AHA Science Advisory

Dietary Protein and Weight Reduction

A Statement for Healthcare Professionals From the Nutrition Committee of the Council on Nutrition, Physical Activity, and Metabolism of the American Heart Association

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Abstract—High-protein diets have recently been proposed as a “new” strategy for successful weight loss. However, variations of these diets have been popular since the 1960s. High-protein diets typically offer wide latitude in protein food choices, are restrictive in other food choices (mainly carbohydrates), and provide structured eating plans. They also often promote misconceptions about carbohydrates, insulin resistance, ketosis, and fat burning as mechanisms of action for weight loss. Although these diets may not be harmful for most healthy people for a short period of time, there are no long-term scientific studies to support their overall efficacy and safety. These diets are generally associated with higher intakes of total fat, saturated fat, and cholesterol because the protein is provided mainly by animal sources. In high-protein diets, weight loss is initially high due to fluid loss related to reduced carbohydrate intake, overall caloric restriction, and ketosis-induced appetite suppression. Beneficial effects on blood lipids and insulin resistance are due to the weight loss, not to the change in caloric composition. Promoters of high-protein diets promise successful results by encouraging high-protein food choices that are usually restricted in other diets, thus providing initial palatability, an attractive alternative to other weight-reduction diets that have not worked for a variety of reasons for most individuals. High-protein diets are not recommended because they restrict healthful foods that provide essential nutrients and do not provide the variety of foods needed to adequately meet nutritional needs. Individuals who follow these diets are therefore at risk for compromised vitamin and mineral intake, as well as potential cardiac, renal, bone, and liver abnormalities overall. (Circulation. 2001;104:1869-1874.)

Key Words: AHA Science Advisory ■ diet ■ nutrition ■ protein ■ obesity

Because more than half of all adults in the United States are either overweight or obese1-3 and because these conditions are associated with increased risk of heart disease, overall morbidity, diabetes, hypertension, dyslipidemia, stroke, gallbladder disease, osteoarthritis, sleep apnea, and respiratory problems, as well as some forms of cancer, effective weight reduction and maintenance strategies are needed.4 Americans are concerned about what they are eating, as demonstrated by an overall decline in the proportion of total fat intake to ≈34% of kilocalories per day. However, there has been an apparent concomitant increase in total energy intake in the average US adult,4 and significant weight gains have been observed over time. It is evident that weight-reduction efforts have met with limited success and that the treatment of obesity is complex and difficult. Importantly, most American adults are dieting.5 Thus, the popularity of diet books promoting high-protein intakes with emphasis on some form of carbohydrate restriction is of concern to informed health professionals because of the lack of scientific evidence to support their claims and their long-term adverse implications for overall health.6,7

Although consensus exists that caloric restriction promotes weight loss, the effect of varying the macronutrient composition of the diet on weight loss has been debated. Diets with altered levels of protein, carbohydrate, or fat are frequently popular with the dieting public, which is desperate to find new strategies for successful weight loss and maintenance. Attention continues to be focused on modification of fat and carbohydrate intake, because these are the major contributors of energy in the diet. However, controversies regarding the efficacy, benefits, and consequences of high-carbohydrate and/or low-fat diets in

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weight-management efforts frequently pique interest in high-protein diets as alternative strategies.

This advisory provides a brief overview regarding the role of protein in the diet and reviews the recent popular high-protein diets and summarizes their limitations. This advisory also builds on and extends recommendations of the current American Heart Association Dietary Guidelines to include considerations regarding high-protein intake specifically for purposes of weight reduction. New guidelines for evaluating high-protein diets are provided.

### Role of Protein in the Diet

Proteins are essential components of the body and are required for the body’s structure and proper function. Proteins function as enzymes, hormones, and antibodies, as well as transport and structural components. Transamination and oxidation result in elimination of protein as water, carbon dioxide, and nitrogen. The continual process of synthesis and subsequent breakdown of protein in the body is referred to as protein turnover. The rate of protein turnover affects organ protein mass, body size, and ultimately the body’s protein and amino acid requirements.

Amino acids are the central units in protein metabolism. They are incorporated into various proteins and converted to metabolically essential compounds (ie, nucleic acids, creatine, and porphyrins). Of the 20 amino acids in human proteins, 12 are manufactured by the body and are known as nonessential amino acids. The remaining 8 (isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine) must be obtained from the diet and are thus termed essential amino acids. Proper protein nutritude is based on proper balance and sufficient intake of essential amino acids and intake of an adequate amount of nitrogen for the body to produce the nonessential amino acids. The nutritional quality of food proteins varies and depends on essential amino acid composition. Foods that contain essential amino acids at levels that facilitate tissue growth and repair are known as complete protein foods. Such foods are also classified as having high biological value, ie, a large proportion of protein is absorbed and retained. Biological value refers to an index in which all protein sources are compared with egg whites, which provide the most complete protein and have the highest biological value of 100. In general, foods with high protein quality or high biological value are from animal sources, such as eggs, milk, meat, poultry, and fish.

