

AHA SCIENTIFIC STATEMENT

# 2021 Dietary Guidance to Improve Cardiovascular Health: A Scientific Statement From the American Heart Association

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**ABSTRACT:** Poor diet quality is strongly associated with elevated risk of cardiovascular disease morbidity and mortality. This scientific statement emphasizes the importance of dietary patterns beyond individual foods or nutrients, underscores the critical role of nutrition early in life, presents elements of heart-healthy dietary patterns, and highlights structural challenges that impede adherence to heart-healthy dietary patterns. Evidence-based dietary pattern guidance to promote cardiometabolic health includes the following: (1) adjust energy intake and expenditure to achieve and maintain a healthy body weight; (2) eat plenty and a variety of fruits and vegetables; (3) choose whole grain foods and products; (4) choose healthy sources of protein (mostly plants; regular intake of fish and seafood; low-fat or fat-free dairy products; and if meat or poultry is desired, choose lean cuts and unprocessed forms); (5) use liquid plant oils rather than tropical oils and partially hydrogenated fats; (6) choose minimally processed foods instead of ultra-processed foods; (7) minimize the intake of beverages and foods with added sugars; (8) choose and prepare foods with little or no salt; (9) if you do not drink alcohol, do not start; if you choose to drink alcohol, limit intake; and (10) adhere to this guidance regardless of where food is prepared or consumed. Challenges that impede adherence to heart-healthy dietary patterns include targeted marketing of unhealthy foods, neighborhood segregation, food and nutrition insecurity, and structural racism. Creating an environment that facilitates, rather than impedes, adherence to heart-healthy dietary patterns among all individuals is a public health imperative.

**Key Words:** AHA Scientific Statements ■ cardiovascular diseases ■ diet, food, and nutrition ■ diet, healthy ■ nutrition policy

This scientific statement supersedes the 2006 American Heart Association (AHA) scientific statement on diet and lifestyle recommendations.<sup>1</sup> The evidence documenting aspects of diet that improve cardiovascular health and reduce cardiovascular risk is summarized, focusing on dietary patterns and food-based guidance. Poor diet quality is strongly associated with elevated risk of cardiovascular disease (CVD) morbidity and mortality.<sup>2</sup> In this context, the purpose of this scientific statement is to (1) emphasize the importance of dietary patterns beyond individual foods or nutrients; (2) underscore the critical role of initiating heart-healthy dietary habits early in life; (3) present common features of dietary patterns that promote

cardiometabolic health; (4) discuss additional benefits of heart-healthy dietary patterns, beyond cardiovascular health; and (5) highlight structural challenges that impede the adoption of heart-healthy dietary patterns.

## DIETARY PATTERNS

Dietary patterns encompass the balance, variety, and combination of foods and beverages habitually consumed. This includes all foods and beverages, whether prepared and consumed at home or outside the home. Adherence to heart-healthy dietary patterns is associated with optimal cardiovascular health.<sup>3</sup> Because CVD starts during

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fetal development and early childhood,<sup>4</sup> it is essential to adopt heart-healthy dietary patterns early in life, including preconception, and maintain it throughout the life course. Food-based dietary pattern guidance is designed to achieve nutrient adequacy, support heart health and general well-being, and encompass personal preferences, ethnic and religious practices, and life stages. In general, heart-healthy dietary patterns, those patterns associated with low CVD risk, contain primarily fruits and vegetables, foods made with whole grains, healthy sources of protein (mostly plants, fish and seafood, low-fat or fat-free dairy products, and if meat or poultry are desired, lean cuts and unprocessed forms), liquid plant oils, and minimally processed foods. These patterns are also low in beverages and foods with added sugars and salt.

Some heart-healthy dietary patterns emphasized in the Dietary Guidelines for Americans include the Mediterranean style, Dietary Approaches to Stop Hypertension (DASH) style, Healthy US-Style, and healthy vegetarian diets.<sup>5</sup> Research on dietary patterns that used data from 3 large cohorts of US adults, the Dietary Patterns Methods Project, found a 14% to 28% lower CVD mortality among adults with high compared with low adherence to high-quality dietary patterns.<sup>6</sup> However, most research on dietary patterns has been conducted in Western populations; future dietary guidance would benefit from research in non-Western countries. There is insufficient evidence to support any existing popular or fad diets such as the ketogenic diet and intermittent fasting to promote heart health.<sup>7,8</sup>

## CRITICAL ROLE OF NUTRITION EARLY IN LIFE AND THROUGHOUT THE LIFE SPAN

Nutrition-related chronic diseases are prevalent over the life course, with growing evidence of maternal-fetal nutritional origins.<sup>9</sup> Excess gestational weight gain, especially among women who experience overweight or obesity at conception, can lead to adverse pregnancy outcomes, subclinical CVD and CVD risk factors in mothers, and an increased risk for pediatric obesity in the offspring.<sup>10,11</sup> There is well-documented evidence that the prevention of pediatric obesity is key to preserving and prolonging ideal cardiovascular health.<sup>12,13</sup> Efforts to achieve and sustain healthy dietary and lifestyle behaviors from birth throughout the life course remain a high priority to reduce the tracking of adverse cardiometabolic conditions: obesity, elevated blood pressure, and metabolic syndrome.<sup>14–17</sup>

## EVIDENCE-BASED GUIDANCE ON DIETARY PATTERNS TO PROMOTE CARDIOMETABOLIC HEALTH

Healthy dietary patterns comprise foods and their nutrient components. The Table and Figure summa-

**Table. Evidence-Based Dietary Guidance to Promote Cardiovascular Health**

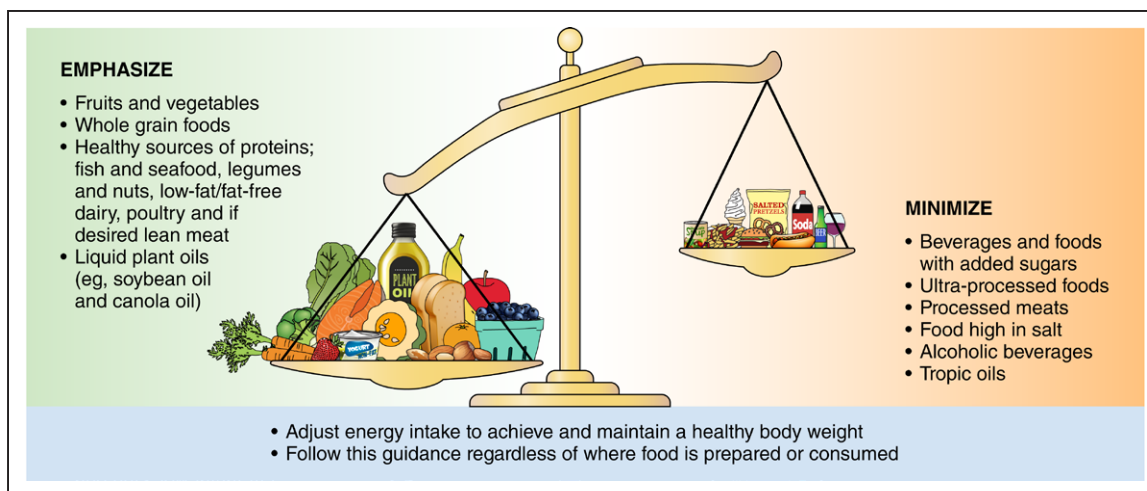
1. Adjust energy intake and expenditure to achieve and maintain a healthy body weight
2. Eat plenty of fruits and vegetables, choose a wide variety
3. Choose foods made mostly with whole grains rather than refined grains
4. Choose healthy sources of protein
a. mostly protein from plants (legumes and nuts)
b. fish and seafood
c. low-fat or fat-free dairy products instead of full-fat dairy products
d. if meat or poultry are desired, choose lean cuts and avoid processed forms
5. Use liquid plant oils rather than tropical oils (coconut, palm, and palm kernel), animal fats (eg, butter and lard), and partially hydrogenated fats
6. Choose minimally processed foods instead of ultra-processed foods*
7. Minimize intake of beverages and foods with added sugars
8. Choose and prepare foods with little or no salt
9. If you do not drink alcohol, do not start; if you choose to drink alcohol, limit intake
10. Adhere to this guidance regardless of where food is prepared or consumed

\*There is no commonly accepted definition for ultra-processed foods, and some healthy foods may exist within the ultra-processed food category.

ize evidence-based guidance for dietary patterns to promote cardiovascular health. The following sections summarize the rationale and evidence for each of the 10 features.

### Feature 1: Adjust Energy Intake and Expenditure to Achieve and Maintain a Healthy Body Weight

Maintaining a healthy body weight throughout the life course is an important component of CVD risk reduction.<sup>18</sup> Over the past 3 decades, increases in energy intake and sedentary lifestyle have shifted the population toward a positive energy balance and accumulation of excess body weight.<sup>19</sup> A healthy dietary pattern coupled with at least 150 minutes of moderate physical activity per week can help to optimize energy balance. However, energy needs vary widely by an individual's age, activity level, sex, and size.<sup>20,21</sup> During adulthood, energy needs decrease by  $\approx 70$  to 100 calories with each decade.<sup>22</sup> Also, large portion sizes, even for healthy foods, can contribute to positive energy balance and weight gain.<sup>21</sup> A public health and clinical focus on promoting adoption of a healthy dietary pattern as recommended in this scientific statement, concurrent with portion control and energy balance, is essential for reducing excess body weight gain and CVD risk. Individual physicians and patients need to balance the risks and benefits of diets that do not follow this guidance but may produce short-term weight loss, with uncertain long-term adherence and



**Figure.** Dietary patterns to promote cardiovascular health.

outcomes. Adopting rapid diet assessment screening tools in health care settings for CVD risk reduction throughout the life course and tracking diet in electronic medical records will facilitate this goal.<sup>23</sup>

### Feature 2: Eat Plenty of Fruits and Vegetables, Choose a Wide Variety

A strong and consistent body of evidence from observational studies has documented that dietary patterns rich in fruits and vegetables, with the exception for white potatoes, are associated with a reduced risk of CVD.<sup>24,25</sup> The results of intervention studies are consistent with these observations.<sup>26-30</sup> Deeply colored fruits and vegetables (eg, leafy greens, peaches) tend to be more nutrient dense than lighter colored and white fruits and vegetables.<sup>31</sup> Whole fruits and vegetables provide more dietary fiber and satiety than their respective juices; hence, the majority of fruits and vegetables should be consumed whole rather than as juice.<sup>31</sup> Most subgroups of fruits and vegetables have been associated with reduced mortality.<sup>32</sup> Consuming a wide variety within these food groups provides adequate essential nutrients and phytochemicals. All forms of fruits and vegetables (fresh, frozen, canned, and dried) can be incorporated in heart-healthy dietary patterns. Frozen fruits and vegetables have a longer shelf-life than fresh forms, are ready-to-use, have similar or higher nutrient content, and at times are lower priced. Types with added salt and sugar should be limited.

