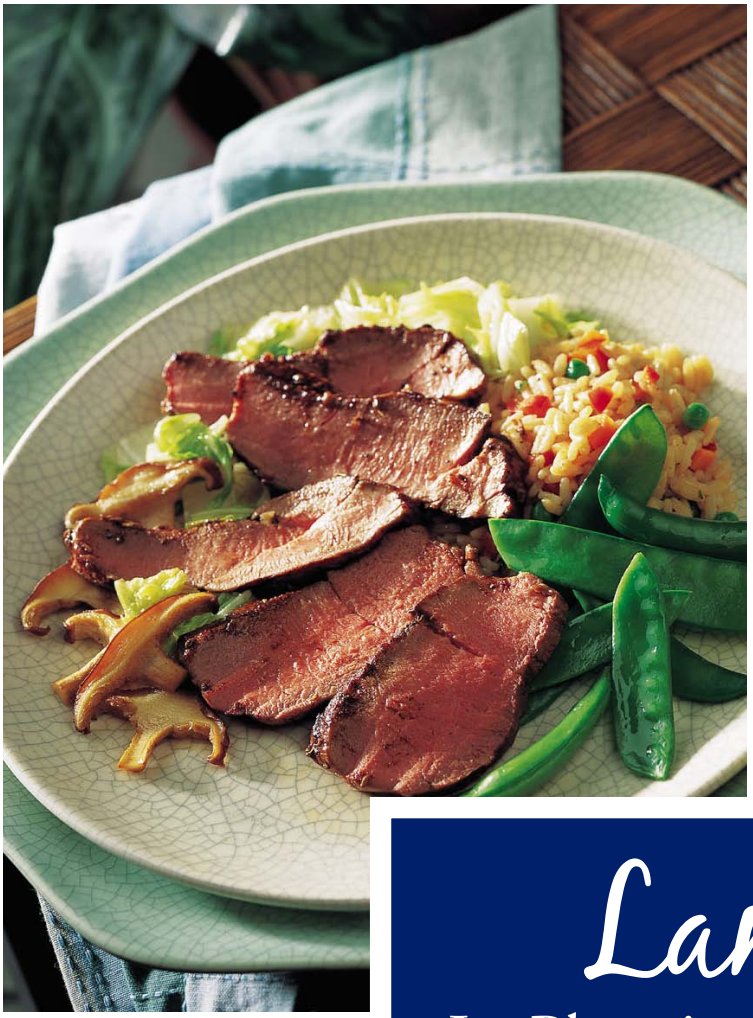

Lamb: Its Place in the U.S. Diet.

PREPARED BY:

Jo Ann S. Carson, PhD, RD, LD
Department of Clinical Nutrition
The University of Texas Southwestern Medical Center
Dallas, Texas

And

G.G. Hilton
D.L. VanOverbeke
Oklahoma State University
Stillwater, Oklahoma

PREPARED AND REVISED FOR:

The Tri-Lamb Group

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TRI-LAMB GROUP

Australia United States New Zealand

The Tri-Lamb Group is a collaborative initiative between United States, Australia, and New Zealand lamb producers to enhance demand for lamb in the United States. The group is currently working with health professionals and consumers to increase their awareness of the nutritional value of lamb and its place in a healthy American diet.

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INTRODUCTION

Nutrition plays an important role in health promotion and prevention of disease in the United States. Numerous governmental agencies and non-profit organizations have developed nutritional guidelines to promote health and reduce morbidity and mortality from diseases, such as heart disease, diabetes, and cancer. As a central feature of many American meals, meat can offer many nutritional benefits. Wise choices of type of meat, quantity, or method of preparation can optimize health benefits. This paper will review the nutritional aspects of lamb and discuss its role in a healthy American diet.

CURRENT LAMB DEMAND AND CONSUMPTION

As a naturally nutrient-rich source of protein with only 175 calories, on average, in a 3-ounce serving, lamb easily fits within a healthy diet. Despite its many nutritional benefits, versatility, and rich flavor, most Americans do not consume it regularly. Research regarding lamb demand in the United States is limited. Shiflett and colleagues (2007) report a 5.7 percent increase in demand for lamb in the United States over the last ten years. Their research revealed a significant positive correlation between income levels and per capita lamb consumption such that, as income levels rise 1 percent, per capita lamb consumption rises 0.68 percent. This relationship also underscores the importance of convenience to American consumers. Price elasticity of demand was estimated at -0.66 percent, indicating that price has relatively low influence on lamb purchasing decisions.

