

Using Internet Technology to Deliver a Behavioral Weight Loss Program

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DEVELOPING EFFECTIVE WEIGHT loss programs that are widely accessible is a health care priority given that more than 54% of US adults are overweight or obese¹ and that weight loss is recommended to reduce the health impact of obesity. Although group behavioral programs involving weekly clinic visits are the most effective treatments available for obesity, most adults would prefer to lose weight without having to participate in a structured face-to-face treatment program.² To accommodate the needs of these individuals and to make obesity treatment more accessible, investigators have explored alternative methods for delivering weight loss programs including mail-based correspondence programs³⁻⁵ interventions delivered via telephone⁶ and television.^{7,8} Although these types of programs have typically produced smaller weight losses than standard group behavioral programs, they offer an important alternative to face-to-face treatment.

In the past decade, computer-mediated interventions have been developed for a variety of behavior changes, including dietary change,^{9,10} smoking cessation,¹¹ and exercise¹²; however, few studies have been conducted using computers for the treatment of obesity. Initial research in this area focused on using hand-held computers for entry of self-monitoring data, to give automated feedback about caloric values and either provide praise for or instructions on modifying eating contingent on performance.^{13,14} Furthermore, research has not expanded or developed

Context Rapid increases in access to the Internet have made it a viable mode for public health intervention. No controlled studies have evaluated this resource for weight loss.

Objective To determine whether a structured Internet behavioral weight loss program produces greater initial weight loss and changes in waist circumference than a weight loss education Web site.

Design Randomized, controlled trial conducted from April to December 1999.

Setting and Participants Ninety-one healthy, overweight adult hospital employees aged 18 to 60 years with a body mass index of 25 to 36 kg/m². Analyses were performed for the 65 who had complete follow-up data.

Interventions Participants were randomly assigned to a 6-month weight loss program of either Internet education (education; n=32 with complete data) or Internet behavior therapy (behavior therapy; n=33 with complete data). All participants were given 1 face-to-face group weight loss session and access to a Web site with organized links to Internet weight loss resources. Participants in the behavior therapy group received additional behavioral procedures, including a sequence of 24 weekly behavioral lessons via e-mail, weekly online submission of self-monitoring diaries with individualized therapist feedback via e-mail, and an online bulletin board.

Main Outcome Measures Body weight and waist circumference, measured at 0, 3, and 6 months, compared the 2 intervention groups.

Results Repeated-measures analyses showed that the behavior therapy group lost more weight than the education group ($P=.005$). The behavior therapy group lost a mean (SD) of 4.0 (2.8) kg by 3 months and 4.1 (4.5) kg by 6 months. Weight loss in the education group was 1.7 (2.7) kg at 3 months and 1.6 (3.3) kg by 6 months. More participants in the behavior therapy than education group achieved the 5% weight loss goal (45% vs 22%; $P=.05$) by 6 months. Changes in waist circumference were also greater in the behavior therapy group than in the education group at both 3 months ($P=.001$) and 6 months ($P=.005$).

Conclusions Participants who were given a structured behavioral treatment program with weekly contact and individualized feedback had better weight loss compared with those given links to educational Web sites. Thus, the Internet and e-mail appear to be viable methods for delivery of structured behavioral weight loss programs.

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the use of this technology as stand-alone obesity treatment or as an adjunct to standard therapy. Computer based programs can easily be adapted for use via the Internet, which has renewed interest in using this technology for weight loss.

Rapid increases in access to the Internet and the World Wide Web has made it a viable and logical mode for public health intervention. The number of US adults who use the Internet

has surged from 9% to 56% of adults in the past 4 years.¹⁵ Conceptually, the Internet has distinct advantages for pro-

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gram delivery because it combines the essential characteristics of the other forms of media. For example, the Internet allows for dissemination of written material, video or photographic materials, and direct communication and social support via e-mail, bulletin boards, or chat rooms. There are numerous Internet sites offering weight loss information and providing such tools as databases of recipes or caloric values, diaries for recording consumption and exercise, and bulletin boards to offer support. Despite the proliferation of weight loss-related Web sites, no controlled studies have evaluated this type of resource for weight loss.

