

Given Diabetes, Is Fat Better Than Thin?

CAROLYN ROSS, MD, MPH
ROBERT D. LANGER, MD, MPH
ELIZABETH BARRETT-CONNOR, MD

OBJECTIVE — To evaluate the association between BMI and mortality in women and men with type II diabetes.

RESEARCH DESIGN AND METHODS — Fasting plasma glucose (FPG), height and weight measurements, and medical history were obtained from 4,483 community-dwelling adults, aged 40–79 years, in 1972–1974. A total of 373 persons with either a history of diabetes or FPG ≥ 7.77 mmol/l were studied. Subjects were grouped into four sex-specific weight categories based on U.S. population data. Vital status after 14 years was known for 99.9% of the patients studied. Cox models were used to assess relative survival by weight category.

RESULTS — Diabetic men and women of average weight had the lowest mortality. A J-shaped relative risk curve by weight category was found, with a poorer survival rate for those who were thin, overweight, or obese. This effect was not explained by early mortality or cigarette smoking.

CONCLUSIONS — Being thin may not provide a mortality benefit for diabetic men and women. Average weight appears to be desirable.

In 1927, Elliott Joslin wrote, “With an excess of fat diabetes begins and from an excess of fat diabetics die, formerly of coma, recently of arteriosclerosis” (1). Two-thirds of diabetic individuals are obese at the time of diagnosis. A strong linear correlation exists between the degree of obesity and the occurrence of diabetes (2). However, it is less clear that being overweight increases the risk of complications after the onset of type II diabetes. The purpose of this study was to examine the relationship between mortality and obesity in older adults with diabetes.

RESEARCH DESIGN AND METHODS

Between 1972 and 1974, baseline data were obtained from 4,483 residents aged 40–79 years in Rancho Bernardo, a geographically defined community in Southern California. Medical and family history, including current

medications, were recorded using standardized forms. Fasting plasma glucose (FPG) was measured using the hexokinase method. There were 373 diabetic subjects. Diabetes was defined by history in 62% of the men and 58% of the women, and by FPG >7.76 mmol/l in the remainder. Few subjects were using insulin. Weight and height were measured with subjects in light clothing and no shoes. BMI was calculated as weight (in kilograms) divided by height (in meters) squared. Waist-to-hip ratio was not measured, but BMI is highly correlated with other estimates of the degree of fatness (3). Four categories of BMI were defined for each sex based on U.S. population data from the National Health and Nutrition Examination Survey (NHANES) II. The thin category reflected the lowest quartile in NHANES II: a BMI of <21.2 kg/m² in women and <22.7 kg/m² in men (4). Corresponding values for overweight were

>27.3 and 27.8 kg/m² and for obese >32.2 and 31.0 kg/m² (5), respectively. Average or normal weight was the range between thin and overweight. Smoking status was dichotomized as nonsmoker (never smoked or quit >2 years ago) or smoker (current smoker or quit <2 years ago). Fasting cholesterol and triglycerides were measured in a Lipid Research Clinic standardized laboratory. Systolic blood pressure (sBP) was measured using a standard clinical protocol.

Vital status at 14 years was known in 99.9% of participants. Death certificates were obtained for all decedents and coded by a certified nosologist, using the ninth revision of the *International Classification of Diseases-Adapted* (ICD-9). ICD-9 codes 400–438 were used to define cardiovascular disease (CVD). Descriptive and survival analyses were run using SPSS software. We fitted Cox proportional hazards models to assess relative survival by weight category, controlling for age, cholesterol, blood pressure, cigarette smoking, and use of antidiabetic medications. Survival time was the interval between the clinic visit and death or date of last contact. All *P* values are two-tailed.

RESULTS — Age, FPG, and sBP were similar in men and women, but women were thinner, almost twice as likely as men to smoke cigarettes, and had higher cholesterol. Men had slightly higher levels of triglycerides ($P = 0.12$). BMI did not vary by age; 32% of men and 27% of women were overweight or obese. While categorical differences were not significant, FPG was highest in the obese category. Use of antidiabetic medication was higher in thin (45.7%) and overweight (32.1%), compared with average-weight (23.7%), subjects. Over one-third of the participants died during the 14-year interval. More than half died from CVD. Figure 1 shows all-cause, CVD, and coronary heart disease (CHD) mortality by relative weight categories. All mortality associations were J-shaped, with the best survival in the average weight category.

There was no interaction between sex and BMI category for mortality. Accordingly, Cox models were fitted for men and women, combined with sex as a covariate. Using the average weight group as the ref-

From the Department of Family and Preventive Medicine, Division of Epidemiology, University of California at San Diego, La Jolla, California.

Address correspondence and reprint requests to Robert D. Langer, MD, MPH, Department of Family and Preventive Medicine, University of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0607. E-mail: rlander@ucsd.edu.

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CHD, coronary heart disease; CVD, cardiovascular disease; FPG, fasting plasma glucose; ICD-9, *International Classification of Diseases*, (9th edition); NHANES, National Health and Nutrition Examination Survey; sBP, systolic blood pressure.

