

Effects of Internet Behavioral Counseling on Weight Loss in Adults at Risk for Type 2 Diabetes

A Randomized Trial

Deborah F. Tate, PhD

Elizabeth H. Jackvony, MPH

Rena R. Wing, PhD

BEHAVIORAL WEIGHT LOSS INTERVENTIONS markedly reduce the risk of developing diabetes, and recent studies suggest that new approaches to prevention are needed.¹⁻³ In the Diabetes Prevention Program (DPP), a behavioral weight loss program produced a 58% reduction in diabetes incidence after 2.8 years. The DPP involved substantial individual face-to-face counseling; such an intensive intervention may be impractical to treat the large number of at-risk individuals.⁴ Consumers also desire alternatives to face-to-face treatment,⁵ creating a need for effective behavioral interventions requiring less face-to-face contact.

The Internet offers opportunities to develop behavioral change interventions minimizing face-to-face interaction. It has been used for diabetes education and self-management,^{6,7} and we have used the Internet to deliver a behavioral weight loss program with favorable short-term results.⁸ However, the efficacy of Internet-based weight loss programs and specifically e-mail counseling has not been used in a population at risk of diabetes nor evaluated for a year-long weight loss intervention.

METHODS

Participants

The 92 participants in our study were recruited through newspaper advertise-

Context Weight loss programs on the Internet appear promising for short-term weight loss but have not been studied for weight loss in individuals at risk of type 2 diabetes; thus, the longer-term efficacy is unknown.

Objective To compare the effects of an Internet weight loss program alone vs with the addition of behavioral counseling via e-mail provided for 1 year to individuals at risk of type 2 diabetes.

Design, Setting, and Participants A single-center randomized controlled trial conducted from September 2001 to September 2002 in Providence, RI, of 92 overweight adults whose mean (SD) age was 48.5 (9.4) years and body mass index, 33.1 (3.8).

Interventions Participants were randomized to a basic Internet (n=46) or to an Internet plus behavioral e-counseling program (n=46). Both groups received 1 face-to-face counseling session and the same core Internet programs and were instructed to submit weekly weights. Participants in e-counseling submitted calorie and exercise information and received weekly e-mail behavioral counseling and feedback from a counselor.

Main Outcome Measures Measured weight and waist circumference at 0 and 12 months.

Results Intent-to-treat analyses showed the behavioral e-counseling group lost more mean (SD) weight at 12 months than the basic Internet group (-4.4 [6.2] vs -2.0 [5.7] kg; $P=.04$), and had greater decreases in percentage of initial body weight (4.8% vs 2.2%; $P=.03$), body mass index (-1.6 [2.2] vs -0.8 [2.1]; $P=.03$), and waist circumference (-7.2 [7.5] vs -4.4 [5.7] cm; $P=.05$).

Conclusion Adding e-mail counseling to a basic Internet weight loss intervention program significantly improved weight loss in adults at risk of diabetes.

JAMA. 2003;289:1833-1836

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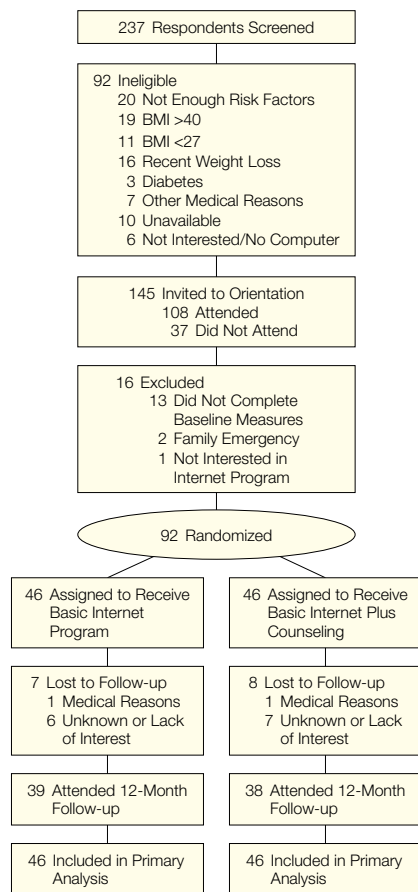
ments and were drawn from a waiting list at our research center (FIGURE 1). Eligibility criteria included access to a computer, being overweight or obese (body mass index [BMI], 27-40), and 1 or more other risk factors for type 2 diabetes.⁴ (BMI is calculated as weight in kilograms divided by the square of height in meters).