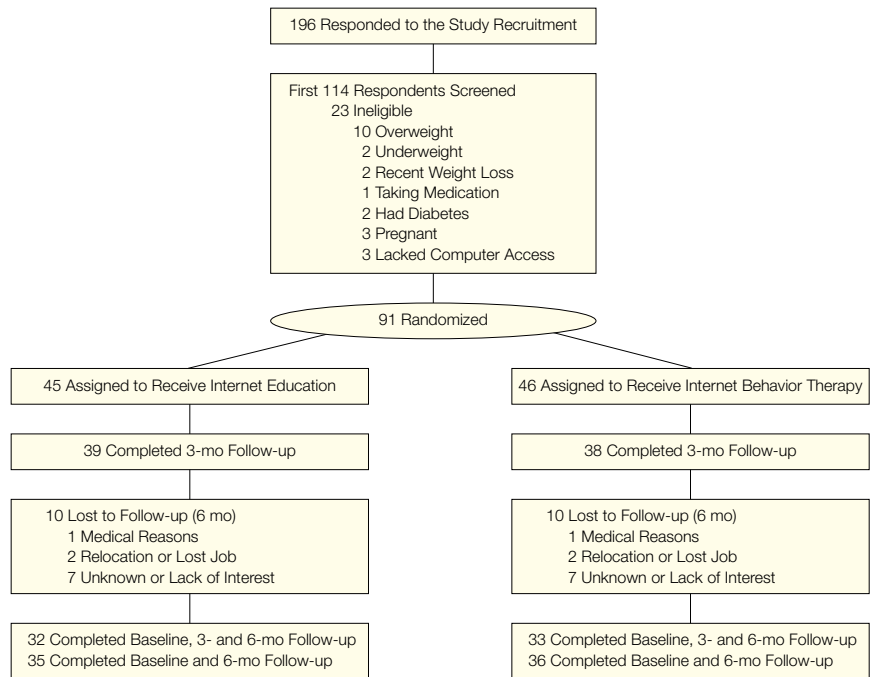
After review of numerous Web sites, it appeared that although much of the content of behavioral weight loss programs was covered on the Web, weight loss Web sites lacked the programmatic nature, structure, and professional contact that are essential elements of face-to-face clinic programs. We hypothesized that better weight loss might be produced by using the Internet to deliver a structured behavioral weight loss program including a sequence of 24 weekly lessons that taught behavioral principles related to weight loss, weekly submission of self-monitoring diaries, weekly recommendations from a therapist, and the opportunity for social support among group members. To test this hypothesis we conducted a randomized controlled trial to test the feasibility and initial efficacy of a structured Internet behavioral weight loss program compared with an educational Web site that was representative of weight loss resources widely available on the Internet.

METHODS

Participants

Ninety-one (81 women, 10 men) healthy overweight adults with a mean (SD) age of 40.9 (10.6) and body mass index (BMI) of 29.0 (3.0) kg/m², all employed by a large network of hospitals with access to e-mail and the Internet, were recruited through a series of 2 e-mail messages and an advertisement posted to the work site's Intranet Web

Figure 1. Participation Flow



site (FIGURE 1). The e-mail messages and advertisement clearly stated the eligibility criteria. Interested participants were further screened for eligibility via telephone. Eligibility criteria included persons aged 18 to 60 years and having a BMI of 25 to 36 kg/m². Participants were ineligible if they had a history of myocardial infarction, stroke, or cancer in the last 5 years; diabetes, angina, or orthopedic or joint problems that would prohibit exercise; major psychiatric diseases; and current, planned, or previous pregnancy within 6 months. All participants agreed not to seek additional weight loss treatment for 1 year. The screening also included the Physical Activity Readiness Questionnaire (PAR-Q).¹⁶ Eleven participants endorsed 1 or more items on the PAR-Q and were required to obtain physician consent to participate.

Design

Following initial screening, participants were randomly assigned to 1 of 2 treatment groups: Internet education (education; n=45) or Internet behavior therapy (behavior therapy;

n=46). All participants were seen at baseline, 3 and 6 months for objective weight and waist measurements and were paid \$10 and \$25 for attending the 3- and 6-month follow-up appointments, respectively. This study was conducted from April to December 1999 and was approved by the institutional review board of the Miriam Hospital in Rhode Island.

