

## Part D. Chapter 2: Dietary Patterns, Foods and Nutrients, and Health Outcomes

### INTRODUCTION

A healthy diet is a pillar of well-being throughout the lifespan. It promotes the achievement of healthy pregnancy outcomes; supports normal growth, development and aging; helps maintain healthful body weight; reduces chronic disease risks; and promotes overall health and well-being. Previous Dietary Guidelines Advisory Committees focused on examining specific foods, nutrients, and dietary components and their relationships to health outcomes. In its review, however, the 2010 DGAC noted that it is often not possible to separate the effects of individual nutrients and foods, and that the totality of diet—the combinations and quantities in which foods and nutrients are consumed—may have synergistic and cumulative effects on health and disease.<sup>1</sup> This approach has been adopted by others as well (e.g. American Heart Association, American College of Cardiology and the National Cancer Institute) and is being used by the 2015 DGAC. The 2010 Committee acknowledged the importance of dietary patterns and recommended additional research in this area. After the release of the *2010 Dietary Guidelines for Americans*, the USDA Nutrition Evidence Library (NEL) completed a systematic review project examining the relationships between dietary patterns and several health outcomes, including cardiovascular disease (CVD), body weight and type 2 diabetes.<sup>2</sup> Their report has been used by the 2015 DGAC.

As also noted in the *2010 Dietary Guidelines for Americans*, individuals can achieve a healthy diet in multiple ways and preferably with a wide variety of foods and beverages. Optimal nutrition can be attained with many dietary patterns and a single dietary pattern approach or prescription is unnecessary. Indeed, for long-term maintenance, a dietary pattern to support optimal nutrition and health should be based on the biological and medical needs as well as preferences of the individual.

Dietary patterns are defined as the quantities, proportions, variety or combinations of different foods and beverages in diets, and the frequency with which they are habitually consumed. Americans consume many habitual dietary patterns, rather than a “typical American pattern,” which reflect their life experiences and wide-ranging personal, socio-cultural and other environmental influences. The nutritional quality of a dietary pattern can be determined by assessing the nutrient content of its constituent foods and beverages and comparing these characteristics to age- and sex-specific nutrient requirements and standards for nutrient adequacy, as shown in *Part D. Chapter 1: Food and Nutrient Intakes, and Health: Current Status and Trends* for the USDA Food Patterns, including the “Healthy U.S.-style Pattern,” the “Healthy Mediterranean-style Pattern,” and the “Healthy Vegetarian Pattern.” Understanding the array of dietary patterns in a population and their nutrient quality allows a more complete

39 characterization of individual eating behaviors and enables their examination in relationship with  
 40 diverse health outcomes. For these reasons, the DGAC focused on considering the evidence for  
 41 overall dietary patterns in addition to key foods and nutrients. A major goal was to describe the  
 42 common characteristics of a healthy diet, which informed and is complementary to the  
 43 quantitative description of dietary patterns provided in *Part D. Chapter 1: Food and Nutrient*  
 44 *Intakes, and Health: Current Status and Trends.*

45  
 46 Dietary patterns can be characterized in three main ways, drawing from Dr. Susan Krebs-Smith's  
 47 presentation to the DGAC during the second public meeting (available at  
 48 [www.DietaryGuidelines.gov](http://www.DietaryGuidelines.gov)). The first is by the use of an a priori index that is based on a set of  
 49 dietary recommendations for a healthy dietary pattern as a result of scientific consensus or  
 50 proposed by investigators using an evidence-based approach. An individual's index/score is  
 51 derived by comparing and quantifying their adherence to the criterion food and/or nutrient  
 52 component of the index and then summed up over all components. A population's average mean  
 53 and individual component scores can be similarly determined. Examples of dietary quality scores  
 54 include: the Healthy Eating Index (HEI)-2005 and 2010,<sup>3</sup> the Alternate HEI (AHEI) and updated  
 55 AHEI-2010,<sup>4</sup> the Recommended Food Score (RFS),<sup>5</sup> the Dietary Approaches to Stop  
 56 Hypertension (DASH) score,<sup>6</sup> the Mediterranean Diet Score (MDS),<sup>7</sup> and the Alternate  
 57 Mediterranean Diet Score (aMed).<sup>8</sup>

58  
 59 The second method of dietary pattern assessment is through data-driven approaches, such as  
 60 cluster analysis (which addresses the question, "Using the self-reported food and beverage intake  
 61 data are there groups of people with distinct (non-overlapping) dietary patterns?") and factor  
 62 analysis (which addresses the question, "Which components of the diet track together to explain  
 63 variations in food or beverage intake across diet patterns?"). These data-driven approaches are  
 64 outcome-independent. That is, the relationships between the dietary patterns and intermediate or  
 65 longer-term health outcomes are examined once the patterns themselves are defined. Other data-  
 66 driven approaches are outcome-dependent, such as reduced rank regression (which addresses the  
 67 question, "What combination of foods explains the most variation in one or more intermediate  
 68 health markers?").

69  
 70 The third method examines individuals' food and beverage intake preferences as they are  
 71 commonly defined by foods included or eliminated. In cohort studies, this pattern is usually  
 72 based upon qualitative self-reported behaviors rather than detailed questionnaires. Vegetarianism  
 73 and its various forms (e.g., ovo-lacto vegetarianism) are examples of this type of dietary pattern.

74  
 75 The dietary patterns approach has a number of major strengths. The method captures the  
 76 relationship between the overall diet and its constituent foods, beverages and nutrients in  
 77 relationship to outcomes of interest and quality, thereby overcoming the collinearity among  
 78 single foods and nutrients. In so doing, it considers the inherent interactions between foods and

79 nutrients in promoting health or increasing disease risk. Because foods are consumed in  
80 combinations, it is difficult, if not impossible, to determine their separate effects on health.  
81 Relationships or effects attributed to a particular food or nutrient may be accurate or reflect those  
82 of other dietary components acting in synergy. The dietary pattern approach has advanced  
83 nutrition research by capturing overall food consumption behaviors and its quality in relationship  
84 to health.

85

86 Despite these considerable strengths, however, the approach has several limitations that are  
87 important to consider. First, the dietary assessment instruments used to define the dietary  
88 patterns (e.g., food frequency questionnaires [FFQ] and 24-hour or multi-day dietary recalls or  
89 records) are based upon self-report and may introduce levels of report bias that can attenuate  
90 diet-health relationships. The FFQ has been evaluated as a valid and reliable measure of usual  
91 food and nutrient intake. However, the extent to which data from FFQs are valid measures of  
92 dietary patterns is not well established. Second, dietary patterns are not uniformly defined by  
93 investigators and vary substantially from one study to the next even though studies may use the  
94 same nomenclature. This may hamper cross-study comparisons and limits reproducibility. Third,  
95 scoring algorithms used to evaluate dietary pattern adherence may differ and affect the results of  
96 studies examining specific health outcomes. Fourth, data-driven methods may not derive  
97 comparable patterns in different populations because these patterns may be population specific.  
98 Lastly, dietary patterns do not assess the frequency of meal and snack consumption, specific  
99 combinations of foods consumed together, and aspects of food purchase and preparation, all of  
100 which may influence the overall dietary pattern.

101

102 Another challenge to examining dietary patterns is that randomized dietary intervention studies  
103 have used different approaches for ensuring that subjects comply with the intervention diet when  
104 testing their relationships with health outcomes. For example, randomized controlled trials  
105 (RCTs), such as Prevencion con Dieta Mediterranean (PREDIMED), coached participants to  
106 follow a dietary pattern and provided them with key foods (e.g., olive oil or nuts) to facilitate  
107 adherence. In contrast, feeding studies (another form of intervention study), such as those  
108 conducted in the DASH and the Optimal Macronutrient Intake Trial for Heart Health  
109 (OmniHeart), provided all food to be consumed to each participant. These study designs across  
110 randomized trials and feeding studies provide strong evidence for the benefits and risks of  
111 particular dietary patterns because a prescribed intervention allows relatively precise definition  
112 of dietary exposures, and randomization helps ensure that any potential confounding variables  
113 are randomly distributed between study arms. However, some trials (i.e. DASH, OmniHeart) are  
114 necessarily restricted to testing a dietary pattern's effect on an intermediate outcome or a  
115 surrogate endpoint, such as blood lipids, because of the complexities involved in maintaining  
116 dietary compliance over long study duration. Additionally, the feeding trials fail to represent  
117 what happens in real world situations. Thus, well-conducted observational cohort studies provide  
118 an important evidentiary complement to RCTs because they enable the study of hard endpoints

119 for disease in addition to intermediate outcomes and often provide a wider range of exposures for  
120 study.

121  
122 Dietary patterns and their food and nutrient characteristics are at the core of the conceptual  
123 model that has guided the DGAC’s work (see *Part B. Chapter 2: 2015 DGAC Themes and*  
124 *Recommendations: Integrating the Evidence*), and the relationship of dietary patterns to health  
125 outcomes is the centerpiece of this chapter. The Committee considered evidence about the  
126 relationship of diet with several health outcomes that are listed as major public health outcomes  
127 of concern in *Part D. Chapter 1: Food and Nutrient Intakes, and Health: Current Status and*  
128 *Trends*. Several of these outcomes—CVD, overweight and obesity, type 2 diabetes, congenital  
129 anomalies, and bone health—also were addressed by the 2010 DGAC. Others—cancers (lung,  
130 colon, prostate and breast) and neurological and psychological illness—while previously  
131 addressed, are considered here in more depth and represent an expanded list of health outcomes  
132 for which there is growing evidence of a diet-disease relationship. The 2015 Committee was not  
133 able to consider the relationship between dietary patterns during the peri- and prenatal period and  
134 pregnancy outcomes (e.g., birth weight, preterm birth, pregnancy complications) or other cancer  
135 outcomes, such as total cancer mortality or gynecological, pancreatic, and gastric-esophageal  
136 cancers due to time limitations and limited work done in these areas involving dietary patterns.  
137 However, it is important to note that recently the NIH-AARP Diet and Health Study (n =  
138 492,823) conducted in the United States demonstrated that high adherence on several indices (the  
139 HEI-2010, the AHEI-2010, the aMED, and DASH) was associated with lower risk of overall  
140 CVD and cancer mortality.<sup>9</sup> The authors concluded that this finding provides further credence  
141 for using the dietary pattern approach, indicating that multiple dietary indices reflecting core  
142 tenets of a healthy diet may lower the risk of mortality outcomes.<sup>9</sup>

143  
144 Over the course of the DGAC’s review, when strong or moderate evidence related to dietary  
145 patterns and a particular health outcome was available, the Committee focused its discussion on  
146 dietary patterns and, as possible, highlighted the most consistent common food and nutrient  
147 characteristics identified in the dietary patterns literature. When only limited or insufficient  
148 evidence related to dietary patterns and a particular health outcome was available (as in the case  
149 of congenital anomalies and neurological and psychological illnesses), the Committee  
150 summarized these findings and also provided a brief summary of existing evidence on specific  
151 foods and/or nutrients and selected health outcomes.

152  
153 In addition to its work on dietary patterns, the DGAC considered conducting an evidence review  
154 on the relationship between the role of the microbiome and various health outcomes. This novel  
155 area of research has generated considerable interest in the scientific community and the lay  
156 public. Investigators are examining the diversity of organisms (i.e., microbes) that inhabit  
157 different parts of the body such as the gut, mouth, skin, and vagina, and are attempting to  
158 understand how the microbial communities are influenced by diet, environment, host genetics

159 and other microbes, as well as their association with various health outcomes. The DGAC  
160 conducted an exploratory search but did not find sufficient evidence to address this question in  
161 the 2015 report. However, the Committee considers the microbiome to be an emerging topic of  
162 potential importance to future DGACs.

163

## 164 **LIST OF QUESTIONS**

### 165 **Dietary Patterns and Cardiovascular Disease**

166 1. What is the relationship between dietary patterns and risk of cardiovascular disease?

167

### 168 **Dietary Patterns and Body Weight**

169 2. What is the relationship between dietary patterns and measures of body weight or obesity?

170

### 171 **Dietary Patterns and Type 2 Diabetes**

172 3. What is the relationship between dietary patterns and risk of type 2 diabetes?

173

### 174 **Dietary Patterns and Cancer**

175 4. What is the relationship between dietary patterns and risk of cancer?

176

### 177 **Dietary Patterns and Congenital Anomalies**

178 5. What is the relationship between dietary patterns and risk of congenital anomalies?

179

### 180 **Dietary Patterns and Neurological and Psychological Illnesses**

181 6. What is the relationship between dietary patterns and risk of neurological and psychological  
182 illnesses?

183

### 184 **Dietary Patterns and Bone Health**

185 7. What is the relationship between dietary patterns and bone health?

186

## 187 **METHODOLOGY**

188 For the first time, the 2015 DGAC included a chapter focusing solely on the relationship between  
189 dietary patterns and health outcomes. Although the 2010 DGAC considered some research on  
190 certain dietary patterns and specific health outcomes, notably body weight, they did not complete

191 NEL systematic reviews on this research. The 2015 DGAC began by acknowledging a desire to  
192 continue and expand on the total diet approach initiated by the 2010 DGAC. They then identified  
193 outcomes of public health concern on which to focus their reviews.  
194

195 For the purposes of the 2015 DGAC, dietary patterns were defined as the quantities, proportions,  
196 variety or combinations of different foods and beverages in diets, and the frequency with which  
197 they are habitually consumed. Because the purpose of the Dietary Guidelines is to develop food-  
198 based recommendations to promote health and reduce risk of diet-related disease, one of the key  
199 aspects of the research that the DGAC considered was a description of the foods and beverages  
200 consumed by participants in the studies that the Committee reviewed. This was particularly  
201 important for the NEL systematic reviews, for which a description of foods and beverages was a  
202 key criterion for inclusion. Data on nutrients were not required for inclusion, but were considered  
203 when provided as part of the dietary pattern description.  
204

205 Self-reported food and beverage intake was typically assessed using a qualitative or semi-  
206 quantitative food intake questionnaire (i.e., FFQ). However, some studies used other methods,  
207 such as 24-hour recalls. When reviewing the evidence, the Committee attempted to adhere to the  
208 language used by the study authors in describing food groupings. There was variability across  
209 the food groupings, and this was particularly apparent in the meat group; for example, “total  
210 meat” may have been defined as “meat, sausage, fish, and eggs,” “red meat, processed meat, and  
211 poultry,” or various other combinations of meat. Similarly, “vegetables” seemed to most often  
212 exclude potatoes, but some studies included potatoes, yet they rarely provided information on  
213 how the potatoes were consumed (e.g., fried versus baked). When reported in the studies, the  
214 Committee considered these definitions in their review.  
215

216 Because of the variability in dietary patterns methodology and food groupings reported, the  
217 Committee focused on providing a qualitative description of healthy dietary patterns.  
218 Additionally, as most studies reported intake in relative terms (e.g., comparing the first and fifth  
219 quintiles or across tertiles), the Committee has presented its conclusions with relative  
220 terminology (e.g., “higher” and “lower” in a certain component). Quantitative information on  
221 dietary patterns is provided in **Part D. Chapter 1: Food and Nutrient Intakes, and Health:  
222 Current Status and Trends** as part of the Dietary Patterns Composition section.  
223

224 A number of studies in the scientific literature describe diets based on macronutrient proportion  
225 or test only a specific food group or nutrient in the diet. For example, a low-carbohydrate diet fits  
226 this description and has been of public interest. The DGAC reviewed the body of evidence  
227 related to this type of diet as part of Question 2. Additionally, the Committee examined the  
228 results of exploratory searches on low-carbohydrate diets (defined as less than 45 percent of  
229 calories from carbohydrate) and all of the health outcomes considered in this chapter published  
230 since 2000. Overall, it appears that only limited evidence is available to address the relationship

231 between low-carbohydrate diets and health, particularly evidence derived from U.S.-based  
 232 populations. The most evidence available focuses on low-carbohydrate diets and body weight.  
 233 The 2010 DGAC examined the relationship between macronutrient proportion and various body  
 234 weight outcomes, concluding that:

235 *“1) There is strong and consistent evidence that when calorie intake is controlled,*  
 236 *macronutrient proportion of the diet is not related to losing weight; 2) A moderate body of*  
 237 *evidence provides no data to suggest that any one macronutrient is more effective than any*  
 238 *other for avoiding weight re-gain in weight reduced persons; 3) A moderate body of evidence*  
 239 *demonstrates that diets with less than 45% of calories as carbohydrates are not more*  
 240 *successful for long-term weight loss (12 months). There is also some evidence that they may*  
 241 *be less safe. In shorter-term studies, low-calorie, high-protein diets may result in greater*  
 242 *weight loss, but these differences are not sustained over time; and 4) A moderate amount of*  
 243 *evidence demonstrates that intake of dietary patterns with less than 45% calories from*  
 244 *carbohydrate or more than 35% calories from protein are not more effective than other diets*  
 245 *for weight loss or weight maintenance, are difficult to maintain over the long term, and may*  
 246 *be less safe.”*

247 The published literature since that review does not provide sufficient evidence to change these  
 248 conclusions. Thus, in summary, although studies that examine macronutrient proportion or that  
 249 test only a specific food group or nutrient are important, they answer different questions related  
 250 to diet and health than those proposed by the DGAC. In addition, these studies generally did not  
 251 meet the DGAC’s definition of a dietary pattern study unless a full description of the dietary  
 252 pattern consumed was provided and appropriate methods were used to adjust for the confounding  
 253 of foods and nutrients.

