Intentional Weight Loss and Death in Overweight and Obese U.S. Adults 35 Years of Age and Older

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Background: **Although weight loss improves risk factors for cardiovascular and metabolic disease, it is unclear whether intentional weight loss reduces mortality rates.**

Objective: **To examine the relationships among intention to lose weight, weight loss, and all-cause mortality.**

Design: **Prospective cohort study using a probability sample of the U.S. population.**

Setting: **Interviewer-administered survey.**

Participants: **6391 overweight and obese persons (body mass index ≥ 25 kg/m^2) who were at least 35 years of age.**

Measurements: **Intention to lose weight and weight change during the past year were assessed by self-report in 1989. Vital status was followed for 9 years. Hazard rate ratios (HRRs) were adjusted for age, sex, ethnicity, education, smoking, health status, health care utilization, and initial body mass index.**

Results: **Compared with persons not trying to lose weight and reporting no weight change, those reporting intentional weight loss had a 24% lower mortality rate (HRR, 0.76 [95% CI, 0.60 to 0.97]) and those with unintentional weight loss had a 31% higher mortality rate (HRR, 1.31 [CI, 1.01 to 1.70]). However, mortality rates were lower in persons who reported trying to lose weight than those in not trying to lose weight, independent of actual weight change. Compared with persons not trying to lose weight and reporting no weight change, persons trying to lose weight had the following HRRs: no weight change, 0.80 (CI, 0.65 to 0.99); gained weight, 0.94 (CI, 0.65 to 1.37); and lost weight, 0.76 (CI, 0.60 to 0.97).**

Conclusions: **Attempted weight loss is associated with lower all-cause mortality, independent of weight change. Self-reported intentional weight loss is associated with lower mortality rates, and weight loss is associated with higher mortality rates only if it is unintentional.**

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Despite the many health risks associated with being overweight (1, 2), the effect of weight loss on long-term health and longevity remains controversial (3–5). Randomized clinical studies in overweight persons have shown that weight loss leads to short-term improvements in physiologic risk factors (6) and can prevent or delay hypertension and diabetes (7–9). However, only observational studies have examined the effect of weight loss on mortality rates (3–5) and have typically found weight loss to be associated with increased rather than decreased mortality (3–5, 10, 11).

Most observational studies examining weight change and subsequent mortality rates have not assessed weight loss intention. The few studies that have tried to differentiate between the effects of intentional and unintentional weight loss have yielded mixed results (12–18). The Cancer Prevention Study I and the Malmö Prevention Study found that intentional weight loss was associated with reduced mortality rates among persons with diabetes (17), impaired glucose tolerance (18), and other health conditions (12, 16). Other studies, however, have found no effect of intentional weight loss on mortality rates (12–16). Another concern is that self-identified intention to lose weight may indicate a healthy lifestyle or better access to health care rather than a biologically protective effect of weight loss.

In 1989, part of the National Health Interview Survey, a nationally representative sample of the U.S. population (19), examined intent to lose weight and self-reported weight change. Death among members of this sample was followed through 1997 (20). Using these data, we estimated the association of weight change and intention to lose weight with all-cause mortality among overweight and obese U.S. adults.

METHODS

Study Design and Study Sample

The National Health Interview Survey is an ongoing nationwide survey of health status, conditions, and behaviors among the U.S. noninstitutionalized population (19, 20). The survey uses a multistage, probability-sampling strategy to select approximately 45 000 households and 120 000 persons yearly. Data are weighted to match the age, sex, and ethnicity distributions of the U.S. population and to account for survey nonresponse.

In this study, we used data from a supplemental survey conducted in 1989 that assessed intentional weight loss in a random subsample of 20 847 adults older than 18 years of age (19). Sufficient data were available to link 20 439 respondents (98%) to the National Death Index, providing follow-up of vital status through December 1997 (up to 9 years). At this time, all survivors were censored (20). The National Death Index is a computerized database with standard identifying information about virtually all deaths in the United States and has been shown to have a high rate of ascertainment (21). We used an algorithm provided by the National Center for Health Statistics to determine which matches should be classified as deaths (20).