Procedures for Internet Education

All participants attended an initial introductory group weight loss session led by a doctoral-level clinical psychologist. At this meeting, baseline measurements and written informed consent were obtained. In addition, participants were taught Web site login procedures for this study. To ensure that all participants had a sufficient level of computer and Internet knowledge, the basics of navigation and login procedures were demonstrated on a computer. A detailed written guide outlining login procedures and Internet navigation was also given to each participant. To protect confidentiality, participants were given a login identifica-

tion code and weight data were transmitted and stored using this code rather than participant names; however, they were advised that the potential existed for data and e-mail messages to be intercepted and read.

The study Web site was accessible on the organization's Intranet and provided a brief review of basic information related to weight loss and an organized directory of selected Internet resources about diet, exercise, self-monitoring, and other resources that included behavioral topics including social support, stimulus control, and managing stress. During the introductory group session, participants received a 1 hour lesson on behavioral weight control. At this session, a standard calorie restriction diet of 1200 to 1500 kcals per day and daily fat intake of less than 20% of calories consumed was recommended. Participants were also instructed to increase gradually their physical activity to burn a minimum of 1000 kcals per week. The importance of self-monitoring was stressed and participants in both groups were encouraged to use the self-monitoring Web resources to keep track of their diet and exercise daily. However, only the behavior therapy group was asked to submit self-monitoring diaries to the therapist each week. All participants were contacted at 3 months and 6 months to schedule individual appointments for follow-up measurements and a brief 15 minute check-in with the clinical psychologist.

Procedures for Internet Behavior Therapy

Behavior therapy participants received all of the above plus the following procedures. They were instructed to report self-monitoring information each week via an electronic diary accessible on the study Web site. Weekly self-monitoring information included weight, calories, fat grams, and exercise energy expenditure. Along with submitting their diaries, participants were also able to submit any comments or questions they had to the therapist.

An e-mail message was sent to behavior therapy participants each week during the 24-week program including a behavioral weight loss lesson and feedback. The behavioral lesson included structured guidance about a variety of weight loss topics on nutrition, exercise, or behavioral self-regulatory strategies. In addition, each weekly e-mail included individualized feedback sent personally from the doctoral-level therapist. The feedback included recommendations and reinforcement based on progress noted in the self-monitoring diary and specifically addressed weight loss progress, dietary intake, and energy expenditure. Recommendations and strategies for improvement also were provided. In addition, the therapist answered any questions raised by participants and provided general support and encouragement via the e-mail message. Participants who did not send in a log were sent a personal e-mail inquiring about their progress and were encouraged to monitor and continue with the program. Participants in the behavior therapy group also had access to an electronic bulletin board to facilitate social support among participants assigned to this intervention.

Dependent Measures

The primary dependent measure was change in body weight. Weight was measured in the clinic at baseline, 3, and 6 months in light street clothing, without shoes, and on a calibrated scale. Height was measured using a wall-mounted stadiometer. The circumference at the waist (measured at the umbilicus) was measured with a Gulick steel tape measure using the procedure recommended by Lohman et al.¹⁷ Physical activity was measured at each assessment using a self-report format of the Paffenbarger activity questionnaire.¹⁸ Dietary intake was measured using the Block Food Frequency Questionnaire¹⁹ at baseline, 3, and 6 months and was analyzed using the National Cancer Institute Dietary Analysis System 4.01 software program. Depressive symptoms were measured using the Centers for Epidemiological Studies Depression Scale.²⁰ Use of the

Web site was tracked using a unique login identification code for each participant to record each login. An index of participants' previous experience with the Internet or e-mail was created by summing the number of months participants had used e-mail plus the number of months they had used the Internet.

Statistical Analysis

Using an α level of .05 and power of 80%, a sample size of 37 for each group was needed to detect a 2.27-kg difference between groups. Assuming an average attrition rate of 20%,²¹ a sample of at least 90 subjects was selected. To detect changes in the outcomes of weight, waist circumference, calorie intake, and expenditure, repeated-measures analysis of variance (ANOVA) models were used. All analyses were performed using the Statistical Package for the Social Sciences (SPSS for Windows version 10.05 SPSS Inc, Chicago, Ill).

RESULTS

A preliminary analysis showed that there were no differences between groups for baseline measures of age, weight, BMI, waist circumference, or Internet experience (TABLE 1). Attrition was 15% and 22% at 3 and 6 months, respectively, and did not vary by treatment group at either assessment (3 mo, $\chi^2=0.288$, $P=.59$; 6 mo, $\chi^2=0.003$, $P=.96$) (Figure 1). Participants who did not attend the 6-month follow-up were significantly younger ($t=-2.75$, $P<.007$) and had less e-mail or Internet experience at baseline but did not differ from attendees on baseline BMI, education, or level of depressive symptoms.