254  
 255 Questions 1, 2, and 3 were answered using existing reports, systematic reviews, and meta-  
 256 analyses. All three of these questions were addressed in the NEL Dietary Patterns Systematic  
 257 Review Project. This project was supported by USDA’s Center for Nutrition Policy and  
 258 Promotion and was informed by a Technical Expert Collaborative of experts in dietary patterns  
 259 research.<sup>2</sup> Additionally, the DGAC reviewed reports from systematic reviews recently conducted  
 260 by the National Heart, Lung, and Blood Institute (NHLBI) that included dietary patterns  
 261 research. For Question 1, the DGAC used the NHLBI *Lifestyle Interventions to Reduce*  
 262 *Cardiovascular Risk: Systematic Evidence Review from the Lifestyle Work Group*<sup>10</sup> and the  
 263 associated American Heart Association (AHA)/ American College of Cardiology (ACC)  
 264 *Guideline on Lifestyle Management to Reduce Cardiovascular Risk*.<sup>11</sup> For Question 2, the DGAC  
 265 used the NHLBI *Managing Overweight and Obesity in Adults: Systematic Evidence Review from*  
 266 *the Obesity Expert Panel*<sup>12</sup> and the associated AHA/ACC/The Obesity Society (TOS) *Guideline*  
 267 *for the Management of Overweight and Obesity in Adults*.<sup>13</sup> For all three questions, in an attempt  
 268 to capture new research published since the searches for these systematic reviews were  
 269 completed, the Committee considered existing systematic reviews and meta-analyses published  
 270 in peer-reviewed journals since 2008. The existing systematic reviews and meta-analyses

271 considered by the DGAC had to meet the general inclusion criteria of the DGAC, and were  
 272 required to consider dietary patterns and the outcomes of interest. A description of the process  
 273 the DGAC used to answer existing report questions is provided in *Part C: Methodology*. The  
 274 DGAC followed this approach, including consideration of reference overlap, for all three  
 275 questions. For more information on the existing reports, systematic reviews, and meta-analyses  
 276 considered by the DGAC, the reader is encouraged to review the original sources, which are  
 277 referenced within each evidence review.

278

279 Questions 4, 5, 6, and 7 were answered using NEL systematic reviews. A description of the NEL  
 280 process is provided in *Part C: Methodology*. All reviews were conducted in accordance with  
 281 NEL methodology, and the DGAC made all substantive decisions required throughout the  
 282 process to ensure that the most complete and relevant body of evidence was identified and  
 283 evaluated to answer each question. All steps in the process were documented to ensure  
 284 transparency and reproducibility. Specific information about individual systematic reviews can  
 285 be found at [www.NEL.gov](http://www.NEL.gov), including the search strategy, inclusion and exclusion criteria, a  
 286 complete list of included and excluded articles, and a detailed write-up describing the included  
 287 studies and the body of evidence. A link for each question is provided following each evidence  
 288 review.

289

290 Introductory sections were written for Questions 4, 5, 6, and 7 because the conclusion statements  
 291 for these questions were graded limited or insufficient. The purpose of the introduction was to  
 292 provide a brief description of the current evidence available related to foods and nutrients and the  
 293 health outcome of interest. However, this evidence was not considered in developing the dietary  
 294 pattern conclusion statements. During the course of the dietary pattern reviews, the DGAC chose  
 295 to highlight particular components of the diet, which are discussed further in *Part D. Chapter 6:*  
 296 *Cross-Cutting Topics of Public Health Importance*.

297

### 298 **Question 1: What is the relationship between dietary patterns and risk of** 299 **cardiovascular disease?**

300 **Source of evidence:** Existing reports

301

### 302 **Conclusion**

303 The DGAC concurs with the conclusions of the NEL Dietary Patterns Systematic Review Project  
 304 and AHA/ACC *Guideline on Lifestyle Management to Reduce Cardiovascular Risk* that strong  
 305 and consistent evidence demonstrates that dietary patterns associated with decreased risk of CVD  
 306 are characterized by higher consumption of vegetables, fruits, whole grains, low-fat dairy, and  
 307 seafood, and lower consumption of red and processed meat, and lower intakes of refined grains,  
 308 and sugar-sweetened foods and beverages relative to less healthy patterns. Regular consumption  
 309 of nuts and legumes and moderate consumption of alcohol also are shown to be components of a



310 beneficial dietary pattern in most studies. Randomized dietary intervention studies have  
 311 demonstrated that healthy dietary patterns exert clinically meaningful impact on cardiovascular  
 312 risk factors, including blood lipids and blood pressure. Additionally, research that includes  
 313 specific nutrients in their description of dietary patterns indicate that patterns that are lower in  
 314 saturated fat, cholesterol, and sodium and richer in fiber, potassium, and unsaturated fats are  
 315 beneficial for reducing cardiovascular disease risk. **DGAC Grade: Strong**

316

### 317 **Implications**

318 Individuals are encouraged to consume dietary patterns that emphasize vegetables, fruits, whole  
 319 grains, legumes, and nuts; include low-fat dairy products and seafood; limit sodium, saturated  
 320 fat, refined grains, and sugar-sweetened foods and beverages; and are lower in red and processed  
 321 meats. Multiple dietary patterns can achieve these food and nutrient patterns and are beneficial  
 322 for cardiovascular health, and they should be tailored to individuals' biological needs and  
 323 cultural as well as individual food preferences. The Committee recommends the development  
 324 and implementation of programs and services at the individual and population levels that  
 325 facilitate the improvement in eating behaviors consistent with the above dietary patterns.

326

### 327 **Review of the Evidence**

328 The DGAC examined research compiled in the NEL Dietary Patterns Systematic Review  
 329 Project, which included 55 articles summarizing evidence from 52 prospective cohort studies and  
 330 7 RCTs, and the 2013 AHA/ACC Lifestyle Guideline and associated NHLBI Lifestyle Report,  
 331 which included primarily RCTs. The Committee drew additional evidence and effect size  
 332 estimates from six published systematic reviews/meta-analyses published since 2008 that  
 333 included one or more studies not covered in the NEL or NHLBI Lifestyle reports.<sup>14-19</sup> In total,  
 334 142 articles were considered in these reports, of which 35 were included in two or more reviews.  
 335 Little evidence on the contribution of dietary patterns to CVD risk factors in the pediatric  
 336 populations was available, and that which was published was not systematically reviewed.

337

338 Most evidence examining hard disease endpoints comes from large, prospective cohort studies in  
 339 adults using a priori scores to rank individuals with respect to adherence to dietary patterns of  
 340 interest. Though the observational design allows the necessary duration of follow-up to observe  
 341 CVD endpoints, comparison across studies was difficult because of different methods for  
 342 deriving scores and different versions of scores measuring adherence to the same dietary pattern.  
 343 In the Mediterranean dietary indices and the AHEI scores, moderate alcohol was included as a  
 344 “positive” component (associated with potential benefits). Red and processed meats were  
 345 “negative” (potentially detrimental) components in the Mediterranean scores, AHEI scores, and  
 346 DASH. Certain scores also included sugars or sugar-sweetened beverages as negative  
 347 components. Poultry was considered as a positive component in the original AHEI. Total high-  
 348 fat dairy was a negative component in the Mediterranean diet scores, but dairy was a positive

349 component when meeting recommended intakes for the HEI-2005, and low-fat dairy was  
350 positive in the DASH scores. As the NEL systematic review points out, several components of  
351 scores associated with decreased CVD risk recurred in multiple dietary patterns and were  
352 associated as part of scores and as individual components with reduced CVD risk. These  
353 included consumption of vegetables, fruits, whole grains, nuts, legumes, unsaturated fats, and  
354 fish.

355  
356 The NHLBI Lifestyle Report summarized the evidence from two RCTs of the DASH dietary  
357 pattern and two trials testing DASH variations with differing levels of sodium or macronutrients.  
358 The diet provided to participants in standard DASH intervention trials was high in vegetables,  
359 fruits, low-fat dairy products, whole grains, poultry, fish, and nuts. It also was low in sweets,  
360 sugar-sweetened beverages, and reduced in (or lower in) red and processed meats. The DASH  
361 dietary pattern is high in fiber and potassium and low in sodium, saturated fat, total fat, and  
362 cholesterol. It is rich in potassium, magnesium, and calcium, as well as protein and fiber.

363  
364 In contrast to the patterns described above, vegetarian diets were defined by what they excluded.  
365 Variations included: vegan (no meat, fish, eggs, or dairy); lacto-ovo vegetarian (includes eggs  
366 and dairy, but no fish or meat), and pesco-vegetarian (includes fish, but no meat) diets. The  
367 content of these diets varied substantially, though they tended to emphasize plant based foods,  
368 especially fruits and vegetables, legumes, nuts, and whole grains.

### 369 ***Dietary Patterns and Blood Pressure (BP)***

#### 371 **DASH or DASH-style Dietary Patterns**

372 The NEL systematic review and AHA/ACC Lifestyle Guideline conclude that strong and  
373 consistent evidence from RCTs demonstrates that compared to a dietary pattern that is relatively  
374 high in saturated fat and sodium and low in vegetables and fruits, the DASH-style dietary pattern  
375 reduced BP by approximately 6/3 mmHg (systolic blood pressure/diastolic blood pressure)  
376 across subgroups defined by sex, race, age, and hypertension status. The DASH trial provided all  
377 food to participants for 8 weeks. Fat intake was relatively low at 26 percent of energy (7 percent  
378 each monounsaturated and saturated, 10 percent polyunsaturated), compared to 36 percent in the  
379 control group. Carbohydrates accounted for 57 percent of energy and protein for 18 percent.  
380 Sodium was stable at 3,000 mg/day and body weight did not change. Variations of the DASH  
381 diet also lowered blood pressure: in the OmniHeart Trial, compared to the standard DASH,  
382 replacing 10 percent of calories from carbohydrate with either the same calorie content of protein  
383 or with unsaturated fat (8 percent MUFA and 2 percent PUFA) lowered systolic BP by 1 mmHg.  
384 Among adults with BP 140–159/90–95 mmHg, these substitutions lowered systolic BP by 3  
385 mmHg relative to standard DASH.<sup>2, 11</sup>

386  
387 Observational evidence summarized in the NEL report included one cohort showing that  
388 increased DASH score was associated with small, but decreased levels of systolic and diastolic

389 BP over time;<sup>20</sup> two others cohorts showed no relationship between DASH scores and risk of  
390 hypertension.<sup>21, 22</sup>

391

### 392 **Mediterranean-Style Dietary Patterns**

393 Several RCTs provide limited to moderate evidence on the benefits of a Mediterranean-style diet  
394 for reducing blood pressure. The AHA/ACC Lifestyle Guideline conclude that consuming a  
395 Mediterranean dietary pattern instead of a lower-fat dietary pattern had beneficial effects on  
396 blood pressure. The NHLBI Lifestyle Report reviewed two RCTs of free-living middle-aged or  
397 older adults (with type 2 diabetes or at least three CVD risk factors) in which a Mediterranean  
398 diet intervention reduced BP by 6–7/2–3 mmHg.<sup>23, 24</sup> The report also reviewed one observational  
399 study of healthy younger adults. Higher adherence to a Mediterranean-style diet, as measured  
400 through a Mediterranean score, was associated with a decrease in BP of 2–3/1–2 mmHg.<sup>25</sup>

401

### 402 **Vegetarian Dietary Patterns**

403 Evidence for the blood pressure benefits of vegetarian dietary patterns is more limited, but  
404 moderately consistent trends appear to exist. A recent meta-analysis of seven RCTs found that  
405 consumption of vegetarian diets was associated with a reduction in mean systolic blood pressure  
406 (-4.8 mm Hg; 95% CI = -6.6 to -3.1;  $p < 0.01$ ) and diastolic blood pressure (-2.2 mm Hg; 95% CI  
407 = -3.5 to -1.0) compared with the consumption of omnivorous diets.<sup>19</sup> The AHA/ACC Lifestyle  
408 Guideline did not find sufficient evidence to examine vegetarian dietary patterns, and the NEL  
409 systematic review summarized only three studies comparing blood pressure outcomes in lacto-  
410 ovo vegetarian diets versus non-vegetarian diets in which meat and fish were consumed. Of the  
411 two studies, one was a large prospective cohort that found no association with blood pressure,<sup>26</sup>  
412 and the other was a RCT among individuals with hypertension that demonstrated a decrease in  
413 systolic blood pressure, but not diastolic blood pressure.<sup>27</sup> The more recent EPIC-Oxford cohort  
414 found lower systolic, but not diastolic blood pressure compared to the findings of Crowe, 2013.<sup>28</sup>

415

### 416 **Other Dietary Patterns**

417 As summarized in the NEL systematic review, adherence to the *2005 Dietary Guidelines for*  
418 *Americans* was related to lower blood pressure in one study of healthy young adults. Zamora et  
419 al reported 20-year findings from the CARDIA study including 4,381 Black and White young  
420 adults.<sup>29</sup> Participants in the highest (vs. lowest) quartile of adherence to the 2005 Dietary  
421 Guidelines had significantly less increase in systolic and diastolic blood pressure over time.

422

### 423 ***Dietary Patterns and Blood Lipids***

#### 424 **DASH or DASH-style Dietary Patterns**

425 As reviewed in the NHLBI Lifestyle Report, RCTs of the DASH diet show favorable effects on  
426 low-density lipoprotein cholesterol (LDL-C) and total cholesterol: high-density lipoprotein  
427 cholesterol (total-C: HDL-C) ratio, and no effect on triglycerides (TG). Benefits were seen with a

428 variety of different macronutrient compositions, though they were enhanced when some  
 429 carbohydrates in the standard DASH pattern were replaced with protein or unsaturated fat. In the  
 430 standard DASH, when food was supplied to adults with a total cholesterol level of less than 260  
 431 mg/dL and LDL-C less than 160 mg/dL, and body weight was kept stable, the DASH dietary  
 432 pattern compared to the control diet decreased LDL-C by 11 mg/dL, decreased HDL-C by 4  
 433 mg/dL, and had no effect on TG. The OmniHeart trial tested the DASH dietary pattern with  
 434 different macronutrient compositions among adults with average baseline LDL-C 130 mg/dL,  
 435 HDL-C 50 mg/dL, and TG 100 mg/dL. Modifying the DASH diet by replacing 10 percent of  
 436 calories from carbohydrate with 10 percent of calories from protein decreased LDL-C by 3  
 437 mg/dL, decreased HDL-C by 1 mg/dL, and decreased TG by 16 mg/dL compared to the DASH  
 438 dietary pattern. Replacing 10 percent of calories from carbohydrate with 10 percent of calories  
 439 from unsaturated fat (8 percent MUFA and 2 percent PUFA) decreased LDL-C similarly,  
 440 increased HDL-C by 1 mg/dL, and decreased TG by 10 mg/dL compared to the DASH dietary  
 441 pattern.<sup>11</sup>

442

#### 443 **Mediterranean-style Dietary Patterns**

444 As with blood pressure, few trials have evaluated the effects of Mediterranean dietary patterns on  
 445 blood lipids. According to the AHA/ACC Lifestyle Guideline, consuming a Mediterranean-style  
 446 diet (compared to minimal or no dietary advice) resulted in no consistent effect on plasma LDL-  
 447 C, HDL-C, and TG. In part, this was due to substantial differences in dietary interventions  
 448 conducted among free-living middle aged or older adults with or without CVD or at high risk for  
 449 CVD.<sup>11</sup> In the PREDIMED trial (reviewed in both the NHLBI Lifestyle and NEL reports), both  
 450 treatment groups (Mediterranean diet +olive oil or +nuts) had favorable changes in HDL-C,  
 451 total-C: HDL-C ratio and TG when compared to the control group, which received minimal  
 452 advice to follow a lower-fat diet.<sup>23</sup> One of the prospective cohort studies reviewed by the NEL  
 453 showed each one-point increase in alternate Mediterranean diet score assessed in adolescence  
 454 and early adulthood was associated with a -6.19 (-10.44, -1.55) mg/dL lower total cholesterol in  
 455 adulthood but no significant effects on HDL-C.<sup>30</sup> Of other observational cohorts reviewed, one  
 456 reported adherence to a Mediterranean diet was associated with favorable changes in HDL-C and  
 457 TG,<sup>31</sup> and another found no associations between adherence to a Mediterranean diet and blood  
 458 lipids.<sup>32</sup>

459

#### 460 **Vegetarian Dietary Patterns**

461 The NEL systematic review included three articles on vegetarian patterns that measured blood  
 462 pressure or blood lipids.<sup>26-28</sup> One study reported decreased total-C<sup>26</sup> and another reported  
 463 decreased non-HDL-C in vegetarian versus non-vegetarian participants.<sup>28</sup>

464

#### 465 **Other Dietary Patterns**

466 Of note, adherence to the *2005 Dietary Guidelines for Americans* also was related to higher  
 467 HDL-C levels in a cohort of Black and White young adults.<sup>29</sup>

468

469 ***Dietary Patterns and Cardiovascular Disease Outcomes***

470 The NHLBI Lifestyle review did not include any trials examining the evidence of particular  
 471 dietary patterns with CVD outcomes. Overall, the NEL systematic review found that individuals  
 472 whose diets mirrored the dietary patterns of interest (typically compared with diets having lower  
 473 scores) was associated with lower CVD incidence and mortality in 14 out of 17 studies. The  
 474 studies were predominantly observational, but included some trial evidence, and they typically  
 475 assessed dietary intakes through self-report. The effect sizes varied substantially, with the  
 476 decrease in risk of CVD ranging from 22 to 59 percent for increased adherence to various  
 477 Mediterranean-style dietary patterns and from 20 to 44 percent for increased adherence to a U.S.  
 478 Dietary Guidelines-related pattern (e.g., HEI or AHEI and updates). The majority of studies that  
 479 assessed coronary heart disease (CHD) incidence or mortality also reported a favorable  
 480 association between adherence to a healthy dietary pattern and CHD risk. The lower CHD risk  
 481 ranged from 29 to 61 percent for greater adherence to Mediterranean-style dietary patterns, from  
 482 24 to 31 percent for greater adherence to a U.S. Dietary Guidelines-related pattern, and from 14  
 483 to 27 percent for greater adherence to DASH. Similarly, the majority of studies assessing stroke  
 484 incidence or mortality reported favorable associations, with the lower stroke risk ranging from 13  
 485 to 53 percent for greater adherence to a Mediterranean-style dietary pattern and from 14 to 60  
 486 percent for greater adherence to a U.S. Dietary Guidelines-related pattern.<sup>2</sup>

487

488 **Mediterranean-style Dietary Patterns**

489 To gather additional information on dietary patterns and CVD outcomes, the DGAC consulted  
 490 two meta-analyses,<sup>15, 18</sup> which included many of the same observational prospective cohort  
 491 studies as one another and as the NEL systematic review. These meta-analyses each reported  
 492 summary estimates across studies as a 10 percent reduction in risk of CVD (fatal or nonfatal  
 493 clinical CVD event) per 2-increment increase in adherence to the Mediterranean-style diet. The  
 494 NEL report also included results from the largest Mediterranean diet trial, PREDIMED, which  
 495 found that a Mediterranean diet (plus extra virgin olive oil or nuts) had favorable effects in high-  
 496 risk participants compared to the control group who were advised to reduce dietary fat intake. An  
 497 approximately 30 percent decrease in risk of major CVD events (a composite endpoint including  
 498 myocardial infarction, stroke, and deaths) was observed and the trial was stopped early for  
 499 meeting benefit requirements.<sup>2, 33</sup> According to food questionnaires measuring adherence to the  
 500 assigned diet by the end of follow-up, the intervention groups had significantly increased  
 501 consumption of fish and legumes and non-significant reductions in refined grains and red meat  
 502 from baseline, in addition to increased intake of supplemental foods (olive oil or nuts depending  
 503 on the intervention arm), compared to the control group.

