Weight-Loss Maintenance for 10 Years in the National Weight Control Registry

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Background: The challenge of weight-loss maintenance is well known, but few studies have followed successful weight losers over an extended period or evaluated the effect of behavior change on weight trajectories.

Purpose: To study the weight-loss trajectories of successful weight losers in the National Weight Control Registry (NWCR) over a 10-year period, and to evaluate the effect of behavior change on weight-loss trajectories.

Methods: A 10-year observational study of self-reported weight loss and behavior change in 2886 participants (78% female; mean age 48 years) in the NWCR who at entry had lost at least 30 lbs (13.6 kg) and kept it off for at least one year. Data were collected in 1993–2010; analysis was conducted in 2012.

Main outcome measures: Weight loss (kilograms; percent weight loss from maximum weight).

Results: Mean weight loss was 31.3 kg (95% CI=30.8, 31.9) at baseline, 23.8 kg (95% CI=23.2, 24.4) at 5 years and 23.1±0.4 kg (95% CI=22.3, 23.9) at 10 years. More than 87% of participants were estimated to be still maintaining at least a 10% weight loss at Years 5 and 10. Larger initial weight losses and longer duration of maintenance were associated with better long-term outcomes. Decreases in leisure-time physical activity, dietary restraint, and frequency of self-weighing and increases in percentage of energy intake from fat and disinhibition were associated with greater weight regain.

Conclusions: The majority of weight lost by NWCR members is maintained over 10 years. Long-term weight-loss maintenance is possible and requires sustained behavior change.
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Introduction

The problem of long-term weight-loss maintenance is well known.[1,2] Although initial weight losses of 5%–10% of body weight are achievable and prevent chronic diseases,[3–6] concerns about sustaining these weight losses have led some to question the wisdom of encouraging weight-loss efforts.[7]

It is often reported that most people who lose weight will regain it within 5 years,[8] but this conclusion is not always supported by data. Using National Health and Nutrition Examination Survey (NHANES) data, Weiss and colleagues reported that among 1300 adults who had lost 10% or more of their body weight, 58% maintained this weight loss and 7% lost more weight over the following year.[9] McGuire and colleagues,[10] using a random-digit-dialing survey, found similar results; among those who had achieved a 10% weight loss, almost half maintained a 10% weight loss for at least 1 year, and 25% for at least 5 years. Clinical studies also report more long-term success than often assumed. In a recent report from Look AHEAD (Action in Health for Diabetes), a clinical trial of lifestyle intervention in more than 5000 adults with type 2 diabetes, 42% of the 887 participants who lost at least 10% of their body weight at Year 1 maintained at least a 10% weight loss at 4 years.[6]

The National Weight Control Registry (NWCR) provides another way to examine this issue. It was founded in

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1993 to identify successful weight-loss maintainers and describe strategies used to achieve and maintain weight loss.[11–15] This article reports on their pattern of weight change over a 10-year follow-up and examines the association between baseline characteristics and changes in key behaviors on the trajectory of weight change.

Methods

Participants

Eligibility criteria for the NWCR include ≥30 pounds (13.6 kg) weight loss, maintained for ≥1 year. Although there are currently more than 10,000 NWCR members, the present analysis focused on the 3284 individuals who enrolled between 1993 and 2000 and thus could have reached the 10-year follow-up. Participants were also required to have completed at least two of the ten annual follow-up questionnaires because of the analytic approach described below, reducing the sample to 2886.

Procedures

Participants are recruited through unpaid coverage in various media (e.g., newspapers, magazines, television) and join by calling a 1-800 number or visiting the NWCR website. Participants are asked to verify their weight loss by providing physician documentation, before and after photos, or a collateral testimony from family or friends. Questionnaires are then sent at entry and once annually for 5 years. At Year 5, they are required to re-consent to continue participating for another 5 years. All procedures were approved by the IRB of the Miriam Hospital.

Measures

Demographics and weight history are collected via questionnaire at baseline. As in previous studies, participants were categorized as having no college or at least some college education, and having maintained their weight loss for <2 or ≥2 years upon enrollment in the NWCR.[14] Current body weight is collected yearly for 10 years via follow-up questionnaires. Previous research has shown that body weights collected via questionnaire in the NWCR are highly accurate (r=0.97).[14] BMI was calculated using standard formula.

