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BEEF FACTS: Nutrition

# Macronutrient Distribution, Diet Plans, and Beef's Role

Major health organizations define healthful diets as those providing 55 to 60% of total calories from carbohydrates, 10 to 20% from protein, and no more than 30% from fat (1-5, Table 1). This general balance of energy-yielding nutrients is supported by the *Dietary Guidelines for Americans* (6) and has been translated into food guidance as part of the *Food Guide Pyramid* (7). The recent popularity of high protein, low carbohydrate diets, particularly for weight loss (8-11), is raising questions about the optimal distribution of carbohydrate, protein, and fat in the diet for health and disease prevention. Recommendations, both proven and unproven, are being made to alter the macronutrient distribution of diets to reduce chronic diseases such as obesity, Type 2 diabetes mellitus, syndrome X (insulin resistance), and cardiovascular disease, as well as to enhance athletic performance.

This review discusses traditional high carbohydrate, low fat diets as well as popular high protein, low carbohydrate diets and the inclusion of lean beef in diets of various macronutrient distributions. Emerging scientific research indicates that for optimal health, diets should be individualized in terms of their macronutrient distribution.

**Table 1. Macronutrient Distribution of Recommended and Popular Diets**

| Diet | Distribution of Calories (%) | | |
|---|---|---|---|
| | Carbohydrate | Protein | Fat |
| **Overweight/Obesity** | | | |
| • NHLBI Expert Panel (1) | 55+ | 15 | <30 |
| **Diabetes Mellitus** | | | |
| • American Diabetes Association (2) | * | 10–20 | ** |
| **Coronary Heart Disease** | | | |
| • American Heart Association (3) | 55–60 (complex carbohydrates) | 10–15 | ≤30 |
| • National Cholesterol Education Program Step I & Step II (4) | 55+ | 15 | <30 |
| **Athletic Performance** | | | |
| • American Dietetic Association and Canadian Dietetic Association (5) | 60–65 | 12–15 | <30 |
| **Popular High Protein, Low Carbohydrate Weight Loss Diets** | | | |
| • Dr. Atkins' New Diet Revolution (8) | 10 | 30 | 60 |
| • Protein Power (9) | 15 | 30 | 55 |
| • Sugar Busters (10) | 39 | 33 | 28 |
| • Enter the Zone (11) | 40 | 30 | 30 |

* Based on nutritional assessment and treatment goals.
** Less than 10% of calories from saturated fat.

## High Carbohydrate, Low Fat Diets

Diets high in carbohydrates and low in fat are recommended to prevent and treat a variety of diseases including obesity, cardiovascular disease, and Type 2 diabetes, as well as to enhance athletic performance.

***Obesity/Weight Loss Diets.*** In the first federal guidelines for safe weight loss, the National Institutes of Health recommends a diet containing approximately 500 to 1000 calories below usual intake/day with carbohydrate (mostly complex) providing 55% or more of total energy, protein at approximately 15% of total energy, and 30% or less of total energy from fat (1). Reducing dietary fat decreases total calorie intake and the energy density of the diet, at least in the short term (12). However, there is little evidence that the macronutrient composition of the diet per se (i.e., low fat versus low carbohydrate), independent of caloric reduction, causes weight loss over the long term (13). In fact, some

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researchers suggest that low fat messages are giving people a license to consume more food (calories), thus contributing to the obesity crisis in the United States (14).

***Cardiovascular Disease***. The American Heart Association (AHA) (3) recommends a diet containing 55 to 60% of calories from complex carbohydrates, 30% from fat, and 10 to 15% from protein to help reduce the risk of heart disease. The AHA recognizes that these population-wide guidelines do not address the specific needs of all individuals. Differences between individuals in certain responses to diet, such as a reduction in LDL cholesterol with high carbohydrate, low fat diets, may be related in part to underlying genetic influences (3). For individuals at high risk of cardiovascular disease, the Expert Panel of the National Cholesterol Education Program recommends Step I and Step II diets which are high carbohydrate (55-60% of total calories), low fat diets with modifications in the type of fat and the amount of dietary cholesterol (4). The Step I diet (8-10% of daily calories from saturated fat, <300 mg/day cholesterol) lowers LDL cholesterol levels approximately 7-9% and the Step II diet (<7% of daily calories from saturated fat, <200 mg/day cholesterol) lowers LDL cholesterol by 10 to 20% (4).

