Comment on FR Doc # 2019-12806

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Notice: **Meetings: 2020 Dietary Guidelines Advisory Committee**

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Comment

RE: Comprehensive List of Evidence from Randomized Controlled Trials on Red Meat Consumption and Cardiovascular Risk Factors

The Beef Checkoff appreciates the opportunity to provide evidence that is relevant to the diet and cardiovascular disease (CVD) research questions currently being examined. The Beef Checkoff is a producer-funded marketing and research program, which includes a significant commitment to supporting nutrition research to better understand beef's role in healthy diets.

As previously communicated in comments to the DGAC, when the 2015 DGAC assessed similar research questions, the evidence they used was lacking at least 70 relevant studies, primarily randomized controlled trial (RCT) study designs, because they "did not assess dietary patterns as defined for this project". We have requested more information on the literature search strategies for these two questions, but since we remain uncertain if the current search approach will capture relevant red meat RCTs, we are providing a comprehensive list (attached), of red meat RCTs (n=36) related to cardiovascular health. Of note, the majority of these RCTs were recently examined in a meta-analysis of red meat consumption (Guasch-Ferr M, et al. 2019) compared to various diets on CVD risk factors, and the authors concluded (among other findings): Despite a wide range of red meat consumption in various RCTs (i.e. 46.5-500 g/d), "there were no significant differences between red meat and all comparison diets combined for changes in blood concentrations of total, low-density lipoprotein, or high-density lipoprotein cholesterol, apolipoproteins A1 and B, or blood pressure."

The authors also cautioned against blanket recommendations to restrict red meat intake, specifically, "In particular, there is a need to determine the relative effects of different plant protein sources and red meats with different processing methods and saturated fat content on CVD and other chronic disease risk factors." Given

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the 2020 DGAC's examination of important diet and CVD questions - and the lack of availability of corresponding search strategies, as well as the potential use of the 2015 DGAC report as the starting point for answering one of these two questions - we are providing this comprehensive list of gold-standard RCTs for consideration.

Thank you for the opportunity to share the attached evidence, to help ensure the Dietary Guidelines for Americans (DGA) are developed by systematically reviewing the totality of the evidence, using best practice methods that are objective and transparent.

Attachments (1)

Beef Checkoff CVD Evidence Overview

View Attachment:

National Cattlemen's Beef Association
a contractor to the Beef Checkoff

February 28, 2020

Barbara Schneeman, PhD
Chair, 2020-2025 Dietary Guidelines Advisory Committee
Ron Kleinman, MD
Vice-Chair, 2020-2025 Dietary Guidelines Advisory Committee

CC: 2020-2025 Dietary Guidelines Advisory Committee Members
U.S. Department of Agriculture
U.S. Department of Health and Human Services
Brandon Lipps, Deputy Undersecretary for Food and Nutrition Consumer Services

RE: Comprehensive List of RCT Evidence on Red Meat Consumption and Cardiovascular Risk Factors

Dear Members of the Dietary Guidelines Advisory Committee (DGAC):

The Beef Checkoff appreciates the opportunity to provide evidence that is relevant to the diet and cardiovascular disease (CVD) research questions currently being examined. The Beef Checkoff is a producer-funded marketing and research program, which includes a significant commitment to supporting nutrition research to better understand beef's role in healthy diets.

As previously communicated in comments to the DGAC, when the 2015 DGAC assessed similar research questions, the evidence they used was lacking at least 70 relevant studies, primarily randomized controlled trial (RCT) study designs, because they "did not assess dietary patterns as defined for this project". We have requested more information on the literature search strategies for these two questions, but since we remain uncertain if the current search approach will capture relevant red meat RCTs, we are providing a comprehensive list (attached), of red meat RCTs (n=36) related to cardiovascular health. Of note, the majority of these RCTs were recently examined in a meta-analysis of red meat consumption compared to various diets on CVD risk factors, and the authors concluded (among other findings): **Despite a wide range of red meat consumption in various RCTs (i.e. 46.5-500 g/d), "there were no significant differences between red meat and all comparison diets combined for changes in blood concentrations of total, low-density lipoprotein, or high-density lipoprotein cholesterol, apolipoproteins A1 and B, or blood pressure."**[1]

The authors also cautioned against blanket recommendations to restrict red meat intake, specifically, "In particular, there is a need to determine the relative effects of different plant protein sources and red meats with different processing methods and saturated fat content on CVD and other chronic disease risk factors."[1] **Given the 2020 DGAC's examination of important diet and CVD questions – and the lack of availability of corresponding search strategies, as well as the potential use of the 2015 DGAC report as the starting point for answering one of these two questions – we are providing this comprehensive list of gold-standard RCTs for consideration.**

Thank you for the opportunity to share the attached evidence, to help ensure the Dietary Guidelines for Americans (DGA) are developed by systematically reviewing the totality of the evidence, using best practice methods that are objective and transparent.

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[1]Guasch-Ferré M, et al. 2019. Meta-Analysis of randomized controlled trials of red meat consumption in comparison with various comparison diets on Cardiovascular Risk Factors. Circulation 139(15):1828-1845.

Comprehensive List of RCT Evidence on Red Meat Consumption and Cardiovascular Risk Factors
Evidence Overview and Supporting Citations

The 2020 Dietary Guidelines Advisory Committee (DGAC) is exploring multiple questions related to diet and cardiovascular disease (CVD), including two in particular that are relevant to the role of red meat; "What is the relationship between dietary patterns consumed and risk of cardiovascular disease?" and "What is the relationship between types of dietary fat consumed and risk of cardiovascular disease?(1)" As communicated in an earlier submission to the 2020 DGAC, evidence relied upon by the 2015 DGAC was lacking at least 70 relevant studies, primarily randomized controlled trial (RCT) study designs, because they "did not assess dietary patterns as defined for this project".(2) In our earlier submission, we provided an abbreviated list of red meat-related RCTs with cardiovascular outcomes that were either excluded by this, or other 2015 eligibility criteria, or were not found by the 2015 literature search strategy. **On October 11, 2019 we contacted the Center for Nutrition Policy and Promotion (CNPP) and requested (3), but have yet to receive, the literature search strategies for these two questions in an effort to better understand the evidence likely to be considered by the Committee. Since we remain uncertain if the current search approach will capture relevant red meat RCTs, we are providing a comprehensive list (Table 1) of red meat RCTs (n=36) related to cardiovascular health.** The majority of these RCTs were recently examined in a **meta-analysis of red meat consumption compared to various diets on cardiovascular risk factors (4), the authors of which include two 2015 DGAC members, Dr. Frank Hu and Dr. Wayne Campbell.** The following is a summary of key points from their analysis:

- 67% of the evidence base was assessed by the authors as high-quality using an NHLBI tool.
- Most studies directly provided study food to the participants, reducing risk of bias.
- Findings from these RCTs are relevant to the general public, as 72% of the studies were conducted in normolipidemic subjects.
- "Red meat industry" funding resulted in no statistically significant or clinically relevant differences in lipid outcomes, with the exception of triglycerides. For triglycerides, "red meat industry" funded studies reported *higher* TG vs comparison diets.
- Despite a wide range of red meat consumption in various RCTs (i.e. 46.5-500 g/d), "there were no significant differences between red meat and all comparison diets combined for changes in blood concentrations of total, low-density lipoprotein, or high-density lipoprotein cholesterol, apolipoproteins A1 and B, or blood pressure."
- Twenty percent of the evidence base were studies of high-quality, plant-based interventions. While red meat interventions resulted in reductions in total and LDL cholesterol, compared to these plant-based interventions, reductions were less favorable.
- Compared to fish interventions, red meat resulted in more favorable reductions in LDL cholesterol.
- Compared to carbohydrate interventions, red meat resulted in more favorable reductions in triglycerides.

The authors concluded in support of RCTs as key evidence for examining the effects of red meat intake, specifically, "Future interventions should consider appropriate comparison foods when examining the effects of red meat intake, or any particular food, on cardiovascular risk factors and should prioritize the use of RCTs to identify food sources that promote optimal health and prevent chronic disease (4)." The authors **also cautioned against blanket recommendations to restrict red meat intake**, specifically, "In particular, there is a need to determine the relative effects of different plant protein sources and red meats with different processing methods and saturated fat content on CVD and other chronic disease risk factors (4)."

The evidence base outlined in the attached table and analyzed in the above meta-analysis represents a broad array of dietary patterns, as well as differing levels of fat, fat types, and fat sources. Consideration of this evidence is therefore particularly relevant to the 2020 DGAC question "What is the relationship between types of dietary fat consumed and risk of cardiovascular disease?" **However, the 2020 DGAC, in an approach inconsistent with every other 2020 DGAC protocol posted to date, proposes to use the 2015 DGAC report as the starting point for answering this question (5). As detailed in our earlier comment (6), in so doing the 2020 DGAC will be introducing the results from 6 external meta-analyses (7) considered by the 2015 DGAC which examine just 3 dietary patterns, i.e. Mediterranean (8-10), DASH (11), and vegetarian (12, 13)**. In DGAC Meeting 1, Dr. Julie Obaggy provided a definition of "relevancy" to guide in the decision of when to use an existing resource to answer a current DGAC research question. Specifically, an existing resource would be considered relevant if it "…addressed the same population, intervention and/or exposure, comparator, and outcomes; used the same definitions for key terms and exclusion criteria (14)." **This relevancy criterion is not met for the 2015 DGAC report as the intervention and/or exposures (i.e. dietary patterns) differ from those considered in the current 2020 DGAC research question (5).**

Science-based dietary guidance relies on systematically reviewing the totality of evidence for the nutrition questions at hand, using best practice methods (15). We look forward to the next set of revised protocols and continued efforts by NESR and the 2020 DGAC to make evidence-based public health recommendations that are objective, transparent, and scientifically valid.

