Maintaining Large Weight Losses: The Role of Behavioral and Psychological Factors

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Abstract

Few studies have examined predictors of weight regain after significant weight losses. This prospective study examined behavioral and psychological predictors of weight regain in 261 successful weight losers who completed an 18-month trial of weight regain prevention that compared a control condition with self-regulation interventions delivered face-to-face or via the Internet. Linear mixed effect models were used to examine behavioral and psychological predictors of weight regain, both as main effects and as interactions with treatment group. Decreases in physical activity were related to weight regain across all 3 groups, and increased frequency of self-weighing was equally protective in the 2 intervention groups but not in the control group. Increases in depressive symptoms, disinhibition, and hunger were also related to weight regain in all groups. Although the impact of changes in restraint was greatest in the Internet group and weakest in the face-to-face group, the latter was the only group with increases in restraint over time and consequent decreases in magnitude of weight regain. Future programs should focus on maintaining physical activity, dietary restraints, and frequent self-weighing and should include stronger components to modify psychological parameters.

Long-term maintenance of weight loss is a major problem in the treatment of obesity. Although initial weight losses have improved over time (Wadden, Butryn, & Byrne, 2004), participants still regain significant amounts of weight. To date, most of the research analyzing predictors of weight regain has been done in the context of behavioral weight control programs, in which weight losses average 10 kg at 6 months and approximately 55% of participants lose ≥5% and 29% of participants lose ≥10% of their initial body weight (Wadden et al., 2005).

Fewer studies have addressed predictors of weight regain after more significant weight losses. A recent analysis using the National Health and Nutrition Examination Survey database included 1,310 individuals who had lost at least 10% of their body weight (Weiss, Galuska, Khan, Gillespie, & Serdula, 2007). Weight regain of >5% over the next year (vs. weight loss or weight maintenance) was associated with being of Mexican American ethnicity, losing a greater percentage of maximum weight, having fewer years since maximum height was reached, reporting greater daily screen time, attempting to control weight, and being sedentary or not meeting the public health recommendations for physical activity. The National Weight Control Registry (NWCR) examined weight regain in individuals (sample ranging from $N = 714$ to $N = 3{,}003$) who reported an initial weight loss of at least 30 lb (13.5 kg; $M = 67$ lb, or 30.2 kg) and kept it off for at least 1 year ($M = 5.7$ years; Butryn, Phelan, Hill, & Wing, 2007; McGuire, Wing, Klem, Lang, & Hill, 1999; Raynor, Phelan, Hill, & Wing, 2006). Key predictors of weight regain in this sample included the following variables: larger initial percent weight loss, shorter duration of weight loss maintenance, psychological variables (baseline levels of disinhibition and depressive symptoms and changes in restraint, hunger, and disinhibition), and behavioral variables (changes in physical activity, dietary fat intake, self-weighing, TV viewing; Butryn et al., 2007; McGuire et al., 1999; Raynor et al., 2006). These prior studies are limited by the use of self-report measures of body weight, so further research assessing a comprehensive set of variables that might be associated with objectively measured weight regain in those who have lost a substantial amount of weight is clearly needed.

STOP Regain was an 18-month controlled trial involving individuals who had lost at least 10% of their body weight ($M = 20\%$) within the past 2 years (Wing, Tate, Gorin, Raynor, & Fava, 2006). These participants were randomly assigned either to a control group or to a self-regulation intervention delivered face-to-face or via the Internet. We have reported that the face-to-face intervention was effective in reducing the magnitude of weight regain and that both the face-to-face intervention and the Internet program reduced the proportion of individuals who regained >5 lb (>2.3 kg) over the 18 months (Wing et al., 2006). In this study, we examined the association between baseline, 6-, 12-, and 18-month behavioral and psychological factors and magnitude of weight regain and sought to determine whether the variables associated with success differed by treatment group.