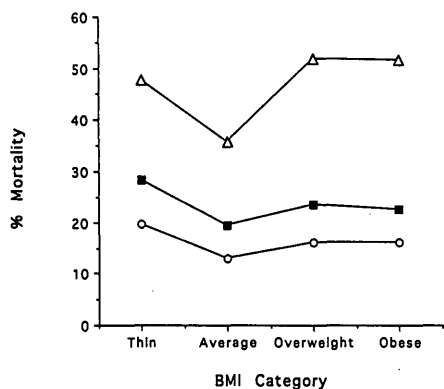


Figure 1—Percent mortality by BMI category and cause of death: diabetic men and women, Rancho Bernardo, CA. Δ , all-cause; \blacksquare , CVD; \circ , CHD.

erent, there was an increased risk of death in the overweight subjects (Table 1). Point estimates for the smaller number of thin and obese participants suggested increased risk, but were not statistically significant. Cigarette smoking, sBP, and cholesterol also contributed independently to all-cause mortality. Sex- and cause-specific analyses showed the same trends (data not shown).

To assess the effect of low weight as a marker for morbidity, analyses were repeated excluding subjects who died within the first 5 years; associations were essentially unchanged (Table 1). Cigarette smoking was associated with a twofold greater relative risk of death from all causes, making it the strongest predictor of mortality. Excluding smokers to test whether smoking confounded the association between weight and mortality had little impact on the relative risk estimates (Table 1).

CONCLUSIONS— Average body weight was associated with the best survival in this cohort of men and women with type II diabetes. Others have reported a variety of patterns. The Framingham study found a minor additional risk for obesity after accounting for other risk factors (6). Obese diabetic women in Framingham had higher mortality from acute myocardial infarction than either obese diabetic men or nonobese diabetic women or men (7). However, a U.S. study that used a similar definition for diabetes found better survival in overweight, compared with normal weight, diabetic patients (8).

The effect of weight change was not tested since data were unavailable on voluntary or involuntary weight loss, but these did not affect event rates in an extensive recent study (9). A mortality advantage associated with weight loss in diabetic

Table 1—The effect of weight category (BMI) on the relative risk (95% CI) for all-cause mortality in diabetic men and women

	All cause	Excluding deaths within the first 5 years	Excluding smokers
Age- and sex-adjusted			
Age	1.09 (1.06–1.11)	1.08 (1.05–1.11)	1.12 (1.08–1.15)
Sex	0.95 (0.68–1.31)	1.02 (0.70–1.50)	0.73 (0.48–1.09)
BMI			
Thin	1.43 (0.89–2.30)	1.41 (0.80–2.47)	1.07 (0.57–2.01)
Average	1.00	1.00	1.00
Overweight	1.85 (1.27–2.70)	1.66 (1.04–2.65)	2.29 (1.48–3.54)
Obese	1.69 (0.99–2.91)	1.96 (1.06–3.59)	1.64 (0.83–3.22)
Multiply adjusted			
Age	1.09 (1.07–1.11)	1.08 (1.05–1.11)	1.11 (1.08–1.15)
Sex	0.81 (0.58–1.14)	0.91 (0.61–1.36)	0.66 (0.43–1.00)
BMI			
Thin	1.61 (1.00–2.62)	1.65 (0.93–2.95)	1.25 (0.66–2.36)
Average	1.00	1.00	1.00
Overweight	1.87 (1.28–2.73)	1.69 (1.06–2.72)	2.42 (1.56–3.77)
Obese	1.50 (0.86–2.62)	1.80 (0.97–3.36)	1.60 (0.80–3.22)
sBP	1.01 (1.01–1.02)	1.02 (1.01–1.03)	1.01 (1.00–1.02)
Cholesterol	1.00 (1.00–1.01)	1.00 (1.00–1.01)	1.00 (1.00–1.01)
Smokers	2.32 (1.61–3.35)	1.85 (1.16–2.94)	
Diabetic medications	1.17 (1.00–1.37)	1.09 (0.86–1.37)	0.96 (0.74–1.26)

patients reported by others could be mediated through improvements in diet and exercise that modify cardiovascular risk factors such as cholesterol and triglycerides (3,10). Some of the risk associated with overweight may be due to its association with unfavorable lipid and sBP levels (3). In the present study, however, the better survival of average-weight older adults with diabetes was independent of these factors.

While physicians have traditionally advocated weight loss as the primary treatment for type II diabetes (10), few studies have examined whether obesity increases mortality after diabetes is diagnosed. The present study confirms that being overweight predicts poorer survival in patients with type II diabetes, but the thinnest diabetic individuals did not fare the best. This could be explained by a larger genetic burden and more severe disease in lean, compared with overweight, type II diabetic individuals (10). Smoking was the most powerful risk factor in this cohort (11), but it did not explain the trend toward increased risk in thin subjects. Based on the age of this cohort and the paucity of insulin therapy, it is unlikely that type I diabetes explains the thinness-mortality association. It is also unlikely that this was due to more advanced diabetes, since early mortality did not explain the association. These results suggest that

being of average weight, in contrast to being thin or overweight, is associated with the best survival rate in adults with type II diabetes.

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