


BMJ Open Long-term weight loss success and the health behaviours of adults in the USA: findings from a nationally representative cross-sectional study

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ABSTRACT

Objective To describe the relationship between long-term weight loss (LTWL) success and lifestyle behaviours among US adults.

Design Serial cross-sectional data from National Health and Nutrition Examination Survey cycles 2007–2014.

Setting and participants Population-based nationally representative sample. The analytic sample included 3040 adults aged 20–64 years who tried to lose weight in the past year.

Measures Participants were grouped into five LTWL categories (<5%, 5%–9.9%, 10%–14.9%, 15%–19.9% and ≥20%). Lifestyle-related behaviours included the following: alcohol intake, physical activity, smoking, fast-food consumption, dietary quality (Healthy Eating Index (HEI)) and caloric intake. Multivariable regression was employed adjusting for age, sex, race/ethnicity, marital status, education, household income and size, current body mass index and self-reported health status.

Results Individuals in the 15%–19.9% LTWL group differed significantly from the reference group (<5% LTWL) in their physical activity and dietary quality (HEI) but not caloric intake. Specifically, they had a higher HEI score ($\beta=3.19$; 95% CI 0.39 to 5.99) and were more likely to meet physical activity guidelines (OR=1.99; 95% CI 1.11 to 3.55). In comparison, the ≥20% LTWL group was significantly more likely to smoke (OR=1.63; 95% CI 1.03 to 2.57) and to consume lower daily calories ($\beta=-202.91$; 95% CI -345.57 to -60.25) than the reference group; however, dietary quality and physical activity did not significantly differ.

Conclusion Among a national sample of adults, a higher level of LTWL success does not necessarily equate to healthy weight loss behaviours. Future research should attempt to design interventions aimed at facilitating weight loss success while encouraging healthy lifestyle behaviours.

INTRODUCTION

Over the past two decades, the prevalence of obesity among US adults increased from 30.5% in 1999–2000 to 42.4% in 2017–2018.¹ Whereas human physiology and genes have remained constant, the environment has

Strengths and limitations of this study

- This study includes four cycles of nationally representative data among US adults attempting to lose weight.
- Few studies have examined (un)healthy weight loss practices among adults with varying levels of long-term weight loss success.
- The study design is cross-sectional which prohibits determining a temporal relationship and reaching causal inferences.
- Despite using validated instruments, many study variables are based on participant report which could lead to overreporting (eg, physical activity) or underreporting (eg, alcohol consumption).

drastically changed to one that is conducive to overeating and physical inactivity.^{2–4} Specifically, the introduction of energy-saving technology (eg, motorised transport) alongside constant environmental cues encouraging increased caloric intake of energy-dense nutrient-poor foods and beverages has led to positive energy balance.^{2 5–7} That is, energy intake exceeds expenditure, which leads to weight gain and often an obesity weight status.^{7–9} Obesity is related to increased risks for type 2 diabetes, cardiovascular disease, some cancers and premature mortality.^{1 10 11} Beyond adverse health outcomes, obesity impacts the medical care system with direct costs related to medical treatment as well as indirect costs, such as productivity loss.¹

Once weight gain has occurred, it is extremely difficult to lose weight with only 20% of the population able to successfully achieve long-term weight loss (LTWL); defined as losing 5%–10% of initial body weight within 6 months and maintaining it for a year or longer.¹² Those successful

have achieved LTWL by significantly changing their diet (eg, improved diet quality and smaller portion sizes) via self-monitoring of weight, and by habitually engaging in health-promoting physical activity.^{13 14} In addition to eating a healthful diet (eg, increased fruits and vegetables) and being physically active, other behaviours have been found to positively or negatively affect LTWL. For example, cigarette smoking has been shown to decrease appetite, thereby positively contributing to LTWL,^{15 16} while simultaneously increasing cancer and premature mortality risk.^{17 18} Thus, engaging in unhealthy behaviours such as smoking may lead to weight loss while having adverse health consequences.¹⁹ However, it is unclear whether adults who reach higher levels of LTWL are in fact engaging in healthy weight loss practices to achieve success. Studies on this topic have primarily focused on adolescents,²⁰ with scant research centred on adults, particularly using nationally representative samples.