Weight-related behaviors are measured at baseline and 1 year via established questionnaires with adequate psychometric properties.[16–18] Dietary intake is assessed via the Block Food Frequency Questionnaire, which provides estimates of daily energy intake and percentage of energy intake from fat.[16] Calories expended through leisure-time physical activity (PA) are assessed with the Paffenbarger Activity Questionnaire.[17] The Three Factor Eating Questionnaire is used to measure dietary restraint (defined as conscious efforts to restrict food intake) and disinhibition (defined as a tendency toward over-eating and loss of control).[18] Participants complete a single question indicating frequency of self-weighing and are categorized as weighing themselves several times per day, 1 time per day, several times per week, 1 time per week, less than 1 time per week, or less than 1 time per month. Other questionnaires are administered, but are not reported on in this paper.

An adverse behavior change index, ranging from 0 to 5, was calculated for each participant to reflect the extent to which, from baseline to 1 year, they modified their behavior in a way that could place them at increased risk for weight regain.[13,14] One point was assigned and summed for each participant who showed (1) a decrease in PA ≥ mean change+1 SD; (2) an increase in percentage of energy intake from fat ≥ mean change+1 SD; (3) a decrease in dietary restraint ≥ mean change+1 SD; (4) an increase in disinhibition ≥ mean change+1 SD; and/or (5) a decrease in the frequency of self-weighing.

Statistical Analysis

Analyses were conducted in 2012 using PASW Statistics 19. Linear mixed models using a restricted maximum likelihood (REML) approach were used to estimate the weight-loss trajectories (kilograms and percent weight loss from maximum weight) across the 10-year follow-up period. Unconditional models were used to examine the average weight-loss trajectory in the absence of covariates and evaluate the variance components associated with intercepts and slopes, which were both treated as random effects in all models. Four additional analyses were conducted to evaluate predictors of weight-loss trajectories. In the first, baseline demographic and weight history characteristics were added to the model simultaneously to predict weight-loss trajectories; only the significant predictors were retained. In a second analysis, baseline values of the behavioral factors were added simultaneously to the unconditional model. Changes in the behavioral factors from baseline to 1 year were added to this model in a third analysis; only the significant predictors were retained. In the fourth analysis, the adverse behavior change index was added to the unconditional model to predict weight-loss trajectories. The final two analyses focused on behavior change over the first year of participation in the NWCR in order to demonstrate prospective effects on weight change. Least squares means were used to estimate weight loss at each year of follow-up. Tests of significance were conducted at α=0.05.

The analytic approach accommodated missing data by allowing all participants with a baseline questionnaire and least two follow-up questionnaires to contribute to the analysis. The effect of missing data on model estimates was assessed in a sensitivity analysis in which a covariate representing the degree of missing data (0=less than 50% missing data, 1=50% or more missing data) was added to the unconditional model. As described below, missing data appeared to have a weak effect on model estimates. Nonetheless, given concerns about the effect of attrition on results, two unconditional models of 10-year weight-loss trajectories were evaluated; one included all participants and a second included only participants who re-consented to follow-up for Years 6–10. Both models are depicted (Figure 1). The more conservative model (i.e., the model depicting greatest regain) was selected for detailed reporting and use in subsequent analyses of predictors in order to best accommodate any bias that may have occurred as the result of attrition.

Results

Participant Characteristics

Baseline characteristics and weight-related behaviors of the 2886 participants are reported in Tables 1 and 2, respectively. Participants entered the registry after losing 31.3 kg (95% CI=30.8, 31.9) on average and keeping it off 6.2 years (95% CI=5.9, 6.5).

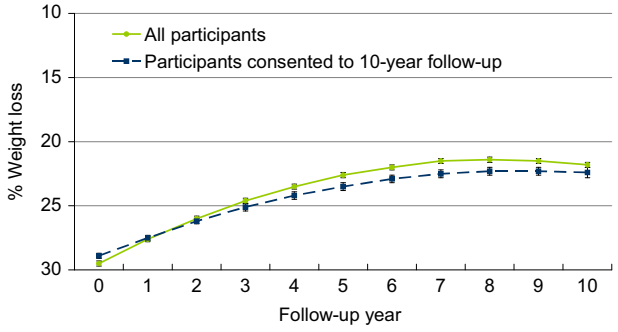

Figure 1. Ten-year weight change
Note: Model estimates of weight change (measured as percent weight loss from maximum weight) over the 10-year follow-up period for the sample as a whole (solid line; N=2886) and for the subset of participants who consented to follow-up during Years 6–10 (dashed line; *n*=1464). Error bars represent the standard error of the mean.