Method

Participants

Participants in STOP Regain were required to have lost ≥10% of their body weight within the past 2 years using any nonsurgical approach. They were recruited through newspaper advertisements, brochures, and contact with commercial and research weight-control programs in the Rhode Island area. The magnitude and timing of weight loss were verified in writing by a physician, friend, or weight loss counselor. Exclusion criteria included serious medical or psychological disorders, pregnancy, or a planned move. A total of 314 participants entered the trial. Although 18-month weight data were obtained on 291 (93%) of these participants, full questionnaires were available on just 261 individuals (83%), who form the sample for the present analysis. These 261 study completers were predominantly female (82%) and Caucasian (98%) and had an average age of 51.2 ± 10.2 years. They had lost an average of 18.2 ± 7.4% (17.9 ± 10.4 kg) of body weight from their lifetime maximum weight and had a current body mass index of 28.5 ± 4.8 kg/m^2. They did not differ from the remaining 53 participants on any of the baseline variables, including

body mass index (28.5 ± 4.8 vs. 29.5 ± 4.4 kg/m^2, p = .16), with one exception: Noncompleters were heavier at baseline (81.9 ± 16.9 vs. 76.8 ± 15.8 kg, p = .04).

Study Design

Participants were stratified according to the amount of weight loss they had achieved prior to the study (10%–20% vs. >20% of body weight) and were then randomized to a control group that received quarterly newsletters or to either an Internet or a face-to-face intervention group. Participants were assessed at baseline, 6, 12, and 18 months and were paid $25 for attending the 6- and 12-month sessions and $50 at 18 months. The protocol was approved by the Miriam Hospital Institutional Review Board.

Intervention

The face-to-face and Internet interventions included identical content and differed only in the mode of presentation (Wing et al., 2006). The interventions were based on self-regulation theory (Kanfer & Goldstein, 1975) and included four initial weekly meetings followed by monthly meetings for the remainder of the 18 months. Members of both groups were taught to weigh themselves daily and to use the information from the scale to determine if changes in eating and exercise behaviors were needed. Participants submitted their weight weekly (via phone or Web-based form) and were provided with monthly token reinforcers if they were within 1.4 kg of their starting weight. Participants were taught to problem solve if they gained 1.4–2.2 kg and to restart their weight loss efforts if they gained ≥2.3 kg. Those who gained ≥2.3 kg were offered additional counseling (via e-mail for the Internet group and in person or by phone for the face-to-face group). Lessons were presented by the same staff across the two conditions, either in face-to-face classes or in Internet chat rooms. The lessons focused on issues related to maintenance of weight loss and recommended strategies that NWCR members had used successfully to maintain their weight loss (e.g., exercising 60 min per day).

Assessments

Assessments were completed by blinded staff and included the following measures.

Weight/height

Weight was assessed with a calibrated scale when the participants were dressed in light street clothes without shoes. Height was measured with a stadiometer at baseline, and this measure was used to compute body mass index.

Paffenbarger Questionnaire

The Paffenbarger Questionnaire (Paffenbarger, Wing, & Hyde, 1978) was completed to indicate the number of stairs climbed, blocks walked, and sports activity performed during the previous week. This questionnaire is scored to determine total energy expenditure (kcal/week expended) and has been shown to relate to weight loss maintenance in a variety of prior studies (Jeffery & French, 1999; Jeffery, Wing, Sherwood, & Tate, 2003; McGuire et al., 1999).

Block Food Frequency Questionnaire

The Block Food Frequency Questionnaire (Block et al., 1986) asks about portion size and frequency of consumption of commonly consumed food items. It is scored to indicate total calories and percentage of calories from fat, protein, and carbohydrates.

Eating Inventory

Restraint (degree of conscious control over eating), disinhibition (susceptibility to loss of control over eating), and hunger (susceptibility to eat in response to hunger) were assessed with the Eating Inventory (Stunkard & Messick, 1985).

Depressive symptomology

Depressive symptomatology was assessed with the Beck Depression Inventory (BDI; Beck & Steer, 1987).

Frequency of weighing

Participants were asked to indicate on a 7-point scale how frequently they had weighed themselves during the past several months. Their answers, which ranged from several times a day to never, were recoded with higher numbers representing more frequent self-weighing (1 = *never*, 2 = *less than once per month*, 3 = *less than once per week*, 4 = *one time per week*, 5 = *several times per week*, 6 = *one time each day*, 7 = *several times per day*).