Very low fat, high carbohydrate diets (e.g., 15% of calories from fat, 15% from protein, 70% from carbohydrate) do not confer unique health benefits and are potentially harmful (15-17). Very low fat diets increase blood triglyceride levels and decrease HDL cholesterol levels without additional reductions in LDL cholesterol levels (15). When hypercholesterolemic men were randomly assigned to isocaloric diets containing either 18, 22, 26, or 30% fat for one year, maximum LDL cholesterol reduction occurred at the 26% fat level, with no additional decrease at lower fat intakes (16). Further, at fat intakes below 26% of calories, reductions in HDL cholesterol and increases in triglyceride levels occurred (16). Protein intake remained at 16 to 18% of calories for each of the diets.

A recent investigation of 38 healthy men found that with a progressive reduction in dietary fat (i.e., from 20-24% of calories to 10% of calories) and a corresponding increase in carbohydrate, an increasing proportion of the men exhibited adverse changes in their blood lipid levels, potentially placing them at high risk of heart disease (17). Specifically, in many of the men following the very low fat, high carbohydrate diet, LDL cholesterol subclass distribution changed from phenotype A (i.e., predominantly large LDLs) to phenotype B (i.e., small, dense LDLs which are unusually atherogenic). Additional downsides of very low fat, high carbohydrate diets include the potential for nutrient deficiencies (e.g., iron, zinc) (15) and difficulty complying to such restrictive diets (15,16).

***Type 2 Diabetes and Syndrome X***. Insulin resistance is caused by the inability of insulin receptors to respond to insulin, a condition aggravated by excess body weight. Insulin resistance is associated with Type 2 diabetes mellitus and is part of Syndrome X (18). Syndrome X, initially described in 1988 by Gerald Reaven, MD (19), is characterized by a cascade of metabolic disorders (20). These include hyperinsulinemia, glucose intolerance, dyslipidemia (elevated triglyceride and decreased HDL cholesterol), and hypertension. Also, hyperuricemia (which leads to gout), small dense LDL cholesterol, and increased plasminogen activator inhibitor-1 (PAI-1) have been associated with Syndrome X (20).

Weight loss and regular exercise help to reverse insulin resistance and reduce the risk of Type 2 diabetes mellitus and symptoms of Syndrome X. Additionally, dietary modifications improve or decrease hyperinsulinemia. Research indicates that a high carbohydrate, low fat diet (60 to 65% carbohydrate and 20 to 25% fat) worsens glucose tolerance in patients with Type 2 diabetes and hypertriglyceridemia as well as in patients with Syndrome X (2,21-24). Specifically, this diet appears to cause persistent increased plasma triglyceride and very low density lipoprotein concentrations, decreased HDL cholesterol levels, hyperinsulinemia, and deterioration in glycemic control. These metabolic changes increase the risk of cardiovascular disease (21). Because intake of saturated and trans fatty acids should be reduced and it is not recommended that polyunsaturated fats be increased beyond 10% of energy intake (3), monounsaturated fats provide a suitable alternative to reduce the carbohydrate load (21,22). Studies indicate that monounsaturated fat diets have a favorable effect on glycemic control and lipoprotein concentrations (24).

The recommended composition of the diet for people with diabetes has changed dramatically over the past 75 years. Today, there is no single "diabetic diet" and specific percentages of macronutrients in the diet are no longer recommended. The American Diabetes Association (2) currently recommends that 80 to 90% of total caloric intake be distributed between carbohydrate and fat, of which less than 10% should be from saturated fats and about 10% or less from polyunsaturated fats. The remaining 60 to 70% of total calories should be divided between monounsaturated fats and carbohydrates with contributions of each being

individualized. A protein intake of 10 to 20% of total calories is recommended for patients with Type 2 diabetes (2).

