PART D. CHAPTER 8: DIETARY PATTERNS

INTRODUCTION

Traditionally, associations of diet to health have focused primarily on a single nutrient or food and an identified health outcome. Since the early 2000s, the focus for quantifying dietary exposures has moved from single nutrients or foods to dietary patterns as a way to more comprehensively represent the totality of the diet and nutrient profiles. Research using the concept of dietary patterns presents certain advantages, including the reality that people do not eat nutrients in isolation, but rather a combination of foods that contain multiple nutrients. Foods and their associated nutrients are known to have synergistic effects,[1] complicating the detection of an effect of a single food or nutrient. Identification of a dietary pattern may reveal a stronger association with a particular indicator of health and may allow for a more comprehensive and inclusive understanding of how nutrients and other bioactive compounds in our food are consumed and how patterns of consumption influence health outcomes. Thus, an emphasis on foods and beverages rather than individual nutrients has improved translation to dietary recommendations for the broad public. Ultimately, dietary patterns can be applied to the general population, allowing researchers to demonstrate the effects of diet on health outcomes and surrogate endpoints.[2-6]

Since 2010, Dietary Guidelines Advisory Committees have placed increasing emphasis on examining dietary patterns and health outcomes. The 2010 Committee identified the importance of encompassing dietary patterns in addition to nutrient adequacy and recommended additional research to formally address this topic. The 2015 Committee conducted the first exploration of the influence of dietary patterns on health outcomes. The 2020 Committee built upon these previous reports and reviewed additional outcomes, including all-cause mortality and sarcopenia. The Committee also included an examination of diets based on macronutrient distributions in its review.

Definitions and Derivation

Dietary patterns are defined as the quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed.[7] The approach of using dietary patterns as an assessment tool to determine diet quality provides a meaningful bridge toward disseminating messages intended to promote high-quality diets.[1,6] Diet quality reflects dietary patterns comprised of foods and beverages that, in total, are associated with better health and reduced risk for chronic disease. High-quality refers to the most nutrient-dense form of a food with the least amount of added sugars, sodium, and saturated fat.[8] 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 recommendations for inadequacy and quantitative limits, as shown in ***Part D. Chapter 7: USDA Food Patterns for Children Younger than Age 24 Months*** and ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older***.

Dietary patterns are derived using multiple methods. Among these methods the two commonly used for identifying dietary patterns include index-based patterns or exploratory patterns.[9] An example of an index-based method is the Dietary Approaches to Stop Hypertension (DASH) score.[10] The exploratory patterns methods include theoretical or data-driven methods using statistical techniques, such as principal component analysis (PCA) to determine dietary patterns based on shared variance across dietary variables within a population. Reduced rank regression (RRR), another example of an exploratory pattern, is an estimation procedure in which dietary patterns in a population are statistically derived relative to response variables that are often non-dietary outcomes. Various data reduction techniques have been used to identify dietary patterns based on both unsupervised and supervised statistical methods.[2-6] More detail about these methods are outlined below.

Index-Based Patterns. A single numerical score to evaluate the diet, termed index-based or a dietary index, is an approach that relies upon pre-determined dietary standards against which each study observation is evaluated.[11-13] This method is based on a priori knowledge of dietary recommendations and scientific consensus using an evidence-based approach.[2-6] Each of the components comprising the index are summed to determine a total score. The individual component scores also can be examined. Examples of diet quality scores include the Healthy Eating Index (HEI)-2010,[14] the alternate Mediterranean Diet Score (aMED),[10] the Alternate (HEI)-2010,[15] and the DASH score.[10] A distinct advantage of these structured patterns is the replication and comparability of study findings. On the other hand, these patterns may not represent all cultural or regional variations of dietary intakes. Some degree of subjective decision making may be used to develop the index or score. This may be a potential drawback. (The HEI-2015 is explained in greater detail in ***Part D. Chapter 1: Current Intakes of Foods, Beverages and Nutrients***)

Exploratory Patterns. In addition to the PCA noted above, cluster and factor analysis also have been used to determine dietary patterns that arise from the data.[16-20] These methods are considered data-driven or a posteriori approaches.[2-6] The first step in most of these methods is to systematically reduce the number of foods or food groups reported by people to reach an optimal combination of food groups that best explains or predicts the outcomes of interest. Once food groups are formed, the inputs or predictors are aggregated into linear combinations that explain the maximum amount of the total variance across all input or predictor variables. These principal components or factors are referred to as dietary patterns.[6] These dietary patterns are often labeled based on the foods that fall within each factor or principal component. Terms such as “sweets,” “healthy,” and “Western” are commonly used in published literature. For example, a sweets pattern can be composed of food such as cakes and other sweet desserts, while a healthy pattern can be composed of foods such as fish, whole grains, and vegetables.[16-19]

A combination of a priori and post priori methods known as reduced rank regression also has been used to derive dietary patterns.[21-24] A reduced rank regression analysis defines factors to be linear combinations of input variables that best explain the total variance in a set of response variables. For example, one may use the response variables of the nutrient density of total fat, carbohydrate, and dietary fiber to examine an outcome (e.g., cancer). The number of response variables determines the number of dietary patterns that will be generated. Factors are either positively or negatively correlated with the response variables. Replication of this method has been demonstrated.[9] Based on the content of the correlated items, a name or label can be developed for each underlying factor. An example of one method of deciding a factor name is to base the name on the foods with greatest positive or negative correlations or loadings.[6,22]

Pattern Direction. For all methods, dietary patterns can be developed with an emphasis on healthy food and beverage components comprising the dietary pattern (e.g., the DASH diet). In this case, the results (higher scores) will most likely reflect reductions in risk for the outcome of interest. In contrast, for dietary patterns emphasizing low nutrition quality (e.g., the NOVA[25] Food Classification System), the results (higher scores) will reflect higher risk for the outcome of interest. Both approaches can be used to confirm the effect of a healthier dietary pattern.

Strengths of the Approach

The dietary patterns approach has several major strengths. Because foods are consumed in combination and reflect dietary components acting in synergy, evidence suggests that a composite of foods and beverages, a dietary pattern, is more likely to influence health or chronic disease than will any single food. A dietary patterns strategy captures the relationship between the overall diet and the interactions between foods and nutrients as either health-promoting or health-compromising. Patterns help to capture the complexity of the overall diet and its constituent parts so that researchers can relate the patterns to outcomes of interest. In doing so, we can essentially deal with the known collinearity among foods and nutrients. This information on a variety of food and beverage items has advanced research and offers evidence of new preventive approaches. As noted in previous Committee reports, individuals can achieve a healthy diet in multiple ways and preferably with a wide variety of foods and beverages. Results from the National Institutes of Health-National Cancer Institute (NIH-NCI) Dietary Patterns Methods Project[1] confirmed this recommendation, when higher scores on 4 independent high-quality dietary patterns were associated with marked reductions in mortality among 3 diverse cohorts, thus, reinforcing the concept that a diverse variety of healthy foods can achieve essential components of a healthy diet.

Expansion from Previous Reviews

The Dietary Patterns chapter reflects evidence the Committee considered on the relationship between dietary patterns and 8 broad health outcomes. Except for all-cause mortality and sarcopenia, these outcomes also were addressed by the 2015 Committee. Because dietary patterns encompass diverse foods and beverages, this chapter complements topics examined throughout this report, including dietary fats and seafood (see ***Part D. Chapter 9: Dietary Fats and Seafood***), beverages (see ***Part D. Chapter 10: Beverages***), alcoholic beverages (see ***Part D. Chapter 11: Alcoholic Beverages***), and added sugars (see ***Part D. Chapter 12: Added Sugars***). In most cases, the conclusions drawn from reviews of these food and beverage components align with the conclusions drawn for dietary patterns, though there are some differences in the conclusions drawn for alcoholic beverages. The Discussion section provides information on how these reviews can be considered together.

The 2020 Committee also examined studies adopting a new exposure, macronutrient distribution, defined as consuming at least 1 macronutrient outside of the Acceptable Macronutrient Distribution Ranges (AMDR), which provide ranges for percent of energy for fat, carbohydrate, and protein as established in the Dietary Reference Intakes.[26] Typical dietary patterns as reported do not include a macronutrient distribution, although increasing interest in this topic warranted inclusion in the Committee's review. In contrast to a dietary pattern's focus on foods, a diet's relative macronutrient distribution can be varied, with increased protein and reduced carbohydrates being the most common modifications.[27] Characteristics of popular diets of this type vary from 65 percent fat/25 percent protein/10 percent carbohydrate to 10 percent fat/20 percent protein/70 percent carbohydrate.[27] For this 2020 Committee review, most of the evaluated articles examined distributions in which the proportion of energy from carbohydrate was below the AMDR, fat was above the AMDR, and protein was within the AMDR.

LIST OF QUESTIONS

1. What is the relationship between dietary patterns consumed and risk of cardiovascular disease?
2. What is the relationship between dietary patterns consumed and growth, size, body composition, and risk of overweight and obesity?
3. What is the relationship between dietary patterns consumed and risk of type 2 diabetes?
4. What is the relationship between dietary patterns consumed and bone health?
5. What is the relationship between dietary patterns consumed and risk of certain types of cancer?
6. What is the relationship between dietary patterns consumed and neurocognitive health?
7. What is the relationship between dietary patterns consumed and sarcopenia?
8. What is the relationship between dietary patterns consumed and all-cause mortality?

METHODOLOGY

All questions discussed in this chapter were answered using systematic reviews conducted with support from USDA's Nutrition Evidence Systematic Review (NESR) team. NESR's systematic review methodology provided a rigorous, consistent, and transparent process for the Committee to search for, evaluate, analyze, and synthesize evidence.

All questions examined the consumption of and/or adherence to a dietary pattern as the primary intervention or exposure of interest. The comparators of interest were consumption of and/or adherence to a different dietary pattern or different levels of consumption of and/or adherence to a dietary pattern. Dietary patterns were defined as "the quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed." To be included in the review on dietary patterns, studies needed to provide a description of the foods and beverages in the pattern. Dietary patterns considered in the review were measured or derived using a variety of approaches, such as adherence to a priori patterns (indices and scores), data-driven patterns (factor and cluster analysis), reduced rank regression, or other methods, including clinical trials. When reporting results, we chose to respect the food/beverage names used by the authors and tried to refrain from inserting new descriptive language not a part of the original research efforts. Given the emphasis on foods and beverages, dietary patterns comprised of only nutrients and bioactive compounds were excluded.