Of the 20 439 persons for whom we had both survey

Context

Although being overweight is associated with many adverse health outcomes, observational studies of weight loss show associations between weight loss and increased mortality. This may be because these studies did not distinguish between intentional and unintentional weight loss.

Contribution

In a national survey of 6391 U.S. adults, people who were trying to lose weight had decreased mortality whether they lost weight or not. Lowest mortality was associated with modest intentional weight loss. People who lost weight unintentionally had increased mortality.

Implications

Weight loss has adverse associations with mortality only if it is unintentional. Trying to lose weight may have benefit even if people do not actually lose weight.

–The Editors

and vital status information, we excluded 11 642 whose body mass index (BMI) was less than 25 kg/m^2 before weight loss, since weight loss is not typically indicated for such persons. We also excluded 2328 persons younger than 35 years of age because the mortality rate in this group is extremely low (1.5 deaths per 1000 persons per year compared with 15.4 deaths per 1000 persons per year for those >35 years of age; hazard rate ratio [HRR], 0.10 [95% CI, 0.06 to 0.15]). Finally, we excluded 78 persons with missing data on weight loss or other covariates, leaving 6391 overweight and obese persons for the analyses.

Measurements

Interviewers determined age, ethnicity, sex, smoking status, self-rated health (on a five-point scale from excellent to poor), hospitalizations in the past year, physician visits, days spent in bed during the past year, and chronic and acute conditions that caused hospitalizations or days spent in bed. Participants were also asked whether they were limited in any activities or work because of an impairment or health problem; if they answered "yes," they were asked to report the primary and secondary limiting health conditions that led to the impairment. Self-reported height and weight were used to compute BMI. To assess intentional weight loss, participants were asked, "Have you tried to lose weight in the past year?"; "Is your weight now more, less, or about the same as a year ago?"; and "In the past year, about how much have you gained or lost?"

Statistical Analyses

Chi-square and analysis of variance tests were used to compare study covariates at baseline across weight loss intent and weight change groups. We used Cox proportional hazards regression analyses to determine the mortality HRR associated with weight loss intention and weight change while adjusting for potentially confounding variables. The HRR is the ratio of two rates of disease or mortality occurrence. It is a relative measure of how rapidly cases of disease or death occur in a group with the risk factor compared with the group without the risk factor. We found no violation of the statistical assumptions underlying the proportional hazards regression in graphical or statistical examinations. Similarly, we found no problematic influential data points or multicollinearity. We also computed predictive margins to estimate the multivariate-adjusted 8-year cumulative hazard rate (equivalent to the mean follow-up) for each weight loss intent and weight change group (22). Predictive margins are a type of direct standardization in which predicted values from the Cox proportional hazards regression models are averaged over the covariate distribution in the sample.

Because we found a statistically significant interaction between weight loss intent and weight change, we stratified weight change according to whether persons reported trying to lose weight. Multivariate models controlled for age, ethnicity, sex, smoking, education, initial BMI, measures of health status (self-rated health and days spent in bed during the past year), diabetes (none, non–insulin treated, insulin treated), cardiovascular disease or cancer cited as a cause of functional limitation, number of acute and chronic conditions, and measures of health care utilization (hospitalizations and physician visits during the past year). We also evaluated models that excluded smokers, since smokers are at increased risk for death and may be more likely to lose weight. We tested for interactions between weight loss intent and weight loss group and age (35 to 64 years vs. ≥65 years), sex, and BMI (<30 kg/m^2 vs. ≥30 kg/m^2) to determine the association with mortality.