According to the USDA's Agricultural Marketing Resource Center, as of 2005, the annual per capita consumption of lamb and mutton in the United States was estimated at 0.8 pounds or 0.36 kilograms on a boneless equivalent. This is in contrast to New Zealand and Australia, where annual per capita consumption of lamb and mutton is 50 pounds or 22.7 kilograms and 37 pounds or 16.8 kilograms, respectively. Greece and Saudi Arabia are other countries with frequent consumption (Schroeder, 2001; Geisler, 2007). Lamb is a common meat in the healthy Mediterranean diet served in Greece.

U.S. consumption is greater on the East and West Coasts, likely due to higher concentration of ethnic groups who consume more lamb—Greeks, Hispanics, Middle Easterners, and Native Americans (Geisler, 2007). Lamb consumption is also somewhat seasonal and higher in the winter and spring. These seasonal patterns are associated with religious holidays and celebrations (Agriculture Marketing Resource Center).

The cuts most popular in the United States are higher value ones, such as those from the leg, rack, and loin (Geisler, 2007). Lamb purchased in the United States is typically from younger animals, thus texture and tenderness have been of little concern when determining consumer acceptability of lamb products.

Lamb flavor is frequently considered the most important determinant of consumer acceptability. Many studies relate flavor to the low lamb consumption in the United States (Jamora, 1998). Rhee and Ziprin (1996) found the majority of tested panelists could differentiate lamb from beef and pork in blind taste tests. They attributed this differentiation to the intensity and uniqueness of the flavor of lamb, as well as its unfamiliarity to the subjects.

U.S. policy makers have enacted programs to aid in the development of marketing tools to address the issue of declining market demand for lamb products. Their goal is to promote the healthfulness of lamb meat, as well as educate consumers in the handling and preparation of lamb. Although current consumption of lamb is limited in the United States, its nutritional profile makes it valuable for inclusion in the variety of foods that together can provide a healthful dietary pattern for Americans.

NUTRIENT CONTENT OF LAMB

As a meat from a mammal with higher myoglobin content, lamb is considered a red meat, along with beef and pork. Therefore, it is one of the few good sources of iron and an excellent source of zinc. On average, a 3-ounce cooked portion of lamb provides greater than 20 percent of the daily value of zinc, vitamin B-12, niacin, and protein in about 175 calories making lamb a nutrient-dense food. Lamb also can be an excellent source of selenium depending upon the selenium content of the soil from which the animals' feed is derived. It is also a good source of riboflavin. Providing many nutrients within limited calories is particularly beneficial among the growing number of obese Americans.

The similarity in the nutritional profiles of a variety of cuts of lamb has allowed the development of a composite set of nutritional values. Nutritional analyses of various lamb cuts produced in the United States, New Zealand, and Australia have been combined to provide the average nutritional content shown in Table 1.

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TABLE 1.

Average Nutrient Data for All Lamb Cuts Available to U.S. Consumers From Australian, New Zealand, or United States Sources.

	AVERAGE VALUES FOR 3-OUNCE OR 85-GRAM EDIBLE PORTION (COOKED)	% DAILY VALUE
Energy (kcal)	174.54	
Protein (g)	23.64	47.27%
Total fat (g)	8.01	
Iron (mg)	1.85	10.30%
Magnesium (mg)	20.15	5.04%
Potassium (mg)	236.04	6.74%
Sodium (mg)	60.00	2.50%
Zinc (mg)	4.55	30.31%
Selenium (ug)	14.30	20.43%
Thiamin (mg)	0.09	6.14%
Riboflavin (mg)	0.28	16.25%
Niacin (mg)	5.10	25.48%
Pantothenic acid (mg)	0.61	6.10%
Vitamin B-6 (mg)	0.20	10.09%
Vitamin B-12 (ug)	2.38	39.64%
Vitamin E (mg)	0.08	
Saturated fat (g)	3.23	
Monounsaturated fat (g)	3.26	
Polyunsaturated fat (g)	0.48	
Cholesterol (mg)	79.69	
Cholesterol (mg) per 100g	93.77	

IRON. Lamb offers a number of benefits for iron status. It is a good source of iron with a 3-ounce cooked portion containing, on average, 1.85 milligrams, slightly more than 10 percent of the daily value of 18 milligrams. Of further benefit is the heme form of iron in lamb. Dietary iron is available in two forms: heme iron, which originates only from animal tissues, and non-heme iron, which is derived from plant sources. Due to different means of absorption, heme iron is absorbed at a higher percentage than non-heme iron. Although some estimate diets containing primarily non-heme iron result in only 5 to 10 percent absorption of iron, the

Recommended Dietary Allowances (RDA) estimates absorption of non-heme iron in the American diet with adequate vitamin C intake to be about 17 percent. Heme iron absorption is estimated at 25 percent or more (IOM, 2001). Interestingly, the meat (heme-containing) sources of iron included in the *2005 Dietary Guidelines for Americans* table of "Food Sources of Iron" are limited to several seafood items (clams, oysters, shrimp, and sardines), organ meats, beef, and lamb. Other common meats, such as fish, poultry, and even pork, are lower in iron. In addition to providing iron, lamb also provides protein important for the synthesis of new red blood cells containing adequate amounts of hemoglobin.

