
Weight Regain in U.S. Adults Who Experienced Substantial Weight Loss, 1999–2002

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Background: Relatively few studies have focused on who is at risk for weight regain after weight loss and how to prevent it. The objectives of this study were to determine the prevalence and predictors of weight regain in U.S. adults who had experienced substantial weight loss.

Methods: Data were analyzed from the 1999–2002 National Health and Nutrition Examination Survey (NHANES). This study examined U.S. adults aged 20–84 years who were overweight or obese at their maximum weight (body mass index ≥ 25) and had experienced substantial weight loss (weighed 10% less than their maximum weight 1 year before they were surveyed) ($n=1310$).

Results: Compared to their weight 1 year ago, 7.6% had continued to lose weight ($>5\%$), 58.9% had maintained their weight (within 5%), and 33.5% had regained weight ($>5\%$). Factors associated with weight regain (vs weight maintenance or loss) included Mexican American ethnicity (versus non-Hispanic white) (odds ratio [OR]=2.0; 95% confidence interval [CI]=1.3–3.1), losing a greater percentage of maximum weight ($\geq 20\%$ vs 10% to $<15\%$) (OR=2.8; 95% CI=2.0–4.1), having fewer years since reaching maximum weight (2–5 years vs >10 years) (OR=2.1; 95% CI=1.2–3.7), reporting greater daily screen time (≥ 4 hours vs 0–1 hour) (OR=2.0; 95% CI=1.3–3.2), and attempting to control weight (OR=1.8; 95% CI=1.1–3.0). Finally, weight regain was higher in those who were sedentary (OR=1.8; 95% CI=1.0–3.0) or not meeting public health recommendations for physical activity (OR=2.0; 95% CI=1.2–3.5).

Conclusions: How to achieve the skills necessary for long-term maintenance of weight loss in the context of an obesogenic environment remains a challenge.
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Introduction

Overweight and obese individuals who lose as little as 10% of their body weight reduce their risk factors for diabetes and cardiovascular disease.^{1,2} Conversely, those who later regain weight experience adverse effects on blood pressure and serum lipid levels³ as well as a reduced health-related quality of life.⁴

Most patients in clinical weight-loss programs regain weight after completing treatment. Patients treated by lifestyle modification generally regain 30% to 35% of their lost weight in the year after treatment and will have regained the majority if not all of the lost weight by 5 years.^{5–8} Furthermore, once weight regain occurs, re-losing weight is challenging. A study of recovery from relapse among successful weight maintainers showed

that of those who regained $\geq 5\%$ of their post-loss weight in 1 year, only 13% re-lost at least half of their weight gain in the next year, and only 5% returned to their post-loss weight or below in the next year.⁹

To examine potential factors responsible for the rise in obesity, studies have explored the characteristics of normal weight, overweight, and obese individuals,¹⁰ described weight loss experiences and expectations,^{11,12} examined trends in population weight gain by sociodemographic group,^{13–15} and examined qualitative differences between weight maintainers and regainers.¹⁶ Less research has focused on who is at risk for weight regain after weight loss and how to prevent it. Most research of weight-loss maintainers has been conducted in populations that may not be representative of the general population. Examples include clinical weight-loss populations^{5–8,17–19} and populations of volunteers from the National Weight Control Registry, consisting of people who have already successfully maintained an intentional weight loss of 30 pounds or more for at least 1 year.^{20–24} The National Weight Control Registry found that larger and more recent weight losses were associated with weight regain.²⁰

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Additionally, weight regain has been associated with fast food consumption,²⁵ higher television viewing,¹⁸ and lower levels of physical activity.^{18,20,21,24,26}

An improved understanding of the factors associated with weight regain could lead to both the identification of those at highest risk for weight regain and the development and testing of more effective interventions to aid in long-term weight-loss maintenance. The objectives of this study were to determine the prevalence and predictors of weight regain in adults in the United States who had experienced substantial weight loss.

Methods

Data from the 1999–2002 National Health and Nutrition Examination Survey (NHANES), a continuous annual survey of the civilian non-institutionalized U.S. population, were used.²⁷ NHANES uses a complex, stratified, multistage probability sampling design. Data collected through in-home interviews were used, with an overall participation rate from 1999–2002 of 83.0% (S. Ramirez, National Center for Health Statistics, via e-mail, June 6, 2006).

Weight status and history were assessed through several questions. Maximum weight was defined by the question, “Up to the present time, what is the most you have ever weighed?”; age at maximum weight by, “How old were you then?”; and weight 1 year ago by, “How much did you weigh a year ago?” To be consistent with prior body weights defined by self-report, current weight and height were defined by the questions, “How much do you weigh without clothes or shoes?” and “How tall are you without shoes?” Body mass index (BMI) was calculated by dividing the participant’s self-reported weight in kilograms by their self-reported height in meters squared.