Questions 1 through 3, 7, and 8, also examined diets based on macronutrient distribution outside of the AMDR, at any level above or below the AMDR, as an intervention or exposure of interest. The comparator of interest was consumption of and/or adherence to a diet with different macronutrient distributions of carbohydrate, fat, and protein. To be included in the systematic review, articles needed to describe the entire macronutrient distribution of the diet by reporting the proportion of energy from carbohydrate, fat, and protein, with at least 1 macronutrient proportion outside of the AMDR. The Committee established these criteria in order to take a holistic approach towards answering the scientific questions, and thus, requiring the entire distribution of macronutrients within the diet, rather than a select macronutrient in isolation. These criteria facilitated consideration of both the relationships with health outcomes associated with diets having 1 macronutrient outside of the AMDR, and also how consumption of that macronutrient displaces or replaces intake of the other macronutrients within the distribution. It was not required for a study to report the foods or food groups consumed to be included for consideration as a diet based on macronutrient distribution. Rather, criteria were designed to cast a wide, comprehensive net to capture any study that examined macronutrients outside the age-appropriate AMDR (e.g., in adults: carbohydrate levels less than 45 percent or greater than 65 percent of energy, fat levels less than 20 percent or greater than 35 percent of energy, and/or protein levels less than 10 percent or greater than 35 percent of energy). Furthermore, when describing and categorizing studies included in these reviews, the Committee did not label the diets examined as “low” or “high,” because no universally accepted, standard definition is currently available, for example, for “low-carbohydrate” or “high-fat” diets. Instead, the Committee focused on whether, and the extent to which, the proportions of the macronutrients were below or above the AMDR.

Details about the methods used to answer the questions discussed in this chapter are provided below. Due to the timeline relative to the workload volume, some questions required the Committee to consider additional inclusion and exclusion criteria prior to completion of literature screening to fine tune and strengthen the resulting body of evidence. The specific modifications from the initial protocol compared to the final protocol are specified below for each question. Three different approaches were used to answer all questions considered in this chapter, including updating existing systematic reviews, using existing systematic reviews, and/or conducting new systematic reviews.

Questions 1 through 3 in this chapter were answered by updating existing systematic reviews (i.e., dietary patterns in children and adolescents), using existing systematic reviews (i.e., dietary patterns in adults), and conducting new systematic reviews (i.e., diets based on macronutrient distribution). The various processes used to accomplish this are described in ***Part C. Methodology***. For all questions, the Committee developed a systematic review protocol, which described how they would apply NESR's methodology to answer the question. The protocol included an analytic framework and inclusion and exclusion criteria to guide identification of the most relevant and appropriate body of evidence to use in answering each systematic review question. Each analytic framework outlined core elements of the systematic review question (i.e., population; intervention and/or exposure and comparator [i.e., the alternative being compared to the intervention or exposure]; and outcomes), and included definitions for key terms, key confounders, and other factors to be considered when reviewing the evidence. The inclusion and exclusion criteria were selected, up front, to operationalize the elements of the analytic framework, and specify what made a study relevant for each systematic review question. Next, a literature search was conducted to identify all potentially relevant articles, and those articles were screened by 2 NESR analysts independently based on the criteria selected by the Committee. Then, for those reviews that were new or updates, for each included article, data were extracted and risk of bias assessed. The Committee qualitatively synthesized the body of evidence to inform development of a conclusion statement(s), and graded the strength of evidence using pre-established criteria for risk of bias, consistency, directness, precision, and generalizability. The existing systematic review conclusion statements that were updated and/or used for these questions were drawn by the 2015 Committee.[28] Detailed information about the 2015 Committee's review of the evidence can be found in their report, which is available at the following website: dietaryguidelines.gov/current-dietary-guidelines/process-develop-2015-2020-dg/advisory-committee. In addition, detailed information about methodology used to conduct the existing systematic reviews that were used or updated in these questions can be found at the following website: nesr.usda.gov/dietary-patterns-systematic-review-project-methodology.

To address dietary patterns consumed by children and adolescents, the 2020 Committee updated the existing systematic reviews used by the 2015 Committee.[28]

To address dietary patterns consumed by adults, the 2020 Committee used the existing reviews previously conducted by the 2015 Committee.[28] The 2020 Committee conducted a systematic evidence scan and determined that the existing systematic reviews still reflect the current state of science, and did not require a formal update. The systematic evidence scans involved a systematic literature search, with screening by two NESR analysts independently, to provide objective information to facilitate decisions about updating the existing systematic reviews. NESR analysts provided the Committee with all newly published articles that met inclusion criteria based on the results of the scan. Committee members considered the newly published articles to determine whether the new evidence was consistent with the body of evidence from the existing NESR systematic review and if newly published studies addressed key gaps or limitations identified in the existing review. The results of the scan, including a list of all new articles that met criteria for inclusion and the rationale for not updating the review, are documented and available online through the link that follows the summary of evidence for each question.

To address diets based on macronutrient distribution, the 2020 Committee conducted new systematic reviews with support from USDA's NESR team.

For Questions 1 through 3, the population of interest was children and adolescents (ages 2 to 18 years), adults (ages 19 to 64 years), and older adults (ages 65 years and older). Women who were pregnant or lactating were examined in a series of related questions that examined the relationship between dietary patterns and gestational weight gain, postpartum weight loss, hypertensive disorders during pregnancy, or gestational diabetes during pregnancy. These questions are detailed in ***Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy*** and ***Chapter 3: Food, Beverage, and Nutrient Consumption During Lactation***.

Outcomes of interest are described below. Questions 1 and 3 included both intermediate and endpoint health outcomes, and their eligibility for inclusion varied by population (i.e., children or adults) and study design.

The outcomes of interest in each of these reviews are as follows:

- Risk of cardiovascular disease (CVD): Intermediate outcomes included total cholesterol, LDL cholesterol (LDL-C), HDL cholesterol (HDL-C) (including total cholesterol:HDL-C and LDL:HDL cholesterol ratios), triglycerides, and blood pressure (systolic and diastolic). Endpoint outcomes included myocardial infarction, coronary heart disease, coronary artery disease, congestive heart failure, peripheral artery disease, stroke, venous thrombosis, and CVD-related mortality. To focus on the strongest available evidence, criteria also were employed to specify which study designs were eligible for inclusion depending on the outcomes being examined. For adults (ages 18 years and older), only evidence on intermediate outcomes from randomized controlled trials (RCTs) was included whereas evidence on endpoint outcomes was considered from all included study designs. For children (ages 2 to 18 years), evidence on intermediate and endpoint outcomes was considered from all included study designs (i.e., RCTs and certain types of observational studies).

- Growth, size, body composition, and risk of overweight and obesity, in ages 2 years and older: weight, weight-for-age, height, length/stature-for-age, body mass index (BMI), BMI z-score, weight-for-length, body circumferences (head, arm, waist, thigh, neck), body composition and distribution (e.g., percent fat mass, fat-free mass, lean mass), and incidence and prevalence of underweight, failure to thrive, stunting, wasting, healthy weight, overweight, or obesity.
- Risk of type 2 diabetes: Intermediate outcomes included hemoglobin A1C (HbA1c) and endpoint outcomes included type 2 diabetes. The original protocol also included glucose, insulin, and prediabetes as intermediate outcomes, but these were later removed to focus on HbA1C as a predictor of type 2 diabetes for which confirmation of fasting is not needed and day-to-day variability is minimized. To focus on the strongest available evidence, criteria also were employed to specify which study designs were eligible for inclusion depending on the outcomes being examined. For adults (ages 18 years and older), only evidence on intermediate outcomes from RCTs was included and evidence on endpoint outcomes was considered from all included study designs. For children (ages 2 to 18 years), evidence on intermediate and endpoint outcomes was considered from all included study designs.

To establish inclusion and exclusion criteria for Questions 1 through 3, the Committee used standard NESR criteria for publication status, language of publication, country, and study participants. Additional criteria for study duration, size of study groups, and energy-restriction were established in the final protocols to ensure that the most relevant and appropriate body of evidence was included to answer these questions. A key aspect of the definition of a dietary pattern is that it represents the habitual diet of an individual, over time. Thus, the Committee established study duration criteria to include studies on dietary patterns and diets based on macronutrient distribution that were longer in duration, and therefore, better represented the concept of a habitual diet. Studies with an intervention or exposure duration of 12 weeks or longer were included, and those shorter than 12 weeks were excluded. This duration of exposure also corresponded with a timeframe that would be expected to capture meaningful changes in HbA1c values for diabetes-related outcomes[29] as well as changes in total cholesterol and LDL-C related to CVD risk. While a longer minimum duration may be advisable for select outcomes, such as CHD incidence,[30] imposing such a criteria could produce a body of evidence that is too narrow. The duration selected by the Committee was intended to obtain literature examining dietary patterns sustained for a sufficient period of time that would deliver valid results across the range in intermediate and endpoint outcomes of interest. Size of study groups criteria were applied to intervention and observational studies because effects or associations observed when power or sample size is inadequate could be due to random chance (i.e., low statistical power increases the likelihood that a statistically significant finding actually represents a false positive result). Therefore, intervention studies with fewer than 30 participants per-arm or no power calculation and observational studies with fewer than 1,000 participants were excluded. Standard health status criteria were applied, but expanded to ensure an evidence base that would allow for more direct comparisons between dietary patterns and outcomes that are independent of the effects that weight loss may have on cardiometabolic health factors. Studies that used hypocaloric or energy-restricted diets to induce weight loss in participants with overweight or obesity were excluded, as it is not possible to isolate whether outcomes were due to reduced energy intake, the proportion of macronutrients or dietary pattern consumed, and/or weight loss.

Two literature searches were conducted to identify all potentially relevant articles for Questions 1 through 3. The first search was designed to update the existing review by searching for articles that examined dietary patterns and all outcomes published from January 2014 to October 2019. This search also was designed to identify articles that examined diets based on macronutrient distribution and all outcomes. Because diets based on macronutrient distribution and these outcomes were not covered in an existing systematic review, the second search was designed to identify all potentially relevant articles published from January 2000 to December 2013. This date range was selected for consistency with the new dietary patterns reviews being conducted by the Committee. After the 2 searches were conducted, duplicates were moved, and the results were combined for screening.

Questions 4 through 6 in this chapter were answered by updating existing systematic reviews that were conducted by the 2015 Committee with support from USDA's NESR team. A description of the process the Committee used to update these existing systematic reviews is provided in ***Part C. Methodology***. In addition, detailed information about the 2015 Committee's review of the evidence can be found in their report, which is available at the following website: nesr.usda.gov/dietary-patterns-foods-and-nutrients-and-health-outcomes-subcommittee and dietaryguidelines.gov/current-dietary-guidelines/process-develop-2015-2020-dg/advisory-committee.

To address dietary patterns consumed, the 2020 Committee updated the existing systematic reviews used by the 2015 Committee. When prioritizing work within the timeline and considering lack of biological plausibility, diets based on macronutrient distribution were not examined for these outcomes.

