

# Randomized, Controlled Trial of an Internet-Facilitated Intervention for Reducing Binge Eating and Overweight in Adolescents

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## What's Known on This Subject

Weight management is notoriously difficult to promote and to maintain among children and adolescents. Research indicates that reducing binge eating may be effective in preventing additional weight gain and may lead to weight loss.

## What This Study Adds

This study investigates the use of an Internet-facilitated intervention for weight maintenance and binge eating in adolescents. Results suggest that an Internet-facilitated intervention is moderately effective in short-term weight loss and weight maintenance and yields a large reduction in binge eating. This study also demonstrates that weight management and reduction of eating disorder psychopathological features can be achieved simultaneously by using an easily disseminated, Internet-facilitated program.

## ABSTRACT

**OBJECTIVE.** This study examined the efficacy of an Internet-facilitated intervention for weight maintenance and binge eating in adolescents.

**METHODS.** A total of 105 adolescent male and female high school students at risk for overweight (mean age:  $15.1 \pm 1.0$  years) were randomly assigned to a 16-week online intervention, StudentBodies2-BED ( $n = 52$ ), or the wait-list control group ( $n = 53$ ).

**RESULTS.** Participants in the StudentBodies2-BED group had significantly lower BMI z scores and BMI from baseline assessment to follow-up assessment, compared with the wait-list control group. In addition, significant reductions in objective binge episodes and subjective binge episodes from baseline assessment to posttreatment assessment and from baseline assessment to follow-up assessment were observed among StudentBodies2-BED participants. The StudentBodies2-BED group also reported significantly reduced weight and shape concerns from posttreatment assessment to follow-up assessment and from baseline assessment to follow-up assessment. Participants in the StudentBodies2-BED group who engaged in objective overeating or binge eating episodes at baseline assessment experienced a significantly greater reduction in BMI at follow-up assessment, compared with the wait-list control group.

**CONCLUSIONS.** Results suggest that an Internet-facilitated intervention is moderately effective in short-term weight loss and weight maintenance and yields a large reduction in binge eating. This study also demonstrates that weight management and reduction of eating disorder psychopathological features can be achieved simultaneously by using an easily disseminated, Internet-facilitated program.

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### Key Words

adolescents, overweight, disordered eating, eating disorders, weight management

### Abbreviations

SB2-BED—StudentBodies2-BED  
WLC—wait-list control  
OBE—objective binge episode  
SBE—subjective binge episode  
OOE—objective overeating episode  
EBI—Eating Behaviors Inventory  
BED—binge eating disorder

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NATIONAL CENTER FOR Health Statistics data indicate a steady increase in the proportions of overweight children and adolescents.<sup>1</sup> This trend has been particularly marked in recent years, with 34.3% of adolescents (12–19 years of age) meeting criteria for either at risk of overweight (ie, age-adjusted BMI of  $\geq$ 85th percentile) or overweight (ie,  $\geq$ 95th percentile).<sup>2</sup> In light of the compromised psychological and physical health associated with overweight<sup>3</sup> and the epidemic scale of the problem, adolescent overweight remains a vitally important area of treatment and prevention research.

There is consistent evidence that increased energy consumption is associated with weight gain; therefore, interventions typically target eating behavior modification. Binge eating, which is associated with greater energy intake, is also linked to increased degree of overweight<sup>4–7</sup> and prospectively predicts weight gain and earlier onset of overweight among children and adolescents.<sup>8–11</sup> Therefore, individuals who binge eat seem to be a relevant target for intervention programs, particularly because cessation of binge eating is often effective in stabilizing weight, thereby preventing future weight gain and perhaps promoting weight loss.<sup>12,13</sup>

The onset of binge eating typically occurs in late childhood or adolescence<sup>14</sup> and is characterized by the sense of loss of control over eating, accompanied by an eating episode involving the consumption of an objectively large amount of food (objective binge episode [OBE]) or smaller amount of food (subjective binge episode [SBE]). Rates of eating disorder pathological conditions, particularly binge eating, are elevated and clinically significant in overweight youths,<sup>15</sup> which supports the need to develop interventions that simultaneously address overweight and binge eating. Children and adolescents who report loss of control over eating not only are heavier and have more body fat than peers without loss of control but also report greater eating-related psychopathological features, including greater weight and shape concerns and depressive symptoms.<sup>16–19</sup> Weight management programs target objective overeating episodes (OOEs) (ie, consumption of an objectively large amount of food without loss of control) to reduce weight but traditionally rely on weight status as the criterion for enrollment and ignore the type and function of overeating episodes, such as the role of overeating and binge eating as a means of regulating negative affect.<sup>20</sup> Traditional weight loss programs may not attend adequately to loss of control, which is the central feature of binge eating,<sup>21</sup> particularly in children and adolescents.<sup>22</sup> In addition, these programs typically do not consider idiosyncratic differences in the maintenance of overeating and binge eating, potentially limiting the long-term effectiveness of the interventions.