Participants with major health or psychiatric diseases, pregnancy, or recent weight loss of 4.5 kg or more were excluded. Physician consent was required from individuals endorsing any

items on the Physical Activity Readiness Questionnaire (PAR-Q)⁹ or taking medications that might be affected by weight loss (n=44). Participants attended a face-to-face orientation and completed baseline measurements including fasting plasma glucose to screen for diabetes. One participant had fast-

Author Affiliations: Brown University School of Medicine/Miriam Hospital, Providence, RI.

Corresponding Author and Reprints: Deborah F. Tate, PhD, Brown University School of Medicine/Miriam Hospital, Weight Control and Diabetes Research Center, 14 Third St, RISE Bldg, Providence, RI 02906 (e-mail: dtate@lifespan.org).

Figure 1. Flow Diagram

BMI indicates body mass index, which is calculated as weight in kilograms divided by the square of height in meters.

ing plasma glucose greater than 126 mg/dL (>6.9 mmol/L), confirmed on retest, and was ineligible.

Design

The protocol was approved by the institutional review board at Miriam Hospital, RI, and written informed consent was obtained from all participants. Following completion of baseline measurements, participants were randomly assigned following simple randomization procedures (computerized random numbers) to 1 of 2 treatment groups: 46 to the basic Internet weight loss program (basic Internet) and 46 to the Internet weight loss program plus behavioral e-counseling (behavioral e-counseling). Participants were seen at

baseline and at months 3, 6, and 12 months for measurement of weight, waist circumference, and fasting blood glucose and were paid \$10 to \$25 for attending the respective assessments.

All participants attended a 1-hour introductory group weight loss session. Internet navigation and login procedures were demonstrated on a computer and participants were provided with a written guide. To protect confidentiality, the study Web site was password protected, participants were given a login identification code, and weight data were transmitted via a Web-based form and stored on a secure server without participant names. Participants were advised of potential breaches in confidentiality during data transmission and e-mail communications and limits to confidentiality were disclosed in the consent form.

During the introductory session, participants received standard behavioral weight-control instruction on diet, exercise, and behavior change.¹⁰ Recommendations included a calorie restricted diet of between 1200 and 1500 kcal/d, fat intake of 20% or fewer calories, and a minimum of 1000 kcal/wk of physical activity (equivalent to walking 10 miles/wk). All participants were encouraged to self-monitor their daily diet and exercise using diaries and calorie books provided.

Basic Internet Program

The study Web site provided a tutorial on weight loss, a new tip and link each week, and a directory of selected Internet weight loss resources. Each group had a separate message board to prevent contamination. Each week, all participants received an e-mail reminder to submit his/her weight and received weight loss information.

Internet Behavioral e-Counseling

Participants in behavioral e-counseling underwent the same procedures as the basic Internet group plus they communicated via e-mail with their assigned weight loss counselor. Counselors had master's or doctoral degrees in health education, nutrition, or psychology and

did not know participants prior to the study. Participants were instructed to report calorie and fat intake, exercise energy expenditure, and any comments or questions for the therapist via a Web-based diary. Participants were instructed to submit daily diaries for the first month and were given the option of submitting daily or weekly thereafter. During the first month, the therapist e-mailed participants 5 times each week. Therapists sent weekly e-mails for the remaining 11 months. Counselor e-mails provided feedback on the self-monitoring record, reinforcement, recommendations for change, answers to questions, and general support. Participants who did not report were sent a personal follow-up e-mail.