References:

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5. https://www.dietaryguidelines.gov/sites/default/files/2019-09/Fats-CVD_protocol_09-19-2019.pdf Accessed January 15, 2020.
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15. National Academies of Sciences, Engineering, and Medicine. Redesigning the Process for Establishing the Dietary Guidelines for Americans. Washington, DC: The National Academies Press, 2017.

Table 1. Summary of Randomized Clinical Trials evaluating diets containing lean red meat/lean beef on cardiovascular disease risk factors (ordered by year of publication)

Reference citation	Study Design	Study Population	Results	Authors' conclusions
Lipoproteins/Cholesterol				
O'Brien BC, et al. Human plasma lipid responses to red meat, poultry, fish, and eggs. Am J Clin Nutr **1980**; 33:2573–80 *Supported in part by the Wallace Genetic Foundation*. DOI:10.1093/ajcn/33.12.2573 (free full-text for ASN members)	High cholesterol red meat diet (HCRM): ≥170 g/d (6 oz./d) of red meat (beef, pork, lamb), 3 eggs/d, no fish/poultry; Low cholesterol red meat diet (LCRM): HCRM w/o eggs; Low cholesterol fish and poultry diet (LCFP): ≥170 g/d (6 oz/d) of fish/poultry, no eggs/red meat; High cholesterol fish and poultry diet (HCFP): LCFP with 3 eggs/d; 4 diets for 6 weeks each, crossover design	n=29 healthy men; 31-60 yrs.; Subjects in group I consumed the diets in the order; subjects in group II consumed the diets in the reverse order *Baseline lipid values (mg/dL):* *Group 1: TC=182* *Group 2: TC=197*	Despite large differences in cholesterol intakes, modest changes in plasma cholesterol concentrations. *End of Study lipid values (mg/dL):* *Group 1: HCRM=199, LCRM=194, HCFP=191 LCFP=191,* *Group 2: HCRM=207; LCRM=191, HCFP=216, LCFP=198*	"…one would have to conclude from these data that even strict adherence to the recommended diet modifications would result in no substantial changes in blood cholesterol concentrations for most individuals." Average beef change from baseline: +9 mg/dl TC beef ↑
Flynn MA, et al. Serum lipids in humans fed diets containing beef or fish and poultry. Am J Clin Nutr **1981**; 34:2734–2741 *Supported by University of Missouri and National Livestock and Meat Board*. DOI:10.1093/ajcn/34.12.2734 (free full-text for ASN members)	141 g/d (5 oz./d) raw beef vs. poultry & fish (PF); 1 egg/d for 3 months; self-selected diets, crossover design	n=129 healthy, free-living men (M1=38, M2=36) and women (F1=31, F2=24); 23-70 yrs. *Baseline lipid values (mg/dL):* *F1: TC=205, HDL=66* *F2: TC=220, HDL=65* *M1: TC=218, HDL=52* *M2: TC=221, HDL=51*	Compared to poultry & fish diet, no changes in serum TC, TG or HDL in men; lower TG in women. *End of Study lipid values (mg/dL):* *F1 PF: TC=204, HDL=66* *F1 beef: TC=199, HDL=59* *F2 PF: TC=219, HDL=67* *F2 beef: TC=226, HDL=58* *M1 PF: TC=212. HDL=52* *M1 beef: TC=208, HDL=46* *M2 PF: TC=217, HDL=49* *M2 beef: TC=225, HDL=46*	"Within their preferred diets, the mean serum lipids of these healthy men did not change when they substituted beef for poultry or fish in their daily intakes." Average beef change from baseline: -9 mg/dl TC ↓ +12 mg/dl non-HDL[#] ↑

Sacks FM, et al. Effect of Ingestion of Meat on Plasma Cholesterol of Vegetarians. JAMA **1981**; 246:640-644. *Support not acknowledged* https://jamanetwork.com/journals/jama/article-abstract/360152	250 g/d (8.8 oz./d) beef for 4 weeks preceded and followed by habitual vegetarian diet for 2 weeks; consecutive diets, no control	n=21 healthy male and female (17, 7)** vegetarians; 20-55 yrs. *Baseline lipid values (mg/dL):* *TC=140* *HDL=31*	HDL did not change during the study, TC rose significantly by 19% at the end of the meat-eating period. *End of Study lipid values (mg/dL):* *TC=166* *HDL=32*	"The study suggests an adverse effect of consumption of beef on plasma lipid and BP levels." Beef change from baseline: +26 mg/dl TC ↑ +25 mg/dl non-HDL[#] ↑
Flynn MA, et al. Dietary ''meats'' and serum lipids. Am J Clin Nutr **1982**; 35:935–942 *Supported by University of Missouri and National Livestock and Meat Board*. DOI:10.1093/ajcn/35.5.935 (free full-text for ASN members)	141 g/d (5 oz./d) raw beef vs. poultry & fish (PF) vs. pork; 6-week ad libitum (ad lib) diet; 1 egg/d for 3 months; self-selected diets, crossover design	n=76 healthy, free-living men (M1=21, M2=26) and women (F1=12, F2=17); 32-62 yrs. *Baseline lipid values (mg/dL):* *F1: TC=216, HDL=61* *F2: TC=211, HDL=64* *M1: TC=210, HDL=53* *M2: TC=226, HDL=50*	No differences in serum TC, TG between diets. *End of Study lipid values (mg/dL):* *F1 PF: TC=211, HDL=61* *F1 beef: TC=207, HDL=53* *F1 ad lib: TC=201, HDL=48* *F1 pork: TC=193, HDL=55* *F2 PF: TC=216, HDL=69* *F2 beef: TC=226, HDL=58* *F2 ad lib: TC=217, HDL=61* *F2 pork: TC=204, HDL=65* *M1 PF: TC=211, HDL=50* *M1 beef: TC=204, HDL=44* *M1 ad lib: TC=202, HDL=43* *M1 pork: TC=201, HDL=47* *M2 PF: TC=220, HDL=47*	"… men who have had normal serum lipids for at last 10 yrs. and who eat reasonable amounts of meat with one daily egg within a self-selected diet do not show a statistically significant mean change in serum total cholesterol." Average beef change from baseline: +0.26 mg/dl TC ↑ +7.25 mg/dl non-HDL[#] ↑

			M2 beef: TC=225, HDL=43 *M2 ad lib: TC=212, HDL=44* *M2 pork: TC=207, HDL=47*	
Heller RF, et al. The effect on blood lipids of eating charcoal-grilled meat. Atherosclerosis **1983**; 48:185-92 *No support acknowledged* DOI:10.1016/0021-9150(83)90105-3	227 g/d (8 oz./d) beef hamburger and 170 g/d (6 oz./d) barbecued beefsteak for 9 days followed by the same, but oven cooked, for 9 days, 30 days later; consecutive feeding, no control	n=13 non-smoking, men; 21-38 yrs. *Baseline lipid values (mmol/L):* *Barbecue: TC=4.74, HDL=1.40* *Oven: TC=4.53, HDL=1.32*	HDL increased 25% from baseline along with a reduction in total cholesterol, these changes were not seen when subjects ate the same quality of meat except cooked in an electric oven. *End of Study lipid values (mmol/L):* *Barbecue: TC=4.4, HDL=1.76* *Oven: TC=4.89, HDL=1.2*	"Despite the beneficial effect that such changes in lipids might have on the risk of coronary heart disease, these findings should not be seen as a guide to long-term changes in cooking practice in view of the possible carcinogenic effects of benzo(a)pyrene produced in this way." Average beef change from baseline: +0.5 mg/dl TC[$] ↑ +4 mg/dl non-HDL[#,$] ↑
Wiebe SL, et al. A comparison of the effect of diets containing beef protein and plant proteins on blood lipids of healthy young men. Am J Clin Nutr **1984**; 40:982–9 *Supported by National Science and Engineering Council of Canada.* DOI:10.1093/ajcn/40.5.982 (free full-text for ASN members)	Animal protein diet (APD) 55% protein from beef patties vs. Plant protein diet (PPD) 55% protein from plants; 2 sequential, 21-day dietary periods, crossover design	n=8 healthy male university students; 18-27 yrs. *Baseline lipid values (mg/dL):* *LDL=96* *HDL=53*	No significant effect on serum total cholesterol levels in subjects, slight increase in HDL cholesterol in beef protein group. *End of Study lipid values (mg/dL):* *APD: LDL=82, HDL=48* *PPD: LDL=82, HDL=42*	"The results of the study indicated that the ingestion of a diet in which 55% of the protein was supplied by beef protein was not associated with a hypercholesterolemic effect in healthy normolipidemic young men." Beef change from baseline: -14 mg/dl LDL-C ↓
Heller, RF et al. Enzyme induction by eating charcoal grilled steak with no effect on blood lipids. Clin Exper Pharm Phys **1989**; 16:783-788. *Support not acknowledged* DOI:10.1111/j.1440-1681.1989.tb01516.x	227 g (8 oz.) steak for one meal and a 227 g (8 oz.) beef burger for the other meal of the day, charcoal vs. oven prepared; over 2 weeks, parallel design	n=18 non-smoking, university students *Baseline lipid values (mmol/L):* *Charcoal: TC=4.5, HDL=1.3* *Oven: TC=4.0, HDL=1.1*	Neither diet had a significant effect on blood lipids. *End of Study lipid values (mmol/L):* *Charcoal: TC=4.41, HDL=1.26* *Oven: TC=4.36, HDL=1.06*	"A previously noted risk in high density lipoprotein cholesterol levels in volunteers fed charcoal-cooked beef may have been due to the effects of charcoal formed by charring of the beef during cooking." Average beef change from baseline: +1 mg/dl TC[$] ↑ +2.25 mg/dl non=HDL [#,$] ↑

