Annals of Internal Medicine | ORIGINAL RESEARCH

Individual- Versus Group-Based Financial Incentives for Weight Loss

A Randomized, Controlled Trial

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Background: Data on the effectiveness of employer-sponsored financial incentives for employee weight loss are limited.

Objective: To test the effectiveness of 2 financial incentive designs for promoting weight loss among obese employees.

Design: Randomized, controlled trial. (ClinicalTrials.gov: NCT01208350)

Setting: Children's Hospital of Philadelphia.

Participants: 105 employees with a body mass index between 30 and 40 kg/m^2.

Intervention: 24 weeks of monthly weigh-ins (control group; n = 35); individual incentive, designed as $100 per person per month for meeting or exceeding weight-loss goals (n = 35); and group incentive, designed as $500 per month split among participants within groups of 5 who met or exceeded weight-loss goals (n = 35).

Measurements: Weight loss after 24 weeks (primary outcome) and 36 weeks and changes in behavioral mediators of weight loss (secondary outcomes).

Results: Group-incentive participants lost more weight than control participants (mean between-group difference, 4.4 kg [95% CI, 2.0 to 6.7 kg]; $P < 0.001$) and individual-incentive participants (mean between-group difference, 3.2 kg [CI, 0.9 to 5.5 kg]; $P = 0.008$). Twelve weeks after incentives ended and after adjustment for 3-group comparisons, group-incentive participants maintained greater weight loss than control group participants (mean between-group difference, 2.9 kg [CI, 0.5 to 5.3 kg]; $P = 0.016$) but not greater than individual-incentive participants (mean between-group difference, 2.7 kg [CI, 0.4 to 5.0 kg]; $P = 0.024$).

Limitation: Single employer and short follow-up.

Conclusion: A group-based financial incentive was more effective than an individual incentive and monthly weigh-ins at promoting weight loss among obese employees at 24 weeks.

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Most adults in the United States are overweight or obese (1), which is a public health challenge associated with increased mortality rates (2–4) and higher costs for employers (5), private payers (6), and public health insurance programs (7–9). Despite the health and economic consequences of obesity, alleviating the problem has had limited success. Hence, there is broad interest in new approaches to combat obesity and changing behaviors that contribute to it (10). The use of financial incentives has shown promise in promoting healthy behaviors. An estimated 67% of large employers are using this strategy (11) with the goal of decreasing the incidence of chronic disease and slowing the growth of health care costs (12, 13).

Although studies have shown that financial incentives can produce short-term weight loss (14–16), interventions have focused more on incentivizing persons and less on leveraging the group structure inherent in workplace settings to potentially achieve greater effectiveness (17). The goal of this study was to test the effectiveness of 2 financial incentive designs in promoting weight loss among obese employees. Both designs used the same up-front allocation of resources but delivered the incentive through an individually targeted approach or a group-based approach.

METHODS

Design Overview

We conducted a 36-week parallel-design, randomized, controlled trial between 17 March 2011 and 21 January 2012. One hundred five participants (**Figure 1**) gave their informed consent, were given the goal of losing 0.4 kg per week for 24 weeks (18, 19), and were randomly assigned to a monthly weigh-in control group or to 1 of 2 monthly financial incentive groups. Weights were measured using incentaHEALTH workplace scales (incentaHEALTH, Denver, Colorado) that provided precision to 0.1 kg. All participants had access to a secure Web site to track their individual progress and complete questionnaires. The protocol was approved by the institutional review board of the University of Pennsylvania, Philadelphia, Pennsylvania.

Setting and Participants

Eligible participants were employees of the Children's Hospital of Philadelphia who were between ages 18 and 70 years and had a body mass index (BMI) of 30 to 40 kg/m^2. The upper age was set at 70 years because there may be less benefit from weight reduction after this age than at younger ages (20). Persons with a BMI less than 30 kg/m^2 were excluded to ensure that all participants could safely lose (and would be likely to benefit from losing) the target weight of 10.8 kg over the 24-week intervention. Other exclusion criteria included conditions that would make

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Context

Paying persons for weight loss helps them to lose weight in the near term.

Contribution

This trial compared 2 employer-based, weight-loss incentive strategies. The first strategy paid persons $100 per month for each month that they met their weight-loss goals, and the second strategy offered groups of 5 persons $500 per month for each month they met their goals, where group members who met their goals received the balance of money unearned by members who did not meet their goals. The group incentive led to weight loss that was approximately 3.2 kg greater than the individual incentive, at the same up-front cost to the employer.

Caution

The study took place in a single work setting.

Implication

An employer-based group incentive was more effective than an individual financial incentive in promoting weight loss among employees.

—The Editors

participation infeasible (for example, inability to consent or illiteracy) or potentially unsafe (for example, current treatment of substance abuse; consumption of >5 alcoholic drinks per day; addiction to prescription medications or street drugs; serious psychiatric diagnoses; myocardial infarction or stroke in the past 6 months; metastatic cancer; diabetes requiring treatment with medication other than metformin; currently pregnant or breastfeeding; or a history of an eating disorder or unsafe weight-loss behaviors, such as laxative or diuretic use).

Participants were recruited through workplace flyers, posters, and e-mail newsletters. Potential participants visited the study Web site to complete a screening questionnaire. Eligible participants were required to complete a weigh-in on the workplace scale to confirm their BMI. Those who met all eligibility criteria were then asked to complete an online informed consent document. All participants were recruited in March and April 2011.

Randomization and Interventions

The study coordinator requested treatment assignment through a Web-based platform, which assigned participants to the 3 study groups using 1:1:1 central computerized randomization with a block size of 15. The allocation sequence was generated dynamically by the randomization program, subject to the constraint that within each block of 15 participants, 5 were assigned to each of the 3 groups; thus, research team members could not predict future assignments. Group assignments were communicated to participants by an automated secure Web site message and an e-mail or a text message. Neither the participants nor the study coordinator could be blinded to group assignment due to the nature of the interventions. Data analysts and all investigators were blinded to group assignment until primary outcome data were collected.

Control participants were provided with a link to the Weight-control Information Network of the National Institute of Diabetes and Digestive and Kidney Diseases (http://win.niddk.nih.gov) and were both scheduled for monthly weigh-ins and reminded by an automated e-mail or text message to attend the weigh-ins. All weights collected were shown to each participant through the secure Web site. After each monthly weigh-in, an automated message notified participants of whether they met or did not meet their weight-loss goal for that 4-week period.

Individual-incentive participants received the information that control participants received but were also told that $100 would be set aside for them at baseline, 4 weeks, 8 weeks, 12 weeks, 16 weeks, and 20 weeks, and that the $100 would be electronically transmitted to them if they met or exceeded their target monthly weight loss as determined by their monthly weigh-in. After each monthly weigh-in, an automated message notified participants of their earnings, or for those not meeting the target, of what they would have earned if they had met their weight-loss goal. The incentive of $100 per participant per month is similar to the incentives used in previous studies (15, 16) and within the range of what employers are allowed to offer as health outcomes–based incentives (21). The total up-front allocation of incentives for meeting weight-loss goals in the individual-incentive group was $21 000.

