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.[1] 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.[2] 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

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

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

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

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

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

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

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

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

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

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

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

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

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

LIST OF QUESTIONS

Dietary Patterns and Cardiovascular Disease

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

Dietary Patterns and Body Weight

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

Dietary Patterns and Type 2 Diabetes

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

Dietary Patterns and Cancer

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

Dietary Patterns and Congenital Anomalies

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

Dietary Patterns and Neurological and Psychological Illnesses

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

Dietary Patterns and Bone Health

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

METHODOLOGY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Source of evidence: Existing reports

Conclusion

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

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

Implications

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

Review of the Evidence

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

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

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

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

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

Dietary Patterns and Blood Pressure (BP)

DASH or DASH-style Dietary Patterns

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

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

BP over time;[20] two others cohorts showed no relationship between DASH scores and risk of hypertension.[21, 22]

Mediterranean-Style Dietary Patterns

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

Vegetarian Dietary Patterns

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

Other Dietary Patterns

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

Dietary Patterns and Blood Lipids

DASH or DASH-style Dietary Patterns

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

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

Mediterranean-style Dietary Patterns

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

Vegetarian Dietary Patterns

The NEL systematic review included three articles on vegetarian patterns that measured blood pressure or blood lipids.[26-28] One study reported decreased total-C[26] and another reported decreased non-HDL-C in vegetarian versus non-vegetarian participants.[28]

Other Dietary Patterns

Of note, adherence to the *2005 Dietary Guidelines for Americans* also was related to higher HDL-C levels in a cohort of Black and White young adults.[29]

Dietary Patterns and Cardiovascular Disease Outcomes

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

Mediterranean-style Dietary Patterns

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

DASH-style Dietary Patterns

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

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

Vegetarian Dietary Patterns

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

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

DIETARY PATTERNS AND BODY WEIGHT

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

Source of evidence: Existing reports

Conclusion

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

DGAC Grade: Strong

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

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

Implications

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

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

Review of the Evidence

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

Dietary Patterns and the Management of Overweight and Obesity

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

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

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

- Higher protein (25 percent of total calories from protein, 30 percent of total calories from fat, 45 percent of total calories from carbohydrate) with provision of foods that realized energy deficit.
- Higher protein Zone™-type diet (5 meals/day, each with 40 percent of total calories from carbohydrate, 30 percent of total calories from protein, 30 percent of total calories from fat) without formal prescribed energy restriction but realized energy deficit.
- Lacto-ovo-vegetarian-style diet with prescribed energy restriction.
- Low-calorie diet with prescribed energy restriction.
- Low-carbohydrate (initially less than 20 g/day carbohydrate) diet without formal prescribed energy restriction but realized energy deficit.
- Low-fat (10 percent to 25 percent of total calories from fat) vegan-style diet without formal prescribed energy restriction but realized energy deficit.
- Low-fat (20 percent of total calories from fat) diet without formal prescribed energy restriction but realized energy deficit.
- Low-glycemic load diet, either with formal prescribed energy restriction or without formal prescribed energy restriction but with realized energy deficit.
- Lower fat (≤30 percent fat), high dairy (4 servings/day) diets with or without increased fiber and/or low-glycemic index/load foods (low-glycemic load) with prescribed energy restriction.
- Macronutrient-targeted diets (15 percent or 25 percent of total calories from protein; 20 percent or 40 percent of total calories from fat; 35 percent, 45 percent, 55 percent, or 65 percent of total calories from carbohydrate) with prescribed energy restriction.
- Mediterranean-style diet with prescribed energy restriction.
- Moderate protein (12 percent of total calories from protein, 58 percent of total calories from carbohydrate, 30 percent of total calories from fat) with provision of foods that realized energy deficit.
- Provision of high-glycemic load or low-glycemic load meals with prescribed energy restriction.
- The AHA-style Step 1 diet (with prescribed energy restriction of 1,500 to 1,800 kcal/day, <30 percent of total calories from fat, <10 percent of total calories from saturated fat).