Therefore, the main goal of this study is to examine the relationship between LTWL and associated health behaviours among adults concerned with their weight. Specifically, we seek to identify lifestyle behaviours related to LTWL success, including physical activity, smoking, alcohol consumption, fast-food consumption, overall dietary quality and caloric intake. To this end, we use data from the National Health and Nutrition Examination Survey (NHANES), which has extensive information pertaining to health behaviours from a nationally representative sample of US adults.

METHODS

Data and participants

Data for the study were derived from four cycles (2007–2008, 2009–2010, 2011–2012 and 2013–2014) of NHANES, which is operated by the National Center for Health Statistics (NCHS). It consists of biannual multi-stage cross-sectional data collection on the health and nutritional status of adults and children in the USA.²¹ All study participants provide informed consent. In this study, we focus on adult participants who were overweight or obese at one point during their life, and who aimed to lose weight.

To this end, a total of 4380 participants meeting the following criteria were considered for inclusion: aged 20–64 years¹²; who tried to lose weight in the past year; who were not underweight (body mass index (BMI) <18.5 kg/m²), had a maximum BMI ≥25 kg/m², not pregnant and free of confusion and memory problems or physical/mental/emotional limitations. Adhering to a complete case analytic approach,¹² a total of 1340 observations were omitted due to missing information on the independent or dependent variables as well as covariates. This resulted in 3040 participants included in the analytic sample. Outliers were not removed from the dataset to minimise type 1 error.²²

Dependent and independent variables

The primary independent variable was LTWL success. Consistent with previous research on this topic,^{5 12 23} LTWL was calculated by subtracting participants' reported current weight or weight 1 year ago (the highest of the two) from their maximum weight. This was then divided by the maximum weight and multiplied by 100 to reach weight loss percentages. LTWL percentages were then grouped into the following clinically meaningful categories: <5% (reference group), 5%–9.9%, 10%–14.9%, 15%–19.9% and ≥20%.^{12 23 24}

The dependent variables pertained to lifestyle behaviours. Specifically, current smoking status was based on the blood cotinine levels using an established cut-off of 3.08 ng/mL.²⁵ Alcohol intake was based on the reported average number of drinks per day consumed in the past 12 months. Participants were defined as meeting alcohol guidelines for moderate use if consuming one alcoholic drink or less per day for women or two drinks or less daily for men.²⁶ Leisure-time physical activity was based on the reported frequency (times) per week and duration (min) per day within moderate and vigorous intensity categories.²⁷ For each intensity category, the product of the reported duration and frequency was multiplied by 4 and 8 metabolic equivalent of tasks (METs) for moderate and vigorous intensity, respectively, and expressed as MET min/week. The intermediate scores were summed to derive a final summary estimate of leisure-time physical activity. A threshold of ≥500 MET min/week was applied to categorise participants as meeting (or not) the 2018 Physical Activity Guidelines²⁸ (3.3 METs×150 min/week; where 3.3 METs are equivalent to walking for pleasure at approximately 3.0 miles per hour).²⁹

Moreover, the number of meals consumed at a fast-food or pizza place in the last 7 days was based on self-report.³⁰ For multivariable analysis, responses were grouped into the following categories based on consumption per week: 0–1, 2–3, 4–6, 7–10 and >10.^{31 32} In addition, participants' dietary quality was determined via the Healthy Eating Index (HEI)-2015, which assesses the degree of alignment with the 2015–2020 Dietary Guidelines for Americans.^{33 34} The HEI score ranges from 0 to 100 with the maximum score indicating complete adherence to dietary recommendations. The HEI-2015 was developed by the US Department of Agriculture Center for Nutrition Policy and Promotion; and then the National Cancer Institute's methodology was employed to compute the HEI scores from the first day of 24-hour dietary recall data.^{35 36} Alongside dietary quality, total daily calories (kcal) intake was regarded as a separate dependent variable.