Given the high prevalence of weight and shape concerns among overweight adolescents,<sup>23,24</sup> some professionals express concern that weight loss programs may increase the risk of eating disorders through iatrogenic effects of increased focus on body weight, stimulus control, and dietary restriction.<sup>25</sup> However, comprehensive weight management interventions may mitigate eating disorder risk by integrating components designed to ad-

dress shared risk factors for overweight and eating disorders, such as dieting, media use, weight-related teasing, and weight and shape concerns.<sup>26,27</sup> Evidence indicates that participation in an integrated weight loss program may not exacerbate risk<sup>28</sup> and may even decrease binge eating symptoms<sup>29,30</sup> and compensatory behaviors,<sup>31</sup> which suggests that professionally administered weight management programs may not have adverse effects on eating disorder psychopathological conditions. Additional empirical evidence is needed to examine more thoroughly the efficacy of integrated interventions for the reduction of overweight and eating disorder symptoms.

Because of the high and increasing prevalence rates of overweight and obesity, the development and dissemination of effective interventions are imperative. Traditional comprehensive behavioral weight management interventions require a large investment of resources and may be prohibitively expensive for many individuals, which limits their accessibility. One possible solution to the problem of limited access to adequate treatment resources involves Internet-facilitated interventions. Online interventions can minimize many barriers, such as cost, time constraints, and transportation difficulties, that may prevent adolescents from seeking treatment.<sup>32</sup> Adolescent participants of focus groups identify minimization of stigmatization as one of the most important features of obesity prevention programs,<sup>32</sup> and the Internet provides unique advantages in the ability to preserve anonymity. Several studies showed that the Internet can be used to provide weight maintenance interventions in adults<sup>33–35</sup> and may be of benefit for overweight adolescents.<sup>36</sup>

This study expands the empirical literature on integrated interventions for weight-related disorders and eating disorders by focusing on adolescents who are at risk for overweight and who report high rates of binge eating, a group that is at high risk of being overweight or obese in adulthood and experiencing adverse health consequences. To date, no studies have examined a program that combines cognitive-behavioral therapy for binge eating and behavioral weight loss treatment in adolescents, although such programs demonstrate moderate efficacy in reducing binge eating and promoting weight loss among adults.<sup>12,13</sup> Whereas behavioral weight loss programs for adults typically seek to reduce weight, weight stabilization may be a more-appropriate goal for children and adolescents at risk for overweight because weight maintenance can be achieved with less energy restriction, thus potentiating habits that are more likely to be maintained.<sup>37</sup> Furthermore, for adolescents who are still growing, weight maintenance reduces overall BMI as height increases, while weight remains the same.<sup>38</sup> Therefore, a logical next step is to examine a combined program targeting both binge eating and weight maintenance for adolescents. The purpose of this study was to determine the effects of an Internet-facilitated, weight management program on reducing binge eating and overeating and preventing weight gain in a population of students at risk of overweight.

**TABLE 1** Participant Baseline Characteristics

	SB2-BED ( <i>n</i> = 52)	WLC ( <i>n</i> = 53)
Gender, <i>n</i>		
Female	38	35
Male	14	18
Age, mean ± SD, y	15.0 ± 1.0	15.2 ± 1.1
Grade in school, <i>n</i>		
9th	26	20
10th	16	19
11th	10	13
12th	0	1
Ethnicity, <i>n</i>		
White	35	32
Black	2	6
Latino/Hispanic/Mexican	12	10
Other	3	5
Born in United States, %	96	92
Mother's education, <i>n</i>		
Less than high school	4	3
Finished high school	17	14
More than high school	26	30
Unknown	5	6
Father's education, <i>n</i>		
Less than high school	5	4
Finished high school	13	9
More than high school	24	30
Unknown	10	10
BMI, mean ± SD, kg/m <sup>2</sup>	30.58 ± 4.9	30.64 ± 5.97

## METHODS

### Participants

A total of 60 participants was deemed necessary for randomization at baseline assessment, to detect a moderate effect size (treatment compared with control) for the primary outcome variables (BMI and BMI *z* score) of ~0.40<sup>39</sup> with 80% power and  $\alpha$  of 5%, assuming a 10% attrition rate. Participants were 105 high school students from 2 public high schools, in Boise, Idaho (*n* = 78), and Hayward, California (*n* = 27), who met the following inclusion criteria: (1)  $\geq$ 85th percentile for age-adjusted BMI, (2) binge eating or overeating behaviors at a frequency of  $\geq$ 1 times per week in the previous 3 months, (3) access to a computer and the Internet, (4) not currently enrolled in a formal binge eating or weight loss program (eg, Weight Watchers), (5) absence of any medical condition in which the actual condition or treatment affects weight and/or appetite (ie, cancer, endocrine diseases, or certain medications), and (6) absence of anorexia nervosa and bulimia nervosa.

Students were recruited to participate in the Internet-based, healthy weight maintenance program through flyers and presentations in health education and physical education classes at cooperating high schools. Additional recruitment presentations were conducted at student rallies, freshmen orientation, and parent back-to-school night. Participant baseline characteristics are provided in Table 1. There were no significant differences between the intervention (StudentBodies2-BED [SB2-BED]) group and the wait-list control (WLC) group with respect to any demographic variables.

### Study Design

Participant random assignment was stratified according to school, and random number sequences were generated by the study coordinator with SPSS 12.0 for Windows (SPSS, Chicago, IL). There were 2 cohorts, each of which included participants from each site. Cohort 1 began the program in the spring of 2005 and completed it over the summer of 2005, and cohort 2 started the program in the autumn of 2005 and ended it in the winter of 2006. The study was approved by the participating school districts and by the institutional review boards of Stanford University and Boise State University.

