

The Role of Meat in a Healthful Dietary Pattern: Evidence from Menu Modeling

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Abstract

Meat is an integral part of America's food culture, contributing high quality protein and essential nutrients, including iron, zinc, B vitamins, selenium, choline, and potassium. While meat consumption has increased in the US since the early 1900s, recent data suggests that it has peaked and consumption is falling. Dietary intake studies indicate that intake of protein foods is below recommended amounts for about 45% of Americans. Dietary guidance, beginning with the release of the first edition of the *Dietary Guidelines for Americans* in 1980, has consistently recommended meat that is lean. Americans currently eat an average of 3.9 ounces of meat, poultry and cured meat per day (2 years and older), which falls within the recommended daily intake levels of the 2010 Dietary Guidelines for Americans (DGA) United States Department of Agriculture (USDA) Food Pattern. The recent Scientific Report of the 2015 Dietary Guidelines Advisory Committee (DGAC) described dietary patterns associated with positive health outcomes for the US population as "lower in red and processed meat," however, there is no target reduction identified for meat. Menu models developed for this paper demonstrate that consumers can achieve healthful dietary patterns eating a variety of foods including meat, poultry, and processed meats. These menus provide adequate intakes of nutrients of concern and also meet current recommended limits for energy and over consumed nutrients (saturated fat, sodium). Recognizing that many Americans enjoy red and processed meats, recommendations that limit or restrict this protein-and nutrient-rich food may threaten the acceptance and implementation of future Dietary Guidelines. Continued promotion and education pertaining to lean meats has the potential to motivate behavior change and increase success in achieving overall healthful dietary patterns.

Introduction

Meat has comprised a substantial proportion of the diet dating back to early civilizations, serving as an important source of energy and nutrients while providing taste and satisfaction. Today, meat is an integral part of our food culture, contributing high quality protein and essential nutrients, including iron, zinc, B vitamins, selenium, choline, and potassium [1]. Consumer research suggests that almost all Americans eat meat; according to a 2012 Gallup Poll, about 5% of American adults (n=1,014) consider themselves vegetarian, largely unchanged from 6% in 1999 and 2001 [2]. Intake data from What We Eat in America (WWEIA) 2011-2012 indicates that Americans 2 years and over consume on average 3.9 ounces (oz) of meat, poultry and cured meat per day, representing 69% of total Protein Food Group intake, and ranging from 3.1 oz per day for adult females to 5.2 oz for adult males (Table 1) [3]. These intake levels fall within the 2010 Dietary Guidelines for Americans (DGA) US Department of Agriculture (USDA) Food Pattern recommended daily intake of 5.5 ounce equivalents (oz eq) of Protein Foods for a 2,000-calorie diet [4].

The recent Scientific Report of the 2015 Dietary Guidelines Advisory Committee (DGAC) described dietary patterns associated with positive health outcomes for the US population as "lower in red and processed meat," with little recognition of the role of lean meat as an important source of protein, iron, and other essential nutrients [5]. However, recommended daily meat servings in the proposed DGAC Healthy US-Style Pattern and Healthy Mediterranean-Style Pattern are unchanged from the 2010 DGA, suggesting there is no target reduction for red and processed meats. Two USDA Food Patterns (Healthy US-Style and Healthy Mediterranean-Style) include 12.5 oz eq per week (1.8 oz eq per day) of meat and 10.5 oz eq per week (1.5 oz eq per day) of poultry. Both categories include fresh and processed meats according to USDA Item Clusters and Representative Foods [5].