Covariates

The following covariates were taken into account in multivariable analyses based on the literature^{5 12}: age (years), sex (women/men), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanics and others), marital status (married/living together, widowed, divorced/separated and never married), college education (no/yes),

household size (continuous), annual household income (<US\$20 000, US\$20 000–US\$44 999, US\$45 000–US\$74 999 and ≥US\$75 000),¹⁴ current BMI (continuous) and self-reported health status (poor, fair, good, very good and excellent).

Statistical analysis

Weighted descriptive statistics were employed to depict participants' baseline characteristics. The weighted mean (SE) of continuous dependent variables (eg, HEI-2015) and the prevalence of categorical-dependent variables (eg, smoking) was summarised by LTWL groups, and a *p* value was computed to test for statistical significance across categories using the adjusted Wald test. In addition, multivariable logistic regression was used when the dependent variables were dichotomous (eg, meeting physical activity guidelines (no/yes)), whereas ordinary least square (OLS) regression models were computed when the dependent variables were continuous (eg, HEI). Furthermore, when the dependent variable was the ordinal (ie, number of fast-food meals consumed per week: 0–1, 2–3, 4–6, 7–10 and >10), ordered logistic regression was used, which should be interpreted as transitioning to a higher category in comparison to remaining in the same category.³⁷ Separate multivariable models were computed for each dependent variable while adjusting for covariates: age, sex, race/ethnicity, marital status, college education, annual house income and household size, current BMI and self-reported health status. In logistic regression models, the point estimates were ORs, whereas in OLS they were beta coefficients (β). The measure of precision was 95% CIs. STATA 15E V.15.1 (Stata-Corp LP) was used for analysis and appropriate survey weights were used to account for the complex sampling design of NHANES.³⁸

Patients and public involvement

Neither the patients nor the public were involved in the study design, data collection, analytics or write up.

RESULTS

Participant characteristics are presented in [table 1](#). Briefly, more than half (56.7%) were women, 70.1% were non-Hispanic white, 13.3% were Hispanics and 10.8% were non-Hispanic blacks. In addition, 21.0% were current smokers and 51.9% met moderate alcohol drinking guidelines. Almost two-thirds (65.2%) met physical activity guidelines. The average daily caloric intake was 2175.4 kcal, and the mean overall dietary quality, as measured by the HEI-2015, was 51.0/100. Participants' current mean BMI (kg/m^2) was 31.8 and they lost 5.9 pounds, on average, from the previous year. Moreover, a total of 39.9% achieved LTWL success of ≥5%. Furthermore, descriptive statistics of the dependent variables (health behaviours, dietary quality and caloric intake) by LTWL categories are depicted in [table 2](#). Daily caloric intake, diet quality and physical activity differed significantly by LTWL ($p<0.05$ for all; see [table 2](#)). For example, the dietary

Table 1 Weighted characteristics of study sample: NHANES 2007–2014 (n=3040)

Characteristics	%*
Women	56.7%
Age: mean (SE)	42.4 (0.3)
Weight change—1 year (lbs)†: mean (SE)	–5.9 (0.4)
Current BMI (kg/m^2): mean (SE)	31.8 (0.2)
LTWL‡	
0%–4.9%	60.1%
5%–9.9%	20.8%
10%–14.9%	9.7%
15%–19.9%	4.4%
≥20%	5.0%
Race/ethnicity	
Non-Hispanic white	70.1%
Hispanic	13.3%
Non-Hispanic black	10.8%
Other	5.7%
Marital status	
Married/living together	67.1%
Widowed	1.0%
Divorced/separated	14.0%
Never married	17.9%
College educated	36.3%
Self-reported health status	
Excellent	9.2%
Very good	33.0%
Good	42.7%
Fair	13.1%
Poor	1.9%
Household size: mean (SE)	3.1 (0.0)
Annual household income	
<US\$20 000	8.9%
US\$20 000–US\$44 999	20.1%
US\$45 000–US\$74 999	25.7%
≥US\$75 000	45.2%
Fast-food meals—past week	
0–1	53.8%
2–3	27.5%
4–6	11.7%
7–10	5.2%
>10	1.8%
HEI-2015§: mean (SE)	51.0 (0.4)
Kcal: mean (SE)	2175.4 (18.1)
Smoking¶	21.0%
Moderate alcohol**	51.9%
Physical activity guidelines††	65.2%