### Feature 3: Choose Foods Made Mostly With Whole Grains Rather Than Refined Grains

Observational studies and clinical trials consistently report favorable associations of daily, compared to infrequent, intake of foods made with whole grains and CVD

risk, coronary heart disease (CHD), stroke, metabolic syndrome, and cardiometabolic risk factors.<sup>33</sup> Whole grains contain intact starchy endosperm, germ, and bran,<sup>34</sup> and are a rich source of fiber. Products made with at least 51% whole grains are typically classified as whole grain. With the use of data from observational studies, substitution analyses indicate that the replacement of refined grain with whole grains is associated with a lower risk of CHD.<sup>35</sup> Beneficial effects of whole grains on laxation and gut microbiota have also been reported.<sup>36</sup> Eating whole grains instead of refined grains has been shown to improve cardiovascular risk factors in randomized controlled intervention studies.<sup>37</sup>

### Feature 4: Choose Healthy Sources of Protein

#### Mostly Protein From Plants (Legumes and Nuts)

Soybeans (including edamame and tofu), other beans, lentils, chickpeas, and split peas are common types of legumes. These plant foods are not only rich in protein, but they are also good sources of fiber.<sup>38</sup> A recent systematic review that compared high and low intake of legumes concluded that higher intake was associated with lower CVD risk.<sup>39</sup> Higher nut intake was associated with lower risk of CVD, CHD, and stroke mortality and incidence.<sup>40,41</sup> Recommendations for plant-based dietary patterns have traditionally centered on replacing animal-source foods with plant-based whole foods such as legumes and nuts, and the products made thereof. Of note, replacing animal-source foods with plant-based whole foods has the additional benefit of lowering the diet's carbon footprint, thus contributing to planetary health.<sup>42</sup>

The rapid emergence of plant-based meat alternatives requires some caution, because, at this time, many are ultra-processed and contain added sugar, saturated fat, salt, stabilizers, and preservatives.<sup>43,44</sup> The nutrient

profile of plant-based meat alternatives is consistently evolving. At present, there is limited evidence on the short- and long-term health effects of these plant-based meat alternatives.<sup>45,46</sup>

### **Regular Intake of Fish and Seafood**

Dietary patterns containing fish and seafood are consistently associated with lower CVD risk. Systematic reviews of prospective observational studies have concluded that 2 to 3 servings of fish per week is associated with a lower incidence of all-cause mortality, CVD, CHD, myocardial infarction, stroke, and heart failure than lesser intakes of fish.<sup>47,48</sup> This finding has been attributed to the omega-3 fatty acid content and substitution effect when fish and seafood replaces other sources of animal protein (eg, red and processed meat or full-fat dairy products).<sup>47</sup> The preparation of fish and seafood matters; fried forms are not associated with the benefits.<sup>49</sup> Current data support dietary patterns that contain at least 2 fish meals per week.<sup>50</sup> The greatest benefits occur when seafood replaces foods rich in saturated fat.<sup>50</sup>

### **Low-Fat or Fat-Free Dairy Products Instead of Full-Fat Dairy Products**

Based on consistent evidence from prospective cohort studies, systematic reviews and meta-analyses, the 2020 Dietary Guidelines Advisory Committee concluded that dietary patterns that included low-fat dairy are associated with a lower risk of all-cause mortality, CVD, overweight, and obesity.<sup>9</sup> Nonfat and low-fat dairy products are 1 component of the DASH dietary pattern.<sup>26,51</sup> A long-term observational study in Finland examined the role of multifactorial lifestyle modifications consisting of multiple dietary changes, including a shift from full-fat to low-fat dairy products and butter to vegetable oils in primary CHD prevention.<sup>52</sup> Over 40 years, the population-wide diet and lifestyle changes were associated with significant reductions in serum cholesterol concentrations and CHD mortality. It was estimated that about half of the benefit was derived from reductions in serum cholesterol,<sup>53</sup> with additional favorable dietary changes including increased fruits, vegetables, and fish, decreased sugar and salt, and a shift from fatty to lean meats contributing to the lower CHD mortality. Prospective observational studies found that replacing dairy fat with vegetable fat or polyunsaturated fat was associated with a lower risk of CHD and stroke.<sup>54</sup> However, it is important to note that the benefits of low-fat and fat-free dairy products compared with full-fat dairy products is not without controversy and continues to be debated.<sup>55</sup> Emerging evidence suggests potential cardiometabolic benefits of consuming fermented dairy such as yogurt, but the evidence remains inconclusive.<sup>56,57</sup> Taken together, replacing full-fat dairy products with nonfat and low-fat dairy products and other sources of unsaturated fat shifts the composition of dietary patterns toward higher

unsaturated to saturated fat ratios that are associated with better cardiovascular health.

### **If Meat or Poultry Are Desired, Choose Lean Cuts and Avoid Processed Forms**

Dietary patterns rich in red meat have been associated with higher CVD incidence and mortality,<sup>58–62</sup> and body mass index and waist circumference, as well.<sup>63,64</sup> Several systematic reviews and meta-analyses have documented a direct association between red meat intake and CVD incidence and mortality, although the magnitude of the association is less strong than that for processed meat.<sup>58,65,66</sup> Substitution analyses based on large cohort studies found that the replacement of red and processed meat with alternative foods such as unprocessed poultry, fish, nuts, and legumes was associated with a lower risk of total and CVD mortality.<sup>62</sup> The potential adverse effect of red meat on CVD risk has been attributed to a combination of factors, including saturated fat and heme iron content, and gut microbiota metabolism of L-carnitine and phosphatidylcholine.<sup>45,67,68</sup>

The term “processed meats” includes meat, poultry, or seafood products preserved by smoking, curing, or salting or the addition of chemical preservatives.<sup>9</sup> Common examples include bacon, sausage, hot dogs, deli meat (eg, turkey, ham), pepperoni, and salami. Ingredients used to make these foods include sodium and nitrites. Many processed meats are high in salt, saturated fat, cholesterol, heme iron, and polycyclic aromatic hydrocarbons, and heterocyclic amines (depending on the heating method), as well. Substitution analyses indicate that the replacement of processed meats with other protein sources is associated with lower mortality rates.<sup>69</sup> Available evidence does not support an adverse association of unprocessed poultry with CVD.<sup>70–72</sup>

### **Feature 5: Use Liquid Plant Oils Rather Than Tropical Oils (Coconut, Palm, and Palm Kernel), Animal Fats (Butter and Lard), and Partially Hydrogenated Fats**

Robust scientific evidence demonstrates the cardiovascular benefits of dietary unsaturated fats (polyunsaturated and monounsaturated fats), in particular, when they replace saturated and *trans* fats. The cardioprotective effects of unsaturated fat, including reducing low-density lipoprotein (LDL) cholesterol concentrations and CVD risk, are somewhat stronger for polyunsaturated than for monounsaturated fats.<sup>73</sup> This difference between the 2 major classes of unsaturated fatty acids may be related, in part, to the 2 primary food sources. Polyunsaturated fat comes primarily from plant oils, whereas monounsaturated fat comes from both meat fat and plant oils. Diets and drugs that lower LDL cholesterol concentrations reduce atherosclerotic progression and have been consistently associated with significant reductions in CVD risk, proportional to the extent of LDL cholesterol lowering.<sup>74</sup> Major dietary

sources of polyunsaturated fat include plant oils such as soybean, corn, safflower and sunflower oils, walnuts, and flax seeds. Major plant sources of monounsaturated fat include canola and olive oils, and nuts; high oleic acid safflower and sunflower oils; and peanuts and most tree nuts and their butters. In addition, fish with a high fat content are a good source of omega-3 fatty acids. To achieve a healthy dietary pattern, saturated and *trans* fats (animal and dairy fats, and partially hydrogenated fat) should be replaced with nontropical liquid plant oils.

### Feature 6: Choose Minimally Processed Foods Instead of Ultra-Processed Foods

Food processing has resulted in both beneficial and adverse effects on food availability and nutritional properties. The category of foods termed ultra-processed (also known as industrial food processing, highly processed) is frequently used, despite the lack of an accepted, standard definition. At present, the most commonly used classification system is NOVA.<sup>43,75,76</sup> In the NOVA system, foods are grouped into (1) unprocessed or minimally processed (edible parts of plants and animals); (2) processed culinary ingredients (food ingredients derived from a minimally processed food by pressing, refining, grinding, or milling); (3) processed foods (foods from either of the 2 previous groups that have added salt, sugar, or fats); and (4) ultra-processed foods (foods from the previous group that go beyond the incorporation of salt, sweeteners, or fat to include artificial colors and flavors and preservatives that promote shelf stability, preserve texture, and increase palatability). Sales of processed foods have increased dramatically worldwide and are predicted to increase further through 2024.<sup>43</sup>

Consumption of many ultra-processed foods is of concern because of their association with adverse health outcomes, including overweight and obesity, cardiometabolic disorders (type 2 diabetes, cardiovascular disease), and all-cause mortality.<sup>77-79</sup> In a 4-week, randomized controlled trial of ad libitum food intake, greater intake of ultra-processed food was associated with excess energy intake and short-term weight gain.<sup>80</sup> Recent prospective studies have also found that high compared with low intake of ultra-processed foods is associated with greater risk of type 2 diabetes,<sup>81</sup> incident CVD,<sup>82,83</sup> and all-cause mortality.<sup>83</sup> A general principle is to emphasize unprocessed or minimally processed foods.

### Feature 7: Minimize Intake of Beverages and Foods With Added Sugars

Added sugars refer to any sugars added to a food or beverage during preparation or processing. Common types of added sugar include glucose, dextrose, sucrose, corn syrup, honey, maple syrup, and concentrated fruit juice.<sup>84</sup> Added sugars have consistently been associated with elevated risk of type 2 diabetes, CHD, and excess

body weight.<sup>85-88</sup> There is strong evidence to support a recommendation to minimize the intake of added sugars across the life span, as recommended by the 2020 Dietary Guidelines Advisory Committee.<sup>9</sup>

Using low-energy sweeteners to replace added sugars in beverages has been proposed as a means to reduce intake of added sugars and energy. However, meta-analyses of clinical trials have reported mixed findings with regard to the effects of low-energy sweeteners on body weight and metabolic outcomes.<sup>89-92,92a</sup> Concern about the influence of reverse causality as a reason for the inconsistent findings from observational studies has been raised.<sup>92-95</sup> Low-abundance mono- and disaccharides, which are metabolized differently than traditional sugars, have recently emerged as potentially preferable, lower-energy substitutes. It is too early to determine how these sugars, in particular, as part of ultra-processed foods, may influence satiety, food cravings, gut microbiota, and long-term health outcomes.<sup>96</sup>

### Feature 8: Choose and Prepare Foods With Little or No Salt

In general, there is a direct, positive relationship between salt (sodium chloride) intake and blood pressure.<sup>97</sup> In randomized trials, lowering sodium intake lowers blood pressure in both nonhypertensive and hypertensive individuals, including those treated with antihypertensive medication, thereby improving the prevention and control of hypertension.<sup>1,98</sup> In observational studies, a reduced sodium intake is associated with a blunted age-related rise in systolic blood pressure<sup>99</sup> and, in some studies, a lower cardiovascular disease risk.<sup>98</sup> In general, the effects of sodium reduction on blood pressure tend to be greater in Black individuals, middle-aged and older-aged people, and individuals with hypertension.<sup>97</sup> The combination of the DASH diet and reduced sodium is greater than either approach alone.<sup>51</sup> In the United States, the leading sources of dietary sodium are processed foods, foods prepared outside the home, packaged foods, and restaurant foods, together accounting for almost three-quarters of total dietary sodium.<sup>100</sup> Of note, even foods labeled 100% whole wheat or organic can be high in sodium. Public health approaches to lower sodium in the food supply are likely the most effective strategy.<sup>101</sup> A promising alternative is replacement of regular salt with potassium-enriched salts, especially in settings in which the addition of salt during food preparation is the most common source.<sup>102</sup>

### Feature 9: If You Do Not Drink Alcohol, Do Not Start; If You Choose to Drink Alcohol, Limit Intake

The relationship between alcohol intake and CVD is complex. Risk appears to differ by amount and pattern of alcohol intake; age and sex of individuals; and type

of CVD outcome. For certain outcomes, the relation is direct, that is, as alcohol intake increases, so does the risk of hemorrhagic stroke and atrial fibrillation.<sup>9,103</sup> For CHD and ischemic stroke, there is a J- or U-shaped relationship, with the lowest risk at low alcohol intake,  $\approx 1$  to 2 drinks per day, and higher risks at no intake and higher intake.<sup>103</sup> These relations are based on observational studies; hence, confounding by other variables cannot be excluded. There has been no intervention trial of alcohol on hard clinical/CVD outcomes, except for a small trial that documented that abstinence from alcohol reduced recurrences of arrhythmia in regular drinkers with atrial fibrillation.<sup>104</sup>

Although low intake has been associated with a lower risk of CHD and ischemic stroke, the AHA does not support initiation of alcohol intake at any level to improve CVD health, given the uncertainty about net health effects, especially in light of the deleterious effects of alcohol on numerous other outcomes (injuries, violence, digestive diseases, infectious diseases, pregnancy outcomes, and cancer).<sup>103</sup> The 2020 Dietary Guidelines Advisory Committee recently concluded that those who do drink should consume no more than 1 drink per day and should not drink alcohol in binges.<sup>9</sup> In contrast, the 2020 to 2025 Dietary Guidelines for Americans continues to recommend no more than 1 drink per day for women and 2 drinks per day for men.<sup>19</sup>

### Feature 10: Adhere to This Guidance Regardless of Wherever Food Is Prepared or Consumed

Food-based dietary guidance applies to all foods and beverages, regardless of where prepared, procured, and consumed. Food is prepared and consumed nearly everywhere in the environment where we live. Policies should be enacted that encourage healthier default options such as making whole grain rather than refined grain products available and minimizing the sodium and sugar content in products.

