

Popular Diets: A Scientific Review

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EXECUTIVE SUMMARY

Introduction

Weight loss is a major concern for the US population. Surveys consistently show that most adults are trying to lose or maintain weight (1). Nevertheless, the prevalence of overweight and obesity has increased steadily over the past 30 years. Currently, 50% of all adult Americans are considered overweight or obese (2,3). These numbers have serious public health implications. Excess weight is associated with increased mortality (4) and morbidity (5). It is associated with cardiovascular disease, type 2 diabetes, hypertension, stroke, gallbladder disease, osteoarthritis, sleep apnea and respiratory problems, and some types of cancer (6,7).

Most people who are trying to lose weight are not using the recommended combination of reducing caloric intake and increasing physical activity (1). Although over 70% of persons reported using each of the following strategies at least once in 4 years, increased exercise (82.2%), decreased fat intake (78.7%), reduced food amount (78.2%), and reduced calories (73.2%), the duration of any one of these behaviors was brief. Even the most common behaviors were used only 20% of the time (8).

Obesity-related conditions are significantly improved with modest weight loss of 5% to 10%, even when many patients remain considerably overweight (6). The Institute of Medicine (9) defined successful long-term weight loss as a 5% reduction in initial body weight (IBW) that is maintained for at least 1 year. Yet data suggest that such losses are not consistent with patients' goals and expectations. Foster (10) reported that in obese women (mean body mass index [BMI] of 36.3 ± 4.3) goal weights targeted, on average, a 32% reduction in IBW, implying expectations that are unrealistic for even the best available treatments. Interestingly, the most important factors that influenced the

selection of goal weights were appearance and physical comfort rather than change in medical condition or weight suggested by a doctor or health care professional. Is it any wonder that overweight individuals are willing to try any new diet that promises quick, dramatic results more in line with their desired goals and expectations than with what good science supports?

The proliferation of diet books is nothing short of phenomenal. A search of books on Amazon.com using the key words "weight loss" revealed 1214 matches. Of the top 50 best-selling diet books, 58% were published in 1999 or 2000 and 88% were published since 1997. Many of the top 20 best sellers at Amazon.com promote some form of carbohydrate (CHO) restriction (e.g., *Dr. Atkins' New Diet Revolution*, *The Carbohydrate Addict's Diet*, *Protein Power*, *Lauri's Low-Carb Cookbook*). This dietary advice is counter to that promulgated by governmental agencies (US Department of Agriculture [USDA]/Department of Health and Human Services, National Institutes of Health) and nongovernmental organizations (American Dietetic Association, American Heart Association, American Diabetes Association, American Cancer Society, and Shape Up America!).

What is really known about popular diets? Is the information scientifically sound? Are popular diets effective for weight loss and/or weight maintenance? What is the effect, if any, on composition of weight loss (fat vs. lean body mass), micronutrient (vitamin and mineral) status, metabolic parameters (e.g., blood glucose, insulin sensitivity, blood pressure, lipid levels, uric acid, and ketone bodies)? Do they affect hunger and appetite, psychological well-being, and reduction of risk for chronic disease (e.g., coronary heart disease, diabetes, and osteoporosis)? What are the effects of these diets on insulin and leptin, long-term hormonal regulators of energy intake and expenditure?

The objective of this article is to review the scientific literature on various types of popular diets based on their macronutrient composition in an attempt to answer these questions (see Appendix for diet summaries).

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Evidence-Based Guidelines

This article is limited to the effects of popular diets in overweight and obese adults; there are no good data on children and adolescents. Dietary claims are scrutinized, diets are analyzed, and information is compared with scientific data published in peer-reviewed journals. No published studies are excluded, despite inherent methodological problems (e.g., small or inadequate sample size, limited duration, lack of adequate controls and randomization, poor or minimal dietary collection and/or description of diets, and potential biases). However, the strength of the evidence supporting various conclusions made throughout the paper is based on the following grading system used by National Heart, Lung, and Blood Institute (NHLBI) (6) (Table 1).