O'Dea, K. et al. Cholesterol-lowering effect of a low-fat diet containing lean beef is reversed by the addition of beef fat. Am J Clin Nutr **1990**; 52:491-4 *Supported by grants from the National Heart Foundation of Australia and the Australian Meat and Livestock Research and Development Corporation.* DOI:10.1093/ajcn/52.3.491 (free full-text for ASN members)	500 g (17.6 oz.) lean beef (2000 kcal, trimmed, pre-weighed, topside, rump, minced topside, fillet, and stewing steak) in a very low-fat (10%) diet vs. habitual diet vs. 30% or 40% diet from added beef fat; 5 weeks, consecutive intervention, no control	n=10 healthy, weight-stable men and women (5, 5) *Baseline lipid values (mmol/L):* *TC=5.84* *LDL=3.88* *HDL=1.71*	TC decreased significantly within 1 week of the low-fat, lean-beef-supplemented diet. No significant increase when 10% dripping was substituted for part of the carbohydrate supplement in week 4 but did rise significantly in week 5 when the proportion of added dripping was increased to 20% energy, this was almost entirely account for by LDL reduction. HDL did not change. *End of Study lipid values (mmol/L):* *Beef alone: TC=4.84, LDL=2.82, HDL=1.60* *Beef + drippings: TC=5.39, LDL=3.25, HDL=1.76*	"These results indicate that it is the beef fat, not lean beef itself, that is associated with elevations in cholesterol concentrations and that lean beef can be included in cholesterol-lowering diets provided it is free of all visible fat and the saturated fatty acid content of the diet Is low." Beef change from baseline: -38 mg/dl TC[$] ↓ -34 mg/dl non-HDL [#,$] ↓
Scott L, et al. Effects of a lean beef diet and of a chicken and fish diet on lipoprotein profiles. Nutr Metab Cardiovasc Dis **1991**; 1:25–30. *Research supported by a grant from Granada Corporation.*	226 g/d (8 oz./d) raw, lean beef vs. chicken & fish in AHA and NCEP Step 1 diet (<30% kcal from total fat, <10% kcal from saturated fat); 11-week study, parallel design	n=46 mild, hypercholesterolemic men; 25-55 yrs. *Baseline lipid values (mg/dL):* *Lean beef: TC=221, LDL=146, HDL=56* *Chicken/fish: TC=225, LDL=148, HDL=59*	Similar decreases in serum TC, LDL in both diets. *End of Study lipid values (mg/dL):* *Lean beef: TC=197, LDL=127, HDL=50* *Chicken/fish: TC=211, LDL=137, HDL=55*	"…can substitute lean beef for chicken and fish without significant changes in serum lipoproteins." Beef change from baseline: -24 mg/dl TC ↓ -18 mg/dl non-HDL[#] ↓

Scott L, et al. Effects of beef and chicken consumption on plasma lipid levels in hypercholesterolemic men. Arch Intern Med **1994**; 154:1261–1267. *This study was supported by a grant from the National Live Stock and Meat Board.* https://jamanetwork.com/journals/jamainternalmedicine/article-abstract/618875	85 g/d (3 oz./d) cooked lean beef vs. chicken & fish in AHA and NCEP Step 1 diet (8-10% kcal from saturated fat); 13-week study, parallel design	n=36 free-living, hypercholesterolemic men; 20-55 yrs. *Baseline lipid values (mg/dL):* *Lean beef: TC=258, LDL=180, HDL=49* *Chicken/fish: TC=256, LDL=183, HDL=45*	Similar decreases in plasma TC and LDL in both diets. *End of Study lipid values (mg/dL):* *Lean beef: TC=249, LDL=173, HDL=46* *Chicken/fish: TC=236, LDL=170, HDL=41*	"…beef and chicken with comparable low-fat content are interchangeable within the Step I Diet with respect to effect on plasma total cholesterol, LDL cholesterol, HDL cholesterol, and triglyceride levels." Beef change from baseline: -9 mg/dl TC ↓ -6 mg/dl non-HDL[#] ↓
Gascon A, et al. Plasma lipoprotein profile and lipolytic activities in response to the substitution of lean white fish for other animal protein sources in premenopausal women. Am J Clin Nutr **1996**; 63:315–21 *Supported by a grant from the Quebec Heart Foundation.* DOI:[10.1093/ajcn/63.3.315](https://doi.org/10.1093/ajcn/63.3.315)	Lean white fish (LWF) diet or a similar diet containing beef, pork, veal, eggs, milk, and milk products (BPVEM); 4-week, crossover design	n=14 premenopausal women *Baseline lipid values (mg/dL):* *LWF: TC=163, LDL=105, HDL=49* *BPVEM: TC=163, LDL=106, HDL=48*	BPVEM diet significantly reduced concentrations of plasma TC, LDL, HDL, while LWF diet did not. *End of Study lipid values (mg/dL):* *LWF: TC=158, LDL=102, HDL=47* *BPVEM: TC=150, LDL=96, HDL=44*	"These results suggest that LWF as a substitute for BPVEM in isoenergetic diets with an elevated PUFA:SFA produces minimal improvement in the lipoprotein profile in premenopausal women." Red meat change from baseline: -13 mg/dl TC ↓ -9 mg non-HDL[#] ↓
Yamashita, Y et al. Arterial compliance, blood pressure, plasma leptin, and plasma lipids in women are improved with weight reduction equally with a meat-based diet and a plant-based diet. Metabolism **1998**; 47:1308-1314. *Supported by grants from the Meat Research Corporation and National Heart Foundation of Australia, and in part by the Manpei Suzuki Diabetes Foundation* DOI:[10.1016/s0026-0495(98)90297-9](https://doi.org/10.1016/s0026-0495(98)90297-9)	150 g (5.3 oz.) lean red meat (beef sirloin), at least 5 days per week. On the 2 remaining days, they consumed either fish or non-soy legumes. The plant-white meat plan consisted of soybean as the main source of protein, and subjects were encouraged to consume soy protein at least 5 days weekly and chicken, fish, and other legumes on the remaining days; 16 weeks, parallel design; weight loss diet	n=36 mostly overweight or obese women; 30-61 yrs. *Baseline lipid values (mmol/L):* *Meat: TC=5.27, LDL=3.50, HDL=1.11* *Plant: TC=4.52, LDL=2.78, HDL=1.18*	No significant effect of diet and no diet X time interactions. Since baseline total and LDL cholesterol levels were higher in the meat group, the absolute decrease in those parameters was also higher for that group. *End of Study lipid values (mmol/L):* *Meat: TC=4.5, LDL=2.94, HDL=1.06* *Plant: TC=4.13, LDL=2.50, HDL=1.17*	"…weight loss and the metabolic benefits of weight loss occurred equally with the meat-based and plant-based diets." Beef change from baseline: -30 mg/dl TC ↓ -28 mg/dl non-HDL[#] ↓

