Eating Smart: Plant-Based Diets for Cardiometabolic Protection
– Breaking Down Nutrients and Portions

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Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality in the United States and globally.\(^1\)\(^2\) Suboptimal nutrition is a leading contributor and risk factor for CVD and premature death,\(^2\) leading to approximately 50% of CVD deaths globally.\(^3\) Diets lacking in proper nutrition have led to increases in obesity, dyslipidemia, hypertension, pre-diabetes, diabetes, and metabolic syndrome.\(^3\) Dietary factors, including high intake of sodium and processed meat products and low intake of fruits and vegetables have been associated with 45.5% of cardiometabolic deaths in the United States.\(^2\) Poor dietary patterns are a leading risk factor for illness in the United States. Identifying healthy dietary patterns that improve health and reduce chronic disease is of significant importance.\(^4\)

*Plant-Based Dietary Patterns – Cardiometabolic Protection and Nutritional Benefits*

Plant-based diets have consistently been associated with beneficial cardiometabolic effects.\(^5\) Plant-based diets are an effective strategy for improving nutrient intake. Plant-based diets are associated with decreased all-cause mortality and decreased risk of obesity, type 2 diabetes, and coronary heart disease.\(^2\) In a recent study, among adults without CVD at baseline, those who ate healthful plant-based diets had an approximately 10% reduced risk for stroke.\(^6\) Higher intake of a plant-based diet rich in healthier plant foods is associated with substantially lower CVD risk\(^7\) and a lower risk of cardiovascular morbidity and mortality in the general population, conferring benefits for cardiovascular health.\(^8\) Dietary patterns that are higher in plant-based food sources and lower in animal food sources confer benefits for cardiovascular health.\(^8\) In large cohort studies, vegetarian diets have been associated with 24%–32% reductions in ischemic heart disease incidence and mortality relative to omnivorous diets.\(^9\)

Plant-based diets help reduce the key contributors to CVD: diabetes, dyslipidemia, elevated blood pressure, and obesity.\(^10\) In the diabetic population, CVD is the major cause of mortality; numerous clinical trials have demonstrated the benefits of plant-based diets in preventing and treating CVD.\(^11\) Plant-based diets boost insulin sensitivity. This is important for reducing the risk of type 2 diabetes and improving glycemic control in individuals with diabetes, which is a major contributor to CVD.\(^2\) Dietary choices are a key driver of insulin resistance. A healthy diet can be
highly effective in preventing and managing type 2 diabetes. Plant-based diets have demonstrated improvements in glycemic control while also reducing risk of type 2 diabetes. The Mediterranean diet with Omega-3 fatty acids can improve insulin sensitivity and is associated with a reduced risk of developing diabetes.

Dyslipidemia is another major contributor to CVD and its clinical progression is worsened by diets rich in saturated fat. Dairy products and meat are the leading sources of saturated fat, and exclusion of these food sources improves plasma lipid profiles. Plasma cholesterol concentrations is less pronounced with plant-based diets than that from diets high in saturated fat. Trans fats also have harmful effects on plasma lipids and pose CVD risks.

Plant-based diets have been associated with lower risk of CVD as well as an improved cardiovascular risk profile, in large extent, through their contributions to lower blood pressure and attain a healthy weight. Vegetarian and vegan diets reduce both systolic and diastolic blood pressure. Lower blood pressure reduces the risk of atherosclerotic changes. Finally, obesity is a well-documented risk factor for CVD. Vegetarian, especially vegan, diets reduce body fat and thus body mass index (BMI).

Several biological mechanisms exist through which healthful plant-based foods exert their cardioprotective benefits. Consuming plant-based diets offer cardiometabolic protection and health benefits as evidenced by: lower caloric intake, increased intake of fiber, reduced intake of saturated fat and cholesterol, higher intake of polyunsaturated and monounsaturated fatty acids, increased intake of antioxidants and micronutrients, higher intake of vegetable protein, and a higher intake of plant sterols. Because plant-based foods are rich in antioxidants, they help reduce oxidative stress. Plant-based foods have also been shown to reduce inflammatory biomarkers.