Dependent Measures

The primary dependent measure was change in body weight from baseline to 12 months. Weight was measured in the clinic at baseline and at months 3, 6, and 12 in a hospital gown, without shoes, on a calibrated scale. Height was measured using a wall-mounted stadiometer. Waist circumference was measured at the umbilicus.¹¹ Venous blood glucose was measured after an overnight fast and analyzed by an independent laboratory. Patients also completed the Paffenbarger activity questionnaire,¹² the Block Food Frequency questionnaire (version 1998),¹³ and the Centers for Epidemiological Studies Depression Scale.¹⁴ An index of prior Internet or e-mail experience was created by summing months of e-mail and Internet use.

Statistical Analysis

Unless noted, all analyses followed an intent-to-treat principle using all randomized participants and assuming no change from baseline for those with missing data. Changes in weight, waist circumference, dietary intake, and energy expenditure were examined separately using repeated measures analysis of variance (ANOVA) when assumptions of the ANOVA were met and nonparametric tests when key assumptions were violated. All analyses were performed using the Statistical

Package for Windows version 11 for the Social Sciences (SPSS, Chicago, Ill).

RESULTS

The 2 study groups did not differ on key baseline measures (TABLE). The 82 women and 10 men were a mean (SD) age of 48.5 (9.4) years and had a BMI of 33.1 (3.8). Numbers of those with the included risk factors are age 45 years or older, 66 (72%); family history of diabetes, 42 (46%); high cholesterol levels or blood pressure, 29 (32%); impaired glucose tolerance, 6 (7%); history of gestational diabetes, 8 (9%); being delivered of a neonate weighing 4 kg or more, 20 (22%); or belonging to a minority group, 10 (11%). Sixty-three participants (69%) reported 3 or more risk factors for type 2 diabetes. Eighty-four percent (n=77) of randomized participants attended the 12-month assessment; attendance did not vary by treatment group ($\chi^2=0.08$; $P=.78$; Figure 1). Participants who did not attend the 12-month follow-up reported expending significantly fewer calories in physical activity at baseline ($t=-2.97$, $P=.005$) but did not differ otherwise from attendees at baseline.

The intent-to-treat analysis at 12 months showed that behavioral e-counseling group had greater reductions in weight (-4.4 [6.2] vs -2.0 [5.7] kg; 95% confidence interval for difference [CI], -0.1 to 4.9; $\chi^2=4.4$, $P=.04$), percentage of initial body weight (4.8% vs 2.2%, $\chi^2=4.8$; $P=.03$), body mass index (-1.6 [2.2] vs -0.8 [2.1]; 95% CI for difference, -0.04 to 1.8; $\chi^2=4.7$, $P=.03$), and waist circumference (-7.2 [7.5] vs -4.4 [5.7] cm; $F=4.0$; 95% CI for difference, 0.02 to 5.6; $P=.05$) compared with the basic Internet group.

The pattern of weight change is shown in FIGURE 2. Weight change for the 77 participants who completed the 12-month follow-up followed a similar pattern with larger mean (SD) weight losses in the behavioral e-counseling group at 3 months (-4.1 [3.7] vs -2.7 [3.3] kg; $P=.04$), 6 months (-5.2 [5.4] vs -2.5 [4.7] kg; $P=.007$), and 12 months (-5.3 [6.5] vs -2.3 [6.1] kg; $P=.03$). The analysis of fasting plasma glucose showed no

differences between groups at 12 months ($P=.93$); however, reduction in glucose was significantly greater in behavioral e-counseling after 3 months (-4.6 [7.9] vs -0.3 [8.4] mg/dL [-0.26 {0.44} vs -0.02 {0.47} mmol/L]; $t=2.5$; $P=.01$) corresponding to the initial weight loss period.