Statistical Analysis

All statistical analyses were conducted with linear mixed effects models, as implemented in Splus 8.2 (Insightful Corporation, 2007). We estimated longitudinal weight change trajectories by jointly analyzing all three follow-ups (6-month, 12-month, and 18-month data) using a random intercept model to accommodate within-subject correlation across time. Weight change at follow-up was regressed upon its own baseline, time, treatment arm, demographic information, and baseline values of behavioral and psychological variables. Baseline demographic variables were retained in the model irrespective of the statistical significance of the respective regression coefficients, in order to allow estimation of longitudinal trajectories tailored to these particular participant characteristics. Possible interactions of time with time-invariant covariates (e.g., treatment group, demographics, baseline values of behavioral and psychological variables) were examined with forward selection. Subsequently, main effects of time-varying covariates (e.g., change in behavioral and psychological variables) and their interactions with treatment arm were added to the model, in order to determine which variables were related to successful weight loss maintenance.

We standardized all continuous variables by subtracting off their baseline mean and dividing by their baseline standard deviation, using values listed in Table 1. Therefore, effect sizes in the original measurement scale can be obtained by multiplying the standardized regression coefficients reported in Tables 2 and 3 by the baseline standard deviations listed in Table 1. Study group (N = newsletter, F = face-to-face, I = Internet) was coded with the control arm N as the reference group, and contrasts are given by (F − I)/2 (i.e., the difference between the active treatment arms) and (F + I)/2 − N (i.e., the difference of the average of the two active treatment arms from the control arm). Time was coded as 0, 1, 2 respectively at the 6-month, 12-month, and 18-month follow-ups, and gender was coded as a binary indicator (0 = female, 1 = male).

In this parameterization, the intercept represents weight regain among typical female newsletter recipients during the first 6 months of follow-up, whereas terms involving time represent either the rate of weight regain from 6 to 18 months (time slope) or the time-varying effects of baseline covariates upon weight regain rates (Time × Covariate interactions). Similarly, terms involving treatment effects represent between-arms differences in either the overall intercept (group main effects) or the slope of time-varying covariates (Group × Covariate interactions). Once the statistical significance of particular between-groups differences was established, we evaluated these differences further by constructing group-specific estimates of the respective regression coefficients. Given our choice of treatment contrasts, these were constructed from the model output depicted in Table 2, using the relations F = N + [(F + I)/2 − N] + (F − I)/2 and I = N + [(F + I)/2 − N] − (F − I)/2. Results are shown in Table 3.

Results

Baseline Variables as Predictors

None of the baseline values of the behavioral or psychological variables of interest were predictive of outcome at any follow-up point, and, thus, they were dropped from the model. Moreover, the demographic (age, gender) and weight-related variables at baseline (baseline weight, percent weight loss from maximum, and time since onset of >10% weight change) were not related to rates of weight regain from 0 to 6 months. However, weight regain from 6 to 18 months was greater among those who were heavier at baseline ($p = .0004$) and those who had lost more weight before entering the program ($p < .0001$).

Changes in Behavioral Variables

Changes in physical activity were strongly associated with weight change ($p = .0005$). The Internet and newsletter groups reported decreases in activity over time, whereas exercise remained more consistent in the face-to-face group. Results from Tables 2 and 3 show that a decrease of 500 kcal/week in total energy expenditure was associated with greater weight regain of .19 kg (95% confidence interval [CI] = 0.084–0.301). In contrast, changes in the number of calories consumed ($p = .41$) or in the percentage of calories from fat ($p = .91$) were not related to weight regain.

The other behavioral variable associated with weight regain was change in self-weighing frequency, and its effect showed significant between-groups variation, $F(4, 472) = 7.089$, $p = .0009$. On the basis of the parameterization employed in Table 2, changes in self-weighing frequency were unrelated to weight regain in the control arm ($p = .58$) but were strongly associated with weight changes within the two intervention arms ($p = .0005$), with a nonsignificant difference between them ($p = .19$). For the combined interventions, a one-unit increase in self-weighing frequency (e.g., from several times a week to once daily) was associated with .98 kg (95% CI = 0.431–1.532) less weight regain among intervention group members relative to control participants who reported the same changes on this behavioral measure.