Plant-based diets are characterized by a dietary pattern that emphasizes plant food sources, such as vegetables, fruits, beans, grains, and fewer animal food sources like meat, eggs, and dairy; the primary focus is to make plant-based foods the central part of the meal. Diets rich in plant foods are increasingly recommended to lower the risk of cardiometabolic diseases because of strong evidence that this dietary pattern is protective and offers many cardiac benefits. Evidence suggests that a higher intake of plant-based foods is associated with a lower risk of cardiometabolic disease. Adoption of proactive approaches to health have led to a growing demand for plant proteins. Plant-based diets are not about totally replacing meat in the diet, but rather, placing plant foods at the center of the meal.
Plant-Based Dietary Patterns

**Vegetarian Diet.** A vegetarian diet focuses on whole grains, dairy, eggs, fruits, vegetables, soy products, and nuts. When eaten over a long period, the Vegetarian diet is associated with a large range of health benefits, including reduced weight, lower cholesterol, and low blood pressure. A meta-analysis in 2017 concluded that a vegetarian diet reduced cholesterol and lowered the risk of dying from coronary artery disease by 25% and it conferred a significant protective effect from ischemic heart disease.\(^\text{14}\) A more recent meta-analysis in 2021 revealed similar findings; concluding a vegetarian diet was associated with reduced risk for ischemic heart disease mortality compared with a nonvegetarian diet.\(^\text{15}\)

**Vegan Diet.** A vegan diet is a vegetarian diet minus all animal-derived products, including eggs, dairy, gelatin, and whey. The Vegan diet has been linked to reduced risk for heart disease, type 2 diabetes, and premature death. A study published in 2018 found that Vegans had lower LDL and triglyceride levels than individuals who ate meat.\(^\text{16}\)

**Mediterranean Diet.** This food pattern derived from countries that rim the Mediterranean Sea. A Mediterranean diet is rich in olive oil, whole grains, fish, and fruit. The main meal is eaten early afternoon with vegetable dishes and olive oil in the main entrée; fruit is the dessert. This style of eating plays a significant role in preventing heart disease and stroke and reducing risk factors such as obesity, diabetes, high cholesterol and high blood pressure. The Framingham Heart Study, Nurses’ Health Study, and Women’s Health Initiative concluded that plant fats yield better cardiovascular health than animal fats.\(^\text{17}\) The research demonstrated that individuals who adhered to this dietary pattern had less inflammation, reduced oxidative stress, and higher serum levels of antioxidants, all of which are associated with reduced risk of CVD.\(^\text{17}\) There is evidence that a Mediterranean diet rich in virgin olive oil may help the body remove excess cholesterol from arteries and maintain patent blood vessels.\(^\text{7}\) A recent review of studies published in 2019 showed the Mediterranean diet can help lower LDL levels and raise HDL levels.\(^\text{17}\) The Mediterranean dietary pattern has been fully adopted and endorsed by the 2015 Dietary Guidelines Advisory Committee.\(^\text{18}\) Decreased meat intake supplemented with a parallel increase in plant-based foods may amplify the beneficial cardiometabolic benefits of the Mediterranean diet and reduce cardiovascular risk.\(^\text{19}\)
Plant-Based Nutrients, Portions/Servings, and Recommended Dietary Allowances

Portion size is a term used to describe the amount of a food consumed in one eating occasion. It is important to pay attention to portion size when making food choices, particularly for foods that are not nutrient-dense. Utilizing the MyPlate and Food Pyramid graphics is extremely helpful in visualizing the portion sizes and number of servings that constitute a healthy plant-based meal that embodies nutrient-rich sources. It is essential to understand the Recommended Dietary Allowance (RDA) and Adequate Intake (AI) for each of the nutrients consumed when following a plant-based diet. Acquiring knowledge of the nutrients garnered from eating a plant-based diet will help ensure appropriate daily intake of recommended quantities of macronutrients and micronutrients. Vitamins and minerals are micronutrients that play crucial roles in performance of bodily functions.

Vitamin A: There are two forms of vitamin A available in the diet; preformed vitamin A, (retinol) and provitamin A (carotenoids). The most abundant carotenoid in plant-based diets is beta-carotene, and it provides fruits and vegetables, such as mangos, oranges, carrots, and beetroot, with a yellow/orange/red color. The RDAs for vitamin A are given as retinol activity equivalents (RAE) to account for the different bioactivities of retinol and carotenoids. One microgram of dietary retinol is equivalent to 12 micrograms of dietary beta-carotene. The RDA for adult men is 900 mcg RAE and for adult women it is 700 mcg RAE daily.

Vitamin B12: Vitamin B12 is found in fish, shellfish, meat, eggs, and dairy, and only in plant foods that have been fortified; it can be challenging for vegans to get enough daily B12. The body stores years’ worth of vitamin B12 in the liver; however, it is important to consume B12-containing foods. Vitamin B12 is needed to form healthy red blood cells and helps support the nervous system. The RDA for an adult men and women is 2.4 mcg daily.