Varied choices of fresh and processed meats can serve as anchors

in a healthful diet. Pairing of meat with whole grains, vegetables, fruits, and low-fat or non-fat dairy may help to increase servings of these under consumed food groups. Processed meats include meat and poultry products that have been changed from their original state by at least one processing or preparation step (Table 2). The purpose of this paper is to demonstrate that a variety of meats can be part of a healthful dietary pattern and play an important role in meeting nutrient needs for all ages. USDA Healthy Food Patterns, as outlined in the 2010 DGA and in the 2015 DGAC Report reinforce the role of meat, poultry, and seafood as part of a healthy dietary pattern rich in vegetables, fruits, whole grains, and dairy. Evidence-based dietary patterns identified in the 2015 DGAC Report suggest that there is more than one approach to consuming a healthful diet, with introduction of a Healthy Mediterranean-Style Pattern based on evidence that Mediterranean-style diets with higher amounts of fruit, seafood and red/processed meats offer health benefits [5]. Menu models (Table 3) that illustrate how real foods fit into USDA/MyPlate food patterns, demonstrate that meat and poultry, including red and processed meats, can meet current energy and nutrient recommendations, including nutrients of concern, and fall within limits for over consumed nutrients (saturated fat,

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	Current Intakes, oz/d (WWEIA 2001-2012)			% Contribution from WWEIA Food Categories (2009-2010)			Food Pattern Recommendation
	Ages 2+	Males 20+	Females 20+	Calories	Saturated Fat	Sodium	2015 DGAC (2000 calorie)
Meat	1.56	2.26	1.19	2.12%	3.33%	2.10%	12.5 oz/wk (1.8 oz/d)
Poultry	1.37	1.71	1.18	3.31%	3.33%	4.41%	10.5 oz/wk (1.5 oz/d)
Cured Meat	0.98	1.27	0.74	1.32%	2.85%	3.18%	--
Total Meat, Poultry, Cured Meat	3.9	5.24	3.11	6.75%	9.50%	9.69%	23 oz/wk ((3.3 oz/d)
Total Protein Foods	5.7	7.59	4.82	11%	15.03%	14.06%	5.5 oz/d

Table 1: Current Intakes, Contributions, and Recommendations for Meat, Poultry, and Cured Meats.

Lean meat	Defined by the USDA, a serving of meat qualifies as “lean” if it contains 4.5 grams or less of saturated fat, less than 10 grams of total fat, and less than 95 milligrams of cholesterol per 100 grams (3.5 ounces) [54]
Processed meat	A broad category of meat and poultry products that have undergone at least one further processing or preparation step that changes the appearance, texture, or taste, such as grinding, adding an ingredient, or cooking. Processed meats may be ready-to-cook or ready-to-eat. Variations in formulations can allow for lean or low-fat and low sodium products, among other choices.
Red meat	No universal definition exists, but generally includes meat from livestock (beef, veal, pork, and lamb) that contain higher levels of myoglobin, a protein that holds oxygen in the muscle and gives meat its reddish color. Red meat may be fresh or processed.
Cured meat	Meat pieces are treated with small amounts of nitrite, either as dry salt or as salt solution in water, to impart a characteristic pink color and distinct taste. Cured meat is primarily consumed as cooked meat, but certain regional products may be raw.
Smoked meat	Meat is flavored, cooked, and preserved by exposing it to smoke from burning or smoldering material, most often wood, or through application of liquid smoke during thermal processing.
Dried meat	Dried meat products are the result of the simple drying of lean meat in natural conditions or in an artificially created environment to meet specific water activity levels.

Table 2: Types of Meats Defined.

sodium). The menu models provide realistic examples that show how consumers can achieve healthy dietary patterns with a variety of foods.

Meat and protein food recommendations and consumption

Since their introduction in the early 1900s, all USDA Food Guides have included a group for meat and protein foods. Although serving guidance has evolved, lean meat was recognized as early as 1930 in food group recommendations [6]. Consumer messaging to “Go lean with protein,” first introduced in the 2005 DGA, has resonated with Americans, promoting greater awareness of lean meat in a healthful diet as well as greater availability of lean meat options [7]. Greater availability of lean meat and processed meat in portion-controlled packaging and reduced fat or reduced sodium options make it possible to include meats in a healthful eating pattern consistent with public health recommendations [8]. The 2010 DGA emphasize “high quality protein” as the preferred source, but provide little guidance on specific criteria to categorize protein quality [4], which is determined by its essential amino acid (EAA) content, unique amino acid profile, and the digestibility of each EAA in the protein [9].