We computed poststratification weights to account for the 78 missing participants and conducted analyses using SUDAAN, version 7.5.4a (Research Triangle Institute, Research Triangle Park, North Carolina), to make the study estimates statistically representative of the U.S. noninstitutionalized population of overweight and obese adults 35 years of age and older. SUDAAN uses Taylor series linearization to estimate variances, allowing analyses to account for the unequal weighting, stratification, and clustering.

Role of the Funding Source

The authors analyzed the data and wrote this article as employees of the U.S. Centers for Disease Control and Prevention. The Centers for Disease Control and Prevention was therefore involved in the analysis and interpretation of the data and in the decision to submit the paper for publication.

RESULTS

Fifty-eight percent, 12%, and 30% of participants reported no weight change, weight gain, and weight loss, respectively (**Table 1**). Compared with persons reporting stable weight, those who reported gaining or losing weight were more likely to be women, to report worse overall

Table 1. **Characteristics of 6391 Overweight Persons, according to Weight Loss Intention and Reported Weight Change***

Characteristic	All Participants	Actual Weight Change			Weight Loss Intent	
		No Change	Gain	Loss	Participants Not Trying To Lose Weight	Participants Trying To Lose Weight
Participants, *n (%)*	6391 (100)	3690 (58)	769 (12)	1931 (30)	2766 (43)	3625 (57)
Women, %	44.9	41.8†	47.9	50.0	35.5‡	52.1
Mean age, *y*	54.2	54.9†	50.9	54.1	56.3‡	52.5
Nonwhite ethnicity, %	13.5	13.7	14.4	12.6	15.5‡	12.0
Current smoker, %	22.1	21.1	21.9	24.2	26.4‡	18.8
High school education or less, %	54.7	55.8	54.1	52.8	62.3‡	49.0
Mean baseline weight, *kg*	85.6	84.2†	82.7	89.3	83.4‡	87.2
Baseline BMI, kg/m^2	29.4	29.0†	28.5	30.8	28.4‡	30.2
Median weight change in the past year, *kg*	−0.3	0†	4.4	−7.0	−0.3‡	−0.4
Self-rated health of fair or poorer, %	17.6	15.2†	21.6	20.9	19.1‡	16.5
>1 week of bed days in the past year, %	16.8	12.6†	21.9	23.2	15.2‡	17.9
Any functional limitations, %	24.6	21.4†	28.4	29.5	24.2	25.0
Hospitalized in the past year, %	11.4	8.4†	12.5	16.9	11.4	11.4
Median physician visits in the past year, *n*	1.5	1.1†	1.7	2.4	1.1‡	1.9
Diabetes, %	6.1	4.6†	4.5	9.6	4.6‡	7.2
Limitation caused by CVD, %	4.5	3.5†	4.7	6.3	3.9	4.9
Limitation caused by cancer, %	0.8	0.6†	0.4	1.3	1.2‡	0.5

* BMI = body mass index; CVD = cardiovascular disease.
† Significantly different ($P < 0.05$) across groups of weight change.
‡ Significantly different ($P < 0.05$) from those trying to lose weight.

health and more days in bed, and to have had functional limitations, physician visits, and hospitalizations during the previous year. Persons who lost weight also had higher baseline BMIs and were more likely to be smokers, to have diabetes, and to have been hospitalized during the previous year than persons with stable weight or weight gain.

Fifty-eight percent of the study participants reported trying to lose weight during the previous year (**Table 1**). Persons who were trying to lose weight reported more weight loss than those who were not trying to lose weight ($P < 0.001$), but the magnitude of this difference was small (median weight change, −0.4 kg vs. −0.3 kg). Compared with persons who were not trying to lose weight, those who reported attempted weight loss were more likely to be women and to have diabetes, were younger, were more likely to be of white ethnicity and nonsmokers, had higher BMIs, and were less likely to report fair or poor health. Persons attempting weight loss also reported more physician visits and more days in bed during the previous year than those who were not trying to lose weight.