### Study Procedures

After expressing interest in the study, potential participants received an initial screening questionnaire, parent consent form, and student assent form to be signed and returned. The baseline questionnaire asked students to report their gender, date of birth, height, weight, grade in school, and contact information. Students were contacted by telephone to complete a more-comprehensive telephone screening questionnaire. Eligible participants were scheduled for an appointment at their respective schools, during which they completed several self-report questionnaires and a semi-structured diagnostic interview (Eating Behaviors Inventory [EBI]) and had their heights and weights measured. Participants completed the same assessment by telephone at the posttreatment assessment and provided self-reported height and weight. Participants were contacted 9 months after the baseline assessment for in-person measurements of height and weight and completion of the telephone self-report questionnaire and semi-structured interview. Assessments were performed by the study coordinator and trained research assistants, who were supervised by a licensed psychologist and psychiatrist. Assessors were blinded with respect to participant assignment at the follow-up assessment but were not blinded with respect to assignment at the postintervention evaluation, because of the inclusion of program satisfaction questionnaires for SB2-BED participants.

### Internet Privacy and Confidentiality Procedures

Participants were informed of the security risks associated with online programs because of the inability to restrict all access to an Internet server; however, participants' privacy was maintained to the greatest extent possible. The online program used a password-protected server, possible intrusions were monitored, and data were removed from the server after program completion. The Web site was also equipped with a privacy feature that automatically logged users out of the program after 15 minutes of inactivity. No intrusions were detected. Both the intervention and the server were compliant with Health Insurance Portability and Accountability Act guidelines. Participants were assigned identification numbers to protect confidentiality and were asked not to reveal identifying information online.

## WLC Group

WLC participants were informed at the start of the study that they would be offered the program at the 9-month follow-up assessment, in either online or printed format. A total of 11 participants elected to use the online version and 6 participants reported using the printed version, although all control participants were offered the intervention.

## Assessment Measures

### BMI

Standing height was measured to the nearest 0.5 inch. Weight was determined to the nearest 0.1 lb by using a digital scale, with participants wearing light indoor clothing without shoes or coats. Participants were not instructed to fast before weight measurement, and measurements were taken during school hours. Height and weight were converted to BMI.

### Binge Eating Behavior

Frequencies of OBEs, SBEs, and OOE were measured with a semi-structured diagnostic interview, which is the recommended approach for evaluating binge eating among children and adolescents.<sup>40</sup> The EBI was adapted from the Eating Disorder Examination<sup>41</sup> for use with an adolescent population.<sup>42</sup> The EBI has been used in several large epidemiologic studies of eating disorder risk factors in adolescents and has  $\kappa$  coefficients of  $\geq .74$  for key questions related to OBEs.<sup>42</sup> For the present study, the EBI was modified to focus specifically on binge eating disorder symptoms and objective overeating, including OBEs, SBEs, OOE, compensatory behaviors, and weight and shape concerns. Existing questions on the EBI about OBEs (eg, "Since [3 months ago], have there been any times when you have eaten what you think is a really large amount of food in 2 hours or less?") were supplemented by questions that attempted to simplify the concept (eg, "We consider a large amount of food to be something like 6 pieces of a large pizza or 5 donuts; do you think that you have eaten this amount of food or its equivalent in 2 hours or less, during the past 3 months?"). Participants were included if they were at risk for overweight or overweight (BMI of 85th percentile) and reported binge eating on the baseline screen, even if they did not meet criteria for having OBEs, SBEs, or OOE during the structured interview. Because individuals with binge eating disorder often experience OBEs and SBEs and loss of control is associated with inappropriate weight gain<sup>2</sup> and greater eating-related psychopathological features and depression,<sup>16,19</sup> frequencies of OBEs and SBEs were combined in the analyses, to represent eating episodes involving loss of control.

### Dietary Fat and Sugar Intake

Dietary fat and sugar intake was measured with the PACE+ dietary fat screening measure.<sup>43</sup> This 21-item self-report inventory assesses dietary intake of high-fat and high-sugar foods over a 1-week time period and has adequate internal consistency ( $\alpha > .70$ ) and test-retest reliability (intraclass correlation  $> 0.60$ ), as well as a

significant positive correlation with percentage of energy from fat ( $r = 0.36$ ;  $P < .01$ ).

### Depressive Mood

Depressed mood was examined by using the Center for Epidemiologic Studies Depression Scale.<sup>44</sup> The Center for Epidemiologic Studies Depression Scale is a 20-item self-report scale designed to measure depressive symptoms, and it has adequate internal consistency ( $\alpha > .86$ ) in a population of high school students.<sup>45</sup>

### Program Adherence

Adherence was calculated as the mean number of content screens accessed per week over the 16 weeks. Examples of data collected include the mean number of food journal entries and number of messages posted to the discussion group.