Follow-Up Completion Rates

Participants completed a mean (SD) of 5.9 (3.3) of the 10 yearly follow-up assessments. Completion rates were higher in the first 5 years (3.8 [1.4] of 5 assessments) than in the second 5 years (2.2 [2.3] of 5 assessments) and 49.3% of participants contributed no data beyond 5 years, probably because of the need to repeat the informed consent procedures at this time. Table 1 depicts differences in the baseline characteristics of those who did and did not consent to follow-up during Years 6–10. Most of the differences are significant because of the large sample size, but the magnitude of the difference is small. The exception is years of maintenance prior to NWCR entry, where it is evident that individuals with a longer history of successful maintenance were more likely to participate in extended follow-up. Analyses conducted to explore the effect of missing data on the estimates of weight-loss trajectories indicated a significant effect ($p<0.001$) of small magnitude, suggesting that compared to individuals with $<50\%$ missing data, the weight regain of individuals with $\geq 50\%$ missing data may be underestimated by about 1.8% weight loss from maximum weight.

Ten-Year Weight Change

Weight change over the 10 years following enrollment in the NWCR is depicted in Figure 1. The model is shown for both all participants and only those who consented to 10-year follow-up. The model including all participants was found to be more conservative, and so this model was selected for subsequent analysis. Weight trajectories were curvilinear, with more rapid regain early in the follow-up period, and very little regain after Year 5.

At enrollment, NWCR participants had lost 31.3 kg (95% CI=30.8, 31.9; 29.7% weight loss from maximum weight, 95% CI=29.3, 30.0). They maintained an average estimated weight loss of 23.8 kg (95% CI=23.2, 24.4; 22.6% weight loss from maximum weight, 95% CI=22.1, 23.0) at 5 years, and 23.1 kg (95% CI=22.3, 23.9; 21.8% weight loss from maximum weight, 95% CI=21.2, 22.4) at 10 years. Moreover, 88.4% and 86.6% were estimated to have maintained a weight loss of at least 10% from maximum weight at 5 years and 10 years, respectively.

Predictors of Weight Change

Demographics and Weight History. Figure 2 shows the association of demographic characteristics and weight trajectories. Each of these variables contributed independently to the prediction of weight regain, but the two most noteworthy predictors were magnitude of initial weight loss and duration of weight loss (both $p<0.001$). As depicted in Figure 2A, participants with larger initial weight losses experienced slightly faster regain early in the follow-up period. Despite this, they maintained substantially larger weight loss over the 10-year follow-up period. Initial weight loss was highly correlated with lifetime maximum weight ($r=0.81$, $p<0.001$). Thus, the same finding is seen if participants are categorized according to maximum lifetime body weight; heavier participants tended to regain more quickly initially but maintained significantly greater weight losses throughout the 10 years (data not shown).

The duration of weight-loss maintenance at NWCR enrollment was also associated with weight-loss trajectories. As depicted in Figure 2B, individuals who had maintained their weight loss for ≥ 2 years upon NWCR enrollment (2045, 70.9%) maintained larger weight losses at baseline (difference, 1.5% weight loss from maximum weight, 95% CI=1.0, 1.9; $p<0.001$) and experienced slower regain ($p<0.001$) over time. As a result, participants with at least 2 years of maintenance at enrollment continued to maintain larger weight losses at 5 years (difference, 6.3% weight loss from maximum weight, 95% CI=5.5, 7.2; $p<0.001$) and 10 years (difference, 6.2% weight loss from maximum weight, 95% CI=4.8, 7.5; $p<0.001$).

Women entered the NWCR with a slightly larger initial percent weight loss than men (difference, 3.8% weight loss from maximum weight, 95% CI=3.3, 4.3; $p<0.001$) but difference in percent weight loss by gender was not significant after Year 5 (Figure 2C). There was a weak, but significant ($p=0.04$), effect of level of education on weight-loss trajectories, such that less-educated participants tended to have a slightly flatter rate of weight regain (Figure 2D). However, there were no differences at any year in percent weight loss by level of education. Ethnic and racial background was not associated with initial weight loss or weight change.