504

505 **DASH-style Dietary Patterns**

506 A recent meta-analysis<sup>17</sup> of six prospective cohort studies with CVD endpoints assessed DASH-  
 507 style diet through the Fung et al. method,<sup>6</sup> which assigns points based on population-specific

508 quintiles of eight DASH dietary pattern components: fruits, vegetables, nuts and legumes, whole  
 509 grains, low-fat dairy, sodium, red and processed meats, and sweetened beverages. This meta-  
 510 analysis reported that greater adherence to a DASH-style diet significantly reduced CVD  
 511 (Relative Risk [RR]=0.80; 95% CI = 0.74 to 0.86), CHD (RR=0.79; 95% CI = 0.71 to 0.88), and  
 512 stroke (RR=0.81; 95% CI = 0.72 to 0.92). All of the studies meta-analyzed also were included  
 513 the NEL's evidence base for the DASH-style diet.

514

### 515 **Vegetarian Dietary Patterns**

516 The NEL systematic review concluded that evidence for the effects of vegetarian dietary patterns  
 517 on cardiovascular endpoints is limited. Most of this evidence was from prospective cohort  
 518 studies; four out of six studies suggested that a vegetarian dietary pattern was associated with  
 519 reduced incidence of ischemic heart disease (IHD) or CVD mortality. A meta-analysis of seven  
 520 studies related to CVD mortality and vegetarian diet<sup>14</sup> (including two of the studies from the  
 521 NEL systematic review) found that mortality from IHD was significantly lower in vegetarians  
 522 than in non-vegetarians (RR=0.71; 95% CI = 0.56 to 0.87). The authors estimated a 16 percent  
 523 lower mortality from circulatory diseases (RR=0.84; 95% CI = 0.54 to 1.14) and a 12 percent  
 524 lower mortality from cerebrovascular disease (RR=0.88; 95% CI = 0.70 to 1.06) in vegetarians  
 525 compared to non-vegetarians.

526

527 *For additional details on this body of evidence, visit:* References 2, 10, 11, 14-19 and *Appendix*  
 528 *E-2.26*

529

530

## 531 **DIETARY PATTERNS AND BODY WEIGHT**

### 532 **Question 2: What is the relationship between dietary patterns and measures of** 533 **body weight or obesity?**

534 **Source of evidence:** Existing reports

535

### 536 **Conclusion**

537 The DGAC concurs with the 2013 AHA/ACC/TOS *Guideline for the Management of*  
 538 *Overweight and Obesity* that strong evidence demonstrates that, preferably as part of a  
 539 comprehensive lifestyle intervention carried out by multidisciplinary teams of professionals or  
 540 nutrition professionals, overweight and obese adults can achieve weight loss through a variety of  
 541 dietary patterns that achieve an energy deficit. Clinically meaningful weight losses that were  
 542 achieved ranged from 4 to 12 kg at 6-month follow-up. Thereafter, slow weight regain is  
 543 observed, with total weight loss at 1 year of 4 to 10 kg and at 2 years of 3 to 4 kg. However,  
 544 some dietary patterns may be more beneficial in the long-term for cardiometabolic health.

545 **DGAC Grade: Strong**

546

547 The DGAC concurs with the NEL Dietary Patterns Systematic Review Project that moderate  
 548 evidence indicates dietary patterns that are higher in vegetables, fruits, and whole grains; include  
 549 seafood and legumes; are moderate in dairy products (particularly low and non-fat dairy) and  
 550 alcohol; lower in meats (including red and processed meats), and low in sugar-sweetened foods  
 551 and beverages, and refined grains are associated with favorable outcomes related to healthy body  
 552 weight (including lower BMI, waist circumference, or percent body fat) or risk of obesity.  
 553 Components of the dietary patterns associated with these favorable outcomes include higher  
 554 intakes of unsaturated fats and lower intakes of saturated fats, cholesterol, and sodium. **DGAC**

555 **Grade: Moderate**

556

557 Evidence for children is limited, but studies in the NEL Dietary Patterns Systematic Review  
 558 Project and the systematic review focused on this age group by Ambrosini et al.<sup>34</sup> suggest that  
 559 dietary patterns in childhood or adolescence that are higher in energy-dense and low-fiber foods,  
 560 such as sweets, refined grains, and processed meats, as well as sugar-sweetened beverages,  
 561 whole milk, fried potatoes, certain fats and oils, and fast foods increase the risk of obesity later  
 562 on in life. **DGAC Grade: Limited**

563

## 564 **Implications**

565 To achieve and maintain a healthy body weight, individuals are encouraged to consume dietary  
 566 patterns that are higher in vegetables, fruits, and whole grains; include seafood and legumes; are  
 567 moderate in dairy products (with an emphasis on low- and non-fat dairy), and alcohol; and are  
 568 lower in meats (including red and processed meats), sugar-sweetened foods and beverages, and  
 569 refined grains. During childhood and adolescence, a time period critical for the prevention of  
 570 obesity later in life, a dietary pattern similar to that associated with a healthy weight in adults  
 571 should be encouraged.

572

573 Among overweight and obese individuals, an energy deficit is necessary to achieve weight loss.  
 574 This can be achieved through a variety of evidence-based dietary patterns and should be  
 575 approached with comprehensive lifestyle interventions. While it is possible to lose weight on  
 576 his/her own, it is more successful if conducted by trained professionals or by referral to a  
 577 nutrition professional for individual or group counseling (for more details refer to  
 578 *AHA/ACC/TOS Guideline for the Management of Overweight and Obesity*<sup>13</sup> algorithm Box  
 579 11B). Strategies should be based on the individual's preferences and health status and consider  
 580 the socio-cultural influences on lifestyle behaviors that relate to long-term behavior maintenance.  
 581 These approaches are best complemented with population-based approaches, as mentioned in  
 582 **Part D. Chapter 3: Individual Diet and Physical Activity Behavior Change** and **Part D.**  
 583 **Chapter 4: Food Environment and Settings**, which will allow all factors influencing lifestyle  
 584 behaviors to be addressed as defined in the socio-ecological model.

585

## 586 **Review of the Evidence**

587 The DGAC considered evidence from the 2013 AHA/ACC/TOS Obesity Guideline and  
 588 associated NHLBI Obesity Report, which included only randomized trials,<sup>12, 13</sup> the NEL Dietary  
 589 Patterns Systematic Review Project,<sup>2</sup> which included 38 studies predominately of prospective  
 590 cohort design and a few randomized trials, and two systematic reviews/meta-analyses published  
 591 since 2008.<sup>34, 35</sup> In total, 81 articles were considered in these reports. The published reviews  
 592 provided evidence for the pediatric population (included 7 studies of which 2 overlapped with  
 593 those in the NEL review) and further evidence for dietary patterns related to the Mediterranean-  
 594 style diet and its effect on obesity and weight loss (all randomized trials of which 1 out of the 16  
 595 studies overlapped with the NEL review).

596

### 597 ***Dietary Patterns and the Management of Overweight and Obesity***

598 In the NHLBI Obesity Report, the 12 randomized studies described in summary Table 3.1 of the  
 599 report all confirm that to lose weight, a variety of dietary pattern approaches can be used and a  
 600 reduction in caloric intake is required. The energy balance equation requires that for weight loss,  
 601 one must consume less energy than one expends or expend more energy than one consumes. The  
 602 report states that any one of the following methods can be used to reduce food and calorie intake:  
 603 prescription of 1,200 to 1,500 kcal/day for women and 1,500 to 1,800 kcal/day for men (kcal  
 604 levels are usually adjusted for the individual's body weight); prescription of a 500 kcal/day or  
 605 750 kcal/day energy deficit; or prescription of an evidence-based diet that restricts certain food  
 606 types (such as high-carbohydrate foods, low-fiber foods, or high-fat foods) in order to create an  
 607 energy deficit by reduced food intake.

608

609 For the different dietary approaches (provided either as part of a comprehensive lifestyle change  
 610 intervention carried out by a multi-disciplinary team of trained professionals or within nutrition  
 611 interventions conducted by nutrition professionals) that the authors of the report evaluated, it is  
 612 evident that all prescribed diets that achieved an energy deficit were associated with weight loss.  
 613 There was no apparent superiority of one approach when behavioral components were balanced  
 614 in the treatment arms. Results indicated that average weight loss is maximal at 6 months with  
 615 smaller losses maintained for up to 2 years, while treatment and follow-up taper. Weight loss  
 616 achieved by dietary techniques aimed at reducing daily energy intake ranges from 4 to 12 kg at  
 617 6-month follow-up. Thereafter, slow weight regain is observed, with total weight loss at 1 year of  
 618 4 to 10 kg and at 2 years of 3 to 4 kg. The following dietary approaches are associated with  
 619 weight loss if reduction in dietary energy intake is achieved:

620

- 621 • A diet from the European Association for the Study of Diabetes Guidelines, which  
 622 focuses on targeting food groups, rather than formal prescribed energy restriction while  
 623 still achieving an energy deficit.



- 624 • Higher protein (25 percent of total calories from protein, 30 percent of total calories from  
625 fat, 45 percent of total calories from carbohydrate) with provision of foods that realized  
626 energy deficit.
- 627 • Higher protein Zone™-type diet (5 meals/day, each with 40 percent of total calories from  
628 carbohydrate, 30 percent of total calories from protein, 30 percent of total calories from  
629 fat) without formal prescribed energy restriction but realized energy deficit.
- 630 • Lacto-ovo-vegetarian-style diet with prescribed energy restriction.
- 631 • Low-calorie diet with prescribed energy restriction.
- 632 • Low-carbohydrate (initially less than 20 g/day carbohydrate) diet without formal  
633 prescribed energy restriction but realized energy deficit.
- 634 • Low-fat (10 percent to 25 percent of total calories from fat) vegan-style diet without  
635 formal prescribed energy restriction but realized energy deficit.
- 636 • Low-fat (20 percent of total calories from fat) diet without formal prescribed energy  
637 restriction but realized energy deficit.
- 638 • Low-glycemic load diet, either with formal prescribed energy restriction or without  
639 formal prescribed energy restriction but with realized energy deficit.
- 640 • Lower fat ( $\leq 30$  percent fat), high dairy (4 servings/day) diets with or without increased  
641 fiber and/or low-glycemic index/load foods (low-glycemic load) with prescribed energy  
642 restriction.
- 643 • Macronutrient-targeted diets (15 percent or 25 percent of total calories from protein; 20  
644 percent or 40 percent of total calories from fat; 35 percent, 45 percent, 55 percent, or 65  
645 percent of total calories from carbohydrate) with prescribed energy restriction.
- 646 • Mediterranean-style diet with prescribed energy restriction.
- 647 • Moderate protein (12 percent of total calories from protein, 58 percent of total calories  
648 from carbohydrate, 30 percent of total calories from fat) with provision of foods that  
649 realized energy deficit.
- 650 • Provision of high-glycemic load or low-glycemic load meals with prescribed energy  
651 restriction.
- 652 • The AHA-style Step 1 diet (with prescribed energy restriction of 1,500 to 1,800 kcal/day,  
653  $<30$  percent of total calories from fat,  $<10$  percent of total calories from saturated fat).

654 Although these dietary patterns with an energy deficit will result in weight loss during a 6-  
655 months to 2-year period, long-term health implications with certain patterns may be detrimental  
656 to cardiometabolic health. These associations have been discussed in the dietary patterns and  
657 cardiovascular health section as well as the saturated fat and cardiovascular health section.

658

659 As presented in Table D2.1 at the end of the chapter, the results of the randomized studies  
660 considered in the AHA/ACC/TOS Guideline provide evidence for what works in terms of the  
661 components of a comprehensive lifestyle intervention or nutrition interventions that are needed  
662 to achieve weight loss with the variety of dietary approaches described above.

663

### 664 ***Dietary Patterns and their Association with Body Weight***

665 A total of 14 studies met the inclusion criteria for the index/score question of the NEL systematic  
666 review and were categorized based on dietary pattern exposure. Two major categories were  
667 identified: (1) studies that examined exposure based on a Mediterranean-designated dietary  
668 pattern and (2) studies that examined exposure based on expert dietary guidelines  
669 recommendations. Taken together, there were six studies on Mediterranean-designated diet  
670 scores,<sup>23, 31, 32, 36-38</sup> five studies on dietary guidelines-based indices,<sup>39-43</sup> two studies on  
671 Mediterranean-designated scores and dietary guidelines indices,<sup>44, 45</sup> and one study that used a  
672 trial-based customized score.<sup>46</sup> Two of the studies were RCTs of positive quality<sup>23, 46</sup> and 12  
673 were prospective cohort studies. The studies were carried out between 2006 and 2012.

674

675 The sample sizes for prospective cohort studies ranged from 732 to 373,803 participants, with  
676 follow-up times from 1.5 to 20 years. Ten out of 12 of the prospective cohort studies were  
677 conducted with generally healthy adults with a mean age of 25 to 63 years. Two studies were  
678 conducted with children and adolescents (one with girls).<sup>39, 40</sup> The two RCTs were conducted in  
679 adults with elevated chronic disease risk: one study with a Mediterranean-designated diet  
680 intervention on older adults at increased CVD risk with more than 90 percent overweight or  
681 obese<sup>23</sup> and one study using an a priori diet intervention on men with pre-existing metabolic  
682 syndrome.<sup>46</sup> The sample sizes for the RCTs were from 187 to 769 subjects and duration of  
683 follow-up ranged from 3 to 12 months.

684

### 685 **Mediterranean-style Dietary Pattern**

686 Four out of the six studies evaluating the Mediterranean style dietary pattern were conducted in  
687 Spain.<sup>23, 32, 36, 37</sup> Of the other two, one study was the European multicenter study that was part of  
688 the EPIC-Physical Activity, Nutrition, Alcohol Consumption, Cessation of Smoking, Eating out  
689 of Home, and Obesity (EPIC-PANACEA) study,<sup>38</sup> and one was conducted in the United States.<sup>31</sup>

690

### 691 Dietary Patterns and Body Weight and Incidence of Overweight and/or Obesity

692 The Prevencion con Dieta Mediterranean (PREDIMED) study tested the effects of a  
693 Mediterranean diet on the primary prevention of cardiovascular disease in a high-risk group of  
694 men and women. Subjects either had type 2 diabetes or three cardiovascular disease risk factors  
695 (such as hypertension or current smoking) and 90 percent were overweight or obese defined as  
696 BMI  $\geq 25$  kg/m<sup>2</sup>. The PREDIMED trial randomly assigned participants to three interventions: (1)  
697 Mediterranean diet with extra virgin olive oil, (2) Mediterranean diet with mixed nuts, and (3)

698 low-fat diet. At end of 3 months of a 4-year clinical trial, the authors found that the  
 699 Mediterranean diet score increased in the two Mediterranean diet groups of the trial and  
 700 remained unchanged in the low-fat group. However, no significant changes in body weight and  
 701 adiposity occurred within or between groups from baseline to the 3 months. Beunza et al., 2010  
 702 reported on a prospective cohort study in Spain, the Seguimiento Universidad de Navarra (SUN)  
 703 study.<sup>36</sup> Participants with the highest adherence to a Mediterranean dietary pattern, assessed  
 704 using the Trichopoulou Mediterranean Diet Score (MDS) were found to have lower average  
 705 yearly weight gain, -0.059 kg/y (95% CI = -0.111 to -0.008 kg/y; p for trend = 0.02), than  
 706 participants in the lowest adherence group.<sup>7</sup> However, the MDS was not associated with  
 707 incidence of overweight or obesity in participants who were normal weight at baseline. Mendez  
 708 et al., 2006 reported on the EPIC-Spain prospective cohort study.<sup>37</sup> Adherence to a  
 709 Mediterranean diet was assessed using a slight modification of the Trichopoulou MDS, with  
 710 exposure categorized in tertiles of low (0-3), medium (4-5), and high (6-8) adherence.  
 711 Participants with highest MDS adherence had reduced incidence of obesity when overweight at  
 712 baseline; overweight women and men were 27 percent and 29 percent, respectively, less likely to  
 713 become obese. High MDS adherence was not associated with incidence of overweight in subjects  
 714 who were normal weight at baseline. The EPIC-PANACEA study examined the association  
 715 between adherence to the relative Mediterranean dietary pattern (rMDS), prospective weight  
 716 change, and the incidence of overweight or obesity. Participants with high rMED adherence  
 717 gained less weight in 5 years than did participants with low rMED adherence (-0.16 kg; 95% CI  
 718 = -0.24 to -0.07 kg) and had a 10 percent lower odds of becoming overweight or obese (OR =  
 719 0.90; 95% CI = 0.82 to 0.96). The contribution of each rMED scoring component also was  
 720 assessed and it was found that the association between rMED and weight change was no longer  
 721 significant when meat and meat products were not part of the score. Lastly, a meta-analysis of  
 722 the odds ratio scores of all 10 European countries showed that a 2-point increase in rMED score  
 723 was associated with 3 percent (95% CI = 1 to 5%) lower odds of becoming overweight or obese  
 724 over 5 years.