ZINC. As shown in Table 1, a 3-ounce portion of cooked lamb provides, on average, 4.55 milligrams of zinc, 30 percent of the daily value. As a component of many enzymes and proteins that regulate gene expression, zinc has many functions in the human body. A lack of adequate zinc can contribute to improper growth and development, reduce immune function, and delay wound healing (IOM, 2001; Andrews 1999). Zinc absorption is influenced by a number of factors. A plant-based diet high in phytate from whole grains reduces absorption; whereas, a diet high in animal protein promotes greater zinc absorption (IOM, 2001). Hence, lamb is an excellent source of zinc and has higher bioavailability than plant sources.

SELENIUM. Although the content of selenium varies from animal to animal, depending upon the selenium content supplied by the animal's diet, lamb, on average, contains 14.3 micrograms per 3-ounce cooked portion of lamb qualifying it as an excellent source, providing 20 percent of the daily value. Selenium functions as an anti-oxidant, particularly as a component of the enzyme glutathione peroxidase (IOM, 2000).

VITAMIN B-12. On average, a 3-ounce cooked portion of lamb provides 2.38 micrograms of vitamin B-12, about 40 percent of the daily value. Found only in animal products, vitamin B-12 functions as a co-enzyme for many important metabolic reactions. Low levels of the vitamin can manifest as anemia, neurological problems, and high levels of the amino acid homocysteine in the blood (IOM, 1998).

NIACIN. Niacin is commonly found in meats, including lamb. A 3-ounce cooked portion contains, on average, 5.1 milligrams, 25 percent of the daily value. As a B vitamin, niacin functions as a co-enzyme, especially in reactions in which our body obtains energy from metabolism of food components (IOM, 1998).

RIBOFLAVIN. As a good source of riboflavin, a 3-ounce cooked portion of lamb provides, on average, 0.28 milligrams riboflavin, 16 percent of the daily value. Riboflavin, another B vitamin that functions as a co-enzyme, is important in metabolic reactions in which reduction and oxidation occurs (IOM, 1998). Not a common deficiency in the United States, symptoms of riboflavin deficiency (such as abnormalities in the tissues around the mouth, tongue, and throat) may be seen in individuals with an overall poor diet with multiple nutritional deficiencies (IOM, 1998).

PROTEIN. Comparable to other meats, a 3-ounce cooked portion of lamb provides, on average, 24 grams protein, 47 percent of the daily value. Protein functions as a major structural component of all human cells. Protein is needed to synthesize enzymes, membranes, transport carriers, and hormones (IOM, 2005). Without adequate protein, growth is limited, healing is impaired, immune function is reduced, and muscle mass can decrease (IOM, 2005).

FAT. In terms of total and saturated fat, nutritional analyses in the USDA Nutrient Database, Release 19 (USDA Nutrient Database Laboratory) indicate that for a 3-ounce cooked portion of lamb, many cuts trimmed to 1/4 inch or less fat meet the FDA definition for lean. In other words, a 100-gram cooked portion contains, on average, less than 10 grams fat, less than 4.5 grams saturated fat, and less than 95 milligrams cholesterol. These lean cuts include those from the leg and loin. Cuts with slightly higher amounts of fat include rib and some samples of shoulder blade.

DIETARY GUIDELINES FOR AMERICANS: HOW LAMB FITS

The *2005 Dietary Guidelines for Americans* (USHHS, 2005) are evidence-based recommendations for how Americans can eat and exercise to promote optimum health and maintain a healthy weight. The advice in the guidelines is framed within the food groups represented in the revised food pyramid, accessible at www.mypyramid.gov (USDA). MyPyramid individualizes for calories and amounts of food based on age, gender, height, weight, and activity. The range of 1,000 to 3,200 calories provides dietary patterns that include a range of 2 to 7 ounces of cooked meat (or meat substitutes) per day. The overall dietary pattern provides 20 percent to 35 percent of calories from fat, less than 10 percent of calories from saturated fat, and less than 300 milligrams cholesterol per day. Lamb is one example of a meat that can be included in the daily meat allowance and dietary pattern.