Conversely, a low concentration of 1 or more essential amino acids in a food lowers its nutritional quality. Although plant proteins form a large part of the human diet, most are deficient in 1 or more essential amino acids and are therefore regarded as incomplete proteins. Their protein quality can be upgraded, however, by combining them with others that are higher in protein quality or that contain whatever essential amino acids are lacking or deficient (protein complementarity). For example, combining corn (limited in lysine) with beans (limited in methionine) results in a high-quality protein food combination. Thus, the requirement for adequate essential amino acids can be met in a vegetarian diet by mixing foods of complementary amino acid composition. Only a few dietary sources of pure protein do not contain fat or carbohydrates, eg, egg white (albumin) and powdered casein from milk. Most high-protein foods contain fat (eg, meat, fish, and poultry) and/or carbohydrates (eg, milk, fruit, vegetables, legumes, nuts, breads, and cereals). Lean animal protein sources and vegetable proteins can be incorporated easily into a healthy diet plan.

An average of 102 g of protein per person per day is available in the US food supply. Actual protein consumption ranges from 88 to 92 g for men and from 63 to 66 g for women. Animal products provide 75% of the essential amino acids in the food supply, followed by dairy products, cereal products, eggs, legumes, fruits, and vegetables. The recommended daily allowance (RDA) for protein of high biological value for adults, based on body weight, is 0.8 g/kg or 0.36 g/lb. There are many conditions in which extra protein is needed, including childhood/adolescence (ie, periods of growth), pregnancy, lactation, intense strength and endurance training and other forms of physical activity, some disease states, and possibly in the elderly. In the general population, however, protein intake above the required amount is inefficiently used by the body and imposes the additional burdens of metabolizing and excreting excess waste products (eg, urea and ammonia) by the liver and kidney.

Low-protein diets (<10% of total energy) are sometimes prescribed to treat kidney and liver disorders. For weight reduction, however, high-protein diets (>20% of total energy) and very-high-protein diets (>30% of total energy) have become popular. Protein intakes at various levels of energy intake are summarized in Table 1. At high levels of total energy intake (3000 kcal/d) and very high levels of protein intake (>30% of kilocalories), protein can exceed 225 g/d (2 to 4 times the range in the typical diet of 50 to 100 g/d). In general, diets with excess total protein raise concerns as outlined below. High-protein diets with carbohydrate restriction (as promoted for weight reduction) are generally self-limiting, and caloric intake rarely exceeds 1500 kcal/d. On the other hand, low-calorie diets (1200 kcal/d) may lack sufficient protein quality and quantity and should be carefully evaluated for protein adequacy.

### Table 1. Protein Intake at Various Levels of Energy Intake

<table>
<thead>
<tr>
<th>Energy Intake, kcal/d</th>
<th>Low-Protein Diet (&lt;10% kcal)</th>
<th>Average Diet (~15% kcal)</th>
<th>High-Protein Diet (~20% kcal)</th>
<th>Very-High-Protein Diet (~30% kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>2000</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>3000</td>
<td>75</td>
<td>112</td>
<td>150</td>
<td>225</td>
</tr>
</tbody>
</table>

Data are from Reference 24. Protein intake is in grams per day.
TABLE 2. Compensatory Changes in the Macronutrient Composition of Various Diets

<table>
<thead>
<tr>
<th>Diet Description</th>
<th>Fat (% kcal)</th>
<th>Carbohydrate (% kcal)</th>
<th>Protein (% kcal)</th>
<th>Alcohol (% kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average diet</td>
<td>34</td>
<td>49</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Moderate-fat diet</td>
<td>30</td>
<td>55</td>
<td>15</td>
<td>...</td>
</tr>
<tr>
<td>Very-low-fat/very-high-carbohydrate diet</td>
<td>15</td>
<td>70</td>
<td>15</td>
<td>...</td>
</tr>
<tr>
<td>Low-carbohydrate/very-high-protein diet</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>...</td>
</tr>
<tr>
<td>Very-low-carbohydrate/very-high-protein/fat diet</td>
<td>55</td>
<td>15</td>
<td>30</td>
<td>...</td>
</tr>
</tbody>
</table>