Group-incentive participants received the same information as control participants. Similar to that in the individual-incentive group, the up-front allocation of incentives for meeting weight-loss goals was $100 per participant per month (totaling $21 000). However, group-incentive participants were placed into groups of 5 and told that they would not learn the identities of the 4 other persons in their group. At the end of each 4-week period during the 24-week intervention, $500 was split among participants in each group who were at or below their monthly target weight. If no participant met the weight-loss goal, then no money was distributed. In cases where a group-incentive member withdrew from the study, the remaining members of that group were still eligible to split the full $500 per month. After each monthly weigh-in, an automated message notified participants of their earnings or, if they failed to meet the target, what they would have earned if they had met their weight-loss goal.

We used 2 strategies to maximize retention of study participants. First, participants received $20 for completing each monthly weigh-in, $50 for completing the 24-week weigh-in, and $50 for completing the 36-week weigh-in. These participation incentives brought the overall resource allocation for incentives (that is, for both participation in scheduled weigh-ins and meeting weight-loss goals) to

$28 000 in each incentive group. Second, the weight-loss goal trajectory was adjusted every 4 weeks for participants who did not meet their monthly goal. In these cases, the slope of the trajectory was increased such that the overall weight-loss goal of 10.8 kg remained, but less successful participants would not have to immediately lose large amounts of weight to meet their monthly goals. The rate of weight loss when trajectories were adjusted was capped at 0.9 kg per week to ensure a safe rate of weight loss. A similar approach was used in previous studies and resulted in rates of participants lost to follow-up of just 8.7% (15) and 9.1% (16).

Participants were monitored for excessive weight loss, defined as losing more than 2.3 kg in 1 week, 3.6 kg in 2 weeks, or 5.4 kg in 4 weeks. If weight loss exceeded any of these thresholds, the study coordinator contacted the participants to inquire about their health status and use of diuretics, diet pills, purging, or excessive exercise.

Outcomes and Follow-up

Our primary outcome was weight loss at 24 weeks. We hypothesized that both group and individual-incentive participants would have greater weight loss than control participants and that group-incentive participants would have greater weight loss than individual-incentive participants.

Secondary outcomes included weight loss at 36 weeks (that is, 12 weeks after incentives ended) and changes in physical activity, eating behaviors, and participation in weight-related wellness programs from baseline to primary outcome measurement at 24 weeks. Physical activity was measured at baseline, 24 weeks, and 36 weeks through online administration of the short form of the International Physical Activity Questionnaire (22) and was operationalized as metabolic equivalent of task–minutes of physical activity during the last 7 days. Eating behaviors were measured at baseline, 24 weeks, and 36 weeks using the