## ADDITIONAL BENEFITS OF HEART-HEALTHY DIETARY PATTERNS

### Desirable Nutrient Profile

#### *Rich in Fiber*

Dietary fiber found in plant foods, including fruits, vegetables, whole grains, nuts, seeds, beans, and legumes, is consistently inversely associated with lower risk of metabolic syndrome,<sup>105</sup> cardiometabolic risk,<sup>106</sup> and CVD.<sup>107–111</sup> Fiber also has beneficial effects on digestive health.<sup>112</sup> Although fiber is commonly categorized as either soluble or insoluble, the underlying biological mechanisms appear to be the degree of fermentability and viscosity in the gastrointestinal tract.<sup>112</sup>

### *Fulfill Essential Nutrient Requirements for Most Individuals*

It is preferable to obtain essential nutrients from foods and beverages that are part of heart-healthy dietary patterns rather than nutrient supplements. This approach avoids the risk of individual nutrient overconsumption. This approach also promotes the consumption of phytochemicals, a group of compounds that have emerged as likely contributors to the desirable nutrient profiles of many plant foods.<sup>113</sup> In addition, at this time, there is insufficient evidence to support the use of high-dose vitamin and mineral supplements to prevent CVD.<sup>114</sup> Trials to date on the effect of nutrient supplements and CVD outcomes have yielded largely null results.<sup>115–123</sup> Healthy dietary patterns are rich in potassium, which has been associated with lower blood pressure especially in people with hypertension.<sup>98</sup> Likewise, heart-healthy dietary patterns tend to be nutrient dense and rich in essential nutrients.<sup>9</sup> Therefore, heart-healthy dietary patterns should continue to emphasize foods to meet nutrient requirements. Vitamin and mineral supplementations should not be used as a replacement for a healthy dietary pattern. However, individual nutrient supplements may be needed in cases of nutrient inadequacy or for those eating restricted diets (eg, vegans, certain groups of older adults).

### *Low in Saturated Fat, Partially Hydrogenated (Trans) Fat, Cholesterol, Added Sugar, and Salt*

Healthy dietary patterns are inherently low in saturated fat, *trans* fat, cholesterol, added sugar, and salt. However, some of these components are commonly added to foods during food preparation. Such products should be limited, as discussed earlier (see features 6–8).

#### *Saturated Fat*

A comprehensive systematic review and meta-analysis documented the detrimental effects of saturated fat relative to unsaturated fat on CVD outcomes and risk factors.<sup>73</sup> Major dietary sources of saturated fats are meats, full-fat dairy products, and tropical oils (coconut, palm, and palm kernel). A meta-analysis that included only high-quality randomized clinical trials concluded modification lowered CVD by  $\approx 30\%$ , similar to the effect of statin drugs.<sup>73</sup> When all randomized trials were combined, regardless of quality, the reduction in CVD was diminished but still significant. Many population studies in which research participants are followed for years showed that diets low in saturated fats and rich in unsaturated fat were associated with lower risk of CVD, diabetes, and other causes of death.<sup>9,73</sup> A similar benefit has not been observed when saturated fat is replaced with refined carbohydrate.<sup>35</sup> Over the past several years, the use of coconut oil has become increasingly prevalent despite its high saturated fat content. These oils raise LDL cholesterol, with little evidence of positive healthy benefits.<sup>124</sup>

### Partially Hydrogenated (Trans) Fat

The major source of dietary *trans* fatty acid has been partially hydrogenated fat.<sup>125</sup> Consistent evidence has documented the adverse effects of *trans* fatty acids on cardiometabolic risk factors.<sup>126</sup> In the United States, these data led to mandatory inclusion of *trans* fat on the Nutrient Facts label and removal of partially hydrogenated fat from the Generally Recognized As Safe list,<sup>82,127</sup> resulting in drastic reductions of *trans* fatty acid content of the food supply.<sup>73,128</sup> Similar trends were recently documented in Canada.<sup>129</sup> Currently, the other source of dietary *trans* fatty acids is animal (ruminant) fat. Following current guidance to replace saturated fat (meat and dairy) with nontropical plant oils also reduces dietary *trans* fatty acids.<sup>130</sup>

### Dietary Cholesterol

Guidance for reducing CVD risk and LDL cholesterol concentrations have historically included recommendations to limit dietary cholesterol, although more recently numerical limits have not been explicit.<sup>131</sup> A positive relation between dietary cholesterol and LDL cholesterol concentrations has been documented; still, the current US intake is similar to the historical 300 mg/d upper level.<sup>132</sup> Consistent with these findings, the 2020 Dietary Guidelines Advisory Committee report noted that current intakes should not be increased.<sup>9</sup> Assessing the independent effect of dietary cholesterol on CVD risk is complicated by the lack of evidence at plausible, rather than extremely high intakes, and the difficulty in isolating the effects of eggs from those of frequently paired foods such as bacon and sausage. Adhering to a dietary pattern consistent with the guidance in this document will result in relatively low dietary cholesterol intakes. An in-depth analysis of the topic can be found in the AHA scientific statement on dietary cholesterol and cardiovascular risk.<sup>132</sup>

### Reduced Risk of Other Chronic Conditions

Suboptimal diet quality is the leading risk factor for death from major noncommunicable diseases in the United States.<sup>18</sup> A comprehensive systematic review recently concluded that the highest-quality diet scores were associated with lower risk of all-cause mortality, CVD incidence or mortality, cancer incidence or mortality, type 2 diabetes, and neurodegenerative diseases.<sup>133</sup>

### Type 2 Diabetes

Type 2 diabetes is a major risk factor for CVD. Evidence from prospective observational studies has consistently identified an inverse association between diet quality and type 2 diabetes risk<sup>134,135</sup>; likewise, the Mediterranean-style eating pattern has been inversely associated with risk for type 2 diabetes.<sup>136,137</sup> The association has been attributed to low-

er body mass index and reduced insulin resistance and inflammation.

### Cognitive Decline

Healthy dietary patterns are linked to better cognitive abilities and slower decline with advancing years.<sup>71</sup> DASH-style dietary patterns, with and without a physical activity program component, are associated with a slower decline in age-associated cognitive tasks.<sup>138–141</sup> Observational studies and randomized clinical trials have also found that a Mediterranean-style diet was associated with a slower decline in cognitive status.<sup>140,142,143</sup> The Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet, which is a hybrid of the DASH and Mediterranean diets, has been associated with slower rates of age-related cognitive decline<sup>144</sup> and a lower incidence of Alzheimer disease.<sup>145</sup> In contrast, a small and short-term randomized trial conducted in Australia reported no significant benefit of Mediterranean-style diet on cognitive functioning.<sup>146</sup>

### Kidney Function Decline

Heart-healthy foods and dietary patterns promote kidney health. Observational studies have reported that higher intake of low-fat dairy, nuts, and legumes; greater adherence to the DASH diet, Mediterranean-type diet, and plant-based diet; and moderate alcohol consumption were associated with lower risk of adverse kidney outcomes; and higher intake of artificially sweetened beverages, sugar-sweetened beverages, and red and processed meat was associated with higher risk of adverse kidney outcomes.<sup>147–154</sup> Clinical trials have demonstrated that restricting sodium and increasing fruits and vegetable intake reduces kidney injury.<sup>155–157</sup>

### Low Environmental Impact

There are increasing concerns about the environmental impact of current dietary patterns and food systems that favor animal-based food production and consumption, which contribute substantially to human-generated, greenhouse gas emissions, and water and land usage.<sup>42</sup> Commonly consumed animal products, particularly red meat, have the largest environmental impact. Reducing meat intake from current high levels will improve diet quality and result in more sustainable dietary patterns and lower carbon footprint.<sup>42</sup> Multiple dietary patterns such as DASH, Mediterranean, Healthy US-Style, and healthy vegetarian patterns are consistent with heart-healthy dietary patterns and also associated with a smaller environmental impact than the average US diet.<sup>158</sup> Of note, sustainability is not always synonymous with heart-healthy dietary patterns. For example, plant-based diets high in refined carbohydrate and added sugar have been associated with increased risk of type 2 diabetes<sup>159</sup> and CVD.<sup>160</sup>

## CHALLENGES TO ADHERING TO HEART-HEALTHY DIETARY PATTERNS

The food environment has a substantial influence on people's food choices, diet quality, and subsequently cardiovascular health at many levels, making it difficult for many Americans to adhere to heart-healthy dietary patterns. In the background of rampant nutrition misinformation,<sup>161</sup> there are numerous systemic federal, state, and local practices and policies that impede the adoption of these dietary patterns. As discussed later on in this scientific statement, factors including targeted food marketing, structural racism, neighborhood segregation, unhealthy built environments, and food and nutrition insecurity create environments in which unhealthy foods are the default option where we eat, work, and live. Moreover, varied access, availability, price, promotion, and placement of products in different environments often make it easier to choose unhealthy versus healthy foods. Improving diet quality and related chronic health conditions across all populations will require addressing these upstream systemic problems, in particular, among people of underrepresented races and ethnicities.<sup>162,163</sup> An important adjuvant approach alongside widespread environmental changes is to directly combat nutrition misinformation among the public and health care professionals. Reintroduction of food and nutrition education in curricula for K-12 and medical school may facilitate these efforts.<sup>164,165</sup>

### Socioeconomic Factors and Food and Nutrition Insecurity

Despite widespread knowledge of the components of a heart-healthy dietary pattern, the United States has made little progress in achieving dietary goals.<sup>15</sup> Disparities in dietary quality by income, race and ethnicity, education, and use of food assistance programs have been well documented,<sup>162,166</sup> yet there has been little action to reduce these gaps that contribute to suboptimal diet quality.

Food and nutrition insecurity is defined as limited or uncertain access to safe and nutritious food, a condition that was estimated to affect 37 million Americans in 2018, with a disproportionate burden on Black and Hispanic households.<sup>167</sup> Numerous studies have shown that food and nutrition insecurity is associated with poor diet quality and high chronic disease rates.<sup>168–172</sup> Federal food assistance programs, such as the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), provide supplemental assistance for food purchases, but these programs only support a fraction of the monthly household food supply.<sup>173</sup> Many food and nutrition-insecure individuals, such as those who are not US citizens or permanent residents, are not eligible for SNAP or WIC benefits. The WIC program was revised in 2009 to increase fruits, vegetables, whole grains, and low-fat milk, and these changes were associated with the purchase of healthier foods.<sup>174,175</sup>

Studies have demonstrated the effectiveness of providing incentives for healthier purchases in the SNAP program, in particular, fruits and vegetables,<sup>176–179</sup> yet corresponding SNAP policies that incentivize healthier purchases have not been implemented.