For Question 4, the outcomes of interest included intermediate outcomes (i.e., bone mass, including bone mineral density, bone mineral content, and biomarkers of bone metabolism) and endpoint outcomes (i.e., osteoporosis, osteopenia, rickets, and fracture). The populations of interest were children and adolescents (ages 2 to 18 years), adults (ages 19 to 64 years), women who were pregnant or lactating, and older adults (ages 65 years and older). To focus on the strongest available evidence, criteria were added to specify which study designs were eligible for inclusion depending on the outcomes and age groups being examined. For adults (ages 18 years and older), only evidence on intermediate outcomes from RCTs was included, and for endpoint outcomes, evidence from RCTs and certain types of observational studies was included. In children (ages 2 to 18 years), evidence on intermediate and endpoint outcomes from both RCTs and certain types of observational studies were included. The Committee used standard NESR criteria for publication status, language of publication, country, study participants, and health status of study participants, and applied the same criteria for study duration and size of study groups as were established for Questions 1 through 3.

For Question 5, the outcomes of interest were initially incident cases of breast, colorectal, lung, prostate, liver, pancreatic, and endometrial cancer in adults and leukemia in children. The protocol was revised to focus on the 4 most common types of cancer in the United States—breast, colorectal, lung, and prostate cancer that were also considered by the 2015 Committee. The populations of interest for the intervention/exposure and outcome were children and adolescents (ages 2 to 18 years), adults (ages 19 to 64 years), and older adults (ages 65 years and older), and the Committee used standard NESR criteria for study design, publication status, language of publication, country, study participants, and health status of study participants.

For Question 6, the outcomes of interest initially included a comprehensive list of neurocognitive health outcomes across the lifespan (i.e., developmental domains [cognitive, language and communication, social-emotional, movement and physical]), attention deficit disorder or attention-deficit/hyperactivity disorder, autism spectrum disorder, academic performance, depression, anxiety, cognitive decline, mild cognitive impairment and dementia, Alzheimer’s disease). However, due to timeline considerations, the final protocol was revised to focus on only those outcomes that had also been considered by the 2015 Committee, which were incident cognitive decline, mild cognitive impairment, dementia, and Alzheimer's disease. The populations of interest for the intervention/exposure were children and adolescents (ages 2 to 18 years), adults (ages 19 to 64 years), women who were pregnant or lactating, and older adults (ages 65 years and older). The populations of interest for the outcome were adults (ages 19 to 64 years old) and older adults (ages 65 years and older). The Committee used standard NESR criteria for publication status, language of publication, country, study participants, and health status of study participants, and applied the same criteria for study duration and size of study group as were established for Questions 1 through 3.

A literature search was conducted for each question to identify all potentially relevant articles published since the existing review was conducted. For Question 4, studies were included if they were published between January 2014 and November 2019. For Question 5, studies were included if they were published between December 2013 and January 2020. For Question 6, studies were included if they were published between January 2014 to February 2020.

Questions 7 and 8 in this chapter were answered with new NESR systematic reviews. A detailed description of NESR's systematic review methodology is provided in ***Part C. Methodology***, including standard inclusion and exclusion criteria applied in many of the Committee's systematic reviews. Complete documentation of each systematic review is available on the following website: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews. Below is a summary of the unique elements of the protocols developed to answer the questions on dietary patterns and sarcopenia, and dietary patterns and all-cause mortality.

For Question 7, the protocol initially included intermediate outcomes of skeletal muscle mass, muscle strength, muscle performance, and endpoint outcomes of severe sarcopenia and sarcopenia. To focus the review directly on sarcopenia, the protocol was revised to include only endpoint outcomes. The definition for sarcopenia was applied based on The Foundation for the National Institutes of Health (FNIH) Sarcopenia Project and consensus from multiple working groups (European Working Group on Sarcopenia in Older People, the European Society for Clinical Nutrition and Metabolism Special Interest Groups, and the International Working Group on Sarcopenia). The operational definition applied in this review for sarcopenia was a progressive and generalized loss of skeletal muscle mass, alone or in conjunction with either or both low muscle strength and low muscle performance. For Question 8, the outcome of interest was all-cause mortality, or the total number of deaths from all causes during a specific time period. Cause-specific mortality was not included in Question 8.

For both Questions 7 and 8, the populations of interest for the intervention/exposure were children and adolescents (ages 2 to 18 years), adults (ages 19 to 64 years), and older adults (ages 65 years and older), and the populations of interest for the outcomes were adults (ages 19 to 64 years) and older adults (ages 65 years and older). Women who were pregnant or lactating were not considered in this review.

When establishing inclusion and exclusion criteria, the Committee used standard NESR criteria for study design, publication status, language of publication, country, study participants, and health status of study participants.

A literature search was conducted for each systematic review question. Both questions included studies published between January 2000 and October 2019. The Committee chose to search for and include studies published starting in 2000 because the field of dietary patterns research is relatively new. Several of the existing systematic reviews used or updated by this Committee searched for literature starting in 1980 but relevant studies published before the year 2000 were uncommon. Therefore, the Committee determined that the preponderance of evidence for these new reviews would be captured by searching literature starting in the year 2000. For consistency, a starting date of 2000 also was selected for studies examining diets based on macronutrient distribution. For the review on sarcopenia, a second search was conducted to ensure that all potentially relevant studies on this topic were identified. The full search strategy is documented in the final protocol within the full systematic reviews.

REVIEW OF THE SCIENCE

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

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns: Children

Limited evidence suggests that dietary patterns consumed by children and adolescents reflecting higher intakes of vegetables, fruits, whole grains, fish, low-fat dairy, legumes, and lower intake of sugar-sweetened beverages, other sweets, and processed meat, are associated with lower blood pressure and blood lipid levels, including low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides later in life. Grade: Limited

Dietary Patterns: Adults

The 2020 Dietary Guidelines Advisory Committee conducted a systematic evidence scan and confirmed that the conclusion drawn by the 2015 Dietary Guidelines Advisory Committee generally[1] reflects the current state of science: Strong and consistent evidence demonstrates that dietary patterns associated with decreased risk of cardiovascular disease 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. 2015 Dietary Guidelines Advisory Committee Grade: Strong

Diets Based on Macronutrient Distribution: Children

No evidence was available to determine the relationship between diets based on macronutrient distribution consumed by children or adolescents and concurrent or future development of cardiovascular disease. Grade: Grade Not Assignable

Diets Based on Macronutrient Distribution: Adults

Limited evidence suggests non-energy restricted diets based solely on macronutrient distribution with either carbohydrate, fat, and/or protein proportions outside of the Acceptable Macronutrient Distribution Range, are neither beneficial nor detrimental regarding risk of

[1] See the Discussion section of this chapter, and ***Part D, Chapter 11: Alcoholic Beverages***, for additional information about alcohol consumption and health outcomes.

cardiovascular disease in adults, primarily among those at high-risk, such as those with overweight, obesity or features of metabolic syndrome. Grade: Limited

Summary of the Evidence

- One-hundred ninety articles were identified that met inclusion criteria and examined the relationship between dietary patterns and/or diets based on macronutrient proportion and risk of CVD.[11-13,31-217] (See the Methodology section for more information about how dietary patterns and diets based on macronutrient distribution were operationalized for this review.)

Dietary Patterns: Children

- Four included articles, all from prospective cohort studies (PCSs) published between January 2014 and October 2019, examined the relationship between dietary patterns in children and CVD.[55,60,66,166]
  - Two of the articles used index or score analyses to examine dietary patterns
  - Two of the articles examined dietary patterns identified with factor and cluster analyses.
  - Most of the studies examined intermediate CVD outcomes in childhood, although 1 study reported on incidence of CVD in adulthood.
  - This body of evidence updates an existing systematic review from the 2015 Dietary Guidelines Advisory Committee, which found insufficient evidence in pediatric populations published between 1980 and 2013 that met inclusion criteria on dietary patterns and CVD and therefore, was unable to form a conclusion statement at the time.

Dietary Patterns: Adults

- One-hundred forty-nine articles examined dietary patterns in adults and CVD.[11-13,31-37,39-43,45-47,49-52,56-59,61-65,68-71,74,76-83,85,87,89,91-93,96,98,99,102-107,109-120,122-125,130-137,139-146,148-152,154-156,158-165,167,170-173,175,177-193,195-200,202,203,205-207,209-213,215-217]
  - These articles represent new evidence published since an existing systematic review that included articles published between January 1980 and 2013, which was reviewed by the 2015 Committee.[28]
  - A systematic evidence scan was conducted to identify and examine newly published evidence, and determine whether a full systematic review update was warranted.
  - Based on results from the systematic evidence scan, the 2020 Committee determined that the newly published evidence was generally consistent with the body of evidence

from the existing review, and a full systematic review update was not needed at this time. Therefore, the conclusion statement and grade from the existing review were carried forward.

Diets Based on Macronutrient Distribution: Children

- No articles were identified that met inclusion criteria and examined diets based on macronutrient distribution consumed by children or adolescents and risk of CVD across the lifespan.

Diets Based on Macronutrient Distribution: Adults

- Forty-nine included articles examined diets based on macronutrient distribution in adults and CVD outcomes, met inclusion criteria, and were published between January 2000 and October 2019.[38,44,48,53,54,61,67-69,72,73,75,77,84,86,88,90,94,95,97,100,101,108,111,121,126-129,134,138,147,148,153,157,168,169,171,174-176,180,185,194,201,204,205,208,214]
    - Nineteen articles came from RCTs and 30 articles came from PCSs.
    - Most studies enrolled participants who were overweight or obese, or exhibited features of metabolic syndrome.
    - The majority of RCTs (n=11) reported no significant effects of macronutrient distributions on intermediate CVD outcomes, such as LDL-C.
        - Although results from several RCTs (n=8) reported significantly improved intermediate CVD outcomes, diets compared between studies were heterogeneous with macronutrient proportions inconsistently above or below the AMDR and dependent upon the comparison of interest (e.g., fat within vs. above the AMDR).
    - Many PCSs reported no significant associations across specified macronutrient distributions and CVD mortality endpoint outcomes.
        - Among the PCSs (n=9 of 30) that also reported dietary patterns, the majority reported that diets with energy derived from total fat intakes above the AMDR were associated with increased CVD risk, and generally reflecting lower diet quality.
    - Numerous limitations were identified across the body of evidence:
        - Vastly different study designs and diet assessment approaches were used to examine macronutrient distributions.
        - Few studies evaluated macronutrient distribution in the context of dietary patterns in relation to CVD.