During 9 years of follow-up (mean, 8.0 years), 892 participants died (age-adjusted rate, 17.8 deaths per 1000 person-years). Compared with persons with no weight change, persons who lost weight (intentional and unintentional weight loss combined) had a 36% higher mortality rate (HRR, 1.36 [CI, 1.13 to 1.63]) after we controlled for age, sex, ethnicity, initial BMI, smoking, education, and weight loss intention (**Table 2**). This association was attributable largely to persons reporting a weight loss of more than 9.1 kg, among whom the mortality rate was 82% higher (HRR, 1.82 [CI, 1.44 to 2.31]). After additional controlling for baseline health status and health care utilization, overall weight loss was not associated with a higher mortality rate but the mortality rate was still 36% higher in persons who lost more than 9.1 kg (HRR, 1.36 [CI, 1.07 to 1.74]). All-cause mortality was 24% lower in persons who reported trying to lose weight than in those not trying to lose weight (HRR, 0.76 [CI, 0.64 to 0.90]), independent of weight change and other covariates. This association was maintained after we controlled for health status and health care use and after persons who smoked were excluded.

We found that this association between weight change and mortality rate depended on whether weight loss was intentional ($P = 0.01$ for interaction). To examine this interaction, we stratified data by both weight loss intention and actual weight loss (**Table 2**). When we controlled for age, sex, ethnicity, education, smoking, and initial BMI, persons with unintentional weight loss had a 77% higher mortality rate than persons who reported maintaining a stable weight and who were not trying to lose weight (HRR, 1.77 [CI, 1.38 to 2.26]). The excess mortality rate associated with unintentional weight loss was reduced to 31% (HRR, 1.31 [CI, 1.01 to 1.70]) in fully adjusted models and in models that excluded persons who smoked (HRR, 1.29 [CI, 0.95 to 1.77]) (**Table 2**). The increased mortality rate associated with unintentional weight loss was most evident (72% higher) in persons with a weight loss of at least 9.1 kg (HRR, 1.72 [CI, 1.24 to 2.38]) (**Figure**). Mortality rate was 38% lower in persons who gained weight and were not trying to lose weight (HRR, 0.62 [CI, 0.38 to 0.99]). This association tended to be stronger among men (HRR, 0.36 [CI, 0.16 to 0.80]) than women (HRR, 0.99 [CI, 0.56 to 1.73]) (data not shown) and diminished after those who smoked were excluded (HRR

Table 2. **Hazard Rate Ratio of All-Cause Mortality by Weight Loss Intent and Actual Weight Loss***

Variable	Median Weight Change, *kg*	Prevalence, %	Hazard Rate Ratio (95% CI)		
			Primary Model (*n* = 6391)†	Fully Adjusted Model (*n* = 6391)‡	Fully Adjusted Model, Excluding Persons Who Smoked (*n* = 4957)‡
No consideration of the interaction between weight loss intent and weight change					
No weight change	0	58.8	1.0 (referent)	1.0 (referent)	1.0 (referent)
Weight loss	−7.0	29.5	1.36 (1.13–1.63)	1.09 (0.90–1.32)	1.03 (0.83–1.28)
1–9.1 kg	−4.8	17.4	1.11 (0.89–1.38)	0.94 (0.75–1.18)	0.91 (0.71–1.18)
≥9.1 kg	−13.6	12.1	1.82 (1.44–2.31)	1.36 (1.07–1.74)	1.23 (0.93–1.64)
Weight gain	4.4	11.6	1.09 (0.82–1.46)	0.92 (0.69–1.24)	1.07 (0.77–1.50)
1–9.1 kg	4.2	8.6	1.06 (0.76–1.46)	0.92 (0.66–1.28)	1.09 (0.76–1.56)
≥9.1 kg	13.6	3.0	1.21 (0.72–2.03)	0.94 (0.56–1.58)	0.99 (0.50–1.94)
Trying to lose weight					
No	−0.3	43.3	1.0 (referent)	1.0 (referent)	1.0 (referent)
Yes	−0.4	56.7	0.77 (0.65–0.92)	0.76 (0.64–0.90)	0.76 (0.62–0.93)
Stratified by weight loss intent					
Not trying to lose weight					
No weight change	0	32.8	1.0 (referent)	1.0 (referent)	1.0 (referent)
Lost weight	−6.9	6.8	1.77 (1.38–2.26)	1.31 (1.01–1.70)	1.29 (0.95–1.77)
Gained weight	4.3	3.7	0.73 (0.46–1.15)	0.62 (0.38–0.99)	0.74 (0.44–1.24)
Trying to lose weight					
No weight change	0	26.0	0.88 (0.71–1.10)	0.80 (0.65–0.99)	0.82 (0.64–1.04)
Lost weight	−7.1	22.8	0.93 (0.74–1.17)	0.76 (0.60–0.97)	0.71 (0.55–0.92)
Gained weight	4.5	7.9	1.17 (0.82–1.67)	0.94 (0.65–1.37)	1.07 (0.70–1.63)