Continued

Table 1 Continued

Characteristics	%*
*If percentages do not reach 100% that is due to rounding.	
†Weight change from previous year to the current year.	
‡LTWL was calculated by subtracting the reported weight 1 year ago or current weight (the higher of the 2), by the reported maximum weight, and then multiplying by 100 to receive a percentage.	
§HEI-2015: indicates adherence to Dietary Guidelines for Americans. The score ranges from 0 to 100 with the highest score indicative of complete compliance with the guidelines. Kcal- total daily calories.	
¶Smoking: current smoking status was based on blood cotinine levels using an established cut-off of 3.08 ng/mL.	
**Moderate alcohol: participants were defined as meeting moderate drinking guidelines, if consuming one alcoholic drink or less per day for women or two drinks or less daily for men.	
††MET minutes per week for leisure time physical activity. Meeting physical activity guidelines refers to ≥500 MET min/week.	
BMI, body mass index; HEI, Healthy Eating Index; LTWL, long-term weight loss; MET, metabolic equivalent of task.	

quality (HEI-2015) of those achieving 15%–19.9% LTWL was higher than individuals in the ≥20% LTWL group (54.8/100 and 50.4/100, respectively).

The multivariable relations of LTWL success with the dependent variables are shown in [table 3](#). In comparison to the reference group (LTWL <5%), the health behaviours of those achieving 5%–9.9% LTWL did not differ significantly except for fast-food intake (OR=0.80; 95% CI 0.64 to 1.00). Similarly, the behaviours of those achieving 10%–14.9% LTWL did not differ

markedly from the reference. In contrast, participants in the 15%–19.9% LTWL group significantly differed in their physical activity and dietary quality, yet not caloric intake. Specifically, the 15%–19.9% LTWL group were almost twice (OR=1.99; 95% CI 1.11 to 3.55) as likely to meet physical activity guidelines, and to have a higher HEI score (β =3.19; 95% CI 0.39 to 5.99). Finally, individuals in the ≥20% LTWL group were 1.63 times (95% CI 1.03 to 2.57) more likely to be current smokers and to consume 202.91 fewer daily calories (95% CI –345.57 to –60.25) than the reference group. No significant differences were observed in dietary quality and other health behaviours ([table 3](#)).

DISCUSSION

This study significantly contributes to the literature by exploring the health behaviours of adults attempting to lose weight from a national sample of Americans using four waves of NHANES data. Few studies to date have examined whether various levels of weight loss success are achieved through healthy weight loss practices in adults. These findings show that higher levels of LTWL do not necessary equate to healthier behaviours. More specifically, our analysis reveals that adults in the 15%–19.9% LTWL category likely achieved this success through healthy behaviours, whereas those losing more weight (LTWL of ≥20%) appear to have attained success through some behaviours that were likely detrimental to their health. More specifically, the 15%–19.9% LTWL group had higher odds to eat a higher quality diet and to meet physical activity guidelines. Notably, participants who achieved LTWL of ≥20% smoked more and consumed

Table 2 LTWL success and lifestyle behaviours of adults attempting to lose weight†: bivariate analysis†