Tables 2 and 3 present regression coefficients indicating what would occur if self-weighing frequency changed by the same amount in all three groups. Figure 1a shows the actual change in self-weighing frequency within each group, and Figure 1b shows the effect of these changes upon realized weight regain. Self-weighing frequency increased by a full unit in the Internet group and by a half unit in the face-to-face group but declined slightly in the control group. As shown in Figure 1b, these increases in weighing frequency resulted in a blunting of weight regain in the intervention groups relative to the control group.

Changes in Psychological Variables

Change in psychological predictors was also associated with weight regain. Increases in depressive symptoms were associated with weight regain ($p < .0001$); an increase in BDI scores at follow-up of 3.88 units was associated with 0.95 kg (95% CI = 0.676–1.222) greater weight gain. Likewise, increases in both hunger ($p = .003$) and disinhibition ($p < .0001$) were related to greater weight regain: A standard unit increase in hunger resulted in 0.65 kg (95% CI = .0230–1.073) greater weight regain, whereas the effect of a standard unit decrease in disinhibition was almost twice as large at 1.07 kg (95% CI = 0.600–1.549).

The entries of Tables 2 and 3 indicate that changes in restraint were negatively associated with changes in weight across all three groups. However, the impact of changes in restraint differed between the two active treatment arms ($p = .0002$). In particular, the Internet group was quite sensitive to changes in restraint, as a standard unit decrease in restraint was associated with additional weight regain of 1.98 kg (95% CI = 1.457–2.495). The effect of a corresponding change in restraint was attenuated in the newsletter arm (weight change modified by 0.88 kg; 95% CI = 0.354–1.410) and appeared weakest in the face-to-face arm (weight change modified by 0.46 kg; 95% CI = −0.168 to 1.088).

Tables 2 and 3 indicate the effects of a hypothetical standard unit change in restraint across all three study groups, but Figures 2a and 2b show, respectively, the actual changes in restraint reported in these groups and the estimated impact of these changes on realized weight regain. Despite an initial drop in restraint at the 6-month follow-up that appeared common across groups, the face-to-face group recovered and eventually experienced large increases in restraint, especially in the later months of the program, whereas the newsletter and Internet groups reported continuing decreases in restraint throughout the 18-month study period. Thus, even though the face-to-face group was relatively insensitive to changes in restraint, it was the only group to experience a blunting in weight regain related to this variable.

Residual Treatment Arm Effects

After we had adjusted for all other variables in the model, weight regain over the first 6 months was somewhat greater in the Internet group than in the face-to-face group ($p = .08$), but the average for the two interventions did not differ significantly ($p = .92$) from weight regain in the control group. In contrast, during Months 6–18, the difference between the two active interventions was not significant ($p = .59$) but the rate of weight regain accelerated in the newsletter group. The result was a significant difference between the combined intervention groups and the newsletter control group ($p = .03$).

Discussion

STOP Regain provides a unique opportunity to examine predictors of weight regain among a group of successful weight losers. We found that few baseline variables were associated with weight regain; however, changes in both behavioral and psychological variables were strongly associated with weight regain over the 18-month program. Among the behavioral variables, changes in frequency of self-weighing and changes in physical activity had the strongest independent effects on weight regain. However, changes in the psychological variables (depressive symptoms, disinhibition, hunger, and restraint) also exerted strong effects on outcome.

The effect of physical activity on weight regain has been consistently observed in prior studies (Phelan, Wyatt, Hill, & Wing, 2006; Schoeller, Shay, & Kushner, 1997; Weiss et al., 2007). Individuals who maintain higher levels of physical activity achieve larger weight losses at 18- or 30-month assessments in standard behavioral weight loss programs (Tate, Jeffery, Sherwood, & Wing, 2007). Decreases in physical activity have also been found to predict weight regain in the NWCR (McGuire et al., 1999; Raynor et al., 2006).