Figure 1. **Study flow diagram.**

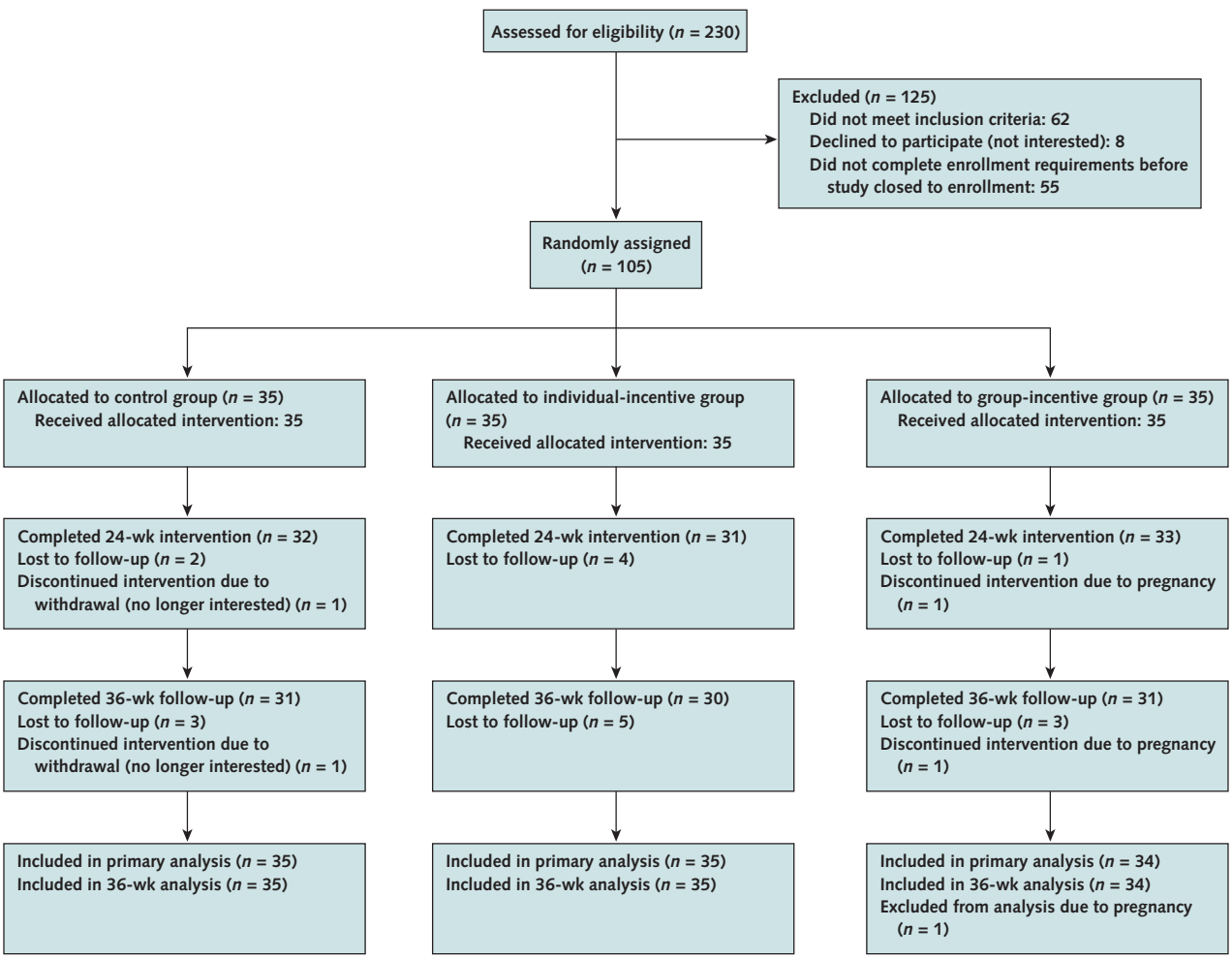


Table 1. **Characteristics of the Study Sample**

Characteristic	Control Group (n = 35)	Individual-Incentive Group (n = 35)	Group-Incentive Group (n = 35)
Women, *n (%)*	32 (91)	30 (86)	31 (89)
Mean age (SD), *y*	44.5 (10)	44.4 (11)	47.0 (9)
Baseline weight measurements			
Mean weight (SD), *kg*	94.1 (14)	94.6 (12)	98.0 (15)
Mean BMI (SD), *kg/m²*	34.13 (3)	34.43 (2)	35.09 (3)
Race or ethnicity, *n (%)**			
White, non-Hispanic	22 (63)	19 (54)	25 (71)
African American, non-Hispanic	8 (23)	15 (43)	8 (23)
Other, non-Hispanic	2 (6)	0 (0)	1 (3)
Hispanic	3 (9)	1 (3)	1 (3)
Education, *n (%)*			
Less than college	2 (6)	1 (3)	5 (14)
Some college	10 (29)	14 (40)	11 (31)
College graduate	9 (26)	11 (31)	10 (29)
Postcollege degree	14 (40)	9 (26)	9 (26)
Annual household income, *n (%)*†			
<$50 000	6 (17)	7 (21)	5 (14)
$50 000–$99 999	12 (34)	13 (38)	18 (51)
≥$100 000	17 (49)	14 (41)	12 (34)
Mean physical activity in the last 7 d (SD), *MET-min*‡	1986 (1816)	2027 (1826)	1395 (1498)
Eating behaviors			
Mean cognitive restraint score (SD)§	45.4 (18)	44.6 (19)	40.4 (17)
Mean uncontrolled eating score (SD)§	43.2 (20)	42.9 (19)	49.8 (16)
Mean emotional eating score (SD)§	49.5 (28)	48.6 (30)	65.7 (24)
Participation in any weight-related program, *n (%)*‖	14 (40)	15 (43)	18 (51)
Mean importance of controlling weight score (SD)¶	9.0 (1.5)	8.8 (1.6)	8.9 (1.6)
Mean confidence in controlling weight score (SD)¶	7.3 (2.1)	7.7 (2.2)	7.0 (2.4)

BMI = body mass index; MET = metabolic equivalent of task.
* Self-identified by participants on baseline questionnaire.
† Income data were missing for 1 individual-incentive participant.
‡ MET-min is a quantification of physical activity that reflects both intensity (in METs) and duration (in min) of activity.
§ Measured on a scale from 0 to 100. Higher scores signify more of that behavior.
‖ Employer-sponsored personal health coaching, employer financial incentive for fitness club attendance, or commercial weight-loss program.
¶ Measured on a scale from 0 to 10. Higher scores signify greater importance of and confidence in controlling weight.

online Three-Factor Eating Questionnaire–R18 (23, 24), with scores from 0 to 100 in cognitive restraint, emotional eating, and uncontrolled eating. Participation in weight-related wellness programs (employer-sponsored health coaching, employer incentive for fitness club attendance, or a commercial weight-loss program) was measured at baseline, 24 weeks, and 36 weeks through an online questionnaire.

We also conducted exploratory analyses of weight-loss goal attainment by month.

Statistical Analysis

All participants who were randomly assigned to a study group were included in the analyses testing for differences between groups, with the exception of 1 participant who became pregnant during the intervention and was excluded from all analyses because she no longer met study inclusion criteria. We used SAS, version 9.3 (SAS Institute, Cary, North Carolina), to analyze the data.

For the primary outcome of 24-week weight loss and the secondary outcome of 36-week weight loss, we did multiple imputation using PROC MI from SAS, version 9.3, to derive missing 24- and 36-week weights (25). For each of the 5 imputed data sets, we used PROC GLM to conduct t tests for direct comparisons of outcomes by group; we also assessed the effect of adjustment for demographic variables. The results were then combined using PROC MIANALYZE. More information about the multiple imputation procedures is in the **Appendix** (available at www.annals.org).

In the remaining secondary outcome and exploratory analyses, we used only observed data. For continuous variables, we used PROC GLM to conduct t tests, with the exception of the exploratory outcome of number of months in which weight-loss goals were met (in this case, we used PROC NPAR1WAY to conduct Wilcoxon–Mann–Whitney U tests). For categorical variables, we used PROC FREQ to conduct Pearson chi-square tests or the Fisher exact tests.

All hypothesis tests were 2-sided. To maintain the type I error rate while testing the 3 hypotheses of primary interest, we used a Bonferroni correction to define an α of 0.0167 as our threshold for statistical significance.

For power calculations, we defined 5.0 kg as a clinically significant amount of weight loss in this population (26, 27), assumed a 5.0-kg SD for weight loss (16), and used a 2-sided α of 0.0167 for statistical significance. On the basis of these assumptions, 27 participants per group would provide 90% power to detect a 5.0-kg difference in

weight loss between groups. We increased this number to 35 to allow for a 20% rate of loss to follow-up and accommodate the need for groups of 5 participants in the group-incentive group.

Sensitivity Analyses

We conducted 2 sensitivity analyses to gauge the robustness of the primary outcome results to include the participant who withdrew after 10 weeks due to pregnancy and evaluate longitudinal 24-week weight change instead of aggregate 24-week weight loss. In the first, we repeated the primary outcome analysis with an imputed 24-week weight for the participant who withdrew (**Appendix**). In the second, we used PROC GENMOD to conduct a repeated measures analysis using observed data and generalized estimating equations.

Role of the Funding Source

This work was funded by the National Institute on Aging. Support was also provided by the Department of Veterans Affairs and the Robert Wood Johnson Foundation. The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; or preparation, review, or approval of the manuscript.

RESULTS

The sample was predominantly female (89%) and white (63%) or African American (30%). The mean baseline BMI was 34.6 kg/m^2. Other sample characteristics are shown in **Table 1**.

Ninety-six participants (91%) completed the 24-week weigh-in. At that time, there was a statistically significant difference in weight loss between participants in the group-incentive and control groups (mean between-group difference, 4.4 kg [CI, 2.0 to 6.7 kg]; $P < 0.001$) and between participants in the group- and individual-incentive groups (mean between-group difference, 3.2 kg [CI, 0.9 to 5.5 kg]; $P = 0.008$) (**Table 2**). We refit the models by adding demographic variables (such as age, sex, education, race, and household income) as covariates along with incentive group and found nearly identical results (data not shown). The results were nearly identical when the participant who withdrew due to pregnancy was included (**Appendix Table 1**, available at www.annals.org), and results were qualitatively the same when modeling longitudinal weight change (**Appendix Table 2**, available at www.annals.org).

At 24 weeks, group-incentive participants had a greater increase in cognitive restraint around eating than the control (mean difference in change in score, 15.4 [CI, 5.9 to 24.8]; $P = 0.002$) and individual-incentive (mean difference in change in score, 12.6 [CI, 3.3 to 22.0]; $P = 0.009$) participants (**Table 3**). We found no statistically significant differences in uncontrolled eating, emotional eating, physical activity, or weight-related wellness program participation at 24 weeks.