Dietary guidance, beginning with the release of the first edition of the Dietary Guidelines for Americans in 1980, has consistently recommended consumption of meat that is lean. This has been reinforced by enduring guidance to choose diets lower in total fat, saturated fat, cholesterol, and sodium. In 2000, guidance for total fat was modified to choosing a diet moderate in total fat. The meat industry has responded to the demand for leaner meats with improved breeding and feeding practices, and advanced trimming and processing to help lower fat and sodium content. For example, 66% of beef cuts sold at retail qualify as “lean” (when cooked and trimmed), and sirloin steak now contains 34% less fat than it did in the 1960s [7]. Nutrition education and advice to choose lean meat has been shown to be effective with shoppers, putting greater emphasis on leaner cuts and portion control [8].

Myriad changes over the last century have influenced meat consumption trends, including rising incomes and trade, improved

understanding of nutrition and health, new technologies and product development, agricultural policies, and changing social norms [10]. Since the early 1900s, when food availability data was first collected, overall meat consumption has increased [11]. However, USDA data suggests that meat consumption has peaked with recent loss-adjusted food availability data indicating that per capita annual meat consumption fell from a high of 146 pounds in 2004 to 132 pounds in 2012 [12]. From 1970 to 2012, an overall downward trend included a 26% reduction in red meat consumption (beef, veal, pork, and lamb), decreasing from 4.2 oz to 3.1 oz per day, with doubled intakes of poultry, increasing from 1.2 oz to 2.4 oz per day [12]. Nutrient availability data, including protein, iron, zinc, and B vitamins, per capita per day in meat and poultry available for consumption over the past decade, and the percentage contributions of these nutrients from meat and poultry, are consistent with these trends [13].

The 2015 DGAC Report recognizes that lean meats can be part of a healthy dietary pattern as shown by USDA Healthy Food Pattern modeling [5]. Consumption data indicates that Americans are currently consuming amounts of meat consistent with the 2010 Dietary Guidelines and the proposed 2015 DGAC Food Patterns, which are based on intake data from WWEIA 2009-2010 (Table 1). According to WWEIA 2011-2012, average intakes of meat, poultry, and cured meats remain within the daily recommended intake of Protein Foods of 5.5 oz/day, which also includes seafood, eggs, nuts and seeds, and are comparable to the proposed USDA Healthy US-Style Food Pattern for 2,000 calories at 26 oz per week (3.7 oz/day) of meat, poultry, and eggs. For adult females 20 years and over, total intake of meat, poultry, and cured meat is below the 2015 DGAC Healthy US-Style Food Patterns recommendation of 23-28 oz/week (3.3-4 oz/day) proposed for calorie levels ranging from 1,600-2,200; and for adult males, intakes are proportionate to higher energy needs and slightly above the allowance of 31-33 oz/week (4.4-4.7 oz/day) proposed for 2,400-3,000 calories [5].

According to the 2015 DGAC Report, meat, poultry, and cured meats together contribute 6.75% of energy, 9.5% of saturated fat, and 9.7% of sodium intakes in the US population ages 2 and older (data

