

## Weight Loss Does Not Differ by Fat, Protein, or Carbohydrate Composition of Diet

Sacks F, Bray G, Carey V, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. *N Engl J Med* 2009;360:859–73.

### Study Overview

**Objective.** To determine whether weight loss differs by protein, fat, and carbohydrate composition of diets.

**Design.** Randomized controlled trial.

**Setting and participants.** Overweight subjects with a body mass index between 25 and 40 kg/m<sup>2</sup> and age between 30 and 70 years in Boston and Baton Rouge, Louisiana. Exclusion criteria were diagnosis of diabetes, unstable cardiovascular disease, use of medications affecting body weight, and insufficient motivation assessed by interview and questionnaire. Researchers recruited subjects through mass mailings to individuals identified through lists of registered voters and drivers.

**Intervention.** Patients were assigned to 1 of 4 diets—percentage of energy from fat, protein, and carbohydrates of (1) 20%, 15%, and 65%; (2) 20%, 25%, and 55%; (3) 40%, 15%, and 45%; and (4) 40%, 25%, and 35%. All diets contained a 750-calorie deficit from baseline intake, included at least 20 g of dietary fiber daily, and had ≤ 150 mg of cholesterol for every 1000 kcal of the diet and ≤ 8% of energy from saturated fat. The goal recommended physical activity was 90 minutes per week of moderate activity. After random assignment to 1 of the 4 diets, subjects participated in individual counseling sessions every 8 weeks for the duration of the study. They participated in group sessions every week (3 out of 4 weeks) during the first 6 months of the trial and for 2 of 4 weeks for the remaining 1.5 years.

**Main outcome measures.** The primary outcome was change in body weight over 2 years of follow-up. Secondary outcomes included change in waist circumference and cholesterol levels. Researchers compared results from each diet to the others. Data were pooled and contrasted to provide direct comparisons between different diet characteristics (high protein vs. moderate protein, high fat vs. low fat, highest carbohydrate vs. lowest carbohydrate). Because diets contained 4 separate carbohydrate levels, a trend analysis across the carbohydrate levels also compared outcomes.

Subjects who were lost to follow-up had their final weight and waist circumference imputed according to a standardized algorithm.

**Main results.** 811 subjects of 1638 screened enrolled in the trial, and 80% completed the trial. The average age was 51 years, 64% were women, 16% were black, 4% were Hispanic, 9% had a high school education or less, and the mean body mass index was 33 kg/m<sup>2</sup>. In the intent-to-treat analysis, mean weight loss at 2 years was 2.9 to 3.6 kg across the diet groups. No differences in weight loss or waist circumference were present between any of the diet groups. 14% to 15% of subjects in each diet group lost at least 10% of their initial weight. Metabolic profiles of all subjects improved during the course of the study. The low-fat diets achieved greater reductions in LDL cholesterol levels than the high-fat diets, and the lowest-carbohydrate diet achieved a larger increase in HDL cholesterol than the highest-carbohydrate diet. Attendance at group sessions and reports of satiety, hunger, and satisfaction were similar across all diets.

**Conclusion.** Diets differing in macronutrient characteristics (fat, protein, and carbohydrate) achieved equivalent weight loss.

### Commentary

The debate about the most effective macronutrient characteristics of diets has been long-standing. Over the last several decades, the carbohydrate content of diets, in particular, has risen and fallen in popularity. Recently, the resurgence of the Atkins diet has fueled a backlash against traditional low-fat diets. Research has followed. Samaha et al [1] found a higher weight loss at 6 months among severely obese subjects following a low-carbohydrate diet (mean of 5.8 kg loss) compared with those following a low-fat diet (mean of 1.9 kg loss). All subjects participated in a high-intensity educational program. Those in the low-carbohydrate diet also had greater improvements in triglycerides and insulin sensitivity. Another study by Foster et al [2] used a low-intensity program to compare a low-carbohydrate diet to a low-fat diet among 63 obese subjects, with 1 year follow-up.

They found more weight loss over 6 months for subjects following the low-carbohydrate diet but no differences at 1 year. Improvements in triglycerides and HDL were higher in the low-carbohydrate arm.

However, even with these initial though short-term positive findings for low-carbohydrate diets, experts have cautioned about their widespread use because of limited long-term data about efficacy and safety (in contrast with copious studies of long-term use of low-fat diets) [3]. Concern remains about the long-term risk for atherogenic effects from a low-carbohydrate diet secondary to the likely high levels of saturated fat consumed while on such a diet, compared with a low-fat diet. Research also has called into question the benefits of the HDL increase that can occur with low-carbohydrate diets. This HDL change appears to be a change in the subfractions of HDL rather than a true increase, and such changes have not been shown to be beneficial in reducing the risk for cardiovascular disease.

Furthermore, prior studies have been limited by high attrition, short duration of follow-up, and small sample sizes. Research comparing diets with different macronutrient diet characteristics has also been highly variable. Among studies with follow-up for more than 1 year, one study found more weight loss for subjects following a very-low-fat vegetarian diet when compared with a traditional low-fat diet [4]. Other studies have shown more weight loss for a low-fat diet compared with a moderate-fat diet [5] or, in contrast, a Mediterranean, moderate-fat diet compared with a low-fat diet [6,7]. Yet another study found no difference comparing a high-protein and low-protein diet [8]. Dansinger et al [9] compared different popular diets (Atkins, Ornish, Weight Watchers, and Zone Diet) among 160 participants and found no difference in weight loss among groups.