Vitamin D: Vitamin D (calciferol) is a fat-soluble vitamin that is naturally present in a few foods and is also produced endogenously through vitamin D synthesis when the skin is exposed to the ultraviolet rays from sunlight. In foods and dietary supplements, vitamin D has two main forms, D2 (ergocalciferol) and D3 (cholecalciferol). Trout, salmon, tuna, and mackerel and fish liver oils are among the best food sources. Cheese and egg yolks have small amounts of vitamin D in the form of vitamin D3. Almost all of the U.S. milk supply is voluntarily fortified with about 3 mcg/cup (120 IU) in the form of vitamin D3. Mushrooms provide variable amounts of vitamin D2. Vitamin D promotes calcium absorption in the gut and maintains adequate serum calcium and phosphate.
concentrations to enable normal bone mineralization. It is also needed for bone growth and bone remodeling by osteoblasts and osteoclasts. Without sufficient vitamin D, bones can become thin, brittle, or misshapen. Vitamin D sufficiency prevents osteomalacia in adults. Together with calcium, vitamin D helps protect older adults from osteoporosis (NIH). The RDA for adult men and women is 15 mcg or 600 IU daily.20

Calcium: Calcium is the most abundant mineral in the body and is found in plenty of plant-based foods. Milk, yogurt, and cheese are rich natural sources of calcium and are the major food contributors of this nutrient. Nondairy sources include vegetables, such as Chinese cabbage, kale, and broccoli. Spinach provides calcium, but its bioavailability is poor. Most grains do not have high amounts of calcium unless they are fortified; however, grains are typically eaten quite frequently in the diet. Foods fortified with calcium include many fruit juices and drinks, tofu, and cereals. Getting enough calcium is important for bone health. Calcium is stored in bones and teeth where it supports structure and hardness. Calcium is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion and support for critical metabolic functions. It is important to note that vegetarians may absorb less calcium because they consume more plant products containing oxalic and phytic acids, which bind with calcium and decreases bioavailability. The RDA for adult men is 1,000 mg daily (≥70 years the RDA is 1,200 mg daily) and for adult women the RDA is 1,000 mg daily (≥51 years the RDA is 1,200 mg daily).20

Choline: Choline plays in important role in the function of cell membranes and is required in producing the neurotransmitter acetylcholine. Choline also plays important roles in modulating gene expression, cell membrane signaling, lipid transport and metabolism. The main dietary sources of choline are found in animal-based products (meat, poultry, fish, dairy products, and eggs). Cruciferous vegetables, certain legumes, nuts, seeds, and whole grains are also rich in choline. The AIs are 550 mg daily for adult men and 425 mg daily for adult women.20

Iodine: Iodine is an essential trace element imperative for brain development, normal growth and metabolism. Iodine is an essential component of the thyroid hormones thyroxine (T4) and triiodothyronine (T3). Adequate iodine intake may be a challenge for individuals who follow a plant-based diet. Recommendations to reduce salt intake to support heart health also means reducing iodine intake from iodized salt. The main source of iodine is from milk and milk products, followed by fish and meat. The high content in milk is a result of iodine addition in cow feed and
iodine-containing disinfectants used during milking. It is important for vegetarians who exchange dairy milk to a plant-based alternative to be aware they may be at risk of inadequate iodine intake. The RDA is 150 mcg per day for adult men and women.\textsuperscript{20}

**Iron:** Iron is a component of hemoglobin in the red blood cells that transport oxygen to the body’s organs and tissues. The richest sources of heme iron in the diet include lean meat and seafood. Dietary sources of nonheme iron include nuts, beans, vegetables, and fortified grain products. If iron consumption is insufficient, iron-deficiency anemia can occur. The RDA is 8 mg daily for adult men and 18 mg daily for adult women (\textgreater 51 years the RDA is 8 mg daily).\textsuperscript{20}

**Omega-3 Fatty Acids:** The two major classes of polyunsaturated fatty acids are the omega-3 and omega-6 fatty acids. Omega-3 is found fish, flaxseed (linseed), soybean, canola oils, chia seeds, and walnuts. The American Heart Association recommends one to two servings of seafood per week to reduce the risk of heart failure, coronary heart disease, ischemic stroke, and sudden cardiac death, and to lower triglyceride levels, especially when the seafood replaces less healthy foods. The 2015–2020 *Dietary Guidelines for Americans*\textsuperscript{18} states an eating pattern that includes seafood is associated with a reduced risk of CVD. There are indications that consuming fish and other types of seafood as part of a balanced diet promotes heart health. The AI for adult men is 1.6 grams daily and for adult women the AI is 1.1 grams daily.\textsuperscript{20}