- Foods and food groups consumed as part of the diet pattern, were inconsistently assessed and reported, thereby limiting meaningful conclusions regarding nutrient density and overall nutritional quality.
- The gradient between proportions compared within and across studies varied widely.
- Although many studies compared proportions that were distinctly different, some compared only slight differences in macronutrient content (e.g., 42.0 fat vs 43.7 percent fat), thereby reducing the specificity of the impact.
- Due to the variability in methodology used to estimate macronutrient intake and/or adjust for total energy, confidence in the accuracy of reported proportions of energy falling outside the AMDR is low.
- Several studies focused on a particular macronutrient of interest, such as “high-protein” or “low-carbohydrate” intake, but the proportion for that macronutrient was within the AMDR.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-cardiovascular-disease

Question 2. What is the relationship between dietary patterns consumed and growth, size, body composition, and risk of overweight and obesity?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns: Children

Limited evidence suggests that dietary patterns consumed by children or adolescents that are lower in fruits, vegetables, whole grains, and low-fat dairy while being higher in added sugars, refined grains, fried potatoes, and processed meats are associated with higher fat-mass index and higher body mass index later in adolescence. Grade: Limited

Dietary Patterns: Adults

The 2020 Dietary Guidelines Advisory Committee conducted a systematic evidence scan and determined that the conclusion drawn by the 2015 Dietary Guidelines Advisory Committee generally[2] reflects the current state of science: Moderate evidence indicates dietary patterns emphasizing vegetables, fruits, and whole grains; seafood and legumes; 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 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. 2015 Dietary Guidelines Advisory Committee Grade: Moderate

Diets Based on Macronutrient Distribution: Children

No evidence is available to determine a relationship between diets based on macronutrient distribution consumed by children or adolescents and growth, size, body composition, and risk of overweight or obesity. Grade: Grade Not Assignable

Diets Based on Macronutrient Distribution: Adults

Insufficient evidence is available to determine the relationship between macronutrient distributions with proportions of energy falling outside of the Acceptable Macronutrient Distribution Range for at least 1 macronutrient and growth, size, body composition, and/or risk of overweight or obesity, due to methodological limitations and inconsistent results. Grade: Grade Not Assignable

Summary of the Evidence

- Eighty-eight articles were identified that met inclusion criteria and examined the relationship between dietary patterns and/or diets based on macronutrient proportion and growth, size, body composition, and/or risk of overweight or obesity.[38,42,55,57,58,60,65,67-70,72,75-77,86,101,105,106,108,112,132,146,157,171,174,183,188,194,201,204,208,218-273] (See the Methodology section for more information about how dietary patterns and diets based on macronutrient distribution were operationalized for this review.)

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[2] See the Discussion section of this chapter, and ***Part D, Chapter 11: Alcoholic Beverages***, for additional information about alcohol consumption and health outcomes.

Dietary Patterns: Children

- Twelve articles examined dietary patterns consumed by children and growth, size, body composition, and/or risk of overweight or obesity, met inclusion criteria, and were published between January 2014 and October 2019.[55,60,218-227]
  - All 12 articles were from PCSs.
  - Dietary patterns were assessed using a variety of methods, including factor or cluster analysis, indices or scores, latent class analysis, and reduced rank regression.
  - Outcome measures varied across studies and included incidence of overweight or obesity, fat mass, lean mass, BMI, central adiposity, and weight and height.
  - Despite variability in methods, dietary patterns in childhood or adolescence that tended to associate with higher fat-mass index and BMI later in adolescence reflect poorer diet quality (e.g., lower in vegetables and fruits, while higher in added sugars, refined grains, and fried potatoes). However, the findings should be interpreted with caution due to several limitations.
    - Across the body of evidence, the direction of significant findings was mixed, with relatively small and inconsistent magnitude.
    - Most of the studies assessed diet once at baseline with methods that were not necessarily validated, reliable, or applicable for children.

Dietary Patterns: Adults

- Fifty-four articles were identified by a systematic evidence scan examining dietary patterns consumed by adults and growth, size, body composition, and/or risk of overweight or obesity.[42,57,58,65,68-70,76,77,86,105,106,108,112,132,146,171,183,188,228-262]
  - These articles represent new evidence published since a review done by the 2015 Committee.[28]
  - A systematic evidence scan was conducted to identify and examine these articles, and determine whether a full systematic review update was warranted.
  - Based on results from the systematic evidence scan, the 2020 Committee determined that the newly published evidence was generally consistent with the body of evidence from the existing review, and a full systematic review update was not needed at this time. Therefore, the conclusion statement and grade from the existing review were carried forward.

Diets Based on Macronutrient Distribution: Children

- No studies identified met inclusion criteria that examined diets based on macronutrient distribution consumed during childhood and growth, size, body composition, and/or risk of overweight or obesity.

Diets Based on Macronutrient Distribution: Adults

- Thirty-one articles examined diets based on macronutrient distribution and growth, size, body composition, and/or risk of overweight or obesity, met inclusion criteria, and were published between January 2000 and October 2019.[38,67-69,72,75,77,86,101,108,157,171,174,194,201,204,208,229,242,257,263-273]
- Twenty-two articles came from RCTs and 9 articles came from PCSs.
    - o Most of the articles examined distributions in which the proportion of energy from carbohydrate was below the AMDR, fat was above the AMDR, and protein was within the AMDR in at least one of the exposure groups compared.
    - o Foods or food groups consumed as part of the diet, were not consistently reported.
- Results across studies were inconclusive, with the majority of studies reporting no significant association between diets based on macronutrient distribution and growth, size, body composition, and/or risk of overweight or obesity.
- Numerous limitations that prevented adequate assessment were identified:
    - o Several studies did not directly test the difference in macronutrient proportions in the context of various dietary patterns during energy balance.
    - o Although statistically significant relationships were reported, the gradient between macronutrient distributions was relatively narrow within studies (e.g., 45.3 percent carbohydrate vs 43.8 percent carbohydrate) and between studies.
    - o Due to the variety of methods used to estimate macronutrient intake and adjust intake for total energy, the confidence in the reported proportions of energy falling outside the AMDR is low.
    - o Several studies reported to be examining 1 particular macronutrient of interest, such as “high-protein” or “low-carbohydrate” intake, but the proportion for that nutrient was within the AMDR.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-growth-size-body-composition-obesity

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

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns: Children

Insufficient evidence is available to determine the relationship between dietary patterns consumed by children or adolescents and risk of type 2 diabetes. Grade: Grade Not Assignable

Dietary Patterns: Adults

The 2020 Dietary Guidelines Advisory Committee conducted a systematic evidence scan and determined that the conclusion drawn by the 2015 Dietary Guidelines Advisory Committee generally reflects the current state of science: 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. 2015 Dietary Guidelines Advisory Committee Grade: Moderate

Diets Based on Macronutrient Distribution: Children

No evidence is available to determine a relationship between diets based on macronutrient distribution consumed by children or adolescents and risk of type 2 diabetes. Grade: Grade Not Assignable

Diets Based on Macronutrient Distribution: Adults

Insufficient evidence is available to determine the relationship between macronutrient distributions with proportions of energy falling outside of the Acceptable Macronutrient Distribution Range for at least 1 macronutrient and risk of type 2 diabetes, due to methodological limitations and inconsistent results. Grade: Grade Not Assignable

Summary of the Evidence

- Seventy-two articles were identified that met inclusion criteria and examined the relationship between dietary patterns and/or diets based on macronutrient distribution and risk of type 2 diabetes.[32,42,53,57,58,65,66,77,81,85,106,108,112,167,178,188,206,274-328] (See the Methodology section for more information about how dietary patterns and diets based on macronutrient distribution were operationalized for this review.)

Dietary Patterns: Children

- One article from a PCS examined dietary patterns consumed during adolescence (retrospectively) and risk of type 2 diabetes.[66]

Dietary Patterns: Adults

- Fifty-two articles examined dietary patterns consumed by adults and risk of type 2 diabetes.
  - These articles represent new evidence published since an existing systematic review that included articles published between January 1980 and 2013, which was reviewed by the 2015 Committee.[28]
  - A systematic evidence scan was conducted to identify and examine newly published evidence, and determine whether a full systematic review update was warranted.
  - Based on results from the systematic evidence scan, the 2020 Committee determined that the newly published evidence was generally consistent with the body of evidence from the existing review, and a full systematic review update was not needed at this time. Therefore, the conclusion statement and grade from the existing review were carried forward.

Diets Based on Macronutrient Distribution: Children

- No articles were identified that met inclusion criteria and examined diets based on macronutrient distribution consumed during childhood and risk of type 2 diabetes across the lifespan.

Diets Based on Macronutrient Distribution: Adults

- Twenty-three articles examined diets based on macronutrient distribution consumed by adults and risk of type 2 diabetes, met inclusion criteria, and were published between January 2000 and October 2019.[53,77,108,309-328]
    - Two studies were RCTs, and 21 articles were PCSs.
    - Most of the articles examined distributions in which the proportion of energy from carbohydrate was below the AMDR, fat was above the AMDR, and protein was within the AMDR in at least 1 of the exposure groups compared.
        - Foods or food groups consumed as part of the diet, were reported among most studies but with limited and inconsistent detail, such as "animal-based" macronutrient distributions.
        - Among studies that provided the context of foods or food groups, diets based on macronutrient distributions with proportions outside of the AMDR tended to have higher amounts of saturated fat, *trans* fat, and/or animal-based sources of protein and fat, such as processed meat, red meat, butter, and cheese as well as refined grains, sugar-sweetened beverages, and lower-fiber cereals and breads.
    - Numerous limitations that prevent adequate assessment across this body of evidence were identified:
        - Several studies did not directly test differences in macronutrient proportions in the context of a constant dietary pattern.
        - The gradient between macronutrient proportions compared within and across studies varied. Several studies compared distinct proportions between groups (e.g., 33.4 percent carbohydrate vs 47.5 percent carbohydrate), whereas others were much closer in proximity relative to one another (e.g., 41.0 percent carbohydrate vs 45.0 percent) or to the AMDR limit (e.g., 44.9 percent vs 45 percent).

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-type-2-diabetes

Question 4. What is the relationship between dietary patterns consumed and bone health?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns: Adults

Moderate evidence indicates that a dietary pattern higher in fruits, vegetables, legumes, nuts, low-fat dairy, whole grains, and fish, and lower in meats (particularly processed meats), sugar-sweetened beverages, and sweets is associated with favorable bone health outcomes in adults, primarily decreased risk of hip fracture. Grade: Moderate

Dietary Patterns: Children

Insufficient evidence is available to determine the relationship between dietary patterns consumed by children and adolescents and bone health. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review update includes 9 PCSs[329-337] that examined the relationship between dietary patterns and bone health, met inclusion criteria, and were published between January 2014 and November 2019.
    - Seven studies examined dietary patterns in adults and bone health in older adults.[329-335]
    - Two articles from the same study were conducted that examined dietary patterns in children and adolescents and bone health outcomes after a 4-year follow-up (approximately age 17 years).[336,337]
- The direction and magnitude of effect across the body of evidence was consistent, pointing to healthier dietary patterns leading to a reduced risk of hip fractures. The studies in adults had large analytic sample sizes with a sufficient number of hip fracture cases occurring over follow-up to examine associations. Although the search strategy included other bone health outcomes, the eligible studies looked only at fractures (mainly hip) and forearm bone mineral density (in adolescents).
- The body of evidence consistently had risks of bias, including lack of adjustment for all potential confounders and a lack of accounting for possible changes in dietary intake that may have occurred over follow-up.