To stay within the fat allowances, the guidelines advise selecting lean choices and low-fat preparation methods. Adhering to the advice to select lean or low-fat meat choices, one can select various cuts from the leg or loin of the lamb. Fat should be trimmed to either 1/4 inch or 1/8 inch on the perimeter of the cut. As mentioned earlier, the average nutritional analysis of lamb meets the FDA criteria for lean.

How does lamb compare with the fat recommendations within the Dietary Guidelines for Americans?

- Limiting dietary fat to 20 to 35 percent of calories would represent 44 to 78 grams of fat daily when 2,000 calories are consumed. On average, a 3-ounce portion of lamb provides 8 grams of total fat.

- Limiting saturated fat to less than 10 percent of 2,000 calories would allow 20 grams of saturated fat daily. Figure 1 illustrates the small portion (about 15 percent) of the saturated fat allowance a 3-ounce lamb portion provides (3 grams of the 20 grams of saturated fat allowance), on average. (For people with high LDL cholesterol, saturated fat should be limited further to less than 7 percent or about 16 grams of saturated fat in a 2,000 calorie diet.) Table 2 compares the saturated fat contribution of a portion of lamb with the saturated fat allowance at less than 10 percent and less than 7 percent of calories.

• Dietary cholesterol should be limited to less than 300 milligrams daily; 3 ounces of lamb provides 80 milligrams of cholesterol, on average.

FIGURE 1.

Proportion of Saturated Fat Allowance Allocated in Three-Ounce Cooked Lamb

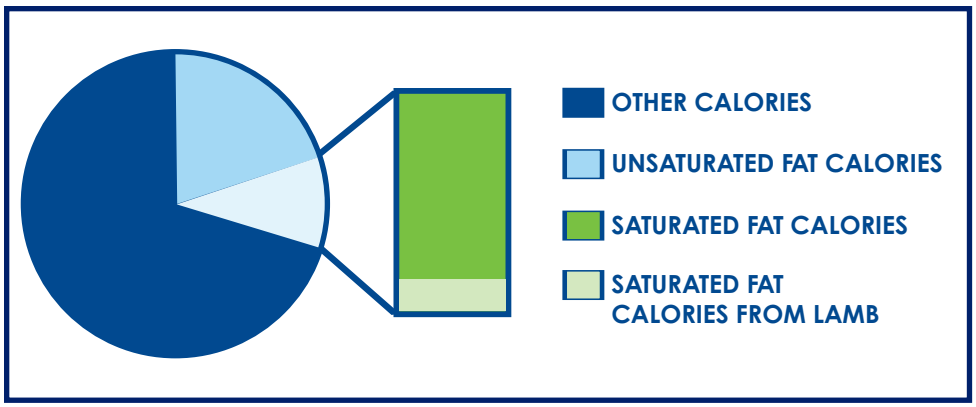

TABLE 2.

Saturated Fat Allowance in Different Calorie Levels

	CALORIE LEVEL	SATURATED FAT (in g) ALLOWED AT <10%	<7%
	1600	18 g or less	12 g or less
	2000	20 g or less*	16 g or less
	2500	25 g or less*	19 g or less
3-ounce lamb composite	175	3 g	3 g

** values rounded to be the same as those on the Nutrition Facts Panel*

LAMB THROUGHOUT THE LIFE CYCLE

The *2005 Dietary Guidelines for Americans* provide general guidance for the public. Nutritional needs and key concerns vary through the stages of the life cycle. When considering specific nutritional recommendations for various age and gender groups, the Dietary Reference Intakes (DRI), including the RDA and Adequate Intakes (AI), are useful.

PREGNANCY. Requirements for several nutrients are increased during pregnancy. Pertinent to the nutritional benefits of lamb, nutritional needs during pregnancy are increased for protein, iron, and zinc. The RDA for zinc for a female 20 to 39 years of age is 8 milligrams per day, increasing to 11 milligrams during pregnancy (IOM, 2001). Based on 1999-2000 National Health and Nutrition Examination Survey (NHANES) data, the mean intake for this age group of non-pregnant

females is 10.2 ± 0.34 milligrams with a median of 8.5 milligrams (Wright, 2003). Based on the data shown in Table 3, a young woman consuming the median intake of 8.5 milligrams could easily meet the additional 3 milligrams of zinc needed daily during pregnancy with a 3-ounce portion of lamb.

