BEEF FACTS

Human Nutrition Research

LEAN BEEF AND HEART HEALTH

Cardiovascular disease (CVD) affects an estimated one in three American adults, and is a leading cause of mortality (1). It is estimated that CVD will cost the American health care system $431.8 billion in 2007 (1). Numerous risk factors are associated with CVD. These include genetics, a family history of premature CVD, cigarette/tobacco smoking, abnormal blood lipid levels (i.e., high total cholesterol and low density lipoprotein cholesterol [LDL-C], low high density lipoprotein cholesterol [HDL-C], and high triglyceride [TG] levels), hypertension, diabetes, abdominal obesity, physical inactivity, and over-consumption of alcohol (1,2).

Dietary recommendations to achieve desirable blood lipid profiles and reduce CVD risk include a reduction in total fat, saturated fat (SFA), trans fat and cholesterol (2-4). To help meet these recommendations, individuals are advised to make dietary changes, one of which is choosing lean meats over fatty meats. Unfortunately, misunderstandings about lean beef's fat composition and lack of awareness of the growing body of scientific evidence related to lean beef and heart health have led to the unnecessary restriction of this nutrient-dense food from the diet. There is no direct evidence that lean beef consumed as part of a heart-healthy diet increases the risk of CVD (5,6). In fact, clinical trials have shown that it is unnecessary to completely substitute fish or poultry for lean red meat choices to achieve desirable blood lipid profiles (7,8). Including lean beef in a lipid lowering, heart-healthy diet plan contributes to the intake of essential nutrients such as iron, zinc, and B-vitamins and may improve acceptance of such diets due to the greater range of food choices.

Dietary Fat Recommendations to Reduce CVD

Dietary guidance from several authoritative health organizations is consistent in their recommendations to reduce the risk of CVD and improve overall health. For example, the American Heart Association (AHA) emphasizes an overall healthy diet and lifestyle to reduce the risk of CVD in the general population (2). With respect to dietary fat, the AHA recommends a total fat intake in the range of 25% to 35% of calories, <7% of calories from SFA, <1% of calories from trans fat, and <300 mg/day of cholesterol (2). Dietary SFAs (with the notable exception of stearic acid) and trans fatty acids (with the possible exception of ruminant derived trans fatty acids) raise LDL cholesterol levels, a risk factor for CVD (2). Recently, evidence-based recommendations have been released for the prevention of CVD in women (3). These guidelines encourage all women to limit SFA intake to less than 10% of calories and if possible to less than 7% of calories (3). Similarly, the Expert Panel of the National Cholesterol Education Program (NCEP) recommends that all individuals at high risk of CVD reduce total fat intake to 25% to 35% of calories, <7% of calories from SFA, and <200 mg/day of cholesterol (4).

The above recommendations are similar to those issued by the Institute of Medicine (9) and the 2005 Dietary Guidelines for Americans (10) which advise a range of total fat intake of 20% to 35% of calories, <10% of calories from SFAs, trans fatty acids as low as possible, and < 300 mg/day of cholesterol. For individuals at risk of CVD, the Dietary Guidelines recommend lower intakes (< 7% of calories) of SFAs and cholesterol (<200 mg/day) (10).

Current dietary guidance to reduce fat intake recommends a food-based approach in which foods such as fruits and vegetables, whole grains, legumes, nuts and seeds, lean meats, poultry, low-fat dairy products, and fish, especially oily fish, are encouraged at the expense of calorie dense, nutrient-poor food choices (2,10). As stated in the AHA guidelines, individuals should strive to improve their overall diet to ensure nutrient adequacy and energy balance, rather than focusing on a single nutrient or food (2).