In the current study, Sacks et al sought to answer the impact of dietary composition on weight loss and metabolic risk once and for all. They enrolled a large study, conducted in collaboration with researchers at the National Heart, Lung, and Blood Institute of the NIH, with the intention of remedying design flaws in all of the prior trials. They designed the trial to be large enough to detect clinically meaningful differences in weight loss between groups and to compare diets across the commonly differing domains of protein, fat, and carbohydrate content. They also conducted the study for 2 years and aggressively pursued adherence, achieving a very high study completion rate of 80%, a rate that was much better than prior studies. They included biologic measures of adherence to further determine whether subjects followed the study protocol.

Among the different diets, the study found no differences in weight loss, measured as average weight loss in all subjects, average weight loss among trial completers, and percent of subjects reaching a pre-specified amount of weight

loss, such as 10% of baseline body weight. All diets had some success, ranging from 2.9 to 3.6 kg of weight loss in intent-to-treat analyses at 2 years. Subjects lost more weight if they attended more counseling sessions. A few of the diets showed some metabolic risk improvements compared with others. The low-fat diets led to more reduction in LDL cholesterol than high-fat diets, and the lowest-carbohydrate diet led to an increase in HDL cholesterol compared with the highest-carbohydrate diet.

Not only was the completion rate excellent, but researchers also effectively accounted for missing data for those lost to follow-up, imputing presumed weight regain at the 2-year mark based on what has been found to be typical for weight regain after diets (0.3 kg per month) [10]. This imputation method appears to be far superior than methods that are often used to account for loss to follow-up, such as least measure carried forward (assuming that someone stayed at the same weight as their last measurement) or use of baseline weight before the study began with the assumption that someone lost to follow-up simply regained any weight that was lost.

Researchers also made impressive attempts to verify dietary adherence through food frequency questionnaires and through biological measurements that could provide evidence about adherence, such as urinary nitrogen excretion as a measure for compliance with the assigned protein content, respiratory quotient for assigned fat content, and HDL cholesterol for assigned carbohydrate content. These measures confirmed expected differences in the diets to which subjects were assigned but the differences were not as substantial as planned. The food frequency questionnaires found an absolute difference of 1% to 2% between the percent of energy from protein in the high-protein diet groups compared with the average-protein diet groups (assigned difference was 10%). Similarly, the difference in fat intake was only 7% between the high- and low-fat diet groups (assigned difference 20%) and 10% for the highest-carbohydrate and lowest-carbohydrate groups (assigned difference 30%). The estimated differences based on the biologic measures of compliance were even smaller than the differences found in the food frequency responses.

The generalizability of this study is better than for most diet studies. Investigators took great efforts to ensure that men were adequately represented in the sample, and they enrolled subjects in 2 geographic regions to reach some reasonable racial/ethnic diversity. However, limitations arise when attempting to compare the results of this study to what might be reasonably expected for a typical clinical setting. Researchers excluded subjects from the study if they were not motivated to comply with dietary recommendations, as measured by a pre-enrollment interview and questionnaire. The educational sessions were quite intensive as well, requiring significant resources over the entire

2-year time period. In a typical clinical setting, such resources would likely be limited to those individuals who could pay out of pocket for such services since most health insurance plans do not cover dietary or weight loss programs.

**Applications for Clinical Practice**

Weight loss through an intensive dietary program can be successful, regardless of the assigned macronutrient characteristics of the diet. No advantages were evident for any of the diets, which differed in fat, protein, and carbohydrate content. Adherence to caloric reduction by itself, rather than diet characteristics, appears to be the most important issue.

—Review by Jason P. Block, MD, MPH

**References**

1. Samaha F, Iqbal N, Seshadri P, et al. A low-carbohydrate as compared with a low-fat diet in severe obesity. *N Engl J Med* 2003;348:2074–81.
2. Foster G, Wyatt H, Hill J. A randomized trial of a low-carbohydrate diet for obesity. *N Engl J Med* 2003;348:2082–90.
3. Bonow R, Eckel R. Diet, obesity, and cardiovascular risk. *N Engl J Med* 2003;348:2057–8.
4. Turner-McGrievy GM, Barnard ND, Scialli AR. A two-year randomized weight loss trial comparing a vegan diet to a more moderate low-fat diet. *Obesity (Silver Spring)* 2007;15:2276–81.
5. Toubro S, Astrup A. Randomized comparison of diets for maintaining obese subjects' weight after major weight loss: ad lib, low fat, high carbohydrate diet v fixed energy intake. *BMJ* 1997;314:29–34.
6. McManus K, Antinoro L, Sacks F. A randomized controlled trial of a moderate-fat, low-energy diet compared with a low fat, low-energy diet for weight loss in overweight adults. *Int J Obes Relat Metab Disord* 2001;25:1503–11.
7. Shai I, Schwarzfuchs D, Henkin Y, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *N Engl J Med* 2008;359:229–41.
8. Due A, Toubro S, Skov AR, et al. Effect of normal-fat diets, either medium or high in protein, on body weight in overweight subjects: a randomised 1-year trial. *Int J Obes Relat Metab Disord* 2004;28:1283–90.
9. Dansinger M, Gleason J, Griffith J, et al. Comparison of the Atkins, Ornish, Weight Watchers, and Zone diets for weight loss and heart disease risk reduction. *JAMA* 2005;293:43–53.
10. Wadden TA, Berkowitz RI, Sarwer DB, et al. Benefits of lifestyle modification in the pharmacologic treatment of obesity: a randomized trial. *Arch Intern Med* 2001;161:218–27.

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