There has been less research on frequency of self-weighing. In the current analysis, this behavior was a strong predictor of weight regain within the intervention groups but not in the control group. This finding may be due to the fact that daily self-weighing was emphasized in the STOP Regain interventions (Wing et al., 2006); this led to significant increases in the frequency of self-weighing (from several times a week to once daily). Also, participants in the intervention arms were taught to use the information from the scale to make adjustments in their eating and exercise behaviors, and strong associations resulted between changes in self-weighing frequency and weight change. In contrast, the control group reported little change in self-weighing frequency; moreover, changes in self-weighing, even if they did occur, had little impact on weight change, because these participants had not been taught strategies for modifying their behaviors in response to the scale. Linde, Jeffery, French, Pronk, and Boyle (2005) reported that increases in frequency of self-weighing were related to weight loss and weight gain prevention, and changes in frequency of self-weighing were also related to weight regain in the NWCR (Butryn et al., 2007). Although some have been concerned about negative psychological effects of frequent (including daily) self-weighing, a detailed analysis of this issue in STOP Regain found no evidence of a negative effect (Wing et al., 2007).

It is of note that the dietary measures had very little association with weight regain. Difficulties in assessing dietary intake may account for this finding. Other studies have found that changes in diet

account for little of the variance in weight regain (Jeffery et al., 2003; Leermakers, Perri, Shigaki, & Fuller, 1999; McGuire et al., 1999; Wadden, Vogt, Foster, & Anderson, 1998).

In this study, changes in psychological parameters were strongly associated with weight regain. Increases in depressive symptoms, disinhibition, and hunger were all related to greater weight regain, and there were particularly strong associations between increases in disinhibition and weight regain. Although the BDI scores in this study were very low at baseline (and even those who gained weight had relatively small increases on this scale), these findings suggest that negative affect and tendencies to uncontrolled eating may be associated with problems in the long-term maintenance of weight loss. Behavioral weight control programs teach participants to identify and try to change negative thoughts and to plan ahead to prevent lapses from becoming relapses. Those individuals who practice these skills may be better able to deal effectively with periods of overeating or slips from the program. Higher baseline levels of depressive symptoms and increases in disinhibition have both been associated with weight regain in the NWCR (McGuire et al., 1999) and in other weight loss studies (Niemeier, Phelan, Fava, & Wing, 2007; Vogels, Diepvens, & Westerterp-Plantenga, 2005).

The Restraint scale on the Eating Inventory includes items that define concerns about weight regain and conscious control of caloric intake. These items relate quite well to the skills taught in the STOP Regain program (e.g., take action if weight gain occurs; use your weight to determine if and when changes in caloric intake are needed). Thus, participants who were able to learn these skills may have been best equipped to maintain their weight losses over the 18-month trial. The finding that the face-to-face group was the only one to show increases in restraint over time suggests that these skills may have been better communicated in this format than in the Internet approach.

The primary finding from STOP Regain reported previously (Wing et al., 2006) was that the face-to-face group experienced less weight regain than did the Internet or the control group. The current analysis shows that after we had adjusted for all of the behavioral and psychological variables, the Internet group had slightly (but not significantly) greater initial rates of regain (0–6 months) than did the face-to-face group. The two intervention groups experienced comparable rates of weight regain between 6 and 18 months, which were significantly lower than the rate in the control group. The difference that remains between the two active interventions and the control group after we had adjusted for changes in the behavioral and psychological variables reflects the effect of unmeasured variables, possibly differences in treatment contact.

This study allowed a comprehensive examination of predictors of weight regain in a large sample of highly successful weight losers. In the typical analysis of predictors of weight gain following a standard behavioral program, many of the participants have never achieved weight loss and the mean weight loss is usually less than half that of STOP Regain participants; however, all participants in this trial had been successful in weight loss and were trying to maintain weight losses of approximately 18% of their body weight (M = 18 kg). In addition, this study allowed us to obtain objective measures of weight, whereas the NWCR data are based on self-report only.

Limitations of the study include the fact that this sample was self-selected and included disproportionate numbers of women and very few minority participants; consequently, the generalizabililty of the findings is limited. Moreover, these participants had lost an average of 18% of their initial body weight, and it is not clear whether the findings can be applied to those who experience smaller weight losses. In addition, about one sixth of those who entered the study did not complete all of the 18-month questionnaire measures and were excluded from this analysis. As noted previously, 93% of the participants were weighed at 18 months, but not all of these individuals were willing to complete the large questionnaire packet. However, our 83% completion rate exceeds that of many weight loss trials. Moreover, we found that those who completed the questionnaires did not differ from noncompleters on any variables at baseline except that completers weighed less at baseline.