***Athletic Performance.*** Physically active people are advised to consume a high carbohydrate, low fat diet containing 55 to 65% of calories from carbohydrate, 25 to 30% from fat, and 10 to 15% protein (5). Endurance athletes (triathletes, cyclists, marathon runners) who train exhaustively on successive days or who compete in prolonged endurance events may need to consume 65 to 70% of their total calories from carbohydrates to maintain the body's relatively limited glycogen stores (5). Reduced glycogen reserves, which can result from inadequate carbohydrate intake, can compromise athletes' performance (25).

## High Protein, Low Carbohydrate Diets

High protein, low carbohydrate diets are being fervently promoted for weight loss in the popular literature (8-11). The promotion of these diets is leading to questions regarding whether they can also benefit other diseases.

***Obesity/Weight Loss Diets.*** The popularity of high protein (30%), low carbohydrate (<40%) diets is attributed to the rapid weight loss achieved by such diets. The initial weight reduction on these low calorie diets is explained by the loss of body fluids. Later weight losses are due to loss of both muscle tissue and body fat. Proponents of high protein, low carbohydrate diets blame carbohydrates, by allegedly causing the body's insulin level to rise and prompting fat storage, for body weight gain, especially in individuals with insulin resistance. Critics counter that there is no scientific evidence for the insulin weight loss theory and that body weight is a function of energy balance, irregardless of the macronutrient composition of the diet (24).

It should be recognized that some high protein, low carbohydrate diets may offer no long term advantage in facilitating weight loss and may be potentially hazardous. These diets may trigger ketosis which may lead to dehydration, gout, and electrolyte imbalance potentially resulting in kidney and liver damage. Ketosis stems from the body's breakdown of fat to provide energy when a restricted carbohydrate, low calorie diet is consumed. Also, because some high protein, low carbohydrate diets are high in saturated fat, these diets may raise blood cholesterol levels and increase the risk of developing heart disease (4). Since high protein, low carbohydrate diets avoid many grains, some fruits, and some vegetables, they can be low in essential nutrients such as folate, vitamin C, fiber, and phytochemicals. Constipation, fatigue, and nausea are reported unpleasant side effects of these diets. The noted adverse effects of high protein, low carbohydrate diets are largely explained by the low carbohydrate, high fat intakes, not by the "high" protein intake per se. Because these diets are generally low in calories (i.e., 800 to 1500 calories), the actual amount of total protein consumed (i.e., grams) is not necessarily high.

***Type 2 Diabetes and Syndrome X.*** There is limited scientific evidence regarding the effect of high protein, low carbohydrate diets on insulin resistance, Type 2 diabetes, and Syndrome X. A high protein diet is generally not recommended for people with diabetes because it increases the risk of chronic renal failure, a complication of diabetes. However, a high protein (2.0 g/kg desirable weight or about 22% of calories) diet improved glycemic control with only small changes in renal function in patients with Type 2 diabetes (26). Also, increasing protein intake, particularly when consumed with glucose (carbohydrate), has been demonstrated to stimulate insulin secretion without raising blood glucose levels (27). Thus, an increase in protein intake, combined with a decrease in carbohydrate and fat intake, could improve blood glucose levels and dyslipidemia in people with diabetes. There is a need for well-designed, controlled, clinical studies of high protein, low carbohydrate diets before dietary recommendations can be made.

***Cardiovascular Disease.*** There is limited evidence regarding the effect of replacing some carbohydrates in the diet with protein, specifically animal protein, on blood lipid levels. However, data from the Nurses' Health Study indicate that replacing carbohydrate with protein, from both animal and vegetable sources, is associated with lower risk of heart disease (28). In this study, carbohydrate intake ranged from 34% to 45% of calories and protein intake ranged from 14.7% to 24% (28).

***Athletic Performance.*** Recently, a high protein, low carbohydrate diet – the so-called 40/30/30 regime (i.e., 40% carbohydrate, 30% protein, 30% fat) – has been promoted for athletes. Although there is some evidence that athletes may require more protein than the Recommended Dietary Allowance (RDA) of 0.8 g/kg body weight (29), the increased need for protein is relatively small and can readily be met by athletes' high calorie intakes.