Davidson MH, et al. Comparison of the effects of lean red meat vs lean white meat on serum lipid levels among free-living persons with hypercholesterolemia: a long-term, randomized clinical trial. Arch Intern Med **1999**; 159:1331–1338. *This research was funded by the National Cattlemen's Beef Association* https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/485065	170 g/d (6 oz./d) lean red vs. lean white meat in NCEP Step I diet (<30% kcal from total fat, 8-10% kcal from saturated fat); 36-week dietary intervention, parallel design	n=191 free-living, hypercholesterolemic men and women (107, 84); 18-75 yrs. *Baseline lipid values (mg/dL):* *Lean red meat: TC=238, LDL=157, HDL=51* *Lean white meat: TC=240, LDL=160, HDL=50*	Similar decreases in serum TC and LDL; no change in TG; HDL slightly increased in both diets. *End of Study lipid values (mg/dL):* *Lean red meat: TC=236, LDL=154, HDL=53* *Lean white meat: TC=235, LDL=155, HDL=52*	"… with instruction regarding meat selection and preparation, free-living persons can effectively incorporate LRMs into their diets on a long-term basis, without compromising the lipid-lowering benefits of the diet." Red meat change from baseline: -2 mg/dl TC ↓ -4 mg/dl non-HDL[#] ↓
Ashton E and Ball M. Effects of soy as tofu vs meat on lipoprotein concentrations. Eur J Clin Nutr **2000**; 54:14-9. *Tofu was kindly provided at cost by Mr E Beng of Blue Lotus Foods, Kilsyth, Australia* DOI:10.1038/sj.ejcn.1600885	150 g/d (5.3 oz./d) (raw weight) of cooked lean red meat, with all visible fat removed vs. 290 g (10.2 oz.) of tofu (90-100% animal protein replacement); 1 month with a 2-week washout, cross-over design	n=45 free-living, healthy males without history of CHD; 35-62 yrs. *Baseline lipid values (mmol/L):* *TC=5.79* *LDL=3.68* *HDL=1.25*	Lean red meat significantly increased HDL and a NS lowering of both LDL and TC from baseline. Tofu resulted in significantly lower TC and HDL vs lean meat. *End of Study Lipid values (mmol/L):* *Lean meat diet: TC=5.65, LDL=3.56, HDL=1.32* *Tofu diet: TC=5.42, LDL=3.48, HDL=1.24*	"The effect of tofu compared with the lean meat in the carefully controlled diets resulted in small changes in lipoprotein levels: however, in real life, replacement of meat with tofu in a habitual diet is likely to reduce saturated fat and increase the PUFA:SAFA ratio, which would have additional beneficial effects on plasma lipoproteins." Red meat change from baseline: -6 mg/dl TC ↓ -9 mg/dl non-HDL[#] ↓
Hunninghake DB, et al. Incorporation of lean red meat into a National Cholesterol Education Program step I diet: a long-term, randomized clinical trial in free-living persons with hypercholesterolemia. J Am Coll Nutr **2000**; 19:351–360. *This research was funded by the National Cattlemen's Beef Association.* DOI:10.1080/07315724.2000.10718931	≥170g/d (6 oz./d) lean red vs. lean white meat in NCEP Step I diet (<30% kcal from total fat, 8-10% kcal from saturated fat); 36-week dietary interventions (76-week study), crossover design Red Meat (Phase 1) – White Meat (Phase 2) *vs.* White Meat (Phase1) – Red Meat (Phase2)	n=145 free-living, hypercholesterolemic men and women (83, 62); 18-75 yrs. *Baseline lipid values (mg/dL):* *Red-White: TC=238, LDL=156, HDL=52*	Similar decreases in serum TC and LDL; no change in TG; HDL slightly increased in both diets. *End of Study lipid values (mg/dL):* *Red-White:* *Phase1: TC=236, LDL=154, HDL=53;* *Phase2: TC=237, LDL=155, HDL=53*	"Findings from this study suggest that the lipid-lowering effects of a low-fat diet are not compromised by incorporation of lean red meats." Average red meat change from baseline: -2.5 mg/dl TC[$] ↓ -1.5 mg/dl non-HDL[#,$] ↓

		White-Red: TC=240, LDL=160, HDL=52	*White-Red: Phase1: TC=236, LDL=155, HDL=53;* *Phase2: TC=237, LDL=156, HDL=54*	
Matvienko, OA, et al. A single daily dose of soybean phytosterols in ground beef decreases serum total cholesterol and LDL cholesterol in young, mildly hypercholesterolemic men. Am J Clin Nutr **2002**; 76:57–64 *Supported by ConAgra, Inc, Omaha; the Center for Designing Foods to Improve Nutrition at Iowa State University; NIH grants HL-28972 and* *HL-45522; the Hatch Act; and the State of Iowa.* DOI:10.1093/ajcn/76.1.57	112 g/d (3.95 oz./d) ground beef (90% lean) with or without 2.7 g (0.095 oz.) added phytosterols; 4 weeks, parallel design	n=34 hyperlipidemic male college students *Baseline lipid values (mmol/L):* *Beef: TC=5.8, LDL=3.95, HDL=1.05* *Beef + phytosterol: TC=5.90, LDL=4.10, HDL=1.10*	Subjects in the beef group had no significant changes from baseline while beef + phytosterol subjects had significantly lower TC and LDL. *End of Study lipid values (mmol/L):* *Beef: TC=5.75, LDL=3.90, HDL=1.05* *Beef + phytosterol: TC=5.35, LDL=3.50, HDL=1.15*	"Phytosterol-supplemented ground beef effectively lowers plasma TC and LDL cholesterol and has the potential to become a functional food to help reduce the risk of cardiovascular disease." Beef change from baseline: -2 mg/dl TC[$] ↓ -2 mg/dl non-HDL[#,$] ↓
Smith, D et al. Increased Beef Consumption Increases Apolipoprotein A-I but Not Serum Cholesterol of Mildly Hypercholesterolemic Men with Different Levels of Habitual Beef Intake. Exp Biol Med Vol. **2002**; 227:266–275. *This work was supported by Briggs Ranch (Rice, TX) and by the Texas Agricultural Experiment Station.* DOI:[10.1177/153537020222700407](10.1177/153537020222700407)	Average of 98 g/d (3.45 oz./d) of lean (Wagyu) or commercial beef for the meat typically consumed; beef was supplied in the form of 114 g (4.02 oz.) of ground beef (four times per week) and 228 g (8.04 oz.) of steaks (one time per week); 6-weeks with a 4-week washout, cross-over design	n=10 mildly hypercholesterolemic men; 34–58 yrs. *Baseline lipid values (mg/dL):*	Beef type (lean versus commercial) had no effect on any variable measured, so results are presented as beef intake. The low-beef intake group consumed an average of 26 g (0.9 oz) of beef/day prior to the study whereas the high-beef-intake group consumed an average of 160 g (5.64 oz) of beef/day. So low beef group increased during the study and high beef group decreased beef intake during the study. *End of Study lipid values (mg/dL):*	"This study had three important findings: i) a lean beef source enriched with oleic acid was no different from commercial beef in its effect on lipoprotein fractions; ii) neither previous level of beef intake nor baseline LDL cholesterol concentration influenced the serum cholesterol response to added dietary beef, which was negative; and iii) apolipoprotein A-I, but not HDL or LDL cholesterol, was sensitive to the additional dietary beef." Average beef change from baseline:

		Low beef: TC=241, LDL=172, HDL=42 *High beef: TC=229, LDL=149, HDL=42*	*Low beef: TC=253, LDL=179, HDL=44* *High beef: TC=233, LDL=144, HDL=40.2*	+8 mg/dl TC ↑ +8 mg/dl non-HDL# ↑
Beauchesne-Rondeau E, et al. Plasma lipids and lipoproteins in hypercholesterolemic men fed a lipid lowering diet containing lean beef, lean fish, or poultry. Am J Clin Nutr **2003**; 77:587–593 *Supported by the Canadian Beef Information Center with funds obtained from the Beef Industry Development Fund, a Canadian federal/provincial initiative, and by the Fonds de la Recherche en Santé du Québec.* DOI:10.1093/ajcn/77.3.587	≥170 g/d (6 oz./d) lean beef vs. lean poultry vs. lean fish into an AHA diet with a high PUFA:SFA and high fiber content; 26-day dietary interventions, crossover design	n=18 hypercholesterolemic men; 21-73 yrs. *Baseline lipid values (mg/dL):* *Lean beef: TC=228, LDL=166, HDL=37* *Lean fish: TC=228, LDL=170, HDL=37* *Poultry: TC=232, LDL=170, HDL=37*	Similar decreases in plasma TC and LDL in all three diets. *End of Study lipid values (mg/dL):* *Lean beef: TC=209, LDL=155, HDL=37* *Lean fish: TC=217, LDL=162, HDL=38* *Poultry: TC=213, LDL=155, HDL=39*	"…with respect to coronary artery disease risk, an AHA diet with a high PUFA:SFA and high fiber content, regardless of the protein source, induced numerous favorable changes such as reductions in plasma total and LDL cholesterol and apo B, total and VLDL triacylglycerols, and total:HDL cholesterol in hypercholesterolemic men…" Beef change from baseline: -19 mg/dl TC ↓ -19 mg/dl non-HDL# ↓
Melanson K, et al. Weight loss and total lipid profile changes in overweight women consuming beef or chicken as the primary protein source. Nutrition **2003**; 19:409–414. *This work was supported by Cattlemen's Beef Board and the National Cattlemen's Beef Association.* DOI:10.1016/s0899-9007(02)01080-8	Lean beef vs. chicken as primary source of protein in individualized hypocaloric diets (19-22% protein in diets); 12-week intervention, parallel design; weight loss study	n=61 overweight women; 21-59 yrs. *Baseline lipid values (mg/dL):* *Beef: TC=224, LDL=129, HDL=56* *Chicken: TC=210, LDL=128, HDL=52*	Similar decreases in body weight and body fat%; similar decreases in plasma TC, LDL and TG in both diets. *End of Study lipid values (mg/dL):* *Beef: TC=202, LDL=119, HDL=56* *Chicken: TC=191, LDL=114, HDL=50*	"Women consuming a diet with lean beef as the primary protein source were able to effectively reduce body weight, reduce body fat content, and improve lipid profile (reduce total and LDL cholesterol and maintain HDL cholesterol). These results were similar to those in women consuming a diet with chicken as the primary protein source." Beef change from baseline: -22 mg/dl TC ↓ -22 mg/dl non-HDL# ↓
Snetselaar, L., et al. Adolescents Eating Diets Rich in Either Lean Beef or Lean Poultry and Fish Reduced Fat and Saturated Fat Intake and Those Eating Beef Maintained Serum Ferritin Status. J Am Diet Assoc. **2004**; 104:424-428. *Supported by a grant from the National Cattleman's*	≥5 servings per week of lean beef (LB) or poultry/fish (LPF) in a low-fat diet; parallel design	n=86 school children (7^{th} and 8^{th} grade)	No significant reductions in cholesterol measurements (total, LDL, and HDL) between groups. The	"Teenagers eating diets low in saturated fat may benefit from adequate amounts of lean red meat."

