Diet, Obesity, and Cardiovascular Risk

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The growing prevalence of obesity and type 2 diabetes in the United States has attracted the attention and concern of the medical profession, the media, policymakers, and the American public. Recent statistics from the Centers for Disease Control and Prevention indicate that nearly two thirds of American adults are overweight (body-mass index [the weight in kilograms divided by the square of the height in meters], greater than 25) and more than 30 percent are frankly obese (body-mass index, greater than 30), that nearly 8 percent are diabetic, and that 24 percent have the metabolic syndrome. The metabolic syndrome is an ominous combination of visceral obesity, atherogenic dyslipidemia (low levels of high-density lipoprotein [HDL] cholesterol and elevated levels of triglycerides), hypertension, and glucose intolerance that contributes to insulin resistance and a heightened risk of diabetes and cardiovascular disease.

These troubling trends have emerged over the past few decades, during which there has been a striking increase in caloric intake and a decrease in physical activity in the U.S. population. These trends have also spawned a number of best-selling books based on popular diet theories, many of which suggest that altering the macronutrient composition of the diet can make it easier to curb caloric intake (or even to induce weight loss without reducing caloric intake) and can help reduce the risk of heart disease, diabetes, and other diseases. Principal among these dietary approaches are those promoting high-protein, low-carbohydrate regimens (e.g., the Atkins diet), which have gained widespread popularity even though the scientific evidence supporting their safety and efficacy is limited. A recent review of low-carbohydrate diets reported that weight loss with these diets is related to the duration of the diet and the restriction of calories but not to the reduction in carbohydrate intake per se and also pointed out the paucity of long-term data.[1] In only five published investigations were subjects following these diets studied for longer than 90 days, and none of the studies were randomized or included a comparison group.

The studies reported by Samaha et al. and Foster et al. in this issue of the *Journal* (pages 2074–2081 and 2082–2090, respectively) extend knowledge about low-carbohydrate diets. Each group of investigators randomly assigned obese subjects to either a low-carbohydrate diet (with high protein and fat content) or a more standard, reduced-fat diet (with fat constituting less than 30 percent of the total caloric intake but more than in some extremely low-fat diets). Each study was designed to follow subjects for more than 90 days. Samaha et al. followed severely obese subjects (mean body-mass index, 43) with a high prevalence of diabetes (39 percent) or of the metabolic syndrome without diabetes (43 percent), whereas Foster et al. studied subjects with less severe obesity (mean body-mass index, 34), none of whom had diabetes. Samaha et al. used fixed-carbohydrate restriction (30 g or less per day), and Foster et al. used the Atkins diet.

Despite these differences in study populations and dietary approaches, both studies demonstrated significantly greater weight reduction with the low-carbohydrate diet than with the reduced-fat diet during the first six months (average reduction, 6 to 7 kg vs. 2 to 3 kg). However, the magnitude of the weight-loss difference (4 kg in both studies) was relatively small, and adherence in the two diet groups was low. In addition, in the study by Foster et al., there was no longer a significant difference in weight loss between the subjects in the low-carbohydrate group and those in the reduced-fat group at 12 months. This finding could reflect the small number of subjects remaining in the study at that time or the possibility that adherence to the diet was low even among those who continued in the study. Any approach to caloric restriction that is not compatible with daily lifestyle patterns is difficult to maintain over the long term.

In both studies, the reduction in serum triglyceride levels in subjects randomly assigned to the low-carbohydrate diet might have been anticipated as a result of their greater weight loss, although it is true that reduced carbohydrate intake is generally associated with reduced triglyceride levels. However, the rise in HDL cholesterol in the subjects following the low-carbohydrate diet (a change observed only by Foster et al.) may reflect a change in HDL subfractions that occurs with increased intake of saturated fats, and this change has not been shown to be beneficial. Thus, caution is urged about over-

Comparison of Low-Carbohydrate and Reduced-Fat Diets.