Characterization of Diets

Diets are characterized below and in Tables 2 and 3.

- High-fat (55% to 65%), low-CHO (<100 g of CHO per day), high-protein diets (e.g., *Dr. Atkins' New Diet Revolution*, *Protein Power*, *Life Without Bread*).
- Moderate-fat (20% to 30%), balanced nutrient reduction diets, high in CHO and moderate in protein (e.g., USDA Food Guide Pyramid, DASH diet, Weight Watchers).
- Low-fat (11% to 19%), and very-low-fat (VLF) (<10%), very-high-CHO, moderate-protein diets (e.g., *Dr. Dean Ornish's Program for Reversing Heart Disease*, *Eat More, Weigh Less*, *The New Pritikin Program*).

Summary of Findings

Weight Loss

Diets that reduce caloric intake result in weight loss. In the absence of physical activity, a diet that contains

~1400 to 1500 kcal/d, regardless of macronutrient composition, results in weight loss. Individuals consuming high-fat, low-CHO diets may lose weight because the intake of protein and fat is self-limiting and overall caloric intake is decreased (11,12). Low-fat and VLF diets contain a high proportion of complex CHOs, fruits, and vegetables. They are naturally high in fiber and low in caloric density. Individuals consuming these types of diets consume fewer calories and lose weight (13–17). Balanced nutrient reduction diets contain moderate amounts of fat, CHO, and protein. When overall caloric intake is reduced, these diets result in loss of body weight and body fat (6,18). Importantly, moderate-fat, balanced nutrient reduction diets produce weight loss even when they are consumed ad libitum.

In sum, all popular diets, as well as diets recommended by governmental and nongovernmental organizations, result in weight loss. However, it is important to note that weight loss is not the same as weight maintenance.

Evidence Statement: Caloric balance is the major determinant of weight loss. Diets that reduce caloric intake result in weight loss. In the absence of physical activity, the optimal diet for weight loss contains ~1400 to 1500 kcal/d, regardless of macronutrient composition. Evidence Category A.

Evidence Statement: Free-living overweight individuals who self-select high-fat, low-CHO diets consume fewer calories and lose weight. Evidence Category C.

Table 1. Grading system and evidence categories

Evidence category	Sources of evidence	Definition
A	RCTs (rich body of data)	Evidence is from endpoints of well-designed RCTs (or trials that depart only minimally from randomization) that provide a consistent pattern of findings in the population for which the recommendation is made.
B	RCTs (limited body of data)	Evidence is from endpoints of intervention studies that include only a limited number of RCTs, post hoc or subgroup analysis of RCTs, or meta-analysis of RCTs. In general, Category B pertains when few randomized trials exist, they are small in size, and the trial results are somewhat inconsistent.
C	Nonrandomized trials observational studies	Evidence is from outcomes of uncontrolled or nonrandomized trials or from observational studies.

RCT, randomized controlled trial.

Table 2. Characterization of diets as percentage of calories

Type of diet	Fat (% kcals)	CHO (% kcals)	Protein (% kcals)
High-fat, low-CHO	55–65	<20% (<100 g)	25–30
Moderate-fat, balanced nutrient reduction	20–30	55–60	15–20
Low- and very-low-fat	<10–19	>65	10–20

Evidence Statement: Overweight individuals consuming high-fat, low-CHO, low-calorie diets under experimental conditions lose weight. Evidence Category C.

Evidence Statement: Overweight individuals consuming moderate-fat, balanced nutrient reduction diets lose weight because they consume fewer calories. These diets can produce weight loss when consumed ad libitum. Evidence Category A.

Evidence Statement: Overweight individuals consuming low-fat and VLF diets lose weight because they consume fewer calories. Evidence Category B.