Association and from grant No. M01-RR-59, National Center for Research Resources, General Clinical Research Centers Program, NCRR, National Institutes of Health. DOI:10.1016/j.jada.2003.12.016		*Baseline lipid values (mmol/L):* *Lean beef: TC=4.54, LDL=2.83, HDL=1.11* *Lean poultry/fish: TC=4.54, LDL=2.91, HDL=1.11*	only significant finding was ferritin levels; the LB group remained unchanged and the LPF group decreased. *End of Study lipid values (mmol/L):* *Lean beef: TC=4.47, LDL=2.78, HDL=1.06* *Lean poultry/fish: TC=4.38, LDL=2.76, HDL=1.01*	Beef change from baseline: -2 mg/dl TC[$] ↓ 0 mg/dl non-HDL[#,$] ↓
Haub, MD et al. Beef and soy-based food supplements differentially affect serum lipoprotein-lipid profiles because of changes in carbohydrate intake and novel nutrient intake ratios in older men who resistive-train. Metab Clin Exper **2005**; 54: 769–774 *This study was support by funds from: The National Cattlemen's Beef Association and the Cattlemen's Beef Board, the National Institutes of Health (R29 AG13409, R01 AG15750, and M01 RR14288), United States Department of Agriculture (98-35200-6151), and a University of Arkansas for Medical Sciences Student Research Fund.* DOI:10.1016/j.metabol.2005.01.019	0.6 g-protein/kg/d (0.21 oz.) consumed by all from portioned quantities of soy-based texturized vegetable protein foods (2 weeks at baseline); 11 men were randomized to continue with texturized vegetable protein foods (VEG group), another 10 men consumed 0.6 g-protein/kg/d (0.21 oz.) from portioned quantities of beef (cube steak, ground beef, and beef tips; BEEF group) and continued their otherwise lacto-ovo-vegetarian diet (12 weeks); 14 week, self-selected lacto-ovo-vegetarian diet, parallel design	n=26 healthy men *Baseline lipid values (mmol/L):* *VEG: TC=4.51, LDL=2.88, HDL=1.16* *BEEF: TC=5.11, LDL=3.35, HDL=1.17*	At end of study the BEEF group had increased concentrations of HDL (P=0.025; HDL-C), LDL (P=0.027; LDL-C), and TC (P=0.015; CHOL). The VEG group did not experience any within-group changes although there was a trend for decreased HDL-C and increased CHOL/HDL-C ratio. HDL, LDL, and TC were greater in the BEEF group at end of study compared with the VEG group. *End of Study lipid values (mmol/L):* *VEG: TC=4.45, LDL=2.80, HDL=1.06* *Beef: TC=5.42, LDL=3.65, HDL=1.24*	"The interaction effects for HDL-C and TG/HDL-C indicate that beef intake decreased risk factors for the metabolic syndrome compared with similar intakes of TVP supplements." Beef change from baseline: +11 mg/dl TC[$] ↑ +3 mg/dl non-HDL[#,$] ↑
Mahon AK, et al. Protein intake during energy restriction: effects on body composition and markers of metabolic and cardiovascular health in postmenopausal women. J Am Coll Nutr **2007**; 26:182–189. *Supported by Cattlemen's Beef Board and the National Cattlemen's Beef Association (Centennial, CO), Agriculture*	3 energy restricted diets: lacto-ovo vegetarian basal diet plus 250 kcal/d of either beef (tenderloin), chicken or carbohydrate/fat foods; control group consumed their habitual	n=54 overweight/mildly obese, postmenopausal women	For all energy restricted diet subjects, fat mass, and fat-free mass similarly decreased. Loss in body mass was similar for chicken and beef	"Findings from this study support that overweight postmenopausal women can use a moderate-protein (25% of energy intake), poultry or beef-containing diet or a lower-protein (17% of energy intake) lacto-ovo

Research Program & Lynn Fellowships at Purdue University, and NIH R29 AG13409 PMCID:PMC2556253	diets; 9-week, weight loss study	*Baseline lipid values (mg/dL):* *Beef: TC=241, LDL=157, HDL=59* *Chicken: TC=218, LDL=141, HDL=50* *Carb: TC=284, LDL=161, HDL=73* *Control: TC=300, LDL=184, HDL=68*	groups, but significantly greater loss in fat mass than carbohydrate/fat foods and control groups. TC, LDL total and LDL similarly decreased with no differences among groups. *End of Study lipid values (mg/dL):* *Beef: TC=218, LDL=140, HDL=57* *Chicken: TC=198, LDL=125, HDL=50* *Carb: TC=240, LDL=141, HDL=61* *Control: TC=294, LDL=174, HDL=71*	vegetarian diet to lose weight and improve lipid-lipoprotein profile." Beef change from baseline: -23 mg/dl TC ↓ -12 mg/dl non-HDL[#] ↓
Leaf DA and Hatcher L. The effect of lean fish consumption on triglyceride levels. Phys Sports Med J **2009**; 37:37-43. *No support acknowledged* DOI:10.3810/psm.2009.04.1681	Cholesterol free (CF) diet (4 weeks) was followed by random assignment of a beef (276 g (9.73 oz.) 15% ground beef) or fish (lean fish) based diet in the context of a 25% or 40% fat background diet for 4 weeks; 20 weeks, cross-over design	n=10 non-smoking men and women with elevated lipids and discontinued lipid lowering meds 3 months prior to study *Baseline lipid values (mg/dL):* *TC=246* *LDL=149* *HDL=43*	Compared with a CF diet, both fish and beef raised plasma LDL but fish resulting in lower TG while beef increased HDL. These results were not influenced by background total fat. *End of Study lipid values (mg/dL):* *CF: TC=231, LDL=149, HDL=40* *Beef: TC=253, LDL=166. HDL=44* *Fish: TC=238, LDL=172, HDL=41*	"These findings can help practitioners to extend their dietary recommendations to incorporate significant quantities of low-fat fish to reduce triglyceride levels." Beef change from baseline: +7 mg/dl TC ↑ +6 mg/dl non-HDL[#] ↑
Adams TH, et al. Hamburger high in total, saturated and trans-fatty acids decreases HDL cholesterol and LDL particle diameter, and increases TAG, in mildly hypercholesterolaemic men. Br J Nutr **2010**; 103:91-8. *Supported in part by a grant by Yama Beef Inc., Mabank, TX, USA, Texas Agricultural Experiment grant no. 5027-04.* DOI:10.1017/S0007114509991516	114 g (4.02 oz.) high saturated fat (SFA) vs. high monounsaturated (MUFA) ground beef (35%/65%) patty; 5 per week for 5 weeks; 3-week habitual diet; additional 5-week; cross-over design	n=10 mildly hypercholesterolaemic men; 30-60 yrs.	Relative to habitual levels and levels during the high-MUFA phase, the high-SFA hamburger: decreased HDL and LDL particle diameter percentile distributions (P,0·05);	"Finally, we cannot discern from the present study design whether the high-MUFA hamburger reversed the effects of the high-SFA hamburger, or whether the subjects gradually adapted to the elevated intake of total fat. It is clear, however, that the high-MUFA hamburger did not exacerbate