The RDA for iron for a female 20 to 39 years of age is 18 milligrams, and it increases to 27 milligrams with pregnancy (IOM, 2001). Based on 1999-2000 NHANES data, the mean iron intake for this age group is well below the RDA with a mean intake of 13.7 ± 0.47 milligrams and a median of 11.7 milligrams (Wright, 2003). Table 3 illustrates how a serving of lamb can contribute significantly toward the increased amounts of iron and protein recommended when a woman becomes pregnant. As a nutrient-rich food, lamb provides these nutrients within a modest number of calories, a valuable attribute for pregnant women, for whom excess weight gain is a significant issue (Kaiser, 2002).

TABLE 3.

Nutritional Contributions of Lamb for Pregnant Women

	ADDITIONAL NEEDED IN PREGNANCY	AMOUNT PROVIDED IN 3 OUNCES OF LAMB*
IRON	9 mg	1.85 mg
ZINC	3 mg	4.55 mg
PROTEIN	25 g	23.64 g

**See Table 1 for reference.*

IRON DEFICIENCY IN CHILDREN, ADOLESCENTS, WOMEN, AND OLDER ADULTS. Iron deficiency anemia is not only a problem in pregnant women, but also for young women in general and other segments of the population. Therefore, before moving on to nutritional issues for different age segments of the population, iron deficiency will be discussed further. Iron deficiency (as defined by NHANES) is an abnormal value for at least two of three laboratory indicators of iron status: serum ferritin, transferrin saturation, and free erythrocyte protoporphyrin. Iron deficiency anemia occurs when iron deficiency is severe enough to reduce hemoglobin levels below normal. NHANES 1999-2000 reported the groups with highest prevalence of iron deficiency were toddlers aged one to two years (7 percent) and females aged 12 to 49 years (9 to 16 percent).

Iron deficiency occurred twice as often among non-Hispanic black and Mexican-American females (19 to 22 percent) than among non-Hispanic white females (10 percent). A smaller proportion of the U.S. population (1 to 4 percent has iron deficiency severe enough to result in iron deficiency anemia (Iron Deficiency—MMWR, 2002).

Although decreased physical performance and possible reduction in mental performance is recognized as accompanying iron deficiency anemia (IOM, 2001), the extent and implications of iron deficiency in the United States may be underappreciated. A recent study of 152 young female students (aged 18 to 35 years) at Penn State University found only 43 of the students had normal iron status. Iron deficiency was present in more than half of the women; 34 students had frank iron deficiency anemia. When tested with a series of cognitive performance tests, the normal iron status women performed significantly better than the anemic women. After treatment with iron supplementation, improvement in serum ferritin was associated with a five-fold improvement in cognitive performance (Murray-Kolb, 2007).

Comparison of NHANES data from 1988-1994 and 1999-2000 indicates groups of the populations with an increase in iron deficiency. In adolescent males, iron deficiency has increased significantly from 1 to 5 percent and in six- to 11-year-old children from 2 to 4 percent (non-significant) (Iron deficiency—MMWR, 2002; Guthrie, 2002; Nicklas, 2004). The prevalence of iron deficiency among women aged 50 to 69 increased significantly from 5 to 9 percent (Iron deficiency—MMWR, 2002). As individuals enter the later decades of life, the decline in calorie intake is accompanied by a decreased intake of iron (Kuczmarski, 2005). The contribution of the iron content of lamb to the iron needs of various ages is shown in Table 4.

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TABLE 4.

Contribution of a Serving of Lamb to RDA for Iron of Various Ages

	RDA FOR IRON (mg/DAY)	AGE APPROPRIATE SERVING OF LAMB	% OF IRON RDA/SERVING OF LAMB*
CHILD, 1-3 YEARS	7 mg	1 ounce	9%
CHILD, 4-8 YEARS	10 mg	2 ounces	12%
CHILD, 9-13 YEARS	8 mg	3 ounces	23%
FEMALE, 14-18 YEARS	15 mg	3 ounces	12%
MALE, 14-18 YEARS	11 mg	3 ounces	17%
FEMALE, 19-50 YEARS	18 mg	3 ounces	10%
MALE, >18 AND FEMALE, > 50	8 mg	3 ounces	23%

**See Table 1 for reference.*

INFANCY. During the first year of life infants move from total reliance on breast milk or infant formula in the first four to six months to eating a variety of foods. As infants grow, they exhaust nutritional stores from birth and have increasing need for a variety of foods to supply iron, zinc, and many vitamins. The first solid food typically introduced at ages four to six months is cereal, usually iron fortified. Krebs and colleagues (Krebs, 2006) investigated the option of meat as an early complementary food. They randomized 88 exclusively breast-fed infants to receive pureed beef or iron-fortified cereal at four months of age. In both groups, about 20 percent of the infants had low plasma zinc and 30 to 40 percent had low iron stores. The meat fed group had higher daily zinc intake and greater increase in head circumference, as related to the zinc and protein intake. Although beef was the meat chosen in this study, lamb would provide similar amounts of protein, zinc, and iron. To limit development of food allergies, introduction of first foods lower in allergenic potential can be helpful. Less allergenic than milk and wheat, lamb and beef have similar allergens (Fiocchi, 1995). Further studies are needed to guide decisions about introduction of solid foods to breast-fed infants.