Evidence Statement: Weight loss on VLF diets may be the result of lifestyle modification, which may include decreased fat and energy intake, increased energy expenditure, or both. Evidence Category B.

Body Composition

As body weight decreases, so does body fat and lean body mass. The optimal diet for weight loss is one that maximizes loss of body fat and minimizes loss of lean body mass. All low-calorie diets result in loss of body weight and body fat (6). Macronutrient composition does not seem to play a major role (19–22). In the short-term, however, high-fat, low-CHO ketogenic diets cause a greater loss of body water

than body fat (23). When these diets end, water weight is regained (24). Eventually, however, all reduced calorie diets result in loss of body fat if sustained long term (25).

Physical activity, an important factor with respect to lean body mass, should be promoted to enhance the effects of diet on body composition.

Evidence Statement: All low-calorie diets result in loss of body weight and body fat. Macronutrient composition does not seem to play a major role. Evidence Category A

Evidence Statement: In the short term, low-CHO ketogenic diets cause a greater loss of body water than body fat. Water weight is regained when the diet ends. If the diet is maintained long term, it results in loss of body fat. Evidence Category C.

Nutritional Adequacy

Proper food choices are always important when considering the nutritional quality of a diet. When individuals consume foods from all food groups, it is more likely that their diet will be nutritionally adequate. The moderate-fat, balanced nutrient reduction diet is optimal for ensuring adequate nutritional intake. However, poor food choices may result in inadequate levels of nutrients (e.g., calcium, iron, zinc), regardless of overall macronutrient composition. High-fat, low-CHO diets are nutritionally inadequate. They are low in vitamins E, A, thiamin, B₆, folate, calcium, magnesium, iron, potassium, and dietary fiber, and require supplementation. These diets are high in saturated fat and cholesterol. VLF diets are low in vitamins E, B₁₂, and zinc because meat and fat intake is low.

Evidence Statement: With proper food choices, the moderate-fat, balanced nutrient reduction diet is nutritionally adequate. Evidence Category B.

Table 3. Characterization of diets in absolute amount (grams)

Type of diet	Total kcals	Fat g (%)	CHO g (%)	Protein g (%)
Typical American	2200	85 (35)	275 (50)	82.5 (15)
High-fat, low-CHO	1414*	94 (60)	35 (10)	105 (30)
Moderate-fat, balanced nutrient reduction	1450	40 (25)	218 (60)	54 (15)
Low- and very-low-fat	1450	16–24 (10–15)	235–271 (65–75)	54–72 (15–20)

* Based on average intake of subjects who self-selected low-CHO diets (see Table 4).

Evidence Statement: High-fat, low-CHO diets are nutritionally inadequate, and require supplementation. Evidence Category C.

Evidence Statement: VLF diets are low in vitamins E, B₁₂, and zinc. Evidence Category B.

Metabolic Parameters

Low-CHO diets result in ketosis, and may cause a significant increase in blood uric acid concentrations.

Blood lipid levels (e.g., total cholesterol [TC], low-density lipoprotein [LDL], high-density lipoprotein [HDL] and triglycerides [TGs]) decrease as body weight decreases (6,26,27). However, the macronutrient and fatty acid composition of energy-restricted diets can exert substantial effects on blood lipids. There are significantly greater decreases in LDL cholesterol during active weight loss when diets are low in saturated fatty acids. Changes in HDL cholesterol depend on dietary fat content and duration of energy restriction (28). Moderate-fat, balanced nutrient reduction diets reduce LDL-cholesterol and normalize the ratio of HDL/TC.

Plasma TG levels also decrease with weight loss (6). Although they increase in response to short-term consumption of a VLF, high-CHO diet (29), the type of CHO consumed must be considered. High-fiber foods, including vegetables and legumes, do not lead to hypertriglyceridemia (30), and may easily be incorporated into moderate-fat, balanced nutrient reduction diets to help normalize plasma TG levels.