			and had no effect on LDL cholesterol.	any of the effects of the high-SFA hamburger and can be viewed as at least neutral in its effects on HDL-C and TAG.”
		Baseline lipid values (mmol/L): *TC[&]=5.41* *LDL=3.57* *HDL=1.02*	*End of Study lipid values (mmol/L):* *High SFA: TC=5.12[&];* *LDL=3.31, HDL=0.88* *High MUFA: TC=5.2[&];* *LDL=3.60, HDL=1.06*	Average beef change from baseline: -9.6 mg/dl TC[$] ↓ -8 mg/dl non-HDL[#,$] ↓
Gilmore LA, et al. Consumption of High-Oleic Acid Ground Beef Increases HDL-Cholesterol Concentration but Both High- and Low-Oleic Acid Ground Beef Decrease HDL Particle Diameter in Normocholesterolemic Men. J. Nutr. **2011**; 141: 1188–1194. *Supported in part by the Beef Checkoff through the National Cattlemen’s Beef Association.* DOI:[10.3945/jn.110.136085](https://doi.org/10.3945/jn.110.136085)	114 g (4 oz.) low MUFA vs. high MUFA ground beef (25%/75%) patty; 5 per week for 5 weeks; 4-week habitual diet; additional 5-week; cross-over design	n=27 free-living, normocholesterolemic men; 23-60 yrs.	Ground beef interventions had no effect on TC or LDL. High MUFA ground beef significantly increased HDL from baseline.	“We now demonstrate that high-MUFA ground beef increases HDL-C concentration, but both high- and low-MUFA ground beef depress HDL2 and HDL3 particle diameters.” “It also is not known at present if decreased HDL2 and HDL3 diameter is indicative of elevated or reduced risk for CVD.”
		Baseline lipid values (mmol/L): *TC=4.73* *LDL=3.04* *HDL=1.17*	*End of Study lipid values (mmol/L):* *Low MUFA: TC=4.64,* *LDL=2.95, HDL=1.20* *High MUFA: TC=4.76,* *LDL=3.01, HDL=1.24*	Average beef change from baseline: -1.5 mg/dl TC[$] ↓ -3.6 mg/dl non-HDL[#,$] ↓
Mateo-Gallego, R et al., Effect of lean red meat from lamb v. lean white meat from chicken on the serum lipid profile: a randomised, cross-over study in women. Br J Nutr **2012**; 107:1403–1407. *This study was supported in part by a grant PET2009-0000I-C03 from Ministerio de Ciencia e Innovacio´n, Spain. CIBEResp and CIBERobn are initiatives of ISCIII, Spain.* DOI:[10.1017/S0007114511004545](https://doi.org/10.1017/S0007114511004545)	125 g (4.4 oz.) of lean red meat (leg and shoulder from the lamb of Rasa Aragonesa breed or lean white meat (chicken breast or leg) three times per week; 5 weeks, cross-over design	n=36 non-smoking nuns; 33-79 yrs.	Neither diet resulted in TC or LDL changes, but both significantly decreased HDL from baseline.	“In conclusion, consumption of lean red meat (lamb) or lean white meat (chicken) as part of the usual diet is associated with a similar lipid response. These two foods can be exchanged in a healthy diet to increase palatability.”
		Baseline lipid values (mg/dL): *TC=194* *LDL=116* *HDL=55*	*End of Study lipid values (mg/dL):* *Lamb: TC=195,* *LDL=119, HDL=53* *Chicken: TC=195,* *LDL=119, HDL=52*	Red meat change from baseline: +1 mg/dl TC[$] ↑ +3.5 mg/dl non-HDL[#,$] ↑
Murphy KJ, et al. Effects of Eating Fresh Lean Pork on Cardiometabolic Health Parameters. Nutrients **2012**; 4:711-723.	150 g (5.3 oz.) servings of “fresh lean pork” from frozen pork comprising of lean steak, stir fry, diced, mince	n=164 overweight, non-smoking men and women; 18-65 yrs.	There were no changes over time in any cardiovascular (CV) or metabolic	“In summary, this pilot study demonstrated that regular inclusion of lean fresh pork in the diet in place of other meats may improve body

This study was funded by Australian Pork Ltd. and the Pork Co-operative Research Centre (Roseworthy, SA, Australia), an Australian Government funding initiative. DOI:10.3390/nu4070711	and sausages, 5-7 servings per week in habitual diet; controls maintained their habitual diet; 6 months, parallel study design	*Baseline lipid values (mmol/L):* *Pork: TC=5.6, LDL=3.7, HDL=1.3* *Control: TC=5.8, LDL=3.7, HDL=1.4*	parameters measured in either the pork or control groups. *End of Study lipid values (mmol/L):* *Pork: TC=5.5, LDL=3.6, HDL=1.3* *Control: TC=5.6, LDL=3.6, HDL-1.3*	composition without adversely affecting risk factors for diabetes and CV disease." Red meat change from baseline: -3 mg/dl TC$^{\$}$ ↓ -3 mg/dl non-HDL$^{\#,\$}$ ↓
Roussell MA, et al. Beef in an Optimal Lean Diet study: effects on lipids, lipoproteins, and apolipoproteins. Am J Clin Nutr **2012**; 95:9-16 *Supported by the Beef Checkoff Program and the General Clinical Research Center, Pennsylvania State University (NIH grant M01RR10732).* DOI:10.3945/ajcn.111.016261	Healthy American Diet (HAD) 20 g (0.7 oz.) beef vs. Dietary Approaches to Stop Hypertension (DASH) 28 g (0.98 oz.) beef vs. Beef in an Optimal Lean Diet (BOLD) 113 g (3.98 oz.) beef vs. Beef in an Optimal Lean Diet plus additional protein (BOLD+) 153 g (5.39 oz.) beef; 5-week dietary interventions, crossover design	n=36 hypercholesterolemic adults; 30-65 yrs. *Baseline lipid values (mg/dL):* *TC=211* *LDL=139* *HDL=52*	Compared to control, all treatment diets decreased TC and LDL equally. *End of Study lipid values (mg/dL):* *HAD: TC=203, LDL=133, HDL=51* *DASH: TC=193, LDL=125, HDL=47* *BOLD: TC=193, LDL=125, HDL=48* *BOLD+: TC=192, LDL=125, HDL=47*	"Low-saturated fat, heart-healthy dietary patterns that contain lean beef elicit favorable effects on cardiovascular disease lipid and lipoprotein risk factors that are comparable to those elicited by a DASH dietary pattern." Average beef change from baseline: -18.5 mg/dl TC$^{\$}$ ↓ -14 mg/dl non-HDL $^{\#,\$}$ ↓
Gilmore LA, et al. Exercise attenuates the increase in plasma monounsaturated fatty acids and high-density lipoprotein cholesterol but not high-density lipoprotein 2b cholesterol caused by high-oleic ground beef in women. Nutr Res **2013**; 33:1003-1011. *This research was funded, in part, by a grant from HeartBrand Beef, Yoakum, TX.* DOI:10.1016/j.nutres.2013.09.003	114 g (4 oz.) ground beef patties (Low MUFA from pasture-fed cattle, High MUFA from grain-fed cattle), 5 per week for two 6-week periods separated by a 4-week washout (habitual diet) period; cross-over design	n=17 postmenopausal women *Baseline lipid values (mmol/L):* *TC=4.89*$^{\&}$ *LDL=3.07* *HDL=1.51*	NS increase in LDL from baseline in response to ground beef; significant increase in HDL from baseline from Hi MUFA ground beef. *End of Study lipid values (mmol/L):* *Low MUFA: TC=5.13*$^{\&}$*,* *LDL=3.19, HDL=1.60* *High MUFA: TC=5.2*$^{\&}$*,* *LDL=3.23, HDL=1.62*	"In conclusion, this study duplicated the ability of a single session of aerobic, intense exercise to increase HDL-C concentrations in postmenopausal women. In addition, high oleic acid ground beef increased HDL-C concentrations, as seen in previous studies from our laboratory." Average beef change from baseline: +10.5 mg/dl TC$^{\$}$ ↑

				+6 mg/dl[#,$] ↑
Grieger JA, et al. Investigation of the effects of a high fish diet on inflammatory cytokines, blood pressure, and lipids in healthy older Australians. Food Nutr Res **2014**; 58:20369. *This work was supported by the Australian Seafood Corporate Research Centre.* DOI:[10.3402/fnr.v58.20369](10.3402/fnr.v58.20369)	8 servings of mixed fish per fortnight (FISH) or 8 servings of red meat (lean, raw, beef scotch fillet, frozen veal schnitzel, lean, raw lamb rump, ham deli meat, 10% fat, beef mince, pork loin chop, frozen beef satay convenience meal) per fortnight) (CONTROL); 8-week randomized controlled, parallel study	n=80 older men and women (39, 41); 64-85 yrs. *Baseline lipid values (mg/dL):* *FISH: TC=213, LDL=124, HDL=66* *BEEF CONTROL: TC=213, LDL=128, HDL=62*	There was no effect of diet allocation on serum cytokines (associated chronic inflammation), blood pressure or lipids. *End of Study lipid values (mg/dL):* *FISH: TC=217, LDL=131, HDL=70* *BEEF CONTROL: TC=209, LDL=124, HDL=66*	"There was no effect of diet allocation on blood pressure or lipids." Red meat change from baseline: -4 mg/dl TC ↓ -8 mg/dl non-HDL[#] ↓
Daly RM, et al. Protein-enriched diet, with the use of lean red meat, combined with progressive resistance training enhances lean tissue mass and muscle strength and reduces circulating IL-6 concentrations in elderly women: a cluster randomized controlled trial. Am J Clin Nutr **2014**; 99:899-910 *Supported by Meat and Livestock Australia Ltd* DOI:10.3945/ajcn.113.064154	~160 g (5.64 oz.) cooked lean red meat 6 d/wk. (meat group) or ≥1 serving pasta or rice/d (control); 4 months, combined with resistance training	n=100 women; 60–90 yrs. *Baseline lipid values (mg/dL):* *Meat group: TC=211, LDL=131, HDL=58* *Control group: TC=215, LDL=130, HDL=62*	Total and LDL cholesterol improved for both groups. *End of Study lipid values (mg/dL):* *Meat group: TC=201, LDL=124, HDL=57* *Control group: TC=206, LDL=122, HDL=61*	"Although the quantity and frequency of red meat consumed by the women in our study was more than that currently recommended by dietary guidelines for older Australians, there was no indication that this dose increased inflammation or the saturated fat intake or negatively influenced kidney function, blood pressure, or blood lipid concentrations." Red meat change from baseline: -10 mg/dl TC ↓ -9 mg/dl non-HDL[#] ↓
Hill AM, et al. Type and amount of dietary protein in the treatment of metabolic syndrome: a randomized controlled trial. Am J Clin Nutr **2015**; 102:757-70 *Supported by The Beef Checkoff and the General Clinical Research Center, The Pennsylvania State University (NIH grant M01RR10732).* DOI:10.3945/ajcn.114.104026	Modified Dietary Approaches to Stop Hypertension (m-DASH) 12 g (0.42 oz.), Beef in an Optimal Lean Diet (BOLD) 139 g (4.9 oz.), Beef in an Optimal Lean Diet plus additional protein (BOLD+) 196 g (6.9 oz.), and baseline Healthy American Diet	n=62 overweight and obese men and women (28, 34) with MetS; 30-60 yrs.	At baseline, all groups had a MetS prevalence of 80–90%, which decreased significantly to 50–60% after weight loss phase.	"Weight loss was the primary modifier of MetS resolution in our study population regardless of protein source or amount. Our findings demonstrate that heart-healthy weight-loss dietary patterns that emphasize either animal or plant protein improve MetS criteria similarly."