Ninety-two participants (88%) completed the 36-week weigh-in. At 36 weeks (**Figure 2**), there remained a statistically significant difference in weight loss relative to baseline between participants in group-incentive and control groups (mean between-group difference, 2.9 kg [CI, 0.5 to 5.3 kg]; $P = 0.016$) but not between the group- and individual-incentive groups (mean between-group difference, 2.7 kg [CI, 0.4 to 5.0 kg]; $P = 0.024$) after the Bonferroni correction. We found no statistically significant differences in change in cognitive restraint around eating, uncontrolled eating, emotional eating, physical activity, or weight-related wellness program participation at 36 weeks (data not shown).

The monthly mean cumulative weight changes by group are shown in **Figure 3**, and exploratory analyses of weight-loss goal attainment by month and overall are presented in **Appendix Table 3** (available at www.annals.org).

In exploratory analyses, we compared incentives earned for achieving weight-loss goals and the frequency of episodes of excessive weight loss over the 24-week intervention. Mean earnings were $514.70 (SD, $522.60) in the

Table 2. **Weight Loss**

Measure*	Within-Group Change			Between-Group Difference in Change†		
	Control Group ($n = 35$)	Individual-Incentive Group ($n = 35$)	Group-Incentive Group ($n = 34$)	Individual-Incentive Group vs. Control Group	Group-Incentive Group vs. Individual-Incentive Group	Group-Incentive Group vs. Control Group
Weight loss at 24 wk						
Mean weight loss, *kg*	0.5	1.7	4.8	1.2	3.2	4.4
95% CI	−1.3 to 2.2	0 to 3.3	3.3 to 6.4	−1.3 to 3.7	0.9 to 5.5	2.0 to 6.7
P value for comparison				0.34	0.008	<0.001
Weight loss at 36 wk						
Mean weight loss, *kg*	0.4	0.8	3.4	0.3	2.7	2.9
95% CI	−1.2 to 2.1	−0.9 to 2.4	1.7 to 5.1	−2.0 to 2.6	0.4 to 5.0	0.5 to 5.3
P value for comparison				0.81	0.024	0.016

* Measures use both observed and imputed data.
† With Bonferroni correction for 3-way comparison, the threshold for statistical significance was 0.0167.

group-incentive group and $128.60 (SD, $165.50) in the individual-incentive group (mean between-group difference, $386.10 [CI, $201.00 to $571.30]; $P < 0.001$). Eleven episodes of excessive weight loss occurred: 8 among 6 group-incentive participants and 3 in 1 individual-incentive participant. Investigation of these episodes did not reveal any unsafe weight-loss strategies.

DISCUSSION

In this weight-loss trial comparing 2 forms of financial incentive with an equal up-front allocation of resources, a group-based incentive was more effective than an individual incentive in promoting weight loss among obese employees at 24 weeks. The difference in weight loss between the group incentive and control groups was sustained 12 weeks after the incentive intervention ended.

We searched PubMed using the terms *financial incentives* and *weight loss* to identify all trials published between 1 January 1980 and 26 November 2012 that evaluated the effects of financial incentives for weight loss. We identified 12 studies (14–16, 28–36) that reported on weight loss but differed from our effort in that they did not use a randomized design (28, 30, 33, 35, 36), did not include follow-up (28–30, 34, 36), were conducted outside of a workplace (15, 16, 28, 30–32, 35), offered incentives within a multifaceted intervention (31, 32, 34, 36), asked participants to put their own money at risk (16, 28–30), or did not compare an individual incentive with a group-based incentive (14–16, 27–34). To our knowledge, our study is the only randomized trial to compare the effects of group-based and individual incentives or demonstrate a statistically significant difference in weight loss between incentive and control groups after incentives ended.

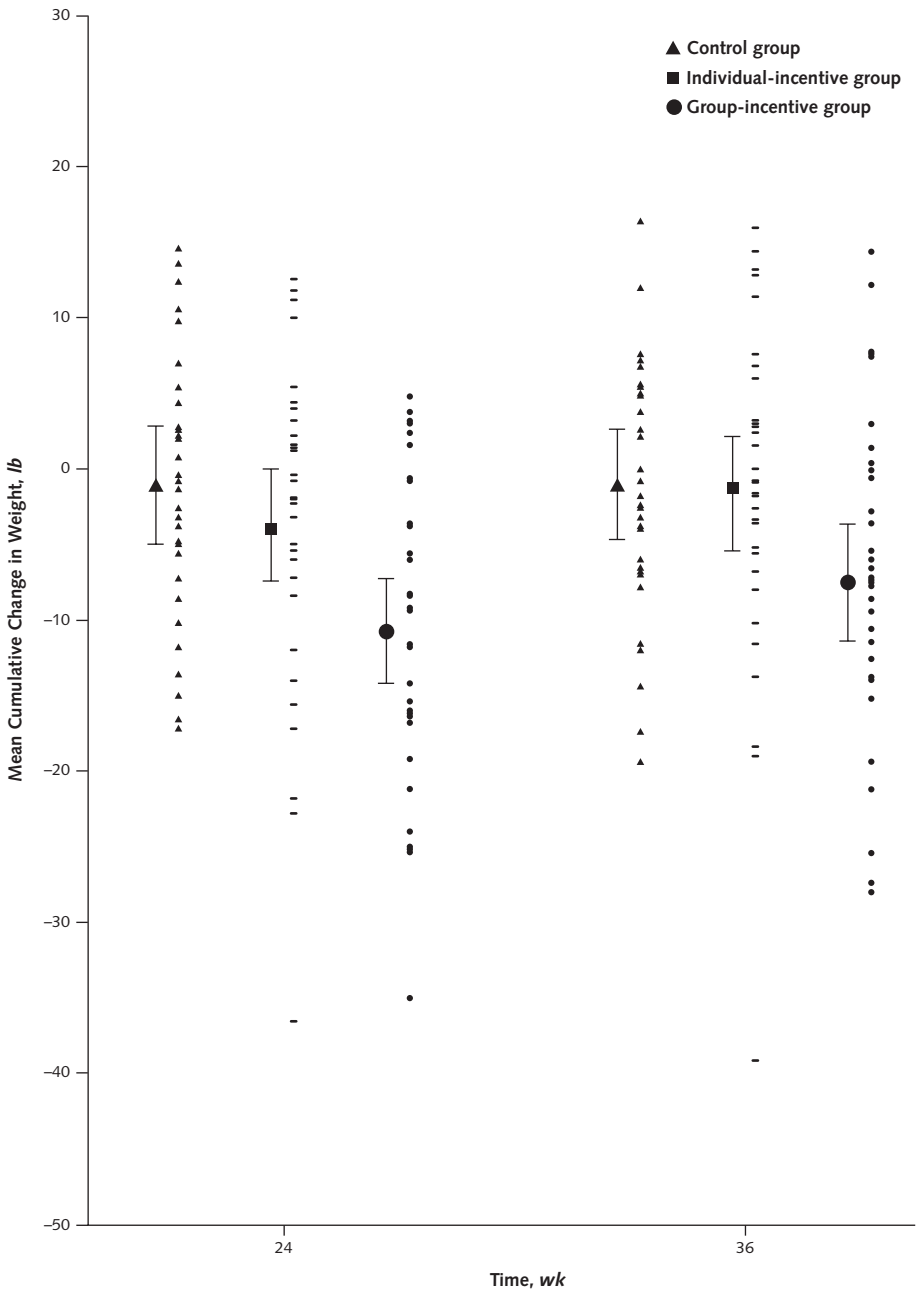
The greater effectiveness of the group incentive could be due to several factors. The opportunity to earn a reward larger than $100 for achieving a weight-loss goal was prob-