725

#### 726 Dietary Patterns and Waist Circumference

727 Rumawas et al., 2009 conducted a prospective cohort study using a subset of the Framingham  
 728 Offspring and Spouse (FOS) study.<sup>31</sup> Dietary exposure was assessed in quintiles of low to high  
 729 adherence to the Mediterranean style dietary pattern score (MSDPS). Participants with a higher  
 730 MSDPS had significantly lower waist circumference (p for trend < 0.001). Tortosa et al., 2007  
 731 reported on the association of the Mediterranean dietary pattern and metabolic syndrome in the  
 732 SUN study conducted in Spain.<sup>32</sup> Participants in the highest tertile of adherence to the MDS had  
 733 lower waist circumference, -0.05 cm over 6 years (p for trend = 0.038), compared to the lowest  
 734 tertile.

735

736 Although some mixed results from prospective studies may be due to differences in the length of  
 737 follow up, definition of the Mediterranean dietary pattern and population included, the results of

738 randomized studies indicate a significant reduction in body weight when calories are restricted.  
 739 A high quality meta-analysis (AMSTAR rating of 11) on the association of a Mediterranean-  
 740 style diet with body weight conducted by Esposito included 16 randomized studies of which  
 741 one<sup>32</sup> overlapped with the NEL systematic review was included in the DGAC body of evidence  
 742 for this question. The meta-analysis included studies conducted in the United States, Italy, Spain,  
 743 France, Israel, Greece, Germany, and the Netherlands that lasted from 4 weeks to 24 months  
 744 with a total of 3,436 participants. Using a random effects model, participants in the  
 745 Mediterranean diet group had significant weight loss (mean difference between Mediterranean  
 746 diet and control diet, -1.75 kg; 95% CI = -2.86 to -0.64) and reduction in BMI (mean difference,  
 747 -0.57 kg/m<sup>2</sup>; 95% CI = 0.93 to 0.21 kg/m<sup>2</sup>) compared to those in the control arm. The effect of  
 748 Mediterranean diet on body weight was greater in association with energy restriction (mean  
 749 difference, -3.88 kg; 95% CI = -6.54 to -1.21 kg), increased physical activity (-4.01 kg; 95% CI  
 750 = -5.79 to -2.23 kg), and follow up longer than 6 months (-2.69 kg; 95% CI = -3.99 to -1.38 kg).  
 751 Across all 16 studies, the Mediterranean style dietary pattern did not cause weight gain.

752

### 753 **Dietary Guidelines-Based Indices**

754 Of the seven studies conducted on dietary guidelines-based indices, three studies were conducted  
 755 in the United States with U.S.-based indices.<sup>39, 41, 43</sup> One study was conducted in Germany with  
 756 an index developed in the United States,<sup>40</sup> and two studies were conducted in France (one used a  
 757 French index,<sup>42</sup> and the other compared six different dietary scores).<sup>44</sup>

758

### 759 Dietary Patterns and Body Weight and Incidence of Overweight and/or Obesity

760 Gao et al., 2008 reported on a prospective cohort study of White, African American, Hispanic,  
 761 and Chinese men and women in the Multi-Ethnic Study of Atherosclerosis (MESA) in the US.  
 762 Two versions of the 2005 HEI were used: the original and a modified version that adjusted the  
 763 food group components to incorporate levels of caloric need based on sex, age, and activity  
 764 level.<sup>41</sup> For the overall population, there was an inverse association between quintiles of each  
 765 HEI score and BMI (p<0.001). The risk of obesity in normal weight participants was inversely  
 766 associated with HEI scores only for Whites (p<0.05). A comparison of the HEI-1995 and HEI-  
 767 2005 scores indicated that beta-coefficients, as predictors of body weight and BMI, were higher  
 768 for the HEI-2005 scores in Whites. Zamora et al., 2010 analyzed data from the prospective  
 769 cohort study, Coronary Artery Risk Development in Young Adults (CARDIA), conducted in the  
 770 United States, to examine the association between diets consistent with the 2005 Dietary  
 771 Guidelines and subsequent weight gain in Black and White young adults.<sup>43</sup> The Diet Quality  
 772 Index (DQI) included 10 components of the 2005 Dietary Guidelines relating to the  
 773 consumption of total fat, saturated fat, cholesterol, added sugars, reduced-fat milk, fruit,  
 774 vegetables, whole grains, nutrient-dense foods, and limited sodium and alcohol intake. They  
 775 found, a 10-point increase in DQI score was associated with a 10 percent lower risk of gaining  
 776 10 kg in normal-weight Whites. However, the same magnitude increase in score was associated  
 777 with a 15 percent higher risk in obese Blacks (p<0.001). Kesse-Guyot et al., 2009 conducted a

778 prospective cohort study in France to examine the association between adherence to a dietary  
 779 score based on the French 2001 nutritional guidelines (Programme National Nutrition Sante´  
 780 guidelines score (PNNS-GS) and changes in body weight, body fat distribution, and obesity  
 781 risk.<sup>42</sup> The PNNS-GS includes 12 nutritional components: fruit and vegetables, starchy foods,  
 782 whole grains, dairy products, meat, seafood, added fat, vegetable fat, sweets, water and soda,  
 783 alcohol, and salt. The last PNNS-GS component is physical activity. In fully adjusted models, an  
 784 increase of one PNNS-GS unit was associated with lower weight gain ( $p=0.004$ ), and lower BMI  
 785 gain ( $p=0.002$ ). An increase of 1 PNNS-GS unit was associated with a lower probability of  
 786 becoming overweight (including obese) (OR = 0.93; 95% CI = 0.88 to 0.99). Similarly, an  
 787 increase of 1 PNNS-GS unit was associated with a lower probability of becoming obese (OR =  
 788 0.89; 95% CI = 0.80 to 0.99).

789  
 790 Two studies were conducted in children. Cheng et al., 2010 analyzed data from a prospective  
 791 cohort study conducted in Germany, the Dortmund Nutritional and Anthropometric  
 792 Longitudinally Designed (DONALD) study, to examine whether the diet quality of healthy  
 793 children before puberty was associated with body composition at onset of puberty.<sup>40</sup> Adherence  
 794 to a diet pattern was assessed by the Revised Children’s Diet Quality Index (RC-DQI) which was  
 795 based on the Dietary Guidelines for Americans. In this study, a higher dietary quality was  
 796 associated with a higher energy intake, and children with a lower diet quality had lower BMI and  
 797 Fat Mass Index (FMI) Z-scores at baseline ( $p<0.01$ ) but not at onset of puberty. Berz et al., 2011  
 798 reported on a prospective cohort study to assess the effects of the DASH eating pattern on BMI  
 799 in adolescent females over a 10-year period.<sup>39</sup> Only seven out of the 10 original components of  
 800 the DASH score were used; the three excluded were added sugars, discretionary fats and oils,  
 801 and alcohol. Overall, girls in the highest vs. lowest quintile of DASH score had an adjusted mean  
 802 BMI of 24.4 vs. 26.3 kg/m<sup>2</sup> ( $p<0.05$ ).

803

#### 804 Dietary Patterns and Waist Circumference

805 Gao et al, found, for the overall population in the MESA study, an inverse association between  
 806 quintiles of each HEI score and waist circumference (WC) ( $p<0.001$ ).<sup>41</sup> The study by Kesse-  
 807 Guyot conducted in France showed, in fully adjusted models, an increase of one PNNS-GS unit  
 808 was associated with lower waist circumference gain ( $p=0.01$ ) and lower waist-to-hip ratio gain  
 809 ( $p=0.02$ ).<sup>42</sup>

810

#### 811 **Other Indices**

812 Jacobs et al., 2009 conducted an RCT in Norway, the Oslo Diet and Exercise Study, to examine  
 813 the effect of changes in diet patterns on body weight and other outcomes among men who met  
 814 the criteria for the metabolic syndrome ( $n=187$  men).<sup>46</sup> Study participants were randomly  
 815 assigned to: (1) the diet protocol, (2) the exercise protocol, (3) the diet + exercise protocol, or (4)  
 816 the control protocol. The trial duration was 12 months. The authors created their own diet score  
 817 to assess adherence to the intervention. The score was based on summing the participants

818 ranking of intake (across tertiles) of 35 food groups that, based on the literature, had a beneficial  
 819 neutral or detrimental effect on health. A higher score reflected greater adherence to the diet  
 820 intervention. Over the course of the intervention, the diet score increased by 2 points (SD  $\pm 5.5$ )  
 821 in both diet groups, with a decrease of an equivalent amount in the exercise and control groups.  
 822 A 10-point change in the diet score during the intervention period was associated with a 3.5 kg  
 823 decrease in weight, a 2.8 cm decrease in waist circumference and 1.3 percent decrease in percent  
 824 body fat (all significant at  $p < 0.0001$ ).

825

### 826 **Studies that Compared Various Dietary Indices**

827 In a study by Lassale et al., subjects were participants in the SUPplementation en Vitamines et  
 828 Mineraux Antioxydants (SU.VI.MAX) study and diet quality was assessed using a  
 829 Mediterranean Score (MDS, rMED, MSDPS), the Diet Quality Index-International (DQI-I), the  
 830 2005 Dietary Guidelines for Americans Adherence Index (DGAI), and the French Programme  
 831 National Nutrition Sante-Guidelines Score (PNNS-GS).<sup>44</sup> Overall, better adherence to a  
 832 Mediterranean diet (except for the MSDPS) or expert dietary guidelines was associated with  
 833 lower weight gain in men who were normal weight at baseline ( $p$  for trend =  $< 0.05$ ). In addition,  
 834 among the 1,569 non-obese men at baseline, the odds of becoming obese associated with one  
 835 standard deviation increase in dietary score ranged from OR = 0.63 (95% CI = 0.51 to 0.78) for  
 836 the DGAI to OR = 0.72 (95% CI = 0.59 to 0.88) for the MDS, only the MSDPS was non-  
 837 significant. In women, no association between diet scores and weight gain or incidence of  
 838 obesity was found. Woo et al., 2008 reported on a prospective cohort study in Hong Kong to  
 839 examine adherence to a diet pattern using the MDS and the Diet Quality Index International  
 840 (DQI-I).<sup>45</sup> They found that increased adherence to either the MDS or DQI-I was not associated  
 841 with becoming overweight.

842

### 843 **Dietary Patterns from Data-Driven Methods**

844 In the NEL review, a total of 11 studies from prospective cohort studies were included that either  
 845 used factor or cluster analyses to derive dietary patterns. Eight of the eleven studies were  
 846 conducted in the United States, with additional studies from the United Kingdom, Iran, and  
 847 Sweden. The sample sizes ranged from 206 to 51,670 participants with follow-up times from 3 to  
 848 20 years. The majority of the studies were conducted with generally healthy adult men and  
 849 women,<sup>47-52</sup> five studies included women only,<sup>53-57</sup> and one was conducted in children to  
 850 examine weight gain in adolescence over the period of follow-up.<sup>56</sup> Outcomes examined  
 851 included change in body weight (3 studies), BMI (7 studies), and waist circumference (6  
 852 studies); one study examined both percent body fat and incidence of overweight/obesity.

853

854 Most of the studies found at least two generic food patterns: a “healthy/prudent” food pattern and  
 855 an “unhealthy/western” pattern. Generally, healthy patterns were associated with more favorable  
 856 body weight outcomes, while the opposite was seen for unhealthy patterns. However, not all  
 857 studies reported significant associations. There was a potential difference in associations found

858 by sex: of the three studies that analyzed men and women separately, men tended to have null  
 859 results. However, data were insufficient to draw conclusions about population subgroups.  
 860 Furthermore, because the patterns are data-driven, they represent what was consumed by the  
 861 study population, and thus it is difficult to compare across the disparate patterns. The one study  
 862 that analyzed the dietary patterns of pre-pubescent children transitioning into adolescence  
 863 showed that patterns vary widely at this age and caution should be observed when analyzing  
 864 these data because the diet of children changes rapidly, as does their weight.

865  
 866 The DGAC considered the systematic review by Ambrosini et al. that included seven articles,  
 867 two of which overlapped with the NEL review.<sup>34</sup> Results demonstrated a positive association  
 868 between a dietary pattern high in energy-dense, high fat, and low fiber foods and later obesity (4  
 869 of the 7 studies), while three studies demonstrated null associations. The seven longitudinal  
 870 studies of children from the United Kingdom, United States, Australia, Norway, Finland, and  
 871 Colombia had follow-up periods ranging from 2 to 21 years and had sample sizes from 427 to  
 872 6772 individuals. The studies determined dietary patterns using factor or cluster analysis (5) or  
 873 reduced rank regression (2).

874  
 875 *For additional details on this body of evidence, visit:* References 2, 13, 34, 35 and *Appendix E-*  
 876 *2.27*

877

## 878 **DIETARY PATTERNS AND TYPE 2 DIABETES**

879 **Question 3: What is the relationship between dietary patterns and risk of type 2**  
 880 **diabetes?**

881 **Source of evidence:** Existing reports

882

### 883 **Conclusion**

884 Moderate evidence indicates that healthy dietary patterns higher in vegetables, fruits, and whole  
 885 grains and lower in red and processed meats, high-fat dairy products, refined grains, and  
 886 sweets/sugar-sweetened beverages reduce the risk of developing type 2 diabetes. **DGAC Grade:**  
 887 **Moderate**

888

889 Evidence is lacking for the pediatric population.

890

### 891 **Implications**

892 To reduce the risk of developing type 2 diabetes, individuals are encouraged to consume dietary  
 893 patterns that are rich in vegetables, fruits, and whole grains and lower in red and processed  
 894 meats, high-fat dairy, refined grains, and sweets/sugar-sweetened beverages in addition to

895 maintaining a healthy body weight. Diabetes can be prevented through the consumption of a  
 896 variety of healthy dietary patterns that share these components and that are tailored to the  
 897 biological needs and socio-cultural preferences of the individual and carried out preferably  
 898 through counseling by a nutrition professional.

899

## 900 **Review of the Evidence**

901 The Committee considered two sources of evidence. The primary source was the NEL Dietary  
 902 Patterns Systematic Review Project which included 37 studies predominantly of prospective  
 903 cohorts design and some randomized trials (n=8).<sup>2</sup> This primary source was supplemented by a  
 904 published meta-analysis<sup>58</sup> that included 15 cohort studies of which 13 overlapped with the NEL  
 905 review.<sup>58</sup> The meta-analysis provided an estimate of the effect size of incident type 2 diabetes  
 906 associated with a healthy and unhealthy dietary pattern.

907

908 Although the NEL rated the overall body of evidence for type 2 diabetes as limited, this was  
 909 primarily a result of examining the different methods for defining dietary patterns (e.g. indices,  
 910 data driven, and reduce rank regression) separately. As such, the NEL noted these  
 911 methodological inconsistencies across studies but stated general support for the consumption of a  
 912 dietary pattern rich in vegetables and fruits and low in high-fat dairy and meats. The DGAC  
 913 concurred with this conclusion. However, the DGAC has elevated the grade of the entire body of  
 914 evidence to moderate given that the NEL findings were corroborated by the results of a high  
 915 quality meta-analysis (AMSTAR rating of 11) and the magnitude of the associations that showed  
 916 when the results of 15 cohort studies are pooled, evidence indicated a 21 percent reduction in the  
 917 risk of developing type 2 diabetes associated with dietary patterns characterized by high  
 918 consumption of whole grains, vegetables, and fruit. Conversely, a 44 percent increased risk of  
 919 developing type 2 diabetes was seen with an unhealthy dietary pattern characterized by higher  
 920 consumption of red or processed meats, high-fat dairy, refined grains, and sweets.

921

### 922 ***Dietary Patterns and Incident Type 2 Diabetes***

#### 923 **Dietary Approaches to Stop Hypertension (DASH)**

924 One study used the DASH score in a cohort of 820 U.S. adults ages 40 to 69 years and with  
 925 equal sex distribution and racial diversity.<sup>59</sup> Liese et al. found adherence to the DASH score was  
 926 associated with markedly reduced odds of type 2 diabetes in Whites but not in the total  
 927 population, or in the Blacks and Hispanics, which comprised the majority of this cohort.