Meal	Menu: Day 1	Nutrient	Daily Total ¹	% Daily Value ²
Breakfast	1 packet instant oatmeal made with: 1 cup fat-free milk 2 tbsp raisins 1 ½ tbsp brown sugar 1 cup orange juice	Calories	1,991	-
		Total fat (g)	65	100%
		Saturated fat (g)	14	68%
		Trans fat (g)	0	-
		Cholesterol (mg)	91	30%
Lunch	1 turkey hot dog 1 whole wheat hot dog bun ½ tsp yellow mustard 16 multigrain chips 1 cup fresh strawberry halves 12 fl oz sweetened tea	Sodium (mg)	2,412	100%
		Potassium (mg)	3,606	103%
		Protein (g)	75	-
		Carbohydrates (g)	293	98%
		Total sugars (g)	165	-
		Dietary Fiber (g)	28	111%
		Vitamin A (IU)	8,463	169%
		Vitamin C (mg)	284	474%
Dinner	Chef's salad made with: 2 cups mixed baby greens ¼ medium red onion ½ medium tomato, chopped 2 oz turkey breast luncheon meat 1 ½ oz Swiss cheese, shredded 1 tbsp olive oil 1 tbsp balsamic vinegar 2 oz whole wheat dinner roll Water	Vitamin D (IU)	250	63%
		Calcium (mg)	1,500	150%
		Iron (mg)	17	96%
		Food Groups¹	Amount	% of goal
		Grains	6.1 oz	102%
		Vegetables	2.6 cups	104%
Snack	1 oz dry roasted, unsalted almonds 1 cup non-fat fruit yogurt with 2 tbsp granola	Fruits	2.3 cups	115%
		Milk Products	3 cups	100%
		Proteins	5.6 oz	102%

Meal	Menu: Day 2	Nutrient	Daily Total ¹	% Daily Value ²
Breakfast	1 whole wheat English Muffin 2 tbsp creamy peanut butter 1 cup cantaloupe pieces	Calories	1,982	-
		Total fat (g)	66	100%
		Saturated fat (g)	14	70%
Snack	1 container (5.3 oz) blueberry nonfat Greek yogurt 2 tbsp slivered almonds	Trans fat (g)	0	-
		Cholesterol (mg)	281	94%
		Sodium (mg)	2,309	96%
Lunch	Spinach salad made with: 2 ½ cups baby spinach 2 slices bacon, broiled 1 large hard-boiled egg ¼ cup sliced mushrooms ¾ cup Mandarin oranges ¼ cup croutons 2 tbsp honey mustard dressing 1 cup fat-free milk	Potassium (mg)	3,597	103%
		Protein (g)	95	-
		Carbohydrates (g)	243	81%
		Total sugars (g)	127	-
		Dietary Fiber (g)	27	108%
		Vitamin A (IU)	14,751	295%
		Vitamin C (mg)	142	237%
		Vitamin D (IU)	343	86%
		Calcium (mg)	1,538	150%
		Iron (mg)	13	72%
Dinner	Spaghetti and meatballs: 1 cup whole grain spaghetti, cooked ½ cup spaghetti sauce 2 oz meatballs (beef and pork) 2 tbsp grated Parmesan ½ cup green beans 4 fl oz red wine	Food Groups¹	Amount	% of goal
		Grains	6 oz	100%
		Vegetables	2.7 cups	108%
		Fruits	1.9 cups	95%
Snack	4 graham cracker squares Chocolate milk made with: 1 ½ cups fat-free milk 2 tbsp chocolate syrup	Milk Products	3.5 cups	116%
		Proteins	5.7 oz	104%

Meal	Menu: Day 3	Nutrient	Daily Total ¹	% Daily Value ²
Breakfast	1 grapefruit Breakfast sandwich made with: 1 large egg, fried 2 oz Canadian bacon 1 4-inch plain bagel	Calories	1,961	-
		Total fat (g)	36	55%
		Saturated fat (g)	10	50%
		Trans fat (g)	0	-
Snack	1 granola bar with fruit and nuts	Cholesterol (mg)	327	109%
		Sodium (mg)	2,259	94%
Lunch	1 medium baked potato topped with: ¼ cup reduced sodium black beans, canned 1 oz part-skim mozzarella, shredded Side salad made with: 1 cup mixed greens ¼ cup cherry tomatoes 1 tsp olive oil 1 tsp balsamic vinegar 4 low-sodium whole wheat crackers 1 ½ cup fat-free milk	Potassium (mg)	4,198	120%
		Protein (g)	102	-
		Carbohydrates (g)	316	105%
		Total sugars (g)	110	-
		Dietary Fiber (g)	27	108%
		Vitamin A (IU)	8,779	176%
		Vitamin C (mg)	190	317%
		Vitamin D (IU)	338	85%
		Calcium (mg)	1,319	110%
		Iron (mg)	14	78%
Dinner	Stir-fry made with: 3 oz skinless, boneless chicken breast ¼ cup broccoli ¼ cup sliced carrots ¼ cup sliced onion ¼ cup sliced mushrooms 1 tsp canola oil 1 tsp low-sodium soy sauce 1 cup cooked white rice Water	Food Groups¹	Amount	% of goal
		Grains	7 oz	116%
		Vegetables	3.5 cups	140%
		Fruits	2 cups	100%
		Milk Products	3.1 cups	103%
		Proteins	6 oz	109%
		Snack	Chocolate pudding made with 1 cup fat-free milk 1 medium apple	Grains
Vegetables	3.5 cups			140%

