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Moderators of two dual eating disorder and obesity prevention programs

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ABSTRACT

Few trials have investigated factors that moderate the effects of eating disorder and obesity prevention programs, which may inform inclusion criteria and intervention refinements. We examined factors hypothesized to moderate the effects of the *Healthy Weight* eating disorder/obesity prevention program that promotes gradual healthy changes, and *Project Health* that adds cognitive dissonance activities. College students at risk for both outcomes because of weight concerns (N = 364, 72% female) were randomized to these interventions or an educational video condition, completing pretest, posttest, and 6, 12, and 24-month follow-up assessments. *Healthy Weight* and *Project Health* produced significantly larger reductions in eating disorder symptoms versus video controls for individuals with higher negative affect, emotional eating, dietary fat/sugar intake, and perceived pressure to be thin. *Project Health* also produced significantly less increases in BMI versus video controls for individuals with lower negative affect. Results suggest that these interventions produce larger eating disorder symptom reductions for individuals at elevated risk for eating pathology but hint that weight gain prevention effects may be attenuated by elevated negative affect. Results imply that larger eating disorder symptom reductions will result when implemented with individuals with both weight concerns and one of the additionally identified risk factors.

1. Introduction

Eating disorders and obesity are prevalent chronic conditions associated with impairment, distress, morbidity, and mortality (Flegal, Carroll, Kit, & Ogden, 2012; Swanson, Crow, Le Grange, Swendsen, & Merikangas, 2011), thus there is a need for prevention programs for these two public health problems. Although several prevention programs designed to reduce future onset of both eating disorders and obesity have been developed, only two have reduced both outcomes. The 3-h *Healthy Weight* prevention program produced greater reductions in eating disorder symptoms and a 60% reduction in future eating disorder onset versus assessment-only controls over 3-year follow-up; it also produced greater reductions in BMI increases versus assessment-only controls and alternative interventions through 3-year follow-up and a 55% reduction in obesity onset versus assessment-only controls through 3-year follow-up (Stice, Marti, Spoor, Presnell, & Shaw, 2008a, b; Stice, Shaw, Burton, & Wade, 2006). In *Healthy Weight* young women with body image concerns make small, lasting healthy changes to dietary intake and exercise, which should reduce weight gain and risk for eating disorders. A refined 4-h version of *Healthy Weight* resulted in less weight gain through 6-month follow-up, greater eating disorder symptom reductions, and a 60% reduction in eating disorder onset over 2-year follow-up versus educational brochure controls (Stice, Rohde, Shaw, & Marti, 2012, 2013). An expanded 6-h version of *Healthy Weight* produced greater reductions in BMI and eating disorder symptoms versus the cognitive reappraisal-based obesity prevention program, as well as greater reductions in body fat and eating disorder symptoms versus educational video controls (Stice et al., 2015).

We developed a novel 6-h intervention (*Project Health*), which retained the participant-driven small, gradual healthy lifestyle modification plan from *Healthy Weight,* and added exercises designed to create dissonance regarding behaviors that contribute to weight gain. In *Project Health* participants discuss health, interpersonal, and societal costs of an unhealthy diet, sedentary behavior, and excess body fat, and benefits of a healthy diet, physical activity, and leanness, which should prompt participants to align their actions with the perspectives assumed in the sessions, resulting in healthier lifestyle choices. An eating disorder prevention program designed to promote dissonance about pursuing the unrealistic beauty ideal produced a reduction in eating disorder symptoms through 2-year follow-up and a 60% reduction in eating disorder onset over 3-year follow-up versus assessment-only controls (Stice et al., 2006, 2008a, b), suggesting dissonance is a robust method of changing health behaviors. Dissonance theory posits that people align their attitudes with their publicly displayed behavior

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(Festinger, 1957), implying that discussing the health problems caused by overeating energy dense foods, sedentary behaviors, and excess body fat should result in an healthier lifestyle choices. In the present trial, college students at risk for both eating disorders and obesity by virtue of weight concerns (Haines, Neumark-Sztainer, Wall, & Story, 2007; van den Berg & Neumark-Sztainer, 2007) were randomized to the 6-h version of *Healthy Weight, Project Health,* or an educational video control condition (Stice, Rohde, Shaw, & Gau, 2018). Main effects analyses revealed that *Project Health* participants showed smaller increases in BMI through 2-year follow-up than both *Healthy Weight* and control participants, and a 40% and 42% reduction in overweight/obesity onset over follow-up than *Healthy Weight* participants and controls, respectively (Stice et al., 2018). *Healthy Weight* and *Project Health* participants also showed larger eating disorder symptom reductions through 2-year follow-up, as well as a 66% reduction in future eating disorder onset than controls over follow-up, though these latter effects were only marginal (Stice et al., 2018). A follow-up report found that reduction in body dissatisfaction and negative affect mediated the effects of both prevention programs on reductions in eating disorder symptoms, but was unable to identify the mediators of the weight gain prevention effects from these two programs (Rohde, Desjardins, Arigo, Shaw, & Stice, 2018).

Although effects were encouraging because few prevention programs have produced effects for both eating disorders and obesity, it would be ideal to improve the efficacy of these programs. One approach is to examine baseline factors that amplify or mitigate the effects of an intervention relative to another intervention or control condition. Moderator analyses can guide the refinement of inclusion criteria so that the most appropriate individuals can be targeted. Moderator analyses can also inform intervention refinements that improve efficacy (e.g., if programs were found to be less effective for individuals with high negative affect, adding intervention elements designed to reduce negative affect might improve efficacy). The aim of the current report was to investigate factors hypothesized to moderate the effects of *Project Health* and *Healthy Weight* in the trial described above (Stice et al., 2018).