Percentage of maximum weight lost was calculated by subtracting weight 1 year ago from maximum weight, dividing by maximum weight, and multiplying by 100. Participants were considered to have experienced substantial weight loss if they had lost at least 10% of their maximum body weight during the period from their maximum weight to their weight 1 year ago.

Percentage of weight change in the past year was calculated as the difference between current weight and weight 1 year ago, divided by weight 1 year ago, and multiplied by 100. Using the result of this calculation, the main outcome categories were defined as weight regain (>5% weight gain in the past year), weight maintenance (staying within 5% of weight in the past year), and continued weight loss (losing >5% of weight in the past year) (Figure 1).

From 1999 to 2000, average daily screen time was assessed by the question, “Over the past 30 days, on a typical day, how much time altogether did you spend sitting and watching TV or videos or using a computer outside of work?” During half of the period from 2001 to 2002, average daily screen time was assessed with two questions: (1) “Over the past 30 days, on average, how many hours per day did you sit and watch TV or videos outside of work?” and (2) “Over the past 30 days, on average, how many hours per day did you use a computer or play computer games outside of work?” These results were

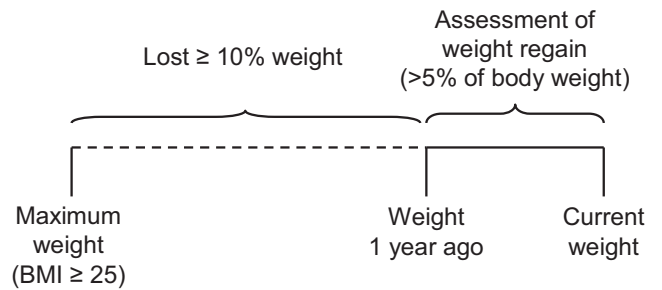


Figure 1. Scheme for assessing weight regain in overweight or obese participants (body mass index ≥ 25) who had lost $\geq 10\%$ of their maximum body weight from the time that they reached their maximum weight until 1 year ago. Weight regain was defined as a gain of $>5\%$ of body weight from weight 1 year ago to current weight.

combined to form an estimate of average daily screen time (TV, video, or computer use) for the entire period from 1999 to 2002.

Physical activity level was assessed by asking participants whether they had engaged in a series of moderate or vigorous leisure-time physical activities for 10 minutes or longer in the past 30 days. Physical activity level was analyzed in four discrete categories: (1) sedentary (reported no moderate or vigorous leisure-time physical activities for 10 minutes or longer); (2) active, not meeting recommendations (reported at least one moderate or vigorous leisure-time physical activity lasting 10 minutes or longer); (3) meeting public health recommendations for improved health,^{28,29} to engage in moderate-intensity physical activity on most, preferably all, days of the week for at least 30 minutes (≥ 5 bouts per week, 150 to <300 minutes of moderate or vigorous physical activity per week), or vigorous-intensity physical activity on 3 or more days of the week for at least 20 minutes (≥ 3 bouts per week, ≥ 60 minutes of vigorous-intensity physical activity per week); and (4) meeting 2005 dietary guidelines recommendations for sustaining weight loss (i.e., preventing weight regain) in adulthood,³⁰ to participate in at least 60 to 90 minutes of daily moderate-intensity physical activity (≥ 5 bouts per week, ≥ 300 minutes of moderate or vigorous physical activity per week).

The factors associated with weight regain were determined by multiple logistic regression, comparing those who regained weight with those who did not (i.e., continued to lose weight or maintained weight). The demographic variables included in the model were gender (male, female); age in years (20–34, 35–44, 45–54, 55–64, 65–74, 75–84); race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican American, other [including multiracial]); and education (less than high school, high school graduate, more than high school). Additional factors were included based on possible associations with body weight changes in the literature. Weight-related variables included percentage of maximum weight lost (from maximum weight to weight 1 year ago) (10% to $<15\%$, 15% to $<20\%$, $\geq 20\%$), years since reaching maximum weight (current age minus age at maximum weight) (2–5, 6–10, >10), and BMI 1 year ago (<25 , 25 to <30 , ≥ 30). Behavioral factors included smoking status (current nonsmoker, smoker who had quit in the past year, current smoker), average times per week of restaurant food consumption (<1 , 1–2, ≥ 3), average daily hours of screen

time outside of work during the past 30 days (0–1, 2–3, ≥4), attempting to control weight (i.e., lose or not gain weight) in the past year (no, yes), and physical activity level (sedentary; active, not meeting recommendations; meeting recommendations for improved health; meeting recommendations for sustaining weight loss).