### Structural Racism and Neighborhood Segregation

Longstanding inequities in consumption of heart-healthy dietary patterns and diet-related chronic diseases risk are exacerbated by factors related to residential segregation and inequitable institutional systems, such as education, employment, criminal justice, and health care (collectively termed, structural racism).<sup>180</sup> Reaching population-level dietary goals will not occur without addressing structural factors responsible for neighborhood segregation, low educational attainment, and low-income. Discriminatory housing policies have led to neighborhood segregation that contributes to built environments that promote unhealthy dietary patterns,<sup>162</sup> such as low consumption of fruits and vegetables and high consumption of unhealthy snacks, desserts, and fast food.<sup>181,182</sup> Many communities with a high proportion of people from underrepresented races and ethnicities have few supermarkets but many fast food, convenience, and dollar stores.<sup>183</sup> Lack of access to adequate transportation adds to the difficulty in purveying healthy foods in these communities.<sup>184</sup> The US Department of Agriculture recently piloted a program in several states that allowed the use of SNAP benefits for online grocery shopping, a policy change intended to improve access to healthy foods for SNAP recipients by eliminating some of the environmental barriers.<sup>185</sup>

### Targeted Marketing of Unhealthy Foods and Beverages

Black and Hispanic children are more likely to be exposed to advertising for processed food and beverages through outdoor, television, digital, and print advertising than non-Hispanic White children.<sup>163,181,186–188</sup> Similar to the tobacco industry, the food and beverage industry has combined targeted advertising efforts with sponsorship of events and organizations targeted toward people of underrepresented races and ethnicities, and through corporate giving, as well, aimed at establishing a goodwill presence in those communities.<sup>163</sup> Online shopping, initially thought to be an opportunity for reducing disparities in food purchases, actually might have the opposite effect by using artificial intelligence to promote unhealthy foods and beverages. These practices are likely to have a disproportionate and deleterious effect on shoppers who may come from low-income, underresourced, and underrepresented groups.<sup>189</sup> Such marketing of unhealthy food and beverages compounds the adverse dietary and



health effects related to the built environment, social determinants, and structural racism.<sup>163</sup>

## LOOKING TO THE FUTURE: PRECISION NUTRITION TO IMPROVE DIETARY PATTERNS AND HEALTH FOR ALL PEOPLE

The National Institutes of Health 2020 to 2030 Strategic Plan for National Institutes of Health Nutrition Research focuses on precision nutrition to determine the impact on health of not only what individuals eat, but also of why, when, and how they eat throughout the life course.<sup>190</sup> Precision nutrition stems from increasing evidence that individual differences (interindividual variability) in dietary intake, behaviors, genetic background, microbiome, and socioeconomic and physical environments influence disease risk.<sup>190–192</sup> The National Institutes of Health strategic plan aims to advance understanding of the interactions and synergies among these factors to inform the development of clinically relevant strategies to improve dietary intake and health.<sup>190</sup> Precision nutrition harnesses the power of genotyping, bioinformatics, and artificial intelligence in combination with implementation and behavioral sciences.<sup>191,193</sup> In the future, multilevel precision nutrition strategies could help reduce socioeconomic and racial and ethnic disparities in dietary intake and cardiovascular disease outcomes.<sup>194</sup> However, although precision nutrition has future potential to provide personalized diets for CVD prevention, the field is still developing. Hence, the current focus on public health nutrition strategies to improve the food environment is warranted.

## CONCLUSION

This AHA scientific statement on dietary guidance to improve cardiovascular health summarizes available evidence, provides contextual guidance for the key

components of dietary patterns to reduce CVD morbidity and mortality, and discusses population-wide adoption of the guidance. Challenges to adhering to heart-healthy dietary patterns include targeted marketing of unhealthy foods and beverages, structural racism, neighborhood segregation, and food and nutrition insecurity. Creating an environment that facilitates, rather than impedes, adherence to heart-healthy dietary patterns among all individuals is a public health imperative.

## ARTICLE INFORMATION

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

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## Disclosures

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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

\*Significant.

## Reviewer Disclosures

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\*Modest.

## REFERENCES

- Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA, Franklin B, Kris-Etherton P, Harris WS, Howard B, et al; American Heart Association Nutrition Committee. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. *Circulation*. 2006;114:82–96. doi: 10.1161/CIRCULATIONAHA.106.176158
- Dai H, Much AA, Maor E, Asher E, Younis A, Xu Y, Lu Y, Liu X, Shu J, Bragazzi NL. Global, regional, and national burden of ischemic heart disease and its attributable risk factors, 1990–2017: results from the global Burden of Disease Study 2017. *Eur Heart J Qual Care Clin Outcomes*. Published online October 5, 2020. doi: 10.1093/ehjqcco/qcaa076
- Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, Greenlund K, Daniels S, Nichol G, Tomaselli GF, et al; American Heart Association Strategic Planning Task Force and Statistics Committee. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. *Circulation*. 2010;121:586–613. doi: 10.1161/CIRCULATIONAHA.109.192703
- Perak AM, Ning H, Khan SS, Van Horn LV, Grobman WA, Lloyd-Jones DM. Cardiovascular health among pregnant women, aged 20 to 44 years, in the United States. *J Am Heart Assoc*. 2020;9:e015123. doi: 10.1161/JAHA.119.015123
- US Department of Agriculture Food and Nutrition Service. USDA food patterns. 2011. Accessed March 26, 2021. <https://www.fns.usda.gov/usda-food-patterns>
- Liese AD, Krebs-Smith SM, Subar AF, George SM, Harmon BE, Neuhauser ML, Boushey CJ, Schap TE, Reedy J. The Dietary Patterns Methods Project: synthesis of findings across cohorts and relevance to dietary guidance. *J Nutr*. 2015;145:393–402. doi: 10.3945/jn.114.205336
- D'Souza MS, Dong TA, Ragazzo G, Dhindsa DS, Mehta A, Sandesara PB, Freeman AM, Taub P, Sperling LS. From fad to fact: evaluating the impact of emerging diets on the prevention of cardiovascular disease. *Am J Med*. 2020;133:1126–1134. doi: 10.1016/j.amjmed.2020.05.017
- Kuchkuntla AR, Limketkai B, Nanda S, Hurt RT, Mundi MS. Fad diets: hype or hope? *Curr Nutr Rep*. 2018;7:310–323. doi: 10.1007/s13668-018-0242-1
- Dietary Guidelines Advisory Committee. Scientific report of the 2020 Dietary Guidelines Advisory Committee: advisory report to the Secretary of Agriculture and the Secretary of Health and Human Services. US Department of Agriculture, Agricultural Research Service; 2020.
- Widen EM, Wyatt RM, Hoepner LA, Ramirez-Carvey J, Oberfield SE, Hassoun A, Perera FP, Gallagher D, Rundle AG. Excessive gestational weight gain is associated with long-term body fat and weight retention

- at 7 y postpartum in African American and Dominican mothers with underweight, normal, and overweight prepregnancy BMI. *Am J Clin Nutr*. 2015;102:1460–1467. doi: 10.3945/ajcn.115.116939
11. Oken E, Taveras EM, Kleinman KP, Rich-Edwards JW, Gillman MW. Gestational weight gain and child adiposity at age 3 years. *Am J Obstet Gynecol*. 2007;196:322.e1–322.e8. doi: 10.1016/j.ajog.2006.11.027
  12. Gillman MW, Rifas-Shiman SL, Kleinman K, Oken E, Rich-Edwards JW, Taveras EM. Developmental origins of childhood overweight: potential public health impact. *Obesity (Silver Spring)*. 2008;16:1651–1656. doi: 10.1038/oby.2008.260
  13. Allen NB, Krefman AE, Labarthe D, Greenland P, Juonala M, Kähönen M, Lehtimäki T, Day RS, Bazzano LA, Van Horn LV, et al. Cardiovascular health trajectories from childhood through middle age and their association with subclinical atherosclerosis. *JAMA Cardiol*. 2020;5:557–566. doi: 10.1001/jamacardio.2020.0140
  14. Savage JH, Lee-Sarwar KA, Sordillo JE, Lange NE, Zhou Y, O'Connor GT, Sandel M, Bacharier LB, Zeiger R, Sodergren E, et al. Diet during pregnancy and infancy and the infant intestinal microbiome. *J Pediatr*. 2018;203:47–54.e4. doi: 10.1016/j.jpeds.2018.07.066
  15. Shan Z, Rehm CD, Rogers G, Ruan M, Wang DD, Hu FB, Mozaffarian D, Zhang FF, Bhupathiraju SN. Trends in dietary carbohydrate, protein, and fat intake and diet quality among US adults, 1999–2016. *JAMA*. 2019;322:1178–1187. doi: 10.1001/jama.2019.13771
  16. Hu EA, Steffen LM, Coresh J, Appel LJ, Rebholz CM. Adherence to the healthy eating index-2015 and other dietary patterns may reduce risk of cardiovascular disease, cardiovascular mortality, and all-cause mortality. *J Nutr*. 2020;150:312–321. doi: 10.1093/jn/nxz218
  17. Reedy J, Krebs-Smith SM, Miller PE, Liese AD, Kahle LL, Park Y, Subar AF. Higher diet quality is associated with decreased risk of all-cause, cardiovascular disease, and cancer mortality among older adults. *J Nutr*. 2014;144:881–889. doi: 10.3945/jn.113.189407
  18. Afshin A, Forouzanfar MH, Reitsma MB, Sur P, Estep K, Lee A, Marczak L, Mokdad AH, Moradi-Lakeh M, Naghavi M, et al. Health effects of overweight and obesity in 195 countries over 25 years. *N Engl J Med*. 2017;377:13–27. doi: 10.1056/NEJMoa1614362
  19. US Department of Agriculture and US Department of Health and Human Services. *Dietary Guidelines for Americans 2020–2025*. 9th ed. December 2020.
  20. Van Horn L. Calories count: but can consumers count on them? *JAMA*. 2011;306:315–316. doi: 10.1001/jama.2011.1022
  21. Van Horn L, Carson JA, Appel LJ, Burke LE, Economos C, Karmally W, Lancaster K, Lichtenstein AH, Johnson RK, Thomas RJ, et al; on behalf of the American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular Disease in the Young; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; and Stroke Council. Recommended dietary pattern to achieve adherence to the American Heart Association/American College of Cardiology (AHA/ACC) Guidelines: a scientific statement from the American Heart Association. *Circulation*. 2016;134:e505–e529. doi: 10.1161/CIR.0000000000000462
  22. Brown JE. *Nutrition Through the Life Cycle*, 6th ed. Cengage Learning; 2017.
  23. Vadiveloo M, Lichtenstein AH, Anderson C, Aspry K, Foraker R, Griggs S, Hayman LL, Johnston E, Stone NJ, Thorndike AN; on behalf of the American Heart Association Council on Lifestyle and Cardiometabolic Health; Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; and Stroke Council. Rapid diet assessment screening tools for cardiovascular disease risk reduction across healthcare settings: a scientific statement from the American Heart Association. *Circ Cardiovasc Qual Outcomes*. 2020;13:e000094. doi: 10.1161/HCO.0000000000000094
  24. Schwingshackl L, Schwedhelm C, Hoffmann G, Boeing H. Potatoes and risk of chronic disease: a systematic review and dose-response meta-analysis. *Eur J Nutr*. 2019;58:2243–2251. doi: 10.1007/s00394-018-1774-2
  25. Wang DD, Li Y, Bhupathiraju SN, Rosner BA, Sun Q, Giovannucci EL, Rimm EB, Manson JE, Willett WC, Stampfer MJ, et al. Fruit and vegetable intake and mortality: results from 2 prospective cohort studies of US men and women and a meta-analysis of 26 cohort studies. *Circulation*. 2021;143:1642–1654. doi: 10.1161/CIRCULATIONAHA.120.048996
  26. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med*. 1997;336:1117–1124. doi: 10.1056/NEJM199704173361601
  27. Lapuente M, Estruch R, Shahbaz M, Casas R. Relation of fruits and vegetables with major cardiometabolic risk factors, markers of oxidation, and inflammation. *Nutrients*. 2019;11:2381. doi: 10.3390/nu11102381
  28. Fatahi S, Daneshzad E, Kord-Varkaneh H, Bellissimo N, Brett NR, Azadbakht L. Impact of diets rich in whole grains and fruits and vegetables on cardiovascular risk factors in overweight and obese women: a randomized clinical feeding trial. *J Am Coll Nutr*. 2018;37:568–577. doi: 10.1080/07315724.2018.1444520
  29. Goraya N, Munoz-Maldonado Y, Simoni J, Wesson DE. Treatment of chronic kidney disease-related metabolic acidosis with fruits and vegetables compared to NaHCO<sub>3</sub> yields more and better overall health outcomes and at comparable five-year cost. *J Renal Nutr*. 2020;31:239–247. doi: 10.1053/j.jrn.2020.08.001
  30. McEvoy CT, Wallace IR, Hamill LL, Hunter SJ, Neville CE, Patterson CC, Woodside JV, Young IS, McKinley MC. Increasing fruit and vegetable intake has no dose-response effect on conventional cardiovascular risk factors in overweight adults at high risk of developing cardiovascular disease. *J Nutr*. 2015;145:1464–1471. doi: 10.3945/jn.115.213090
  31. Minich DM. A review of the science of colorful, plant-based food and practical strategies for "eating the rainbow." *J Nutr Metab*. 2019;2019:2125070. doi: 10.1155/2019/2125070
  32. Wang DD, Li Y, Bhupathiraju SN, Rosner BA, Sun Q, Giovannucci EL, Rimm EB, Manson JE, Willett WC, Stampfer MJ, et al. Fruit and vegetable intake and mortality: results from 2 prospective cohort studies of us men and women and a meta-analysis of 26 cohort studies. *Circulation*. 2021;143:1642–1654. doi: 10.1161/CIRCULATIONAHA.120.048996
  33. Ferruzzi MG, Jonnalagadda SS, Liu S, Marquart L, McKeown N, Reicks M, Riccardi G, Seal C, Slavin J, Thielecke F, et al. Developing a standard definition of whole-grain foods for dietary recommendations: summary report of a multidisciplinary expert roundtable discussion. *Adv Nutr*. 2014;5:164–176. doi: 10.3945/an.113.005223
  34. US Food and Drug Administration. Draft guidance for industry and FDA staff: whole grain label statements. February 2006. FDA-2006-D-0298. 2006. <https://www.fda.gov/regulatory-information/search-fda-guidance-documents/draft-guidance-industry-and-fda-staff-whole-grain-label-statements>
  35. Li Y, Hruby A, Bernstein AM, Ley SH, Wang DD, Chiuve SE, Sampson L, Rexrode KM, Rimm EB, Willett WC, et al. Saturated fats compared with unsaturated fats and sources of carbohydrates in relation to risk of coronary heart disease: a prospective cohort study. *J Am Coll Cardiol*. 2015;66:1538–1548. doi: 10.1016/j.jacc.2015.07.055
  36. Tosh SM, Bordenave N. Emerging science on benefits of whole grain oat and barley and their soluble dietary fibers for heart health, glycemic response, and gut microbiota. *Nutr Rev*. 2020;78(suppl 1):13–20. doi: 10.1093/nutrit/nuz085
  37. Reynolds A, Mann J, Cummings J, Winter N, Mete E, Te Morenga L. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet*. 2019;393:434–445. doi: 10.1016/S0140-6736(18)31809-9
  38. Polak R, Phillips EM, Campbell A. Legumes: health benefits and culinary approaches to increase intake. *Clin Diabetes*. 2015;33:198–205. doi: 10.2337/diaclin.33.4.198
  39. Vigiouliou K, Glenn AJ, Nishi SK, Chiavaroli L, Seider M, Khan T, Bonaccio M, Iacoviello L, Mejia SB, Jenkins DJA, et al. Associations between dietary pulses alone or with other legumes and cardiometabolic disease outcomes: an umbrella review and updated systematic review and meta-analysis of prospective cohort studies. *Adv Nutr*. 2019;10(suppl 4):S308–S319. doi: 10.1093/advances/nmz113
  40. Kim Y, Keogh JB, Clifton PM. Does nut consumption reduce mortality and/or risk of cardiometabolic disease? An updated review based on meta-analyses. *Int J Environ Res Public Health*. 2019;16:4957. doi: 10.3390/ijerph16244957
  41. Becerra-Tomás N, Paz-Graniel I, Kendall CWC, Kahleova H, Rahelić D, Sievenpiper JL, Salas-Salvado J. Nut consumption and incidence of cardiovascular diseases and cardiovascular disease mortality: a meta-analysis of prospective cohort studies. *Nutr Rev*. 2019;77:691–709. doi: 10.1093/nutrit/nuz042
  42. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S, Garnett T, Tilman D, DeClerck F, Wood A, et al. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet*. 2019;393:447–492. doi: 10.1016/S0140-6736(18)31788-4
  43. Monteiro CA, Cannon G, Levy RB, Moubarac J-C, Jaime P, Martins AP, Canella D, Louzada M, Parra D. NOVA. The star shines bright. Food classification. Public health. *World Nutr*. 2016;7.
  44. Gehring J, Touvier M, Baudry J, Julia C, Buscail C, Srour B, Hercberg S, Péneau S, Kesse-Guyot E, Allès B. Consumption of ultra-processed foods by