Energy restriction, independent of diet composition, improves glycemic control (21,22,31–33). As body weight decreases, so does blood insulin and plasma leptin levels (21,34).

Blood pressure decreases with weight loss, independent of diet composition (6,22,26). However, the DASH diet, high in fruits, vegetables, and low-fat dairy products effectively lowers blood pressure (35).

Evidence Statement: High-fat, low-CHO diets result in ketosis. Evidence Category B.

Evidence Statement: Metabolic profiles are improved with energy restriction and weight loss. Evidence Category A.

Evidence Statement: Low-CHO diets that result in weight loss may also result in decreased blood lipid levels, decreased blood glucose and insulin levels, and decreased blood pressure. Evidence Category C.

Evidence Statement: Low-fat and very low-fat diets reduce LDL-cholesterol, and may also decrease plasma TG levels, depending on diet composition. Evidence Category B.

Evidence Statement: Moderate-fat, balanced nutrient reduction diets reduce LDL-cholesterol, normalize the ratio of HDL/TC, and normalize plasma TGs. Evidence Category A.

Hunger and Compliance

Many factors influence hunger, appetite, and subsequent food intake. Macronutrient content of the diet is one, and it may not be the most important. Neurochemical factors (e.g., serotonin, endorphins, dopamine, hypothalamic neuropeptide transmitters), gastric signals (e.g., peptides, stomach distention), hedonistic qualities of food (e.g., taste, texture, smell), genetic, environmental (e.g., food availability, cost, cultural norms) and emotional factors (e.g., eating when bored, depressed, stressed, happy) must be considered. These parameters influence appetite primarily on a meal-to-meal basis. However, long-term body weight regulation seems to be controlled by hormonal signals from the endocrine pancreas and adipose tissue, i.e., insulin and leptin. Because insulin secretion and leptin production are influenced by the macronutrient content of the diet (36,37), effects of different diets on these long-term regulators of energy balance also need to be considered when investigating hunger and appetite.

All fat-restricted diets provide a high degree of satiety. Subjects who consume fat-restricted diets do not complain of hunger, but of having “too much food” (38,39). These diets, high in fiber and water content are low in caloric density. Subjects who consume these diets develop a distaste for fat (40), which may be useful in long-term adherence to reduced fat, low-calorie diets. However, it is not clear that restricting fat provides any advantage over restricting CHOs. Ogden (41) reports weight loss maintainers used healthy eating habits and adhered to calorie-controlled diets.

Long-term compliance to any diet means that short-term weight-loss has a chance to become long-term weight maintenance (42–44). Dietary compliance is likely a function of psychological issues (e.g., frequency of dietary counseling, coping with emotional eating, group support) rather than macronutrient composition, per se (42,45). Being conscious of one’s behaviors, using social support, confronting problems directly, and using personally developed strategies may enhance long-term success (46). Ogden (41) notes that successful weight loss and maintenance may be predicted by an individuals’ belief system (e.g., that obesity is perceived as a problem that can be modified and if modifications bring changes in the short-term that are valued by the individual concerned).

Evidence Statement: Many factors influence hunger, appetite, and subsequent food intake. There does not seem to be an optimal diet for reducing hunger. Evidence Category B.

Evidence Statement: Long-term compliance is likely a function of psychological issues rather than macronutrient composition. Evidence Category B.

Summary and Recommendations

Caloric balance (calories in vs. calories out), rather than macronutrient composition is the major determinant of weight loss. However, what is not clear is the effect of macronutrient content on long-term weight maintenance and adherence. Furthermore, it is not known whether maintenance of weight loss and dietary adherence is related to psychological issues (and brain neurochemistry), physiological parameters (e.g., hormones involved in body weight regulation such as insulin and leptin), physical activity, energy density, or some other factor(s).

Controlled clinical trials of high-fat, low-CHO, and low-fat and VLF diets are needed to answer questions regarding long-term effectiveness (e.g., weight maintenance rather than weight loss) and potential long-term health benefits and/or detriments.