* All hazard rate ratios were derived from Cox proportional hazards models. Estimates for trying to lose weight were also adjusted for weight change, and estimates for weight change were also adjusted for weight loss intent.
† Adjusted for age, sex, ethnicity, smoking, education, and initial body mass index.
‡ Adjusted for age, sex, ethnicity, smoking, education, initial body mass index, self-rated health, diabetes, acute and chronic conditions, functional limitations due to cardiovascular disease or cancer, hospital days, bed days.

for men and women combined, 0.74 [CI, 0.44 to 1.24]) (**Table 2**).

When we examined weight change as a continuous variable among persons not trying to lose weight, we found that a quadratic term improved the fit of the model ($P = 0.01$). The HRR increased with greater unintentional weight loss. For example, compared with no weight change, a 5-kg unintentional weight loss was associated with a 35% higher mortality rate and a 10-kg unintentional weight loss was associated with an 87% higher mortality rate.

Compared with stable weight and no attempts to lose weight, intentional weight loss was associated with a 24% lower mortality rate (HRR, 0.76 [CI, 0.60 to 0.97]) in fully adjusted analyses and a 29% lower mortality rate (HRR, 0.71 [CI, 0.55 to 0.92]) in analyses that excluded persons who smoked (**Table 2**). Among persons trying to lose weight, we found no statistically significant linear or quadratic association between amount of weight change and mortality rate ($P > 0.2$). However, when we stratified participants according to amount of weight loss, we found that lower mortality rate was more evident in those with weight loss of 1 to 9 kg, among whom the HRR was 30% lower (HRR, 0.70 [CI, 0.53 to 0.92]) in fully adjusted analyses (**Figure**) and 38% lower (HRR, 0.62 [CI, 0.45 to 0.85]) in analyses that excluded persons who smoked (data not shown). Mortality rates were not lower among those who intentionally lost more than 9 kg (HRR, 0.90 [CI, 0.64 to 1.25]) (**Figure**).

We found no statistically significant interactions between weight loss intention and age, sex, or BMI that affected the association with mortality rate. In addition, our findings relating weight loss intention and weight changes to mortality did not change appreciably after we excluded deaths that occurred within the first 2 years of follow-up.

DISCUSSION

The effect of weight loss on mortality has been controversial. Many observational studies have found that weight loss is associated with increased rather than decreased risk for death (3–5, 10, 11). In this national sample of overweight and obese adults, we observed three key findings related to this controversy. First, mortality rate was 24% lower among persons with intentional weight loss than among persons who did not attempt to lose weight and whose weight did not change. This association was largely driven by persons who reported a weight loss of 1 to 9 kg. Mortality rate was 30% lower in this group than in those whose weight remained stable and who were not trying to lose weight. Second, attempted weight loss may be a more important predictor of longevity than weight change itself. Third, the previously reported associations between weight loss and increased mortality rates may be

explained by unintentional weight loss. As in previous epidemiologic studies (3–5, 10, 11, 13), we found that overall weight loss was associated with increased mortality rate. However, this effect depended on whether the weight loss was intentional. The relationship between weight loss and death was explained by persons with unintentional weight loss, among whom the mortality rate was up to 77% higher.