CHILDREN. The biggest recent nutritional concern for pre-school and school-aged children is excessive calorie intake that results in an increasing number of children being overweight (Nicklas, 2004). Family meals are an important aspect for childhood nutrition. Children who eat family meals at home generally have a more nutritious diet and are less likely to become overweight (Nicklas,

2004; Gable, 2007). Provision of lamb in convenient and child-friendly forms could encourage family meals at home, as well as provide easily absorbed iron important for the small percentage of youth who are iron deficient.

OLDER ADULTS. As older adults decrease their caloric intake, their micronutrient intake declines. Nutrients of concern include iron, zinc, and B vitamins (Ervin, 2004; Wright, 2003; Kuczmarski, 2005). Lack of iron can reduce oxygenation of blood in older adults with already limited respiratory capacity. Lack of zinc can reduce wound healing and immune function. Limited intake of B vitamins, such as vitamins B-6 and B-12 not only can impair nutrient metabolism, but also may decrease cognitive function in older adults (Tucker, 2005). Iron, zinc, and vitamins B-6 and B-12 are all provided by lamb.

Although zinc intake declines as adults age, NHANES data from 1999-2000 indicates the mean intake of adults over the age of 60 is near the RDA. Zinc intake for men is 10.6 ± 0.36 milligrams/d with a median of 8.6 milligrams; for women it is 9.3 ± 0.59 milligrams/d with a median of 7.4 milligrams (Wright, 2003). The RDA is 11 milligrams for older men and 8 milligrams for older women (IOM, 2001). Known as an immune enhancer, zinc appears helpful in reducing infection among older adults. When 50 healthy men and women aged 55 to 87 years were randomized to receive placebo or 45 milligrams zinc daily for 12 months, those supplemented with zinc had fewer infections. Among the placebo group, 88 percent had at least one infection in the year, while only 29 percent of the zinc supplemented subjects had an infection, such as a cold or upper respiratory infection ($p<.001$; Prasad, 2007). Regular consumption of excellent food sources of zinc, such as lamb, could improve zinc status among older adults and potentially reduce morbidity due to infections.

Although the mean U.S. dietary intake of vitamin B-12 is above the RDA for all age levels of adults (Ervin, 2004), deficiency is a concern among the elderly due to decreased absorption. The prevalence of atrophic gastritis and common use of proton pump inhibitors can reduce vitamin B-12 absorption in older adults (IOM, 1998). Indicators of vitamin B-12 status, serum vitamin B-12 and methylmalonic acid levels, point toward less than optimum vitamin B-12 status among older adults. Although the use of fortified foods or supplements as a source of vitamin B-12 is recommended for those over the age of 50, animal foods are also good sources.

Among animal foods, lamb, on average, is an excellent source of vitamin B-12. As shown in Table 1, a 3-ounce cooked portion provides, on average, approximately 2.4 micrograms, equal to the RDA for adults, all ages. (Based on current label requirements it provides only 40 percent of the Daily Value because the Daily Value is based on an older, higher recommended amount of the vitamin (IOM, 1998). Lamb and beef are both excellent sources of vitamin B-12, as contrasted with pork, poultry, and milk that have less than half as much as lamb and beef.

AUDIENCES WITH SPECIAL HEALTH RISKS

The *Dietary Guidelines for Americans* incorporate nutritional principles intended to reduce risk for diseases, such as heart disease and cancer. In addition, organizations, such as the American Heart Association (AHA) and the American Cancer Society (ACS), provide more specific guidance designed to reduce the incidence of heart disease and cancer.

HEART DISEASE. Although the AHA recommendations are similar to the *Dietary Guidelines for Americans*, of most significance to lamb consumption are the recommendations regarding fat intake. As shown in Table 5, AHA recommends that Americans limit saturated fat to less than 7 percent of calories and trans fat to less than 1 percent of calories to reduce the incidence of heart disease. AHA advises consumers to choose lean meats and minimize intake of partially hydrogenated vegetable oils that provide trans fat. They also suggest selection and preparation of foods with little or no salt (Lichtenstein, 2006).