928

#### 929 **Mediterranean-style Dietary Patterns**

930 Three studies assessed Mediterranean-style dietary pattern adherence (Mediterranean Diet Score  
 931 [MDS]) with sample sizes ranging from 5,000 to more than 20,000 in both Mediterranean and  
 932 U.S. populations. One study conducted in Spain with the SUN cohort (n=13,380) found a  
 933 favorable association between the MDS (the original MDS of Trichopoulou) and risk of type 2



934 diabetes. Overall, a 2-point increase in MDS was associated with a 35 percent reduction in risk  
 935 of type 2 diabetes.<sup>60</sup> Another study, conducted in Greece with the EPIC-Greece cohort  
 936 (n=22,295), also assessed the relationship between the MDS and type 2 diabetes. In this second  
 937 Mediterranean population, adherence to the MDS also was favorably associated with decreased  
 938 risk of diabetes.<sup>61</sup> Conversely, a study conducted in the United States, using the authors'  
 939 MedDiet Score with the Multi-Ethnic Study of Atherosclerosis (MESA) cohort (n=5,390) found  
 940 no association between their MedDiet Score and type 2 diabetes incidence in the total  
 941 population, in men or women, or in specific racial/ethnic groups.<sup>62</sup>

942

### 943 **Dietary Indices based on the Dietary Guidelines**

944 Four studies used dietary guidelines-based indices such as the AHEI and the Diet Quality Index  
 945 (DQI). The sample sizes of the studies ranged from 1,821 to 80,029. A study that assessed  
 946 adherence to the AHEI in the United States found a favorable association between AHEI score  
 947 and risk of incident type 2 diabetes in women in the Nurses' Health Study (n=80,029).<sup>63</sup> In the  
 948 CARDIA study (n=4,381), also from the United States, the authors found no association between  
 949 DQI-2005 score and type 2 diabetes incidence in the total population or in Blacks or Whites.<sup>29</sup>  
 950 Studies from outside the United States included one conducted in Australia using a Total Diet  
 951 score in the Blue Mountains Eye Study (BMES, n=1,821) and one from Germany using a  
 952 German Food Pyramid Index with the EPIC-Potsdam cohort (n=23,531). Neither found an  
 953 association between these scores and incident type 2 diabetes.<sup>64, 65</sup> Thus, evidence for an  
 954 association only exists with the AHEI, which does contain slightly different components from  
 955 the other indices, such as nuts and legumes, trans fat, EPA + DHA (n-3 FAs), PUFAs, alcohol,  
 956 red and processed meat.

957

### 958 **Data-Driven Approaches**

959 Eleven studies used factor analysis and one study used cluster analysis. These analyses were all  
 960 conducted using data from prospective cohort studies published between 2004 and 2012 and had  
 961 sample sizes ranging from 690 to more than 75,000 individuals. Five studies were conducted in  
 962 the United States and the rest from developed countries around the world. Each study identified  
 963 one to four dietary patterns, with the most common comparison between "western"/"unhealthy"  
 964 and "prudent"/"healthier" patterns; a total of 35 diverse dietary patterns were identified within  
 965 the body of evidence. Many studies had null findings, particularly studies with duration of less  
 966 than 7 years of follow up.<sup>66-69</sup> Patterns associated with lower risk of type 2 diabetes were  
 967 characterized by higher intakes of vegetables, fruits, low-fat dairy products, and whole grains,  
 968 and those associated with increased risk were characterized by higher intakes of red meat, sugar-  
 969 sweetened foods and drinks, French fries, refined grains, and high-fat dairy products. However,  
 970 the food groups identified varied substantially, even among patterns with the same name.

971

972 Three prospective cohort studies used reduced rank regression to examine the relationship  
 973 between dietary patterns and type 2 diabetes.<sup>70-72</sup> Two of the studies were conducted in the

974 United States and one in the United Kingdom. The sample sizes were 880 for Liese (2009),  
 975 2,879 for Imamura (2009), and 6,699 for McNaughton (2008). The independent variables in  
 976 these studies were dietary pattern scores, and biomarkers were used as response variables in two  
 977 of the studies. Dietary patterns that included meat intake and incident type 2 diabetes were  
 978 positively associated in the two studies that used biomarkers as response variables, though the  
 979 definitions of meat differed.<sup>70, 71</sup> However, because so few studies were available and the  
 980 methodology used and different populations considered varied so much, the information was  
 981 insufficient to assess consistency or draw conclusions.

982

### 983 **Other Dietary Patterns**

984 The body of evidence examined included seven studies conducted between 2004 and 2013,  
 985 consisting of six RCTs<sup>73-79</sup> and one prospective cohort study (PCS).<sup>80</sup> Two studies were  
 986 conducted in the United States; one in the United States and Canada; one in Spain (2  
 987 PREDIMED articles); and one each in Greece, Italy, and Sweden. The sample sizes of the RCTs  
 988 ranged from 82 to 1,224 participants and the PCS had a sample size of 41,387 participants. All  
 989 eight studies were conducted in adults. RCT duration ranged from 6 weeks to a median of 4  
 990 years and the PCS duration was 2 years. The RCTs were primary prevention studies of at-risk  
 991 participants. Baseline health status in the study participants included those with mild  
 992 hypercholesterolemia, overweight or obesity, metabolic syndrome, abdominal obesity, and three  
 993 or more CVD risk factors, including metabolic syndrome. The PCS participants were individuals  
 994 in the Adventist Health Study who did not have type 2 diabetes.<sup>80</sup> Three studies looked at a  
 995 Mediterranean-style diet,<sup>75, 77-79</sup> one study examined the Nordic diet (defined by the authors of  
 996 the study as a diet rich in high-fiber plant foods, fruits, berries, vegetables, whole grains,  
 997 rapeseed oil, nuts, fish and low-fat milk products, but low in salt, added sugars, and saturated  
 998 fats),<sup>73</sup> and three studies looked at either the DASH diet or a variation of the DASH diet,<sup>74, 76</sup> or a  
 999 vegetarian diet.<sup>80</sup>

1000

1001 Two of the seven studies examined the association between adherence to a dietary pattern and  
 1002 incidence of type 2 diabetes.<sup>79, 80</sup> Although the results of both studies showed a favorable  
 1003 association between either a Mediterranean-style or a vegetarian dietary pattern and incidence of  
 1004 type 2 diabetes the studies differed in design and dietary pattern used to assess diet exposure.  
 1005 The other studies examined the intermediate outcomes of impaired glucose tolerance and/or  
 1006 insulin resistance and are discussed in the next section.

1007

### 1008 ***Dietary Patterns and Intermediate Outcomes***

1009 Five studies examined adherence to a dietary pattern and intermediate outcomes related to  
 1010 glucose tolerance and/or insulin resistance: two RCTs<sup>23, 46</sup> and three prospective cohort studies.<sup>29,  
 1011 31, 64</sup> It was difficult to assess food components across these studies, as numerous different scores  
 1012 were used and no compelling number of studies used any one score or index. Even so, favorable  
 1013 associations between dietary patterns and intermediate outcomes were found.

1014  
 1015 The two RCTs were conducted in populations in Europe that were at risk of diabetes. An early  
 1016 report from the PREDIMED trial showed that a Mediterranean diet decreased fasting blood  
 1017 glucose, fasting insulin, and HOMA-IR scores in a Spanish population at risk of CVD.<sup>23</sup> In the  
 1018 Oslo Diet and Exercise Study (ODES), increased adherence to the authors' a priori diet score  
 1019 resulted in decreased fasting insulin and insulin after a glucose challenge, but not fasting glucose,  
 1020 in Norwegian men with metabolic syndrome.<sup>46</sup> Results from prospective cohort studies were  
 1021 consistent in showing a favorable association between diet score and fasting glucose, fasting  
 1022 insulin or HOMA-IR,<sup>29, 31</sup> with the exception of one study that found the association with fasting  
 1023 glucose only in men.<sup>64</sup>

### 1024 1025 **Data-Driven Approaches**

1026 Variations in populations studies, definition of outcomes, dietary assessment methodologies, and  
 1027 methods used to derive patterns resulted in a highly variable set of dietary patterns, thus making  
 1028 it difficult to draw conclusions from studies using data-driven approaches. For example, one  
 1029 study measured fasting blood glucose with a cutoff of 6.1 and greater mmol/L;<sup>47</sup> another study  
 1030 measured plasma glucose with a cutoff of 5.1 and greater mmol/L,<sup>81</sup> while a third study  
 1031 measured plasma glucose after an overnight fast and after a standard 75 g oral glucose tolerance  
 1032 test.<sup>82</sup> Three prospective cohort studies assessed the association between dietary patterns and  
 1033 plasma glucose levels. Two U.S. studies derived patterns using cluster analysis<sup>47, 81</sup> and one  
 1034 study conducted in Denmark used factor analysis.<sup>82</sup> Duffey et al. identified two diet clusters:  
 1035 "Prudent Diet" and "Western Diet";<sup>47</sup> Kimokoti et al. identified five clusters: "Heart Healthier,"  
 1036 "Lighter Eating," "Wine and Moderate Eating," "Higher Fat," and "Empty Calories";<sup>81</sup> and Lau  
 1037 et al. derived two factors: "Modern" and "Traditional."<sup>82</sup>

1038  
 1039 *For additional details on this body of evidence, visit:* References 2, 58, and *Appendix E-2.28*

## 1040 1041 1042 **DIETARY PATTERNS AND CANCER**

### 1043 **Existing Evidence around Foods and Nutrients and Cancer**

1044 The role of dietary composition in cancer risk has been postulated since ancient times, yet  
 1045 scientific evidence for such relationships was sparse until nearly a century ago. Experimental  
 1046 models of cancer based upon chemical carcinogens, radiation, viral-transmission, and inherited  
 1047 genetic variations gradually emerged in first half of the 20th century and were soon found to be  
 1048 influenced by dietary and nutritional interventions. The establishment of population-based cancer  
 1049 registries around the globe in the years following World War II clearly indicated that the  
 1050 incidence and mortality of specific cancers and the patterns of cancers varied widely between  
 1051 countries. Soon, studies of migrant populations demonstrated that in parallel with acculturation,

1052 cancer risk evolved toward that observed in the adopted country, implicating a strong role for  
1053 environmental influences, such as dietary patterns, in cancer risk. When coupled with national  
1054 food consumption data, relationships between dietary patterns or components and cancer risk  
1055 were hypothesized. The development of dietary assessment tools, such as FFQs, paved the way  
1056 for large prospective epidemiologic cohort studies designed to examine more precisely the role  
1057 of dietary patterns, foods, and specific nutrients in the risk of various cancers.<sup>83</sup> Additional diet  
1058 assessment tools, such as food diaries, and single and multi-day 24-hr recalls enhanced the  
1059 ability to undertake population studies and mechanism-based RCTs. These studies were made  
1060 possible by USDA support of research to advance laboratory methods to define the nutrient  
1061 content of foods in the U.S. food supply and establish a database that, when coupled with diet  
1062 assessment tools, provides an estimated intake of energy, macronutrients, vitamins, minerals and  
1063 other dietary variables. More recently, inclusion into the database of non-nutrient bioactive  
1064 components primarily found in vegetables and fruits has enhanced the ability to define human  
1065 intake of bioactive components that may affect health and disease.

1066  
1067 In 1982, the American Institute for Cancer Research (AICR), a part of the World Cancer  
1068 Research Fund (WCRF) global philanthropic network, was established. Together, the mission of  
1069 WCRF/AICR is to fund research and disseminate evidence-based cancer prevention guidelines to  
1070 the public. In 1997, the AICR/WCRF published the results of a comprehensive multi-year effort  
1071 to systematically review the published scientific literature and develop dietary guidelines for  
1072 cancer prevention.<sup>84</sup> With a rapid expansion of available data in the subsequent years, the  
1073 process was repeated for the 2007 AICR/WCRF report.<sup>85</sup> This effort has been enhanced in  
1074 subsequent years by the AICR/WCRF Continuous Update Project (CUP), in which data are  
1075 reviewed and updated on a continuous, rolling basis for specific cancers, with several reports  
1076 completed annually.<sup>86</sup> This effort is accomplished through a rigorous systematic review process  
1077 in which scientific evidence is gathered, reviewed and judged by panels of experts in nutrition  
1078 and cancer in order to generate nutrition and cancer prevention goals for policy makers, the  
1079 general population, and individuals seeking to reduce cancer risk.<sup>87</sup> The most recent summary  
1080 of the systematic review which documents important information about the relationship between  
1081 specific foods, nutrients and other lifestyle behavior and cancer risk is found in Table D2.2.

1082  
1083 As previously mentioned, the 2015 DGAC chose to determine whether an examination of dietary  
1084 patterns, could inform the understanding of diet and cancer risk. As this scientific literature is  
1085 relatively early in its development, we limited our search to the four most common malignancies  
1086 affecting the American public—lung, breast, colon/rectal, and prostate—which account for the  
1087 majority of the cancer burden in the United States. Although the published literature on dietary  
1088 patterns and cancer risk is relatively young, the DGAC felt it was important to examine the  
1089 evidence and conclusions, consider the implications for development of dietary guidelines, and  
1090 indicate areas for future research.

1091

1092 **Table D2.2. American Institute for Cancer Research / World Cancer Research Fund**  
 1093 **(AICR/WCRF) Summary of Strong Evidence on Diet, Nutrition, Physical Activity, and**  
 1094 **Cancer Prevention, updated 2014**

	Mouth, Pharynx, Larynx (2007)	Nasopharynx (2007)	Esophagus (2007)	Lung (2007)	Stomach (2007)	Pancreas (2007)	Gall bladder (2007)	Liver (2007)	Colorectum (2011)	Breast Premenopause (2010)	Breast (Postmenopause) (2010)	Ovary (2014)	Endometrium (2013)	Prostate (2014)	Kidney (2007)	Skin (2007)
↓↓ Convincing decreased risk. ↓ Probable decreased risk. ↑↑ Convincing increased risk. ↑ Probable increased risk. • Substantial effect on risk unlikely.																
Foods containing dietary fiber									↓↓							
Aflatoxins	↓		↓		↓			↑↑								
Non-starchy vegetables <sup>1</sup>					↓											
Allium vegetables									↓							
Garlic	↓		↓	↓	↓											
Fruits <sup>2</sup>									↑↑							
Red meat									↑↑							
Processed meat																
Cantonese-style salted fish		↑														
Diets high in calcium <sup>3</sup>									↓							
Salt, salted and salty foods					↑											
Glycemic load													↑			
Arsenic in drinking water				↑↑												↑
Mate			↑													
Alcoholic drinks <sup>4</sup>	↑↑		↑↑					↑	↑↑	↑↑	↑↑				•	
Coffee					•								↓		•	
Beta-carotene <sup>5</sup>				↑↑										•		•
Physical activity <sup>6</sup>									↓↓		↓		↓			
Body fatness <sup>7</sup>			↑↑			↑↑	↑		↑↑	↓	↑↑	↑	↑↑	↑	↑↑	
Adult attained height						↑			↑↑	↑	↑↑	↑↑		↑		
Greater birth weight										↑						
Lactation										↓↓	↓↓					

1095

<sup>1</sup> Includes evidence on foods containing carotenoids for mouth, pharynx, larynx; foods containing beta-carotene for esophagus; foods containing vitamin C for esophagus.

<sup>2</sup> Includes evidence on foods containing carotenoids for mouth, pharynx, larynx, and lung; foods containing beta-carotene for esophagus; food containing vitamin C for esophagus.

<sup>3</sup> Evidence is from milk and studies using supplements for colorectum.

<sup>4</sup> Convincing increased risk for men and probably increased risk for women for colorectum. Evidence applies to adverse effect for kidney.

<sup>5</sup> Evidence derived from studies using supplements for lung.

<sup>6</sup> Convincing increased risk for colon not rectum.

<sup>7</sup> Probable increased risk for advanced not non-advanced prostate cancer.

1096 **AICR/WCRF Evidence Stratification**<sup>87</sup>

1097 **Convincing:** The evidence for a convincing grade is strong enough to support a causal relationship. This relationship is  
 1098 robust enough that it is unlikely to be modified of research in the foreseeable future. A grade of “convincing” requires evidence  
 1099 from more than one study type, data from at least two cohort studies, no unexplained heterogeneity between study types with  
 1100 regard to the presence or absence of an association, good quality studies where random or systematic errors are unlikely, presence  
 1101 of a dose-response relationship, and strong and plausible experimental evidence relating typical human exposures to relevant  
 1102 cancer outcomes.

1103 **Probable:** The criteria for determining a probable diet and cancer relationship include: evidence from at least two cohort  
 1104 studies or at least five case-control studies, no substantial unexplained heterogeneity between or within study types in the  
 1105 presence or absence of an association or direction of effect, good quality studies where the likelihood of random or systematic  
 1106 error is low, and evidence for biologic plausibility.

1107 **Limited—suggestive:** This grade is assigned when the evidence is too limited to permit a probable or convincing judgment,  
 1108 but there is evidence of a direction of effect. The evidence may have methodological flaws, or there may be a limited number of  
 1109 studies. A grade of “limited-suggestive” requires the following: evidence from at least two cohort studies or five case-control  
 1110 studies, there is some evidence for biologic plausibility, and the direction of the effect is generally consistent, although there may  
 1111 be some unexplained heterogeneity.