Few studies have examined moderators of eating disorder and obesity prevention programs. Seven trials found that eating disorder prevention programs produced larger eating disorder symptom reductions compared to control conditions for participants with higher versus lower baseline symptoms (Butryn, Rohde, Marti, & Stice, 2014; Müller & Stice, 2013; Stice, Rohde, Shaw, & Marti, 2013; Taylor et al., 2006; Völker, Jacobi, Trockel, & Taylor, 2014), presumably because it is easier to detect reductions in this outcome among individuals with elevated baseline scores. Participants with higher versus lower baseline body dissatisfaction showed larger eating disorder symptom reductions in response to two eating disorder prevention programs relative to control participants (Stice et al., 2008a, b). Further, participants with baseline elevations in emotional eating and BMI showed stronger eating disorder symptom reductions in response to the *Healthy Weight* prevention program compared to controls (Stice et al., 2008a, b). One study found stronger eating disorder onset prevention effects compared to controls for individuals with higher versus lower initial BMI scores (Taylor et al., 2006), though another from that team found the opposite effect (Völker et al., 2014). An additional study found stronger eating disorder symptom reductions compared to controls for participants with initially higher versus lower perceived pressure to be thin (Stice et al., 2013). Regarding moderators of obesity prevention effects, one trial found that *Healthy Weight* produced stronger reductions in BMI compared to controls for those with initially elevated eating disorder symptoms and BMI scores (Stice et al., 2012) and another found a physical activity obesity prevention program produced stronger BMI reduction effect compared to controls for boys who were overweight or obese versus lean at baseline (Lubans, Morgan, & Callister, 2012). In sum, results suggest that these prevention programs typically produced larger effects for participants with initially higher symptoms and BMI, and for those at risk for the two outcomes due to elevations in certain risk factors. These findings converge with evidence that prevention program effects are often larger for selective and indicated prevention programs versus universal prevention (Horowitz & Garber, 2006; Stice, Shaw, Bohon, Marti, & Rohde, 2009; Stice, Shaw, & Marti, 2007).

In the current report, we investigated several moderators hypothesized to amplify the effects of these prevention programs. Although past studies have examined moderators of the *Healthy Weight* prevention program, none has examined moderators of the *Project Health* prevention program. Based on past findings, we hypothesized that effects of these two interventions would be stronger for those with initial elevations in baseline eating disorder symptoms and BMI, presumably because such participants have more room for reductions in these outcomes. Also based on past findings, we hypothesized that effects would be larger for individuals with elevations in factors that increase risk for future eating disorders, including body dissatisfaction, negative affect, and perceived pressure to be thin (Killen et al., 1996; Stice et al., 2013; Stice, Gau, Rohde, & Shaw, 2017). We likewise hypothesized that effects would be larger for individuals with higher scores on factors that increase risk for weight gain, including elevated intake of high-calorie foods, cravings for high-calorie foods, emotional eating, impulsivity, and substance use (Blair, Lewis, & Booth, 1990; Boswell & Kober, 2016; Cummins & Macintyre, 2006; Hill & Peters, 1998; Hodgkins, Frost-Pineda, & Gold, 2007).

2. Methods

2.1. Participants and procedures

Participants were 364 women and men (*M* age = 19.1, SD = 1.2; *M* BMI = 23.5, SD = 2.5; 72% female; 15% Asian/Pacific Islander, 3% American/Alaskan native, 3% African American, 0.5% native Hawaiian/Pacific Islander, 11% Hispanic, and 68% Caucasian). Recruitment material invited students at 3 universities with weight concerns to participate in a weight gain prevention trial. Informed written consent was collected for this IRB approved study. Exclusion criteria were a reported BMI < 18 or > 30 or a diagnosis of an eating disorder. Participants provided data at pretest, posttest (6-weeks later), and 6, 12, and 24 months following posttest. Participants received $30 for completing each assessment (see Stice et al., 2018 for greater details regarding the methods (Stice et al., 2017).

Participants were randomized to *Healthy Weight*, *Project Health*, or an educational video control condition via a random number table produced by the study statistician. Research assistants were masked to allocation sequence. Both interventions consisted of 6 weekly 1-h group sessions with 6–10 participants and 2 facilitators (trained and supervised college mental health staff).

2.2. Interventions

Healthy Weight. This intervention has participants select small, sustainable changes to diet and exercise on a weekly basis to achieve balance between caloric intake and output (e.g., eating unsweetened yogurt instead of sweetened yogurt). Sessions include educational handouts, in-session discussions, review of change goals, and developing healthy behavior change plans for the next session. Home exercises included making participant-selected diet and exercise changes, and keeping a food/exercise log to identify future change goals. Although the first version of *Healthy Weight* was implemented in 3 1-h sessions and the second was implemented in 4 1-h sessions, the version evaluated in this trial was implemented in 6 1-h sessions to expand lifestyle change practice time.

Project Health. Mirroring *Healthy Weight*, participants in *Project Health* commit to making small participant-identified gradually increasing improvements to their dietary intake and exercise in an effort to achieve energy balance. Verbal, written, and behavioral activities

were added to *Project Health* to induce cognitive dissonance about engaging in lifestyle behaviors that contribute to weight gain and promote lifestyle behaviors that contribute to a healthy weight.

Sessions begin with a verbal commitment to participate and includes exercises in which participants discussed health, interpersonal, and societal costs of overeating high-calorie foods, sedentary behaviors, and obesity, as well as health, interpersonal, and societal benefits of consuming low-calorie foods, regular exercise, and a lean physique. For instance, the group discusses the main medical problems that result from obesity, such as heart attacks, strokes, cancer, and diabetes. (The intervention scripts for *Healthy Weight* and *Project Health* can be found at http://www.bodyprojectsupport.org/). These activities are shared with the group and video-recorded to create accountability and maximize dissonance-induction.

Educational Video Control Condition. Participants were provided a link to a free video, called *The Weight of the World*, a 51-min documentary on the costs of obesity. We decided to use an educational video control condition because it is a credible approach to addressing weight concerns and many early obesity prevention programs focused on providing education about the factors that contribute to excessive weight gain.

2.3. Measures

Eating disorder symptoms and diagnosis. The Eating Disorder Diagnostic Interview assessed DSM-IV eating disorder symptoms on a month-to-month basis over 3 months at baseline and since the last interview during follow-up. Items assessing symptoms in the past month at each assessment were summed to form a composite. It has shown internal consistency (α = 0.89), inter-rater agreement (interclass correlation coefficient; ICC = 0.93), 1-week test-retest reliability (r = 0.95), and sensitivity to detecting intervention effects (Stice et al., 2013). In the present trial, it showed internal consistency (α = 0.70 at baseline), inter-rater agreement (ICC r = 0.90), and 1-week test-retest reliability (ICC r = 0.93). It should be noted that in our trials we have one randomly selected subset of participants complete the diagnostic interview twice with the same assessor within 1 week to estimate test-retest reliability, and have another randomly selected subset of participants complete diagnostic interviews with two different assessors within two days to estimate inter-rater agreement, so as not to conflate test-retest reliability with inter-rater agreement.