¹ Data derived from menu analysis using The Food Processor, version 10.15.0 (ESHA Research, Salem, Oregon).

² Percent Daily Value (DV) are based on a 2,000 calorie diet.

Table 3: Menu Models with Meat Based on Healthy U.S.-Style Pattern, 2,000 Calories.

derived from WWEIA 2009-2010) [5]. However, this does not include meat and poultry consumed in burgers, tacos, sandwiches, and mixed dishes, which contribute heavily to intakes of energy, saturated fat, and sodium, but also contribute other food groups and nutrients including grains, vegetables, and dairy foods, as well as under consumed nutrients (fiber, calcium, potassium, and vitamin D). Total beef consumption contributes 5% of the calories and 10% or less of total fat and saturated fat in the US diet [1]. Consumption of lean pork contributes 3% of total energy, fat, and saturated fat, and 10% of total protein intake in the diets of lean pork consumers [14]. Data on other meats and poultry are not available. Recent consumption data and scientific evidence suggest that inclusion of red meat and processed meat at current intake levels is associated with positive health outcomes and improved diet quality [15]. Results from clinical trials reveal that lean red meat can be included in a cholesterol-lowering diet that reduces risk for cardiovascular disease [16,17].

Meal patterns with meats

Menu models using the 2010 USDA Food Pattern for a 2,000 calorie diet illustrate that menus incorporating commonly consumed foods and meals, including red and processed meats and foods eaten away from home, meet daily Myplate and energy goals, adhere to limits for saturated fat and sodium, and meet or exceed needs for key nutrients including nutrients of concern (Table 3). This modeling reinforces guidance emphasizing proper portion sizes and smart choices within food groups to build an overall eating pattern consistent with dietary guidance. Meats paired with other food groups, such as in sandwiches, salads, soups, and stews, can help increase intakes of whole grains, vegetables, and low-fat dairy. Research examining red meat consumption indicates that higher vegetable consumption is associated with eating meat [18].

Updated 2015 USDA Food Patterns at 12 calorie levels, using the most current food composition and food intake data available, meet nearly all nutritional goals for adequacy with the exception of potassium, vitamin D, vitamin E, and choline in almost all patterns [5]. Daily nutrient totals for the menu models indicate that most all nutrient goals were met within 75% of daily goals, illustrating that realistic menus consistent with USDA food patterns are attainable with a variety of popular food choices, including whole and convenience foods.

Nutrient contributions of meats

Meats make important nutrient contributions that if lowered in dietary patterns may result in unintended consequences of nutrient inadequacy, lower diet quality, and reduced compliance. Meats, including red meat, poultry, and processed meats, are nutrient-dense choices, serving as food sources of key nutrients, including high-quality protein, bioavailable iron and zinc, B vitamins, including thiamin, niacin, riboflavin, vitamin B6 and B12, and selenium and choline. For example, a 3-ounce serving of beef is considered an excellent source (20% or more of the Daily Value per serving) of protein, zinc, selenium, niacin, vitamin B6, and vitamin B12, and a good source (10-19% of the Daily Value per serving) of phosphorus, iron, riboflavin, and choline [19].