1112 **Limited—no conclusion:** This grade describes diet and cancer relationships where the evidence was ample for review by  
 1113 the panel, but it was too limited to receive one of the other grades. The available studies may be of good quality, but limited in  
 1114 number or yielding inconsistent results.

1115 **Substantial effect on risk unlikely:** This grade is assigned when the evidence is strong that a particular nutrient, food,  
 1116 dietary pattern, or physical activity is unlikely to have a substantial causal relationship to a cancer outcome. Data must be strong  
 1117 enough that modification in the foreseeable future is unlikely.

1118

1119 **Question 4: What is the relationship between dietary patterns and risk of cancer?**1120 **Source of evidence:** NEL systematic review

1121

1122 **Conclusions**

1123 **Colon/Rectal Cancer:** Moderate evidence indicates an inverse association between dietary  
 1124 patterns that are higher in vegetables, fruits, legumes, whole grains, lean meats/seafood, and low-  
 1125 fat dairy and moderate in alcohol; and low in red and/or processed meats, saturated fat, and  
 1126 sodas/sweets relative to other dietary patterns and the risk of colon/rectal cancer. Conversely,  
 1127 diets that are higher in red/processed meats, French fries/potatoes, and sources of sugars (i.e.,  
 1128 sodas, sweets, and dessert foods) are associated with a greater colon/rectal cancer risk. **DGAC**

1129 **Grade: Moderate**

1130

1131 **Breast Cancer:** Moderate evidence indicates that dietary patterns rich in vegetables, fruit, and  
 1132 whole grains, and lower in animal products and refined carbohydrate, are associated with  
 1133 reduced risk of post-menopausal breast cancer. The data regarding this dietary pattern and pre-  
 1134 menopausal breast cancer risk point in the same direction, but the evidence is limited due to  
 1135 fewer studies. **DGAC Grade: Moderate for postmenopausal breast cancer risk; Limited for**  
 1136 **premenopausal breast cancer risk**

1137

1138 **Lung Cancer:** Limited evidence from a small number of studies suggests a lower risk of lung  
 1139 cancer associated with dietary patterns containing more frequent servings of vegetables, fruits,

1140 seafood, grains/cereals, and legumes, and lean versus higher fat meats and lower fat or non-fat  
 1141 dairy products. Despite reported modest significant reductions in risk, definitive conclusions  
 1142 cannot be established at this time due to the small number of articles, as well as wide variation in  
 1143 study design, dietary assessment, and case ascertainment. **DGAC Grade: Limited**

1144  
 1145 **Prostate Cancer:** No conclusion can be drawn regarding the relationship between dietary  
 1146 patterns and the risk of prostate cancer. This is due to limited evidence from a small number of  
 1147 studies with wide variation in study design, dietary assessment methodology and prostate cancer  
 1148 outcome ascertainment. **DGAC Grade: Grade not assignable**

## 1149 1150 **Implications**

1151 The data accumulating regarding the impact of dietary patterns on risk of certain types of cancers  
 1152 supports the concept that a healthy dietary pattern may significantly reduce the overall burden of  
 1153 cancer in the United States. Emerging studies on dietary patterns support the findings of expert  
 1154 reviews regarding individual foods and nutrients. Effective strategies to initiate early in life and  
 1155 maintain a healthy dietary pattern and body weight, coupled with regular physical activity, will  
 1156 significantly reduce the cancer burden in America.

## 1157 1158 **Review of the Evidence**

### 1159 ***Dietary Patterns and Colorectal Cancer***

1160 This systematic review included 21 articles from prospective cohort studies and one article from  
 1161 an RCT published since 2000 that examined the relationship between dietary patterns and risk of  
 1162 colorectal cancer.<sup>88-109</sup> The articles used diverse methodology to assess dietary patterns. Nine  
 1163 articles used indices/scores to assess dietary patterns, 10 articles used data-driven methods, and  
 1164 three used other approaches.

1165  
 1166 The dietary patterns examined in this systematic review were defined in various ways, making  
 1167 comparisons between articles difficult. However, despite general heterogeneity in this body of  
 1168 evidence, some protective dietary patterns emerged, particularly in articles where patterns were  
 1169 defined by index or score; articles using data-driven methods were less consistent. Patterns  
 1170 emphasizing vegetables, fruits, fish/seafood, legumes, low-fat dairy, and whole grains were  
 1171 generally associated with reduced risk of colorectal cancer. Patterns higher in red/processed  
 1172 meats, potatoes/French fries, and sodas/sweets/added sugars were generally associated with  
 1173 increased risk of colorectal cancer.

1174  
 1175 The relationship between dietary patterns and colorectal cancer risk often varied by sex and  
 1176 tumor location. Results based on analysis by sex were mixed, while analysis in tumor subgroups  
 1177 seemed to indicate that dietary patterns may be more strongly associated with tumor  
 1178 development in distal regions of the colon/rectum. Although most cohort studies make extensive

1179 efforts to include participants across a wide range of race/ethnic groups and across the socio-  
 1180 economic continuum, there still may be some groups for which the association between dietary  
 1181 patterns and colorectal cancer risk cannot be reliably assessed and therefore conclusions cannot  
 1182 be drawn.

1183

### 1184 ***Dietary Patterns and Breast Cancer***

1185 This systematic review included 25 prospective cohort studies and one RCT published since  
 1186 2000 that examined the relationship between dietary patterns and risk of breast cancer.<sup>94, 101, 104,</sup>

1187 <sup>110-131</sup> The studies used multiple approaches to assess dietary patterns and cancer risk. Eight  
 1188 studies used indices/scores to assess dietary patterns, 13 studies used factor or principal  
 1189 components analysis, two used reduced rank regression, two made comparisons on the basis of  
 1190 animal product consumption, and one conducted an RCT of a low-fat dietary pattern.

1191

1192 This moderate body of evidence encompassed a large diversity in methods to assess or determine  
 1193 dietary patterns, making comparison across studies challenging. Despite this variability, 17 of the  
 1194 included studies found statistically significant relationships between dietary patterns and breast  
 1195 cancer risk, particularly among certain groups of women. Because a variety of different  
 1196 methodologies were employed to derive dietary patterns, and the patterns, while similar in many  
 1197 respects, were composed of different combinations of foods and beverages, it was difficult to  
 1198 determine which patterns had the greatest impact on breast cancer risk reduction.

1199

1200 The relationship between dietary patterns and breast cancer risk may be more consistent among  
 1201 postmenopausal women, but additional research is needed to explore the relationships for both  
 1202 pre- and post- menopausal cancer. Certain histopathologic and molecular phenotypes of breast  
 1203 cancer may be affected more by certain dietary patterns, but this has not yet been explored  
 1204 sufficiently. For example, limited studies to date suggest that estrogen or progesterone receptor  
 1205 status of breast cancers may define subgroups with unique dietary risk profiles, but no  
 1206 conclusions can be drawn at this time. More research is needed to explore other factors that may  
 1207 influence the relationship between dietary patterns during various stages of life and breast cancer  
 1208 risk, such as anthropometrics, BMI (including weight change over adulthood), physical activity,  
 1209 sedentary behavior, and reproductive history, including ages of menarche, age of menopause,  
 1210 parity, and breast feeding.

1211

### 1212 ***Dietary Patterns and Lung Cancer***

1213 This systematic review included three prospective cohort studies and one nested case-cohort  
 1214 study published since 2000 that examined the relationship between dietary patterns and risk of  
 1215 lung cancer.<sup>101, 104, 132, 133</sup> The studies used different methods to assess dietary patterns. Two

1216 studies used an index/score to measure adherence to a dietary pattern, one study derived dietary  
 1217 patterns using principal components analysis, and another based dietary patterns on participant  
 1218 reports of animal product intake. With only four relevant studies that used different approaches



1219 for assessing or determining dietary patterns, the evidence available to examine the relationship  
1220 between dietary patterns and risk of lung cancer is limited.

1221

### 1222 ***Dietary Patterns and Prostate Cancer***

1223 This systematic review included seven prospective cohort studies (from six different cohorts)  
1224 published since 2000 that examined the relationship between dietary patterns and risk of prostate  
1225 cancer.<sup>101, 134-139</sup> The studies used different methods to assess dietary patterns. Three studies used  
1226 index/scores to assess dietary patterns, two studies used factor analysis, one study used principle  
1227 components analysis, and one made comparisons on the basis of animal product consumption.

1228

1229 Most of the seven studies included in this systematic review did not detect clear or consistent  
1230 relationships between dietary patterns and risk of prostate cancer, though one found that  
1231 adherence to the Dietary Guidelines (assessed using the HEI-2005 and AHEI-2010) was  
1232 associated with a lower risk of prostate cancer, particularly among men who had a prostate-  
1233 specific antigen screening in the past 3 years. Because these studies used a range of different  
1234 approaches for assessing dietary patterns in populations with variable cancer screening patterns,  
1235 had heterogeneous prostate cancer outcome ascertainment, and were typically limited to dietary  
1236 exposure late in life, the results were inconclusive regarding risk for clinically significant  
1237 prostate cancer.

1238

1239 *For additional details on this body of evidence, visit:* <http://NEL.gov/topic.cfm?cat=3344>

1240

## 1241 **DIETARY PATTERNS AND CONGENITAL ANOMALIES**

### 1242 **Existing Evidence around Foods and Nutrients and Congenital Anomalies**

1243 It is well established that adequate folate status is critical for the prevention of neural tube  
1244 defects, specifically anencephaly and spina bifida, as well as other birth defects.<sup>140</sup> Folate is  
1245 often described by its source, with “folate” referring to naturally occurring folate from food  
1246 sources, and “folic acid” referring to the synthetic form used in dietary supplements and food  
1247 fortification. After mandatory fortification of enriched cereal products with folic acid in 1998,  
1248 serum folate concentrations in the U.S. population more than doubled, and rates of neural tube  
1249 defects decreased by 20 to 30 percent.<sup>141, 142</sup>

1250

1251 Despite this decrease, nearly one fifth of females ages 14 to 30 years do not meet the estimated  
1252 average requirement for folate, the level deemed to be adequate for one half of healthy females  
1253 in the age group.<sup>143</sup> The current U.S. Preventive Services Task Force recommends that women  
1254 capable of becoming pregnant should take 400 to 800 micrograms of folic acid daily from  
1255 fortified food or supplements in addition to a healthy diet rich in food sources of folate and folic  
1256 acid to reduce risk of neural tube and other birth defects.<sup>144</sup> Women with a history of a pregnancy

1257 affected by a neural tube defect or who are at high risk of neural tube defects require 4 mg of  
1258 synthetic folic acid supplements daily under the supervision of a physician.<sup>145</sup> Given the  
1259 emphasis on a healthy diet, the DGAC was interested in understanding which dietary patterns, if  
1260 any, were associated with a decreased risk of congenital anomalies among women of  
1261 reproductive age.

1262

### 1263 **Question 5: What is the relationship between dietary patterns and risk of** 1264 **congenital anomalies?**

1265 **Source of evidence:** NEL systematic review

1266

### 1267 **Conclusion**

1268 Limited evidence suggests that healthy maternal dietary patterns during the preconception period  
1269 that are higher in vegetables, fruits, and grains, and lower in red and processed meats, and low in  
1270 sweets were associated with lower risk of developing of neural tube defects, particularly among  
1271 women who do not take folic acid supplements. Whereas some dietary patterns were associated  
1272 with lower risk of developing anencephaly, others were associated with lower risk of developing  
1273 spina bifida.

1274

1275 Evidence is insufficient to determine an association between maternal dietary patterns and  
1276 congenital heart defects or cleft lip/palate.

1277

1278 All studies were consistent in demonstrating that folic acid supplementation periconceptionally  
1279 was associated with a decreased risk of having a child with a birth defect (e.g. neural tube  
1280 defects, congenital heart defects, and cleft lip/palate). **DGAC Grade: Neural Tube Defects –**  
1281 **Limited; Congenital Heart Defects – Grade not assignable; Cleft Lip/Palate – Grade not**  
1282 **assignable**

1283

### 1284 **Implications**

1285 Women of reproductive age should consume folic acid in the form of a supplement or through  
1286 fortified foods in the range recommended by the U.S. Preventive Services Task Force (400 to  
1287 800 micrograms) in addition to consuming a diet rich in vegetables, fruits, and grains; lower in  
1288 red and processed meats; and low in sweets.

1289

### 1290 **Review of the Evidence**

1291 This series of systematic reviews included five case-control studies (using data from three  
1292 cohorts) published since 1980 that examined the relationship between maternal dietary patterns  
1293 and congenital anomalies in infants.<sup>146-150</sup> Three articles examined neural tube defects,<sup>146, 147, 149</sup>

1294 two articles examined congenital heart defects,<sup>147, 150</sup> and two articles examined orofacial  
 1295 clefts.<sup>146, 148</sup>

1296

1297 Although all five case-control studies reported significant associations between dietary patterns  
 1298 and risk of congenital anomalies in women not taking folic acid supplementation, the variability  
 1299 of dietary patterns methodology used and composition of dietary patterns identified made it  
 1300 difficult to draw conclusions. All studies were consistent in finding that folate delivered  
 1301 periconceptionally in food or as a supplement as a key nutrient was associated with lower risk of  
 1302 developing congenital anomalies. It should be noted that some of the included studies were  
 1303 conducted in countries with mandatory folate fortification, while others were from countries that  
 1304 prohibit such fortification.

1305

1306 *For additional details on this body of evidence, visit:* <http://NEL.gov/topic.cfm?cat=3356>

1307

## 1308 **DIETARY PATTERNS AND NEUROLOGICAL AND PSYCHOLOGICAL** 1309 **ILLNESSES**

### 1310 **Existing Evidence around Foods and Nutrients and Neurological and** 1311 **Psychological Illnesses**

1312 Neuropsychological development and function is increasingly recognized as a high national  
 1313 priority for health promotion and chronic disease prevention. Two major components of  
 1314 neuropsychological function are *cognition*, the ability to reason, and *mood*, balanced and  
 1315 appropriate to enable optimal cognition.

1316

1317 Nutrition for optimal neurodevelopment in very young children has long been a subject of  
 1318 research. The 2010 DGAC concluded that moderate evidence supported a positive relationship  
 1319 between maternal dietary intakes of n-3 from seafood and improved cognitive ability in  
 1320 infants.<sup>151</sup> The rising numbers of U.S. older adults and the potential human and financial cost of  
 1321 age-related cognitive impairments, such as Alzheimer's disease and other dementias, also have  
 1322 helped drive national interest in chronic mental disease.<sup>152, 153</sup> Separately, depression affected 8  
 1323 percent of Americans for at least two weeks annually from 2007-2010, and of these, 80 percent  
 1324 report functional impairment.<sup>154</sup> Many preclinical and human studies have established  
 1325 relationships between traditional nutrients (e.g., omega-3 fatty acids) and central nervous system  
 1326 composition and function. Studies appearing in the last few years reflect the increasing research  
 1327 interest in the links between diet and neurological health.

1328

1329 The hypothesis that nutrition can reduce and/or play a role in the treatment of these mental  
 1330 diseases and their related burdens has been studied in relation to several nutrients and foods,  
 1331 including the B vitamins, vitamin E, and selenium.<sup>155, 156</sup> The omega-3 fatty acids

1332 eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are among the most studied  
 1333 nutrients for neural health, in part because DHA is a major component of the brain, specifically  
 1334 gray matter and its synapses, and the specialized light detecting cells of the retina. DHA, in  
 1335 particular, supports the amplitude and signaling speed of neural response. EPA has emerged as a  
 1336 nutrient with antidepressive properties and continued studies to define its role in prevention and  
 1337 therapy are underway. Sufficiently strong medical evidence has been obtained for EPA and DHA  
 1338 such that supplements are now considered as complementary therapy for major depressive  
 1339 disorder by the American Psychiatric Association<sup>157</sup> and more recent data from a meta-analysis  
 1340 has found them effective.<sup>158</sup> Before 2010, the number of published dietary pattern studies was  
 1341 small. However, a more substantial literature on dietary patterns and neuropsychological health  
 1342 has been published since 2010. The DGAC was therefore able to consider prevention of adult  
 1343 neuropsychological ill health for the first time.

1344

1345 **Question 6: What is the relationship between dietary patterns and risk of**  
 1346 **neurological and psychological illnesses?**

1347 **Source of evidence:** NEL systematic review

1348

1349 **Conclusion**

1350 Limited evidence suggests that a dietary pattern containing an array of vegetables, fruits, nuts,  
 1351 legumes and seafood consumed during adulthood is associated with lower risk of age-related  
 1352 cognitive impairment, dementia, and/or Alzheimer’s disease. Although the number of studies  
 1353 available on dietary patterns and neurodegenerative disease risk is expanding, this body of  
 1354 evidence, which is made up of high-quality observational studies, has appeared only in recent  
 1355 years and is rapidly developing. It employs a wide range of methodology in study design,  
 1356 definition and measurement ascertainment of cognitive outcomes, and dietary pattern  
 1357 assessment. **DGAC Grade: Limited**

1358

1359 Limited evidence suggests that dietary patterns emphasizing seafood, vegetables, fruits, nuts, and  
 1360 legumes are associated with lower risk of depression in men and non-perinatal women. However,  
 1361 the body of evidence is primarily composed of observational studies and employs a range of  
 1362 methodology in study design, definition, and measurement of dietary patterns and ascertainment  
 1363 of depression/depressive signs and symptoms. Studies on dietary patterns in other populations,  
 1364 such as women in the post-partum period, children and adolescents, as well as those in various  
 1365 ethnic and cultural groups, are too limited to draw conclusions. **DGAC Grade: Adults –**  
 1366 **Limited; Children, adolescents, and women in the post-partum period – Grade not**  
 1367 **assignable**

1368

1369 **Implications**

1370 Dietary patterns emphasizing vegetables, fruits, seafood, legumes and nuts similar to those that  
 1371 achieve chronic disease risk reduction are consistent with maintaining neurocognitive health,  
 1372 including cognitive ability in healthy aging, and balanced mood.