Adults aged 20–84 years who were overweight or obese at their self-reported maximum weight (BMI ≥25) and had experienced substantial weight loss were included in the analysis (self-reported weight 1 year ago at least 10% lower than their self-reported maximum weight) ($n=1506$). Participants were excluded if they were pregnant or were missing pregnancy information ($n=88$) or if they were missing information on any of the demographic, behavioral, or weight-related factors in the multivariate model ($n=8$). After excluding those who reported unintentional weight loss (≥10 pounds) from weight 1 year ago to current weight ($n=100$), the final sample included 1310 adults. Data were weighted to account for the complex sampling design using SUDAAN version 9.0 (Research Triangle Institute, Research Triangle Park NC, 2005). Analyses were conducted from 2004 to 2006.

Results

The final weighted sample was divided evenly between men and women and was 75.8% non-Hispanic white, 10.6% non-Hispanic black, 4.9% Mexican American, and 8.8% other races or multiracial. Nearly half had completed more than a high school education, and about one quarter had not graduated from high school (Table 1).

Among adults who had experienced substantial weight loss, 7.6% ($n=98$) had continued to lose weight (>5%) in the past year, 58.9% ($n=785$) had maintained their weight (within 5%), and 33.5% ($n=427$) had regained weight (>5%). Because only 98 people in this sample continued to lose weight, they were combined with those who maintained their weight for the purposes of this analysis. The only demographic variable significantly associated with weight regain was Mexican American ethnicity, with the highest prevalence of weight regain (48.3%) and twice the odds of weight regain compared with non-Hispanic whites (Table 2).

Greater percentage of maximum weight lost and fewer years since reaching maximum weight were significantly positively associated with weight regain in the past year. Compared with those who had lost 10% to <15% of their maximum weight, the odds of weight regain were 1.5 for those who lost 15% to <20% and 2.8 for those who lost ≥20% of their maximum weight. Compared to those with more than 10 years since reaching their maximum weight, the odds of weight regain were 1.6 for those with 6 to 10 years, and 2.1 for those with 2 to 5 years.

Attempting to control weight, more daily screen time, and lower physical activity levels were also significantly associated with weight regain. Those who at-

Table 1. Demographics of U.S. adults^a who had experienced substantial weight loss,^b NHANES 1999–2002

	<i>n</i>	%
Overall	1310	
Gender		
Male	689	50.3
Female	621	49.7
Age (years)		
20–34	200	20.3
35–44	199	22.0
45–54	269	26.1
55–64	195	11.5
65–74	246	11.7
75–84	201	8.5
Race/ethnicity		
Non-Hispanic white	680	75.8
Non-Hispanic black	268	10.6
Mexican American	273	4.9
Other (including multiracial)	89	8.8
Education		
Less than high school	490	24.1
High school graduate	295	27.3
More than high school	525	48.7

Sample sizes were unweighted. Percentages were weighted to be nationally representative.

^aAged 20–84 years.

^bStudy population was limited to those who were overweight or obese at their maximum weight (body mass index ≥25) and had experienced substantial weight loss (weighed 10% less than their maximum weight 1 year before they were surveyed).

NHANES, National Health and Nutrition Examination Survey.

tempted to control their weight in the past year had significantly higher odds (1.8) of weight regain compared with those who did not. Compared with those reporting 0 to 1 daily hours of screen time, the odds of weight regain were 1.5 for those reporting 2 to 3 hours and 2.0 for those reporting 4 or more hours. Lastly, the odds of weight regain were approximately two times higher in those who were sedentary or not meeting public health recommendations for physical activity compared with those meeting 2005 dietary guideline recommendations for sustaining weight loss in adulthood.

Discussion

Among overweight or obese adults, weight regain after weight loss is a common problem. Approximately one-third of participants who had experienced substantial weight loss in this nationally representative study had regained more than 5% of their body weight in the previous year. Factors associated with weight regain included Mexican American ethnicity, greater percentage of maximum weight lost, fewer years since reaching maximum weight, attempting to control weight, greater daily screen time, and not meeting physical activity recommendations.