Table 1. Demographic characteristics and weight history

	Full sample (N=2886)	Consented for Year 6–10 follow-up (*n*=1464)	Did not consent for Year 6–10 follow-up (*n*=1422)
Gender (%)			
Men	22.5	23.5	21.5
Women	77.5	76.5	78.5
Age (SD), years	47.8 (12.4)	49.2 (12.0)	46.4 (12.6)***
Ethnicity (%)			
Caucasian	95.7	96.9	94.4**
African-American	2.1	1.6	2.7
Asian	0.3	0.3	0.3
Hispanic	1.0	0.6	1.5
Other	0.9	0.6	1.1
Marital status (%)			
Single	19.7	18.4	21.0***
Married	65.3	67.9	62.6
Separated/divorced	15.0	13.7	16.4
Education (%)			
High school or less	11.9	11.7	12.2***
Some college	33.7	29.1	38.4
College or university degree	25.4	25.5	25.2
Graduate degree	29.0	33.7	24.2
Weight history, M (SD)			
Maximum weight, kg	102.0 (24.9)	100.0 (22.9)	104.0 (26.8)***
Weight at enrollment, kg	70.6 (15.3)	70.0 (14.4)	71.3 (16.1)*
Maximum BMI	35.9 (7.9)	35.2 (7.3)	36.6 (8.5)***
BMI at enrollment	24.8 (4.5)	24.6 (4.2)	25.1 (4.8)**
Weight loss at enrollment, kg	31.3 (16.3)	30.0 (14.6)	32.7 (17.7)***
Percent of maximum weight	29.7 (9.2)	29.1 (8.7)	30.2 (9.6)***
Duration of weight loss, y	6.2 (8.0)	7.2 (8.7)	5.3 (7.3)***

Note: All values were obtained at the time of study enrollment.

Behavior Change from Baseline to 1-Year Follow-Up. Baseline levels of dietary intake, percent of calories from fat, restraint, disinhibition, self-weighing frequency, and leisure-time caloric expenditure were not associated with 10-year weight change. However, with the exception of dietary intake, adverse changes in each behavior from baseline to 1 year were independently associated with 10-year weight-loss trajectories (Figure 3; all $p<0.05$). Decreases in leisure-time caloric expenditure, restraint, and self-weighing frequency from baseline to 1 year were associated with increased weight regain across the 10-year follow-up, as were increases in percent of intake from fat and disinhibition. Table 2 presents the mean and SD of the changes in each behavior from baseline to Year 1.

The additive effect of changes in multiple behaviors was measured via the adverse behavior change index, which ranged from 0 to 5 for each participant (0=no high-risk behaviors adopted, 1=1 high-risk behavior adopted). The proportion of participants with each value was as follows: 0 (55.9%); 1 (33.0%); 2 (8.5%); 3 (1.8%); 4 (0.7%); and 5 (0.0%). This index was significantly associated with weight trajectories ($p<0.001$; Figure 3).

Table 2. Weight-related behaviors (N=2886)

	Baseline	1-year follow-up	Change from baseline to 1 year
Daily dietary intake, M (SD), kcal	1399.2 (11.0)	1411.3 (12.2)	3.7 (464.5)
Percent calories from fat, M (SD)	26.4 (0.2)	27.2 (0.2)	0.8 (6.5)
Leisure-time caloric expenditure, M (SD), kcal/week	2617.6 (46.3)	2364.4 (52.2)	−267.3 (2035.2)
Dietary restraint, M (SD)	14.9 (0.1)	14.5 (0.1)	−0.4 (2.9)
Disinhibition, M (SD)	6.6 (0.1)	6.9 (0.1)	0.3 (2.4)
Self-weighing frequency (%)			
several times/day	6.5	5.0	
1 time/day	29.1	26.4	14.0% increased
several times/week	18.4	18.1	58.9% no change
1 time/week	23.4	20.9	27.1% decreased
<1 time/week	11.0	12.4	
<1 time/month	11.6	17.0	