The 40/30/30 diet does not provide adequate energy to sustain most athletes' performance (30). Further, there is no scientific evidence that this dietary regime improves performance. Carbohydrates in the form of glycogen are the primary source of energy during physical activity (25). Recently, four health professional associations – the American Dietetic Association, the American College of Sports Medicine, the Women's Sports Foundation, and the Cooper Institute for Aerobic Research - issued a joint statement indicating that high protein diets do not improve athletic performance nor are they the solution for weight loss (30). However, recommended (moderate) protein intakes can be used as a source of energy and are important for tissue repair, maintenance, and growth (25).

## The Role of Beef in Diets of Various Macronutrient Distributions.

The Food Guide Pyramid (7) recommends 5 to 7 ounces of foods such as lean beef from the Meat Group. There is no scientific evidence that intake of lean beef needs to be adjusted in diets of different macronutrient composition. On the contrary, evidence indicates that including lean meat such as beef in a variety of diet plans offers potential health benefits.

***High Carbohydrate, Low Fat Diets.*** Most high carbohydrate, low fat diets, even very low fat diets, recommend a protein intake of 10 to 20% (1-5,15). Recommended intakes of meat such as lean beef can be readily incorporated into diets with this protein level. For example, low fat diet plans such as the National Cholesterol Step I and Step II diets to lower blood cholesterol levels recommend 5 and 6 ounces of lean meat (e.g., lean sirloin, lean round steak)/day, respectively (4).

Unfortunately, recommendations to consume a high carbohydrate, low fat diet, especially for prevention or treatment of heart disease, are often misinterpreted to mean avoidance of red meat (31-33). The cholesterol-raising influence of red meats is attributed to the total fat and cholesterol-raising fatty acids in these foods (33). However, research demonstrates that avoiding or severely restricting red meat is not only unnecessary, but also may adversely affect long-term dietary adherence (32-34).

Researchers from three sites recently compared the blood lipid effects of intake of lean meat (beef, veal, pork) versus white meat (poultry/fish) (33). The meat was consumed in amounts of 6 ounces/day, five to seven days/week for 9 months, as part of a low fat diet (<30% of calories) to 191 men and women with mild to moderate high blood cholesterol levels (33). Over the 36 weeks, total cholesterol and LDL cholesterol remained 1 to 3% below baseline levels regardless of whether the subjects consumed lean red meat or white meat as part of the diet (Table 2). In both treatment groups, mean triglyceride levels remained similar to baseline levels, but HDL cholesterol levels increased approximately 2% from baseline.

**Table 2. Serum Lipid Values (mg/dL) at Baseline and Over a 9-Month Treatment Period (33).**

| Lipid | Baseline[1] | Treatment Period - Av.[2] | Mean % Change |
|---|---|---|---|
| **Total Cholesterol** | | | |
| Lean Beef | 238 | 236 | -1.0+/-0.6 |
| Chicken/Fish | 240 | 235 | -1.8+/-0.6 |
| **LDL-Cholesterol** | | | |
| Lean Beef | 157 | 154 | -1.7+/-0.7 |
| Chicken/Fish | 160 | 155 | -2.9+/-0.8 |
| **HDL-Cholesterol** | | | |
| Lean Beef | 51 | 53 | 2.3+/-0.8 |
| Chicken/Fish | 50 | 52 | 2.4+/-0.7 |
| **Triglyceride** | | | |
| Lean Beef | 150 | 147 | 1.3+/-2.6 |
| Chicken/Fish | 149 | 146 | -0.5+/-2.1 |
| **Total/HDL-Cholesterol** | | | |
| Lean Beef | 4.9 | 4.7 | -2.8+/-0.9 |
| Chicken/Fish | 5.0 | 4.8 | -3.7+/-0.8 |

[1] Average of weeks - 4, -2, -1.
[2] Average of weeks 4, 12, 20, 28, 36.