High-Protein Diets and Weight Reduction

Weight reduction is achieved if there is an energy deficit, that is, if caloric intake is reduced below the level of energy expenditure. In obese individuals, macronutrient composition of the diet has little effect on the rate or magnitude of weight loss over the short term unless nutrient composition influences caloric intake.25–27 Importantly, however, overall caloric intake depends on the overall palatability of the diet and satiety. The current average macronutrient composition of the American diet is 12% to 16% of calories from protein, 34% from fat, and 49% from carbohydrate.15,16,24 The majority of dietary advice has focused on the fat content of the diet because fats provide ≈9 kcal/g, whereas protein and carbohydrate provide ≈4 kcal/g. However, the essentiality and palatability of protein have led periodically to its popularity in numerous diets.28–31

Major shifts in the proportion of one macronutrient result in compensatory changes in the other macronutrients.24 Variations in macronutrients in various diets are presented for comparisons in Table 2. Many of the popular high-protein diets promote protein intakes of 71 to 162 g/d, or 28% to 64% of energy, and severely limit carbohydrates to 7 to 56 g/d, or 3% to 16% of energy.28–32

High-protein, high-fat diets induce metabolic ketosis and are initially attractive because they may induce quick weight loss. This initial weight loss, however, may be attributed in part to the diuretic effect from low carbohydrate intake and its effects on sodium and water loss, glycogen depletion, and ketosis. As the diet is sustained, loss of appetite associated with ketosis leads to lower total caloric intake.33 High-protein diets of ≥30% kilocalories from protein also can promote negative energy balance due to significant restriction in the type and amount of foods eaten. The structured eating plan, strict eating schedules, and limited tolerance for high-protein foods reduce overall flexibility but offer initial appeal. These characteristics may help limit caloric intake and may account for weight loss. However, neither the efficacy of these diets compared with higher carbohydrate diets in promoting weight loss nor the safety of these diets has been documented in long-term studies.

The amount of protein recommended in high-protein diet regimens exceeds established requirements19 and may impose significant health risks. First, animal protein (rather than plant-based proteins that also contain carbohydrates) is generally advocated in these diets. A diet rich in animal protein, saturated fat, and cholesterol raises low-density lipoprotein (LDL) cholesterol levels, an effect that is compounded when high-carbohydrate, high-fiber plant foods that help lower cholesterol are limited or eliminated.16,24–37 Furthermore, a high-carbohydrate diet that includes fruit, vegetables, nonfat dairy products, and whole grains has been shown to lower blood pressure,38 so limitation of these foods may raise blood pressure via associated reductions in potassium, calcium, and magnesium coupled with increased sodium intake. High-protein foods such as meat, poultry, seafood, eggs, seeds, and nuts are high in purines. Purines are broken down into uric acid, so excess consumption of these foods increases uric acid levels and may cause gout in susceptible individuals.39 A surplus of protein in the system also increases urinary calcium loss, which may facilitate osteoporosis.40 In addition, elimination or severe restriction of fruit, vegetables, beans, and whole grains from the diet may increase cancer risk.41 A very-high-protein diet is especially risky for patients with diabetes, because it can speed the progression, even for short lengths of time, of diabetic renal disease.42–44 Finally, because food choices may be severely restricted on high-protein diets, healthful foods such as low-fat milk products, cereals, grains, fruits, and vegetables (which are higher in carbohydrates and contain essential nutrients) are also generally restricted or eliminated.28–32 This can lead to deficiencies in essential vitamins, minerals, and fiber over the long term; these deficiencies can have adverse health effects if they are allowed to persist. Furthermore, when carbohydrates are severely restricted with high-protein diets, fatigue often occurs when muscle glycogen is depleted during bouts of exercise.45 Some popular high-protein/low-carbohydrate diets limit carbohydrates to 10 to 20 g/d,6 which is one fifth of the minimum 100 g/d that is necessary to prevent loss of lean muscle tissue.