Body mass. BMI scores were used to reflect height-adjusted weight. After removing shoes and coats, height was measured to the nearest millimeter using stadiometers and weight was assessed to the nearest 0.1 kg using scales. BMI correlates with direct measures of body fat (r = 0.80–0.90) and health measures such as blood pressure (Pietrobelli et al., 1998).

Body dissatisfaction. The 35-item Body Esteem Scale (Franzoi & Shields, 1984) assesses opinions about various body parts and functions, such as legs, face, and muscular strength. It has shown 3-month test-retest reliability (r = 0.58-0.87 (Franzoi, 1994);); α = 0.91 at baseline.

Negative affect. Sadness, guilt, and fear/anxiety was assessed with the Positive Affect and Negative Affect Scale-Revised (PANAS-X; (Watson & Clark, 1992), which has shown internal consistency (α = 0.95), 3-week test-retest reliability (r = 0.78), and sensitivity to detecting intervention effects (Stice et al., 2006); α = 0.93 at baseline.

Dietary Intake. The 60-item Block Food Frequency Questionnaire assessed dietary intake (Block FFQ; (Block & Subar, 1992). Participants estimate the frequency of consuming 60 specific foods and indicate serving size (definition provided). Block FFQ values correlate with doubly labeled water estimates of total energy intake (Stice et al., 2012), detect obesity treatment effects (Harris, French, Jeffery, McGovern, & Wing, 1994), show 2-week test-retest reliability (M r = 0.69; (Klohe et al., 2005), and produced values within 3% of values obtained from 7-day weighed food records (Surrao, Sawaya, Dallal, Tsay, & Roberts, 1998). We calculated the percentage of total calories from fat and sugar to index risk for weight gain from consuming a diet high in fat and sugar.

Emotional Eating. The 13-item Emotional Eating scale (van Strien, Frijters, Bergers, & Defares, 1986) assessed whether participants eat in response to negative emotions. It has shown internal consistency (M α = 0.90), predictive validity, and association with greater activation of brain reward circuitry in response to food receipt during a negative mood induction (Bohon, Stice, & Spoor, 2009; Stice, Presnell, & Spangler, 2002; van Strien et al., 1986); α = 0.93 at baseline.

Substance use. Ten items (Johnston, O'Malley, & Bachman, 1993) measuring the frequency of use of various substances during the past year assessed substance use. It has shown internal consistency (M α = 0.86), test-retest reliability (M r = 0.86), and has been found to attenuate the effects of depression prevention program (Gau, Stice, Rohde, & Seeley, 2012); α = 0.78 at baseline.

Perceived sociocultural pressure to be thin. Pressure from family, friends, dating partners, and the media to be thin was assessed with an expanded 20-item Perceived Sociocultural Pressure Scale, an extension of the original 8-item scale (Stice & Bearman, 2001). Because this sample included males, we added 8 items assessing perceived pressure for muscularity, as well as 4 items that assessing appearance criticism. It has shown internal consistency (α = 0.88), 2-week test-retest reliability (r = 0.93), and predictive validity (Stice et al., 2002); α = 0.89 at baseline.

Food craving. The Food Craving Inventory (White, Whisenhunt, Williamson, Greenway, & Netemeyer, 2002) assessed degree of craving for 28 types of foods. It has shown internal consistency (α = 0.93), 2-week test-retest reliability (r = 0.86), and sensitivity to detecting intervention effects (Martin, O'Neil, & Pawlow, 2006; White et al., 2002); α = 0.90 at baseline.

Impulsivity. The 30-item Barratt Impulsivity Scale assessed impulsivity (Patton, Stanford, & Barratt, 1995). Participants report the extent to which descriptions regarding impulsivity apply to them. It has shown internal consistency (α = 0.79 - 0.83), 2-week test-retest reliability (r = 0.88), and discriminates between psychiatric patients and controls (Patton et al., 1995; Suris et al., 2004); α = 0.84 at baseline.

2.4. Data analysis

We modeled change in BMI from baseline through 2-year follow-up using a linear mixed effects model, controlling for random deviations in initial BMI (intercepts) and trajectories (slopes) for each participant. We included a linear time variable, dummy variables that coded for condition (*Project Health* vs. educational video, *Healthy Weight* vs. educational video, or *Project Health* vs. *Healthy Weight*); a mean-centered moderator; and all 2-way and 3-way interactions between these variables. Higher-order growth curves were not considered because mean growth curves for participants in the three conditions were linear (Fig. 1). Because we were interested in how the difference in BMI slope between conditions varied as a function of the moderator; the parameter associated with the 3-way interaction of time, condition dummy variable, and the moderator was the focus. We tested its significance using p values obtained after applying Satterthwaite's method for approximating degrees of freedom (Kuznetsova, Brockhoff, & Christensen, 2017).

Eating disorder symptoms were modeled as change during the intervention because the mean growth curves suggested that reductions in this outcome occurred between pretest and posttest (Fig. 1). Change in symptoms, calculated as the difference between symptoms at posttest and pretest, was regressed onto dummy variables reflecting condition; eating disorder symptoms at pretest (mean-centered); a moderator (mean-centered); and the interaction between the condition and the moderator. Because we were interested in how the difference in symptom change differed between the two conditions varied as a function of the moderator, the parameter associated with the 2-way

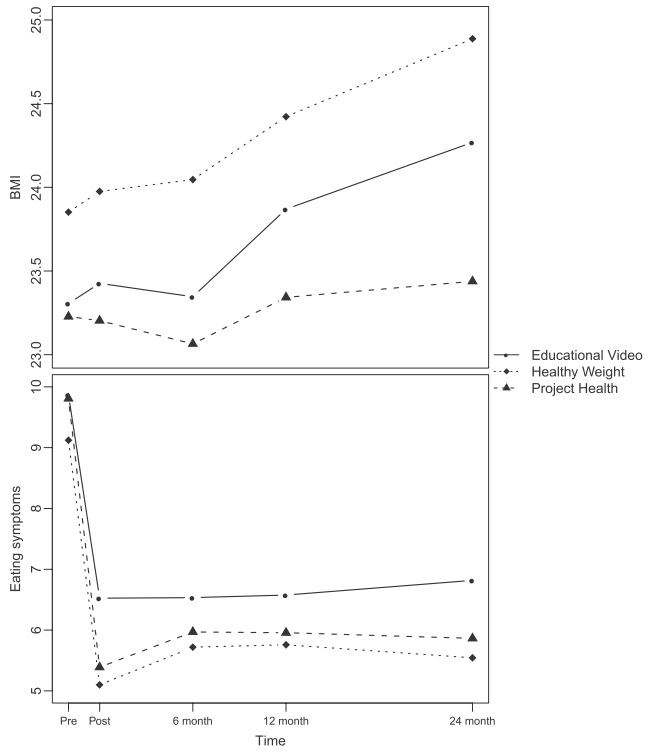

Fig. 1. Mean growth curve for BMI and eating symptoms by conditions.
Note. Pre refers to start of the intervention; Post to the end of the intervention; and 6 month, 12 month, and 24 month to the follow ups.

interaction was the principal focus.