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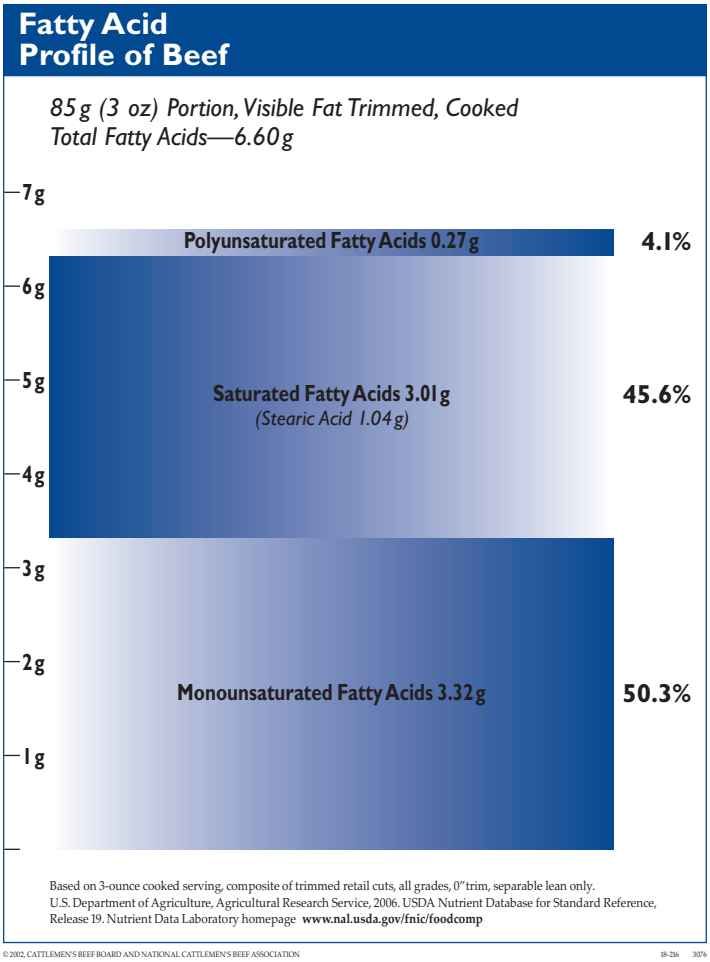
Beef's Nutrients

Beef's Lipid Profile

Lean beef contains less than 10 g total fat, no more than 4.5 g of SFAs, and less than 95 mg cholesterol per 3-ounce serving, a nutrition profile that readily fits into a heart-healthy diet (11,12). Based on the AHA's dietary fat recommendations, individuals consuming a 2,000 calorie diet are advised to consume between 56 g and 78 g of total fat and a SFA intake of 16 g or less. As noted above, a 3-ounce serving of lean beef contains levels of total fat and SFA well below these limits, and cholesterol levels below the recommendation of <300 mg/day. There currently are 29 cuts of beef which meet USDA's labeling guidelines for lean (11-13).

The fatty acid profile of beef fat is often misunderstood. In lean beef, 54% of the fatty acids are monounsaturated (MUFA) or polyunsaturated (PUFA), which are the types favored by health professional and government agencies such as the AHA (2) and the Dietary Guidelines for Americans (10). Also, one-third of the SFAs in beef are stearic acid, which, unlike other long-chain SFAs, has been shown to be neutral in its effects on blood cholesterol levels in humans (14,15). In addition, beef naturally contains low amounts of trans fatty acids and evidence suggests that ruminant trans fatty acids, unlike the trans fatty acids produced industrially in partially hydrogenated vegetable oils, do not increase the risk of CVD and actually may favorably affect health (13,16).



Emerging findings from experimental animal studies suggest that the trans fatty acid, conjugated linoleic acid (CLA), particularly rumenic acid (c9, t11, isomer) which is produced in beef, may have a favorable influence on blood lipid levels and CVD risk (17,18). However, the effects of CLA, and in particular its individual isomers, on lipid levels and CVD risk in humans remain to be determined.

Other Nutrients in Beef

Beef is an excellent source of vitamin B12 (37% of the Daily Value per 3-ounce serving) and a good source of vitamin B6 (16% of the Daily Value per 3-ounce serving). Adequate intakes of vitamin B6, vitamin B12, and the B-vitamin folic acid, are necessary to maintain optimal blood concentrations of homocyteine (2,19). Observational studies show that increased blood levels of this amino acid are associated with an increased risk of CVD (2). Increasing intake of folic acid, vitamin B6 and vitamin B12 can lower blood levels of homocysteine (20). Although it was previously hypothesized that consumption of animal products would increase blood homocysteine levels, emerging findings from observational studies indicate that meat consumption is inversely associated with blood homocysteine levels (21-24). A randomized, controlled intervention trial found that a high protein diet rich in lean meat and dairy products did not increase blood levels of homocysteine, but rather resulted in a non-significant 25% decrease in levels compared to a low protein diet (25). More clinical trials are needed to determine whether intake of red meat such as beef lowers this potential biomarker of CVD risk.

Beef is also an excellent source of selenium (24% of the Daily Value per 3-ounce serving), a trace element with antioxidant properties. Suggestive evidence from observational studies indicates that low blood selenium concentrations are associated with increased risk of CVD (26). Findings from an on-going clinical trial in more than 32,000 men in the U.S. and Canada are anticipated to provide more conclusive evidence of selenium's role in CVD risk (26).