### Intervention

The SB2-BED intervention is a 16-week, Internet-facilitated, semi-structured program that incorporates cognitive-behavioral principles from the self-help manual for binge eating disorder by Fairburn,<sup>46</sup> the adolescent weight loss intervention, Healthy Habits, described by Saelens et al,<sup>47</sup> and hunger and satiety awareness skills.<sup>48</sup> The intervention combines psychoeducation and behavioral interventions such as self-monitoring, goal-setting, stimulus control, and appetite awareness and introduces emotion regulation skills. The primary goals of the intervention were (1) to reduce binge eating, (2) to maintain weight, (3) to increase healthy eating, (4) to increase physical activity, and (5) to reduce sedentary activities. The program introduced a new topic related to healthy eating, physical activity, binge eating, and weight loss/maintenance each week (Table 2), with content from previous weeks being accessible at any time. In addition to psychoeducational material, the online program included interactive components such as self-monitoring journals for dietary intake, physical activity, weight, personal thoughts, and goals, as well as an asynchronous discussion group moderated by a research assistant. Students were given a packet of the monitoring forms to complete off-line, followed by entering the data into their online journal. As an additional program aid, a handbook was developed for parents.

Weekly letters were sent to participants to reinforce program participation and to encourage participants who did not comply with study expectations for participation. In addition, intermittent motivational messages were mailed to participants in an attempt to increase program adherence. Because of the relatively low adherence to the intervention observed for the first cohort, students in cohort 2 were given the option of face-to-face meetings with a mentor.

### Statistical Analyses

Data were double-entered for verification and were analyzed by using SPSS 12.0 for Windows. All statistical tests were 2-sided and used a significance level of .05 unless otherwise noted. Statistical tests were conducted

**TABLE 2 Weekly Themes**

Week	Topic
1	Introduction, social support, and goal-setting: introduction to program goals, group support, and beginning goal-setting
2	Introduction to self-assessment: 24-h recall of food intake and physical activity; introduction of binge eating attributable to restraint and negative affect, overeating/grazing, and sedentary lifestyle; review of records for individual patterns
3–6	Binge eating, nutrition, and physical activity: introduction of recommended regular meal pattern (ie, 3 meals and 2 snacks); introduction of identification of emotions associated with urges to binge eat, to overeat, or to graze and alternate coping strategies; identification of hunger and satiety cues; continued goal-setting
7	Move It to Lose It: strategies to increase physical activity and to reduce sedentary activities; 24-h food intake and physical activity recall; goal-setting
8	Social support, environment, and weight loss: eliciting support from parents, friends, siblings, and group; assessment of school and home environment for barriers to achieving goals; modification of environment; refusal skills, portion control, flexible restraint, stimulus control, and food substitution
9	Unhealthy weight loss methods and eating disorders: psychoeducation related to unhealthy dieting, eating disorders, negative body image, and media
10–11	Teasing, criticism, and self-esteem: encouragement of discussion related to teasing, negative thoughts about self, and critical comments from parents, coaches, peers, and siblings; strategies to cope with negative comments, thoughts, and feelings; 24-h food intake and physical activity recall, evaluation, and goal-setting
12	Lapse and relapse: road to relapse; getting back on track
13	Rewarding success
14–15	Maintenance of change: participants are asked to record anticipated barriers to maintaining treatment gains and to make plans to prevent relapse.
16	Closure

by using completer analyses and intention-to-treat analyses, with baseline scores being carried forward. Only results from the completer analysis are included, because there were no differences between the completer and intention-to-treat analyses. Linear regression analyses were conducted on change scores for continuous dependent variables by using the following equation: change score =  $c_{\text{group}} + c_{\text{site}} + c_{\text{cohort}} + (c_{\text{group}} \times c_{\text{site}}) + (c_{\text{group}} \times c_{\text{cohort}}) + (c_{\text{site}} \times c_{\text{cohort}}) + (c_{\text{group}} \times c_{\text{site}} \times c_{\text{cohort}})$ , in which  $c$  denotes centering. Effect sizes were calculated by dividing the difference between the mean change in the treatment group and the mean change in the WLC group by the pooled SD.

## RESULTS

### Attrition and Adherence

Participant flow can be seen in Fig 1. Overall, 105 participants were eligible and assigned randomly to either the SB2-BED group ( $n = 52$ ) or the WLC group ( $n = 53$ ). Eighteen participants (17%) had no follow-up data and were not available for the completer analysis. Pearson's

$\chi^2$  tests and independent-sample  $t$  tests were used to compare dropouts and completers with respect to all baseline variables. Dropouts were more likely to be white ( $\chi^2 = 7.25$ ;  $P < .01$ ) and to report depressed mood ( $t_{96} = -3.17$ ;  $P < .01$ ) and had greater weight and shape concerns ( $t_{101} = -2.36$ ;  $P < .05$ ), compared with completers. In the WLC group, 1 participant at posttreatment assessment and 1 participant at follow-up assessment reported participation in an outside weight loss program. There were no site or cohort differences in any primary outcome variable at baseline assessment, however, there was a greater incidence of binge eating in the treatment group at baseline assessment, which was addressed through the use of nonparametric analyses.

Approximately 27% of all SB2-BED participants ( $n = 14$ ) used some component of the online program for  $\geq 8$  weeks, 42% ( $n = 22$ ) used the program for 1 to 7 weeks, and 31% ( $n = 16$ ) never logged on. Participants used the online food journal function more frequently than the other online journals (Table 3). For cohort 2, on average, students attended only 1 mentor session. Spearman's correlation coefficients were used to examine the relationship between adherence and primary outcome variables and yielded no significance. There were also no significant differences between cohorts in any primary outcome variables.