General analytic plan. We examined each condition contrast separately. For each model, we examined the robustness of our model to assumptions (i.e., homogeneity of variance, normality of residuals, effect of outliers; (Cook & Weisberg, 1999); none exhibited gross violations of assumptions and findings were not driven by influential observations. We applied the Benjamini-Hochberg method (BH; (Benjamini & Hochberg, 1995), which controlled for the inflated Type I error resulting from multiple testing. For each significant moderator, we constructed a regions of significance plot using the Johnson-Neyman technique (Bauer & Curran, 2005). In these plots, 95% confidence bands that do not overlap with zero indicate a significant difference for participants in the two conditions at that level of the moderator. Statistical analysis were performed in R (R Core Team, 2017) using functions in the stats, lme4 (Bates, Mächler, Bolker, & Walker, 2014), and lmerTest (Kuznetsova et al., 2017) packages. Data and code are available upon request.

3. Results

Correlations between the moderators ranged from $r = 0.001$ to 0.431 (Table 1), with an average $r = 0.093$, implying that the moderators shared little variability, on average. Given that this was the first trial of the *Healthy Weight* prevention program to include both females and males, preliminary analyses tested whether participant sex moderated the effects of the two prevention programs on change in BMI and eating disorder symptoms; sex did not significantly moderate the effects of the two interventions on either outcome.

3.1. Body mass index

The intervention effect on change in BMI for *Project Health* versus video control, *Healthy Weight* versus video control, and *Project Heath* versus *Healthy Weight* did not vary as a function of any of the moderators after applying the BH correction, with one exception. For negative affect, the intervention effect of *Project Health* versus video control on the slope of BMI was significant ($t = 2.800$, $df = 202.170$, $p = .004$, adjusted $p = .046$, partial $r = .19$). For individuals in the lower 60% of the distribution of negative affect, *Project Health* participants showed significantly less increase in BMI than video controls ($d = 0.67$, Fig. 2). Conversely, for individuals in the upper 3% of the distribution of negative affect, *Project Health* participants showed significantly greater BMI gain than video controls.

3.2. Eating disorder symptoms

Project Health versus video controls. The effects of *Project Health* versus video controls on change in eating disorder symptoms was moderated by negative affect (F (1, 228) = 14.826, $p < .001$, BH adjusted $p = .003$, partial $r = .26$) and emotional eating (F (1, 228) = 16.893, $p < .001$, BH adjusted $p = .003$, partial $r = .27$; Table 2). Regarding the first moderator effect, *Project Health* participants with negative affect levels in the upper 36% of the distribution (negative affect > 2, $n = 84$, $d = 0.28$) experienced significantly greater decreases in symptoms than video controls (Fig. 3). In contrast, for individuals in the lower 2.6% of the distribution of negative affect (negative affect < 1.14, $n = 6$), video controls showed significantly greater decreases in symptoms than *Project Health* participants.

Regarding the second moderator effect, *Project Health* participants with emotional eating levels in the upper 52% of the distribution (emotional eating > 2.68, $n = 120$, $d = 0.13$) experienced significantly greater decreases in symptoms than video controls (Fig. 3). For individuals in the lower 14% of the emotional eating distribution (emotional eating < 1.61, $n = 32$), video controls had significantly greater decreases in symptoms than *Project Health* participants.

Healthy Weight versus video controls. The effects of *Healthy Weight* versus video controls on change in eating disorder symptoms during the intervention was moderated by four variables: percent of calories from fat and sugar (F (1, 236) = 10.762, $p = .001$, BH adjusted $p = .011$,

Table 1
Correlations of potential moderators.

		1	2	3	4	5	6	7	8	9	10
1	% of calories from fat & sugar	1									
2	Body self-esteem	−0.035	1								
3	Negative affect	0.060	−0.363	1							
4	Emotional eating	0.057	−0.282	0.395	1						
5	Barratt impulsivity	−0.001	−0.093	0.277	0.331	1					
6	Substance use	−0.117	0.002	0.106	0.076	0.316	1				
7	Perceived pressure to be thin	−0.039	−0.151	0.312	0.369	0.244	0.215	1			
8	Food craving	−0.041	−0.088	0.253	0.261	0.254	0.125	0.269	1		
9	Baseline BMI	0.013	−0.168	0.039	0.082	−0.011	−0.013	−0.018	−0.085	1	
10	Baseline eating symptoms	0.054	−0.336	0.433	0.433	0.264	0.142	0.297	0.236	0.136	1

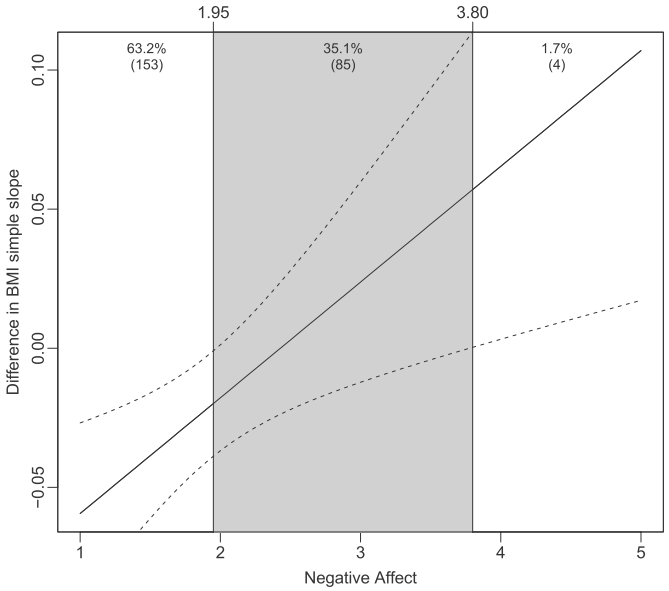

Fig. 2. Region of significance plot for the difference in the simple slope of BMI between *Project Health* and educational video participants as a function of negative affect.
Note. When the solid line is above zero, *Project Health* participants had a greater BMI slope than video participants, whereas when the line is below zero, educational video participants had a significantly greater BMI slope than *Project Health* participants. Where the dashed lines do not overlap with zero (the white region), this indicates a significant difference between the conditions at that level of the moderator. The percent of the sample and numbers of participants in each of the three columns are presented along the top of the figure.