Beef is a good source of iron, providing 14% of the Daily Value per 3-ounce serving. Despite the suggestion that dietary iron is a risk factor for the development of CVD (27), the Institute of Medicine has concluded that the body of evidence does not provide convincing support for a causal relationship between the level of dietary iron intake and the risk for CVD (28). Iron absorption is tightly regulated and there is little evidence that iron intakes typical of the U.S. diet lead to high iron stores in healthy individuals (29). In addition, epidemiological studies attempting to link high iron stores in the body with the

incidence of CVD have yielded contradictory findings (30,31). No dietary intervention studies have investigated the effect of iron stores on the incidence of CVD. Likewise, there is no convincing evidence that dietary sources of iron such as beef or red meat are associated with CVD in healthy persons. Proponents of the iron hypothesis for CVD suggest that excess iron promotes CVD by initiating oxidative damage and inflammation. However, an 8-week clinical trial in 60 iron-replete adults found that when lean red meat intake was increased at the expense of dietary carbohydrate-rich foods, markers of oxidative stress and inflammation were decreased, not elevated (32). Whether or not increased iron intake is causally related to increased risk of CVD remains to be proven.

Beef and Risk of CVD

Lean Beef Intake is Not Associated with the Incidence of CVD.

There is no compelling evidence that consumption of lean beef is associated with increased risk of CVD. In general, epidemiological studies that have examined meat intake and CVD risk factors (e.g., serum lipids) as endpoints have not isolated intake of red meat or beef and have not found any associations before or after correcting for potential confounding variables. Additionally, epidemiological studies frequently use insufficient dietary data (e.g., a single 24-hour food recall interview). Likewise, observational studies that used CVD morbidity or mortality as endpoints suffer from similar methodological limitations. For example, an epidemiological study of 10,146 adults with no previous history of angina showed that consumption of red meat (beef, lamb, pork) four to seven days a week was not associated with the incidence of ischemic heart disease after controlling for several confounding factors (33). Another epidemiological study found a positive association between red meat intake and increased risk of CHD, but this association was eliminated after correction for confounding variables (34). It is important to note that none of the epidemiological studies have considered the relationship between intake of lean beef and CVD risk.

Interchangeability of Beef and Poultry/Fish on Blood Lipid Levels

There is convincing evidence that lean beef has similar effects on serum lipids as chicken or fish when consumed as part of a lipid-lowering diet (7,8,35-39). In two short-term (4 to 5 weeks) randomized, controlled clinical trials, Scott and colleagues (35,36) directly compared the blood lipid responses to lean beef and chicken/fish or chicken in men with borderline or frank hypercholesterolemia. In these studies, lean meats were incorporated into heart healthy diets containing less than 30% of calories from fat, less than 10% of calories from SFAs, and < 300 mg cholesterol, and all food during the test periods was provided to the free-living men. Similar reductions in blood total cholesterol, LDL-C, HDL-C, and TG levels were found in men consuming lean beef versus chicken, or chicken and fish (35,36). The researchers concluded that lean beef and chicken are interchangeable in the heart healthy diets.

Researchers in Quebec reported no significant differences in total cholesterol, LDL-C, HDL-C, or TG levels among 18 hypercholesteromic men consuming a lipid-lowering diet (<30% of calories from fat) containing either lean beef, poultry (without the skin), or fish (37). The subjects consumed each of the three diets for 26 days and all meals were prepared by the investigators.

In another study, 61 obese women consumed lean beef or chicken as the primary protein source in a calorie-reduced (500 calorie/day deficit) diet, in conjunction with a fitness walking program for 12 weeks (38). Blood total cholesterol, LDL-C, and HDL-C levels significantly decreased in both groups, but there was no difference between the beef or chicken treatments (38). Serum TG levels did not change and were similar for the two groups. The SFA content of both diets was low, but the beef diet provided slightly more SFA (~7.5%) than did the chicken diet (~5.3%). In adolescents consuming a low fat diet (~28% total fat, ~10% SFA) with five or more servings per week of lean beef or poultry/fish for three months, total cholesterol, LDL-C, and HDL-C levels did not change significantly and there were no differences in these lipid levels between the two groups (39). An advantage of consuming the lean beef diet was maintenance of serum iron status, which declined with the poultry/fish diet.

In addition to the above studies which examined the effects of beef, other investigations have shown that intake of mixed sources of meat protein (i.e., beef, veal, or pork) is equivalent to similar diets containing chicken/fish with respect to their effects on blood lipid levels. Results of a 76-week randomized, controlled cross-over trial of free-living hypercholesterolemic men and women demonstrated no differences in blood lipid responses between those consuming either lean red meat (beef, veal, pork) or lean white meat (poultry and fish) as part of a NCEP Step 1 diet (7,8). Study participants consumed 6 ounces of lean red meat or lean white meat five to seven days a week as part of the NCEP Step 1 diet (30% or less of calories from fat, 8% to 10% of calories as SFA, <300 mg cholesterol). This multi-center trial was conducted in two 36-week phases, the first phase involving 191 subjects and the second phase 140 subjects. Fasting serum lipid levels were determined at regular intervals throughout both phases. According to this 76-week multi-center trial, total blood cholesterol was reduced by 1%, LDL-C was reduced by 2%, and HDL-C was increased by 2 to 3% in both lean

meat treatment phases and was equivalent regardless of whether hypercholesterolemic subjects incorporated lean red meat or lean white meat into a NCEP Step 1 diet (7,8, Table). Considering that beef is one of the most popular meats consumed in the U.S., the researchers suggest that inclusion of beef in a low fat or cholesterol-lowering diet may provide additional variety to the diet to help improve long-term adherence (8).

