Assignment: Discussion Essay

Effects of Low-carbohydrate Diets on Weight and Cardiovascular Health

Over the last decade, the most popular nutritional approaches to weight control and health promotion have been carbohydrate-restricted diets. Prior to 2003, most mainstream nutrition experts were strongly opposed to low-carbohydrate diets, voicing arguments about their ineffectiveness and health risks. The mainstream approach to dieting is founded on the "calorie theory," which holds that we lose weight only by consuming fewer calories than we expend. According to this view, successful dietary approaches to weight loss depend entirely on reducing calorie intake rather than on any alterations of macronutrient composition such as reductions of carbohydrate intake. In support of the calorie theory, Golay et al. (1996) found that weight loss did not differ significantly between obese subjects on a 1,000 kcal/day high-carbohydrate diet and their counterparts on an isocaloric low-carbohydrate diet. Prior to 2003, most mainstream nutrition experts also argued that low-carbohydrate diets would promote cardiovascular disease because they contain relatively large amounts of fat.

A funny thing happened in 2003: The first controlled studies to ever be conducted on low-carbohydrate diets yielded results that sharply questioned mainstream dietary beliefs and practices. In an article published in the highly reputable *New England Journal of Medicine*, Samaha et al. (2003) reported a study on the popular Atkins diet, which is extremely low in carbohydrate content (approximately 20 to 50 grams per day), high in fat content (approximately 60% of overall caloric intake), and unrestricted in calories. The researchers found that over a 6-month period subjects on the Atkins Diet lost significantly more weight (5.8 kg) than subjects on a high-carbohydrate, low-fat, calorie-cutting diet (1.9 kg). Subjects on the low-carbohydrate diet also experienced significant improvements in measures of several risk factors for cardiovascular disease and type 2 diabetes. Since 2003, numerous other studies have revealed substantial weight loss and improvements in markers of cardiovascular health in individuals on low-carbohydrate diets (in our list of research readings, see the review by Westman et al., 2007).

Supporters of low-carbohydrates diets do not accept the calorie theory, contending instead that macronutrient composition can indeed influence weight loss by creating a so-called "metabolic advantage." Low-carbohydrate diets, supporters say, can cause extraordinary weight loss even when calorie intake exceeds calorie expenditure through basic metabolism and daily physical activity. Physiological arguments for the metabolic advantage of low-carbohydrate diets are usually based on the following two hypothesized mechanisms.

1. **Ketogenesis**, which involves the diet-induced production and excretion of fat-derived molecules called ketones. This theory holds that dietary carbohydrate restriction causes metabolic adaptations enabling the body to synthesize ATP with a greater-than-normal reliance on substrates other than glucose and glycogen. Specifically, free fatty acids and ketones become major sources of energy. According to the ketogenic theory, low-carbohydrate diets turn the body into a fat-burning and fat-excreting machine.

2. **Thermogenesis**, which involves an increase in energy expenditure associated with the thermic effect of food (TEF). TEF is the energy cost of chewing, ingesting, digesting, absorbing, and storing food. TEF accounts for approximately 10 to 15% of total daily energy expenditure in
individuals on balanced, conventional diets. Note, however, that TEF varies for the three macronutrients. The thermic effect of protein is much greater than that of carbohydrate and fat. Theoretically, then, a diet that increases protein intake and reduces carbohydrate intake might create a metabolic advantage for weight loss.

Critics of the metabolic advantage theory claim that low-carbohydrate diets work simply by reducing hunger and increasing satiety, or feelings of fullness. Some critics contend that the diets increase satiety through psychological mechanisms, especially through the boredom and monotony that can result from eliminating many carbohydrate-rich food groups such as vegetables, fruits, and grains. The critics reason that if low-carbohydrate diets cause weight loss by reducing hunger and food intake, their effects are attributable to a negative energy balance; this is ultimately the same mechanism underlying weight loss in individuals on conventional, calorie-cutting diets.

Conflicting study results and debate still characterize the issue of whether, for promoting effective and healthy weight loss, obese individuals should eat conventional or low-carbohydrate diets. The issue remains unresolved largely due to methodological shortcomings in previous studies. Consider, for example, the study conducted by Golay et al., which led to the conclusion that a negative energy balance, rather than dietary macronutrient composition, determines weight loss. In addition to consuming a high-carbohydrate or low-carbohydrate diet, the subjects in this study received nutritional counseling and participated in an exercise program. These additional treatments may have introduced confounding effects on weight loss. The study conducted by Samaha et al. also had major methodological limitations. While the researchers speculated that the greater weight loss experienced by the low-carbohydrate dieters was caused by increased satiety and calorie restriction, they did not measure calorie intake directly. Instead, the subjects self-reported their food intake. This method is not always valid. Thus, Samaha et al.’s argument—that the Atkins Diet causes greater weight loss than the conventional diet through increasing satiety and reducing calorie intake—is debatable.