partial $r = .21$), negative affect (F (1, 236) = 11.951, $p = .001$ BH adjusted $p = .007$, partial $r = .23$), emotional eating (F (1, 236) = 14.599, $p < .001$, BH adjusted $p = .003$, partial $r = .25$), and perceived pressure to be thin (F (1, 235) = 13.744, $p < .001$, BH adjusted $p = .004$, partial $r = .24$; Table 2). Regarding the first moderator, at levels of dietary fat and sugar intake in the upper 52% of the distribution (percent of calories from fat and sugar > 59.59%, $n = 124$, $d = .19$), *Healthy Weight* participants showed significantly greater decreases in symptoms than video controls (Fig. 4). For individuals in the lower 1.5% of the distribution of dietary fat and sugar intake distribution (percent of calories from fat and sugar < 44.23%, $n = 4$), video controls had significantly greater decreases in symptoms than *Healthy Weight* participants.

With regard to the second moderator, *Healthy Weight* participants with negative affect levels in the upper 38% of the distribution (negative affect > 1.93, $n = 92$, $d = 0.14$) showed significantly greater decreases in symptoms than video controls (Fig. 4). Similarly, *Healthy Weight* participants with levels of emotional eating in the upper 52% of the distribution (emotional eating > 2.6, $n = 124$, $d = .11$) had significantly greater decreases in symptoms than video controls (Fig. 4). For individuals in the lower 8% of the emotional eating distribution (emotional eating < 1.34, $n = 19$), video controls had significantly greater decreases in symptoms than *Healthy Weight* participants.

Regarding the final moderator, *Healthy Weight* participants with levels of perceived pressure to be thin in the upper 43% of the distribution (perceived pressure to be thin > 2.59, $n = 104$, $d = .01$) showed significantly greater decreases in symptoms than video controls (Fig. 4). For individuals in the lowest 4% of the distribution perceived pressure to be thin < 1.58, $n = 8$) of pressure to be thin, video controls had significantly greater decreases in symptoms than *Healthy Weight* participants.

Project Health versus Healthy Weight. The effects of *Project Health* versus *Healthy Weight* on change in eating disorder symptoms did not vary as a function of the moderators (Table 2).

3.3. Post-hoc composite moderator of eating disorder symptoms

To better understand the relations among the moderators and to create a composite moderator that might be of more practical significance for clinicians (Kraemer, 2013), we performed a principal components analysis (PCA). Because percent of calories from fat and sugar and BMI did not load highly on the first component (loadings of 0.04 and 0.12, respectively), they were removed and the PCA was run again. This first component explained 35% of the variance among the remaining moderators and loadings ranged from 0.34 for substance use to 0.71 for negative affect and emotional eating (see Tables 3 and 4). All loadings were positive except for body self-esteem (−0.41). We extracted these scores and then used them as a moderator. This composite moderated the effects of *Project Health* versus video control (F (1, 226) = 12.73, $p < .001$, partial $r = .24$) and *Healthy Weight* versus video control (F (1, 234) = 11.45, $p < .001$, partial $r = .22$) on change in eating symptoms. For the composite moderator, both *Project Health* and *Healthy Weight* participants in the upper halves of their distribution (63rd and 58th percentiles, respectively) experienced significantly greater decreases in eating symptoms than video controls ($d = 0.17$ and $d = 0.10$, respectively), while at the lower end of the distributions (9th

Table 2
Change in eating disorder symptoms moderated regression analysis by contrast.

Moderator	Contrast								
	PH vs. Video[a]			HW vs. Video[a]			PH vs. HW[b]		
	F	*p*	adjusted *p*	*F*	*p*	adjusted *p*	*F*	*p*	adjusted *p*
% of calories from fat & sugar	2.581	.110	.384	10.762	.001	.011	2.715	.101	.384
Body self-esteem	6.406	.012	.082	2.542	.112	.384	1.432	.233	.530
Negative affect	14.826	< .001	.003	11.951	.001	.007	0.703	.403	.609
Emotional eating	16.893	< .001	.003	14.599	< .001	.003	0.494	.483	.609
Barratt impulsivity	3.786	.053	.271	1.925	.167	.452	0.418	.519	.629
Substance use	0.780	.378	.609	0.570	.451	.609	3.657	.057	.271
Perceived pressure to be thin	6.016	.015	.085	13.744	< .001	.004	1.272	.261	.530
Food craving	0.515	.474	.609	2.130	.146	.425	0.487	.486	.609
BMI	0.115	.735	.806	0.574	.449	.609	0.219	.640	.760
Eating symptoms	0.643	.424	.609	1.323	.251	.530	0.125	.724	.806

Note. PH is Project Health, HW is Healthy Weight, and Video is educational video participants. *F* is the F-statistic for the two-way interaction between condition and the moderator.
[a] Degrees of freedom (df) were 1 and 236 except for perceived pressure to be thin and food craving (df were 1 and 235).
[b] Degrees of freedom (df) were 1 and 228 except for body self-esteem and perceived pressure to be thin (df were 1 and 227). The adjusted *p* column adjusts for the 57 regressions using the Benjamini & Hochberg method.