### Weight Change

In the completer analyses, there were significant differences in the change in BMI  $z$  score ( $t_{87} = -3.1$ ;  $P < .01$ ; effect size: 0.8) (Fig 2) and the change in BMI ( $t_{87} = -2.7$ ;  $P < .01$ ; effect size: 0.6) from baseline assessment to follow-up assessment, with SB2-BED participants experiencing greater reductions in BMI  $z$  score and BMI. Intention-to-treat analyses also revealed significant differences in the changes in BMI  $z$  score ( $t_{103} = -3.15$ ;  $P < .01$ ) and BMI ( $t_{103} = -2.58$ ;  $P < .01$ ) from baseline assessment to follow-up assessment for the SB2-BED group, compared with the WLC group. Data from the posttreatment assessment at 4 months are included in Fig 2 for descriptive purposes but were not included in the analyses because they were self-reported rather than measured directly.

Among completers, 7% of the SB2-BED participants (3 of 44 participants) and 5% of the WLC participants (2 of 43 participants) were not at risk for overweight (ie, BMI of  $< 85$ th percentile) at baseline assessment. At follow-up assessment, 27% of SB2-BED participants were not at risk for overweight, compared with 12% in the WLC group ( $\chi^2 = 3.4$ ;  $P = .067$ ).

### Changes in Binge Eating and Eating Disorder Psychopathological Features

Mann-Whitney tests indicated significant reductions in OBEs and SBEs from baseline assessment to posttreatment assessment ( $U_{81} = 565$ ;  $P < .01$ ) and from baseline assessment to follow-up assessment ( $U_{84} = 652.5$ ;  $P < .05$ ) for SB2-BED participants. The baseline assessment to posttreatment assessment ( $U_{103} = 939.5$ ;  $P < .01$ ) and baseline assessment to follow-up assessment ( $U_{103} =$

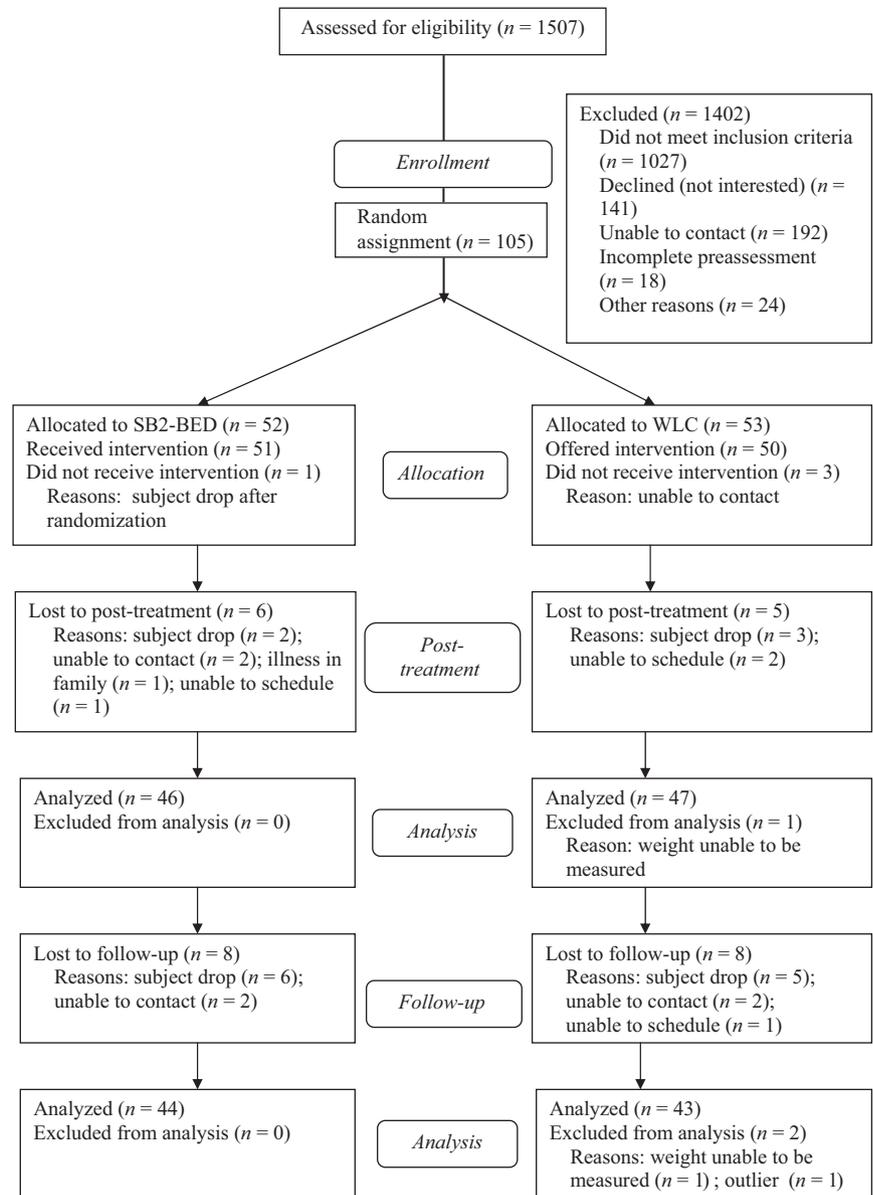


FIGURE 1  
Participant flow.