LTWL‡	HEI-2015§	Kcal§	Fast-food¶	Smoking**	Moderate alcohol††	Physical activity‡‡
	Mean (SE)	Mean (SE)	Percentage§§	Percentage§§	Percentage§§	Percentage§§
0%–4.9%	50.44 (0.43)	2202.18 (23.49)	47.9	19.9	52.2	62.6
5%–9.9%	50.86 (0.69)	2192.77 (39.11)	43.8	21.5	50.4	68.9
10%–14.9%	52.93 (1.21)	2128.84 (63.22)	44.0	22.9	51.7	64.1
15%–19.9%	54.81 (1.42)	2132.19 (102.71)	41.1	21.1	58.7	77.3
≥20%	50.45 (1.22)	1911.68 (68.50)	44.3	29.5	48.6	73.5%
P value¶¶	0.02	0.00	0.48	0.28	0.68	0.02

*NHANES data 2007–2014 (n=3040).

†Weighted descriptive statistics were employed to describe the mean (SE) for continuous variables and percentage for categorical variables by LTWL categories.

‡LTWL was calculated by subtracting the reported weight 1 year ago or current weight (the higher of the two), by the reported maximum weight, and then multiplying by 100 to receive a percentage.

§HEI-2015: indicates adherence to Dietary Guidelines for Americans. The score ranges from 0 to 100 with the highest score indicative of complete compliance with the guidelines. Kcal- total daily calories.

¶Number of fast-food or pizza place was dichotomised into ≥2 (yes/no) meals in the past 7 days in bivariate analysis to ease interpretation.

**Smoking: current smoking status was based on blood cotinine levels using an established cut-off of 3.08 ng/mL.

††Alcohol: participants were defined as meeting moderate drinking guidelines, if consuming one alcoholic drink or less per day for women or two drinks or less daily for men.

‡‡MET minutes per week for leisure time physical activity. Meeting physical activity guidelines refers to ≥500 MET min/week.

§§Row percentage, that is, the percent of each categorical dependent variable (eg, smoking) in each LTWL group. For example, 19.9% of participants in the 0%–4.9% LTWL group were current smokers.

¶¶Adjusted p value computed using the Wald test.

HEI, Healthy Eating Index; LTWL, long-term weight loss; MET, metabolic equivalent of task; NHANES, National Health and Nutrition Examination Survey.

Table 3 LTWL success and lifestyle behaviours of adults attempting to lose weight††: multivariable regression‡

LTWL§	HEI-2015¶	Kcal¶	Fast-food**	Smoking††	Moderate alcohol‡‡	Physical activity§§
(Ref. 0%–4.9%)	β (95% CI)	β (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
5%–9.9%	0.25 (–1.12 to 1.61)	–15.54 (–109.38 to 78.30)	0.80 [†] (0.64 to 1.00)	1.03 (0.79 to 1.35)	0.94 (0.76 to 1.16)	1.25 (0.96 to 1.62)
10%–14.9%	1.59 (–0.92 to 4.10)	–17.22 (–140.93 to 106.49)	0.94 (0.66 to 1.33)	1.35 (0.92 to 1.96)	1.01 (0.71 to 1.25)	1.04 (0.70 to 1.53)
15%–19.9%	3.19** (0.39 to 5.99)	–47.66 (–229.90 to 134.59)	0.78 (0.50 to 1.22)	1.33 (0.81 to 2.19)	1.30 (0.85 to 1.99)	1.99* (1.11 to 3.55)
≥20%	–0.27 (–2.74 to 2.19)	–202.91** (–345.57 to –60.25)	0.92 (0.62 to 1.36)	1.63* (1.03 to 2.57)	0.92 (0.60 to 1.42)	1.70 (0.95 to 3.01)

*p<0.05; **p<0.01.

†NHANES data 2007–2014 (n=3040).

‡Separate regression models were employed for each dependent variable. Logistic and ordinal regression models were used when the variable was dichotomous (eg, meeting physical activity guidelines: yes/no) and ordered (fast-food), respectively. Ordinary least square regression models were used for continuous variables (HEI, kcal). NHANES weights were employed. Models adjusted for age, sex, race/ethnicity, marital status, college education, household income, household size, current BMI and self-rated health status.