- pesco-vegetarians, vegetarians, and vegans: associations with duration and age at diet initiation. *J Nutr*. 2021;151:120–131. doi: 10.1093/jn/nxaa196
45. Crimarco A, Springfield S, Petlura C, Streaty T, Cunanan K, Lee J, Fielding-Singh P, Carter MM, Topf MA, Wastyk HC, et al. A randomized crossover trial on the effect of plant-based compared with animal-based meat on trimethylamine-N-oxide and cardiovascular disease risk factors in generally healthy adults: Study With Appetizing Plantfood-Meat Eating Alternative Trial (SWAP-MEAT). *Am J Clin Nutr*. 2020;112:1188–1199. doi: 10.1093/ajcn/nqaa203
  46. Khandpur N, Martinez-Steele E, Sun O. Plant-based meat and dairy substitutes as appropriate alternatives to animal-based products? *J Nutr*. 2021;151:3–4. doi: 10.1093/jn/nxaa351
  47. Jayedi A, Shab-Bidar S. Fish consumption and the risk of chronic disease: an umbrella review of meta-analyses of prospective cohort studies. *Adv Nutr*. 2020;11:1123–1133. doi: 10.1093/advances/nmaa029
  48. Zhang B, Xiong K, Cai J, Ma A. Fish consumption and coronary heart disease: a meta-analysis. *Nutrients*. 2020;12:2278. doi: 10.3390/nu12082278
  49. Krittanawong C, Isath A, Hahn J, Wang Z, Narasimhan B, Kaplin SL, Jneid H, Virani SS, Tang WHW. Fish consumption and cardiovascular health: a systematic review. *Am J Med*. 2021;134:713–720. doi: 10.1016/j.amjmed.2020.12.017
  50. Rimm EB, Appel LJ, Chiuve SE, Djoussé L, Engler MB, Kris-Etherton PM, Mozaffarian D, Siscovick DS, Lichtenstein AH; American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Epidemiology and Prevention; Council on Cardiovascular Disease in the Young; Council on Cardiovascular and Stroke Nursing; and Council on Clinical Cardiology. Seafood long-chain n-3 polyunsaturated fatty acids and cardiovascular disease: a science advisory from the American Heart Association. *Circulation*. 2018;138:e35–e47. doi: 10.1161/CIR.0000000000000574
  51. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER 3rd, Simons-Morton DG, et al; DASH-Sodium Collaborative Research Group. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med*. 2001;344:3–10. doi: 10.1056/NEJM200101043440101
  52. Jousilahti P, Laatikainen T, Peltonen M, Borodulin K, Männistö S, Jula A, Salomaa V, Harald K, Puska P, Vartiainen E. Primary prevention and risk factor reduction in coronary heart disease mortality among working aged men and women in eastern Finland over 40 years: population based observational study. *BMJ*. 2016;352:j721. doi: 10.1136/bmj.j721
  53. Pietinen P, Vartiainen E, Seppänen R, Aro A, Puska P. Changes in diet in Finland from 1972 to 1992: impact on coronary heart disease risk. *Prev Med*. 1996;25:243–250. doi: 10.1006/pmed.1996.0053
  54. Chen GC, Tong X, Xu JY, Han SF, Wan ZX, Qin JB, Qin LQ. Whole-grain intake and total, cardiovascular, and cancer mortality: a systematic review and meta-analysis of prospective studies. *Am J Clin Nutr*. 2016;104:164–172. doi: 10.3945/ajcn.115.122432
  55. Krauss RM, Kris-Etherton PM. Public health guidelines should recommend reducing saturated fat consumption as much as possible: debate consensus. *Am J Clin Nutr*. 2020;112:25–26. doi: 10.1093/ajcn/nqaa134
  56. Salas-Salvadó J, Guasch-Ferré M, Díaz-López A, Babio N. Yogurt and diabetes: overview of recent observational studies. *J Nutr*. 2017;147:1452S–1461S. doi: 10.3945/jn.117.248229
  57. Koskinen TT, Virtanen HEK, Voutilainen S, Tuomainen TP, Mursu J, Virtanen JK. Intake of fermented and non-fermented dairy products and risk of incident CHD: the Kuopio Ischaemic Heart Disease Risk Factor Study. *Br J Nutr*. 2018;120:1288–1297. doi: 10.1017/S0007114518002830
  58. Wang X, Lin X, Ouyang YY, Liu J, Zhao G, Pan A, Hu FB. Red and processed meat consumption and mortality: dose-response meta-analysis of prospective cohort studies. *Public Health Nutr*. 2016;19:893–905. doi: 10.1017/S1368980015002062
  59. Zhong VW, Van Horn L, Greenland P, Carnethon MR, Ning H, Wilkins JT, Lloyd-Jones DM, Allen NB. Associations of processed meat, unprocessed red meat, poultry, or fish intake with incident cardiovascular disease and all-cause mortality. *JAMA Intern Med*. 2020;180:503–512. doi: 10.1001/jamainternmed.2019.6969
  60. Rohrmann S, Linseisen J. Processed meat: the real villain? *Proc Nutr Soc*. 2016;75:233–241. doi: 10.1017/S0029665115004255
  61. Kim K, Hyeon J, Lee SA, Kwon SO, Lee H, Keum N, Lee JK, Park SM. Role of total, red, processed, and white meat consumption in stroke incidence and mortality: a systematic review and meta-analysis of prospective cohort studies. *J Am Heart Assoc*. 2017;6:e005983. doi: 10.1161/JAHA.117.005983
  62. Zheng Y, Li Y, Satija A, Pan A, Sotos-Prieto M, Rimm EB, Willett WC, Hu FB. Association of changes in red meat consumption with total and cause specific mortality among US women and men: two prospective cohort studies. *BMJ*. 2019;365:l2110. doi: 10.1136/bmj.l2110
  63. Smith JD, Hou T, Ludwig DS, Rimm EB, Willett W, Hu FB, Mozaffarian D. Changes in intake of protein foods, carbohydrate amount and quality, and long-term weight change: results from 3 prospective cohorts. *Am J Clin Nutr*. 2015;101:1216–1224. doi: 10.3945/ajcn.114.100867
  64. Rouhani MH, Salehi-Abargouei A, Surkan PJ, Azadbakht L. Is there a relationship between red or processed meat intake and obesity? A systematic review and meta-analysis of observational studies. *Obes Rev*. 2014;15:740–748. doi: 10.1111/obr.12172
  65. Kwok CS, Gulati M, Michos ED, Potts J, Wu P, Watson L, Loke YK, Mallen C, Mamas MA. Dietary components and risk of cardiovascular disease and all-cause mortality: a review of evidence from meta-analyses. *Eur J Prev Cardiol*. 2019;26:1415–1429. doi: 10.1177/2047487319843667
  66. Bechthold A, Boeing H, Schwedhelm C, Hoffmann G, Knüppel S, Iqbal K, De Henauw S, Michels N, Devleeschauwer B, Schlesinger S, et al. Food groups and risk of coronary heart disease, stroke and heart failure: a systematic review and dose-response meta-analysis of prospective studies. *Crit Rev Food Sci Nutr*. 2019;59:1071–1090. doi: 10.1080/10408398.2017.1392288
  67. Tang WH, Wang Z, Levison BS, Koeth RA, Britt EB, Fu X, Wu Y, Hazen SL. Intestinal microbial metabolism of phosphatidylcholine and cardiovascular risk. *N Engl J Med*. 2013;368:1575–1584. doi: 10.1056/NEJMoa1109400
  68. Guasch-Ferré M, Satija A, Blondin SA, Janiszewski M, Emlen E, O'Connor LE, Campbell WW, Hu FB, Willett WC, Stampfer MJ. Meta-analysis of randomized controlled trials of red meat consumption in comparison with various comparison diets on cardiovascular risk factors. *Circulation*. 2019;139:1828–1845. doi: 10.1161/CIRCULATIONAHA.118.035225
  69. van den Brandt PA. Red meat, processed meat, and other dietary protein sources and risk of overall and cause-specific mortality in The Netherlands Cohort Study. *Eur J Epidemiol*. 2019;34:351–369. doi: 10.1007/s10654-019-00483-9
  70. Oude Griep LM, Seferidi P, Stamler J, Van Horn L, Chan C, Tzoulaki I, Steffen LM, Miura K, Ueshima H, Okuda Net al; INTERMAP Research Group. Relation of unprocessed, processed red meat and poultry consumption to blood pressure in East Asian and Western adults. *J Hypertens*. 2016;34:1721–1729. doi: 10.1097/HJH.0000000000001008
  71. Dominguez LJ, Barbagallo M, Muñoz-García M, Godos J, Martínez-González MA. Dietary patterns and cognitive decline: key features for prevention. *Curr Pharm Des*. 2019;25:2428–2442. doi: 10.2174/1381612825666190722110458
  72. Würtz AM, Hansen MD, Tjønneland A, Rimm EB, Schmidt EB, Overvad K, Jakobsen MU. Substitution of meat and fish with vegetables or potatoes and risk of myocardial infarction. *Br J Nutr*. 2016;116:1602–1610. doi: 10.1017/S0007114516003500
  73. Sacks FM, Lichtenstein AH, Wu JHY, Appel LJ, Creager MA, Kris-Etherton PM, Miller M, Rimm EB, Rudel LL, Robinson JG, et al; American Heart Association. Dietary fats and cardiovascular disease: a presidential advisory from the American Heart Association. *Circulation*. 2017;136:e1–e23. doi: 10.1161/CIR.0000000000000510
  74. Hsu HY, Lin CJ, Lee YS, Wu TH, Chien KL. Efficacy of more intensive lipid-lowering therapy on cardiovascular diseases: a systematic review and meta-analysis. *BMC Cardiovasc Disord*. 2020;20:334. doi: 10.1186/s12872-020-01567-1
  75. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr*. 2018;21:5–17. doi: 10.1017/S1368980017000234
  76. Juul F, Vaidean G, Parekh N. Ultra-processed foods and cardiovascular diseases: potential mechanisms of action. *Adv Nutr*. Published online May 3, 2021. doi: 10.1093/advances/nmab049
  77. Costa de Miranda R, Rauber F, Levy RB. Impact of ultra-processed food consumption on metabolic health. *Curr Opin Lipidol*. 2021;32:24–37. doi: 10.1097/MOL.0000000000000728
  78. Zhang Z, Jackson SL, Martinez E, Gillespie C, Yang Q. Association between ultraprocessed food intake and cardiovascular health in US adults: a cross-sectional analysis of the NHANES 2011–2016. *Am J Clin Nutr*. 2021;113:428–436. doi: 10.1093/ajcn/nqaa276
  79. Elizabeth L, Machado P, Zinöcker M, Baker P, Lawrence M. Ultra-processed foods and health outcomes: a narrative review. *Nutrients*. 2020;12:1955. doi: 10.3390/nu12071955