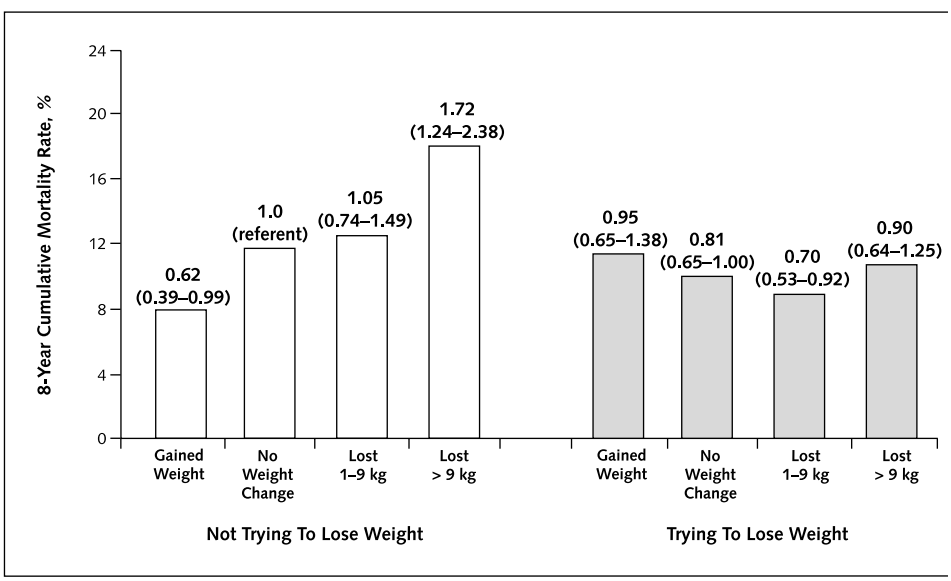
Our finding that intentional weight loss is associated with reduced mortality rates is consistent with previous findings from several studies. In the Cancer Prevention Study I (12, 16), intentional weight loss was associated with 20% to 40% lower all-cause, diabetes-related, and cancer-related mortality rates among women (12) and 33% lower diabetes-related mortality rates among men (16). A more recent study of men and women with diabetes-associated weight loss reported approximately a 25% reduced mortality rate (17). Similarly, a 12-year follow-up of the Swedish Malmö Prevention Trial, a nonrandomized lifestyle intervention with a net 2.8% decrease in BMI, found that risk for death from heart disease and all-cause mortality were reduced by 50% among the study sample (18). In other studies and study subgroups, such as men in the Cancer Prevention Study I, middle-aged and older women in the Iowa Women's Health Study, and the Cardiovascular Health Study, intentional weight loss was not consistently associated with all-cause mortality or with death from cardiovascular disease (13–16).

Our study specifically examined the association between intention to lose weight and death, independent of weight change. The most plausible explanation for our finding that attempted weight loss was independently associated with reduced mortality is that weight loss attempts are a marker of healthy behaviors. However, we lacked data on behavior and physiologic risk factors, which would have allowed us to examine the underlying mechanisms of the association between lower mortality rates and weight loss intent. Successful diabetes prevention trials in China (23), Finland (8), and the United States (7, 9) have emphasized reductions in total dietary and fat intake, increases in physical activity and fiber intake, and modest weight loss. Studies in India and the United States combined weight loss with aggressive fat reduction and high fiber intake and reported a reduction in cardiovascular events (24, 25). Together, these studies suggest that multidisciplinary lifestyle change aimed at weight loss is likely to improve many health outcomes (7–9, 17, 18, 23–25). However, better clarification of the degree to which benefits in these studies are derived specifically from weight loss itself, rather than the direct effects of behavioral factors such as physical activity and qualitative changes in diet, may help prioritize public health interventions.