1040.5;  $P < .05$ ) changes in OBEs and SBEs remained the same when baseline scores were carried forward. Weight and shape concerns in the SB2-BED group decreased significantly from baseline assessment to follow-up assessment ( $t_{78} = -2.4$ ;  $P < .05$ ) among completers, but not in the intention-to-treat analysis. No

significant effects were observed for changes in OOE, dietary fat and sugar intake, or depression. Although a self-report physical activity measure was used, the measure proved unreliable in this sample because of large variations among participants and inaccurate scores (eg, sum of time spent engaged in sedentary activity, walking, and moderate or vigorous physical activity exceeded 24 hours). The means for follow-up completers for all outcome variables are provided in Table 4. Although there were negligible differences between the completer analysis and the intention-to-treat analysis, the intention-to-treat results are presented in Table 5.

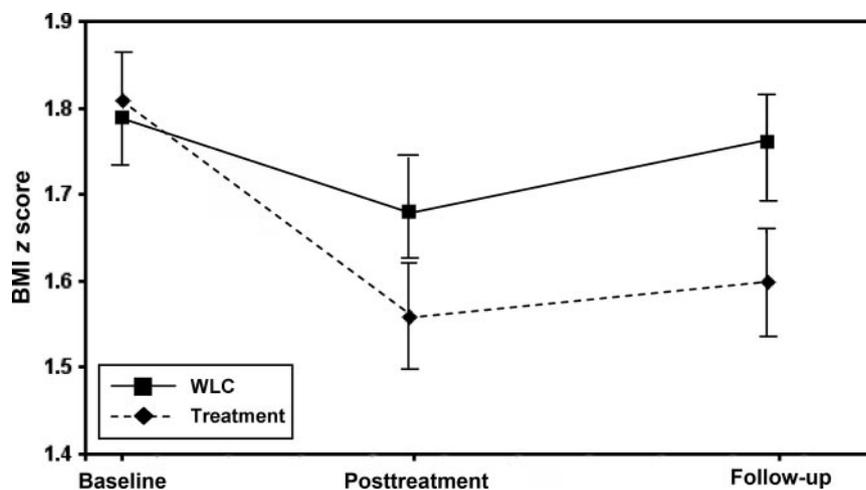
TABLE 3 Participant Adherence

Adherence Variable	Mean $\pm$ SD (Range)
No. of main topic screens viewed (of 104)	20.2 $\pm$ 28.2 (0–94)
Weeks of content screens accessed	4.5 $\pm$ 5.2 (0–16)
No. of food journal entries	21.4 $\pm$ 30.7 (0–107)
No. of physical activity journal entries	8.4 $\pm$ 23.4 (0–157)
No. of weight journal entries	2.8 $\pm$ 4.3 (0–16)
No. of discussion group postings	5.2 $\pm$ 8.6 (0–34)
No. of personal journal entries	3.0 $\pm$ 5.4 (0–23)

#### Relationship of Binge Eating to Weight Change

To determine the relationship of binge eating to weight change, we evaluated the changes in BMI z scores for participants with baseline OBEs, SBEs, or OOE (Fig 3). For SB2-BED participants with no baseline disordered-

FIGURE 2  
Mean BMI z scores at baseline, posttreatment, and follow-up assessments.



eating episodes ( $n = 19$ ), the mean change in BMI z score from baseline assessment to follow-up assessment was  $-0.12 \pm 0.24$ , compared with  $0.08 \pm 0.23$  for WLC participants ( $n = 27$ ). For SB2-BED participants with baseline disordered-eating episodes ( $n = 25$ ), the mean change in BMI z score from baseline assessment to follow-up assessment was  $-0.28 \pm 0.34$ , compared with  $0.05 \pm 0.22$  for the WLC group ( $n = 16$ ;  $t_{40} = -3.78$ ;  $P < .01$ ).

## DISCUSSION

This is the first study to demonstrate the efficacy of an Internet-facilitated intervention for adolescent weight maintenance and binge eating reduction. The results indicate that weight management and eating disorder psychopathological feature reduction can be achieved simultaneously by using an easily disseminated, Internet-facilitated program. The strengths of this study include the randomized, controlled design and the inclusion of a heterogeneous group of adolescents who were at risk for overweight and overweight, some but not all of whom reported engaging in binge eating and overeating. This study has several limitations, including the use of a WLC group instead of a comparison group, self-reported height and weight data at postintervention assessment, nonblinding of assessors to

randomization at postintervention assessment, and low adherence rates.

Although the intervention had a significant effect on weight maintenance, the findings are somewhat surprising, given the fact that the majority of participants used the online program for  $<8$  weeks and there was no relationship between adherence and outcomes. The low adherence is a limitation of this study and may be a result of the competing time demands faced by adolescents or a failure of the intervention to engage participants sufficiently. The self-directed nature of the SB2-BED intervention has the advantage of allowing participants to access the program at their convenience, removing barriers to access; however, this may be less advantageous for adolescents, who may benefit from greater structure. The data suggest that a 16-week program may not be necessary to achieve behavior change and that adolescents who are at risk for overweight may experience benefits from a shorter intervention, possibly with booster sessions and a longer follow-up period. Furthermore, given the decline in program use over the 16 weeks, future programs should “front-load” the core program content, to maximize the effectiveness of early sessions.