Changes in Body Weight and Waist Circumference

Analyses were conducted for the 65 participants with objective follow-up data at all 3 assessments (33 behavior therapy, 32 education). Repeated-measures ANOVA examining weight showed a significant treatment \times time interaction ($P=.005$) (FIGURE 2). Those in the behavior therapy group lost more weight than those in the education group from baseline to 3 months. Both

groups maintained their weight loss between 3 and 6 months but did not lose additional weight. Among these participants who completed all 3 assessments, the behavior therapy group lost mean (SD) 4.0 (2.8) kg by 3 months and 4.1 (4.5) kg by 6 months. Weight loss in the education group was 1.7 (2.7) kg at 3 months and 1.6 (3.3) kg by 6 months. Post hoc *t* tests showed that mean weight losses were significantly different between the groups at both 3 ($t=3.4$; $P=.001$) and 6 months ($t=2.1$; $P=.04$). In addition, 45% of participants in the behavior therapy group lost greater than or equal to 5% of initial body weight compared with 22% of those in the education group ($\chi^2=4.03$; $P=.05$).

Similarly, repeated-measures ANOVA examining changes in waist circumference between 0, 3, and 6 months showed a significant treatment \times time interaction ($P=.005$). Among those with all follow-up data, the mean (SD) waist circumference reduction in the behavior therapy group was 6.7 (4.7) cm at 3 months and 6.4 (5.5) cm by 6 months. In the education group, the mean (SD) waist circumference reduction was 3.0 (4.0) cm at 3 months and 3.1 (4.4) cm by 6 months. Post hoc *t* tests showed mean (SD) waist reductions were significantly different between the groups at both 3 months ($P=.001$) and 6 months ($P=.009$).

An intention-to-treat analysis was performed examining the pattern of weight change from baseline to 3 and 6 months, including all randomized participants using baseline weight for anyone with missing data at any follow-up period. Repeated-measures ANOVA on the pattern of weight loss showed a significant treatment \times time interaction ($P<.001$). In the intent-to-treat analysis, the education group lost a mean (SD) of 1.0 (2.4) kg at 3 months and 1.3 (3.0) kg by 6 months. Weight loss in the behavior therapy group was 3.2 (2.9) kg by 3 months and 2.9 (4.4) kg by 6 months. Post hoc *t* tests showed mean weight losses were significantly different between the groups at both 3 months ($P<.001$) and 6 months ($P=.04$). Within the intent-to-treat sample, χ^2 tests were

Table 1. Baseline Characteristics of Participants in Both Groups*

Variable	Internet Education (n = 45)	Internet Behavior Therapy (n = 46)
Sex		
Women	40 (89)	41 (89)
Men	5 (11)	5 (11)
Ethnicity		
White	35 (77.8)	41 (89)
Education		
High school	3 (7)	5 (11)
Some college	17 (38)	12 (26)
College degree	14 (31)	15 (33)
Graduate degree	11 (24)	14 (30)
Marital status		
Married	29 (64.5)	36 (78.3)
Separated/divorced	6 (13.3)	2 (4.3)
Never married	10 (22.2)	8 (17.4)
Age, mean (SD), y	40.6 (9.7)	41.1 (11.6)
Weight, mean (SD), kg	78.8 (11.6)	77.4 (9.4)
Body mass index, mean (SD), kg/m ²	28.9 (3.1)	29.1 (3.0)
Waist circumference, mean (SD), cm	98.4 (10.2)	98.5 (9.4)
Web or e-mail experience, mean (SD), mo	60.8 (43.7)	60.9 (47.4)

*Values are expressed as No. (percentage) unless otherwise indicated.

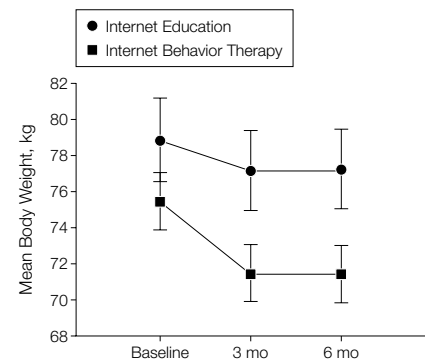
used to compare the proportion of participants in each group who lost at least 5% of initial body weight by 6 months. More participants in the behavior therapy group than in the education group achieved the 5% weight loss goal (35% vs 18%; $\chi^2=3.39$; $P=.07$).