Reduced mortality rates among people attempting to lose weight may also reflect positive health behaviors (for example, seat belt use and moderate alcohol consumption) or more frequent contact with health care providers and preventive care. Persons trying to lose weight reported more physician visits, but controlling for this variation did not influence our findings. Our lack of information about screening for risk factors for cardiovascular disease and early treatment for disease remains a limitation because these factors could have varied according to weight loss intention.

Our findings that unintentional weight loss was asso-

Figure. **Eight-year cumulative mortality rates and corresponding hazard rate ratios by amount of intentional and unintentional weight loss.**



All data were derived from Cox proportional hazards models controlled for age, sex, ethnicity, smoking, education, initial body mass index, self-rated health, diabetes, acute and chronic conditions, functional limitations due to cardiovascular disease or cancer, hospital days, and bed days. Values in parentheses are 95% CIs.

ciated with a 29% to 77% increased mortality rate and that intent to lose weight was independently associated with lower mortality rates have implications for the large body of research linking weight loss to increased mortality. Unintentional weight loss is common and is associated with older age and harmful health behaviors. It is also part of the natural history of many diseases, such as depression, end-stage heart disease, and cancer (26–28). Thus, the underlying factors of unintentional weight loss may spuriously affect associations between weight loss and death in observational studies. Controlling for health status and health care utilization considerably diminished the risk for death associated with unintentional weight loss in our study. It seems likely that the excess risk for death that remained after we controlled for health status was due to undetected disease or harmful health behaviors not measured by the survey.

An unexpected finding was the decreased mortality rate among those who reported gaining weight and who were not trying to lose weight. This association existed primarily among men and was not maintained after persons who smoked were excluded. However, it was based on a small portion of the overall sample (4%) and warrants further examination. The lower mortality rate among persons who gained weight may indicate that weight gain is a marker of short-term health and low risk for hidden disease. Longer follow-up may have resulted in different findings for weight gain.

Our study has several limitations. First, both body weight and weight loss were based on self-report. Previous studies, however, have found self-reports of both weight change and intentional weight loss to be fairly reliable and accurate (28, 29). If recall error is not associated with weight loss intent or mortality, then it would have no effect or would bias results toward the null. It is also possible that persons who tried to lose weight but did not have better weight maintenance than those who did not try to lose weight. The limited time frame for weight change (during the past year) would lead to an underestimate of the benefit of actual weight loss. Finally, we cannot rule out residual confounding related to adequately assess underlying health status. We controlled for health status and health care utilization at baseline, but undetected subclinical disease at baseline might have affected both weight change and mortality rates. This, in turn, could have led to underestimates of both the benefit of intentional weight loss and the mortality risk associated with unintentional weight loss. For example, our finding that intentional weight loss of more than 9 kg was not associated with mortality rates could have been influenced by persons who were simultaneously trying to lose weight and were losing weight because of underlying disease. In other words, the group with large intentional weight loss might have included persons whose weight loss arose from both beneficial and harmful reasons, nullifying the association with mortality rates.

In summary, we found that modest intentional weight loss was associated with decreased mortality rates and unintentional weight loss was associated with increased mortality rates among overweight and obese U.S. adults who were at least 35 years of age. However, our results do not fully clarify the issue of whether greater intentional weight loss confers greater benefits. Also, important questions about the effect of weight loss intent, weight loss, and weight gain on mortality remain unanswered, including the attributes of those who reported attempting to lose weight. In addition to mortality studies, well-designed observational studies and clinical trials are needed to assess the effect of weight loss on disease incidence, as well as the variation of this effect according to such participant characteristics as age, sex, and duration of obesity.

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