Variable	Low-Carbohydrate Diet*	Reduced-Fat Diet†
Caloric restriction	Not necessary; ketosis may help to reduce intake	Necessary
Food choices	Highly restricted	Moderately restricted
Initial rate of weight loss	Rapid, with increased diuresis	Gradual, with some diuresis
Weight loss	Dependent on duration	Dependent on duration
Weight maintenance	Unproven over the long term	Unproven over the long term
Cholesterol‡		
LDL	No change	Decrease
HDL	Greater increase	Increase
Triglycerides	Greater decrease	Decrease
Potential long-term concerns	Calciuria (renal stones and decreased bone mass) Relatively high protein content (patients with renal or hepatic disease) Atherogenicity (high saturated fat, trans fat, and cholesterol levels and relative absence of fruits, vegetables, and whole grains)	None

* A low-carbohydrate diet is defined as one that provides less than 35 g of carbohydrate per day. The Atkins diet begins with a stricter limitation (20 g per day) for at least the first two weeks, with a gradual increase of 5 g per week to achieve a rate of weight loss of approximately 2 lb (0.9 kg) per week until a weight within 5 to 10 lb (2.3 to 4.5 kg) of the goal is achieved. Carbohydrate intake is then further increased by 10 g per week until weight loss ceases.

† A reduced-fat diet is defined as one in which fat constitutes less than 30 percent of the total caloric intake; under certain circumstances (e.g., in some patients with the metabolic syndrome), fat intake of up to 35 percent of the total caloric intake is recommended.

‡ LDL denotes low-density lipoprotein and HDL high-density lipoprotein.

interpretation of this observation as a beneficial result of a low-carbohydrate, high-fat diet.

The results of both studies demonstrate that initial weight loss is much easier to achieve than is long-term maintenance of weight loss. Even if long-term adherence is possible, there are concerns related to the long-term use of this diet (see Table), since its high content of fat (particularly saturated fat) is potentially atherogenic. A wealth of epidemiologic and nutritional data collected over the past several decades indicates that the consumption of high levels of saturated fat has adverse consequences on health. Low-carbohydrate diets may also lack important vitamins and fiber. Moreover, in marked contrast to the paucity of long-term data on low-carbohydrate diets, a number of studies reporting the long-term effects of reduced-fat diets have been reported. The Finnish Diabetes Prevention Study Group[2] and the Diabetes Prevention Program Research Group[3] demonstrated, in studies involving obese persons with impaired glucose tolerance, that the combination of a reduced-fat diet and physical activity over an average of three years facilitated weight reduction equivalent to that observed in the two current studies of low-carbohydrate diets and that this combination also appeared to delay the onset of diabetes. Data from the National Weight Control Registry have shown that long-term maintenance of weight reduction can be achieved with a reduced-fat diet accompanied by regular physical activity. Moreover, others have shown a reduction in the rate of death from cardiovascular causes among persons who consume diets high in fruit and vegetables, whole grains, and fish. Thus, there is evidence to support the "heart-healthiness" of a balanced diet consisting of a wide variety of foods, including fruits and vegetables, whole grains, legumes, lean meat and poultry, and fish, with the total intake of fat accounting for less than 30 percent of the total number of calories and the total intake of saturated fat and trans fat accounting for less than 10 percent of the total calories.

The recipe for effective weight loss is a combination of motivation, physical activity, and caloric restriction; maintenance of weight loss is a balance between caloric intake and physical activity, with lifelong adherence. For society as a whole, prevention of weight gain is the first step in curbing the increasing epidemic of overweight and obesity. Until further evidence is available regarding the long-term benefits of a low-carbohydrate approach, physicians should continue to recommend a healthy lifestyle that includes regular physical activity and a balanced diet.

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1. Bravata DM, Sanders L, Huang J, et al. Efficacy and safety of low-carbohydrate diets: a systematic review. JAMA 2003;289:1837-50.
2. Tuomilehto J, Lindström J, Eriksson JG, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001;344:1343-50.
3. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393-403.

: The treatment of obesity and cardiovascular diseases is one of the most difficult and important challenges nowadays. Weight loss is frequently offered as a therapy and is aimed at improving some of the components of the metabolic syndrome. Among various diets, ketogenic diets, which are very low in carbohydrates and usually high in fats and/or proteins, have gained in popularity. Results regarding the impact of such diets on cardiovascular risk factors are controversial, both in animals and humans, but some improvements notably in obesity and type 2 diabetes have been described. Unfortunatel