Similarly, a repeated-measures ANOVA examining changes in waist circumference between 0, 3, and 6 months using the baseline waist measurement for those with missing follow-up data showed a significant treatment \times time interaction ($P=.004$). The mean (SD) waist reduction in the education group was 2.1 (3.9) cm at 3 months and 2.3 (3.9) cm by 6 months. In the behavior therapy group, mean (SD) waist reduction was 5.3 (4.9) and 4.6 (5.5), respectively. Post hoc *t* tests showed that mean waist reductions were significantly different between the groups at both 3 months ($P=.001$) and 6 months ($P=.02$).

Web Site Login Frequency

To obtain an objective measure of Web site use, login data for all participants were tracked over the 24-week period. Participants in the behavior therapy group logged in to the Web site a mean (SD) of 19 (10.9) times over the first 3 months compared with 8.5 (10.4) for

Figure 2. Patterns of Changes in Body Weight



Sixty-five participants in this analysis completed all 3 assessments. ($P=.005$). Error bars indicate SEM.

those in the education group ($P<.001$). Between months 3 and 6, logins decreased for both groups ($P<.001$); however, participants in behavior therapy group still logged in more often during this period—a mean (SD) of 6.8 (6.2) times compared with 1.0 (3.0) times among education participants ($P<.001$). Login frequency was significantly correlated with weight change between 0 and 6 months both in the behavior therapy ($r_s=-0.43$; $P=.003$) and in the education group ($r_s=-0.33$, $P=.03$).

Table 2. Mean Calories From Diet and Physical Activity of Internet Study Groups*

	Daily Dietary Intake, Mean (SD), kcal		Weekly Physical Activity, Mean (SD), kcal	
	Education (n = 30)	Behavior Therapy (n = 32)	Education (n = 28)	Behavior Therapy (n = 32)
Baseline	1757 (857)	1558 (654)	1031 (981)	1360 (1415)
3 mo	1256 (696)	1062 (395)	1500 (1513)	1903 (1757)
6 mo	1286 (564)	1146 (450)	1125 (1320)	1289 (919)

*Participants included in these analyses had data at all 3 assessments.

Changes in Dietary Intake and Exercise

Changes in dietary intake (kcal/d) at 0, 3, and 6 months were examined using repeated-measures ANOVA for those with dietary data at all 3 assessments (n=62). There was a significant time effect ($P<.001$) but no treatment \times time interaction ($P=.88$), indicating that both groups changed over time (TABLE 2). The change in dietary intake between baseline and 3 months was marginally associated with weight loss during the same period in the behavior therapy group ($r_s=0.28$, $P=.10$) but not in the education group ($r_s=0.02$, $P=.93$). Between months 3 and 6 the correlation between dietary change and weight change was similar in both groups but only reached significance in the education group (behavior therapy, $r_s=0.30$; $P=.10$ vs education, $r_s=0.38$; $P=.04$).

Changes in physical activity between 0, 3, and 6 months were examined using repeated-measures ANOVA for those with activity data at all 3 assessments (n=60). There was a significant time effect ($P=.03$) but no treatment \times time interaction. The change in physical activity between baseline and 3 months was associated with weight loss during the same period in the behavior therapy group ($r_s=-0.32$, $P=.05$) but not in the education group ($r_s=-0.05$, $P=.79$).

Behavior Therapy Only

The behavior therapy group was asked to send in a self-monitoring diary each week. Participants submitted a mean (SD) 13.65 (6.4) of self-monitoring diaries during the 24-week program. Participants submitted more diaries during the first 3 months than in the latter 3 months (8.5 [3.6] vs 4.6 [4.4]). Diary

submissions represented 46% of the total number of logins. Total number of diaries submitted was significantly correlated with weight loss ($r_s=-0.50$, $P=.001$). Only 28% ever posted a note to the bulletin board with a range of 1 to 7 postings per person over the 6 months.