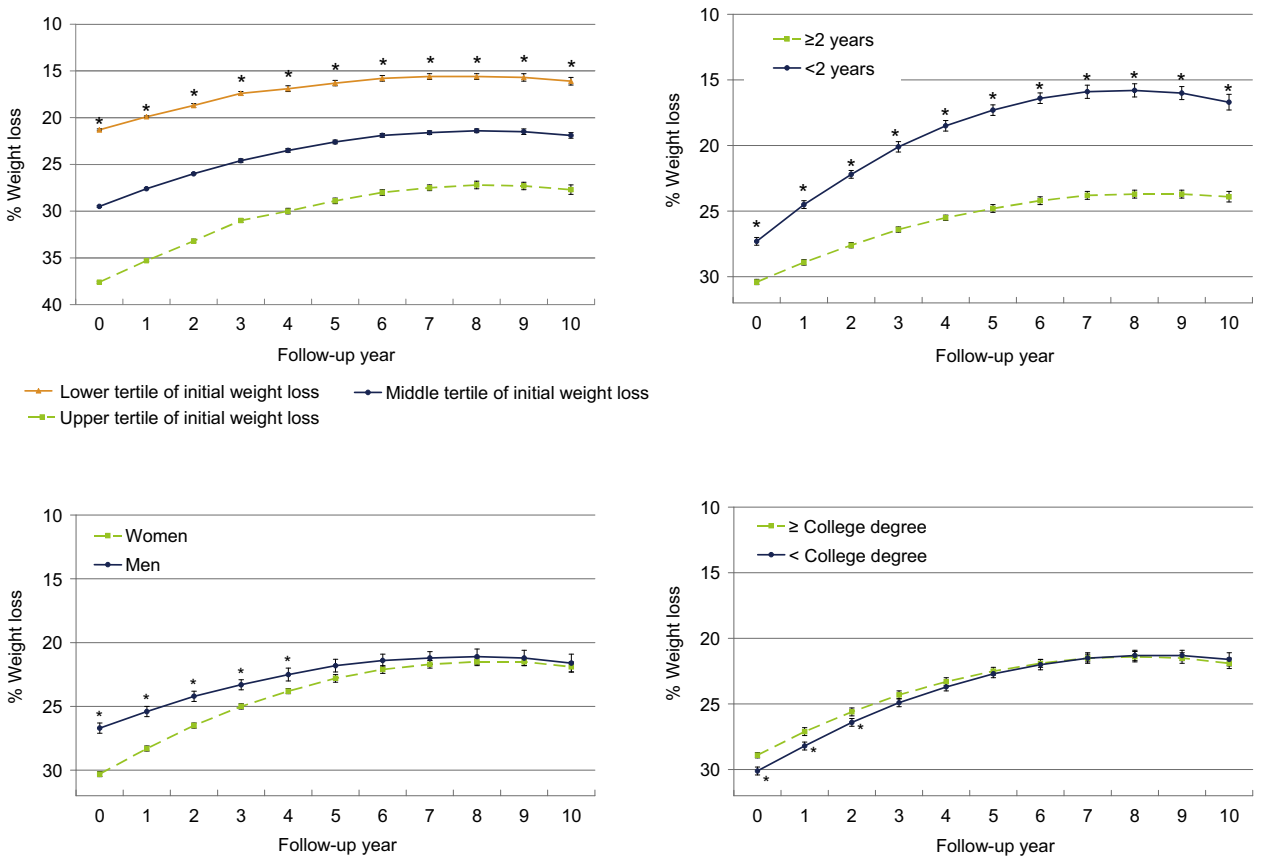

Figure 2. Predictors of weight change

Note: Model estimates of weight change (measured as percent weight loss from maximum weight) over the 10-year follow-up period with the following covariates: (1) magnitude of the initial weight loss at baseline (sample divided by tertiles); (2) duration of weight loss at baseline; (3) gender; and (4) level of education at baseline. Error bars represent the standard error of the mean. An asterisk denotes a significant difference between groups at $p<0.05$ at the given year.

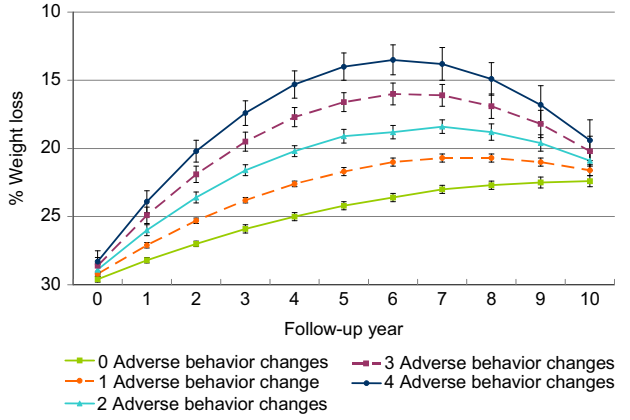

Figure 3. Relationship between behavior change from baseline to 1 year and weight change

Note: Model estimates of weight change (measured as percent weight loss from maximum weight) over the 10-year follow-up period, as a function of the total number of adverse behavior changes from baseline to 1 year.

Individuals with scores of 0 demonstrated the least regain, and there was an additive effect of each additional adverse behavior change.