- This systematic review updates and builds upon an existing systematic review from the 2015 Committee,[28] which previously determined that limited evidence suggests a relationship between dietary patterns and bone health in adults. In that previous review, a grade was not assignable in children and adolescents due to limited evidence from a small number of studies with wide variation in study design, dietary assessment methodology, and bone health outcomes.
    - Based on the 7 additional studies in this update to the existing review examining dietary patterns in adults, moderate evidence is now available to indicate a significant relationship between dietary patterns and risk of hip fracture in older adults.
    - Based on the 2 additional studies in this update to the existing review examining dietary patterns in children or adolescents, no change is warranted in the level of evidence to evaluate the relationship between dietary patterns and bone health in children.
    - Although the number of recent studies is modest, they are consistent in how dietary intake was evaluated, in magnitude of effect reported, and in evaluated outcomes.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-bone-health

Question 5. What is the relationship between dietary patterns consumed and risk of certain types of cancer?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns: Breast Cancer

Moderate evidence indicates that dietary patterns rich in vegetables, fruits, and whole grains, and lower in animal-source foods and refined carbohydrates, are associated with reduced risk of postmenopausal breast cancer. The data regarding these dietary patterns and premenopausal breast cancer risk point in the same direction, but the evidence is limited as fewer studies include premenopausal breast cancer. Grade: Moderate - Postmenopausal breast cancer risk; Limited – Premenopausal breast cancer risk

Dietary Patterns: Colorectal Cancer

Moderate evidence indicates that dietary patterns higher in vegetables, fruits, legumes, whole grains, lean meats and seafood, and low-fat dairy and low in red and processed meats, saturated fat and sugar-sweetened beverages and sweets relative to other dietary patterns are associated with lower risk of colon and rectal cancer. Moderate evidence also indicates that dietary patterns that are higher in red and processed meats, French fries, potatoes, and sources of sugars (e.g., sugar-sweetened beverages, sweets and dessert foods) are associated with a greater colon and rectal cancer risk. Grade: Moderate

Dietary Patterns: Lung Cancer

Limited evidence suggests that dietary patterns containing more frequent servings of vegetables, fruits, seafood, grains and cereals, legumes and lean vs higher fat meats and lower fat or non-fat dairy products may be associated with lower risk of lung cancer, primarily among former smokers and current smokers. Grade: Limited

Dietary patterns: Prostate Cancer

Limited evidence suggests no relationship between dietary patterns and risk of prostate cancer. Grade: Limited

Summary of the Evidence

Dietary Patterns: Breast Cancer

- This systematic review update includes 26 studies that examined the relationship between dietary patterns and risk of breast cancer, met inclusion criteria, and were published between January 2014 and January 2020:
    - Three studies were RCTs[338-340]
    - Twenty-one were PCSs [206,341-360]
    - Two studies were nested case-control studies.[361,362]
- The studies were heterogeneous, in terms of which methods were used to identify or assess dietary patterns, how dietary intake was assessed, and duration of follow-up. However, despite this heterogeneity, the body of evidence was consistent in the types of foods and beverages examined in a number of the patterns, particularly in those studies that reported statistically significant associations with lower risk of breast cancer.

- In a number of studies, dietary patterns that included vegetables, fruits, and whole grains, and that were lower in animal products and refined carbohydrates, were associated with reduced risk of postmenopausal breast cancer.
- Alcohol was not consistently included within the patterns found to be inversely associated with breast cancer risk.
- Few studies reported results for premenopausal breast cancer risk.

- The studies were direct and generalizable, in that the populations, interventions, comparators, and outcomes of interest in the included studies were directly related to the systematic review question, and were applicable to the U.S. population.
- The body of evidence had several risks of bias, particularly in the observational studies, including lack of adjustment for all key confounders, assessment of a dietary pattern only once at baseline or in the first few years of follow-up, and a lack of accounting for possible changes in dietary intake that may have occurred over follow-up.
- This systematic review updates and concurs with the conclusions drawn by the 2015 Committee.[28]

Dietary Patterns: Colorectal Cancer

- This systematic review update includes 24 studies that examined the relationship between dietary patterns and risk of colorectal cancer, met inclusion criteria, and were published between January 2014 and January 2020:
  - Two studies were RCTs[338,339]
  - Twenty-one studies were PCSs[206,341,344,353,363-379]
  - One study was a nested case-control study[380]
- The studies were heterogeneous, in terms of which methods were used to identify or assess dietary patterns, how dietary intake was assessed, and duration of follow-up. However, despite this heterogeneity, the body of evidence was consistent in the types of foods and beverages examined in a number of the patterns, particularly in those studies that reported statistically significant associations with lower risk of colorectal cancer.
  - In a number of studies, dietary patterns that included vegetables, fruits, legumes, whole grains, lean meats and seafood, and low-fat dairy, and that were lower in red and processed meats, saturated fat, sodas, and sweets were associated with lower risk of colorectal cancer.

  - Alcohol was not consistently included within the patterns found to be inversely associated with colorectal cancer risk.
  - Results were more consistent in men, and for total colorectal cancer risk.
- The studies were direct and generalizable, in that that the populations, intervention, comparators, and outcomes of interest in the included studies were directly related to the systematic review question and were applicable to the U.S. population.
- The body of evidence had several risks of bias, particularly in the observational studies, including lack of adjustment for all key confounders, assessment of a dietary pattern only once at baseline or in the first few years of follow-up, and a lack of accounting for possible changes in dietary intake that may have occurred over follow-up.
- This systematic review updates the conclusions drawn by the 2015 Committee.[28] The 2020 Committee determined that the body of evidence included in this update was consistent with that considered by the 2015 Committee, with the exception of alcohol. Because alcohol was not consistently part of the patterns found to be significantly associated with lower colorectal cancer risk, and in some cases, were part of cases associated with increased risk, “moderate alcohol” was removed from the conclusion statement.

Dietary Patterns: Lung Cancer

- This systematic review update includes 7 PCSs[206,341,351,363,381-383] and one nested case-control study[384] that examined the relationship between dietary patterns and risk of lung cancer, met inclusion criteria, and were published between January 2014 and January 2020
- Though the body of evidence had some inconsistencies in direction and magnitude of effect, most studies reported significant associations between adherence to a dietary pattern and lower risk of lung cancer.
  - In several studies, dietary patterns containing more frequent servings of vegetables, fruits, seafood, grains and cereals, legumes and lean vs higher fat meats and lower fat or non-fat dairy products were associated with lower risk of lung cancer.
  - The protective effects of the patterns were more consistent among participants who were former smokers and current smokers than among participants who were never smokers.
  - Alcohol was not consistently included within the patterns found to be inversely associated with lung cancer risk.

- Most studies had large analytic sample sizes with a sufficient number of lung cancer cases occurring over follow-up to examine associations. However, the width of confidence intervals indicates some degree of imprecision within the body of evidence.
- The studies were direct and generalizable, in that the populations, intervention, comparators, and outcomes of interest in the included studies were directly related to the systematic review question, and were applicable to the U.S. population.
- The body of evidence had several risks of bias, including lack of adjustment for all key confounders, assessment of dietary pattern only once at baseline or in the first few years of follow-up, and a lack of accounting for possible changes in dietary intake that may have occurred over follow-up.
- This systematic review updates and concurs with the conclusions drawn by the 2015 Committee.[28]

Dietary Patterns: Prostate Cancer

- This systematic review update includes 7 PCSs[341,343,344,351,353,385,386] and 1 nested case-control study[387] that examined the relationship between dietary patterns and risk of prostate cancer, met inclusion criteria, and were published between January 2014 and January 2020.
- Though the direction and magnitude of effect across the body of evidence was inconsistent, most studies reported no significant associations between adherence to a dietary pattern and risk of prostate cancer. Most studies had large analytic sample sizes with a sufficient number of prostate cancer cases occurring over follow-up to examine associations. However, the width of confidence intervals indicates some degree of imprecision within the body of evidence.
- The studies were direct and generalizable, in that the populations, exposures, comparators, and outcomes of interest in the included studies were directly related to the systematic review question, and were applicable to the U.S. population.
- The body of evidence had several risks of bias, including lack of adjustment for all key confounders, assessment of a dietary pattern only once at baseline or in the first few years of follow-up, and a lack of accounting for possible changes in dietary intake that may have occurred over follow-up.
- This systematic review updates the review done by the 2015 Committee,[28] which did not draw a conclusion regarding the relationship between dietary patterns and the risk of prostate cancer due to limited evidence from a small number of studies with wide variation in

study design, dietary assessment methodology and prostate cancer outcome ascertainment. The 2020 Committee determined that, based on the 8 additional studies in their update, limited evidence is now available to suggest no relationship between dietary patterns and risk of prostate cancer.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-cancer

Question 6. What is the relationship between dietary patterns consumed and neurocognitive health?

Approach to Answering Question: NESR systematic review

Conclusion Statement

Limited evidence suggests that dietary patterns containing vegetables, fruits, unsaturated vegetable oils and/or nuts, legumes, and fish or seafood consumed during adulthood are associated with lower risk of age-related cognitive impairment and/or dementia. Grade: Limited

Summary of the Evidence

- This systematic review update includes 26 articles that met inclusion criteria and were published between January 2014 and February 2020.[206,388-412]
  - Four studies were RCTs.[388-391]
  - Twenty-two articles were from observational studies, with 21 PCS designs and 1 nested-case control design.[206,392-412]
  - This body of evidence updates and builds upon the existing systematic review from the 2015 Committee,[28] which consisted of 30 articles from a wide range of study designs that used different methods to measure neurocognitive outcomes but produced relatively consistent findings.
  - Studies in this update to the existing review produced similarly consistent results regarding the relationship between dietary patterns in adults and age-related cognitive decline, mild cognitive impairment, and/or dementia.
  - Dietary patterns were examined using various approaches, including 17 studies that examined adherence to a dietary pattern using indices or scores, 4 articles identified

dietary patterns using factor or cluster analysis, and 1 study using reduced rank regression.