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

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

Dietary Patterns and their Association with Body Weight

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

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

Mediterranean-style Dietary Pattern

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

<u>Dietary Patterns and Body Weight and Incidence of Overweight and/or Obesity</u>

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

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

Dietary Patterns and Waist Circumference

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

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

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

Dietary Guidelines-Based Indices

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

<u>Dietary Patterns and Body Weight and Incidence of Overweight and/or Obesity</u>

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

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

Two studies were conducted in children. Cheng et al., 2010 analyzed data from a prospective cohort study conducted in Germany, the Dortmund Nutritional and Anthropometric Longitudinally Designed (DONALD) study, to examine whether the diet quality of healthy children before puberty was associated with body composition at onset of puberty.[40] Adherence to a diet pattern was assessed by the Revised Children's Diet Quality Index (RC-DQI) which was based on the Dietary Guidelines for Americans. In this study, a higher dietary quality was associated with a higher energy intake, and children with a lower diet quality had lower BMI and Fat Mass Index (FMI) Z-scores at baseline ($p<0.01$) but not at onset of puberty. Berz et al., 2011 reported on a prospective cohort study to assess the effects of the DASH eating pattern on BMI in adolescent females over a 10-year period.[39] Only seven out of the 10 original components of the DASH score were used; the three excluded were added sugars, discretionary fats and oils, and alcohol. Overall, girls in the highest vs. lowest quintile of DASH score had an adjusted mean BMI of 24.4 vs. 26.3 kg/m2 ($p<0.05$).

Dietary Patterns and Waist Circumference

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

Other Indices

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

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

Studies that Compared Various Dietary Indices

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

Dietary Patterns from Data-Driven Methods

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

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

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

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

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

DIETARY PATTERNS AND TYPE 2 DIABETES

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

Source of evidence: Existing reports

Conclusion

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

Evidence is lacking for the pediatric population.

Implications

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

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

Review of the Evidence

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

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

Dietary Patterns and Incident Type 2 Diabetes

Dietary Approaches to Stop Hypertension (DASH)

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

Mediterranean-style Dietary Patterns

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

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

Dietary Indices based on the Dietary Guidelines

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

Data-Driven Approaches

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

Three prospective cohort studies used reduced rank regression to examine the relationship between dietary patterns and type 2 diabetes.[70-72] Two of the studies were conducted in the

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

Other Dietary Patterns

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

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

Dietary Patterns and Intermediate Outcomes

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

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

Data-Driven Approaches

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

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

DIETARY PATTERNS AND CANCER

Existing Evidence around Foods and Nutrients and Cancer

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

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

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

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

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

↓↓ Convincing decreased risk. ↓ Probable decreased risk. ↑↑ Convincing increased risk. ↑ Probable increased risk. • Substantial effect on risk unlikely.	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)
Foods containing dietary fiber									↓↓							
Aflatoxins	↓		↓		↓			↑↑								
Non-starchy vegetables[1]					↓											
Allium vegetables									↓							
Garlic	↓		↓	↓	↓											
Fruits[2]									↑↑							
Red meat									↑↑							
Processed meat																
Cantonese-style salted fish		↑														
Diets high in calcium[3]									↓							
Salt, salted and salty foods					↑											
Glycemic load													↑			
Arsenic in drinking water				↑↑												↑
Mate			↑													
Alcoholic drinks[4]	↑↑		↑↑					↑	↑ ↑↑	↑↑	↑↑				•	
Coffee					•								↓		•	
Beta-carotene[5]				↑↑										•		•
Physical activity[6]									↓↓		↓		↓			
Body fatness[7]			↑↑			↑↑	↑		↑↑	↓	↑↑	↑	↑↑	↑	↑↑	
Adult attained height						↑			↑↑	↑	↑↑	↑↑		↑		
Greater birth weight										↑						
Lactation										↓↓	↓↓					

[1] Includes evidence on foods containing carotenoids for mouth, pharynx, larynx; foods containing beta-carotene for esophagus; foods containing vitamin C for esophagus.
[2] Includes evidence on foods containing carotenoids for mouth, pharynx, larynx, and lung; foods containing beta-carotene for esophagus; food containing vitamin C for esophagus.
[3] Evidence is from milk and studies using supplements for colorectum.
[4] Convincing increased risk for men and probably increased risk for women for colorectum. Evidence applies to adverse effect for kidney.
[5] Evidence derived from studies using supplements for lung.
[6] Convincing increased risk for colon not rectum.
[7] Probable increased risk for advanced not non-advanced prostate cancer.

AICR/WCRF Evidence Stratification[87]

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

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

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

Limited—no conclusion: This grade describes diet and cancer relationships where the evidence was ample for review by 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 number or yielding inconsistent results.