Protein

Dietary intake data suggest that protein food intake is below recommendations for about 45% of Americans, with approximately 70% of adolescent girls and older women not meeting daily protein food recommendations [5]. Proposed healthy dietary patterns recommend protein intakes at 87-100 g/d for diets 1,800-2,200 calories/d, yet protein intakes for adult women average at 68 g/d, with adolescent girls at 63 g/d and older women (70+ years) consuming only 59 g/d [3]. The Acceptable Macronutrient Distribution Range (AMDR) for protein, established as the range associated with reduced risk for chronic disease while providing adequate intakes of essential nutrients, is 10-35% of energy intake for adults, or 50-175 g for a 2,000-calorie diet, with the lower end of the range set at approximately the Recommended Dietary Allowance (RDA), or 0.8-0.95 g/kg/d for ages 4 and older [20]. Most adults currently consume about 15% of their daily calories from protein [3].

A growing body of evidence suggests positive health outcomes associated with protein intakes at the higher end of the AMDR range or approximately 1.0-1.6 g/kg/d, and evenly distributing protein intake at meals throughout the day [21]. Dietary protein has been shown to be a key element of most effective weight loss regimens, with evidence

for enhanced satiety, increased thermic effect of food, and preservation of lean body mass during weight loss [22-27]. Protein-induced satiety is believed to be an important component of weight loss and maintenance, with evidence for higher protein meals enhancing satiety measures for several hours after a meal [24,25,28,29]. Higher protein weight loss diets (1.2-1.6 g/kg/d) resulted in greater losses in body weight and body fat, preservation of lean body mass, and reductions in triglycerides, blood pressure, and waist circumference [25,30,31]. During weight maintenance, higher protein diets favor regain of fat-free mass over fat mass, and reduce the efficiency of weight gain [22].

Food sources of protein differ in their protein content, and in the quality of protein provided, as measured by the provision of EAAs. Animal proteins are known to provide a higher quality and greater quantity of protein compared to plant proteins, and often provide a more energy efficient source of protein. For example, to obtain the same amount of protein found in lean meat from most plant proteins, such as beans, nuts and grains, calories may be 1½ to 2 times greater (Table 4). According to an analysis of food sources of energy and nutrients among US adults, poultry and beef are among the three highest ranked food sources of protein; beef was also within the top three food sources of total fat and saturated fat [32]. Plant sources of protein included yeast bread and rolls ranked as number 5 and nuts and seeds at number 12 [32].

Dietary guidance emphasizing nutrient density supports a similar approach to categorize a protein source's ability to provide EAAs in an efficient manner specific to its energy content [33]. This proposed concept of EAA density underscores the critical role dietary protein has in preventing, slowing the progression of, or managing chronic disease. Consuming high-quality protein with optimum ratios of essential amino acids at multiple meals each day has been shown to support metabolic health [29,34]. Essential amino acids act as metabolic signals, influencing protein synthesis, inflammation responses, and satiety. Leucine, an EAA found in higher amounts in animal proteins, has been found to stimulate muscle protein synthesis and may improve satiety and insulin sensitivity [35-39]. In older adults, protein intake may reduce the risk of sarcopenia, or the gradual loss of muscle mass and function. Evidence indicates that consuming a moderate amount of high-quality protein (1.0-1.5 g/kg/d) evenly distributed at each eating occasion (i.e., 20-30 g/meal), combined with physical activity, can be an effective strategy for adults to maximize lean body mass before its decline, and help slow the progression of or prevent sarcopenia in older adults [30,40-42].

Food Source and Amount	Calories	Protein (g)
Lean sirloin, 3 oz cooked	160	26
Skinless chicken breast, 3 oz cooked	137	26
Pork loin chop, 3 oz cooked	148	25
Red beans, 1.6 cups cooked	366	25
Firm tofu, 10 oz	235	25

Calories required to obtain approximately 25 grams protein (cooked or ready-to-eat portions)

Source: United States Department of Agriculture Agricultural Research Service National Nutrient Database for Standard Reference Release 27

Table 4: Energy Comparison of 25-gram Protein Sources.