Both groups reported significant reductions in caloric intake between 0 and 12 months ($F=21.734$, $P<.001$). The behavioral e-counseling group reduced percentage of calories consumed from fat by 4% compared with 1% reduction in the basic Internet group from 0 to 12 months ($F=3.6$; $P=.06$). The respective mean (SD) increase in exercise energy expenditure of the groups did not differ from 0 through 12 months (342 [945] vs 63 [1211] kcal; $P=.26$). Changes in exercise followed the same pattern as blood glucose with between-group differences on increases in energy expenditure at 3 months only (446 [789] vs 38 [674] kcal, respectively; $P=.02$).

Logins to the Web site were significantly greater in the behavioral e-counseling group at all times (FIGURE 3; $P<.05$). Logins were significantly correlated with weight change between 0 and 12 months in both groups (behavioral e-counseling, $r=-0.47$; $P=.003$; basic Internet, $r=-0.61$, $P<.001$). Logins during the first 3 months of the program were significantly lower in those participants who did not attend the 12 month follow-up compared with those who completed the program ($t=5.0$, $P<.001$).

COMMENT

The impact of the DPP lifestyle intervention on preventing diabetes has made dissemination of behavioral interventions a priority. This study showed that for individuals at risk of type 2 diabetes, an Internet weight loss program with behavioral e-counseling produced significantly more weight loss and greater reductions in waist circumference at 1 year than the same basic program without behavioral e-counseling. The addition of e-counseling doubled the percentage of initial body weight lost. The weight loss observed in the behavioral e-counseling group at 12 months is en-

Table. Baseline Characteristics*

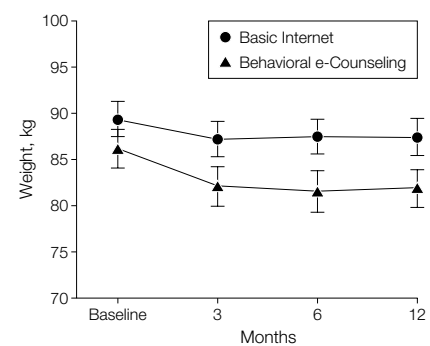
Variable	Basic Internet (n = 46)	Behavioral e-Counseling (n = 46)
Women, No. (%)	41 (89)	42 (91)
White, No. (%)	41 (89)	41 (89)
Education, No. (%)		
High school	7 (15)	7 (15)
Some college	17 (37)	15 (33)
College degree	14 (31)	12 (26)
Graduate degree	8 (17)	12 (26)
Marital status, No. (%)		
Married	38 (82.6)	33 (72)
Divorced	4 (8.7)	8 (17)
Widowed or never married	4 (8.7)	5 (11)
Age, y	47.3 (9.5)	49.8 (9.3)
Weight, kg	89.4 (12.6)	86.2 (14.3)
BMI	33.7 (3.7)	32.5 (3.8)
Waist circumference, cm	111 (11.7)	108 (12.4)
Fasting blood glucose, mg/dL	95.5 (8.2)	98.9 (9.9)
Web/e-mail experience, mo	80 (58)	87 (71)
Weekly Internet use, h	3.8 (4.9)	5.1 (5.5)
Dietary intake, kcal/d	2278 (934)	1982 (1174)
Fat intake, % of calories/d	38.5 (6.6)	38.6 (7.2)
Energy expenditure, kcal/wk	803 (1015)	886 (832)

Abbreviations: BMI, body mass index, which is calculated as weight in kilograms divided by the square of height in meters.

Conversions: To convert fasting blood glucose from mg/dL to mmol/L, multiply by 0.0555.

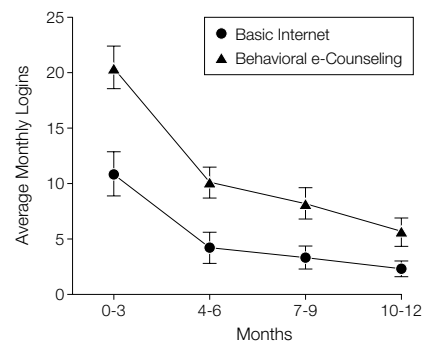
*Values are expressed as mean (SD) unless otherwise indicated.