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

Question 4: What is the relationship between dietary patterns and risk of cancer?

Source of evidence: NEL systematic review

Conclusions

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

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

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

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

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

Implications

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

Review of the Evidence

Dietary Patterns and Colorectal Cancer

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

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

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

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

Dietary Patterns and Breast Cancer

This systematic review included 25 prospective cohort studies and one RCT published since 2000 that examined the relationship between dietary patterns and risk of breast cancer.[94, 101, 104, 110-131] The studies used multiple approaches to assess dietary patterns and cancer risk. Eight studies used indices/scores to assess dietary patterns, 13 studies used factor or principal components analysis, two used reduced rank regression, two made comparisons on the basis of animal product consumption, and one conducted an RCT of a low-fat dietary pattern.

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

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

Dietary Patterns and Lung Cancer

This systematic review included three prospective cohort studies and one nested case-cohort study published since 2000 that examined the relationship between dietary patterns and risk of lung cancer.[101, 104, 132, 133] The studies used different methods to assess dietary patterns. Two studies used an index/score to measure adherence to a dietary pattern, one study derived dietary patterns using principal components analysis, and another based dietary patterns on participant reports of animal product intake. With only four relevant studies that used different approaches

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

Dietary Patterns and Prostate Cancer

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

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

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

DIETARY PATTERNS AND CONGENITAL ANOMALIES

Existing Evidence around Foods and Nutrients and Congenital Anomalies

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

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

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

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

Source of evidence: NEL systematic review

Conclusion

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

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

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

Implications

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

Review of the Evidence

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

two articles examined congenital heart defects,[147, 150] and two articles examined orofacial clefts.[146, 148]

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

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

DIETARY PATTERNS AND NEUROLOGICAL AND PSYCHOLOGICAL ILLNESSES

Existing Evidence around Foods and Nutrients and Neurological and Psychological Illnesses

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

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

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

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

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

Source of evidence: NEL systematic review

Conclusion

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

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

Implications

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

Review of the Evidence

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

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

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

- Patterns higher in vegetables, fruits, nuts, legumes, and seafood were generally associated with reduced risk of age-related cognitive impairment, dementia, and/or Alzheimer's disease.
- Patterns higher in red and/or processed meats were generally associated with greater age-related cognitive impairment. Relatively few studies reported on refined sugar and added salt, and patterns including these nutrients tended to report greater cognitive impairment.

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

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

Dietary Patterns and Depression

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

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

- Patterns emphasizing seafood, vegetables, fruits, and nuts, were generally associated with reduced risk of depression.
- Patterns emphasizing red and processed meats and refined sugar were generally associated with increased risk of depression.

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

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

DIETARY PATTERNS AND BONE HEALTH

Existing Evidence around Foods and Nutrients and Bone Health

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

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

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

Question 7: What is the relationship between dietary patterns and bone health?

Source of evidence: NEL systematic review

Conclusion

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

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

Implications

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

Review of the Evidence

This systematic review included two articles that used data from RCTs and 11 articles from prospective cohort studies published since 2000 that examined the relationship between dietary patterns and bone health.[207-219]

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

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

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

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

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

CHAPTER SUMMARY

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

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

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

Table D2.3. Description of the dietary patterns highlighted in the DGAC's Conclusion Statements that are associated with benefit related 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 patterns and the health outcome. In some cases, dietary components were associated with increased health risk and this is noted in the table.)

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

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

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

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

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

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

[§§] 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.

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

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

NEEDS FOR FUTURE RESEARCH

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

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

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

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

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

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

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

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

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

Critical Question 4a. 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? **Critical Question 4b.** 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?		
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. *(High)*
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. *(High)*
		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. *(Moderate)*
		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. *(High)*
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. *(Moderate)*
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.

		(Low)
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. *(Low)*
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. *(Low)*
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). *(High)*
		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. *(High)*
		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. *(Low)*
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. *(Moderate)*
		ES 8b. 35% to 60% of overweight/obese adults who participate in a high intensity long-term comprehensive lifestyle intervention maintain a loss of ≥5% of initial body weight at ≥2 year's follow-up (post-randomization). *(Moderate)*
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). *(High)*
		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. *(Moderate)*
		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 (≥14 sessions in 6 months) typically produce greater net-of-control weight losses than low-to-moderate intensity interventions. *(Moderate)*

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*. *(Low)*
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. *(Low)*