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Associations with Weight Loss and Subsequent Mortality Risk

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PURPOSE: Studies have shown a high prevalence of weight loss in older adults is associated with an increased risk of death. We investigated this in a population-based study.
METHODS: Persons living in Beaver Dam, Wisconsin, participated in a baseline examination between 1988 and 1990 (n = 4926). A medical examination and standardized questionnaire were administered. Weight loss was defined as percent loss in body weight from highest lifetime weight to measured weight at baseline.
RESULTS: Weight loss was associated with older age, higher rates of diseases such as diabetes, and lower baseline levels of blood pressure and serum total cholesterol. After controlling for age, medical, and lifestyle factors, both men and women had higher mortality rates over a 10+ year period for increasing categories of weight loss (hazard ratio [95% CI]: 1.16 [1.06, 1.27] for men and 1.23 [1.13, 1.34] for women). Increased mortality rates with increasing weight loss was shown in stratified analyses of age, body mass index (BMI) at highest weight, smoking, and disease status, but did not always reach statistical significance. Persons on weight loss diets within the year prior to baseline did not have increased mortality with increasing weight loss.
CONCLUSION: The strong association between weight loss (likely involuntary) and mortality may be a useful way of estimating overall risks to longevity in populations.
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KEY WORDS: Weight Loss, Involuntary Weight Loss, Mortality, Population-based, Epidemiology.

INTRODUCTION

An association between weight loss and increased mortality has been demonstrated in many epidemiological studies (1–14). This association has been demonstrated defining weight loss over short intervals (4), from an average weight (7), or highest lifetime weight (2). It also has been demonstrated for a wide variety of causes of death (8, 12). However, the conclusions reached from these studies remain controversial, in part, because voluntary and involuntary weight loss may not be distinguished (15–17). The underlying assumption is that involuntary weight loss indicates illness, perhaps occult, while voluntary weight loss does not. Despite this controversy, an increased risk of mortality in persons who have voluntarily lost weight has been shown (6, 8). This may in part be attributable to diseases such as diabetes or hypertension, where the treatment may involve weight loss. To attempt to compensate for underlying diseases and treatments, statistical methods such as adjusting for pre-existing illness and excluding deaths in early follow-up are used. After employing these methods the results between weight loss and increased mortality are generally attenuated, but many times remain statistically significant, although some researchers have argued that there is still uncontrolled confounding (12, 18).

In the current study, we measured weight loss and subsequent mortality risks over 10 years in persons ranging in age from 43 to 86 years in a large population-based study and attempted to determine whether or not weight loss was an independent marker for mortality.

METHODS

Population

A private census of the population of Beaver Dam, Wisconsin, was performed from September 15, 1987 to May 4, 1988, to identify all eligible residents in the city or township of Beaver Dam, WI (19). Of the 5924 eligible individuals, 4926 (83%) persons aged 43 to 86 years participated in the baseline examination between March 1, 1988 and September 14, 1990. Differences between participants and non-participants have been published in a previous report (19). Ninety-nine percent of the population was white. All data were collected with Institutional Review Board approval in conformity with

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Selected Abbreviations and Acronyms

HDL = high density lipoproteins
BMI = body mass index
ICD = International Classification of Diseases
HR = hazard ratio
CI = confidence interval
BP = blood pressure
SD = standard deviation
M = men
W = women

all federal and state laws, and the study was in adherence to the tenets of the Declaration of Helsinki as revised in 1983.

Procedures and Definitions

Participants were examined in the study suite at a local hospital or nursing home. Height and body weight were measured with participants wearing light clothing and no shoes. A medical chart or self-report was used to obtain height and weight if we were unable to measure it directly (1.5%). Blood pressure was measured twice with a random-zero sphygmomanometer according to the Hypertension Detection and Follow-up Program protocol, and the average of the two measurements was used for analysis (20). Hypertension status was defined as systolic BP $\geq$ 140 and/or diastolic BP $\geq$ 90 mmHg and/or current use of antihypertensive medications. Non-fasting blood and urine specimens were collected and various laboratory measurements were obtained including serum cholesterol (total and high density lipoprotein [HDL]), glycosylated hemoglobin, random blood sugar, gross proteinuria, hematocrit, serum albumin, white blood cell count, and serum creatinine (21). Diabetes was defined as a previous history of diabetes and/or hyperglycemia. Hyperglycemia was defined as glycosylated hemoglobin $>$ 2 standard deviations above the mean for the appropriate age and sex group or a casual blood glucose level $\geq$ 200 mg/dl (1.1 mmol/l) (22).

A standardized questionnaire was administered to collect information on weight loss, medical history, smoking status, alcohol use, and physical activity (21). Participants were asked about their highest weight (non-pregnant for women). This information was recorded and body mass index (BMI, kg/m^2) was calculated using the measured height at the examination. Percent weight loss from highest weight to the baseline examination was calculated as:

$$100 * [(\text{weight at baseline exam} - \text{highest weight})/(\text{highest weight})]$$

To minimize bias from differences between actual and self-reported weights, we categorized weight loss into four categories (loss $<$ 5%, loss 5–9.9%, loss 10–19.9%, loss $\geq$ 20%). Participants were asked if they had lost 10 or more pounds in the last year. If they answered yes, then they were further asked if they were on a special diet to lose weight.

A history of cardiovascular disease was defined as having a history of angina, myocardial infarction, and/or stroke. Smokers were identified by answering yes to smoking at least 100 cigarettes in their lives. They were further categorized as current smokers if they had not stopped smoking at the baseline examination. Heavy drinkers were identified by answering yes to ever having a period in their life when they consumed four or more alcoholic beverages on a daily basis. Participants were asked if they engaged in a regular activity long enough to work up a sweat. Persons who on average did such activities less than three times a week were considered to have a sedentary lifestyle.

Vital status was monitored by reading the obituaries of local papers and by annual telephone contact. Persons not known to have died, but whom we could not reach, had their survival time as their last contact date. When a death was identified in the state of Wisconsin, a request was made to the Wisconsin Department of Health and Family Services, Division of Health Care Financing, Bureau of Health Information, Vital Records Section for death certificate information of these persons. Persons known to have died out of Wisconsin as well as persons with whom we have lost contact (no contact since December 31, 1999) and were not known to be dead, were submitted to the National Death Index for matching against national death data. We ascertained mortality between the baseline examination in 1988–1990 and December 31, 1999. Cause of death was defined as any contributing cause listed in the death certificate, according to the International Classification of Diseases, Ninth and Tenth (for deaths after December 31, 1998) Revision, Clinical Modification codes. Cardiovascular disease mortality was defined to include deaths from heart disease, stroke, atherosclerosis and arterial disease, according to the following codes: ICD-9: 391.0–398.9, 402.0–402.9, 404.0–404.9, 410.0–429.9, 430.0–438.9, 440.0–440.9, 441.0–448.9; ICD-10: I01.0–I09.9, I11.0–I11.9, I13.0–I13.9, I20.0–I51.9, I60.0–I69.9, I70.0–I70.9, I71.0–I78.9. Cancer mortality was defined to include deaths according to the following codes: ICD-9: 140.0–208.9; ICD-10: C00.0–C97.9. By December 31, 1999 we had confirmed that 24% (n = 1199) of the baseline cohort had died.

Statistical Analysis

All analyses were performed using SAS, version 8.1 (23). Since the distributions of height, weight, and BMI were different for men and women, all analyses were conducted separately for the genders. We first compared various characteristics collected at the baseline examination by