The reductions in OBEs, SBEs, and OOE in the WLC group were surprising, given that few of those partici-

TABLE 4 Primary Outcome Data for Follow-up Completers

	SB2-BED			WLC		
	Baseline	Posttreatment	Follow-up	Baseline	Posttreatment	Follow-up
BMI, mean $\pm$ SD, kg/m <sup>2</sup>	30.58 $\pm$ 4.9	28.76 $\pm$ 4.72	29.76 $\pm$ 5.34	30.64 $\pm$ 5.97	29.99 $\pm$ 5.92	31.17 $\pm$ 6.33 <sup>a</sup>
BMI z score, mean $\pm$ SD	1.81 $\pm$ 0.47	1.56 $\pm$ 0.59	1.60 $\pm$ 0.62	1.79 $\pm$ 0.51	1.68 $\pm$ 0.54	1.76 $\pm$ 0.57 <sup>a</sup>
Binge eating, mean $\pm$ SD, no. of episodes						
OBEs and SBEs	15.16 $\pm$ 20.78	0.95 $\pm$ 3.88	2.29 $\pm$ 7.67	8.42 $\pm$ 18.74	6.98 $\pm$ 17.55	2.74 $\pm$ 8.60 <sup>b</sup>
OOEs	7.89 $\pm$ 14.28	2.05 $\pm$ 6.98	2.16 $\pm$ 9.33	7.53 $\pm$ 14.28	2.34 $\pm$ 5.25	1.07 $\pm$ 2.80
Weight and shape concerns, mean $\pm$ SD, score	1.3 $\pm$ 0.80	1.05 $\pm$ 0.64	0.81 $\pm$ 0.67	1.35 $\pm$ 0.92	1.27 $\pm$ 0.78	1.14 $\pm$ 0.72 <sup>b</sup>
Dietary fat intake, mean $\pm$ SD, PACE+DFS score	24.54 $\pm$ 8.63	18.88 $\pm$ 6.56	18.25 $\pm$ 6.95	22.06 $\pm$ 10.73	20.05 $\pm$ 7.49	17.33 $\pm$ 7.57
Depressed mood, mean $\pm$ SD, CES-D score	14.26 $\pm$ 9.43	9.63 $\pm$ 8.30	12.42 $\pm$ 11.59	15.63 $\pm$ 10.33	12.57 $\pm$ 10.10	10.49 $\pm$ 11.21

CES-D indicates Center for Epidemiologic Studies Depression Scale; DFS, Dietary Fat Screening.

<sup>a</sup>  $P < .001$ , compared with the WLC group.

<sup>b</sup>  $P < .05$ , compared with the WLC group.

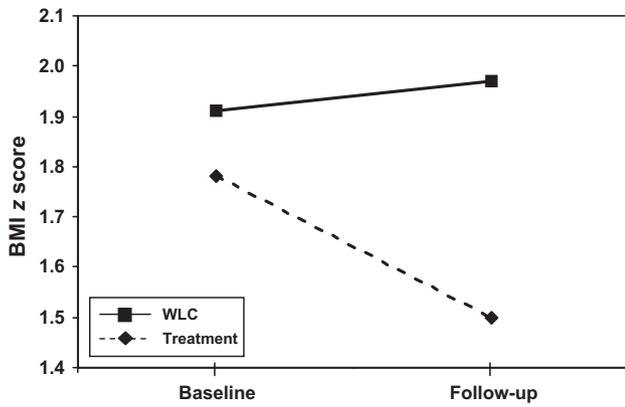


FIGURE 3 Mean BMI z scores at baseline and follow-up assessments for participants with baseline OBE, SBE, and OOE values.

pants reported engaging in outside weight loss program or binge eating treatment. However, this might reflect the variable course and transitory nature of binge eating symptoms<sup>49</sup> or might be a result of measurement error, given the difficulty of assessing binge eating accurately in adolescents.<sup>40</sup> This finding also might be attributable to the fact that many participants engaged in subclinical levels of binge eating, representing a temporary occurrence of disordered eating rather than a stable behavioral pattern. A social desirability effect might have resulted in fewer participants reporting overeating episodes at follow-up assessment in both groups. The reductions in OBEs, SBEs, and OOE values in the SB2-BED group seem to be consistent with previous research suggesting that weight management interventions may lead to decreases in disordered eating.<sup>29,30,50</sup>

The study raises questions about weight maintenance versus weight loss as a strategy among students at risk for overweight. On average, participant BMIs in this sample were ~0.75 lower 9 months after baseline measurements, despite the program's focus on weight maintenance. This study produced a similar but slightly greater effect on BMI, compared with that found by Williamson et al,<sup>36</sup> who described a BMI reduction of ~0.55 among overweight, black, adolescent girls after a 6-month, Internet-delivered intervention. Given the

finding of weight regain at the 2-year follow-up assessment reported by Williamson et al<sup>36</sup> and the upward trend in BMI observed in this study at the 6-month follow-up assessment, prolonged maintenance interventions, possibly also involving parents, may provide the support required for lasting weight maintenance.