- Outcomes were measured using various approaches and reported as global cognition, cognitive performance, mild cognitive impairment, and/or incident dementia.
  - The majority of significant findings reported dietary patterns consumed during adulthood were “protective” in either improving measures of cognitive impairment and/or reducing risk of cognitive impairment or dementia. These protective dietary patterns contained vegetables, fruits, unsaturated vegetable oils and/or nuts, legumes, and fish or seafood. Many of these dietary patterns also emphasized whole grains, non-refined grains, or (non-refined) breads/cereals.
  - Not all of these protective dietary patterns contained alcoholic beverages. The benefit of the overall dietary pattern with the outcome was still observed if alcoholic beverages, particularly red wine, were included.
  - The non-significant findings or those reporting mixed associations reported healthy dietary patterns consumed during adulthood did not worsen cognition.
- Numerous limitations were identified across the body of evidence, including the lack of RCTs, considerable variation in testing methods used, inconsistent validity and reliability of cognitive testing methods, and differences between dietary patterns and cognitive outcomes examined.
- The 2020 Committee updates, concurs, and builds upon the conclusion drawn by the 2015 Committee.[28]

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-neurocognitive-health

Question 7. What is the relationship between dietary patterns consumed and sarcopenia?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns

Insufficient evidence is available to determine the relationship between dietary patterns and sarcopenia in older adults. Grade: Grade Not Assignable

Diets Based on Macronutrient Distribution

Insufficient evidence was available to determine the relationship between diets based on macronutrient distribution and sarcopenia. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review includes 4 PCSs that examined the relationship between dietary patterns and sarcopenia, 2 of which also examined diets based on macronutrient distribution that met inclusion criteria, and were published between January 2000 and June 2019. [413-416]
    - Two of the studies reported macronutrient distributions in which the percent of energy from fat was higher than the AMDR.[414,415]
- The studies were inconsistent, both in terms of which dietary patterns or macronutrient distribution was examined, how dietary intake was assessed, assessment of sarcopenia, and results reported regarding the association between dietary patterns and risk of sarcopenia. In addition, the studies had relatively small sample sizes with few cases of sarcopenia.
- The body of evidence had several risks of bias, including lack of adjustment for all potential confounders, assessment of diet only once at baseline, and a lack of accounting for possible changes in dietary intake that may have occurred over follow-up.
- The studies were direct and generalizable, in that the intervention, comparators, and outcomes of interest in the included studies were directly related to the systematic review question, and were applicable to the U.S. population. However, study participants may have been healthier than the average older adult.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-sarcopenia

Question 8. What is the relationship between dietary patterns consumed and all-cause mortality?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Dietary Patterns

Strong evidence demonstrates that dietary patterns in adults and older adults characterized by vegetables, fruits, legumes, nuts, whole grains, unsaturated vegetable oils, and fish, lean meat or poultry when meat was included, are associated with decreased risk of all-cause mortality. These patterns were also relatively low in red and processed meat, high-fat dairy, and refined carbohydrates or sweets. Some of these dietary patterns also included alcoholic beverages[3] in moderation.

Diets Based on Macronutrient Distribution

Insufficient evidence is available to determine the relationship between diets based on macronutrient distributions and all-cause mortality. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review identified 153 articles, [11-13,18,24,40,41,43,49,50,52,53,59,61,64,73,78,84,97,98,102,103,109,111,114,116,124,126,128,136-138,141,147-149,154,156,161,163,164,172,179,181,182,185,186,189,197,202,206,207,210,211,213-215,217,417-511] including 1 RCT[78] and 152 PCS designs that met criteria for inclusion and were published between January 2000 and May 2019.

Dietary Patterns

- 141 studies examined the relationship between dietary patterns and all-cause mortality. The studies used multiple approaches to assess dietary patterns and all-cause mortality.
    - One RCT[78] assigned participants to consume a Mediterranean dietary pattern with extra virgin olive oil or mixed nuts compared to a control diet

[3] See the Discussion section of this chapter, and ***Part D, Chapter 11: Alcoholic Beverages***, for additional information about alcohol consumption and health outcomes.

- One hundred and ten articles[11-13,40,43,49,50,52,59,61,64,98,102,103,109,111,116,124,136,156,161,163,164,172,179,181,182,186,189,197,202,206,207,210,211,213,215,217,417-488] examined dietary patterns using index or score analysis.
- Twenty-five articles[18,41,53,59,114,137,141,149,154,424,440,469,476,489-500] examined dietary patterns identified with factor and cluster analysis
- Eleven articles[24,185,494,501-508] used other methods, including only reduced rank regression, comparisons based on animal-based food consumption vs avoidance, or comparisons based on "ultra-processed" food consumption, to examine the relationship between dietary patterns and/or diets based on macronutrient distribution.

- Despite the variety of different methods applied to examine or derive dietary patterns, the majority of studies finding statistically significant relationships between dietary patterns consumed and all-cause mortality risk was remarkably consistent.
  - Although the dietary patterns examined were characterized by different combinations of foods and beverages due to the variety of methods used, protective dietary patterns emerged with the following themes:
    - Patterns emphasizing higher consumption of vegetables, legumes, fruits, nuts, whole grains, fish, lean meat or poultry, and unsaturated fats relative to saturated fats, either as a ratio of monounsaturated fatty acids to saturated fatty acids or monounsaturated fatty acids + polyunsaturated fatty acids to saturated fatty acids, or olive oil specifically were generally associated with decreased risk of all-cause mortality. Notably, the inclusion of fish and/or seafood showed particular consistency.
      - Some of these dietary patterns also included alcoholic beverages in moderation or within specific thresholds.
    - Reduced risk of all-cause mortality was observed in several studies that examined dietary patterns without animal-products, such as those described as vegetarian, vegan, or determined by "plant-based" diet indices.
    - Of the dietary patterns that included animal-based foods, protective associations were generally observed with relatively lower consumption of red and processed meat or meat and meat products. However, a limitation in the evidence is methodological heterogeneity in the food categories and terminology used to classify meat.
    - The inclusion of the ratio of white vs red meat, type and amount of dairy products, and refined carbohydrates and sweets as elements to these patterns was less

consistent across the evidence. The dietary patterns that included those elements and that tended to show reduced risk of all-cause mortality had:

- Higher consumption of white meat relative to red or processed meat,
- Low-fat dairy relative to high-fat dairy, and/or
- Lower relative to higher intake of refined carbohydrates and sweets.

- Despite the variability between approaches used to examine dietary patterns, higher adherence to dietary patterns with common labels, such as “Mediterranean,” dietary-guidelines-related (e.g., “Healthy Eating Index,” “DASH” scores), or “plant-based” were generally protective against all-cause mortality risk. This highlights that a high-quality dietary pattern comprised of nutrient-dense foods, regardless of the label, is associated with reduced all-cause mortality risk.
- Results based on additional analyses according to a variety of key or potential confounders generally confirmed the robustness of results.
- Although the majority of included studies were PCSs, most adjusted for key confounders, with the exception of race and ethnicity. The results are likely generalizable to adults of various races and ethnicities though it is difficult to determine the influence that race and ethnicity specifically may have on the relationship between dietary patterns and all-cause mortality due to a lack of reporting.

Diets Based on Macronutrient Distribution

- Twenty-eight articles[53,61,73,84,97,111,126,128,136,138,147,148,156,185,214,430,435,438,442,467,480,489,494,497,498,509-511] examined the relationship between diets based on macronutrient distributions but results were inconsistent.
  - Diets with proportions of carbohydrate and fat within the AMDR compared to outside the AMDRs tended to associate with reduced all-cause mortality risk, particularly when the diets examined were of higher quality (i.e., emphasizing vegetables, fruits, nuts, whole grains, legumes, fish, and/or lean meat or poultry).
  - Comparison of macronutrient distributions with or without the context of the foods and food groups comprising the dietary pattern showed inconsistent findings, likely due to several limitations that prevent the adequate assessment of the body of evidence:
    - The gradient between the macronutrient proportions compared between distributions was often small, e.g., 41 percent vs 41.7 percent.
    - Methods used to estimate macronutrient intake differed between studies.

    - Many of the proportions outside of the AMDR were only marginally outside and often estimated differently between studies.
  - Most of these articles reported a proportion of energy from carbohydrate below and/or fat above the AMDR in at least one of the exposure groups compared.
  - Some of these articles also described the dietary pattern (i.e., foods and beverages) consumed, in addition to having macronutrient proportions outside of the AMDR.
- Insufficient evidence was available to determine the relationship between dietary patterns and all-cause mortality in younger populations (approximately ages younger than 35 years).

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-patterns-subcommittee/dietary-patterns-all-cause-mortality

DISCUSSION

Overview

The dietary patterns approach captures the relationship between the overall diet and its constituent foods, beverages, and nutrients in relationship to health outcomes of interest. The evidence base for associations between eating patterns and specific health outcomes has grown since the previous review by the 2015 Committee.[28] Many dietary patterns were identified, with the most common ones defined using indices or scores, such as the HEI-2015, DASH, Mediterranean, or vegetarian patterns, and data-driven approaches.

The 2020 Committee assessed evidence in adults for the relationship of dietary patterns with 8 broad health outcomes: CVD and associated risk factors; overweight and obesity; type 2 diabetes; bone health; cancers of the colon, lung, breast, and prostate; neurocognitive health; sarcopenia; and all-cause mortality. For adults, evidence was considered Moderate or Strong for the association between dietary patterns and all health outcomes, except for neurocognitive health, and cancers of the prostate and lung, where the evidence was Limited. Insufficient evidence was available to evaluate dietary patterns and sarcopenia outcomes.

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 (Table D8.1). Common characteristics of dietary patterns associated with positive health outcomes include higher intake of vegetables, fruits, legumes, whole grains, low- or non-fat dairy, seafood, nuts, and unsaturated vegetable oils, and low consumption of red and processed meats, sugar-sweetened foods and drinks, and refined grains. Although vegetables and fruits were consistently identified in every conclusion statement across the health outcomes, whole grains were identified in all except 1 of the health outcomes examined. Low- or non-fat dairy, seafood, legumes and nuts were identified as beneficial components of the diet for many, but not all, outcomes. In addition, the Committee found that negative (detrimental) health outcomes were associated with dietary patterns characterized by higher intake of red and processed meats, sugar-sweetened foods and beverages, and refined grains. A noteworthy difference from the 2015 Committee report is that whole grains are now identified with almost the same consistency as vegetables and fruits as beneficial for the outcomes examined, suggesting that these 3 plant-based food groups are fundamental constituents of a healthy dietary pattern. Legumes and seafood also are consistently identified. In identifying the dietary components, the Committee used the terminology in the papers evaluated and a limitation is that terms such as lean meat, red meat, processed meat were not always defined clearly or differentiated from each other. This type of specification is important for future work on dietary patterns.

The Committee addressed the complexities of interpreting the role of alcoholic beverage consumption as a potential component of a healthy dietary pattern. Previous evidence from the 2015 Committee noted in some studies, moderate alcohol intake as a component of a dietary pattern with favorable outcomes for CVD and body weight. Similarly, the 2020 Committee found that alcohol was reported as a component in some studies as part of a dietary pattern that reduced the risk of all-cause mortality. However, this was widely inconsistent across studies, including some that found alcohol to be significantly associated with a lower risk of incident colorectal cancer and others reporting alcohol to be part of a dietary pattern associated with increased risk. Thus, “moderate alcohol” was not included in the 2020 Committee’s conclusion statement on dietary patterns associated with reduced risk for colorectal cancer.