Several high-protein diets are described in Table 3. These diets are also evaluated according to the evaluation criteria listed in Table 4. A popular premise of high-protein diets is that excess carbohydrate results in elevated insulin levels, which in turn promotes storage of body fat and other metabolic consequences. To induce weight loss, the high ratio of protein and fat to carbohydrate purportedly promotes metabolic changes that reduce serum insulin levels. However, in fact, protein intake also stimulates insulin secretion.46 Insulin resistance or hyperinsulinemia is complex and regulated by a number of interacting factors. It occurs as a result of obesity or excess fat storage and lack of physical activity, and it can be reduced significantly by caloric restriction, weight loss, and exercise.47–50 Changes in calorie balance over wide ranges of fat intake apparently do not influence insulin action in humans.51

There are very few long-term studies of high-protein diets. One randomized dietary intervention study52 in 65 healthy overweight men and women that compared 2 ad lib diets varying in protein content (12% versus 25% of kilocalories from protein) demonstrated larger weight losses with the higher-protein diet (8.9 kg) versus the lower-protein diet (5.1 kg) over 6 months. However, another study53 showed similar weight losses with diets of varying protein and fat composition, which indicates that total energy intake is the most...
TABLE 3. Diet Summaries

<table>
<thead>
<tr>
<th>Diet philosophy</th>
<th>Atkins29</th>
<th>Zone30</th>
<th>Protein Power31</th>
<th>Sugar Busters32</th>
<th>Stillman38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foods to avoid</td>
<td>Carbohydrates, specifically bread, pasta, most fruits and vegetables, milk</td>
<td>Carbohydrates, specifically bread, pasta, fruit (some types), saturated fats</td>
<td>Carbohydrates</td>
<td>Potatoes, white rice, corn, carrots, beets, white bread, all refined white flour products</td>
<td>High-protein foods burn body fat. If carbohydrates are consumed, the body stores fat instead of burning it</td>
</tr>
<tr>
<td>Diet composition—average for 3 days</td>
<td>Protein 27%; carbohydrates 5%; fat 68% (saturated 26%)</td>
<td>Protein 34%; carbohydrates 36%; fat 29% (saturated 9%); alcohol 1%</td>
<td>Protein 26%; carbohydrates 16%; fat 54% (saturated 18%); alcohol 4%</td>
<td>Protein 27%; carbohydrates 52%; fat 21% (saturated 4%)</td>
<td>Protein 64%; carbohydrates 3%; fat 33% (saturated 13%)</td>
</tr>
<tr>
<td>Recommended supplements</td>
<td>Atkins supplement that includes chromium picolinate, carnitine, coenzyme Q10</td>
<td>200 IU vitamin E</td>
<td>Multivitamin and mineral supplement</td>
<td>No</td>
<td>Multivitamin and mineral supplement</td>
</tr>
<tr>
<td>Health claims scientifically proven?</td>
<td>No long-term, validated studies published</td>
<td>No. Theories and long-term results are not validated</td>
<td>No long-term, validated studies published</td>
<td>No long-term, validated studies published</td>
<td>No long-term, validated studies published</td>
</tr>
<tr>
<td>Practicality</td>
<td>Limited food choices. Difficult to eat in restaurants because only plain protein sources and limited vegetables/salads allowed</td>
<td>Food must be eaten in required proportions of protein, fat, carbohydrates. Menus plain and not appealing; vegetable portions very large. Difficult to calculate portions</td>
<td>Not practical for long term. Rigid rules</td>
<td>Eliminates many carbohydrate foods. Discourages eating fruit with meals</td>
<td>Extreme limitations in food choices. Very little variety</td>
</tr>
<tr>
<td>Lose and maintain weight?</td>
<td>Yes, but initial weight loss is mostly water. Does not promote a positive attitude toward food groups. Difficult to maintain long-term because diet restricts food choices</td>
<td>Yes, via caloric restriction. Could result in weight maintenance if carefully followed. Diet rigid and difficult to maintain</td>
<td>Yes, via caloric restriction. Limited food choices not practical for long term</td>
<td>Yes, via caloric restriction. Limited food choices not practical for long term</td>
<td>Yes, but loss is mostly water. Maintenance based on strict calorie counting. Very limited food choices not practical for long term</td>
</tr>
</tbody>
</table>

important determinant for weight loss. The short-term effects of high-protein diets have been appraised mainly in terms of increased weight loss and its associated benefits. Deleterious effects on cardiovascular disease risk factors were demonstrated in a study37 of 24 obese individuals who followed the Atkins diet for 3 months, in whom caloric intake declined but LDL cholesterol levels rose despite the weight loss. Most of the weight loss occurred in the first few weeks, which suggests the combined effects of fluid loss and potential anorectic effects of induced ketosis.

