Eating Behaviors 22 (2016) 10–15

Contents lists available at ScienceDirect

Eating Behaviors

Examining the effect of binge eating and disinhibition on compensatory changes in energy balance following exercise among overweight and obese women

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ARTICLE INFO

Article history:
Received 9 November 2015
Received in revised form 14 March 2016
Accepted 30 March 2016
Available online 2 April 2016

Keywords:
Behavioral compensation
Energy balance
Exercise
Disinhibition
Binge eating

ABSTRACT

Some women behaviorally compensate for the energy expended during exercise by increasing their energy intake or becoming more sedentary, thereby decreasing their energy expenditure. Although behavioral compensation can attenuate or even reverse the energy deficit generated by exercise, few data are available on predictors of compensatory responses to exercise. The present study aimed to identify eating-related predictors of compensatory changes in energy balance following exercise. Overweight and obese, physically inactive women ($N = 48$) completed self-report measures of disinhibition and binge eating and participated in two experimental conditions, exercise and rest, in counterbalanced order. Energy intake and expenditure were measured for 24-hours following each experimental condition to estimate energy balance. On average, women were 21.33 ± 2.09 years old and 63% were white. Of the sample, 63% compensated for the energy expended during exercise by increasing their energy intake or decreasing their energy expenditure. Linear mixed effects modeling with repeated measurement showed that disinhibition was not predictive of behavioral compensation. However, there was a significant difference between the negative energy balance observed following the rest condition and the positive energy balance observed following the exercise condition among women who reported binge eating, which was driven by a tendency to spend less time being physically active and more time being sedentary following exercise. These findings indicate that women who binge eat may be at greatest risk of compensating for exercise. Future research is needed to better understand psychosocial predictors and common mechanisms through which behavioral compensation is promoted.

1. Introduction

Obesity is a disorder of positive energy balance (EB), which occurs when the amount of energy consumed is greater than the amount of energy expended (Blundell & Cooling, 2000). EB is determined by variability in energy intake (EI) and energy expenditure (EE), which are driven by a variety of psychological and biological mechanisms (Blundell & Cooling, 2000; DeLany, 2012). Exercise is a modifiable component of EB that can lead to an acute energy deficit and is often prescribed, in combination with dietary restriction, as a means of weight loss and control (Jakicic et al., 2001). However, exercise alone typically fails to produce expected weight loss (Catenacci & Wyatt, 2007), which partly may result from maladaptive behavioral responses to exercise that impede the ability of exercise to produce a sustained energy deficit (Blundell & King, 2000).

Women tend to respond less favorably to exercise interventions than do men (Ballor & Keesey, 1991; Donnelly et al., 2003). For example, Donnelly and Smith (2005) found that, among a sample of overweight and obese adults participating in a 16-month supervised exercise intervention, the majority of men lost weight whereas women were equally likely to lose or gain weight. Given that exercise compliance was maintained under supervision throughout the intervention, the authors posited that women who exhibited weight gain likely had behaviorally compensated for the energy expended during exercise by increasing their dietary intake or decreasing their lifestyle physical activity. Indeed, behavioral compensation can attenuate or even reverse the energy deficit generated by exercise and is estimated to result in 55% to 64% less weight loss than predicted during exercise interventions (Dhurandhar et al., 2014). As such, behavioral compensation may partly explain the difficulty women have in losing weight during exercise interventions.

A recent review highlighted the need to better understand who is susceptible to behaviorally compensate for exercise (Melanson, Keadle, Donnelly, Braun, & King, 2013). To date, investigations designed

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http://dx.doi.org/10.1016/j.eatbeh.2016.03.033
1471-0153/

to identify predictors of behavioral compensation following exercise have focused on the role of disinhibition, a personality trait associated with a failure to resist urges to eat despite satiation and an inability to control dietary intake as well as a tendency to opportunistically overeat in response to food palatability, negative affect, and social settings (Stunkard & Messick, 1985). The characteristics of disinhibition may promote the reestablishment of a positive EB following exercise, and several studies have shown that overweight women high on disinhibition are more likely to engage in dietary compensation following exercise than are those low on disinhibition (Keim, Canty, Barbieri, & Wu, 1996; Visona & George, 2002). Similarly, binge eating is a behavior associated with a susceptibility to emotional eating (Ricca et al., 2009) and a preference for palatable foods (Mathes, Brownley, Mo, & Bulik, 2009) but is further characterized by intense psychological distress (American Psychological Association, 2013). Whereas disinhibition is a trait factor that influences general eating behavior, binge eating is a pathological eating disturbance characterized by the consumption of a large amount of food accompanied by a sense of loss of control over eating.