In conclusion, we found that increases in two behaviors (frequency of self-weighing and physical activity) along with increases in dietary restraint and decreases in disinhibition, hunger, and depressive symptomatology were associated with improved weight loss maintenance. These findings suggest that future programs for weight loss maintenance should focus on modifying these behavioral and psychological variables.

Table 1: Sample Characteristics at Baseline (*N* = 261)

Variable	*M*	*SD*
Age (years)	51.16	10.19
Body mass index (kg/m^2)	28.46	4.83
Months duration of >10% weight change	13.25	7.61
% below maximum weight	18.17	7.36
Total exercise expenditure (kcal/week)	2,042	1,450
Caloric intake (kcal/day)	1,638	638
% calories from fat	34.47	8.74
Weighing frequency[a]	5.06	1.29
BDI	3.91	3.88
Eating Inventory, Hunger	5.33	3.39
Eating Inventory, Disinhibition	8.31	3.49
Eating Inventory, Restraint	15.01	3.32
Weight (kg)	76.84	15.82

Note. BDI = Beck Depression Inventory (Beck & Steer, 1987).

[a] 1 = *never,* 2 = *less than once per month,* 3 = *less than once per week,* 4 = *one time per week,* 5 = *several times per week,* 6 = *one time each day,* 7 = *several times per day.*

Table 2: Longitudinal Regression Model Predicting Weight Change Since Baseline at the 6-Month, 12-Month, and 18-Month Follow-Ups

Variable	Value	*SE*	*df*	*t*	*p*
Baseline to 6 months					
Intercept	0.0649	0.0321	472	2.0254	0.0434
Group (face-to-face vs. Internet)	-0.0416	0.0238	253	-1.747	0.0818
Group (active interventions vs. control)	0.0039	0.0238	253	0.1006	0.92
Baseline weight	0	0	253	0.2685	0.7885
% below maximum weight	0	0.0186	253	0.8916	0.3735
Time since onset of >10% weight change (months)	-0.0117	0.0167	253	-0.7009	0.484
Male	0.0067	0.0482	253	0.1382	0.8902
Age (years)	0.0113	0.0165	253	0.6852	0.4939
6 to 18 months					
Time	0.0985	0.0129	472	7.6615	<.0001
Time X Group (face-to-face vs. Internet)	-0.0051	0.0096	472	-0.5387	0.5903
Time X Group (active interventions vs. control)	-0.0339	0.016	472	-2.1163	0.0348
Time X Baseline Weight	0.027	0.0076	472	3.5609	0.0004
Time X % Below Maximum Weight	0.0459	0.0076	472	6.0715	<.0001
Change in behavioral and psychological variables					
Change in total energy expenditure	-0.0353	0.0101	472	-3.5154	0.0005
Change in caloric intake	0.0105	0.0129	472	0.8182	0.4136
Change in % calories from fat	0.0014	0.0124	472	0.1111	0.9115
Change in weighing frequency	-0.0099	0.018	472	-0.5486	0.5835
Change in Weighing Frequency X Group (face-to-face vs. Internet	0.0186	0.0142	472	1.3103	0.1907
Change in Weighing Frequency X Group (active interventions vs. control)	-0.08	0.0229	472	-3.5006	0.0005
Change in BDI	0.06	0.0088	472	6.8411	<.0001
Change in hunger	0.0412	0.0136	472	3.0164	0.0027
Change in disinhibition	0.0679	0.0153	472	4.432	<.0001
Change in restraint	-0.0558	0.017	472	-3.2883	0.0011
Change in Restraint X Group (face-to-face vs. Internet	0.0479	0.0127	472	3.7642	0.0002
Change in Restraint X Group (active interventions vs. control)	-0.0212	0.021	472	-1.0111	0.3125

Note. Time has been coded as 0, 1, and 2 respectively at the 6-month, 12-month, and 18-month follow-ups. We have standardized all other continuous variables by subtracting off their baseline mean and dividing by their baseline standard deviation, using values listed in Table 1. Study group has been coded with the control arm (N _ newsletter) as the reference group. Treatment contrasts are given by (a) the difference between the two active treatment arms (face-to-face, Internet), and (b) the difference between the average of the two active treatment arms and the control arm. BDI _ Beck Depression Inventory (Beck & Steer, 1987).