COMMENT

This study showed that participants who received a more structured Internet behavior therapy intervention, including weekly e-mail contact, lost significantly more weight and showed greater reductions in waist circumference at 3 and 6 months than those who received access to numerous weight loss Web sites. Moreover, the behavior therapy program was effective in almost doubling the percentage of participants who achieved a 5% weight loss goal. Weight loss treatment goals of between 5% and 10% of initial body weight have been recommended based on substantial evidence that many obesity-related conditions are improved with weight losses of this magnitude.²²⁻²⁴

The pattern of weight losses in this program were essentially the same for both groups and suggest that the weight losses occurred in the first 3 months. Encouragingly, participants maintained their weight losses, on average, rather than showing regain during months 3 and 6. This maintenance was observed despite decreased login frequency from months 3 through 6 in both groups and diary submissions in the behavior therapy group. Both logins and diary submissions were related to weight loss suggesting that if adherence to the program could be improved and extended beyond 3 months, weight losses might also continue.

Attrition is also a substantial problem in many minimal-contact intervention^{25,26} studies and work-site programs. In our study, attrition was 15% at 3 months and 22% at 6 months and did not vary by treatment group. These rates are lower than several other minimal-contact interventions and considerably lower than that reported for other work-site weight loss programs.^{27,28} The differences between the behavior therapy and education groups were statistically significant when those participants who attended all assessments were examined and when an intent-to-treat analysis was used.

Weight losses achieved in the behavior therapy group are better than losses achieved with other minimal interventions^{5,29,30} and are comparable with those achieved in recent evaluation of a structured commercial program.³¹ Although our study did not include a face-to-face program as a comparison group, weight losses in this study were not as good as are seen in the research literature on standard behavioral weight loss programs. Such programs involving weekly face-to-face contact typically produce 9.1-kg weight losses in 20 to 24 weeks. As noted above, procedures to promote sustained use of the Web resources and continued diary submission might improve weight losses; however, the advantage of Internet weight loss programs may be in increasing the audience and the reach of treatment programs. These types of programs might not produce weight losses that rival face-to-face programs.

Participants in both the behavior therapy and education groups reported changes in diet and exercise behaviors of similar magnitude despite significantly different weight losses. Other studies with significant between-group differences in weight loss have also failed to find differences on self-reported dietary and exercise measures.^{32,33} Despite the lack of difference detected by the measures used in this study, the only explanation for differences in changes in body weight and waist circumference is differential changes in either 1 or both of these behaviors.³⁴ The inability

ity to detect differences in eating and exercise between the groups may reflect difficulty of accurately measuring these behaviors. It is also probable that participants in the behavior therapy group became more accurate in their estimation of dietary intake and exercise because they were self-monitoring intake and activity; hence, there was a greater association between behavior changes and weight change in this group.

The major strength of our study is that it was a randomized trial with objective weight and waist measurements and was the first study to examine using Internet technology to deliver a structured behavioral weight loss program. The primary limitation of our study is that these results are for initial weight loss. The efficacy of a program such as this for producing longer-term weight losses and maintenance remains to be demonstrated. Further studies with larger samples including equal numbers of men and women are needed to replicate these findings. Furthermore, as this study was an initial feasibility and efficacy trial, the design does not allow for dismantling of the behavior therapy program to determine the critical components of this intervention. Certainly, continued contact has been a critical element of weight loss programs and other behavior-change programs. The difference in contact between conditions may be responsible for the differences in weight loss. Future studies could examine the effects of different types of contact on weight loss using the Internet and e-mail. Finally, it should be noted that participants in behavior therapy group had met face-to-face with the therapist that they had been corresponding with weekly by e-mail. Other Internet programs using exclusively e-mail or online communications without an initial face-to-face meeting may produce different results.

In summary, the results of this study showed that a treatment program that included access to Internet weight loss resources, structured behavioral components, weekly contact, and individualized therapist feedback, delivered via e-mail, produced better initial weight losses compared with providing access

to Internet weight loss resources alone. Thus, the Internet appears to be a viable method for delivery of structured behavioral weight loss programs deserving of future research.

Author Contributions:

Study concept and design: Tate, Wing, and Winett.
Acquisition of data: Tate.

Analysis and interpretation of data: Tate, Wing, and Winett.

Drafting of the manuscript: Tate, Wing, and Winett.
Critical revision of the manuscript for important intellectual content: Tate and Wing.

Statistical expertise: Tate and Wing.

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