Figure 2. Pattern of Change in Body Weight



Each data point represents the mean value for all participants randomized with missing data assuming no change from baseline ($P<.05$ at 3, 6, and 12 months). Error bars indicate SEM.

couraging because weight losses of similar magnitude (4.1 kg in DPS and 6.4 kg in DPP)^{2,3} are known to reduce risk for diabetes. Outcomes achieved in our study with only 1 in-person meeting are comparable to prior results,^{2,3,15} suggesting that Internet behavioral programs may

Figure 3. Login Frequency

$P < .05$ at all times. Error bars indicate SEM.

offer an alternative to more burdensome clinic programs.

We previously reported that an Internet behavior therapy program produced greater weight loss at 6 months than an Internet educational program⁸ but were unable to determine if therapist contact was a key component of the overall program. This is critical information for evaluating the public health application of the Internet given the expense of the counselors. Results from our study suggest that therapist contact improves 1-year efficacy.

Future research should explore the optimal use of Internet communications for promoting weight loss and maintenance. From a public health perspective, it is important to determine whether an expert system providing automated feedback contingent on predetermined criteria produces weight loss. Future studies are also needed to improve long-term efficacy of Internet programs that produce less weight loss than group face-to-face treatment and to determine the optimal combination of Internet and face-to-face modalities.¹⁶

The major strength of this study is that it was a randomized trial with objective measurements after 12 months of Internet treatment in an at-risk population. This study used an easy way to identify a high-risk population appropriate for weight-loss intervention by selecting overweight individuals with an additional diabetes risk factor rather than screening for impaired glucose tolerance. In addition, this study demonstrates that

Internet interventions can be used for longer periods; a necessary model for treatment of chronic diseases.

The limitations of our study include relatively small sample size, no follow-up beyond 1 year, and no data on whether weight losses achieved in this study reduce diabetes incidence. In addition, participants were predominantly white, were college educated, and were required to have computer access, which are characteristics that may reflect the fact that computer access is more available to those with higher income. It is also likely that adults interested in computer communications self-selected into our program. This study confirmed that older adults and novice computer users can benefit from interactive technology interventions.^{17,18} Neither prior Internet experience nor average hours of Internet use at baseline were related to outcome. Although participants were advised during the consent process of the risks to confidentiality in receiving e-mail counseling, future studies may need to provide additional safeguards such as encrypted e-mail, an e-mail anonymizer, or password restricted access to a database in which messages are stored without identifying information.

In summary, the results of this study showed that an Internet weight loss program with weekly e-mail counseling produced an average weight loss of 4.4 kg after 1 year among adults at risk of type 2 diabetes. The addition of e-mail behavioral counseling doubled the percentage of initial body weight lost compared with an Internet intervention without individualized therapist guidance. Thus, Internet interventions involving weekly behavioral e-counseling have the potential for producing behavioral changes and weight loss, which may help reduce risk for type 2 diabetes.

Author Contributions: Study concept and design: Tate, Wing.
Acquisition of data: Tate, Jackvony.
Analysis and interpretation of data: Tate.
Drafting of the manuscript: Tate, Jackvony.
Critical revision of the manuscript for important intellectual content: Tate, Wing.
Statistical expertise: Tate.
Obtained funding: Tate, Wing.

Administrative, technical, or material support: Jackvony.

Study supervision: Tate, Wing.

Funding/Support: This study was supported by a Clinical Research Award from the American Diabetes Association (Dr Tate).

Disclaimer: The Internet programs described in this article are not commercially available and the authors hold no financial interest therein.

Acknowledgment: We thank H. Sylvia, D. DeMaio, P. Coward, and A. Francis for their assistance with the conduct of this study and Drs A. Gorin, S. Phelan, and W. Lang for their helpful suggestions on the manuscript.

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