Table 3. **24-Week Change in Potential Weight-Loss Mediators***

Measure	Within-Group Change			Between-Group Difference in Change†		
	Control Group ($n = 28$)	Individual-Incentive Group ($n = 29$)	Group-Incentive Group ($n = 30$)	Individual-Incentive Group vs. Control Group	Group-Incentive Group vs. Individual-Incentive Group	Group-Incentive Group vs. Control Group
Physical activity in last 7 d						
Mean activity, *MET-min*‡	368§	489	1087	121	597	718
95% CI	−521 to 1258	−419 to 1398	29 to 2144	−1215 to 1458	−704 to 1898	−607 to 2043
P value for comparison				0.86	0.36	0.28
Cognitive restraint in eating‖						
Mean score	4.6	7.3	19.9¶	2.7	12.6	15.4
95% CI	−1.2 to 10.4	2.1 to 12.4	11.0 to 28.9	−6.7 to 12.2	3.3 to 22.0	5.9 to 24.8
P value for comparison				0.57	0.009	0.002
Uncontrolled eating‖						
Mean score	−3.8	−2.6	−6.8¶	1.3	−4.2	−2.9
95% CI	−7.8 to 0.1	−6.2 to 1.1	−13.1 to −0.4	−5.3 to 7.9	−10.8 to 2.3	−9.5 to 3.7
P value for comparison				0.70	0.20	0.38
Emotional eating‖						
Mean score	0.4	0.4	−2.2	0.0	−2.6	−2.6
95% CI	−8.6 to 9.4	−5.3 to 6.1	−9.9 to 5.4	−10.4 to 10.4	−12.9 to 7.7	−13.0 to 7.7
P value for comparison				1.00	0.61	0.62
Started weight-related program during study**						
Participants, %	7	7	13	0	6	6
95% CI	0 to 24	0 to 23	4 to 31	−25 to 25	−19 to 31	−20 to 31
P value for comparison				1.00	0.67	0.67
Continued weight-related program during study**						
Participants, %	21	34	37	13	2	15
95% CI	6 to 37	17 to 52	19 to 54	−10 to 36	−22 to 27	−8 to 38
P value for comparison				0.27	0.86	0.20

MET = metabolic equivalent of task.
* The response rate for the 24-wk survey was 84%.
† With Bonferroni correction for 3-way comparison, the threshold for statistical significance was 0.0167.
‡ MET-min is a quantification of physical activity that reflects both intensity (in METs) and duration (in min) of activity.
§ 27 participants for this measure.
‖ Higher scores signify more of that behavior.
¶ 29 participants for this measure.
** Employer-sponsored personal health coaching, employer financial incentive for fitness club attendance, or commercial weight-loss program.

Figure 2. **Weight change through 24-wk intervention and 36-wk follow-up.**

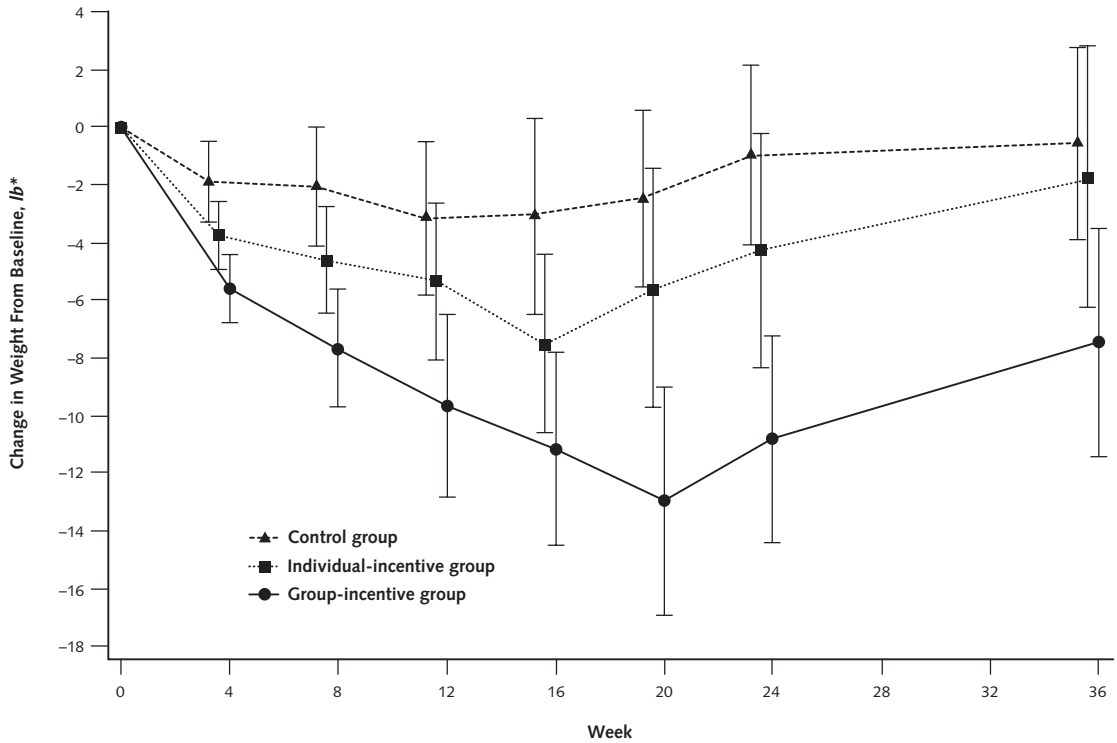


Error bars indicate 95% CIs. We imputed 8 missing 24-wk weights and 12 missing 36-wk weights. Plots of mean weight change, the respective CIs, and individual weight change include both observed and imputed data. To convert lb to kg, multiply by 0.45.

ably strong motivator. Two factors would have augmented this motivation. First, persons are often overly optimistic about their abilities relative to others (37) and, thus, may have expected greater success, and a larger reward, than fellow group members. Second, expectation of a larger reward would have been reinforced because most group members did not meet their weight-loss goals in most months, leaving a larger reward for those who did meet goals.