Table 3: Point Estimates and 95% Confidence Intervals of Standardized Group-Specific Intercepts and Slopes in Longitudinal Regression Model Predicting Weight Change Since Baseline at the 6-Month, 12-Month, and 18-Month Follow-Ups

Variable	Value	Lower CI	Upper CI
Intercept			
Newsletter	0.0649	0.0019	0.1279
Internet	0.1104	0.0406	0.1803
Face-to-face	0.0273	-0.0402	0.0948
Slope: Time			
Newsletter	0.0985	0.0733	0.1238
Internet	0.0698	0.0427	0.0969
Face-to-face	0.0595	0.0334	0.0856
Slope: Change in weighing frequency			
Newsletter	-0.0099	-0.0452	0.0255
Internet	-0.1085	-0.1438	-0.0732
Face-to-face	-0.0713	-0.1146	-0.028
Slope: Change in restraint			
Newsletter	-0.0558	-0.0891	-0.0224
Internet	-0.1249	-0.1577	-0.0921
Face-to-face	-0.0291	-0.0688	0.0106

Note. Time has been coded as 0, 1, and 2 respectively at the 6-month, 12-month, and 18-month follow-ups. We have standardized all other continuous variables by subtracting off their baseline mean and dividing by their baseline standard deviation, using values listed in Table 1. Study group has been coded with the control arm (newsletter) as the reference group. Treatment contrasts are given by (a) the difference between the two active treatment arms (face-to-face, Internet) and (b) the difference between the average of the two active treatment arms and the control arm. CI = confidence interval.