	(HAD) with 40 g (1.41 oz.) lean beef, dietary interventions; 5-week weight maintenance followed by 6-week weight loss phase	*Baseline lipid values (mg/dL):* *m-DASH: TC=198, LDL=126, HDL=36* *BOLD: TC=198, LDL=126, HDL=38* *BOLD+: TC=191, LDL=118, HDL=40*	*End of Study (after weight loss phase) lipid values (mg/dL):* *m-DASH: TC=182, LDL=115, HDL=37* *BOLD: TC=183, LDL=115, HDL=39* *BOLD+: TC=169, LDL=103, HDL=37*	Average beef change from baseline: -18.5 mg/dl TC ↓ -17.5 mg/dl non-HDL# ↓
Thorning TK, et al. Diets with high-fat cheese, high-fat meat, or carbohydrate on cardiovascular risk markers in overweight postmenopausal women: a randomized crossover trial. Am J Clin Nutr **2015**; 102:573–81. *Supported 50% by the Danish Dairy Research Foundation and the Danish Agriculture and Food Council (Denmark) and 50% by the Dairy Research Institute (United States), the Dairy Farmers of Canada (Canada), the Centre National Interprofessionel de l'Economie Laitie`re (France), Dairy Australia (Australia), and the Nederlandse Zuivel Organisatie (Netherlands)* DOI:10.3945/ajcn.115.109116	240 g (8.46 oz.) high-fat red (beef and pork) and processed meat per day vs. high cheese or high carbohydrate diet; 2-week intervention with a 2-week washout, cross-over design	n=14 overweight, postmenopausal women; 45-68 yrs. *Baseline lipid values (mmol/L):* *Cheese: TC=5.98, LDL= 3.64, HDL=1.56* *Carb: TC=6.21, LDL=3.86, HDL=1.53* *Meat: TC=6.23, LDL=3.84, HDL=1.55*	HDL declined from baseline for all diets. The CHEESE diet caused a 5% higher HDL than the CARB diet. Also, the MEAT diet caused an 8% higher HDL than the CARB diet. There were no differences between CHEESE and MEAT diets in HDL. There were no significant differences between diets in TC or LDL although both declined for all treatments from baseline. *End of Study lipid values (mmol/L):* *Cheese: TC=5.79, LDL=3.58, HDL=1.39* *Carb: TC=5.74, LDL=3.68, HDL=1.30* *Meat: TC=5.96, LDL=3.82, HDL=1.42*	"Diets with cheese and meat as primary sources of SFAs cause higher HDL cholesterol and apo A-I and, therefore, appear to be less atherogenic than is a low-fat, high-carbohydrate diet." Red meat diet change from baseline: -21 mg/dl TC ↓ -16 mg/dl non-HDL# ↓
Li J, et al. Effects of dietary protein source and quantity during weight loss on appetite, energy expenditure, and cardio-metabolic responses. Nutrients **2016**; 8:63. *This study was jointly funded by the Beef Checkoff and the National Pork Board. Additional support was provided by the National Institutes of Health Indiana Clinical and Translational Sciences Institute, funded in part by grant UL1TR001108.* DOI:10.3390/nu8020063	10%, 20%, or 30% of energy from protein (predominant protein source- lean beef/pork (OMV) vs. soy/legume (LOV)); 4-week energy restricted dietary interventions, crossover design	n=34 overweight and obese men and women (11, 23); ≥21 yrs. *Baseline lipid values (mg/dL):* *OMV: TC=186, LDL=112, HDL=50*	20% and 30% protein diets reduced cholesterol measures. *End of Study lipid values (mg/dL):* *OMV: 10%: TC=164, LDL=94, HDL=44;*	"diets varying in protein quantity with either beef/pork or soy/legume as the predominant source have minimal effects on appetite control, energy expenditure and cardio-metabolic risk factors during energy restriction-induced weight loss." Average red meat change from baseline:

		LOV: TC=176, LDL=102, HDL=53	*20%: TC=151, LDL=89, HDL=40;* *30%: TC=154, LDL=92, HDL=42* *LOV: 10%: TC=149, LDL=83, HDL=44;* *20%: TC=145, LDL=81, HDL=44;* *30%: TC=143, LDL=82, HDL=44*	-30 mg/dl TC ↓ -22 mg/dl non-HDL[#] ↓
Sayer RD, et al. Equivalent reductions in body weight during the Beef WISE Study: beef's role in weight improvement, satisfaction and energy. Obes Sci Prac **2017**; 3:298-310. *The Beef Checkoff, National Heart, Lung, and Blood Institute (grant #: T32 HL116276, an institutional postdoctoral training grant for Dr. Sayer), The National Center for Research Resources that supports the Colorado Clinical and Translational Science Institute (grant #: UL1 RR025780), and the National Institute of Diabetes and Digestive and Kidney Diseases, Colorado Nutrition Obesity Research Center (P30 DK48520).* DOI:10.1002/osp4.118	High protein diet (HP) ≥4 weekly servings of lean beef (B), or HP diet restricted in all red meats (NB); 16-week, weight loss intervention	n=120 overweight or obese men and women (21, 99); 18-50 yrs. *Baseline lipid values (mg/dL):* *Beef: TC=169, LDL=101, HDL=45* *Non-beef: TC=167, LDL=98, HDL=48*	Similar improvements in total cholesterol, LDL, triglycerides, systolic BP and diastolic BP for all subjects. *End of Study lipid values (mg/dL):* *Beef: TC=156, LDL=93, HDL=46* *Non-beef: TC=153, LDL=89, HDL=47*	"Results of this study demonstrate that high protein diets – either rich or restricted in red meat intakes – are effective for decreasing body weight (especially body fat) and improving cardiometabolic health." Beef change from baseline: -13 mg/dl TC ↓ -14 mg/dl non-HDL ↓
O'Connor LE, et al. A Mediterranean-style eating pattern with lean, unprocessed red meat has cardiometabolic benefits for adults who are overweight or obese in a randomized, crossover, controlled feeding trial. Am J Clin Nutr **2018**; 108:33-40 *Funded in part by the Beef Checkoff, the Pork Checkoff, the National Institute of Health's Ingestive Behavior Research Center at Purdue University (5T32DK076540-08), and the National Institute of Health's Indiana Clinical and Translational Sciences Institute.* DOI:10.1093/ajcn/nqy075	Mediterranean Diet (MD) with 500 g (17.6 oz)lean, unprocessed beef or pork per week (Med-Red); MD with 200 g (7 oz) of the same (Med-Control); 5-week, cross-over with interim 4-week self-selected diet	N=41 overweight or obese men and women (13,28); 30-69 yrs *Baseline lipid values (mmol/L):* *Med-Red: TC=5.0, LDL=3.11, HDL=1.27* *Med-Control: TC=4.97, LDL=3.06, HDL=1.30*	TC and HDL decreased with both diets. LDL decreased only with Red-Med. No change in TG. *End of Study lipid values (mmol/L):* *Med-Red: TC=4.56, LDL=2.80, HDL=1.19* *Med-Control: TC=4.71, LDL=2.98, HDL=1.19*	"Adults who are overweight or moderately obese may improve multiple cardiometabolic disease risk factors by adopting a Mediterranean-style eating pattern with or without reductions in red meat intake when red meats are lean and unprocessed." Beef change from baseline: -17 mg/dL TC ↓ -3 mg/dL non HDL ↓

AHA – American Heart Association, BP – blood pressure, CHD – coronary heart disease, CHOL – cholesterol, CVD – cardio vascular disease, d – day, dL – decaliter, g – grams, HDL – high density lipoprotein, HDL-C – high density lipoprotein cholesterol, kcal – kilocalories, kg – kilogram, L – liter, LDL – low density lipoprotein, LDL-C – low density lipoprotein cholesterol, LRMs – lean red meats, MetS – measure of exercise tolerance before surgery, mg – milligrams, mmol – millimoles, MUFA – monounsaturated fatty acid, NCEP – National Cholesterol Education Program, NR – not reported, oz. – ounces, PUFA – polyunsaturated fatty acid, SFA – saturated fatty acid, TAG – triacylglycerol, TC – total cholesterol, TG – triglycerides, TVP – textured vegetable protein, VLDL – very low density lipoprotein, wk. – week, yrs. - years

*Info for beef type was not available for: Flynn 1981, Flynn 1982, O'Brien 1980, Sacks 1981; **Distribution of men, women; [#]calculated as TC-HDL (triglycerides not reported in several studies and/or only cholesterol values extracted for purposes of this table); [$]-converted from mmol/L to mg/dl to calculate average; [&] calculated from publication (HDL+LDL+VLDL)