The group-incentive group also sought to introduce the threat of "social takeover" (knowledge that group members would acquire the incentive that other group members did not earn) (38), competition, loss aversion (16, 39), and regret (40, 41). Although these factors may have also motivated weight loss, we cannot determine their relative effect because we did not ask participants about their perceptions.

Figure 3. **Mean cumulative weight change by month during 24-wk intervention.**



Participants, *n*								
Control group	35	32	27	25	24	25	32	31
Individual-incentive group	35	34	30	26	26	20	31	30
Group-incentive group	34	32	29	29	27	26	33	31

Error bars indicate 95% CIs. Mean weight changes at each time point and the respective CIs include only observed data. To convert lb to kg, multiply by 0.45.

These results have important implications for future incentive design. First, more dollars were earned in the group-incentive group than in the individual-incentive group despite offering the same amount of incentives to participants at the start of the study. Second, although we did not design this study to compare daily versus monthly rewards, the amount of weight loss in the individual-incentive group, when contrasted with previous studies that offered daily rewards (15, 16), suggests that more frequent rewards may be a key ingredient to the success of individually targeted incentives. Although frequent rewards require frequent weigh-ins and thus can be administratively complex, these results suggest a tradeoff between the effectiveness and administrative simplicity of incentive designs. Although administrative complexity could be reduced through technologies that provide "automated hovering" (42), future studies should explicitly examine reward frequency to inform program planners of the implications of different approaches.

Although our study was not powered to detect differences in potential mediators of weight loss, our findings provide insight into how incentives for weight loss may affect obesity-related behaviors. Among group-incentive participants, we saw a statistically significant 24-week increase in cognitive restraint around eating, a key factor in weight management (43).

We tested 1 group-based incentive design, although other group-based designs are possible. Such approaches as "The Biggest Loser," for example, have received popular attention as ways to harness group dynamics to encourage weight loss. However, because the winner-take-all nature of such approaches could be demotivating for all but the most successful person, we provided a reward to all participants who achieved monthly weight-loss goals. Given the range of possible group-based incentive designs, more data are needed on their comparative effectiveness.

Our study has limitations. We tested these approaches in 1 group of employees in a setting that may not be generalizable to all settings. We could not collect data on all mechanisms through which incentives may motivate weight loss, although our measures provide some insight into processes. Our follow-up data are limited to 12 weeks after incentives end (44). Although the adjustment of weight-loss goal trajectories produced a retention rate that

exceeded those of many weight-loss studies (45–47), the larger monthly weight-loss goals when trajectories were adjusted could have diminished motivation to achieve these goals in subsequent months. Finally, our use of a Bonferroni correction for the 3 pairwise comparisons may be overly conservative.

In summary, this weight-loss trial comparing 2 forms of financial incentive with an equal up-front allocation of resources found that a group-based incentive was more effective than an individual incentive in promoting weight loss among obese employees at 24 weeks. Most large employers offer financial incentives to promote healthy lifestyle activities among employees (11, 48), and the Patient Protection and Affordable Care Act will allow health outcome–based incentives to grow to 30% of total health insurance premiums in 2014 (49, 50). As employers' use of financial incentives to motivate healthy behaviors accelerates, this study demonstrates that varying features of incentive design can lead to important differences in the costs of incentives and their effects on health outcomes.

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References

1. **Flegal KM, Carroll MD, Kit BK, Ogden CL.** Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA. 2012;307:491-7. [PMID: 22253363]

2. **Mokdad AH, Marks JS, Stroup DF, Gerberding JL.** Actual causes of death in the United States, 2000. JAMA. 2004;291:1238-45. [PMID: 15010446]

3. **Stewart ST, Cutler DM, Rosen AB.** Forecasting the effects of obesity and smoking on U.S. life expectancy. N Engl J Med. 2009;361:2252-60. [PMID: 19955525]

4. **Finkelstein EA, Brown DS, Wrage LA, Allaire BT, Hoerger TJ.** Individual and aggregate years-of-life lost associated with overweight and obesity. Obesity (Silver Spring). 2010;18:333-9. [PMID: 19680230]

5. **Finkelstein E, Fiebelkorn lC, Wang G.** The costs of obesity among full-time employees. Am J Health Promot. 2005;20:45-51. [PMID: 16171161]

6. **Finkelstein EA, Trogdon JG, Cohen JW, Dietz W.** Annual medical spending attributable to obesity: payer- and service-specific estimates. Health Aff (Millwood). 2009;28:w822-31. [PMID: 19635784]

7. **Finkelstein EA, Fiebelkorn IC, Wang G.** State-level estimates of annual medical expenditures attributable to obesity. Obes Res. 2004;12:18-24. [PMID: 14742838]

8. **Finkelstein EA, Trogdon JG, Brown DS, Allaire BT, Dellea PS, Kamal-Bahl SJ.** The lifetime medical cost burden of overweight and obesity: implications for obesity prevention. Obesity (Silver Spring). 2008;16:1843-8. [PMID: 18535543]

9. **Cai L, Lubitz J, Flegal KM, Pamuk ER.** The predicted effects of chronic obesity in middle age on medicare costs and mortality. Med Care. 2010;48:510-7. [PMID: 20473195]

10. **Schroeder SA.** Shattuck Lecture. We can do better—improving the health of the American people. N Engl J Med. 2007;357:1221-8. [PMID: 17881753]

11. **Towers Watson, National Business Group on Health.** The Road Ahead: Shaping Health Care Strategy in a Post-Reform Environment. 16th Annual Towers Watson/National Business Group on Health Employer Survey on Purchasing Value in Health Care. Towers Watson/National Business Group on Health; 2011. Accessed at www.towerswatson.com/assets/pdf/3946/TowersWatson-NBGH-2011-NA-2010-18560.pdf on 4 February 2013.

12. **Claxton G, DiJulio B, Whitmore H, Pickreign J, McHugh M, Finder B, et al.** Job-based health insurance: costs climb at a moderate pace. Health Aff (Millwood). 2009;28:w1002-12. [PMID: 19755489]

13. **Heinen L, Darling H.** Addressing obesity in the workplace: the role of employers. Milbank Q. 2009;87:101-22. [PMID: 19298417]

14. **Finkelstein EA, Linnan LA, Tate DF, Birken BE.** A pilot study testing the effect of different levels of financial incentives on weight loss among overweight employees. J Occup Environ Med. 2007;49:981-9. [PMID: 17848854]

15. **Volpp KG, John LK, Troxel AB, Norton L, Fassbender J, Loewenstein G.** Financial incentive-based approaches for weight loss: a randomized trial. JAMA. 2008;300:2631-7. [PMID: 19066383]

16. **John LK, Loewenstein G, Troxel AB, Norton L, Fassbender JE, Volpp KG.** Financial incentives for extended weight loss: a randomized, controlled trial. J Gen Intern Med. 2011;26:621-6. [PMID: 21249462]

17. **Jeffery RW.** Financial incentives and weight control. Prev Med. 2012;55(Suppl):S61-7. [PMID: 22244800]

18. **National Heart, Lung, and Blood Institute.** Aim for a Healthy Weight. Bethesda, MD: National Heart, Lung, and Blood Institute; 2005. Accessed at www.nhlbi.nih.gov/health/public/heart/obesity/aim_hwt.pdf on 4 February 2013.