Table. Percent Change in Serum Lipid Concentrations from Baseline to Lean Red Meat and Lean White Meat Treatments* (8)

Lipid Variable	Lean Red Meat % change	Lean White Meat % change
Total Cholesterol	-0.92	-1.21
LDL Cholesterol	-1.88	-2.01
HDL Cholesterol	2.82	2.23
Total/HDL Cholesterol	-3.00	-2.55
Triglycerides	1.30	0.19

**Percent changes were calculated using the average of blood lipid concentrations over the second 36-week period of lean red meat or lean white meat consumption.*

Individual Variation and Responses to Lipid-Lowering Diets

It is important to appreciate that individuals differ in their blood lipid responses to lipid-lowering diets, suggesting that there is no "one-size-fits-all" dietary recommendation for the prevention and treatment of CVD (40). For example, a randomized, double-blind controlled trial in men found that subjects with increased adiposity and insulin resistance were less responsive to the benefits of a lipid-lowering diet (i.e., smaller reductions in blood LDL-C levels) (41).

Multiple gene interactions explain the wide variations in blood lipid responses to dietary changes and consequently CVD risk (42). Diet-gene interactions affecting LDL subclass patterns (i.e., A or B) may explain differences among individuals in their blood lipid responses to low fat diets (40,43). Individuals with LDL subclass pattern B (characterized by a predominance of small, dense LDL particles) are at high risk for CVD, whereas those with pattern A (characterized by large, buoyant LDL particles) are at relatively low risk for CVD. When adult males were fed a low fat diet (24% fat) for six weeks, those with subclass pattern B exhibited twice the decline in LDL-C levels than did pattern A subjects (43). While the low fat diet was especially beneficial for pattern B subjects, it led to a more atherogenic lipoprotein response in some pattern A subjects by switching them to the pattern B phenotype (43). Similar findings have been observed in other investigations of men, women, and children (40). Krauss (40) estimates that approximately two-thirds of the male population has a genetic tendency to respond negatively to a low fat diet. Findings that reduced fat diets may not be beneficial or equally beneficial for everyone support individualized dietary and lifestyle recommendations to prevent and treat CVD.

Summary

Multiple genetic and environmental factors, including dietary factors, influence CVD. Dietary recommendations to achieve desirable blood lipid levels and reduce the risk of CVD call for reductions in total fat, SFA, trans fat, and cholesterol. It is important to appreciate that individuals vary in their blood lipid responses to dietary changes and that there is no "one-size-fits-all" dietary recommendation for the prevention and treatment of CVD.

Unfortunately, dietary guidelines to reduce CVD risk often are oversimplified and advice to choose lean meat is often misinterpreted to mean avoid all red meats, including lean beef. However, there is no convincing scientific evidence indicating that lean beef contributes to increased CVD risk. In fact, evidence from dietary intervention studies is accumulating to show that lean beef may be a useful tool in the management of CVD when consumed as part of a heart-healthy diet (5,6). Lean beef consumed as part of a diet low in SFAs has been demonstrated to impart a neutral or beneficial effect on blood lipids. As reviewed by Li et al. (5), dietary intervention and cross-sectional observational studies show that visible fat trimmed lean red meat does not raise blood total and LDL cholesterol levels. Moreover, low SFA diets containing lean red meat are associated with a reduction in LDL-C levels in both subjects with hypercholesterolemia and healthy subjects.

In its report on the role of beef in the American diet, the American Council on Science and Health concludes, "lean beef, in moderate servings, fits well in a heart-healthy diet" (44). Because beef is a naturally nutrient-rich source of many nutrients, including high-quality protein, iron, zinc, and many B-vitamins, its inclusion in the diet can help individuals meet their nutrient needs, as well as provide additional variety and flexibility to their diet, which can improve long-term adherence (7,8,12).

Due to a combination of production practices and trimming, consumers have more lean beef choices than ever before. There currently are at least 29 cuts of beef that meet the government's labeling guidelines for lean (12,13). To further reduce fat intake from all meats, consumers can trim visible fat from retail cuts, choose low-fat cooking methods, and eat appropriate portion sizes (9).

There are no "good" foods or "bad" foods relative to blood cholesterol levels or CVD risk (2). In its recent diet and lifestyle recommendations, the AHA emphasizes the importance of consuming an overall healthy diet to meet nutrient needs and energy balance, rather than focusing on a single nutrient or food (2).

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