Blood Pressure				
Sacks FM, et al. Effect of Ingestion of Meat on Plasma Cholesterol of Vegetarians. JAMA **1981** 246:640-644. https://www.ncbi.nlm.nih.gov/pubmed/7019459 *Support not acknowledged*	250-g (8.8 oz) portion of beef daily for 4 weeks preceded and followed by habitual vegetarian diet for 2 weeks; consecutive diets, no control group	n=21 healthy male and female (17,7) vegetarians; 20-55 year old *Data not extracted, available in figure only*	There were "small" but statistically significant increases in mean systolic BP and pulse rate during the meat stage (Figure). A decline to baseline levels followed the withdrawal of the meat from the diet. Diastolic BP did not change *Data not extracted, available in figure only*	"The study suggests an adverse effect of consumption of beef on plasma lipid and BP levels."
Yamashita, Y et al. Arterial compliance, blood pressure, plasma leptin, and plasma lipids in women are improved with weight reduction equally with a meat-based diet and a plant-based diet. Metabolism **1998** 47:1308-1314. DOI:10.1016/s0026-0495(98)90297-9 *Supported by grants from the Meat Research Corporation and National Heart Foundation of Australia, and in part by the Manpei Suzuki Diabetes Foundation*	150 g lean red meat (beef sirloin), at least 5 days per week. On the 2 remaining days, they consumed either fish or non-soy legumes. The plant-white meat plan consisted of soybean as the main source of protein, and subjects were encouraged to consume soy protein at least 5 days weekly and chicken, fish, and other legumes on the remaining days; 16 weeks, parallel design; weight loss diet	n= 36 women, mostly overweight or obese, aged 40 + 9 years *Baseline Mean Arterial Pressure (MAP; mm Hg):* *Meat:85* *Plant:88*	"MAP for both diet groups was significantly lower (7%) at 16 weeks versus baseline (P < .0001), but there was no significant effect of diet and no significant interaction between diet and time" *End of Study MAP (mm Hg):* *Meat:79* *Plant:81*	"…weight loss and the metabolic benefits of weight loss occurred equally with the meat-based and plant-based diets."
Hodgson JM, et al. Partial substitution of carbohydrate intake with protein intake from lean red meat lowers blood pressure in hypertensive persons. Am J Clin Nutr **2006**;83:780-7. *Supported by Meat and Livestock Australia Limited* DOI:10.1093/ajcn/83.4.780	Partial substitution of carbohydrates with protein from lean red meat (with counseling from dietitian); 8 wk study; parallel design	n=60 hypertensive adults *Baseline blood pressure (mmHg):* *Meat group: SBP-134, DBP-79* *Control group: SBP-138, DBP-77*	Compared to control group, protein group had lower clinical systolic blood pressure measurements *End of Study blood pressure (mmHg):* *Meat group: SBP-132, DBP-78* *Control group: SBP-140, DBP-78*	"We showed that modest substitution of carbohydrate intake from carbohydrate-rich foods… with protein intake from lean red meat results in a reduction in systolic BP in hypertensive persons."

Nowson CA, et al. Low-sodium Dietary Approaches to Stop Hypertension-type diet including lean red meat lowers blood pressure in postmenopausal women. Nutr Res **2009**;29:8–18. *The study was supported by the Meat & Livestock Australia.* DOI:10.1016/j.nutres.2008.12.002	Low-sodium DASH diets: 6 servings of 100 g cooked lean red meat/wk vs. control diet with ≤2 servings red meat/wk	n=95 women age 45-75y *Baseline blood pressure (mmHg):* Low-Na DASH: SBP-, DBP- Control: SBP-, DBP-	Low-sodium DASH diet led to lower SBP, no difference in DBP *End of Study blood pressure (mmHg):* Low-Na DASH: SBP-, DBP- Control: SBP-, DBP-	"We concluded that a low-sodium DASH diet with a low dietary acid load, which also included lean red meat on most days of the week, was effective in reducing BP in older women, particularly in those taking antihypertensive medications."
Grieger JA, et al. Investigation of the effects of a high fish diet on inflammatory cytokines, blood pressure, and lipids in healthy older Australians. Food Nutr Res **2014**;58:20369. *This work was supported by the Australian Seafood Corporate Research Centre.* DOI:10.3402/fnr.v58.20369	8-week randomized controlled, parallel study; FISH diet (8 servings of mixed fish/fortnight) or CONTROL diet (8 servings of red meat per fortnight)	n=80 older adults *Baseline blood pressure (mmHg):* FISH: SBP-126, DBP-69 CONTROL: SBP-126, DBP-67	There was no effect of diet allocation on serum cytokines (associated chronic inflammation), blood pressure or lipids *End of Study blood pressure (mmHg):* FISH: SBP-124, DBP-68 CONTROL: SBP-126, DBP-66	"There was no effect of diet allocation on blood pressure or lipids."
Roussell MA, et al. Effects of a DASH-like diet containing lean beef on vascular health. J Hum Hypertens **2014**;28:600-5 *This study was funded by The Beef Checkoff, and supported by the General Clinical Research Center, Pennsylvania State University (NIH Grant M01RR10732).* DOI:10.1038/jhh.2014.34	28g beef vs.113g beef vs. 153 g beef daily in a DASH-like dietary pattern and control (Healthy American Diet), 5wk dietary interventions; crossover design	n=36 normotensive adults *Baseline blood pressure (mmHg):* Males: SBP-124, DBP-72 Females: SBP-112, DBP-66 (*results were not separate by gender)	Compared to control, moderate protein diet with 153g beef/d significantly decreased systolic blood pressure *End of Study blood pressure (mmHg):* HAD: SBP-116, DBP-70 DASH: SBP-113, DBP-69 BOLD: SBP-114, DBP-69 BOLD+: SBP-111, DBP-69	"…a variety of protein sources including lean beef can also be used to increase total dietary protein in a heart-healthy diet as a strategy to reduce systolic blood pressure in normotensive individuals."
Daly RM, et al. Protein-enriched diet, with the use of lean red meat, combined with progressive resistance training enhances lean tissue mass and muscle strength and reduces circulating IL-6 concentrations in elderly women: a cluster randomized controlled trial. Am J Clin Nutr **2014**;99:899-910. *Supported by Meat and Livestock Australia Ltd* DOI:10.3945/ajcn.113.064154	~160g cooked lean red meat 6 d/wk or ≥1 serving pasta or rice/d; combined with resistance training for 4-months	n=100 women aged 60–90 y who were residing in 15 retirement villages *Baseline blood pressure (mmHg):* Meat group:SBP-137, DBP-75 Control group: SBP-135, DBP-74	Systolic blood pressure improved for both groups, no group effect *End of Study blood pressure (mmHg):* Meat group:SBP-130, DBP-72 Control group: SBP-131, DBP-74	"Although the quantity and frequency of red meat consumed by the women in our study was more than that currently recommended by dietary guidelines for older Australians, there was no indication that this dose increased inflammation or the saturated fat intake or negatively influenced kidney function, blood pressure, or blood lipid concentrations."

Hill AM, et al. Type and amount of dietary protein in the treatment of metabolic syndrome: a randomized controlled trial. Am J Clin Nutr **2015**;102:757-70. *Supported by The Beef Checkoff and the General Clinical Research Center, The Pennsylvania State University (NIH grant M01RR10732).* DOI:10.3945/ajcn.114.104026	12g (m-DASH), 139g (BOLD), 196g (BOLD+) lean beef in a modified DASH diet and baseline Healthy American Diet with 40g lean beef, dietary interventions: 5 wk weight maintenance followed by 6 wk weight loss phase	n=62 overweight adults with MetS *Baseline blood pressure (mmHg):* *m-DASH:SBP-127, DBP-86* *BOLD: SBP-122, DBP-85* *BOLD+: SBP-127, DBP-85*	At baseline, all groups had a MetS prevalence of 80–90%, which decreased significantly to 50–60% after weight loss phase *End of Study (after weight loss phase) blood pressure (mmHg):* *m-DASH: SBP-120, DBP-83* *BOLD: SBP-120, DBP-82* *BOLD+: SBP-120, DBP-82*	"Weight loss was the primary modifier of MetS resolution in our study population regardless of protein source or amount. Our findings demonstrate that heart-healthy weight-loss dietary patterns that emphasize either animal or plant protein improve MetS criteria similarly."
Sayer RD, et al. Equivalent reductions in body weight during the Beef WISE Study: beef's role in weight improvement, satisfaction and energy. Obes Sci Prac **2017**;3:298-310. *The Beef Checkoff, National Heart, Lung, and Blood Institute (grant #: T32 HL116276, an institutional postdoctoral training grant for Dr. Sayer), The National Center for Research Resources that supports the Colorado Clinical and Translational Science Institute (grant #: UL1 RR025780), and the National Institute of Diabetes and Digestive and Kidney Diseases, Colorado Nutrition Obesity Research Center (P30 DK48520).* DOI:10.1002/osp4.118	≥4 weekly servings of lean beef, following State of Slim weight management program for 16 week	n=99 overweight or obese adults *Baseline blood pressure (mmHg):* Beef: SBP-116, DBP-76 Non-Beef: SBP-117, DBP-77	Similar improvements in total cholesterol, LDL, triglycerides, systolic BP and diastolic BP for all subjects. *End of Study blood pressure (mmHg):* Beef: SBP-111, DBP-72 Non-Beef: SBP-109, DBP-72	"Results of this study demonstrate that high protein diets – either rich or restricted in red meat intakes – are effective for decreasing body weight (especially body fat) and improving cardiometabolic health."