Figure 1

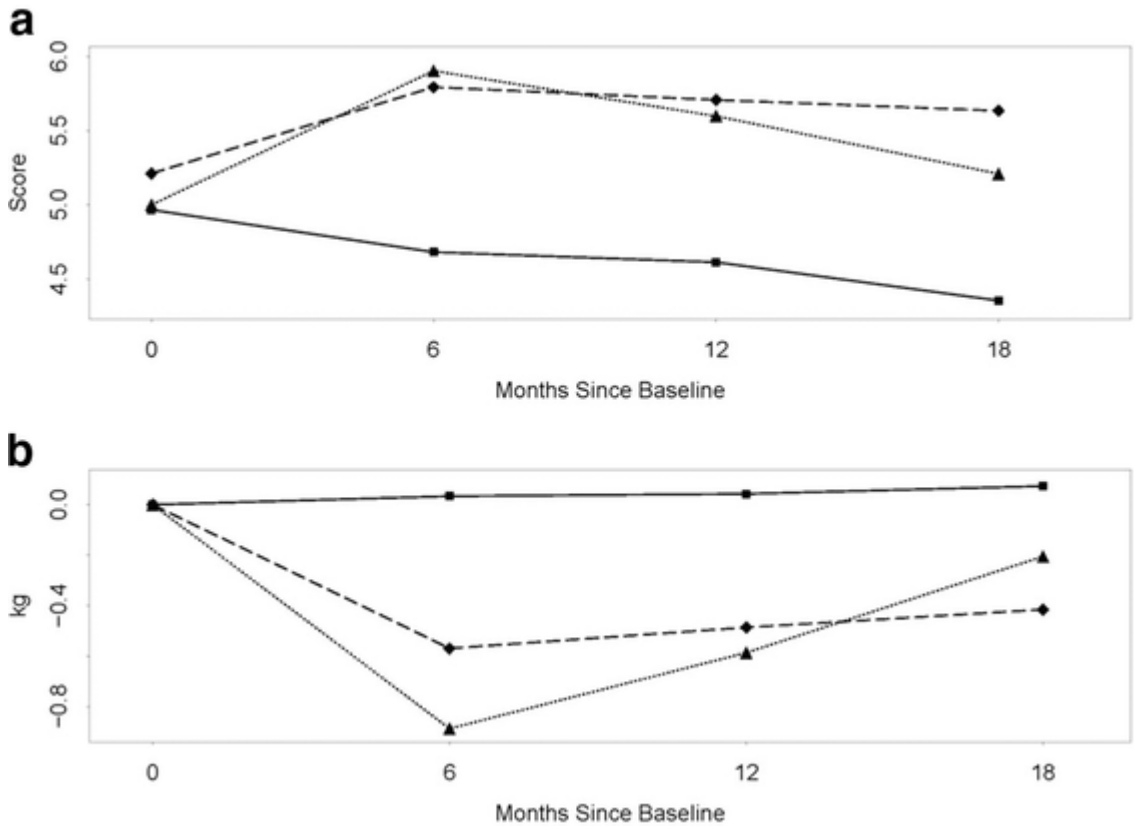

Figure 1. a: Frequency of self-weighing reported by participants in the newsletter (square), Internet (triangle), and face-to-face (diamond) groups at 0, 6, 12, and 18 months. b: The corresponding effect on weight regain.

Figure 2

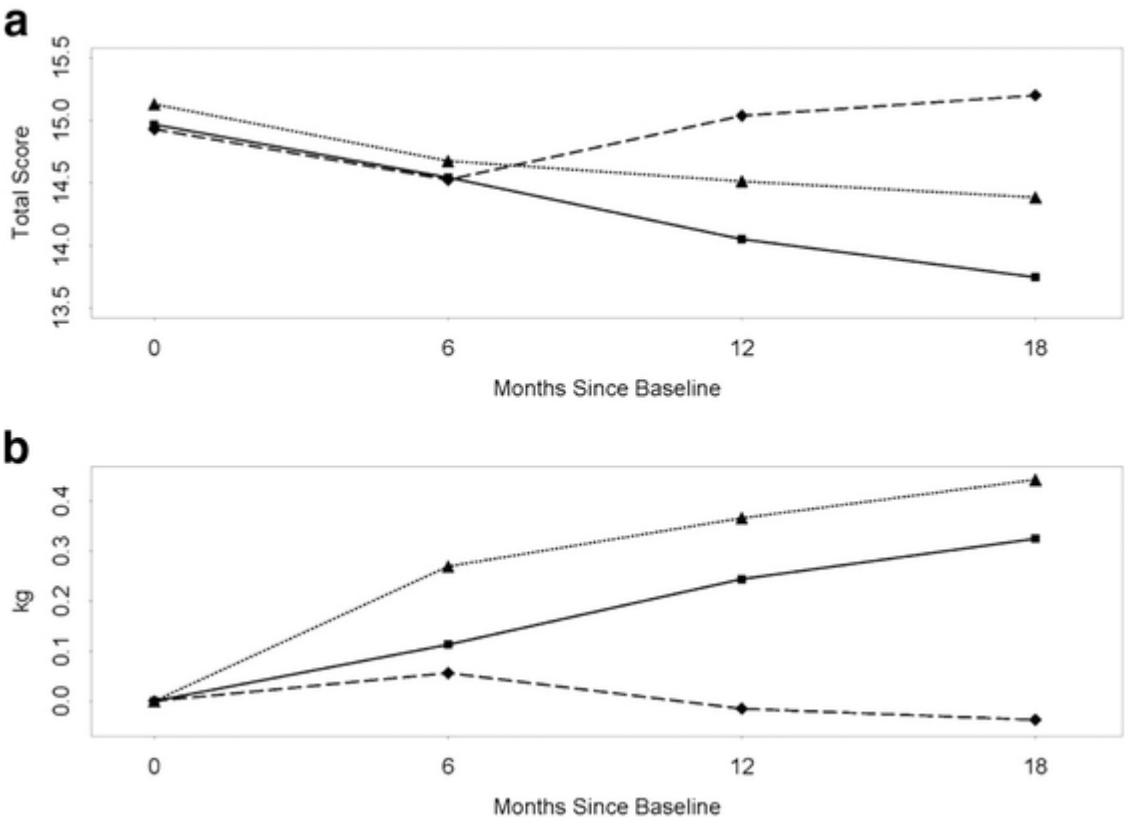

Figure 2. a: Dietary restraint scores reported by participants in the newsletter (square), Internet (triangle), and face-to-face (diamond) groups at 0, 6, 12, and 18 months. b: The corresponding effect on weight regain.

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