§LTWL was calculated by subtracting the reported weight 1 year ago or current weight (the higher of the two), by the reported maximum weight, and then multiplying by 100 to receive a percentage.

¶HEI-2015: indicates adherence to Dietary Guidelines for Americans. The score ranges from 0 to 100 with the highest score indicative of complete compliance with the guidelines.

Kcal: total daily calories.

**Number of fast-food or pizza place meals in the past 7 days: 0–1, 2–3, 4–6, 7–10 and >10.

††Smoking: current smoking status was based on blood cotinine levels using an established cut-off of 3.08 ng/mL.

‡‡Alcohol: participants were defined as meeting moderate drinking guidelines, if consuming one alcoholic drink or less per day for women or two drinks or less daily for men.

§§MET minutes per week for leisure time physical activity. Meeting physical activity guidelines refers to ≥500 MET min/week.

HEI, Healthy Eating Index; LTWL, long-term weight loss; MET, metabolic equivalent of task; NHANES, National Health and Nutrition Examination Survey.

significantly fewer calories. Thus, while reaching a higher degree of weight loss might lower cardiometabolic risk,¹² achieving this goal by engaging in harmful behaviours, such as smoking, could adversely impact health and longevity.^{18 39} Indeed, it increases cancer risk and shortens lifespans.^{17 39 40}

Evidence has shown that engaging in multiple health behaviours simultaneously reduces mortality risk from all-causes, cardiovascular disease and cancer. For example, Khaw *et al*⁴¹ found that in comparison to those adhering to four healthy behaviours (physical activity, fruit and vegetable intake, not smoking and moderate drinking), not adhering to any healthy behaviours was associated with a fourfold increased risk for all-cause mortality. Unlike the study by Khaw *et al*, this study focuses on the health behaviours of individuals with various levels of LTWL success rather than mortality as an endpoint.⁴¹ A previous study by Wilson,⁴² examined the relationship between physical activity and diet to LTWL among NHANES participants, finding that those with 10% LTWL were more likely to engage in vigorous intensity physical activity and to have lower caloric intake.⁴² This study, however, differs from Wilson's study in the following two main ways: (1) this research uses four waves of NHANES versus two waves and (2) it focuses specifically on adult dieters who may experience specific weight control challenges,⁴³ while employing a more nuanced approach by examining five levels of LTWL (consistent with previous research on this topic)^{12 23} versus a dichotomous LTWL variable.⁴²

This exploration of multiple levels of LTWL revealed that those achieving the highest level of success might have attained it by engaging in detrimental practices (eg, smoking). Smoking has been found in the literature to suppress appetite and prevent overeating, subsequently leading to LTWL success, despite its harmful effects.^{39 44 45} Phelan *et al*⁴⁵ in a

population-based study, observed that higher odds of LTWL success were related to markedly more smoking. Indeed, in this study those reaching ≥20% LTWL were 63% more likely to be current smokers than those who were not successful in weight loss (<5% LTWL). Research among adolescents underscores that there is a relationship between unhealthy weight loss practices (eg, diet pill use, fasting) and substance use behaviours, such as tobacco and marijuana smoking.²⁰ A longitudinal study by Haynos *et al*⁴⁶ found that unhealthy weight control practices among adolescents persist into adulthood and therefore there is a need to design intervention programmes to decrease these practices in adolescence and young adulthood. This study was conducted among adults aged 42 years (on average), showing that those best at LTWL (≥20%) likely achieved this not by being physically active and improving diet quality but via caloric reduction (202.9 fewer daily calories), which might have been the result (at least partly) of smoking's appetite suppression effects. This explanation, however, should be regarded as a supposition since variables needed to explain behavioural choices were not available in the dataset.