Studies that examine overall dietary patterns in adults often vary in how alcoholic beverage intake is assessed, the thresholds applied for amounts of alcohol consumed, and scoring procedures of alcohol as a dietary component (e.g., a positive component, positive in moderation, or negative component). Studies of alcoholic beverage intake have many potential sources of bias that are unique to this exposure, some of which can be mitigated using a Mendelian randomization study design. Although alcohol is often consumed by those following a Mediterranean-style diet, newer evidence (including Mendelian randomization studies) suggests low-dose alcohol consumption may not have beneficial effects on CVD (see ***Part D. Chapter***

11: Alcoholic Beverages for a discussion of recent Mendelian randomization studies). For these reasons, the Committee does not agree with including moderate alcohol intake for the specific purpose of CVD risk reduction within the context of otherwise healthy dietary patterns, particularly in the absence of RCTs of healthy dietary patterns (e.g., the Mediterranean diet) that have been randomized with respect to the alcohol component.

Rather, the Committee encourages adherence to the *2015-2020 Dietary Guidelines for Americans* recommendations to not begin drinking for the purpose of improved health. For those who choose to drink and those who consume alcohol in excess of *Dietary Guidelines* recommended limits, moderating consumption to lower levels is recommended to better protect health. Additional information and discussion of related topics is included in ***Part D. Chapter 11: Alcoholic Beverages***.

The Committee also considered evidence for dietary patterns and 4 health outcomes in children: overweight and obesity, type 2 diabetes, CVD risk factors, and bone health. Overall, the evidence was graded as Limited for overweight and obesity and CVD risk factors. The characteristics of dietary patterns associated with overweight and obesity and CVD risk factors were similar to adults, including dietary patterns that are higher in fruits, vegetables, whole grains and low-fat dairy and lower in added sugars (for example, sugar-sweetened beverages) and processed meats. Type 2 diabetes and bone health were both classified as Grade Not Assignable, indicating that insufficient evidence was available.

Table D8.1. Dietary pattern components in the Committee's Conclusion Statements that are associated with the health outcomes of interest.*+

Health Outcome of Interest:	**All-cause mortality**	**Cardiovascular disease[a]**	**Growth, size, body composition and risk of overweight and obesity[a]**	**Type 2 diabetes[a]**	**Bone health[a]**	**Colorectal Cancer[b]**	**Breast Cancer** (Post-menopausal)[b]	**Lung Cancer[b]**	**Neurocognitive health**
Grade:	*Strong (adults)*	*Strong (adults); Limited (children)*	*Moderate (adults); Limited (children)*	*Moderate (adults)*	*Moderate (adults)*	*Moderate (adults)*	*Moderate (adults)*	*Limited (adults)*	*Limited (adults)*
Dietary patterns associated with lower risk of disease consistently included the following components.									
Components									
Fruits	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Vegetables	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Whole grains/cereal	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Legumes	**X**	**X**	**X** (adults)		**X**	**X**		**X**	**X**
Nuts	**X**	**X** (adults)			**X**				**X**
Low-fat dairy	**X**	**X**	**X**		**X**	**X**		**X**	
Fish and/or seafood	**X**	**X**	**X** (adults)		**X**	**X**		**X**	**X**
Unsaturated vegetable oils	**X**	**X**	**X** (adults)						**X**
Lean meat	**X**					**X**		**X**	
Poultry	**X**								
Dietary patterns associated with higher risk of disease consistently included the following components.									
Red meat	**X**	**X** (adults)	**X** (adults)	**X**		**X**			
Processed meat	**X**	**X**	**X**	**X**	**X**	**X**			
High-fat meat								**X**	
High-fat dairy	**X**			**X**					
Animal-source foods							**X**		
Saturated fats		**X** (adults)	**X** (adults)			**X**			

Sugar-sweetened beverages and/or foods	**X**	**X**	**X**	**X**	**X**	**X**			
Refined grains	**X**	**X**	**X**	**X**			**X**		
Fried potatoes/ French fries and potatoes			**X** (children)			**X**			
Added sugars			**X** (children)						
Sodium		**X** (adults)	**X** (adults)						

* Note: The reader is directed to the full conclusion statement above for more information on the relationship between dietary patterns and health outcomes.

+ An empty box indicates the research examined in the body of evidence on dietary patterns and the health outcome of interest in that column did not consistently include that component as part of the dietary patterns. Some research efforts may have included that individual component, but that component was not consistently mentioned in the aggregate body of evidence examined. It was beyond the scope of these systematic reviews examining dietary patterns and health outcomes of interest to reclassify or standardize the component categories as originally used in the evidence reviewed.

[a] For both cardiovascular disease and growth, size, body composition and risk of overweight and obesity outcomes, the components listed are applicable to both adults and children. The components that are relevant only to adults or children are identified with parentheses. Evidence for the relationship between children's dietary patterns and type 2 diabetes and bone health also were examined but the evidence was insufficient to determine a relationship.

[b] The relationship between dietary patterns and prostate cancer was reviewed. Limited evidence suggested no relationship between dietary patterns and risk of prostate cancer.

Dietary Patterns and Health Outcomes

Cardiovascular Disease

The current review confirmed a grade of Strong evidence for dietary patterns in reducing risk of CVD, and emerging evidence suggests the need to support healthy eating patterns in childhood to prevent CVD in adulthood. Intermediate risk factors including blood lipids, blood pressure, overweight, blood glucose, and inflammatory markers are favorably influenced by habitual adherence to dietary patterns that include fruits, vegetables, whole grains, legumes, nuts, unsaturated vegetable oils, fish, seafood, lower fat dairy products, and that reduce intake of sugar, sodium and saturated fats. Such an eating pattern initiated early and maintained over the life course offers long-term benefits, but adopting these eating behaviors at any age may improve endpoint outcomes, including cardiovascular and all-cause mortality. The research reviewed provided evidence that cross-cultural differences in dietary pattern preferences were common and that food choices within and across most of the dietary patterns studied vary. Specifying the macronutrient distribution and identifying sources of carbohydrates (refined vs complex), protein (animal vs vegetable), and fat (unsaturated vs saturated vs monounsaturated and/or specific fatty acids) within these dietary patterns is recommended in future studies, as these differences may be related to the cardiovascular intermediate and endpoint outcomes.

Growth, Size, Body Composition and Risk of Overweight and Obesity

The current review confirmed and expanded upon a central tenant of the 2015 Committee—excess weight gain is preventable by consuming a nutrient-dense, high-quality dietary pattern over time. Although treatment of obesity was beyond the scope of the reviewed questions, evidence regarding avoidance of excess weight gain is critical and essential to addressing dietary recommendations to reverse the epidemic of obesity appearing in the United States over the past 3 decades. Excess adiposity is driving an increase in other chronic diseases considered by the 2020 Committee. To address this public health epidemic, reducing the incidence and prevalence of overweight and obesity is critical at every stage of life to preserve ideal health. Dietary patterns that focus on nutrient-dense foods to prevent excessive weight gain starting in pregnancy, continuing through infancy and childhood, adolescence, and adulthood are of high public health relevance.

The dietary patterns considered in the Committee's review offer potential evidence of a key prevention strategy that could be combined with systems to support broader population adoption.

The Limited strength of evidence for the effect of dietary patterns on growth and body size in children in the current review was likewise reported in the 2015 Committee's review. This lack of scientific evidence represents a significant need and an opportunity to fill a major research gap needed to draw meaningful conclusions regarding the role of dietary patterns specifically tailored to this stage of life to prevent excess weight gain and preserve maintenance of a healthy weight over the life course.

Type 2 Diabetes

The role of weight and weight management in the prevention of type 2 diabetes is well established. Thus, the identification of evidence for consumption of a high-quality dietary pattern over time to reduce the risk of type 2 diabetes is expected. Indeed, the current literature review led to concurrence with the 2015 Committee in support of established healthy patterns in which the evidence extends beyond body weight benefits to reducing the risk of developing type 2 diabetes. The available evidence has 3 important limitations, however. First, while several PCSs demonstrated that improvement in weight status is a mediator of the association of high-quality dietary patterns with reduced risk of developing type 2 diabetes, the magnitude of effect both for weight-dependent and weight-independent effects of specific dietary patterns remains unclear. Second, the role of macronutrient distribution in the context of an overall healthy dietary pattern to reduce type 2 diabetes risk is unknown. The 2020 Committee recognizes the high level of interest in low-carbohydrate diets relative to a variety of health outcomes. However, studies that met the criteria for inclusion to address this question relative to type 2 diabetes risk reduction for either weight-dependent or weight-independent effects could not answer the question due to methodological limitations and inconsistent results. Third, the potential for benefit of a high-quality dietary pattern beginning early in life to reduce type 2 diabetes risk throughout adolescence into adulthood is unknown. This is a critical point because of the increasing incidence[512] and prevalence[513] of type 2 diabetes in youth.

Bone Health

The 2020 Committee's update of the 2015 systematic review on dietary patterns and bone health outcomes resulted in a strengthening of the evidence grade from Limited to Moderate. The Committee upgraded the evidence because of the consistency across studies in the direction and magnitude of effect of dietary patterns on bone health outcomes, in the outcomes evaluated (i.e., hip fracture), and how dietary intake was assessed. Notable differences with the

2015 Committee's conclusion include the addition of key foods and beverages that should be limited as a part of a dietary pattern associated with a low risk of fracture. Whereas the previous evidence for added sugars was less consistent, the 2020 Committee noted a consistent pattern of greater risk associated with larger intakes of added sugars in foods and beverages. A similar association was noted for higher intakes of processed meats. As a result, limited intakes of processed meats, sweets and sugar-sweetened beverages are now specifically noted in the 2020 Committee conclusion given the consistent association with a greater risk of fracture when larger amounts of these foods and beverages are consumed.

Although the consistency in evaluated outcomes was a strength of the reviewed literature, these observations do not limit the Committee's ability to express views more broadly beyond the outcome of hip fracture. Hip fracture is a major bone health outcome that is estimated to affect approximately 18 percent of women and 6 percent of men globally and to have significant negative societal effects.[514] However, it remains important to understand the influence of dietary patterns on outcomes that are proximal to hip fracture, including bone mineral density and risk for osteopenia and osteoporosis. Future Dietary Guidelines Advisory Committee reviews may be able to expand their reviews to these outcomes. Another limitation of the conclusions related to bone health in the 2020 assessment of dietary patterns was a lack of data in children, an important age to begin assessing and recommending optimum dietary patterns. An important note is the lack of RCT data and that understanding how dietary patterns modulates formation of peak bone mass in children and teens relies on PCSs and it is very hard to study bone development without longitudinal data starting in childhood.[515] As bone mineralization in children is vital for promoting bone strength in adulthood, it is important to study bone quality in childhood and adolescence with a focus on dietary patterns that provide optimum levels of essential minerals combined with dietary components that maximize absorption of these minerals.