**Protein:** As a macronutrient, protein provides the body with energy (calories) and calorie-containing nutrients (carbohydrates and fat). Amino acids are the building blocks for protein. There are twenty types of amino acids that the body uses to build proteins. Amino acids are classified as either essential or non-essential. Our bodies cannot make essential amino acids, meaning they are essential for us to consume in our diet. Complete proteins have all of the essential amino acids. Animal-based protein like meat, poultry, fish, eggs, milk, and cheese are considered complete proteins, whereas Quinoa and soy are plant-based complete proteins. A right balance of protein is required so the body does not break down protein in the body (for example, muscles) to obtain the needed amino acids; therefore, emphasis is placed on assuring that a variety of foods are eaten that contain all of the essential amino acids over the course of the day. Protein is digested differently than carbohydrates and fat, which provides and increased sense of satiety.\textsuperscript{20}

The ideal amount of protein in the daily diet may be calculated by two methods: the weight-based RDA is 0.8 grams per kilogram of body weight for individuals nineteen years of age and older. Based on percent of calories, approximately 10% of calories should come from protein
Using the weight-based method a 150-pound individual would need approximately 55 grams of protein daily, while a 120-pound individual would need 44 grams daily.\textsuperscript{20}

**Zinc:** This mineral is found in all of the organs, tissues, and fluids of the body. Zinc plays a major role in cell reproduction, wound healing, and carbohydrate metabolism. Zinc also helps the immune system and supports the senses of smell and taste. Oysters contain more zinc per serving than any other food. Other food sources include red meat and poultry, beans, nuts, crab and lobster, whole grains, fortified breakfast cereals, and dairy products. It is important to note that zinc binds with phytate, a compound found in grains, nuts, and beans (primary plant-based food choices) which interferes with bioavailability. For individuals nineteen years of age and older, the RDA is 11 mg daily for men and 8 mg daily for women.\textsuperscript{20}

**Nutrient-Dense Foods**

Randomized controlled studies show that nutrient-dense diets improve CVD risk factors.\textsuperscript{4} Diets rich in plant foods are increasingly recommended to lower the risk of cardiometabolic diseases because of strong evidence that **vegetables, fruits, whole grains, legumes, nuts, seeds and dairy** are protective.\textsuperscript{4}

**Vegetables.** **Dark-Green Vegetables:** All fresh, frozen, and canned dark-green leafy vegetables and broccoli, cooked or raw: for example, amaranth leaves, bok choy, broccoli, chard, collards, kale, mustard greens, poke greens, romaine lettuce, spinach, taro leaves, turnip greens, and watercress. **Red and Orange Vegetables:** All fresh, frozen, and canned red and orange vegetables or juice, cooked or raw: for example, carrots, red or orange bell peppers, sweet potatoes, tomatoes, and winter squash. **Beans, Peas, Lentils:** All cooked from dry or canned beans, peas, chickpeas, and lentils: for example, black beans, black-eyed peas, chickpeas (garbanzo beans), edamame, kidney beans, lentils, lima beans, mung beans, pinto beans, and split peas. **Starchy Vegetables:** All fresh, frozen, and canned starchy vegetables: for example, cassava, corn, jicama, lotus root, lima beans, plantains, white potatoes, taro root, water chestnuts, yam, and yucca. **Other Vegetables:** All other fresh, frozen, and canned vegetables, cooked or raw: for example, asparagus, avocado, bamboo shoots, beets, bitter melon, Brussels sprouts, cabbage (green, red, napa, savoy), cactus pads, cauliflower, celery, chayote, cucumber, eggplant, green beans, kohlrabi, luffa, mushrooms, okra, onions, radish, rutabaga, seaweed, snow peas, summer squash, tomatillos, and turnips.\textsuperscript{18}
**Fruits.** All fresh, frozen, canned, and dried fruits and 100% fruit juices: for example, apples, Asian pears, bananas, berries (blackberries, blueberries, currants, huckleberries, kiwifruit, mulberries, raspberries, and strawberries); citrus fruit (calamondin, grapefruit, lemons, limes, oranges, and pomelos); cherries, dates, figs, grapes, guava, jackfruit, lychee, mangoes, melons (cantaloupe, casaba, honeydew, and watermelon); nectarines, papaya, peaches, pears, persimmons, pineapple, plums, pomegranates, raisins, rhubarb, sapote, and soursop.\(^{18}\)

**Whole Grains.** All whole-grain products and whole grains used as ingredients: for example, amaranth, barley (not pearled), brown rice, buckwheat, bulgur, millet, oats, popcorn, quinoa, dark rye, whole-grain cornmeal, whole-wheat bread, whole-wheat chapati, whole-grain cereals and crackers, and wild rice.\(^{18}\)