1373

1374 **Review of the Evidence**

1375 ***Dietary Patterns and Cognitive Impairment, Dementia, and Alzheimer's Disease***

1376 This systematic review includes 30 articles (two articles analyzed data taken from RCTs and 28  
 1377 articles used data from prospective cohort studies) published since 1980 (with all but two  
 1378 published since 2008) that examined the relationship between dietary patterns and age-related  
 1379 cognitive impairment, dementia, and/or Alzheimer's disease.<sup>159-188</sup> Twenty of the articles  
 1380 included in this review assessed the relationship between dietary patterns and cognitive  
 1381 impairment, 10 articles examined cognitive impairment or dementia, and eight articles looked at  
 1382 Alzheimer's disease.

1383

1384 The articles used several different methods to assess dietary patterns. Two articles analyzed data  
 1385 from RCTs that tested or described dietary patterns, 23 articles used indices/scores to assess  
 1386 dietary patterns quality or adherence, three articles used data-driven methods, and three used  
 1387 reduced rank regression. Most (18 of 28) articles found an association between dietary patterns  
 1388 and age-related cognitive impairment, dementia, and/or Alzheimer's disease. Despite some  
 1389 heterogeneity in this body of evidence, some common elements of dietary patterns were  
 1390 associated with measures of cognitive impairment, dementia, and/or Alzheimer's disease:

1391

1392 • Patterns higher in vegetables, fruits, nuts, legumes, and seafood were generally associated  
 1393 with reduced risk of age-related cognitive impairment, dementia, and/or Alzheimer's  
 1394 disease.

1395 • Patterns higher in red and/or processed meats were generally associated with greater age-  
 1396 related cognitive impairment. Relatively few studies reported on refined sugar and added  
 1397 salt, and patterns including these nutrients tended to report greater cognitive impairment.

1398 Although some studies included participants from a range of race/ethnic and socioeconomic  
 1399 groups, the results are most applicable to the general healthy aging population. In addition,  
 1400 dietary patterns were derived using dietary intake measured at baseline only, and therefore, may  
 1401 not reflect patterns consumed throughout relevant periods of life before enrollment in the study,  
 1402 or changes in intake that may have occurred over the duration of the study. Similarly, several  
 1403 studies measured cognitive function only at a single time point (follow-up), and therefore, could  
 1404 not assess change in cognitive function over time. Finally, though these studies controlled for a  
 1405 number of confounders, not all apparently relevant potential confounders were adjusted for (e.g.,  
 1406 existing or family history of cognitive decline, dementia, or Alzheimer's disease; baseline health

1407 status; changes in dietary intake over time) and, as with all association studies, residual  
 1408 confounding is possible.

1409

1410 ***Dietary Patterns and Depression***

1411 This systematic review includes nineteen articles (17 from prospective cohort studies, and 2  
 1412 using data from RCTs) published since 1980 (all of which were published since 2008) that  
 1413 assessed the relationship between dietary patterns and depression.<sup>175, 182, 189-205</sup>

1414

1415 The articles used several different methods to assess dietary patterns. Two studies tested the  
 1416 effects of dietary patterns as part of an RCT, six articles used indices/scores to assess dietary  
 1417 patterns, 10 articles used data-driven methods, and one used reduced rank regression. Despite  
 1418 methodological and outcome heterogeneity in this body of evidence, some protective dietary  
 1419 patterns emerged:

1420

1421 • Patterns emphasizing seafood, vegetables, fruits, and nuts, were generally associated with  
 1422 reduced risk of depression.

1423 • Patterns emphasizing red and processed meats and refined sugar were generally  
 1424 associated with increased risk of depression.

1425 This body of evidence did have several limitations. There was considerable variability in how the  
 1426 outcome of depression was assessed, with some studies using various depression scales, some  
 1427 using physician diagnosis/hospital discharge records, and others using proxies such as use of  
 1428 depression medication. Although most studies make extensive efforts to include participants  
 1429 across a wide range of race/ethnic groups and across the socio-economic continuum, there still  
 1430 may be some subgroups for which the association between dietary patterns and depression risk  
 1431 cannot be reliably assessed and therefore conclusions cannot be drawn for them. Research is  
 1432 needed to determine whether dietary patterns are associated with risk of depression in  
 1433 particularly vulnerable subgroups, specifically children, adolescents, young adults, and women  
 1434 during the post-partum period. Additional limitations within this body of evidence make it  
 1435 difficult to draw stronger conclusions, including assessment of dietary patterns and depression  
 1436 outcomes at a single point in time, potential for residual confounding despite adjustment for a  
 1437 number of factors, and few studies conducted in U.S.-based populations.

1438

1439 ***For additional details on this body of evidence, visit: <http://NEL.gov/topic.cfm?cat=3352>***

1440

1441

## 1442 **DIETARY PATTERNS AND BONE HEALTH**

### 1443 **Existing Evidence around Foods and Nutrients and Bone Health**

1444 Low bone mineral density and osteoporosis are common in the United States, particularly in  
1445 older adults, and its contribution to disability and cost to the health care system continues to rise  
1446 in parallel to longer life expectancy. As described in *Part D. Chapter 1: Food and Nutrient*  
1447 *Intakes, and Health: Current Status and Trends*, more than half of women ages 60 to 69 years  
1448 have low bone mass and approximately 12 percent meet established criteria for osteoporosis. The  
1449 prevalence of osteoporosis increases with age; about one-quarter of women ages 70 to 79 years  
1450 and about one-third of women older than age 80 years have osteoporosis. Low bone mass is less  
1451 common in older men but is increasingly recognized. Among U.S. men ages 60 to 69 years,  
1452 about a third have low bone mass and this increases to about 40 percent and slightly more than  
1453 50 percent for men ages 70 to 79 years and 80 years and older, respectively.

1454  
1455 Poor bone health and osteoporotic fractures are a major cause of morbidity and mortality in the  
1456 elderly and account for significant health care costs. Understanding the extent to which dietary  
1457 factors can help improve bone health and reduce the incidence of fractures across all segments of  
1458 the population, particularly in the elderly, is important for the health and well-being of the  
1459 nation.

1460  
1461 The most critical nutrients for healthy bone are calcium, vitamin D, and phosphorous. As part of  
1462 their 2011 report on Calcium and Vitamin D, the Institute of Medicine extensively reviewed the  
1463 available data and updated the Dietary Reference Intakes (DRIs) for calcium and vitamin D for  
1464 men and women across life stages.<sup>206</sup> The new reference values were based upon a strong body  
1465 of evidence regarding bone growth and maintenance. At the time of the report, these bone health  
1466 outcomes (in particular bone mass [bone mineral content]) were the only indicators on which  
1467 there was sufficient scientific evidence to define DRIs; a thorough review of other outcomes  
1468 (bone mineral density, risk of fractures, and osteoporosis) provided mixed and inconclusive  
1469 results, and thus did not inform the DRIs. *Part D. Chapter 1: Food and Nutrient Intakes, and*  
1470 *Health: Current Status and Trends* of this DGAC report concluded that calcium and vitamin D  
1471 were shortfall nutrients of public health concern. The estimated low levels of intake in various  
1472 age and sex groups place many at risk for suboptimal bone health. The DGAC asked additional  
1473 questions regarding bone health that went beyond those relating to the role of specific and well-  
1474 known nutrients on bone remodeling. Specifically, the DGAC considered the influence of dietary  
1475 patterns and their relationship to bone health and specific bone health outcomes across the  
1476 lifespan, including bone density and fractures. This approach enabled the DGAC to consider the  
1477 relationship between the total diet and its component foods and nutrients, acting in combination,  
1478 on bone health outcomes. This section reviews this evidence and forms the basis for the DGAC  
1479 recommendation for action at individual and population level as well as its research  
1480 recommendations.

1481

1482 **Question 7: What is the relationship between dietary patterns and bone health?**1483 **Source of evidence:** NEL systematic review

1484

1485 **Conclusion**

1486 Limited evidence suggests that a dietary pattern higher in vegetables, fruits, grains, nuts, and  
 1487 dairy products, and lower in meats and saturated fat, is associated with more favorable bone  
 1488 health outcomes in adults, including decreased risk of fracture and osteoporosis, as well as  
 1489 improved bone mineral density. Although a growing number of studies are examining the  
 1490 relationship between dietary patterns and bone health in adults, the number of high-quality  
 1491 studies is modest and those available employ a wide range of methodologies in study design,  
 1492 dietary assessment techniques, and varying bone health outcomes.

1493

1494 Definitive conclusions regarding the relationship between dietary patterns and bone health  
 1495 outcomes (bone mineral density and bone mineral content) in children and adolescents cannot be  
 1496 drawn due to the limited evidence from a small number of studies with wide variation in study  
 1497 design, dietary assessment methodology, and bone health outcomes. **DGAC Grade: Adults –**  
 1498 **Limited; Children and Adolescents - Grade not assignable**

1499

1500 **Implications**

1501 Only limited evidence is available on the relationships between *dietary patterns* and bone health  
 1502 outcomes in adults and other age groups. Although there is strong evidence on the roles of  
 1503 vitamin D and calcium in bone health across the age spectrum, further research is needed on  
 1504 dietary patterns that are most beneficial.

1505

1506 **Review of the Evidence**

1507 This systematic review included two articles that used data from RCTs and 11 articles from  
 1508 prospective cohort studies published since 2000 that examined the relationship between dietary  
 1509 patterns and bone health.<sup>207-219</sup>

1510

1511 The articles employ diverse methodologies to assess dietary patterns. Four articles used an index  
 1512 or score, six articles used factor analysis/principal components analysis, two articles used  
 1513 reduced rank regression, and two articles tested dietary patterns in an intervention study where  
 1514 bone health or fractures were either secondary or tertiary trial outcomes. Seven studies assessed  
 1515 risk of fracture, six studies assessed bone mineral density, bone mineral content, or bone mass,  
 1516 and one study examined risk of osteoporosis. The dietary patterns examined in this systematic  
 1517 review were defined in various ways, making comparisons between articles difficult. However,  
 1518 despite heterogeneity in this body of evidence, some common characteristics of dietary patterns



1519 associated with better or adverse bone health outcomes emerged, particularly in articles where  
 1520 patterns were defined by index or score. Articles using data-driven methods were less consistent.  
 1521 The following overall conclusions can be drawn:

- 1522
- 1523 • Patterns emphasizing vegetables, fruits, legumes, nuts, dairy, and  
 1524 cereals/grains/pasta/rice, and unsaturated fats were generally associated with more  
 1525 favorable bone health outcomes.
  - 1526 • Patterns higher in meats and saturated fats were generally associated with increased risk  
 1527 of adverse bone health outcomes.
  - 1528 • Results were far less consistent for added sugars, alcohol, and sodium in relation to bone  
 1529 health.

1530 Although many cohort studies make extensive efforts to include participants across a wide range  
 1531 of race/ethnic groups and across the socio-economic continuum, there still may be some groups  
 1532 for which the association between dietary patterns and bone health cannot yet be determined  
 1533 (i.e., children, adolescents).

1534  
 1535 *For additional details on this body of evidence, visit:* <http://NEL.gov/topic.cfm?cat=3360>

1536  
 1537

## 1538 **CHAPTER SUMMARY**

1539 The dietary patterns approach captures the relationship between the overall diet and its  
 1540 constituent foods, beverages, and nutrients in relationship to outcomes of interest. Numerous  
 1541 dietary patterns were identified, with the most common ones defined using indices or scores such  
 1542 as the HEI-2010, the AHEI-2010, or various Mediterranean-style dietary patterns, the DASH  
 1543 pattern, vegetarian patterns, and data-driven approaches.

1544  
 1545 The Committee’s examination of the association between dietary patterns and various health  
 1546 outcomes revealed remarkable consistency in the findings and implications that are noteworthy.  
 1547 When looking at the dietary pattern conclusion statements across the various health outcomes,  
 1548 certain characteristics of the diet were consistently identified (see Table D2.3). Common  
 1549 characteristics of dietary patterns associated with positive health outcomes include higher intake  
 1550 of vegetables, fruits, whole grains, low- or non-fat dairy, seafood, legumes, and nuts; moderate  
 1551 intake of alcohol (among adults); lower consumption of red and processed meat, and low intake  
 1552 of sugar-sweetened foods and drinks, and refined grains. Vegetables and fruits are the only  
 1553 characteristics of the diet that were consistently identified in every conclusion statement across  
 1554 the health outcomes. Whole grains were identified slightly less consistently compared to  
 1555 vegetables and fruits, but were identified in every conclusion with moderate to strong evidence.  
 1556 For studies with limited evidence, grains were not as consistently defined and/or they were not

1557 identified as a key characteristic. Low- or non-fat dairy, seafood, legumes, nuts, and alcohol  
1558 were identified as beneficial characteristics of the diet for some, but not all, outcomes. For  
1559 conclusions with moderate to strong evidence, higher intake of red and processed meats was  
1560 identified as detrimental compared to lower intake. Higher consumption of sugar-sweetened  
1561 foods and beverages as well as refined grains were identified as detrimental in almost all  
1562 conclusion statements with moderate to strong evidence.  
1563  
1564

1565 **Table D2.3. Description of the dietary patterns highlighted in the DGAC’s Conclusion Statements that are associated with benefit related**  
 1566 **to the health outcome of interest. (Note: The reader is directed to the full Conclusion Statement above for more information on the relationship between dietary**  
 1567 **patterns and the health outcome. In some cases, dietary components were associated with increased health risk and this is noted in the table.)**  
 1568

Health Outcome	DGAC Grade <sup>a</sup>	Description of the Dietary Pattern Associated with Beneficial Health Outcomes
Cardiovascular disease	Strong	Dietary patterns characterized by higher consumption of <i>vegetables, fruits, whole grains, low-fat dairy, and seafood</i> , and lower consumption of <i>red and processed meat</i> , and lower intakes of <i>refined grains</i> , and <i>sugar-sweetened foods and beverages</i> relative to less healthy patterns; regular consumption of <i>nuts and legumes</i> ; moderate consumption of <i>alcohol</i> ; lower in <i>saturated fat, cholesterol, and sodium</i> and richer in <i>fiber, potassium, and unsaturated fats</i> .
Measures of body weight or obesity	Moderate	Dietary patterns that are higher in <i>vegetables, fruits, and whole grains</i> ; include <i>seafood and legumes</i> ; are moderate in <i>dairy products (particularly low and non-fat dairy)</i> and <i>alcohol</i> ; lower in <i>meats (including red and processed meats)</i> , and low in <i>sugar-sweetened foods and beverages</i> , and <i>refined grains</i> ; higher intakes of <i>unsaturated fats</i> and lower intakes of <i>saturated fats, cholesterol, and sodium</i> .
	Limited	Dietary patterns in childhood or adolescence that are higher in energy-dense and low-fiber foods, such as <i>sweets, refined grains, and processed meats</i> , as well as <i>sugar-sweetened beverages, whole milk, fried potatoes, certain fats and oils, and fast foods</i> are associated with an increased risk.
Type 2 diabetes	Moderate	Dietary patterns higher in <i>vegetables, fruits, and whole grains</i> and lower in <i>red and processed meats, high-fat dairy products, refined grains, and sweets/sugar-sweetened beverages</i> .
Cancer	Moderate	Colon/Rectal Cancer: Dietary patterns that are higher in <i>vegetables, fruits, legumes, whole grains, lean meats/seafood, and low-fat dairy</i> and moderate in <i>alcohol</i> ; and low in <i>red and/or processed meats, saturated fat, and sodas/sweets</i> . (Conversely, diets that are higher in <i>red/processed meats, French fries/potatoes, and sources of sugars (i.e., sodas, sweets, and dessert foods)</i> are associated with a greater risk.)
	Moderate (post) / Limited (pre)	Breast Cancer: Dietary patterns rich in <i>vegetables, fruit, and whole grains</i> , and lower in <i>animal products and refined carbohydrate</i> .
	Limited	Lung Cancer: Dietary patterns containing more frequent servings of <i>vegetables, fruits, seafood, grains/cereals, and legumes</i> , and <i>lean versus higher fat meats and lower fat or non-fat dairy products</i> .
	Not assignable	Prostate Cancer: N/A
Congenital anomalies	Limited – Neural tube defects	Neural tube defects: Dietary patterns during the preconception period that are higher in <i>vegetables, fruits, and grains</i> , and lower in <i>red and processed meats</i> , and low in <i>sweets</i> .
	Not assignable	Congenital heart defects or cleft lip/palate: N/A
Neurological and psychological illnesses	Limited	Age-related cognitive impairment, dementia, and/or Alzheimer’s disease: Dietary patterns containing an array of <i>vegetables, fruits, nuts, legumes and seafood</i> .
	Limited	Depression: Dietary patterns emphasizing <i>seafood, vegetables, fruits, nuts, and legumes</i> .
Bone health	Limited	Adults: Dietary patterns higher in <i>vegetables, fruits, grains, nuts, and dairy products</i> , and lower in <i>meats and saturated fat</i> .
	Not assignable	Children: N/A

1569 <sup>a</sup> The DGAC Grade presented represents the grade the Committee provided for the conclusion statement with the dietary pattern components described. Some health outcomes had  
 1570 more than one graded conclusion. Only the conclusion statements that describe dietary pattern components are presented here. Post = Post-menopausal; Pre = Pre-menopausal

1571 As alcohol is a unique aspect of the diet, the DGAC considered evidence from several sources to  
 1572 inform recommendations. As noted above, moderate alcohol intake among adults was identified  
 1573 as a component of a healthy dietary pattern associated with some health outcomes, which  
 1574 reaffirms conclusions related to moderate alcohol consumption by the 2010 DGAC. The  
 1575 Committee also concurs with the conclusions reached by the 2010 DGAC on the relationship  
 1576 between alcohol intake and unintentional injury and lactation.<sup>1</sup> However, as noted in Table D2.1,  
 1577 evidence also suggests that alcoholic drinks are associated with increased risk for certain cancers,  
 1578 including pre- and post-menopausal breast cancer. After consideration of this collective  
 1579 evidence, the Committee concurs with the 2010 DGAC that if alcohol is consumed, it should be  
 1580 consumed in moderation, and only by adults. However, it is not recommended that anyone begin  
 1581 drinking or drink more frequently on the basis of potential health benefits because moderate  
 1582 alcohol intake also is associated with increased risk of violence, drowning, and injuries from falls  
 1583 and motor vehicle crashes. Women should be aware of a moderately increased risk of breast  
 1584 cancer even with moderate alcohol intake. There are many circumstances in which people should  
 1585 not drink alcohol:

- 1586 • Individuals who cannot restrict their drinking to moderate levels.
- 1587 • Anyone younger than the legal drinking age.
- 1588 • Women who are pregnant or who may be pregnant.
- 1589 • Individuals taking prescription or over-the-counter medications that can interact with  
 1590 alcohol.
- 1591 • Individuals with certain specific medical conditions (e.g., liver disease,  
 1592 hypertriglyceridemia, pancreatitis).
- 1593 • Individuals who plan to drive, operate machinery, or take part in other activities that  
 1594 require attention, skill, or coordination or in situations where impaired judgment could  
 1595 cause injury or death (e.g., swimming).