Discussion

Although the NWCR is a highly select group, the data from this study are important in documenting the possibility of achieving long-term weight-loss maintenance and the variables associated with success. This is the first study to follow successful weight losers over a 10-year period. Although some weight regain occurred over time, participants maintained an average estimated weight loss of 23.8 kg (77% of their initial weight loss) at 5-year follow-up, and 23.1 kg (74% of their initial weight loss) at 10 years. Using a 10% weight loss as the criterion of success, 88% were estimated to be still successful at Year 5 and 87% at Year 10.

This study also provides important data on the trajectory of weight change. Regain was shown to be fastest in the early years of follow-up, with decreasing rates over each of the first 5 years, followed by relatively stable maintenance over the subsequent 5 years. Similarly, individuals who had maintained their weight loss for $\geq$ 2 years upon study enrollment experienced slower regain and continued to maintain larger weight loss at 5 and 10 years. This is consistent with previous research from the NWCR suggesting that weight-loss maintenance becomes less effortful over time.[19]

These data also show clearly that those who had larger initial weight losses at entry into the NWCR maintained larger weight losses throughout the entire follow-up period. Similarly, a large number of clinical trials also provide evidence that those who lose more weight initially achieve the best long-term success.[3–6] Thus, obese participants in weight-loss programs should be encouraged to achieve large weight losses in order to obtain the largest health benefits, with the recognition that even if this leads to slightly greater weight regain, the overall sustained weight losses will be greater.

The successful weight losers in the current sample, like those in prior analyses, reported high levels of physical activity, low calorie and fat intake, high levels of restraint, and low levels of disinhibition.[11–15] In addition, most participants weighed themselves at least several times a week.[20] However, none of these behaviors at baseline were related to subsequent weight regain, a finding often observed in studies attempting to predict weight-loss outcomes.[14,20–22]

In contrast, adverse changes in each of these behaviors from baseline to Year 1, with the exception of change in total caloric intake, were related to weight-gain trajectories. The failure to see an association with changes in caloric intake likely reflects the inaccuracies inherent in this measure. However, those participants who reported large decreases in physical activity, dietary restraint, and self-weighing frequency, and increases (worsening) in their level of disinhibition, experienced the greatest weight regains. The role of dietary fat in the treatment of obesity has become somewhat contentious.[23,24] As in prior NWCR research, maintaining low levels of dietary fat was associated with better weight-loss maintenance. Although previous studies have shown that changes in weight-related behaviors often cluster together,[25,26] the current study found that change in each of these behaviors was independently related to outcome, and that each high-risk behavior change had an additive effect on weight regain. Of note, more than half of participants (55.9%) reported no adverse behavior change from baseline to 1 year. An important clinical message is that continued adherence to each behavior can improve long-term outcomes.

Although the behaviors examined in this study are not novel, most previous studies have examined changes in behavior occurring concurrently with changes in weight. This is one of the only studies to examine the relationship prospectively and show that changes in behaviors over a short time period (1 year) are predictive of outcomes 1–9 years later.

Limitations of this study include loss to follow-up over the 10-year period, although the analytic approach allowed all available data from all 2886 participants to be included in the analysis. Sensitivity analysis suggests that attrition had a relatively minor effect on model estimates, and the most conservative model was explicitly selected, which depicted the greatest rate of weight regain. Data were collected via self-report measures, which could be susceptible to bias. However, participants were asked to provide evidence of their initial weight

loss, and previous research suggests that self-reported weights in the NWCR are highly accurate.[14] Additionally, changes in behavioral factors were examined only at the 1-year follow-up, rather than examining temporally contiguous changes in behavior on weight trajectories. Lastly, the NWCR is a largely homogenous sample, and thus it is unknown whether the findings from the NWCR are generalizable to more-diverse populations. This problem is further complicated by the wide geographic area from which NWCR members are drawn in the U.S.; environments across the U.S. vary, and the present study did not examine the potential influence this may have on weight maintenance trajectories. However, findings from a random-digit-dial national telephone survey suggest that the NWCR may be representative of the larger population of U.S. weight losers.[10] Important strengths of this study include the large sample size, the examination of weight-loss maintenance over an extended period, and the assessment of a variety of demographic and behavioral predictors of weight trajectories.

In summary, this study provides evidence that some individuals can successfully maintain substantial weight losses over a long-term follow-up, despite environmental and physiological challenges that they may face, and emphasizes the importance of maintaining key behavior changes to maintain weight losses long-term and prevent risk of disease.

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