This recent, long-term (36 week) study with free-living individuals supports findings from earlier short-term, highly-controlled, investigations (32,34) demonstrating that lean meats such as beef are interchangeable with lean white meats in high carbohydrate, low fat diets. Moreover, the inclusion of lean beef in these diets potentially improves long-term dietary adherence (33).

For individuals following high carbohydrate, low fat diets to reduce risk of heart disease, including lean beef in the diet also increases the intake of B-vitamins such as folate and vitamin $B_{12}$ (35). Intake of these vitamins can reduce blood levels of homocysteine, a risk factor for heart disease (36). In addition, inclusion of lean beef in a high carbohydrate, low fat diet, especially a very low fat diet, can increase intake of potentially limiting nutrients such as iron and zinc (35).

For individuals with insulin resistance, Type 2 diabetes, and Syndrome X, for whom a moderately high carbohydrate, low fat diet rich in monounsaturated fatty acids may be beneficial, lean beef is a source of monounsaturated fatty acids (35, Table 3).

**Table 3. Fatty Acid Composition of Beef* (35).**

| | Amount per 3 oz (85g) serving |
|---|---|
| **Total Fatty Acids** (g) | 7.05 |
| **Fatty Acids** | |
| • Saturated, total (g) | 3.22 |
| • Monounsaturated, total (g) | 3.54 |
| • Poly unsaturated, total (g) | 0.29 |
| **% of Total Fatty Acids** | |
| • Saturated | 45.7 |
| • Monounsaturated | 50.2 |
| • Polyunsaturated | 4.1 |

* Composite of all cuts, lean only, cooked

***High Protein, Low Carbohydrate Diets.*** There is some evidence that slightly increasing protein intake may be beneficial for athletes (29). But whether or not increasing protein intake above recommended dietary intakes is beneficial for individuals with Type 2 diabetes, Syndrome X, or cardiovascular disease remains to be established. Also, there is no scientific evidence that high protein diets preferentially contribute to long-term weight loss (24). Nevertheless, including lean beef in moderately high protein, low carbohydrate diets can help to meet protein needs, provide other essential nutrients, and, by allowing a greater range of food choices, may help to improve acceptance and compliance to dietary regimens (33).

***The Move Toward Individualized Diets.*** In recent years there has been a move away from generalized dietary guidance to more individualized guidance. This is exemplified by dietary recommendations offered by the American Heart Association (3) and the American Diabetes Association (2). The American Heart Association recognizes that individuals vary in their blood lipid responses to changes in dietary fat intake and that not everyone will benefit equally from a low fat, high carbohydrate diet (3). Likewise, the American Diabetes Association (2) recommends that the macronutrient distribution of the diet be individualized based on treatment goals for blood glucose, blood lipids, and body weight. This professional organization no longer endorses any particular meal plan or specified percentages of macronutrients for people with diabetes. This move toward individualized guidelines offers greater flexibility in food choices, including intake of lean beef.

## Summary

Lean beef can be included in diets of varied macronutrient composition, such as high carbohydrate, low fat diets and moderately high protein, low carbohydrate diets. Diets high in carbohydrate and low in fat are recommended to prevent and treat a variety of diseases, as well as to enhance athletic performance. These diets generally recommend 10 to 20% of calories from protein. Including lean beef in the diet can help to meet this protein recommendation. The belief that red meat cannot be part of a high carbohydrate, low fat diet to reduce risk of heart disease is unfounded. Studies have demonstrated that lean meats such as beef are interchangeable with lean white meats in these diets. Furthermore, including lean beef in high carbohydrate, low fat diets can improve adherence to the diets. Lean beef is also a source of monounsaturated fatty acids which appear to be beneficial in diets recommended for individuals with insulin resistance, Type 2 diabetes, and Syndrome X. Lean beef is a nutrient dense food providing nutrients such as iron and zinc which may be limiting in some diets. For specific population groups that may benefit from a higher protein diet, intake of lean beef as part of the overall diet provides another opportunity to meet protein needs. The move toward individualized diets allows for greater flexibility in food choices which can include lean beef.

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