Micronutrients

In addition to high quality protein, meat and poultry are important sources of micronutrients, including iron, zinc, selenium, and vitamins B12, B6, thiamin, riboflavin, niacin, and potassium. Iron is recognized

as being under consumed by adolescent and premenopausal women, including women who are pregnant. The 2015 DGAC Report recognizes that red meats are an excellent source of heme iron, a highly bioavailable form of iron. Plant sources of iron may contain phytates, tannins, and other compounds that reduce absorption of non-heme iron. Consuming meat, poultry, and vitamin C with a plant-source of iron, and soaking beans and grains in water can help to increase absorption of iron from plant sources. Research suggests that at least 50 g or about 2 oz of meat or poultry may improve iron absorption from a meal by approximately 45% [43].

Up to 16% of US adults and more than 20% of adults over 60 years old are marginally depleted in vitamin B12, with inadequate intake due to low consumption of animal-source foods as a primary cause of low serum vitamin B12 [44]. Animal foods are an excellent source of vitamin B12, an essential vitamin not naturally available in plant protein sources. Deficiency of this vitamin increases with age, with the added complication of gastric atrophy with aging, which reduces absorption of vitamin B12 in older adults. The decline in protein food intake observed with age may exacerbate the increased risk of vitamin B12 seen in older adults. Of adults 71 years and older, only about 30% of women and 50% of men meet the daily recommendation for Protein Foods [5]. An analysis of food sources of energy and nutrients among US adults indicates that beef is the highest ranked food source of vitamin B12, while beef and poultry rank among the top 5 sources of vitamin B6, zinc, and phosphorus [32]. Beef, poultry, pork, and processed meats are ranked at numbers 6, 8, 12, and 14 respectively, as top food sources of potassium, a nutrient of public health concern recognized by the 2015 DGAC [5,32].

In regards to sodium, meat and poultry processing often uses salt for flavoring and to enhance food safety, making these options higher in sodium compared to fresh meats. According to the North American Meat Institute, meat and poultry processors are actively engaged in efforts to reduce sodium and currently offer a variety of choices with different sodium contents, including 'reduced sodium' with a 75% reduction from the original formulation, and 'low sodium' with 140 mg of sodium or less per serving [45].

Positive and realistic guidance on meat intake

Consumer inertia toward healthier eating, or the tendency to do nothing or remain unchanged, is a significant challenge in moving consumer behaviors closer to achieving dietary guidance goals [46]. Changes in nutrition guidance and contradictory nutrition messages have led to consumer confusion, with negative advice to avoid or limit foods likely contributing to a backlash against nutrition recommendations [47,48]. For food guidance to have the intended effect, it must be positive and realistic, without an expectation that consumers must surrender the foods they love. The effectiveness of dietary guidance is contingent on advice that is also consistent, easy-to-understand, and actionable, personalized and fits within consumers' time, money, and skill constraints [49]. Related to meat intake, guidance that reinforces consumers' preferences and provides targeted and tailored advice for subgroups that may be under or over consuming meat or selecting less healthful options is critical to help consumers achieve a balanced lifestyle with better health outcomes.

Although consumers want to maintain control over their food choices, they are receptive to messages that empower, encourage, reassure, and offer advice that fits within their everyday lives [49]. Traditional "one size fits all" nutrition advice may have contributed to the lack of motivation and apathy around changing eating behaviors,

while targeted and tailored nutrition messages are more likely to be perceived as personally relevant and achievable [50,51]. Behavioral research also suggests that positive and practical nutrition education is a more effective approach to behavior change than penalizing with taxes and restrictions. A 2013 nationally representative survey of 1,011 US adults found that 83% of those surveyed were in favor of the government providing nutritional guidelines and information about how to make healthy choices, yet there is little support for policies that would constrain or penalize consumer choices [52,53]. Seventy-four percent strongly or somewhat opposed limiting the types or amounts of food and drinks that people can buy, and 59 percent opposed placing a tax on the sale of unhealthy foods and drinks [53].