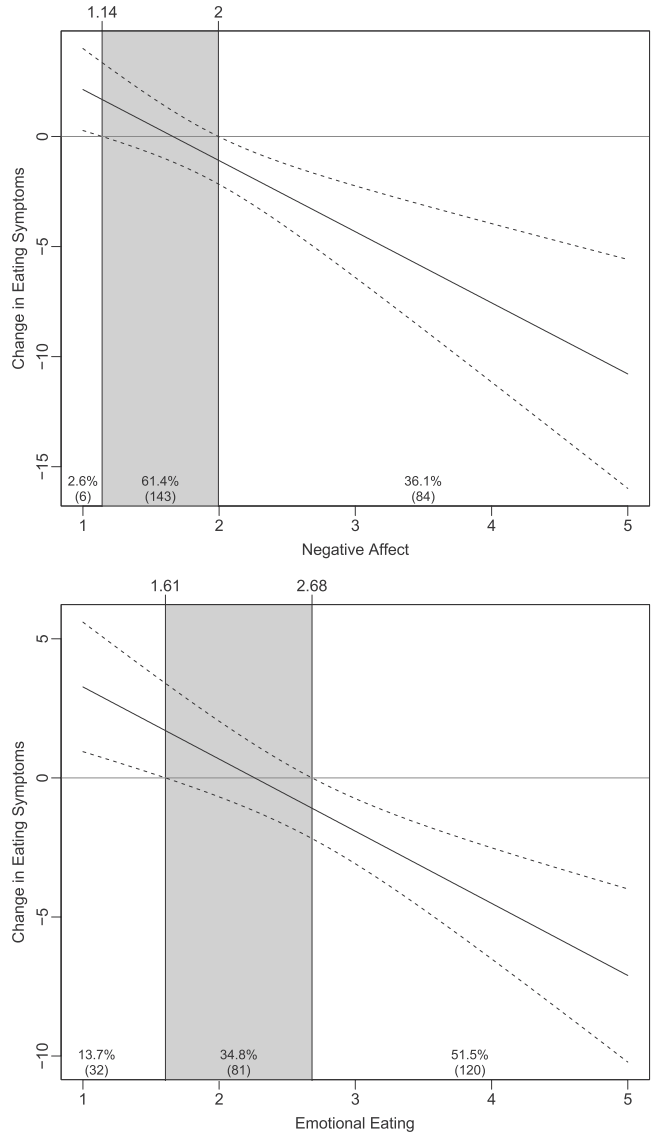

Fig. 3. Region of significance plots for the difference between *Project Health* and educational video participants for the two significant moderators.
Note. When the solid line is above zero, video participants had a greater reduction in eating symptoms than *Project Health* participants, whereas when the line is below zero, *Project Health* participants had a greater reduction in eating symptoms than video participants. Where the dashed lines do not overlap with zero (the white regions), this indicates a significant difference between the conditions at that level of the moderator. The percent of the sample and numbers of participants in each of the three columns are presented along the bottom of the figures.

and 3rd percentiles, respectively), video controls experienced significantly greater decreases than *Project Health* and *Healthy Weight* participants (Fig. 5). This implies that participants coming in with a profile that is generally high on these moderators and low on body self-esteem would benefit more from receiving *Project Health* or *Healthy Weight* rather than the educational video.

4. Discussion

This report sought to identify moderators of the effects of two dual eating disorder and obesity prevention programs, with the aim of guiding refinements of inclusion criteria so that these programs can be delivered to those most likely to benefit, and to guide changes in intervention content to improve efficacy. Although past studies have examined variables that moderate the effects of the *Healthy Weight* prevention program, this is the first report to examine moderators of the *Project Health* prevention program.

Project Health produced larger reductions in eating disorder symptoms relative to video controls for individuals with higher negative affect and emotional eating. It was noteworthy that these two moderators also identified individuals who showed larger reductions in symptoms in response to *Healthy Weight* versus video control. The effect sizes for these four moderating effects were all medium in magnitude. The fact that these two baseline factors identified individuals who showed larger symptoms reduction in response to both prevention programs suggests that these may be the most reliable effects. The fact that negative affect and emotional eating both tap a similar underlying vulnerability process likewise provides increased confidence in these effects. This appears to be the first study to find that participants with elevated negative affect and emotional eating show significantly greater reductions in eating disorder symptoms from an eating disorder prevention program, though one previous trial found that elevated depression was associated with greater reductions in eating disorder risk factors in response to a prevention program (Wilksch & Wade, 2013). Results imply that individuals at elevated risk for eating disorders by virtue of elevated negative affect and emotional eating show greater benefits from these prevention programs, potentially in part because they have greater room for reductions in outcomes. Table 1 confirms that negative affect and emotional eating correlated with eating disorder symptoms, though the fact that baseline symptoms did not moderate the effects of these interventions on symptom reduction suggests that these moderating effects were not driven by elevated baseline symptoms. These results may imply that the gradual lifestyle improvement plan, designed to balance dietary intake with energy expenditure, is particularly effective in reducing eating disorder symptoms for individuals with elevated negative affect and emotional eating, possibly because improving dietary intake and increasing activity improves mood.

Healthy Weight produced larger eating disorder symptom reductions for individuals with higher versus lower perceived pressure to be thin, converging with results from an independent trial that evaluated this prevention program (Stice et al., 2013). The effect size for this moderator effect was also medium in magnitude. The fact that this moderating effect emerged in two trials suggests it is a robust relation, though it is unclear why this moderator was associated with larger eating disorder symptom reductions for *Healthy Weight* but not *Project Health*, given that both programs reduced symptoms in our trial. Nonetheless, this pattern of findings is consistent with the general finding that prevention programs produce larger effects for individuals at higher versus lower risk for eating disorder symptoms, given that perceived pressure to be thin increases risk for future eating disorder onset (e.g., Stice, Marti, & Durant, 2011).

Further, *Healthy Weight* produced larger eating disorder symptom reductions for individuals with higher dietary fat and sugar intake. This moderator effect also reflected a medium effect size. Though little research has examined the relation of energy dense food intake and eating disorder symptoms, overeating has been found to increase risk for future eating disorder onset (Stice et al., 2017). Thus, this novel moderating effect provides additional evidence that eating disorder prevention programs produce larger symptom reductions for individuals at elevated risk for eating pathology, consistent with meta-analytic reviews indicating that prevention program effects are often larger for selective versus universal prevention programs (Horowitz & Garber, 2006; Stice et al., 2009, 2007).

We also conducted a principle components analyses to explore whether a latent variable that captured the variance across the moderators that we examined showed stronger moderating effects, as recommended by Wallace, Frank, and Kraemer (2013). We extracted a latent factor for which the highest loading variables were negative affect and emotional eating. Consistent with the results for the individual