80. Hall KD, Ayuketah A, Brychta R, Cai H, Cassimatis T, Chen KY, Chung ST, Costa E, Courville A, Darcey V, et al. Ultra-processed diets cause excess calorie intake and weight gain: an inpatient randomized controlled trial of ad libitum food intake. *Cell Metab*. 2019;30:67–77.e3. doi: 10.1016/j.cmet.2019.05.008
81. Srour B, Fezeu LK, Kesse-Guyot E, Allès B, Debras C, Druet-Pecollo N, Chazelas E, Deschasaux M, Hercberg S, Galan P, et al. Ultra-processed food consumption and risk of type 2 diabetes among participants of the NutriNet-Santé prospective cohort. *JAMA Intern Med*. 2020;180:283–291. doi: 10.1001/jamainternmed.2019.5942
82. Srour B, Fezeu LK, Kesse-Guyot E, Allès B, Méjean C, Andrianasolo RM, Chazelas E, Deschasaux M, Hercberg S, Galan P, et al. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). *BMJ*. 2019;365:11451. doi: 10.1136/bmj.11451
83. Bonaccio M, Di Castelnuovo A, Costanzo S, De Curtis A, Persichillo M, Sofi F, Cerletti C, Donati MB, de Gaetano G, Iacoviello L. Ultra-processed food consumption is associated with increased risk of all-cause and cardiovascular mortality in the Moli-sani Study. *Am J Clin Nutr*. 2021;113:446–455. doi: 10.1093/ajcn/nqaa299
84. Food and Drug Administration Center for Food Safety and Applied Nutrition (CFSAN). Nutrition and supplement facts labels: questions and answers related to the compliance date, added sugars, and declaration of quantitative amounts of vitamins and minerals: guidance for industry. Accessed October 12, 2021. <https://www.fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-nutrition-and-supplement-facts-labels-questions-and-answers-related-compliance>.
85. Lichtenstein AH. Last nail in the coffin for sugar-sweetened beverages. *Circulation*. 2019;139:2126–2128. doi: 10.1161/CIRCULATIONAHA.119.040245
86. Malik VS, Popkin BM, Bray GA, Després JP, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation*. 2010;121:1356–1364. doi: 10.1161/CIRCULATIONAHA.109.876185
87. Laclaustra M, Rodriguez-Artalejo F, Guallar-Castillon P, Banegas JR, Graciani A, Garcia-Esquinas E, Ordovas J, Lopez-Garcia E. Prospective association between added sugars and frailty in older adults. *Am J Clin Nutr*. 2018;107:772–779. doi: 10.1093/ajcn/nqy028
88. Hoare E, Varsamis P, Owen N, Dunstan DW, Jennings GL, Kingwell BA. Sugar- and intense-sweetened drinks in Australia: a systematic review on cardiometabolic risk. *Nutrients*. 2017;9:1075. doi: 10.3390/nu9101075
89. Laviada-Molina H, Molina-Segui F, Pérez-Gaxiola G, Cuello-García C, Arjona-Villicaña R, Espinosa-Marrón A, Martínez-Portilla RJ. Effects of non-nutritive sweeteners on body weight and BMI in diverse clinical contexts: systematic review and meta-analysis. *Obes Rev*. 2020;21:e13020. doi: 10.1111/obr.13020
90. Karalexi MA, Mitrogiorgou M, Georgantzi GG, Papaevangelou V, Fessatou S. Non-nutritive sweeteners and metabolic health outcomes in children: a systematic review and meta-analysis. *J Pediatr*. 2018;197:128–133.e2. doi: 10.1016/j.jpeds.2018.01.081
91. Nichol AD, Holle MJ, An R. Glycemic impact of non-nutritive sweeteners: a systematic review and meta-analysis of randomized controlled trials. *Eur J Clin Nutr*. 2018;72:796–804. doi: 10.1038/s41430-018-0170-6
92. Malik VS, Hu FB. Sugar-sweetened beverages and cardiometabolic health: an update of the evidence. *Nutrients*. 2019;11:1840. doi: 10.3390/nu11081840
- 92a. Johnson RK, Lichtenstein AH, Anderson CAM, Carson JA, Després J-P, Hu FB, Kris-Etherton PM, Otten JJ, Towfighi A, Wylie-Rosett J; on behalf of the American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Quality of Care and Outcomes Research; and Stroke Council. Low-calorie sweetened beverages and cardiometabolic health: a science advisory from the American Heart Association. *Circulation*. 2018;138:e126–e140. doi: 10.1161/CIR.0000000000000569
93. Mossavar-Rahmani Y, Kamensky V, Manson JE, Silver B, Rapp SR, Haring B, Beresford SAA, Snetselaar L, Wassertheil-Smoller S. Artificially sweetened beverages and stroke, coronary heart disease, and all-cause mortality in the Women's Health Initiative. *Stroke*. 2019;50:555–562. doi: 10.1161/STROKEAHA.118.023100
94. Yin J, Zhu Y, Malik V, Li X, Peng X, Zhang FF, Shan Z, Liu L. Intake of sugar-sweetened and low-calorie sweetened beverages and risk of cardiovascular disease: a meta-analysis and systematic review. *Adv Nutr*. 2021;12:89–101. doi: 10.1093/advances/nmaa084
95. Tasevska N, Pettinger M, Kipnis V, Midthune D, Tinker LF, Potischman N, Neuhauser ML, Beasley JM, Van Horn L, Howard BV, et al. Associations of biomarker-calibrated intake of total sugars with the risk of type 2 diabetes and cardiovascular disease in the Women's Health Initiative Observational Study. *Am J Epidemiol*. 2018;187:2126–2135. doi: 10.1093/aje/kwy115
96. Van Laar ADE, Grootaert C, Van Camp J. Rare mono- and disaccharides as healthy alternative for traditional sugars and sweeteners? *Crit Rev Food Sci Nutr*. 2021;61:713–741. doi: 10.1080/10408398.2020.1743966
97. Appel LJ, Brands MW, Daniels SR, Karanja N, Elmer PJ, Sacks FM; American Heart Association. Dietary approaches to prevent and treat hypertension: a scientific statement from the American Heart Association. *Hypertension*. 2006;47:296–308. doi: 10.1161/01.HYP.0000202568.01167.B6
98. National Academies of Sciences, Engineering, and Medicine. *Dietary Reference Intakes for Sodium and Potassium*. The National Academies Press; 2019. doi: 10.17226/25353
99. Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. Intersalt Cooperative Research Group. *BMJ*. 1988;297:319–328. doi: 10.1136/bmj.297.6644.319
100. Harnack LJ, Cogswell ME, Shikany JM, Gardner CD, Gillespie C, Loria CM, Zhou X, Yuan K, Steffen LM. Sources of sodium in US adults from 3 geographic regions. *Circulation*. 2017;135:1775–1783. doi: 10.1161/CIRCULATIONAHA.116.024446
101. Cobb LK, Appel LJ, Anderson CA. Strategies to reduce dietary sodium intake. *Curr Treat Options Cardiovasc Med*. 2012;14:425–434. doi: 10.1007/s11936-012-0182-9
102. Greer RC, Marklund M, Anderson CAM, Cobb LK, Dalcin AT, Henry M, Appel LJ. Potassium-enriched salt substitutes as a means to lower blood pressure: benefits and risks. *Hypertension*. 2020;75:266–274. doi: 10.1161/HYPERTENSIONAHA.119.13241
103. World Health Organization. Global status report on alcohol and health 2018. 2018. <https://apps.who.int/iris/handle/10665/274603>
104. Voskoboinik A, Kalman JM, De Silva A, Nicholls T, Costello B, Nanayakkara S, Prabhu S, Stub D, Azzopardi S, Vizi D, et al. Alcohol abstinence in drinkers with atrial fibrillation. *N Engl J Med*. 2020;382:20–28. doi: 10.1056/NEJMoa1817591
105. Shay CM, Van Horn L, Stamler J, Dyer AR, Brown IJ, Chan Q, Miura K, Zhao L, Okuda N, Daviglius ML, et al; INTERMAP Research Group. Food and nutrient intakes and their associations with lower BMI in middle-aged US adults: the International Study of Macro-/Micronutrients and Blood Pressure (INTERMAP). *Am J Clin Nutr*. 2012;96:483–491. doi: 10.3945/ajcn.111.025056
106. Hardy DS, Garvin JT, Xu H. Carbohydrate quality, glycemic index, glycemic load and cardiometabolic risks in the US, Europe and Asia: a dose-response meta-analysis. *Nutr Metab Cardiovasc Dis*. 2020;30:853–871. doi: 10.1016/j.numecd.2019.12.050
107. Soliman GA. Dietary fiber, atherosclerosis, and cardiovascular disease. *Nutrients*. 2019;11:1155. doi: 10.3390/nu11051155
108. McRae MP. Dietary fiber is beneficial for the prevention of cardiovascular disease: an umbrella review of meta-analyses. *J Chiropr Med*. 2017;16:289–299. doi: 10.1016/j.jcmm.2017.05.005
109. Ning H, Van Horn L, Shay CM, Lloyd-Jones DM. Associations of dietary fiber intake with long-term predicted cardiovascular disease risk and C-reactive protein levels (from the National Health and Nutrition Examination Survey Data [2005–2010]). *Am J Cardiol*. 2014;113:287–291. doi: 10.1016/j.amjcard.2013.09.020
110. Kim Y, Je Y. Dietary fiber intake and total mortality: a meta-analysis of prospective cohort studies. *Am J Epidemiol*. 2014;180:565–573. doi: 10.1093/aje/kwu174
111. Greenland P, Knoll MD, Stamler J, Neaton JD, Dyer AR, Garside DB, Wilson PW. Major risk factors as antecedents of fatal and nonfatal coronary heart disease events. *JAMA*. 2003;290:891–897. doi: 10.1001/jama.290.7.891
112. Dahl WJ, Stewart ML. Position of the Academy of Nutrition and Dietetics: health implications of dietary fiber. *J Acad Nutr Diet*. 2015;115:1861–1870. doi: 10.1016/j.jand.2015.09.003
113. Mozaffarian D, Wu JHY. Flavonoids, dairy foods, and cardiovascular and metabolic health: a review of emerging biologic pathways. *Circ Res*. 2018;122:369–384. doi: 10.1161/CIRCRESAHA.117.309008
114. Fortmann SP, Burda BU, Senger CA, Lin JS, Whitlock EP. Vitamin and mineral supplements in the primary prevention of cardiovascular disease and cancer: an updated systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med*. 2013;159:824–834. doi: 10.7326/0003-4819-159-12-201312170-00729