Although psychological variables that illuminate participants' decision-making are not available in the data, the psychological literature might shed light on these findings. Previous research has linked high levels of self-regulation to virtuous decision making in the health, education, and financial domains.^{5 47–49} Specifically, high self-regulation necessitating goal setting and planning to meet a priori objectives, overcoming impediments and the ability to delay immediate gratification,^{50 51} has been linked to reduced obesity and cardiovascular disease risk, as well as better employment prospects.^{52–55} In a previous study among NHANES participants of low-income, we found that participants in the highest LTWL category (≥20%)



were also 45% less likely to save money.⁵ Based on the previous research, we hypothesised that this group used significant cognitive efforts to achieve LTWL and therefore did not have enough ‘mental resources’ when it came to financial decision making.^{5 43}

The current results add to our prior findings by showing that highest LTWL category ($\geq 20\%$) might have achieved weight loss via lower caloric intake and more smoking which suppress appetite, thereby likely exerting less self-control when it came to making healthy food choices. Indeed, the dietary quality of participants in the high LTWL group resembled those of the reference group (ie, LTWL $< 5\%$). It is unclear from the current study, whether these decisions were implicit or explicit,⁵⁶ thus future research using data with robust psychological variables to examine the above-mentioned suppositions is needed. In comparison, participants in the 15%–19.9% LTWL category appear to be more likely to engage in healthy behaviours to achieve their weight loss goal. It is plausible that these participants had a higher level of self-regulation than the $\geq 20\%$ LTWL group, yet this assumption needs to be substantiated with direct measurement. Furthermore, based on the previous health psychology research, it is possible that the 15%–19.9% LTWL group might have had a mental framework of themselves (ie, self-schema) as being healthy weight maintainers, thereby facilitating healthy behaviours.^{57–59} The NHANES dataset, however, does not measure self-schemas, thus these explanations need to be empirically examined in future work.

Beyond lacking psychological variables, this study has additional limitations that should be noted. Specifically, many of the variables used are based on participant reported responses to questionnaires which often leads to either overreporting (eg, physical activity) or underreporting (eg, alcohol intake). However, validated instruments were employed using standard protocols, thus if misclassification has occurred it is likely non-differential which leads to results being biased towards the null.⁶⁰ Hence, the observed point estimates might be weaker than the true difference. In addition, the study design is cross-sectional which impedes examining a temporal relationship between the exposure and outcome and subsequently inferring any causal relationships. Moreover, it should be noted that participants’ weight (maximum, 1 year ago and now) used to calculate LTWL, was determined at one point in time. Although historical weight has been found to be relatively stable,^{12 61} a longitudinal approach is preferable and prevents recall bias. Additionally, while participants’ self-reported health status was adjusted for in multivariable analysis, as with other similar NHANES studies,^{23 42} medical conditions (eg, diabetes and coronary heart disease) and subsequent prescribed medication, which could influence LTWL and health behaviours, were not accounted for in this

study. Finally, since a complete case analytic approach was taken,¹² the analytic sample did not include participants with missing information on the independent and dependent variables as well as covariates.

In summary, data from a nationally representative sample of US adults who tried to lose weight shows that higher LTWL does not necessary relate to healthy weight loss practices. Notably, those achieving the most LTWL ($\geq 20\%$) were more likely to smoke, and to have lower caloric intake without improved diet quality. In comparison, those achieving slightly less LTWL (15%–19.9%) were engaged in healthy behaviours, such as meeting physical activity guidelines and having a better-quality diet. Thus, higher LTWL does not necessarily reflect healthier lifestyle practices, which might in turn, adversely impact future health and welfare. Future research should focus on understanding mechanisms explaining healthy and unhealthy weight loss practices of adults. This will enable the design and implementation of interventions aimed at helping adults lose weight while improving future health outcomes.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

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Data availability statement Data are available in a public, open access repository. The current study used data from NHANES. It is publicly available and can be downloaded from the Centers for Disease Control and Prevention website: <https://www.cdc.gov/nchs/nhanes/>

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