It is difficult to compare the prevalence estimates of weight regain with those of other studies because there

Table 2. Prevalence^a and predictors of weight regain^b among U.S. adults,^c NHANES 1999–2002

	Total participants <i>n</i>	Weight regain prevalence %	Weight regain predictors ^d OR (95% CI) ^e
Overall	1310	33.5	
Gender			
Male	689	28.9	1.0
Female	621	38.3	1.2 (0.8–1.7)
Age (years)			
20–34	200	39.7	1.0
35–44	199	34.0	0.8 (0.5–1.5)
45–54	269	40.5	1.3 (0.8–2.3)
55–64	195	30.0	1.0 (0.5–1.8)
65–74	246	22.8	0.6 (0.3–1.3)
75–84	201	16.1	0.5 (0.2–1.0)
Race/ethnicity			
Non-Hispanic white	680	31.0	1.0
Non-Hispanic black	268	37.3	1.2 (0.8–1.8)
Mexican American	273	48.3	2.0 (1.3–3.1)*
Other (including multiracial)	89	42.9	2.0 (1.0–4.1)
Education			
Less than high school	490	35.2	1.2 (0.8–1.8)
High school graduate	295	32.7	0.9 (0.6–1.5)
More than high school	525	33.2	1.0
Percentage of maximum weight lost^f			
10% to <15%	596	26.0	1.0
15% to <20%	335	34.0	1.5 (1.0–2.3)*
≥20%	379	45.8	2.8 (2.0–4.1)*
Years since reaching maximum weight			
2–5 years	327	43.9	2.1 (1.2–3.7)*
6–10 years	266	36.8	1.6 (1.0–2.4)*
>10 years	717	26.2	1.0
Body mass index (kg/m²) 1 year ago			
<25.0	549	34.2	1.5 (1.0–2.2)
25.0 to <30.0	502	33.2	1.3 (0.9–1.9)
≥30.0	259	32.8	1.0
Smoking status			
Current nonsmoker	913	31.7	1.0
Quit in past year	42	43.8	1.7 (0.7–4.5)
Current smoker	355	36.6	0.9 (0.6–1.4)
Average weekly restaurant food consumption			
<1 time per week	436	29.3	1.0
1–2 times per week	475	36.0	1.5 (0.9–2.7)
≥3 times per week	399	34.1	1.4 (0.9–2.3)
Average daily screen time^g			
0–1 hour	330	28.3	1.0
2–3 hours	591	33.7	1.5 (1.0–2.1)*
≥4 hours	389	38.1	2.0 (1.3–3.2)*
Attempting to control weight^h			
No	699	27.4	1.0
Yes	611	39.2	1.8 (1.1–3.0)*
Physical activity levelⁱ			
Sedentary	642	33.3	1.8 (1.0–3.0)*
Active, not meeting recommendations	308	40.9	2.0 (1.2–3.5)*
Meeting recommendations for improved health ^j	140	24.2	1.0 (0.5–2.0)
Meeting recommendations for sustaining weight loss ^k	220	28.7	1.0

Sample sizes were unweighted. Percentages were weighted to be nationally representative.

^aStudy population was limited to those who were overweight or obese at their maximum weight (body mass index ≥25) and had experienced substantial weight loss (weighed 10% less than their maximum weight 1 year before they were surveyed).

^bWeight regain was defined as a weight gain (>5%) in the past year.

^cAged 20–84 years.

^dComparison group is those who did not regain weight (>5%) (i.e., continued to lose weight or maintained weight).

^eOR adjusted for gender, age, race/ethnicity, education, smoking status, body mass index 1 year ago, percent previous weight loss, years since reaching maximum weight, average weekly restaurant food consumption, average daily screen time, attempted to control weight, and physical activity level.

^fFrom maximum weight, to weight 1 year ago.

^gDefined as average daily hours of TV, video, or computer use outside of work in the past 30 days.

^hDefined as attempting to lose or not gain weight in the past year.

ⁱThe total minutes spent on leisure-time physical activities in the previous 30 days was used to calculate the average minutes of weekly leisure-time physical activity.

^jMet recommendations for ≥5 bouts per week, 150 to <300 minutes per week of moderate or vigorous leisure-time physical activity, or ≥3 bouts per week, ≥60 minutes per week of vigorous leisure-time physical activity.

^kMet recommendations for ≥5 bouts per week, ≥300 minutes per week of moderate or vigorous leisure-time physical activity.

*Significant at $p < 0.05$ (bolded).

NHANES, National Health and Nutrition Examination Survey; OR, odds ratio; CI, confidence interval.

is no standard definition of weight regain^{20,31,32} and because most studies of weight regain have been conducted on select populations such as the National Weight Control Registry or clinical weight-loss populations.^{5-8,17-24,33} Most people who lose weight do so without clinical treatment,^{20,31,34} and as such, the prevalence estimates of weight regain in this study on a nationally representative sample may be more indicative of the general population.