TABLE 5.

Comparison of Fat Recommendations from the Dietary Guidelines for Americans and the American Heart Association

	DIETARY GUIDELINES FOR AMERICANS	AMERICAN HEART ASSOCIATION RECOMMENDATIONS
TOTAL FAT	20% to 35% of calories	25% to 35% of calories
SATURATED FAT	<10% of calories	<7% of calories
TRANS FAT	As low as possible	<1% of calories
CHOLESTEROL	<300 mg per day	<300 mg per day

As shown earlier in Table 2, a 3-ounce serving of lamb, on average, fits well within the saturated fat limits of both the *2005 Dietary Guidelines for Americans* and the AHA recommendations. It can be easily incorporated with whole grains, vegetables, and fruits to provide meals that contain 25 to 35 percent of calories from total fat and less than 7 percent of calories from saturated fat. Similar to other ruminant meats and dairy products, lamb contains small amounts of trans fatty acids (4 to 5 percent of total fatty acids). Trans fatty acids from partially hydrogenated vegetable oils have been shown to have adverse effects on serum lipids (Mensink, 2003; Lichtenstein, 2003) and have been associated with increased risk of heart disease in epidemiological studies (Baylin, 2003; Oomen, 2001; Willett, 1993). Whether the array of trans fatty acids in ruminant fats has similar effects is yet to be determined. Nevertheless, lamb trimmed of visible fat in order to limit dietary total and saturated fat will contain very low levels of trans fatty acids.

CANCER. Because studies that have investigated meat and colorectal cancer are epidemiological in nature, a causal relationship has not been established (Truswell, 2002; Johnson, 2007; Key 2004). This view is supported by a meta-analysis of five prospective cohort studies comparing death rates among vegetarians and meat-eaters with similar healthy lifestyles, which found low and identical rates for colorectal cancer and all other cancers (Key, 1999). The small effect size, lack of a dose-response relation, and inconsistency of the epidemiological data with postulated mechanisms by which red meat might increase colorectal cancer risk raise the possibility that the observed relations of meat consumption and colorectal cancer may be the result of residual confounding. Specifically, some studies have examined the relationship between both processed meat and red meat (Sandhu, 2001; Norat, 2002; Larsson, 2006). The relationship appears to be stronger for processed meats than red meat, and, when analyses are separated, red meat has a less significant relationship than processed meats (Norat, 2005; Chao, 2005). In contrast, evidence for a clear link between obesity and lack of physical activity and colon cancer is considered convincing (Johnson, 2007).

The ACS updated its guidelines for the public with a focus on maintaining a healthy weight, being physically active, and eating a healthy diet, with emphasis on plant sources (Kushi, 2006). They mention limiting intake of processed meats and red meats and make the recommendation to "select lean cuts and eat smaller portions." The nutrient density of lean lamb and its lower total fat, saturated fat, and salt content relative to processed meats are significant in this context.

A different issue related to cancer is the role of selenium in prevention of cancer. Several trials with selenium supplements are underway to clarify initial observations that higher intakes of selenium reduce development of cancer. One study looked retrospectively at the blood selenium levels of subjects in trials of fiber to reduce development of growths in the colon. Those with the highest blood levels of selenium had a 34 percent lower chance of developing pre-cancerous growths in the colon (Jacobs, 2004). As an excellent source of dietary selenium, lamb can contribute to higher serum levels of selenium.

Red meat certainly can be incorporated in a healthy diet, but to reduce risk of cancer, the diet should not exceed calorie needs and should incorporate generous amounts of colorful fruits and vegetables. Meat servings should be modest portions, such as 3-ounces or less, be lean choices, and not be prepared at high temperatures for long periods of time, which increases the potential for creation of carcinogens.

OBESITY. With two-thirds of Americans overweight or obese, the role of diet in weight control is a major issue. For overweight and obese adults, the National Institutes of Health (1998) recommends a low-calorie diet (a reduction of 500 to 1,000 calories/day), physical activity, and behavior modification for lifestyle change to achieve weight loss. Their sample 1,200 and 1,600 calorie menus include 4 to 5 ounces of lean meat daily. Numerous studies substantiate that regardless of the dietary approach to weight loss, long term compliance is generally low. Individuals who participate in a structured weight loss program have regained about 75 percent of their lost weight by five years (Anderson, 2001). Higher protein diets appear to increase short-term weight loss (Hu, 2005). Recently published trials document the benefit of a high protein, low carbohydrate diet for weight loss in pre-menopausal overweight or obese women (Gardner, 2007), adults with cardiac risk factors (Dansinger, 2005), and women with polycystic ovary syndrome (Galletly, 2007). In the later group, less depression and better self-esteem was observed on a high protein, low carbohydrate weight-loss regimen as compared to a low protein, high carbohydrate plan. For weight control, protein has several benefits. Having a high satiety value, protein keeps one satisfied longer, reducing the likelihood of overindulgence. When protein is substituted for carbohydrate, serum triglycerides are lowered. Lamb offers a satiating, nutrient-rich, and carbohydrate-free food to incorporate in a variety of weight