**Dairy.** All fluid, dry, or evaporated milk, including lactose-free and lactose-reduced products and fortified soy milk, buttermilk, yogurt, kefir, frozen yogurt, dairy desserts, and cheeses. Most choices should be fat-free or low-fat. Cream, sour cream, and cream cheese are not included due to their low calcium content.\(^{18}\)

**Protein.** Meats, Poultry, Eggs: Meats include beef, goat, lamb, pork, and game meat (bison, moose, elk, deer). Poultry includes chicken, Cornish hens, duck, game birds (ostrich, pheasant, and quail), goose, and turkey. Eggs include chicken eggs and other birds’ eggs. Meats and poultry should be lean or low-fat.

**Seafood:** Seafood that are lower in methylmercury include: anchovy, black sea bass, catfish, clams, cod, crab, crawfish, flounder, haddock, hake, herring, lobster, mullet, oyster, perch, pollock, salmon, sardine, scallop, shrimp, sole, squid, tilapia, freshwater trout, light tuna, and whiting.

**Nuts, Seeds, Soy Products:** Nuts and seeds include all nuts (tree nuts and peanuts), nut butters, seeds (chia, flax, pumpkin, sesame, and sunflower), and seed butters (sesame or tahini and sunflower). Soy includes tofu, tempeh, and products made from soy flour, soy protein isolate, and soy concentrate. Nuts should be unsalted.\(^{18}\)

*Plant-Based Dietary Patterns – CVD Prevention*

Poor dietary patterns have surpassed all other mortality risk factors and accounts for half of CVD deaths globally. Implementation of nutrition recommendations from the American Heart Association (AHA), American College of Cardiology (ACC) and the National Lipid Association (NLA) can confer significant cardiometabolic benefits. These recommendations include: 1) nutrition screening at medical visits; 2) referral to a registered dietitian; 3) follow AHA/ACC Nutrition and Diet Recommendations for CVD prevention and management of weight, type 2
diabetes and hypertension; 4) include NLA nutrition goals for optimizing low-density lipoprotein cholesterol and high-density lipoprotein cholesterol; 5) utilize evidence-based heart-healthy eating patterns for improving cardiometabolic risk factors; 6) implement ACC/AHA/NLA nutrition and lifestyle recommendations for optimizing triglyceride levels; 7) understand the impact of saturated fats, trans fats, omega-3 and omega-6 polyunsaturated fats and monounsaturated fats on CVD risk; 8) limit intake of dietary cholesterol; and 9) include dietary fiber and plant-based foods. 

The AHA 2030 goals have shifted from managing heart disease to the prevention of heart disease. 

The AHA emphasis is to support healthful behavior changes, specifically diet, for prevention and management of obesity, diabetes mellitus, hypertension, hyperlipidemia and CVD. Implementation of dietary strategies that promote healthier dietary patterns to reduce CVD risk is critical. As part of its recommendations for nutrition and diet, the 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease states a diet that emphasizes the intake of vegetables, fruits, legumes, nuts, whole grains, and fish is recommended to decrease CVD risk factors (COR I; LOE B-R). 

The 2015-2020 Dietary Guidelines for Americans recommends appropriately planned vegetarian diets for improved health, emphasizing their applicability to individuals who are at risk of chronic conditions and diseases, such as CVD, type 2 diabetes, and obesity. People who are living with a chronic illness can benefit from a healthy dietary pattern are encouraged to follow the recommendations on the foods that make up a healthy dietary pattern. Health professionals can adapt the Dietary Guidelines to meet the specific needs of their patients with chronic diseases, as part of a multifaceted treatment plan.

Plant-based diets play a key role in cardiovascular health and are an effective strategy for improving nutrient intake and reducing the risk of developing metabolic syndrome. Nearly one half of cardiometabolic deaths in the U.S. might be prevented through proper nutrition. Plant-based diets are associated with decreased risk of obesity, type 2 diabetes, and coronary heart disease. Plant-based diets may reduce the risk of coronary heart disease events by an estimated 40% and the risk of cerebral vascular disease events by 29%. Properly planned plant-based diets are healthful, nutritional, effective for glycemic control, and provide metabolic and cardiovascular benefits, including decreasing blood lipids and blood pressure. The use of plant-based diets as a means of prevention and treatment of cardiometabolic disease should be promoted through dietary
guidelines and recommendations. Healthy plant-based diets can be customized to fit individual and cultural preferences and can enhance cardiovascular health.\textsuperscript{18,21}
References

   


   


   
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