Because this study used an ethnically diverse sample of the U.S. population, differences in weight regain by ethnicity could be documented; specifically, Mexican Americans were more likely than non-Hispanic whites to regain weight. This finding has not been previously reported and should be confirmed. Mexican Americans have a higher prevalence of overweight or obesity (72.5%) than non-Hispanic whites (63.3%).³⁵⁻³⁷ It is possible that the behavioral, cultural, and societal factors associated with Mexican Americans and weight may also be factors in weight regain. It has been suggested that as Mexican Americans assimilate into mainstream U.S. society, many adopt unhealthy food choices and become more sedentary.^{37,38} No data were collected before and after the period of weight regain, and as a consequence, changes in dietary behaviors and physical activity contributing to this regain could not be determined. Because Mexican Americans are disproportionately affected by obesity compared with non-Hispanic whites, more research on the factors influencing weight regain in Mexican Americans is needed.

Consistent with the National Weight Control Registry,²² this study demonstrates that weight regain was more common in those who lost a greater percentage of their maximum weight. One possible explanation is that those who lost larger percentages of their maximum weight may have had to make greater lifestyle changes that are difficult to incorporate and sustain. Another possibility is that those who lose larger amounts of weight may not be as concerned about relatively small regains.

Furthermore, weight regain was twice as high in those with fewer years since reaching their maximum weight. People who maintain weight loss longer report that less effort and attention are required to maintain weight loss.²³ Over time, the acquisition of critical behaviors or skills may protect against relapse.²³ Attempting to control weight was also associated with weight regain, although the lack of information on a temporal relationship in this cross-sectional study precludes a causal interpretation. Whether the participants trying to control their weight did so because of weight regain cannot be determined in this study.

Hours of television watched per week have previously been associated with weight regain after successful completion of a commercial weight loss program.¹⁸ Because adult TV viewing has consistently been associated with greater obesity risk,^{39,40} the finding that

higher daily screen time (including TV viewing) was associated with increased risk of weight regain is not surprising. Possible mechanisms for this elevated risk include the displacement of moderate and vigorous physical activities, prolonged inactivity (as an independent factor), increased exposure to advertisements promoting highly processed energy-dense foods, and snacking in front of the TV.^{39,41,42}

Finally, weight regain was higher in those who were sedentary or not meeting public health recommendations for physical activity. Regular physical activity has consistently been associated with long-term weight loss maintenance.^{6,7,18,20,24,26} Recommendations in the 2005 dietary guidelines suggest that the optimal amount of physical activity to sustain weight loss may be 1 hour or more per day;³⁰ however, the current study found that those who met public health physical activity recommendations for improving health were no more likely to regain weight than those who met higher recommended levels. The optimal dose and intensity of physical activity for preventing weight regain may depend on individual factors not analyzed in this study, such as caloric intake or resting metabolic rate.

These findings are subject to several limitations. Both current and past body weights are based on self-report. Previous studies have shown that women tend to underestimate their weight,⁴³⁻⁴⁵ whereas men tend to overestimate their height.⁴⁵ Although measured current weight data are available in NHANES, only self-reported data were available on past body weights. The decision to use self-reported data on both current and past body weights was based on the assumption that inaccuracies in recall of past weights would be more similar to inaccuracies in self-reported current weights than measured weights for the purposes of determining weight regain. Recall of weight change tends to overestimate weight loss and underestimate weight gains.⁴⁶ Also, it could not be determined whether the initial weight loss was intentional. Unintentional weight loss occurs frequently and may have different causes and consequences than intentional weight loss.^{47,48} Whether factors associated with weight regain differ by weight-loss intention has not been examined. Additionally, data on total caloric and nutrient intake could not be included because data released were from only one 24-hour dietary recall interview per subject and because nutrient values for many foods were revised between 1999-2000 and 2001-2002.²⁷ Because of considerable within-person variability, measured intake on a single day is a poor estimator of long-term usual intake.⁴⁹⁻⁵¹ Finally, data are cross-sectional and cannot be used to determine causation.

Conclusion

To be successful at reducing risk factors for diabetes and cardiovascular disease, weight loss must be main-

tained. Long-term maintenance of weight loss may require new skill development and may be more difficult to achieve than short-term loss.⁵² In this study, odds of weight regain were still elevated in those with up to 6 to 10 years since reaching their maximum weight, a finding that highlights the diligence necessary to sustain weight loss. How to achieve the skills necessary for the long-term maintenance of weight loss in the context of an obesogenic environment remains a challenge.⁵³⁻⁵⁸

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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