Prevention of weight gain and weight maintenance are important goals. Scientifically validated, yet understandable information is clearly needed by millions of overweight and obese Americans who often find weight loss attainable, but maintaining weight loss nearly impossible.

I. High-Fat, Low-Carbohydrate Diets

(55% to 65% fat, <100 g of CHO per day)

Despite controversy surrounding their use, high-fat, low-CHO diets are among the most popular types of diets today. The most famous is *Dr. Atkins' Diet Revolution* (47) first published in 1972, and updated 20 years later as *Dr. Atkins' New Diet Revolution* (48). Promoting a "lifetime nutritional philosophy," Atkins claims that his diet has been embraced by an estimated 20-plus million people worldwide since the release of his first book (www.atkinscenter.com). His program was one of the first to popularize low-CHO, high-protein, ketogenic diets that individuals could use on their own, rather than in a medical setting (e.g., a protein-sparing modified fast). Other low-CHO diets with similar themes include *Protein Power* (49), *The Carbohydrate Addict's Diet* (50), *Dr. Bernstein's Diabetes Solution* (51), and *Life Without Bread* (52).

A. Underlying Philosophy, Claims, and Proposed Solutions

Proponents of high-fat, low-CHO diets dismiss the notion that caloric intake is important to either weight gain or

weight loss. They claim that "most overweight individuals do not overeat" (48, p. 7; 50, p. 21), even as they suggest that high-CHO meals leave individuals less satisfied than meals that contain adequate fat, resulting in increased hunger and increased food intake (48, p. 55; 50, p. 43). They suggest that those who do overeat do so "because of a metabolic component driving them on, most often a truly addictive craving for CHOs" (48, p. 7; 52, p. 142). Because "carbohydrates are addictive," the carbohydrate "addict" continues to eat carbohydrates, producing more and more insulin, which inhibits brain serotonin release. Reductions in this "satiety" neurotransmitter result in a decreased sense of satisfaction (50, pp. 26, 43; 51, p. 41). With respect to weight loss, Atkins (48) claims that on a low-CHO diet there are "metabolic advantages that will allow overweight individuals to eat as many or more calories as they were eating before starting the diet yet still lose pounds and inches" (p. 10).

Furthermore, proponents contend overproduction of insulin, driven by high CHO intake, is the cause of the metabolic imbalance that underlies obesity (48,50,53). Eating too much CHO results in increased blood glucose, increased blood insulin, and increased TGs (48, pp. 50–51). An already overweight person who continues to overeat CHOs develops hyperinsulinemia and insulin resistance, "resulting in insulin's lack of effectiveness in converting glucose into energy, but enabling glucose (e.g., dietary CHO) to be stored as fat" (48, p. 52).

Advocates of low-CHO diets propose a simple solution to this "vicious cycle" of CHO addiction, CHO overeating, hyperinsulinemia, decreased glucose use and increased fat storage. It involves restricting CHOs severely enough to produce ketosis. The ketosis is a reliable indicator of fat mobilization. In this condition, the key benefit is that blood glucose and blood insulin levels are reduced, and appetite is suppressed. In short, authors contend that a high-fat, low-CHO, high-protein, ketogenic diet results in weight loss, body fat loss, preservation of lean body mass, and correction of serious medical complications of diabetes (51), heart disease, and high blood pressure (48, pp. 6, 63). The contention is that the high-fat, low-CHO diet supports long-term health, controls weight without hunger, and should be followed for the rest of one's life (48, p. 27).

B. Scientific Evaluation of Claims

1. Caloric Intake, Body Weight, and Body Composition

- Is caloric intake relevant when looking at weight gain and weight loss?
- What is the effect of diet composition on weight loss, e.g., will consuming a high-fat, low-CHO diet, regardless of caloric intake, result in weight loss, body fat loss, and preservation of lean body mass?