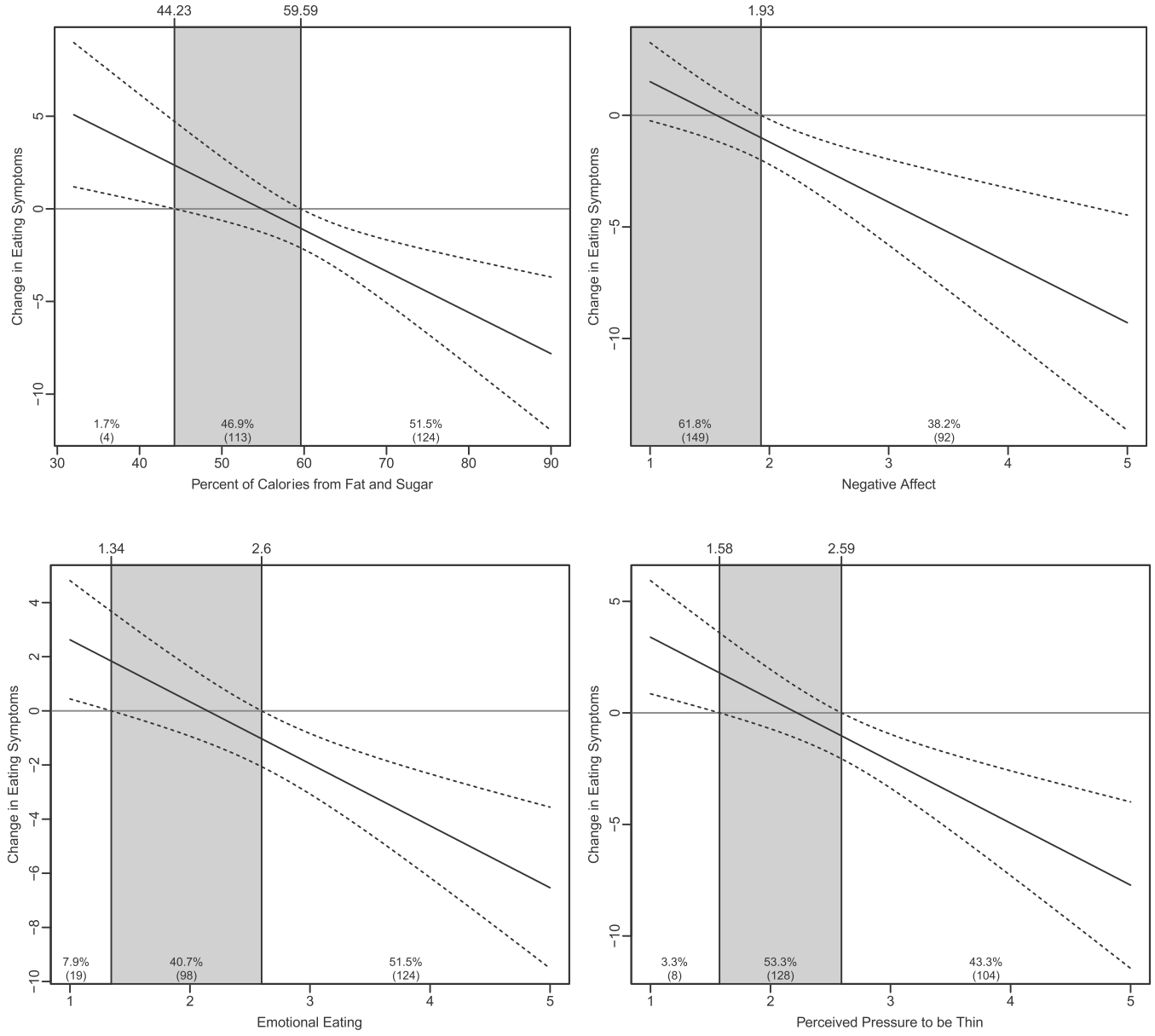

Fig. 4. Region of significance plots for the difference between *Healthy Weight* and educational video participants for the four significant moderators.
Note. When the solid line is above zero, video participants had a greater reduction in eating symptoms than *Healthy Weight* participants, whereas when the line is below zero, *Healthy Weight* participants had a greater reduction in eating symptoms than video participants. Where the dashed lines do not overlap with zero (the white regions), this indicates a significant difference between the conditions at that level of the moderator. The percent of the sample and numbers of participants in each of the three columns are presented along the bottom of the figures.

Table 3
Loadings for the first principal component.

Moderator	Loading
Body self-esteem	-.48
Negative affect	.71
Emotional eating	.71
Barratt impulsivity	.57
Substance use	.34
Perceived pressure to be thin	.62
Food craving	.51
Eating symptoms	.70

Table 4
Loadings for the first principal component.

Moderator	Loading
Body self-esteem	-.48
Negative affect	.71
Emotional eating	.71
Barratt impulsivity	.57
Substance use	.34
Perceived pressure to be thin	.62
Food craving	.51
Eating symptoms	.70

moderators, the effects of *Project Health* and *Healthy Weight* compared to educational video controls were significantly stronger for participants with higher versus lower scores on this latent factor at baseline. Interestingly, these moderating effects ($r = 0.24$ and 0.22, respectively) were not larger than the parallel moderating effects for negative affect ($r = 0.26$ and 0.23, respectively) or emotional eating ($r = 0.27$ and

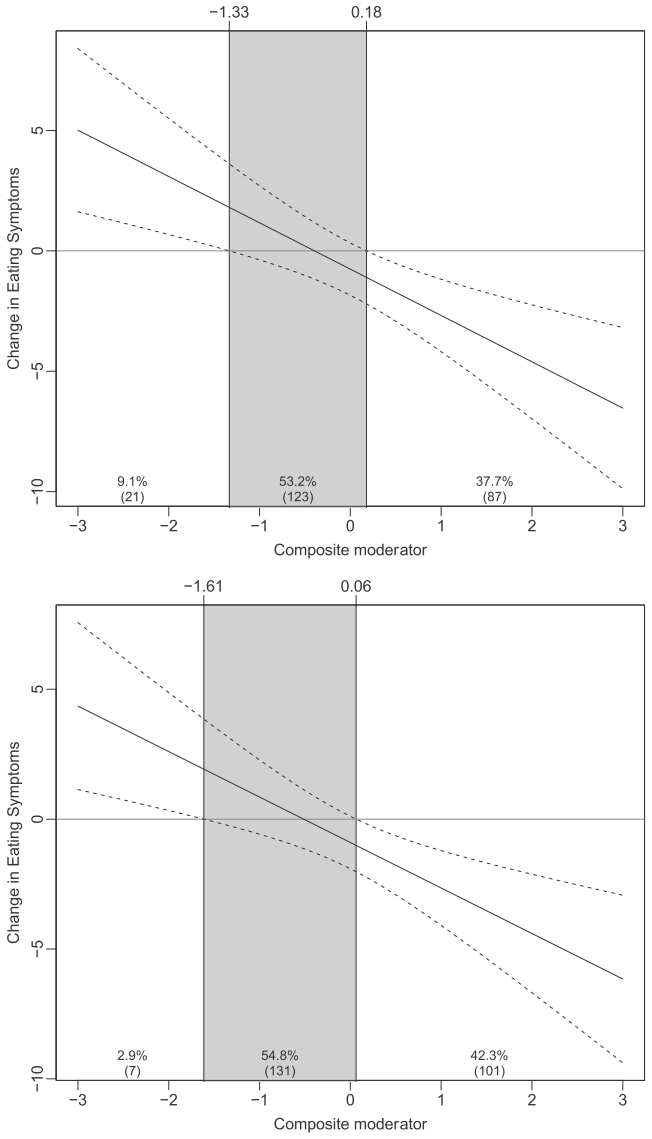

Fig. 5. Region of significance plots for the difference between *Project Health* and educational video (top) and *Healthy Weight* educational video (bottom) participants for the composite moderator.