Positive messages that show consumers how to choose and incorporate lean meats, including red and processed meats, are more likely to inspire positive behavior change. Providing consumers with alternative options, such as lean cuts of meat and products with reduced fat or sodium that can be tailored to personal preferences may improve the likelihood of long-term success in maintaining a healthy dietary pattern. Guidance supported with education about choosing lean and lower sodium meats, both fresh and processed, can help consumers balance their diets and lifestyle, practice portion control, and meet their energy and nutrient needs.

Conclusion

While it is important to consume protein from a variety of animal- and plant-based sources, animal foods generally provide more protein by weight than plant foods and supply higher quality protein, which are concepts warranting greater attention in dietary guidance. Furthermore, fewer calories are needed to achieve adequate protein intake from animal-based compared to plant-based foods.

Consumption data indicates that Americans are eating meat in moderation the only MyPlate food group being consumed within the recommended daily amounts in USDA food patterns. Protein is not considered a shortfall nutrient, with dietary intake data indicating that Americans are meeting the RDA for protein, which falls at the low end of the AMDR. However, significant and emerging evidence supports the role of high-quality protein intakes at the mid-to-high end of the AMDR in weight management, metabolic function, healthy aging, and nutrient adequacy, which translates to intakes of protein of up to twice the RDA from both animal and plant sources, and balancing intake throughout the day to optimize these benefits [33].

The term "red meat" is ambiguous, both in research and in dietary guidance, and may or may not include "processed meat," which also lacks a universal definition. In research, the lack of a standard definition for red meat means that measurement of consumption is subject to either individual study participant interpretation of what constitutes red meat or differing definitions provided by researchers, both of which may account for the conflicting research results on the effects of red and processed meat on health. The lack of a uniform strategy for characterizing and analyzing red and processed meat intake limits the possibility of comparing study findings and drawing clear and consistent conclusions within and across studies of the associations between meat and health outcomes. The 2015 DGAC acknowledged that further evaluation of studies and the definition of meats are needed to provide evidence of the differences between certain foods and relationships to health outcomes [5]. Research derived from a standardized definition of red meat that differentiates between various types (i.e., lean, processed) and is consistently used across studies is

more likely to produce results that can be used to inform scientifically accurate messages about red and processed meat in education, outreach, and nutrition policy-making efforts.

A recommendation to reduce meat intake may be detrimental, with the potential consequence of lowering protein and nutrient intakes, and reducing satisfaction and compliance with health-promoting diets due to physiological and/or psychological parameters associated with limiting protein- and nutrient-rich meats. Advice to successfully change eating habits must reflect how Americans eat, and promote a positive approach for how to include desirable foods rather than constraining consumer choice. While there is broad support for government policies that would facilitate a healthier lifestyle, the majority of consumers draw the line at policies that limit choice [53]. As noted by the 2015 DGAC, a range of diverse foods can be included to achieve healthful eating patterns, consistent with personal, cultural, and religious preferences [54]. This and other advice recognizing that there are many ways and foods that can be included in a healthful diet aligns with consumer research supporting positive nutrition messages that target and tailor nutrition advice to specific audiences.

Menu models demonstrate that a variety of red and processed meats can be incorporated into a healthful eating pattern that meets energy and nutrient recommendations from the 2010 Dietary Guidelines for Americans and MyPlate food groups. Recognizing that many Americans enjoy red and processed meats, recommendations that limit or restrict this protein- and nutrient-rich food may threaten the acceptance and implementation of future Dietary Guidelines. High quality protein, including lean red meat and reduced-fat or low-sodium processed meat, has a critical role in human health and nutrition, and continued promotion of lean meats has the potential to motivate behavior change and increase success in achieving healthful dietary patterns.

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