Using methods intended to avoid confounding variables and to control macronutrient and calorie intake precisely, we sought to answer the following research questions:

1. Do low-carbohydrate diets offer a metabolic advantage for weight loss?

2. Do low-carbohydrate diets cause significant improvements in markers of cardiovascular health?
Methods

Subjects

We recruited 200 men and women to participate in our 6-month study. Subjects were between 25 to 34 years old. The number of subjects represented the US population with respect to race. To be included in the study, subjects had to meet the following criteria:

- BMI (kg/m^2) values between 34-36, which indicate clinical obesity
- Sedentary lifestyle
- No previous experience with a low-carbohydrate diet
- Clinical evidence of dyslipidemia and metabolic syndrome (google these terms for their definitions)
- No current drug treatment for dyslipidemia and metabolic syndrome

Baseline Assessment of Energy Balance

Over a 2-week baseline period we measured each subject's daily calorie intake and energy expenditure, including energy expended through normal physical activity and resting metabolism. As described in more detail below, we used these measures to reduce subjects' daily caloric intake by a standard amount.

Diets

Subjects were randomly assigned to a conventional diet (n = 50 women; n = 50 men) or to a low-carbohydrate diet (n = 50 women; n = 50 men). To ensure that subjects adhered to their prescribed diets, we moved them into an isolated resort hotel for the duration of the study. Subjects were not permitted to leave the hotel grounds. All subjects ate three meals a day in the hotel dining room under our strict observation.

Conventional diet. In accordance with recommendations of mainstream health organizations, the composition of this diet was 55% carbohydrate, 30% fat, and 15% protein. To create the negative energy balance that characterizes conventional diets, we used the subjects' baseline measures of daily energy intake and expenditure to determine the caloric intake that constituted energy balance for each individual. For each subject, we designed a diet that lowered daily caloric intake by 500 kcals per day under the baseline values that accounted for energy balance. Subjects maintained their sedentary lifestyle throughout the study.

Low-carbohydrate diet. Subjects in this group were restricted to 20-50 grams of carbohydrate intake per day. Upon reaching this limit, subjects freely chose foods that contained only fat and protein. To control for the potentially confounding effects of weight loss on changes in blood lipids, we created an isocaloric design by reducing each subject's calorie intake by 500 kcals per day below the value that constituted energy balance. Subjects maintained their sedentary lifestyle throughout the study.
Results

Table 1. Mean values for body weight, blood lipids, and daily calorie intake at 2-month intervals.

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<thead>
<tr>
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<th>Conventional Diet Group (n = 100)</th>
<th>Low-carbohydrate Diet Group (n = 100)</th>
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<tr>
<td></td>
<td>Baseline 2 months 4 months 6 months</td>
<td>Baseline 2 months 4 months 6 months</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>130.6 126.8 123.1 119.2</td>
<td>130.7 126.0† 121.3† 116.6†</td>
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<tr>
<td>LDL cholesterol (mg/dL)</td>
<td>165 163 161 159</td>
<td>166 159† 153† 142†</td>
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<tr>
<td>HDL cholesterol (mg/dL)</td>
<td>32 34 35 37</td>
<td>32 41† 45† 48†</td>
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<tr>
<td>Triglycerides (mg/dL)</td>
<td>204 193 186 181</td>
<td>202 183† 165† 140†</td>
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<td>Daily calorie intake (kcals)</td>
<td>2532 2030 2033 2046</td>
<td>2530 2025 2037 2042</td>
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† = p < .001 (comparison of means across the two diet groups at 2-month intervals)

Writing Assignment

What to write: The assignment is to write what we'll call a "discussion essay" based on the methods and results of the hypothetical study reported in this document. Note that you won't write the entire discussion section of a standard research paper. Instead, you'll write selected parts of a discussion section, adapting the content and structure to meet criteria that we'll discuss in upcoming class sessions.

Paper length: The maximum length for the first draft and final paper is 1600 words (not counting the reference list, the title, your name, and section headings). To have the potential for an excellent grade, you must not exceed the maximum word count. To develop your ideas and arguments fully, you should get as close to the maximum as possible on your first draft and final paper.

Audiences: Your audiences are (1) upper-division integrative physiology majors who are not in IPHY 3700 this semester and (2) me, your scientific writing instructor. We'll devote class time to talking about how to develop and tailor your paper's content, structure, and language by considering the needs, expectations, and values of your readers.

Grading criteria: In class meetings over the first half of the semester, I'll talk extensively about how I'll grade these papers.

Style, format, and paper submission guidelines: Guidelines for preparing and submitting papers are in the handout, "Instructions to IPHY 3700 Authors." You'll find a link to this handout in the Everyday Stuff menu on the course Web site.

Deadlines

First Draft: September 22 || Final Revision: October 20
See the course syllabus for information about point deductions for papers turned in after deadlines.

**Readings**

In the *Everyday Stuff* menu on the course Web site, you'll find a link to a list of downloadable PDF articles on various aspects of our research issue. Some of the articles are core readings that will be assigned over the first few weeks of the semester. Others are supplementary articles that you might want to read as you begin to develop a plan for your paper. For this project, I don't expect you to spend much time searching for additional articles on your own. (For the position paper assignment, later in the semester, you'll learn how to use databases of scientific literature to search for and obtain journal articles.)

If you can't find information that you need in the readings on the course Web site, contact our teaching assistant, Chase Dukes (chase.dukes@colorado.edu). He'll help you get the literature you need.