Note. When the solid line is above zero, video participants had a greater reduction in eating symptoms than *Project Health* participants, whereas when the line is below zero, *Project Health* participants had a greater reduction in eating symptoms than video participants. Where the dashed lines do not overlap with zero (the white regions), this indicates a significant difference between the conditions at that level of the moderator.

0.25, respectively). This pattern of effect sizes suggests that it might be best for clinicians to target individuals with elevations in emotional eating at baseline if they want to maximize the effects of these two prevention programs in terms of reducing eating disorder symptoms.

Only one variable moderated the effects of the prevention programs on change in BMI; *Project Health* produced significantly less increases in BMI compared to video controls for individuals with lower versus higher negative affect. The effect size for this moderator was small in magnitude. Thus, results suggested that elevated negative affect mitigates the effects of these prevention programs on overeating, which represents another unique contribution of this study. One interpretation for the small number of BMI moderators is that it might be easier to identify moderators that predict short-term (i.e., eating disorder symptom change from pretest to posttest) rather than long-term intervention response (i.e., BMI change over 2-year follow-up). Alternatively, it may be more difficult to identify moderators of objective biological outcomes versus self-reported outcomes. This latter interpretation is consistent with the fact that five past studies had identified moderators of prevention programs on eating disorder symptoms (Butryn et al., 2014; Müller & Stice, 2013; Stice et al., 2013; Taylor et al., 2006; Völker et al., 2014), relative to only two that identified moderators of prevention programs on BMI (Lubans et al., 2012; Stice et al., 2013). The moderating effect of negative affect on BMI change, if replicated, offers a potential direction for improving the efficacy of *Project Health*: namely, adding intervention elements designed to reduce negative affect might improve weight gain prevention effects. It was noteworthy that the six moderation effects for symptom reduction had the opposite association: the prevention programs were superior to controls at higher (i.e., more pathological) levels of moderators, which helps to improve inclusion guidelines but does not offer suggestions for refining an intervention to produce larger reductions in eating disorder symptoms.

Of note, analyses did not identify any baseline factors that identified individuals for whom *Project Health* produced larger eating disorder symptom effects relative to *Healthy Weight*, or vice versa. This may indicate that it is more difficult to identify factors that moderate the effects of one group-based intervention versus another group-based intervention, in contrast to identifying factors that moderate the effect of a group-based intervention versus a minimal-intervention control condition. The fact that non-specific effects, such as group support and public accountability for lifestyle changes, were operating in both group-based interventions might make it more difficult to identify moderators of intervention effects of two active interventions matched on intensity and modality.

It was noteworthy that five of the interactions suggested that participants at very low levels of the moderators showed significantly larger eating disorder symptom reductions if they were randomized to the educational video condition versus *Project Health* of *Healthy Weight*. For instance, participants in the lower 8% of the emotional eating distribution (10 participants) showed greater symptom reductions if randomized to the educational video condition versus the *Healthy Weight* prevention program. Although participants assigned to the educational video condition only showed greater reductions in eating disorder symptoms than those assigned to *Project Health* or *Healthy Weight* for 3 to 17 participants in this trial (1.5%–14%), it is important to consider whether these effects represent iatrogenic effects. We therefore examined symptoms change for participants in the in each condition, focusing on the interaction with the largest number of participants in the apparent iatrogenic range of the moderator. Among the 32 participants in the lower 14% of the distribution of emotional eating for whom educational brochure controls showed greater reductions in eating disorder symptoms than *Project Health* participants, the mean symptom reduction for educational video controls was 2.12, whereas the mean symptom reduction for *Project Health* participants was 2.00. Thus, results suggest that participants at the lowest risk for eating pathology, by virtue of low negative affect, emotional eating, intake of dietary fat and sugar, and pressure to be thin gain more from educational information about eating disorders than from interventions that promote gradual lifestyle changes that are designed to balance caloric intake with energy expenditure. There was no evidence that participants assigned to *Project Health* or *Healthy Weight* showed increases in eating disorder symptoms.

Regarding study limitations, we examining a somewhat narrow number of factors that may moderate the effects of these prevention programs. Future studies should continue to search for moderators that predict response to these types of prevention programs. Additionally, although most young adults in the United States attend college and we selected this population because it is easy to reach with prevention programs, findings may not generalize to young adults who do not attend college or to older adults (*The Condition of Education*, 2008). Finally, approximately two thirds of the sample was European-

American. Thus, results may not generalize well to minority groups that were under-represented in this sample.

In conclusion, results from these moderator analyses suggest that dual eating disorder and obesity prevention programs may produce larger reductions in eating disorder symptoms, but not BMI, when delivered to individuals at higher risk for future eating disorders, by virtue of weight concerns and one or more of the other risk factors that moderated effects. For instance, *Project Health* may produce larger eating disorder symptom reductions if offered to young adults with a confluence of weight concerns and emotional eating versus those with only weight concerns. It might therefore be useful to conduct a confirmatory randomized trial that expressly tests whether participants assigned to *Project Health* versus an educational video control condition produces larger reductions in eating disorder symptoms for participants with both weight concerns and emotional eating at baseline versus those with only weight concerns. We think it critical to replicate the moderator effects in a separate data set in an effort to ensure that the effects are reliable before broadly implementing this prevention program to dually at-risk individuals. Results also suggest that it would be useful to evaluate whether adding intervention components to reduce emotional eating to *Project Health* results in larger eating disorder symptom reductions than the version of *Project Health* evaluated in the present trial. Likewise, it might be useful to evaluate whether adding intervention components to reduce negative affect to *Project Health* results in larger weight gain prevention effects relative to the version of *Project Health* evaluated in the present trail. Such experimental therapeutics trials may represent a powerful method of refining prevention programs to make them even more effective.

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