19. **National Institute of Diabetes and Digestive and Kidney Diseases.** Talking With Patients About Weight Loss: Tips for Primary Care Professionals. Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Diseases; 2005. Accessed at http://win.niddk.nih.gov/publications/PDFs/TalkingWPAWL.pdf on 4 February 2013.

20. **Ryan DH, Espeland MA, Foster GD, Haffner SM, Hubbard VS, Johnson KC, et al; Look AHEAD Research Group.** Look AHEAD (Action for Health in Diabetes): design and methods for a clinical trial of weight loss for the prevention of cardiovascular disease in type 2 diabetes. Control Clin Trials. 2003;24:610-28. [PMID: 14500058]

21. **Department of Labor, Department of Treasury, Department of Health and Human Services.** Nondiscrimination and wellness programs in health coverage in the group market. Fed Regist. 2006;71:75014-55.
22. **Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al.** International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35:1381-95. [PMID: 12900694]
23. **Anglé S, Engblom J, Eriksson T, Kautiainen S, Saha MT, Lindfors P, et al.** Three factor eating questionnaire-R18 as a measure of cognitive restraint, uncontrolled eating and emotional eating in a sample of young Finnish females. Int J Behav Nutr Phys Act. 2009;6:41. [PMID: 19615047]
24. **de Lauzon B, Romon M, Deschamps V, Lafay L, Borys JM, Karlsson J, et al; Fleurbaix Laventie Ville Sante Study Group.** The Three-Factor Eating Questionnaire-R18 is able to distinguish among different eating patterns in a general population. J Nutr. 2004;134:2372-80. [PMID: 15333731]
25. **Little RJA, Rubin DB.** Statistical Analysis with Missing Data, 2nd ed. Hoboken, NJ: J Wiley; 2002.
26. Summary: weighing the options—criteria for evaluating weight-management programs. Committee to Develop Criteria for Evaluating the Outcomes of Approaches to Prevent and Treat Obesity Food and Nutrition Board, Institute of Medicine, National Academy of Sciences. J Am Diet Assoc. 1995;95:96-105. [PMID: 7798589]
27. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults—The Evidence Report. National Institutes of Health. Obes Res. 1998;6(Suppl 2):51S-209S. [PMID: 9813653]
28. **Butsch WS, Ard JD, Allison DB, Patki A, Henson CS, Rueger MM, et al.** Effects of a reimbursement incentive on enrollment in a weight control program. Obesity (Silver Spring). 2007;15:2733-8. [PMID: 18070764]
29. **Forster JL, Jeffery RW, Sullivan S, Snell MK.** A work-site weight control program using financial incentives collected through payroll deduction. J Occup Med. 1985;27:804-8. [PMID: 4067685]
30. **Hubbert KA, Bussey BF, Allison DB, Beasley TM, Henson CS, Heimburger DC.** Effects of outcome-driven insurance reimbursement on short-term weight control. Int J Obes Relat Metab Disord. 2003;27:1423-9. [PMID: 14574356]
31. **Jeffery RW, Wing RR.** Long-term effects of interventions for weight loss using food provision and monetary incentives. J Consult Clin Psychol. 1995;63:793-6. [PMID: 7593872]
32. **Jeffery RW, Wing RR, Thorson C, Burton LR, Raether C, Harvey J, et al.** Strengthening behavioral interventions for weight loss: a randomized trial of food provision and monetary incentives. J Consult Clin Psychol. 1993;61:1038-45. [PMID: 8113481]
33. **Lahiri S, Faghri PD.** Cost-effectiveness of a workplace-based incentivized weight loss program. J Occup Environ Med. 2012;54:371-7. [PMID: 22371060]
34. **Morgan PJ, Collins CE, Plotnikoff RC, Cook AT, Berthon B, Mitchell S, et al.** Efficacy of a workplace-based weight loss program for overweight male shift workers: the Workplace POWER (Preventing Obesity Without Eating like a Rabbit) randomized controlled trial. Prev Med. 2011;52:317-25. [PMID: 21300083]
35. **Relton C, Strong M, Li J.** The 'Pounds for Pounds' weight loss financial incentive scheme: an evaluation of a pilot in NHS Eastern and Coastal Kent. J Public Health (Oxf). 2011;33:536-42. [PMID: 21447522]
36. **Seidman LS, Sevelius GG, Ewald P.** A cost-effective weight loss program at the worksite. J Occup Med. 1984;26:725-30. [PMID: 6436454]
37. **Swenson O.** Are we all less risky and more skillful than our fellow drivers? Acta Psychologica. 1981;47:143-8.
38. **Hoelzl E, Loewenstein G.** Wearing out your shoes to prevent someone else from stepping into them: anticipated regret and social takeover in sequential decisions. Organizational Behavior and Human Decision Processes. 2005;98:15-27.
39. **Kahneman D, Tversky A.** Prospect theory: an analysis of decision under risk. Econometrica. 1979;47:263-92.
40. **Connolly T, Butler D.** Regret in economic and psychological theories of choice. J Behav Decis Mak. 2006;19:139-54.
41. **Zeelenberg M, Pieters R.** Consequences of regret aversion in real life: the case of the Dutch postcode lottery. Organizational Behavior and Human Decision Processes. 2004;93:155-68.
42. **Asch DA, Muller RW, Volpp KG.** Automated hovering in health care—watching over the 5000 hours. N Engl J Med. 2012;367:1-3. [PMID: 22716935]
43. **Johnson F, Pratt M, Wardle J.** Dietary restraint and self-regulation in eating behavior. Int J Obes (Lond). 2012;36:665-74. [PMID: 21829162]
44. **Franz MJ, VanWormer JJ, Crain AL, Boucher JL, Histon T, Caplan W, et al.** Weight-loss outcomes: a systematic review and meta-analysis of weight-loss clinical trials with a minimum 1-year follow-up. J Am Diet Assoc. 2007;107:1755-67. [PMID: 17904936]
45. **Davis MJ, Addis ME.** Predictors of attrition from behavioral medicine treatments. Ann Behav Med. 1999;21:339-49. [PMID: 10721442]
46. **Honas JJ, Early JL, Frederickson DD, O'Brien MS.** Predictors of attrition in a large clinic-based weight-loss program. Obes Res. 2003;11:888-94. [PMID: 12855759]
47. **Teixeira PJ, Going SB, Houtkooper LB, Cussler EC, Metcalfe LL, Blew RM, et al.** Pretreatment predictors of attrition and successful weight management in women. Int J Obes Relat Metab Disord. 2004;28:1124-33. [PMID: 15263921]
48. **Towers Watson.** Health Care Changes Ahead. Philadelphia: Towers Watson; 2011. Accessed at www.towerswatson.com/assets/pdf/5622/TW-survey-report_HC-Changes-Ahead_101411.pdf on 4 February 2013.
49. **Volpp KG, Asch DA, Galvin R, Loewenstein G.** Redesigning employee health incentives—lessons from behavioral economics. N Engl J Med. 2011;365:388-90. [PMID: 21812669]
50. **Madison KM, Volpp KG, Halpern SD.** The law, policy, and ethics of employers' use of financial incentives to improve health. J Law Med Ethics. 2011;39:450-68. [PMID: 21871042]