115. Siscovick DS, Barringer TA, Fretts AM, Wu JH, Lichtenstein AH, Costello RB, Kris-Etherton PM, Jacobson TA, Engler MB, Alger HM, et al; American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Epidemiology and Prevention; Council on Cardiovascular Disease in the Young; Council on Cardiovascular and Stroke Nursing; and Council on Clinical Cardiology. Omega-3 polyunsaturated fatty acid (fish oil) supplementation and the prevention of clinical cardiovascular disease: a science advisory from the American Heart Association. *Circulation*. 2017;135:e867–e884. doi: 10.1161/CIR.0000000000000482
116. Kalstad AA, Myhre PL, Laake K, Tveit SH, Schmidt EB, Smith P, Nilsen DWT, Tveit A, Fagerland MW, Solheim S, et al; OMEMI Investigators. Effects of n-3 fatty acid supplements in elderly patients after myocardial infarction: a randomized, controlled trial. *Circulation*. 2021;143:528–539. doi: 10.1161/CIRCULATIONAHA.120.052209
117. Nicholls SJ, Lincoff AM, Garcia M, Bash D, Ballantyne CM, Barter PJ, Davidson MH, Kastelein JJP, Koenig W, McGuire DK, et al. Effect of high-dose omega-3 fatty acids vs corn oil on major adverse cardiovascular events in patients at high cardiovascular risk: the STRENGTH randomized clinical trial. *JAMA*. 2020;324:2268–2280. doi: 10.1001/jama.2020.22258
118. Abdelhamid AS, Brown TJ, Brainard JS, Biswas P, Thorpe GC, Moore HJ, Deane KH, AlAbdulghafoor FK, Summerbell CD, Worthington HV, et al. Omega-3 fatty acids for the primary and secondary prevention of cardiovascular disease. *Cochrane Database Syst Rev*. 2018;11:CD003177. doi: 10.1002/14651858.CD003177.pub4
119. Martí-Carvajal AJ, Solà I, Lathyris D, Dayer M. Homocysteine-lowering interventions for preventing cardiovascular events. *Cochrane Database Syst Rev*. 2017;8:CD006612. doi: 10.1002/14651858.CD006612.pub5
120. Li Y, Huang T, Zheng Y, Muka T, Troup J, Hu FB. folic acid supplementation and the risk of cardiovascular diseases: a meta-analysis of randomized controlled trials. *J Am Heart Assoc*. 2016;5:e003768. doi: 10.1161/JAHA.116.003768
121. Michos ED, Cainzos-Achirica M, Heravi AS, Appel LJ. Vitamin D, calcium supplements, and implications for cardiovascular health: JACC focus seminar. *J Am Coll Cardiol*. 2021;77:437–449. doi: 10.1016/j.jacc.2020.09.617
122. Manson JE, Cook NR, Lee IM, Christen W, Bassuk SS, Mora S, Gibson H, Gordon D, Copeland T, D'Agostino D, et al; VITAL Research Group. Vitamin D supplements and prevention of cancer and cardiovascular disease. *N Engl J Med*. 2019;380:33–44. doi: 10.1056/NEJMoa1809944
123. Miller ER 3rd, Pastor-Barriuso R, Dalal D, Riemersma RA, Appel LJ, Guallar E. Meta-analysis: high-dosage vitamin E supplementation may increase all-cause mortality. *Ann Intern Med*. 2005;142:37–46. doi: 10.7326/0003-4819-142-1-200501040-00110
124. Jayawardena R, Swarnamali H, Lanerolle P, Ranasinghe P. Effect of coconut oil on cardio-metabolic risk: a systematic review and meta-analysis of interventional studies. *Diabetes Metab Syndr*. 2020;14:2007–2020. doi: 10.1016/j.dsx.2020.09.033
125. Lichtenstein AH. Dietary trans fatty acids and cardiovascular disease risk: past and present. *Curr Atheroscler Rep*. 2014;16:433. doi: 10.1007/s11883-014-0433-1
126. Wang DD, Hu FB. Dietary fat and risk of cardiovascular disease: recent controversies and advances. *Annu Rev Nutr*. 2017;37:423–446. doi: 10.1146/annurev-nutr-071816-064614
127. Food and Drug Administration. Small entity compliance guide: trans fatty acids in nutrition labeling, nutrient content claims, and health claims. 68 FR 41434. 2003. Accessed October 12, 2021. <https://www.federalregister.gov/documents/2003/08/20/03-21228/small-entity-compliance-guide-on-labeling-trans>
128. Otite FO, Jacobson MF, Dahmubak A, Mozaffarian D. Trends in trans fatty acids reformulations of US supermarket and brand-name foods from 2007 through 2011. *Prev Chronic Dis*. 2013;10:E85. doi: 10.5888/pcd10.120198
129. Franco-Arellano B, Arcand J, Kim MA, Schermel A, L'Abbé MR. Progress towards eliminating industrially produced trans-fatty acids in the Canadian marketplace, 2013–2017. *Public Health Nutr*. 2020;23:2257–2267. doi: 10.1017/S13688980019004816
130. Eckel RH, Borra S, Lichtenstein AH, Yin-Piazza SY; Trans Fat Conference Planning Group. Understanding the complexity of trans fatty acid reduction in the American diet: American Heart Association Trans Fat Conference 2006: report of the Trans Fat Conference Planning Group. *Circulation*. 2007;115:2231–2246. doi: 10.1161/CIRCULATIONAHA.106.181947
131. Dietary Guidelines Advisory Committee. Scientific report of the 2015 Dietary Guidelines Advisory Committee: advisory report to the Secretary of Health and Human Services and the Secretary of Agriculture. US Department of Agriculture, Agricultural Research Service; 2015.
132. Carson JAS, Lichtenstein AH, Anderson CAM, Appel LJ, Kris-Etherton PM, Meyer KA, Petersen K, Polonsky T, Van Horn L; American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Peripheral Vascular Disease; and Stroke Council. Dietary cholesterol and cardiovascular risk: a science advisory from the American Heart Association. *Circulation*. 2020;141:e39–e53. doi: 10.1161/CIR.0000000000000743
133. Morze J, Danielewicz A, Hoffmann G, Schwingshackl L. Diet quality as assessed by the Healthy Eating Index, Alternate Healthy Eating Index, Dietary Approaches to Stop Hypertension score, and health outcomes: a second update of a systematic review and meta-analysis of cohort studies. *J Acad Nutr Diet*. 2020;120:1998–2031.e15. doi: 10.1016/j.jand.2020.08.076
134. Chiuve SE, Fung TT, Rimm EB, Hu FB, McCullough ML, Wang M, Stampfer MJ, Willett WC. Alternative dietary indices both strongly predict risk of chronic disease. *J Nutr*. 2012;142:1009–1018. doi: 10.3945/jn.111.157222
135. Wang DD, Li Y, Afshin A, Springmann M, Mozaffarian D, Stampfer MJ, Hu FB, Murray CJL, Willett WC. Global improvement in dietary quality could lead to substantial reduction in premature death. *J Nutr*. 2019;149:1065–1074. doi: 10.1093/jn/nxz010
136. O'Connor LE, Hu EA, Steffen LM, Selvin E, Rebholz CM. Adherence to a Mediterranean-style eating pattern and risk of diabetes in a U.S. prospective cohort study. *Nutr Diabetes*. 2020;10:8. doi: 10.1038/s41387-020-0113-x
137. Ahmad S, Demler OV, Sun Q, Moorthy MV, Li C, Lee IM, Ridker PM, Manson JE, Hu FB, Fall T, et al. Association of the Mediterranean diet with onset of diabetes in the Women's Health Study. *JAMA Netw Open*. 2020;3:e2025466. doi: 10.1001/jamanetworkopen.2020.25466
138. Berendsen AAM, Kang JH, van de Rest O, Feskens EJM, de Groot LCPGM, Grodstein F. The dietary approaches to stop hypertension diet, cognitive function, and cognitive decline in American older women. *J Am Med Dir Assoc*. 2017;18:427–432. doi: 10.1016/j.jamda.2016.11.026
139. Smith PJ, Blumenthal JA, Babyak MA, Craighead L, Welsh-Bohmer KA, Brownlyke JN, Strauman TA, Sherwood A. Effects of the dietary approaches to stop hypertension diet, exercise, and caloric restriction on neurocognition in overweight adults with high blood pressure. *Hypertension*. 2010;55:1331–1338. doi: 10.1161/HYPERTENSIONAHA.109.146795
140. Wengreen H, Munger RG, Cutler A, Quach A, Bowles A, Corcoran C, Tschanz JT, Norton MC, Welsh-Bohmer KA. Prospective study of Dietary Approaches to Stop Hypertension- and Mediterranean-style dietary patterns and age-related cognitive change: the Cache County Study on Memory, Health and Aging. *Am J Clin Nutr*. 2013;98:1263–1271. doi: 10.3945/ajcn.112.051276
141. Blumenthal JA, Smith PJ, Mabe S, Hinderliter A, Welsh-Bohmer K, Brownlyke JN, Doraiswamy PM, Lin PH, Kraus WE, Burke JR, et al. Longer term effects of diet and exercise on neurocognition: 1-year follow-up of the ENLIGHTEN trial. *J Am Geriatr Soc*. 2020;68:559–568. doi: 10.1111/jgs.16252
142. Martínez-Lapiscina EH, Clavero P, Toledo E, Estruch R, Salas-Salvadó J, San Julián B, Sanchez-Tainta A, Ros E, Valls-Pedret C, Martínez-González MÁ. Mediterranean diet improves cognition: the PREDIMED-NAVARRA randomised trial. *J Neurol Neurosurg Psychiatry*. 2013;84:1318–1325. doi: 10.1136/jnnp-2012-304792
143. Richard EL, Laughlin GA, Kritiz-Silverstein D, Reas ET, Barrett-Connor E, McEvoy LK. Dietary patterns and cognitive function among older community-dwelling adults. *Nutrients*. 2018;10: 1088. doi: 10.3390/nu10081088
144. Morris MC, Tangney CC, Wang Y, Sacks FM, Barnes LL, Bennett DA, Aggarwal NT. MIND diet slows cognitive decline with aging. *Alzheimers Dement*. 2015;11:1015–1022. doi: 10.1016/j.jalz.2015.04.011
145. Morris MC, Tangney CC, Wang Y, Sacks FM, Bennett DA, Aggarwal NT. MIND diet associated with reduced incidence of Alzheimer's disease. *Alzheimers Dement*. 2015;11:1007–1014. doi: 10.1016/j.jalz.2014.11.009
146. Knight A, Bryan J, Wilson C, Hodgson JM, Davis CR, Murphy KJ. The Mediterranean diet and cognitive function among healthy older adults in a 6-month randomised controlled trial: the Medley study. *Nutrients*. 2016;8: 579. doi: 10.3390/nu8090579
147. Hu EA, Coresh J, Anderson CAM, Appel LJ, Grams ME, Crews DC, Mills KT, He J, Scialla J, Rahman M, et al; CRIC Study Investigators. Adherence to healthy dietary patterns and risk of CKD progression and all-cause mortality: findings from the CRIC (Chronic Renal Insufficiency Cohort) study. *Am J Kidney Dis*. 2021;77:235–244. doi: 10.1053/j.ajkd.2020.04.019
148. Heindel J, Baid-Agrawal S, Rebholz CM, Nadal J, Schmid M, Schaeffner E, Schneider MP, Meiselbach H, Kaesler N, Bergmann M, et al; GCKD Study Investigators. Association between dietary patterns and kidney function in patients with chronic kidney disease: a cross-sectional analysis of the