Although in-person cognitive-behavioral treatment for overweight adolescents seems to yield the strongest effect on weight loss,<sup>51</sup> Internet-facilitated programs may offer an effective means of preventing weight gain among adolescents at risk for overweight. Perhaps a focus on general meal size, eating control, and satiation is a more practical strategy than a program focused on weight loss for nonobese adolescents at risk of overweight. Emphasizing weight maintenance versus weight loss in the intervention's philosophy, language, and goal-setting might have allowed participants to set realistic expectations for behavior change, possibly minimizing disappointment and discouragement for participants who experienced gradual BMI changes, rather than marked decreases in BMI. Of note, this is one of the few programs to include a focus on training students to monitor satiation, with the goal of stopping eating when full. The food journal function asked participants to rate their hunger and satiety and to identify triggers for overeating. Overall, participants used the food journal slightly more than 1 time per week (mean: 21.4 entries; SD: 30.7 entries), which suggests that adolescents are reasonably interested in monitoring intake. In addition, a focus on lifestyle changes, positive body image, improving self-esteem and mood, and responding to teasing and negative sociocultural norms might have strengthened the overall effect of the intervention. The intervention was designed also to change other weight-related health indicators, including physical activity and fat and sugar intake. Reductions in self-reported dietary fat and sugar intake were reported in both groups. Unfortunately, the data reported for physical activity were unreliable and are not reported.

The inclusion of participants with a wide range of overeating behaviors, some with binge eating and some without, allowed the comparison of these 2 subgroups with respect to primary outcome variables. For the overall sample, there was no relationship between change in

TABLE 5 Primary Outcome Variables for Intention-to-Treat Analysis

	SB2-BED			WLC		
	Baseline	Posttreatment	Follow-up	Baseline	Posttreatment	Follow-up
BMI, mean ± SD, kg/m <sup>2</sup>	30.53 ± 5.17	29.22 ± 5.2	29.83 ± 5.3	31.03 ± 6.29	30.44 ± 6.69	31.47 ± 6.55 <sup>a</sup>
BMI z score, mean ± SD	1.79 ± 0.49	1.60 ± 0.58	1.61 ± 0.61	1.81 ± 0.52	1.68 ± 0.62	1.78 ± 0.57 <sup>b</sup>
Binge eating, mean ± SD, no. of episodes						
OBEs and SBEs	18.37 ± 22.63	7.44 ± 17.89	9.0 ± 19.45	8.27 ± 17.75	6.16 ± 16.10	3.20 ± 8.92 <sup>a</sup>
OOEs	8.75 ± 15.0	3.98 ± 11.25	3.69 ± 11.68	7.78 ± 13.89	3.63 ± 7.14	1.43 ± 0.92
Weight and shape concerns, mean ± SD, score	1.38 ± 0.84	1.10 ± 0.72	1.0 ± 0.82	1.43 ± 0.92	1.24 ± 0.76	1.25 ± 0.77
Dietary fat intake, mean ± SD, PACE+DFS score	24.02 ± 8.49	19.73 ± 7.15	18.51 ± 7.17	22.12 ± 10.57	20.0 ± 7.4	18.22 ± 8.07
Depressed mood, mean ± SD, CES-D score	16.62 ± 10.26	11.29 ± 9.76	12.35 ± 11.57	15.94 ± 10.49	13.22 ± 10.79	11.16 ± 11.05

CES-D indicates Center for Epidemiologic Studies Depression Scale; DFS, Dietary Fat Screening.

<sup>a</sup> *P* < .05, compared with the WLC group.

<sup>b</sup> *P* < .001, compared with the WLC group.

binge eating and change in BMI z score, which is consistent with other studies that demonstrated that similar amounts of weight loss could be achieved by individuals with and without binge eating.<sup>50</sup> However, SB2-BED participants who reported binge eating or overeating at baseline assessment experienced significantly greater reductions in BMI z score than did WLC subjects. This suggests that, whereas a combined intervention for binge eating and weight maintenance effectively stabilizes weight among adolescents with and without disordered-eating episodes, the combined intervention is particularly effective in preventing weight gain among participants with a history of binge eating and overeating. In fact, the effect of the intervention overall may be related to changes in binge eating. As mentioned, binge eating predicts weight gain in adolescents, the intervention was designed to reduce binge eating, and there was a significant change in binge eating. However, these findings need to be considered in light of the much higher binge eating rates at baseline assessment in the SB2-BED group, compared with the WLC group, and the fact that the reported reductions for both groups were large.

Some professionals suggest that weight loss programs increase attention to weight, thereby increasing the risk for eating disorders. The reduction in weight and shape concerns observed from baseline assessment to follow-up assessment suggests that the intervention was associated with reduction in risk factors for eating disorders (eg, weight and shape concerns and dietary restriction). These improvements may be a result of the inclusion of intervention components designed specifically to address eating disorder psychopathological conditions. This finding supports the conclusion that weight management programs that integrate key components of eating disorder prevention programs pose minimal risk for precipitating eating disorders in adolescents at risk for overweight<sup>28</sup> and may even reduce the risk of developing eating disorders.

Although this study found a strong effect for stabilization of weight gain and reduction in binge eating and overeating at 9-month follow-up assessment, an extended follow-up period would enhance the importance of the findings. In addition, comparison of the Internet-facilitated intervention and face-to-face intervention would provide a more-rigorous and clinically meaningful comparison. Given the significant differences between dropouts and completers in terms of ethnicity, depression, and weight and shape concerns, future studies are needed to examine the effects of matching participants to more-intensive, possible face-to-face interventions, based on demographic data and severity of psychopathological features or risk factors.

This study suggests that a short-term Internet-facilitated program can promote weight maintenance and reduce binge eating in motivated adolescents. It has the potential to be delivered in a variety of settings, including pediatric offices and schools, and to be incorporated into community-based programs.

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