A recent review of the literature regarding the effects of low-carbohydrate (high-protein) diets reported from 1956 to 2000 concluded from 20 published studies that there is a pattern of weight loss that ranges from 2.8 to 12.0 kg within varying time frames and number and type of subjects included.6,7 However, when carbohydrate is restricted, subjects generally reduce their overall intake of calories, and this calorie deficit is related to the weight loss. These studies raised important questions regarding the long-term effects of these diets on weight maintenance and overall health. Long-term studies are needed to determine the overall safety and efficacy of high-protein diets. In particular, benefits and potential risks beyond the initial weight loss observed should be addressed.

**Guidelines for Evaluating High-Protein Diets**

In evaluating high-protein diets, it is important to ensure that eating patterns follow the AHA Dietary Guidelines8 and incorporate primary prevention strategies for coronary heart
disease, such as those outlined by the National Cholesterol Education Program, especially in persons with multiple risk factors, including obesity:

1. Total protein intake should not be excessive (average 50 to 100 g/d) and should be reasonably proportional (≈15% of kilocalories per day) to carbohydrate (≈55% of kilocalories per day) and fat (≈30% of kilocalories per day) intake.
2. Carbohydrates should not be omitted or severely restricted. A minimum of 100 g of carbohydrate per day is recommended to ensure overall nutritional adequacy through the provision of a variety of healthful foods.
3. Selected protein foods should not contribute excess total fat, saturated fat, or cholesterol.
4. The diet should be safely implemented over the long term, ie, it should provide adequate nutrients and support dietary compliance with a healthful eating plan to prevent increases in disease risk.

Summary

Scientific studies do not demonstrate that high-protein diets without concomitant decreases in caloric intake result in sustained weight loss or improved health. Most Americans consume more protein than their bodies need. Extra protein is not used efficiently by the body and may impose a metabolic burden on the kidneys and liver. High-protein diets may also be associated with increased risk for coronary heart disease due to intakes of saturated fat, cholesterol, and other associated dietary factors. When diets high in protein are severely limited in carbohydrates, food choices become restrictive, and overall nutrient adequacy and long-term palatability are also of concern. Successful weight loss occurs most frequently when a nutritionally adequate diet that allows for caloric deficits (~500 kcal/d for each 1 lb lost per week) is tailored according to individual food preferences. A minimum of 1200 kcal/d for women and 1500 kcal/d for men should be provided. Total energy deficit has the greatest impact on weight reduction, especially when coupled with increased physical activity and behavior modification to maintain negative energy balance. Over the long term, diet composition should be consistent with a balanced eating plan that supports weight maintenance and lowers chronic disease risk.

References

7. St. Jeor et al. Dietary Protein and Weight Reduction. 1873. 54 especially in persons with multiple risk factors, including obesity:

<table>
<thead>
<tr>
<th>Total Protein Criteria</th>
<th>Atkins29</th>
<th>Zone30</th>
<th>Protein Power31</th>
<th>Sugar Busters32</th>
<th>Stillman28</th>
</tr>
</thead>
<tbody>
<tr>
<td>not excessive (average 50–100 g/d)</td>
<td>1st 2 weeks = 125 g/d (36%)</td>
<td>No.</td>
<td>127 g/d (34%)</td>
<td>91 g/d (26%)</td>
<td>No.</td>
</tr>
<tr>
<td>proportional 15–20% kcal/day to carbohydrates and fat</td>
<td>No.</td>
<td>Ongoing weight loss = 161 g/d (35%)</td>
<td>1st 2 weeks = 28 g/d (5%)</td>
<td>Yes.</td>
<td>135 g/d (36%)</td>
</tr>
<tr>
<td>Carbohydrates are not omitted or severely restricted. Minimum of 100 g/d</td>
<td>1st 2 weeks = 28 g/d (5%)</td>
<td>Ongoing weight loss = 33 g/d</td>
<td>Maintenance = Yes 128 g/d</td>
<td>No.</td>
<td>29% total calories, 4% saturated fat per day</td>
</tr>
<tr>
<td>Total diet can be safely implemented over the long term by providing nutrient adequacy and support a healthful eating plan to prevent increases in disease risk</td>
<td>Limited food choices. Diet low in fiber, vitamin D, thiamine, pantothenic acid, copper, magnesium, manganese, potassium, calcium.* High in total fat and saturated fat</td>
<td>No.</td>
<td>Food must be eaten in required proportions of protein, fat, carbohydrates. Menus not appealing, vegetable portions very large. Low in copper*</td>
<td>No.</td>
<td>Not practical for long term. Rigid rules. Diet low in calcium, fiber, pantothenic acid, copper, manganese.* High in total fat and saturated fat</td>
</tr>
</tbody>
</table>

*Nutrients <67% RDA for women 25–50 years old.
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