- German Chronic Kidney Disease Study. *J Ren Nutr.* 2020;30:296–304. doi: 10.1053/j.jrn.2019.09.008
149. Hu EA, Steffen LM, Grams ME, Crews DC, Coresh J, Appel LJ, Rebholz CM. Dietary patterns and risk of incident chronic kidney disease: the Atherosclerosis Risk in Communities study. *Am J Clin Nutr.* 2019;110:713–721. doi: 10.1093/ajcn/nqz146
  150. Kim H, Caulfield LE, Garcia-Larsen V, Steffen LM, Grams ME, Coresh J, Rebholz CM. Plant-based diets and incident CKD and kidney function. *Clin J Am Soc Nephrol.* 2019;14:682–691. doi: 10.2215/CJN.12391018
  151. Haring B, Selvin E, Liang M, Coresh J, Grams ME, Petruski-Ivleva N, Steffen LM, Rebholz CM. Dietary protein sources and risk for incident chronic kidney disease: results from the Atherosclerosis Risk in Communities (ARIC) study. *J Ren Nutr.* 2017;27:233–242. doi: 10.1053/j.jrn.2016.11.004
  152. Rebholz CM, Crews DC, Grams ME, Steffen LM, Levey AS, Miller ER 3rd, Appel LJ, Coresh J. DASH (Dietary Approaches to Stop Hypertension) diet and risk of subsequent kidney disease. *Am J Kidney Dis.* 2016;68:853–861. doi: 10.1053/j.ajkd.2016.05.019
  153. Rebholz CM, Young BA, Katz R, Tucker KL, Carithers TC, Norwood AF, Correa A. Patterns of beverages consumed and risk of incident kidney disease. *Clin J Am Soc Nephrol.* 2019;14:49–56. doi: 10.2215/CJN.06380518
  154. Rebholz CM, Grams ME, Steffen LM, Crews DC, Anderson CA, Bazzano LA, Coresh J, Appel LJ. Diet soda consumption and risk of incident end stage renal disease. *Clin J Am Soc Nephrol.* 2017;12:79–86. doi: 10.2215/CJN.03390316
  155. Slagman MC, Waanders F, Hemmelder MH, Woittiez AJ, Janssen WM, Lambers Heerspink HJ, Navis G, Laverman GD; Holland Nephrology Study Group. Moderate dietary sodium restriction added to angiotensin converting enzyme inhibition compared with dual blockade in lowering proteinuria and blood pressure: randomised controlled trial. *BMJ.* 2011;343:d4366. doi: 10.1136/bmj.d4366
  156. Goraya N, Simoni J, Jo CH, Wesson DE. Treatment of metabolic acidosis in patients with stage 3 chronic kidney disease with fruits and vegetables or oral bicarbonate reduces urine angiotensinogen and preserves glomerular filtration rate. *Kidney Int.* 2014;86:1031–1038. doi: 10.1038/ki.2014.83
  157. Goraya N, Simoni J, Jo CH, Wesson DE. A comparison of treating metabolic acidosis in CKD stage 4 hypertensive kidney disease with fruits and vegetables or sodium bicarbonate. *Clin J Am Soc Nephrol.* 2013;8:371–381. doi: 10.2215/CJN.02430312
  158. Nelson ME, Hamm MW, Hu FB, Abrams SA, Griffin TS. Alignment of healthy dietary patterns and environmental sustainability: a systematic review. *Adv Nutr.* 2016;7:1005–1025. doi: 10.3945/an.116.012567
  159. Satija A, Bhupathiraju SN, Rimm EB, Spiegelman D, Chiuve SE, Borgi L, Willett WC, Manson JE, Sun Q, Hu FB. Plant-based dietary patterns and incidence of type 2 diabetes in US men and women: results from three prospective cohort studies. *PLoS Med.* 2016;13:e1002039. doi: 10.1371/journal.pmed.1002039
  160. Satija A, Bhupathiraju SN, Spiegelman D, Chiuve SE, Manson JE, Willett W, Rexrode KM, Rimm EB, Hu FB. Healthful and unhealthful plant-based diets and the risk of coronary heart disease in U.S. adults. *J Am Coll Cardiol.* 2017;70:411–422. doi: 10.1016/j.jacc.2017.05.047
  161. Adamski M, Truby H, M Klassen K, Cowan S, Gibson S. Using the internet: nutrition information-seeking behaviours of lay people enrolled in a massive online nutrition course. *Nutrients.* 2020;12:750. doi: 10.3390/nu12030750
  162. Kris-Etherton PM, Petersen KS, Velarde G, Barnard ND, Miller M, Ros E, O'Keefe JH, Williams K Sr, Horn LV, Na M, et al. Barriers, opportunities, and challenges in addressing disparities in diet-related cardiovascular disease in the United States. *J Am Heart Assoc.* 2020;9:e014433. doi: 10.1161/JAHA.119.014433
  163. Nguyen KH, Glantz SA, Palmer CN, Schmidt LA. Transferring racial/ethnic marketing strategies from tobacco to food corporations: Philip Morris and Kraft General Foods. *Am J Public Health.* 2020;110:329–336. doi: 10.2105/AJPH.2019.305482
  164. Lichtenstein AH, Ludwig DS. Bring back home economics education. *JAMA.* 2010;303:1857–1858. doi: 10.1001/jama.2010.592
  165. Aspry KE, Van Horn L, Carson JAS, Wylie-Rosett J, Kushner RF, Lichtenstein AH, Devries S, Freeman AM, Crawford A, Kris-Etherton P; American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Council on Cardiovascular Radiology and Intervention; and Stroke Council. Medical nutrition education, training, and competencies to advance guideline-based diet counseling by physicians: a science advisory from the American Heart Association. *Circulation.* 2018;137:e821–e841. doi: 10.1161/CIR.0000000000000563
  166. Kirkpatrick S, Dodd K, Reedy J, Krebs-Smith S. Income and race/ethnicity are associated with adherence to food-based dietary guidance among US adults and children. *J Acad Nutr Diet.* 2012;112:624–635. doi: 10.1016/j.jand.2011.11.012
  167. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A. Household food security in the United States in 2018. Economic Research Report No (ERR-270). September 2019. <https://www.ers.usda.gov/publications/pub-details/?pubid=94848>.
  168. Seligman HK, Schillinger D. Hunger and socioeconomic disparities in chronic disease. *N Engl J Med.* 2010;363:6–9. doi: 10.1056/NEJMp1000072
  169. Vercammen KA, Moran AJ, McClain AC, Thorndike AN, Fulay AP, Rimm EB. Food security and 10-year cardiovascular disease risk among U.S. adults. *Am J Prev Med.* 2019;56:689–697. doi: 10.1016/j.amepre.2018.11.016
  170. Berkowitz SA, Gao X, Tucker KL. Food-insecure dietary patterns are associated with poor longitudinal glycemic control in diabetes: results from the Boston Puerto Rican Health study. *Diabetes Care.* 2014;37:2587–2592. doi: 10.2337/dc14-0753
  171. Morales ME, Berkowitz SA. The relationship between food insecurity, dietary patterns, and obesity. *Curr Nutr Rep.* 2016;5:54–60. doi: 10.1007/s13668-016-0153-y
  172. Wolfson JA, Leung CW. Food insecurity and COVID-19: disparities in early effects for US adults. *Nutrients.* 2020;12:1648. doi: 10.3390/nu12061648
  173. McGuire S. IOM (Institute of Medicine) and NRC (National Research Council). 2013. Supplemental nutrition assistance program: examining the evidence to define benefit adequacy. Washington, DC: The National Academies Press, 2013. *Adv Nutr.* 2013;4:477–478. doi: 10.3945/an.113.003822
  174. Andreyeva T, Luedicke J, Middleton AE, Long MW, Schwartz MB. Positive influence of the revised Special Supplemental Nutrition Program for Women, Infants, and Children food packages on access to healthy foods. *J Acad Nutr Diet.* 2012;112:850–858. doi: 10.1016/j.jand.2012.02.019
  175. Andreyeva T, Luedicke J. Incentivizing fruit and vegetable purchases among participants in the Special Supplemental Nutrition Program for Women, Infants, and Children. *Public Health Nutrition.* 2015;18:33–41. doi: 10.1017/S1368980014000512
  176. Choi SE, Seligman H, Basu S. Cost effectiveness of subsidizing fruit and vegetable purchases through the Supplemental Nutrition Assistance Program. *Am J Prev Med.* 2017;52:e147–e155. doi: 10.1016/j.amepre.2016.12.013
  177. Polacsek M, Moran A, Thorndike AN, Boulos R, Franckle RL, Greene JC, Blue DJ, Block JP, Rimm EB. A supermarket double-dollar incentive program increases purchases of fresh fruits and vegetables among low-income families with children: the Healthy Double Study. *J Nutr Educ Behav.* 2018;50:217–228.e1. doi: 10.1016/j.jneb.2017.09.013
  178. Olsho LE, Klerman JA, Wilde PE, Bartlett S. Financial incentives increase fruit and vegetable intake among Supplemental Nutrition Assistance Program participants: a randomized controlled trial of the USDA Healthy Incentives Pilot. *Am J Clin Nutr.* 2016;104:423–435. doi: 10.3945/ajcn.115.129320
  179. Harnack L, Oakes JM, Elbel B, Beatty T, Rydell S, French S. Effects of subsidies and prohibitions on nutrition in a food benefit program: a randomized clinical trial. *JAMA Intern Med.* 2016;176:1610–1618. doi: 10.1001/jamainternmed.2016.5633
  180. Bailey ZD, Krieger N, Agénor M, Graves J, Linos N, Bassett MT. Structural racism and health inequities in the USA: evidence and interventions. *Lancet.* 2017;389:1453–1463. doi: 10.1016/S0140-6736(17)30569-X
  181. Franco M, Diez Roux AV, Glass TA, Caballero B, Brancati FL. Neighborhood characteristics and availability of healthy foods in Baltimore. *Am J Prev Med.* 2008;35:561–567. doi: 10.1016/j.amepre.2008.07.003
  182. Larson NI, Story MT, Nelson MC. Neighborhood environments: disparities in access to healthy foods in the U.S. *Am J Prev Med.* 2009;36:74–81.E10. doi: 10.1016/j.amepre.2008.09.025
  183. Anderson CAM, Thorndike AN, Lichtenstein AH, Van Horn L, Kris-Etherton PM, Foraker R, Spees C. Innovation to create a healthy and sustainable food system: a science advisory from the American Heart Association. *Circulation.* 2019;139:e1025–e1032. doi: 10.1161/CIR.0000000000000686
  184. D'Agostino EM, Patel HH, Hansen E, Mathew MS, Messiah SE. Longitudinal effects of transportation vulnerability on the association between racial/ethnic segregation and youth cardiovascular health. *J Racial Ethn Health Disparities.* 2021;8:618–629. doi: 10.1007/s40615-020-00821-8
  185. Bossarte RM, Blois JR, Piegari RI, Hill LL, Kane V. Housing instability and mental distress among US veterans. *Am J Public Health.* 2013;103(suppl 2):S213–S216. doi: 10.2105/AJPH.2013.301277

186. Grier SA, Kumanyika SK. The context for choice: health implications of targeted food and beverage marketing to African Americans. *Am J Public Health*. 2008;98:1616–1629. doi: 10.2105/AJPH.2007.115626
187. Powell LM, Szczypka G, CMhaloupka FJ.M Adolescent exposure to food advertising on television. *Am J Prev Med*. 2007;33(4 suppl):S251–S256. doi: 10.1016/j.amepre.2007.07.009
188. Fleming-Milici F, Harris JL. Television food advertising viewed by preschoolers, children and adolescents: contributors to differences in exposure for black and white youth in the United States. *Pediatr Obes*. 2018;13:103–110. doi: 10.1111/ijpo.12203
189. Chester J, Kopp K, Montgomery KC. Does buying groceries online put SNAP participants at risk? How to protect health, privacy and equity. July 16, 2020. Center for Digital Democracy. <https://www.democraticmedia.org/article/does-buying-groceries-online-put-snap-participants-risk>
190. Rodgers GP, Collins FS. Precision nutrition – the answer to “what to eat to stay healthy.” *JAMA*. 2020;324:735–736. doi: 10.1001/jama.2020.13601
191. de Roos B, Brennan L. Personalised interventions—a precision approach for the next generation of dietary intervention studies. *Nutrients*. 2017;9:847. doi: 10.3390/nu9080847
192. Ordovas JM, Ferguson LR, Tai ES, Mathers JC. Personalised nutrition and health. *BMJ*. 2018;361:bmj.k2173. doi: 10.1136/bmj.k2173
193. Hughes RL, Kable ME, Marco M, Keim NL. The role of the gut microbiome in predicting response to diet and the development of precision nutrition models. Part II: results. *Adv Nutr*. 2019;10:979–998. doi: 10.1093/advances/nmz049
194. Mensah GA, Brown AGM, Pratt CA. Nutrition disparities and cardiovascular health. *Curr Atheroscler Rep*. 2020;22:15. doi: 10.1007/s11883-020-0833-3