control regimens. As a good source of iron and excellent source of zinc and vitamin B-12, lamb provides valuable nutrients that sometimes can be limited when calories are reduced.

When diet and exercise are ineffective, some patients undergo gastrointestinal surgery for weight loss. With bariatric surgeries increasing in popularity, hospitalizations for surgical treatment of obesity increased more than five-fold in the five years from 1996 to 2001. In the United States, over 45,000 surgeries were performed in 2001 (Livingston, 2004). Compared to the lap-band reduction in the size of the gastric reservoir, the more extensive Roux-en-Y gastrectomy and pancreatic diversion procedures present more nutritional issues. For patients with the latter two surgeries, daily vitamin and mineral supplements providing iron and vitamin B-12 are especially important (Malinowski, 2006). Although supplements are indicated, meats, like lamb, eaten in small amounts can be a valuable source of iron and vitamin B-12.

VEGETARIANS. Nutritional concerns for vegetarians or those consuming only small amounts of meat primarily focus on nutrients that may be low or missing entirely in the diets of strict vegetarians. Dietary intake for these individuals who do not consume animal products can be low for calcium, zinc, and vitamins B12 and D (Mangels, 2003). For individuals who choose a plant-based diet for optimum health, the occasional inclusion of lamb and beef can enhance iron absorption and improve zinc and vitamin "B-12" status.

HEALTHFUL PREPARATION METHODS

With the goal of providing meat that is low in saturated fat and cholesterol, two aspects to preparation are important: trimming the outer fat from various cuts of lamb and methods of cooking. Currently fat is trimmed to 1/4 or 1/8 inches on most cuts of lamb. The consumer may trim the remaining fat from the meat before or after cooking.

The method of cooking also can influence the amount of fat and saturated fat that remains in meat. Dry heat cooking methods, such as grilling, rotisserie, broiling, and roasting, allow fat to melt and drip from the meat, reducing total fat. Moist heat methods, such as braising or stewing, allow any fat to float to the top of the cooking liquid after cooking, which can then be removed.

To reduce development of carcinogens in red meats, the ACS recommends cooking methods that allow lower temperatures, such as braising, steaming, poaching, stewing, and microwaving. Frying or charbroiling at very high temperatures for periods that result in charring is not recommended. Carcinogens (heterocyclic amines and polycyclic aromatic hydrocarbons) are in charred meat and meat exposed to the smoke from fat burned when it drips on charcoal. These carcinogens can damage DNA and may increase risk of colon cancer when the gastrointestinal tract is exposed to these chemicals frequently (Kushi, 2006). The research base for this recommendation originates in epidemiological studies that indicate an association, rather than a definitive cause and effect.

LAMB FOR HEALTH

Lamb fits into healthy diets as an excellent protein source providing many essential vitamins and minerals. It provides two minerals that can be lacking in the American diet – iron and zinc. With iron deficiency a common problem, its provision of easily absorbed heme iron is especially helpful for young women who often have marginal iron status. This benefit has growing importance with the increasing Hispanic population, a group with higher prevalence of iron deficiency in the United States. Lean cuts of lamb easily fit within the fat recommendations for a healthy diet. As a meat with a variety of cuts that come naturally in small portions, lamb can fit the message of moderation in a healthy lifestyle. With a three-ounce portion providing, on average, 175 calories, lamb can be positioned well as offering variety in the higher protein, lower carbohydrate, high satiety approaches to healthy eating. It can also serve as a means of providing protein and iron needed in pregnancy. Lamb also offers variety that can appeal to those looking for a unique eating experience.

Although lamb consumption in the United States is low, it can be increased by meeting consumer needs. Developing kid-friendly offerings for fast food restaurants and school food service could tap into new markets. Showcasing lamb in restaurants can increase the public's familiarity with it. Presenting recipes and menu ideas that promote lower calorie options with colorful fruits and vegetables can position lamb as an integral part of the optimal diet that is nutrient-rich, modest in calories, and may reduce risk for heart disease and cancer.

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