1596 Finally, because of the substantial evidence clearly demonstrating the health benefits of  
 1597 breastfeeding, occasionally consuming an alcoholic drink does not warrant stopping  
 1598 breastfeeding. However, women who are breastfeeding should be very cautious about drinking  
 1599 alcohol, if they choose to drink at all.<sup>§§</sup>

1600  
 1601 The common characteristics of a healthy dietary pattern found in the conclusion statements  
 1602 across the outcomes examined implies that following a dietary pattern associated with reduced  
 1603 risk of CVD, overweight, and obesity will have positive health benefits beyond these categories

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<sup>§§</sup> If the infant's breastfeeding behavior is well established, consistent, and predictable (no earlier than at 3 months of age), a mother may consume a single alcoholic drink if she then waits at least 4 hours before breastfeeding. Alternatively, she may express breast milk before consuming the drink and feed the expressed milk to her infant later.

1604 of health outcomes. Thus, the U.S. population should be encouraged and guided to consume  
 1605 dietary patterns that are rich in vegetables, fruits, whole grains, seafood, legumes, and nuts;  
 1606 moderate in low- and non-fat dairy products and alcohol (among adults); lower in red and  
 1607 processed meat; and low in sugar-sweetened foods and beverages and refined grains. These  
 1608 dietary patterns can be achieved in many ways and should be tailored to the individual's  
 1609 biological and medical needs as well as socio-cultural preferences. As described in the DGAC's  
 1610 conceptual model, a multi-level process at individual and population levels is required to help  
 1611 achieve a healthy diet and other lifestyle behaviors so as to achieve chronic disease risk  
 1612 reduction and overall well-being. The Committee recommends the development and  
 1613 implementation of programs and services that facilitate the improvement in eating behaviors  
 1614 consistent with healthy dietary patterns in various settings, including preventive services in our  
 1615 healthcare and public health systems as well as those that reach populations in other settings of  
 1616 influence such as preschool and school settings and workplaces.

1617  
 1618 The dietary pattern characteristics being recommended by the 2015 DGAC reaffirms the dietary  
 1619 pattern characteristics recommended by the 2010 DGAC, despite the fact that different  
 1620 approaches were employed. Additionally, this dietary pattern aligns with recommendations from  
 1621 other groups, including AICR and AHA/ACC. The majority of evidence considered focuses on  
 1622 dietary patterns consumed in adulthood on health risks, primarily risks of chronic disease  
 1623 development and, in the case of pregnancy, birth defects. Very little evidence considered here  
 1624 was directed to dietary patterns in children, and risk reduction studies evaluating children's diets  
 1625 and risk of overweight and obesity provided limited evidence. No conclusions on chronic disease  
 1626 apply directly to evidence developed in children. Recommendations based on adult studies have  
 1627 implications for children based on general nutritional principles but caution is warranted,  
 1628 considering the fact that children with developing bodies and neurocognitive capabilities present  
 1629 unique nutritional issues.

1630  
 1631

## 1632 **NEEDS FOR FUTURE RESEARCH**

- 1633 1. Conduct additional dietary patterns research for other health outcomes to strengthen the  
 1634 evidence beyond CVD and body weight in populations of various ethnic backgrounds and  
 1635 life course stages in order for future DGACs to draw stronger conclusions.

1636  
 1637 **Rationale:** The NEL systematic reviews demonstrated that considerable CVD research  
 1638 related to dietary patterns is available. However, it also is important to note, that unlike CVD,  
 1639 some of the other health outcomes are more heterogeneous and thus may require greater  
 1640 specificity in the examination of diet and disease risk. There is a clear need for all studies  
 1641 examining the relationship between dietary patterns and health outcomes to include the full  
 1642 age spectrum and to take a life course perspective (including pregnancy); insufficient  
 1643 research is being devoted to children and how diseases may evolve over time. An increased

1644 emphasis should be placed on understanding how the diets of all those in the U.S. population  
 1645 from various ethnic backgrounds may be associated with health outcomes, thereby  
 1646 broadening knowledge beyond Hispanics and African Americans to include the diversity that  
 1647 exists in the United States today. This may require our national nutrition monitoring  
 1648 programs to over-sample individuals from other national origins to conduct subgroup  
 1649 analysis.

1650

1651 2. Improve the understanding of how to more precisely characterize dietary patterns by their  
 1652 food constituents and the implications of the food constituents on nutrient adequacy through  
 1653 the use of Food Pattern Modeling. More precise characterization, particularly of protein  
 1654 foods, is needed.

1655

1656 **Rationale:** Researchers are characterizing dietary patterns very differently and yet  
 1657 sometimes use similar nomenclatures. This makes it difficult to compare results across  
 1658 studies and as demonstrated in the NEL systematic reviews, can impair the grading of the  
 1659 body of evidence as strong. The reason why researchers are not replicating others findings in  
 1660 different populations may be a function of publication bias. It is important for editors of  
 1661 scientific journals and peer reviewers to appreciate the replication of findings first and then  
 1662 value a research group's methodological nuance that may improve the examination of the  
 1663 association between dietary patterns and health outcomes. Perhaps what should be stressed is  
 1664 a harmonization of research methods across various cohorts or randomized trials, similar to  
 1665 what is being done at the National Cancer Institute's Dietary Patterns Methods Project<sup>9, 220</sup>  
 1666 led by Drs. Krebs-Smith and Reedy. The use of Food Pattern Modeling as demonstrated in  
 1667 ***Part D. Chapter 1: Food and Nutrient Intakes, and Health: Current Status and Trends***  
 1668 allows questions about the adequacy of the dietary patterns given specific food constituents  
 1669 to be addressed and how modifications of the patterns by altering the foods for specific  
 1670 population groups or to meet specific nutrient targets can be achieved.

1671

1672 3. Examine the long-term cardio-metabolic effects of the various dietary patterns identified in  
 1673 the *AHA/ACC/TOS Guidelines for the Management of Overweight and Obesity in Adults* that  
 1674 are capable of resulting in short-term weight loss (see Question 2, above).

1675

1676 **Rationale:** Although the research to date demonstrates that to lose weight, a variety of  
 1677 dietary pattern approaches can be used if a reduction in caloric intake is achieved, the long-  
 1678 term effects of these diets on cardio-metabolic health are not well known. Emerging research  
 1679 is exploring health effects of variations of the low-carbohydrate, higher protein/fat dietary  
 1680 pattern. In some approaches (such as Atkins), the dietary pattern which emphasizes animal  
 1681 products, may achieve a macronutrient composition that is higher in saturated fat. Others  
 1682 may emphasize plant-based proteins and fats and may achieve a lower saturated fat content  
 1683 and may be higher in polyunsaturated fats and dietary fiber. Research is needed to determine

1684 the impact of these alternative approaches, and perhaps others, on CVD risk profiles as well  
 1685 as other health outcomes. As mentioned in the review of the literature associated with  
 1686 saturated fat and cardiovascular disease in *Part D. Chapter 6: Cross-Cutting Topics of*  
 1687 *Public Health Importance*, substituting one macronutrient for another may result in  
 1688 unintended consequences. Careful consideration to the types of foods that are used in these  
 1689 diets and in particular the type of fat and amount of added sugars should be taken into  
 1690 account.

1691  
 1692

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2514 **Table D2.1. AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults, 2013**

<p><b>Critical Question 4a.</b> Among overweight and obese adults, what is the efficacy/effectiveness of a comprehensive lifestyle intervention program (i.e., comprised of diet, physical activity, and behavior therapy) in facilitating weight loss or maintenance of lost weight?  <b>Critical Question 4b.</b> What characteristics of delivering comprehensive lifestyle interventions (e.g., frequency and duration of treatment, individual versus group sessions, onsite versus telephone/email contact) are associated with greater weight loss or weight loss maintenance?</p>		
Intervention/Question	Included Studies	Evidence Statement (Strength of Evidence)
3.4.1. Description of the Diet, Physical Activity, and Behavior Therapy Components in High-Intensity, Onsite Lifestyle Interventions	12 RCTs	ES1. The principal components of an effective high-intensity, on-site comprehensive-lifestyle intervention include: 1) prescription of a moderately-reduced calorie diet; 2) a program of increased physical activity; and 3) the use of behavioral strategies to facilitate adherence to diet and activity recommendations. <i>(High)</i>
3.4.2. Comprehensive Interventions Compared with Usual Care, Minimal Care, or No-Treatment Control	15 RCTs	ES 2a (Short-Term Weight Loss). In overweight and obese individuals in whom weight loss is indicated and who wish to lose weight, comprehensive lifestyle interventions consisting of diet, physical activity, and behavior therapy (all 3 components) produce average weight losses of up to 8 kg in 6 months of frequent (i.e., initially weekly), onsite treatment provided by a trained interventionist* in group or individual sessions. Such losses (which can approximate reductions of 5% to 10% of initial weight) are greater than those produced by usual care (i.e., characterized by the limited provision of advice or educational materials). Comparable 6-month weight losses have been observed in treatment comparison studies of comprehensive lifestyle interventions, which did not include a usual care group. <i>(High)</i>
		ES 2b (Intermediate-Term Weight Loss). Longer-term comprehensive lifestyle interventions, which additionally provide weekly to monthly on-site treatment for another 6 months, produce average weight losses of up to 8 kg at 1 year, losses which are greater than those resulting from usual care. Comparable 1-year weight losses have been observed in treatment comparison studies of comprehensive lifestyle interventions, which did not include a usual care group. <i>(Moderate)</i>
		ES 2c (Long-Term Weight Loss). Comprehensive lifestyle interventions which, after the first year, continue to provide bimonthly or more frequent intervention contacts, are associated with gradual weight regain of 1 to 2 kg/year (on average), from the weight loss achieved at 6 to 12 months. Long-term (>1 year) weight losses, however, remain larger than those associated with usual care. Comparable findings have been observed in treatment comparison studies of comprehensive lifestyle interventions, which did not include a usual care group. <i>(High)</i>
3.4.3. Efficacy/Effectiveness of Electronically Delivered, Comprehensive Interventions in Achieving Weight Loss Evidence Statement	13 RCTs	ES 3. Electronically delivered, comprehensive weight loss interventions developed in academic settings, which include frequent self-monitoring of weight, food intake, and physical activity—as well as personalized feedback from a trained interventionist*—can produce weight loss of up to 5 kg at 6 to 12 months, a loss which is greater than that resulting from no or minimal intervention (i.e., primarily knowledge based) offered on the internet or in print. <i>(Moderate)</i>
3.4.4. Efficacy/Effectiveness of Comprehensive, Telephone-Delivered Lifestyle Interventions in Achieving Weight Loss	3 RCTs	ES 4. In comprehensive lifestyle interventions that are delivered by telephone or face-to-face counseling, and which also include the use of either commercially-prepared prepackaged meals or an interactive web based program, the telephone delivered and face-to-face delivered interventions produced similar mean net weight losses of approximately 5 kg at 6 months and 24 months, compared with a usual care control group.

		( <i>Low</i> )
3.4.5. Efficacy/Effectiveness of Comprehensive Weight Loss Programs in Patients Within a Primary Care Practice Setting Compared With Usual Care	4 RCTs	ES 5. In studies to date, low to moderate-intensity lifestyle interventions for weight loss provided to overweight or obese adults by primary care practices alone, have not been shown to be effective. ( <i>Low</i> )
3.4.6. Efficacy/Effectiveness of Commercial-Based, Comprehensive Lifestyle Interventions in Achieving Weight Loss	4 RCTs	ES 6. Commercial-based, comprehensive weight loss interventions that are delivered in person have been shown to induce an average weight loss of 4.8 kg to 6.6 kg at 6 months in 2 trials when conventional foods are consumed and 6.6 kg to 10.1 kg at 12 months in 2 trials with provision of prepared food, losses that are greater than those produced by minimal-treatment control interventions. ( <i>Low</i> )
3.4.7. Efficacy/Effectiveness of Very Low-Calorie Diets, as Used as Part of a Comprehensive Lifestyle Intervention, in Achieving Weight Loss	4 RCTs	ES 7a. Comprehensive, high intensity on-site lifestyle interventions that include a medically supervised very low-calorie diet (often defined as <800 kcal/day), as provided by complete meal replacement products, produce total weight loss of approximately 14.2 kg to 21 kg over 11 to 14 weeks, which is larger than that produced by no intervention or a usual care control group (i.e., advice and education only). ( <i>High</i> )
		ES 7b. Following the cessation of a high intensity lifestyle intervention with a medically supervised very-low calorie diet of 11 to 14 weeks, weight regain of 3.1 kg to 3.7 kg has been observed during the ensuing 21 to 38 weeks of non-intervention follow-up. ( <i>High</i> )
		ES 7c. The prescription of various types (resistance or aerobic training) and doses of moderate intensity exercise training (e.g., brisk walking 135 to 250 minutes/week), delivered in conjunction with weight loss maintenance therapy does not reduce the amount of weight regained after the cessation of the very-low calorie diet, as compared with weight loss maintenance therapy alone. ( <i>Low</i> )
3.4.8. Efficacy/Effectiveness of Comprehensive Lifestyle Interventions in Maintaining Lost Weight	14 RCTs	ES 8a. After initial weight loss, some weight regain can be expected, on average, with greater regain observed over longer periods of time. Continued provision of a comprehensive weight loss maintenance program (onsite or by telephone), for periods of up to 2.5 years following initial weight loss, reduces weight regain, as compared to the provision of minimal intervention (e.g., usual care). The optimal duration of weight loss maintenance programs has not been determined. ( <i>Moderate</i> )
		ES 8b. 35% to 60% of overweight/obese adults who participate in a high intensity long-term comprehensive lifestyle intervention maintain a loss of $\geq 5\%$ of initial body weight at $\geq 2$ year's follow-up (post-randomization). ( <i>Moderate</i> )
3.4.9. Characteristics of Lifestyle Intervention Delivery That May Affect Weight Loss: Intervention	10 RCTs	ES 9a (Moderate-Intensity Interventions). Moderate intensity, on-site comprehensive lifestyle interventions, which provide an average of 1 to 2 treatment sessions per month typically produce mean weight losses of 2 kg to 4 kg in 6 to 12 months, losses which generally are greater than those produced by usual care (i.e., minimal intervention control group). ( <i>High</i> )
		ES 9b (Low-intensity Interventions). Low intensity, on-site comprehensive lifestyle interventions, which provide fewer than monthly treatment sessions do not consistently produce weight loss when compared to usual care. ( <i>Moderate</i> )
		ES 9c (Effect of intervention intensity). When weight loss with each intervention intensity (i.e., low, moderate, and high) is compared to usual care, high-intensity lifestyle interventions ( $\geq 14$ sessions in 6 months) typically produce greater net-of-control weight losses than low-to-moderate intensity interventions. ( <i>Moderate</i> )

3.4.10. Characteristics of Lifestyle Intervention Delivery That May Affect Weight Loss or Weight	15 RCTs	ES 10. There do not appear to be substantial differences in the size of the weight losses produced by individual- and group-based sessions in high-intensity, comprehensive lifestyle intervention delivered on site by a trained interventionist*. ( <i>Low</i> )
3.4.11. Characteristics of Lifestyle Intervention Delivery That May Affect Weight Loss or Weight Loss Maintenance: Onsite Versus Electronically Delivered Interventions		ES 11. Weight losses observed in comprehensive lifestyle interventions, which are delivered onsite by a trained interventionist* in initially weekly and then biweekly group or individual sessions, are generally greater than weight losses observed in comprehensive interventions that are delivered by Internet or email and which include feedback from a trained interventionist. ( <i>Low</i> )

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