protocols via such processes.

Social cognitive theory [9] emphasizes the importance of self-regulation in behavioral change, in general, and specifically in health behavior change [10]. In support of social cognitive theory, Baker and Brownell posited that exercise supports dietary improvements through effects on mood and feelings of well-being, coping methods, and feelings of the self [11]. They also suggested that positive changes in depression, anxiety, and overall mood could lead to, "... a climate in which individuals have more cognitive and emotional resources, as well as motivation and energy, to sustain the long-term commitment to a weight-loss program." [11,p. 320]. Self-regulation research generally supports the benefits of positive mood states on self-regulation's effect on changing a behavior [12]. However, that is less clear when multiple

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behaviors are being addressed simultaneously [13]. Although some research suggests that self-regulation incorporated for one health behavior (e.g., exercise) strengthens another (e.g., healthy eating) through skills development occurring from practice [14] (analogous to how a muscle develops [15]), other studies conversely suggest a depletion effect where overtaxing limited self-regulatory resources becomes counter-productive to advancing a paired behavior [16].

There have been different priorities within weight-loss treatments such as self-regulatory skills development, countering hunger cues, and, most commonly, providing education about healthy eating. Thus, interventions range from novel approaches where eating change is deferred until self-regulation skills have first been rehearsed and readied through adapting to regular exercise [8], to more common procedures that primarily advise participants how to improve their eating [2]. Regardless of treatment architects' prioritization of self-regulation, it is generally considered important for success. Therefore, there is a benefit for ascertaining conditions where it functions best for weight loss including evaluating the role of mood in self-regulating both exercise and eating behaviors.

Interventions might also benefit if behavioral treatment targets are clearly specified. For example, it was originally thought that the more exercise a participant completes the better, mostly because more exercise would result in greater energy expenditures (and greater weight loss). Based on that assumption, providing general (and often vague) information on the possible benefits of plethora of specialized exercises types, regimens, and apparatus was common. However, in consideration of research reviews definitively indicating that higher volumes of exercise also result in greater drop out [17], recent research suggested that only 2.5–3 moderate exercise sessions/week has as much benefit for weight loss as does more taxing amounts [8]. Thus, treatment targets for exercise could be more clearly specified. Within this alternative perspective, it was theorized that exercise's benefits for weight loss in deconditioned individuals were more from associated changes in mood and other psychosocial factors impacting controlled eating, than from energy expenditures [8].

Although typical nutrition interventions instruct participants in numerous areas such as macronutrient proportions, meal replacements, supplements, and foods to seek and others to avoid, alternative approaches might advocate a minimal amount of target behaviors on which to focus one's attention. Applied behavioral analytic techniques often advocate such an approach to behavioral change. For example, because fruit and vegetable intake has been suggested as a proxy for the adequacy of the diet as a whole [18], then increasing fruit/vegetable intake could be specifically targeted. Sweets could also be a target for change because its excess might be indicative of an overall poor diet [19].

To help optimize the structure and effectiveness of behavioral weight-loss treatments to serve as an alternative to decades of failed attempts, increased clarity is required on: (1) the role of self-regulation change in changing eating behaviors in the presence of educationally focused vs. self-regulation focused treatments, especially accounting for possible moderators such as mood; and (2) whether fruit/vegetable intake change affects positive change in other aspects of the diet, and overall weight loss. Thus, the present investigation accordingly assessed data from the initial 6 months (i.e., "weight-loss" phase [5,20]) of several community-based treatments in women with obesity [21–23]. The following hypotheses were given:

- (1) The self-regulation-focused treatment groups will demonstrate greater effects on self-regulation, mood, exercise and eating behaviors, and weight when contrasted with the more typical, educationally centered, weight-loss treatment groups.
- (2) Changes in self-regulation will significantly mediate the prediction of exercise- and eating-behavior changes, by treatment type.
- (3) Change in mood, and mood score after 3 months of treatment, will significantly moderate the relationship of treatment type with

changes self-regulatory skills usage.

- (4) Increase in fruit/vegetable intake will be significantly associated with reduced weight, as well as reduced intake from other food groups.

## 2. Methods

### 2.1. Participants

Available participant data were extracted and synthesized from previous behavioral weight-loss studies [21–23] for re-analysis with the present research. Data were from 2012 to 2016, collected from the community wellness centers in the southeast United States. Specifically, data from 4 treatment groups were represented – 2 educationally focused [21,22] and 2 self-regulatory skills focused [22,23]. Written informed consent was received from each participant. Approval from the Institutional Review Board of Kennesaw State University (study 13–173) was attained. Principles of the Declaration of Helsinki were followed, throughout.

Inclusion criteria for all were: female  $\geq 21$  years of age, weight-to-height ratio within the classification of obesity (body mass index [BMI]  $\geq 30$  kg/m<sup>2</sup>), no mental or physical contraindication for participation, and no current/soon-planned pregnancy. Based on the goals of the present research and U.S. governmental recommendations [24,25], participants were also required to have consumed no more than 5 servings/day of fruits and vegetables, and complete no more than (the equivalent of) 5 moderate-intensity sessions of exercise/week, at baseline. Because there were no significant differences on any variable planned for analysis within the 2 treatment types, participant data were merged into one educational treatment group ( $n = 127$ ) and one self-regulation treatment group ( $n = 107$ ) for analyses. There was no significant difference at baseline in age (overall  $47.1 \pm 8.4$  years), BMI (overall  $35.0 \pm 3.2$  kg/m<sup>2</sup>), and yearly family income (overall median = US\$71,000 [middle income]) across treatment types.

### 2.2. Measures

To assess overall use of self-regulation skills related to weight-loss behaviors, responses (1 = never to 5 = often) to 10 items each addressing self-regulation for exercise (e.g., "I set my times to be physically active", "I set physical activity goals") and self-regulation for eating (e.g., "I set eating goals", "I keep a record of my eating") were summed [26]. This yielded possible score ranges of 10–50 for both the self-regulation for exercise and self-regulation for eating scales. Internal consistencies were Cronbach  $\alpha$ -values = 0.79–0.80 [26]. Test-retest reliabilities over 2 weeks were 0.74–0.78 [26]. For the present data, Cronbach  $\alpha$ -values were 0.80 and 0.79, respectively.

To assess overall negative mood, responses (0 = not at all to 4 = extremely) to the 30 items of Profile of Mood States Brief Version [27] factors of depression (e.g., "sad"), fatigue (e.g., "weary"), tension (e.g., "anxious"), anger (e.g., "furious") and confusion (e.g., "confused") were summed, and the vigor (e.g., "energetic") factor score was then subtracted. This scale of "total mood disturbance" [27] yielded a possible score range of -20 to 100. Internal consistencies across factors were Cronbach  $\alpha$ -values = 0.84–0.95 [27]. Test-retest reliability over 2 weeks was 0.69 [27]. Cronbach  $\alpha$ -values were 0.76–0.86 for the present data.

Recall of daily servings of fruits (e.g., 118 mL fruit juice); vegetables (e.g., 118 mL carrots); sweets (e.g., 118 mL [small] brownie); bread products (e.g., 59 mL [2 slices] rye bread); dairy products (e.g., 236 mL yogurt); and meats, beans, nuts, and other proteins (e.g., 59 mL fish), as indicated by U.S. governmental sources [25,28], were summed using a brief self-report survey. Intake of fruits and vegetables (FV) were summed. This brief survey demonstrated significant correspondences (all  $\beta$ -values = 0.45–0.83,  $p$ -values < 0.001) with comprehensive food frequency recall instruments [29,30]. Test-retest reliabilities over

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