Given that the dispositional and behavioral aspects of these factors may relate to predict a greater likelihood to behaviorally compensate for exercise, we sought to evaluate the independent and synergistic effects of disinhibition and binge eating on compensatory changes in EB following a single bout of supervised aerobic exercise among overweight and obese, physically inactive women. Relative to women lower on disinhibition, we hypothesized that women higher on disinhibition would demonstrate greater compensatory increases in EI and decreases in EE following exercise, resulting in a more positive EB, and that this effect would be enhanced among women who also reported binge eating.

2. Material and methods

2.1. Participants and procedures

Participants were female, overweight or obese (body mass index [BMI] ≥25 kg/m^2), nonsmokers, not pregnant or lactating, not currently taking medications that affect weight or food intake, free of chronic diseases, and physically inactive, defined as having participated in fewer than 30 consecutive minutes of aerobic exercise no more than twice per week for the past six months (Visona & George, 2002).

Study procedures were approved by an Institutional Review Board and written informed consent was documented. Women completed an exercise and rest condition 7 days apart in counterbalanced order. Women were instructed to abstain from eating or drinking anything aside from water on the morning of each assessment and arrived at the laboratory at 10:00 a.m. Women received a standard breakfast bar upon arrival (160 kcal, 72% carbohydrate, 23% fat, and 5% protein) and 6 fluid ounces of water.

2.1.1. Experimental conditions

For the exercise condition, women engaged in moderate-intensity exercise by walking on a treadmill for 30-minutes. Heart rate was recorded at 1-minute intervals using a Polar Pacer heart rate monitor (Polar Electro Inc., Port Washington, NY), and women were maintained at 60% to 70% of their age-predicted maximal heart rate. All women began the exercise condition by walking at 3 miles per hour with a 0% grade. If heart rate dropped below 60% of the age-predicted maximal heart rate for 2 consecutive minutes, the treadmill grade was increased until heart rate was sufficiently elevated. If heart rate rose above 70% of the age-predicted maximal heart rate for 2 consecutive minutes, either the treadmill speed or grade was decreased until heart rate was sufficiently reduced. For the rest condition, women sat quietly in a private exam room for 30-minutes.

2.1.2. First experimental visit

Women were provided the standard breakfast and completed a questionnaire battery. Height and weight were recorded. Women were fitted with an activity monitor to measure EE and completed the experimental condition. Women were instructed to wear the activity monitor for 24-hours and were contacted by the experimenter the following day to complete a food recall.

2.1.3. Second experimental visit

Seven days following the first experimental visit, women returned to the laboratory for their second experimental visit. Women again were provided the standard breakfast and fitted with the activity monitor. Women completed the remaining experimental condition and were instructed to wear the activity monitor for 24-hours. Women were contacted by the experimenter the following day to complete a second food recall.

2.2. Measures

2.2.1. Demographic information

Women reported age, race and ethnicity, job status, and income.

2.2.2. Body mass index

Height and weight were measured while women were dressed in street clothes without shoes and BMI (kg/m^2) was calculated.

2.2.3. Binge eating

The Eating Disorder Examination Questionnaire, a 38-item, self-report measure assessing eating pathology over the previous 28 days (Fairburn & Beglin, 1994), was used to assess pathological eating behavior. Women reported whether they engaged in objective binge eating (i.e., the consumption of an objectively large amount of food accompanied by a sense of loss of control over eating) or subjective binge eating (i.e., the experience of loss of control over eating without the necessary consumption of an objectively large amount of food) during the previous 28 days. As in prior research (Emery, King, Fischer, & Davis, 2013), a single dichotomous variable was created to indicate the presence or absence of any binge eating during the previous 28 days.

2.2.4. Disinhibition

The disinhibition subscale of the Three Factor Eating Questionnaire consists of 16-items measuring responsiveness to emotional and situational stimuli that trigger eating behavior (Stunkard & Messick, 1985). The items consist of true or false and Likert scale response options. Each item is assigned a binary code and summed, with higher scores indicating higher disinhibition.

2.2.5. Energy intake

EI was assessed using the Nutrition Data System for Research (NDSR; University of Minnesota, Minneapolis, MN). The NDSR food recall interview is structured using a multiple-pass approach, providing several opportunities to recall EI for the previous 24-hour period. Women were provided a booklet of standard portion sizes and measurements, allowing for a more accurate estimation of food and beverage amounts consumed. EI data was gathered via telephone and entered directly into the NDSR program by the experimenter. Using the NDSR program, EI in kcals and macronutrient intake in grams were determined from the foods and beverages consumed through 11:59 p.m. on each experimental day.

2.2.6. Energy expenditure

EE was assessed objectively using the SenseWear Pro Armband (Body Media, Pittsburgh, PA), a commercially available device that provides accurate estimates of EE when compared to indirect calorimetry (Jakicic et al., 2004). Women were instructed to wear the activity monitor for 24-hours following the completion of each experimental