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Appendix

Multiple Imputation Methods

Multiple imputation was implemented using PROC MI in SAS, version 9.3. The following variables were included as covariates to predict 24- and 36-week weights: incentive group, age, sex, race, education, household income, baseline weight, importance of controlling weight, and confidence in controlling weight. Importance of and confidence in controlling weight were both measured in the online baseline survey on a scale from 0 to 10, in which higher scores indicate greater importance of and more confidence in controlling weight. The expectation–maximization algorithm (51) was used to produce maximum likelihood estimates; because we had monotone missing data patterns, we used the parametric regression imputation procedure assuming multivariate normality and missing-at-random data (52). After the 5 imputed data sets were obtained, we used PROC GLM to conduct *t* tests for each data set separately; results from these analyses were combined using the standard formulae presented by Rubin (52), as implemented in PROC MIANALYZE in SAS, version 9.3.

Attainment of Weight-Loss Goals

In the first month, more group-incentive participants met their weight-loss goals than control group participants (difference, 42 percentage points [CI, 19 to 62 percentage points]; $P < 0.001$). This pattern continued through the fourth month, when more group-incentive participants met their monthly goals than control participants (difference, 32 percentage points [CI, 9 to 53 percentage points]; $P < 0.001$).

Overall, the median number of monthly weight-loss goals met statistically significantly differed between group-incentive participants and both control (difference, 2 [CI, 1 to 3]; $P < 0.001$) and individual-incentive (difference, 1 [CI, 0 to 2]; $P = 0.010$) participants. However, the proportion of participants in each group who met the overall 10.8-kg weight-loss goal did not statistically significantly differ (**Appendix Table 3**).

51. **Dempster AP, Laird NM, Rubin DB.** Maximum likelihood from incomplete data via the EM algorithm. J R Stat Soc Series B Stat Methodol. 1977;Series B(39):1-38.
52. **Rubin DB.** Multiple Imputation for Nonresponse in Surveys. New York: J Wiley; 1987.

Appendix Table 1. 24-Week Weight Loss Including the Participant Excluded Due to Pregnancy*

Weight Loss	Within-Group Change			Between-Group Difference in Change		
	Control Group (n = 35)	Individual-Incentive Group (n = 35)	Group-Incentive Group (n = 35)	Individual-Incentive Group vs. Control Group	Group-Incentive Group vs. Individual-Incentive Group	Group-Incentive Group vs. Control Group
Mean weight loss, *kg*†	0.4	1.7	4.8	1.2	3.2	4.3
95% CI	−1.1 to 2.0	0.0 to 3.3	3.2 to 6.3	−1.0 to 3.4	0.9 to 5.4	2.1 to 6.5
P value for comparison				0.30	0.006	<0.001

* This participant discontinued the study after 10 wk.
† Measure uses both observed and imputed data.

Appendix Table 2. 24-Week Longitudinal Weight Loss

Weight Loss	Within-Group Change			Between-Group Difference in Change		
	Control Group (n = 35)	Individual-Incentive Group (n = 35)	Group-Incentive Group (n = 35)	Individual-Incentive Group vs. Control Group	Group-Incentive Group vs. Individual-Incentive Group	Group-Incentive Group vs. Control Group
Mean weight loss, *kg**	1.0	2.1	5.8	1.1	3.7	4.8
95% CI	−0.6 to 2.6	0.1 to 4.1	4.1 to 7.6	−1.4 to 3.6	1.1 to 6.4	2.5 to 7.2
P value for comparison				0.39	0.006	<0.001

* Measure uses only observed data. Every participant is included, using only observed weight measurements.

Appendix Table 3. **Attainment of Weight-Loss Goals***

Measure	Within-Group Change†			Between-Group Difference in Change		
	Control Group (n = 35)	Individual-Incentive Group (n = 35)	Group-Incentive Group (n = 35)	Individual-Incentive Group vs. Control Group	Group-Incentive Group vs. Individual-Incentive Group	Group-Incentive Group vs. Control Group
Met monthly weight-loss goal						
4 wk						
Participants, %	34	54	76	20	22	42
95% CI	19 to 52	37 to 71	59 to 89	−5 to 43	−1 to 45	19 to 62
P value for comparison				0.148	0.077	<0.001
8 wk						
Participants, %	17	29	47	11	18	30
95% CI	7 to 34	15 to 46	30 to 65	−13 to 35	−6 to 40	6 to 50
P value for comparison				0.39	0.140	0.010
12 wk						
Participants, %	6	20	47	14	27	41
95% CI	1 to 19	8 to 37	30 to 65	−11 to 38	3 to 48	18 to 60
P value for comparison				0.151	0.022	<0.001
16 wk						
Participants, %	3	14	35	11	21	32
95% CI	0 to 15	5 to 30	20 to 54	−13 to 35	−3 to 42	9 to 53
P value for comparison				0.198	0.054	<0.001
20 wk						
Participants, %	3	9	18	6	9	15
95% CI	0 to 15	2 to 23	7 to 35	−19 to 30	−15 to 31	−9 to 37
P value for comparison				0.61	0.31	0.055
24 wk						
Participants, %	0	3	9	3	6	9
95% CI	0 to 10	0 to 15	2 to 24	−22 to 37	−18 to 29	−15 to 31
P value for comparison				1.00	0.36	0.114
Met overall 10.8-kg weight-loss goal						
Participants, %	0	3	15	3	12	15
95% CI	0 to 11	0 to 17	5 to 32	−21 to 27	−13 to 35	−9 to 38
P value for comparison				0.49	0.198	0.053
Months the goal was met						
Median months, *n*	0	1	2.5	0	1	2
95% CI	0 to 1	0 to 1	1 to 3	0 to 1	0 to 2	1 to 3
P value for comparison				0.141	0.010	<0.001

* With Bonferroni correction for 3-way comparison, the threshold for statistical significance was 0.0167.
† Numbers in each group at the start of the intervention. Because all measures use observed data only, the number in each group decreases over time due to missing data. The numbers by week by group are shown in **Figure 2**.