Cancer

For colon and rectal cancer, the 2020 systematic review changed one recommendation from the previous 2015 Committee report. Alcohol was not consistently a part of the patterns found to be significantly associated with a lower risk of incident colorectal cancer and in some cases was part of patterns associated with increased risk. Thus, "moderate alcohol" was removed from the 2020 Committee conclusion statement. Otherwise the conclusions and grade of Moderate strength of evidence for the 2020 Committee were consistent with the 2015 Committee's conclusion statement. The systematic review conclusions for breast cancer (Moderate –

postmenopausal breast cancer; Limited – premenopausal breast cancer) and lung cancer (Limited) both concur with the 2015 Committee. The 2015 Committee review for prostate cancer was unable to establish a firm conclusion whereas the 2020 review found the additional available studies provided Limited evidence suggesting no relationship between dietary patterns and the risk of developing prostate cancer.

The Committee did not have time to address dietary patterns and pancreatic cancer, and liver cancer was not identified as a priority. Future Committees may prioritize liver cancer because non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH) are increasing in prevalence and linked to liver cancer risk. (Additional information about the prevalence of liver enzymes associated with underlying liver disease and inflammation can be found in ***Part D. Chapter 1: Current Intakes of Foods, Beverages and Nutrients***.) NAFLD and NASH now represent the most common liver diseases in high-income countries and are recognized as associated with metabolic co-morbidities that include type 2 diabetes, metabolic syndrome, and liver cancer.[516-518] NAFLD also is the most common liver disease in children worldwide.[518] Evidence also suggests racial and ethnic disparities regarding propensity to accumulate fat intra-abdominally and within the liver.[519] Three European professional associations addressing liver health, diabetes, and obesity, respectively, created joint clinical practice guidelines for the management of NAFLD that include diet and lifestyle changes. The European Joint Clinical Practice Guidelines[520] established the Mediterranean diet as the lifestyle modification of choice in the management of NAFLD. The dietary patterns identified by the 2020 Committee that were associated with reductions in risk for some cancers, CVD, and obesity could likely affect NAFLD through effects on intra-abdominal adipose tissue, which has greater metabolic activity than does subcutaneous adipose tissue because of a close proximity to the portal vein[521-523] and is associated with an increased risk of cardiometabolic diseases and certain malignancies, including liver and pancreatic cancer. The emerging research mandates a broader examination of dietary patterns and their effect on NAFLD, NASH, and liver and pancreatic cancers.

Neurocognitive Health

Evidence for relating dietary patterns to age-related cognitive impairment, such as dementia and Alzheimer’s disease, has expanded since release of the 2015 Committee’s report, with high-quality published observational studies. Compared to the 2015 NESR systematic review on dietary patterns and cognitive impairment, dementia, and Alzheimer’s disease, the current review included about the same number of articles (n=26) for a 6-year period (2014-2020) as the previous review (n=30) included from 1980 to 2014. With the near doubling of the literature base related to neurocognitive health and dietary patterns, the Committee was able to evaluate whether different conclusions could be drawn compared to the previous review. Ultimately, the Committee reached a similar conclusion as the 2015 Committee, identifying all of the same elements in the dietary pattern as previously delineated in the 2015 report as being associated with a lower risk of age-related cognitive impairment, dementia, and Alzheimer's disease. The notable addition in this update to that review is the inclusion of unsaturated vegetable oils as a part of the dietary pattern of intake. The inclusion of unsaturated vegetable oils is a result of the high representation of Mediterranean-style patterns in the included reviews where unsaturated vegetable oils, such as olive oil, are the primary sources of fat intake, and by contrast, many of the dietary patterns associated with a greater risk of cognitive decline included greater amounts of saturated fats and/or lower levels of unsaturated fats.

The Limited strength of evidence points to some ongoing challenges with the body of literature that remain since the prior review, when the evidence grade also was Limited. A primary challenge for an outcome that is likely influenced by multiple exposures over a long time trajectory is the limited assessment of dietary exposures. In many instances, dietary intake was assessed only once, with a very distant follow up to assess the outcome. This may not be representative of the typical dietary intake for the individual and contributes to increased risk of bias. Additionally, as more objective measures of cognitive function are developed and ways to link functional brain imaging to cognitive outcomes emerge, these types of outcomes should be linked to dietary intakes to increase precision and directness of the findings. Although this type of outcome assessment may be ideal, routine measures of neurocognitive functioning as assessed by questionnaires and surveys are likely to continue as the mainstay. Given this likelihood, higher levels of validation are needed, along with corresponding medical diagnoses that are often missing in current studies. This is particularly true in children, where a parent may be identifying a neurocognitive problem based on a few questions from non-validated questionnaires without a pediatrician's medical diagnosis.

Sarcopenia

With the increasing life expectancy of Americans over the past several decades, the problem of age-related loss of skeletal muscle mass and functional capacity is of intense public interest. Sarcopenia is accompanied by an increased risk of adverse outcomes and premature mortality.[524] Discussions regarding the role of diet continue in the scientific community, beginning with how to define and prevent sarcopenia and other closely related disorders characterized by subnormal levels of skeletal muscle mass and function.[525] The Committee considered a broad definition of sarcopenia as operationalized by the consensus statements of several working groups and included loss of skeletal muscle mass alone or in conjunction with either low muscle strength (e.g., handgrip strength) or low muscle performance (e.g., walking speed).

The Committee streamlined this question to focus only on the endpoint outcomes of sarcopenia and severe sarcopenia and not intermediate outcomes or on as-yet ill-defined conditions such as pediatric sarcopenia, pre-sarcopenia, or sarcopenic obesity. The review included outcomes in adults and older adults, but most evidence concentrated on older adults due to the prevalence of sarcopenia as an age-related disease. ***Part D. Chapter 1: Current Intakes of Foods, Beverages and Nutrients*** provides more detail on the incidence of reduced muscle strength and bone mass in the U.S. population. The literature on this topic is in a nascent stage with only 4 articles found for review, all prospective cohort designs. These investigations similarly involved diet that was assessed only once, at baseline in older participants, with no evidence of potential influence of dietary patterns earlier in life. This represents a major gap in our understanding regarding the role of diet over the life course as it may contribute risk for developing sarcopenia. This condition typically begins in mid-life and slowly progresses into the seventh and eighth decades. Accordingly, insufficient evidence was available to establish the relationship between dietary patterns and sarcopenia in older adults; thus, the strength of evidence was Grade Not Assignable. Future studies are encouraged that include multiple evaluation time points and study groups that are large and diverse with respect to sex and race and ethnicity, both of which are associated with variation in muscularity and the rate of skeletal muscle mass loss with age. RCTs that go beyond the few observational studies now available for review would help to strengthen future dietary recommendations for reducing the risk of developing sarcopenia.

All-Cause Mortality

This Committee is the first to examine the associations between self-reported dietary patterns and all-cause mortality. A vital question for Americans is whether there is an optimal pattern of food and beverage intakes over the lifespan that is associated with a long and healthy life. A review of more than 150 studies that met the criteria for review provided the Committee with compelling and consistent evidence linking consumption of specific dietary patterns with lower all-cause mortality in adults and older adults, resulting in a strength of evidence grade of Strong. These robust findings are supported by multiple analytic approaches, including index or score analysis, factor and cluster analysis, and multiple other methods. Studies were well-designed and conducted using rigorous methods, with most having low or moderate risk of bias across various domains despite being prospective cohort study designs.

The current efforts extend and strongly support the 2015 Committee's report, which noted that the 2014 NIH-AARP Diet and Health Study of 492,823 adults found high adherence scores on several indices (e.g., the HEI-2010, DASH)[11] were associated with a significantly lower risk of overall CVD and cancer mortality. These observations led the 2015 Committee to articulate the important concept that the dietary pattern approach as represented by multiple indices reflecting core tenets of a healthy diet may lower the risk of mortality outcomes. One year later, in 2015, the NIH-NCI Dietary Patterns Methods Project[1] reported that higher scores on independent high-quality diet patterns were associated with substantial reductions in mortality among adult cohorts.

The totality of the evidence reinforces recommendations supporting dietary patterns comprised of vegetables, fruits, legumes, nuts, whole grains, unsaturated vegetable oils, and fish, and lean meat or poultry (when meat is included). Such a dietary pattern is generally associated with a decreased risk of cardiovascular and all-cause mortality. When alcohol intake was considered in addition to the eating pattern, lower intake of alcohol was associated with a lower risk of cancer and all-cause mortality compared to higher intakes. These patterns associate with a variety of labels including, for example "Mediterranean" and "DASH," but generally have a common feature emphasizing plant-based foods as the core of the diet. This feature was typically present in studies that identified a beneficial dietary pattern for reducing the risk of all-cause mortality.

Another feature that was apparent across the range of studies and dietary patterns considered was the benefit of preferentially including nutrient-dense choices in the diet. The Committee viewed this feature as a marker of dietary quality, where higher quality choices within a food group or subgroup would tend to have lower amounts of added sugars, sodium, and solid fats while providing a major contribution toward meeting essential nutrients, including nutrients of concern. The effect of nutrient-dense choices was most apparent for meat, dairy, and sources of carbohydrates. When any of these foods were reported by study participants, nutrient density was enhanced and resulted in dietary patterns that were linked to a lower risk of all-cause mortality. Consistent with these findings, consumption of red and processed meats, high-fat dairy, and refined carbohydrates should be lower and fruits, vegetables, whole grains, legumes, nuts, lean meats, lower fat dairy foods, and fish and seafood are preferred choices.

Despite the high level of consistency regarding certain aspects of evaluated literature, several limitations of the Committee's review should be considered. Insufficient evidence was available to determine the relationship between dietary patterns and all-cause mortality in younger populations, particularly for those younger than around age 35 years. Evidence also was insufficient to determine the impact that race and ethnicity may have in the relationship between dietary patterns and all-cause mortality.

Diets Based on Macronutrient Distribution and Health Outcomes

The question of optimal macronutrient distribution in relation to health outcomes is of great public interest, as demonstrated by the plethora of books, print media, and Internet resources that address this topic, including diets that are low or very low in carbohydrate, high in fat, or promote higher intakes of protein. In an attempt to address this issue, the Committee reviewed studies where at least 1 macronutrient was outside the AMDR established by the National Academies of Sciences (e.g., the AMDR in adults is: protein, 10 to 35 percent; fat, 20 to 35 percent; carbohydrate, 45 to 65 percent of total energy intake). Articles needed to describe the entire macronutrient distribution of the diet by reporting the proportion of energy from carbohydrate, fat, and protein. The Committee established these criteria in order to examine the entire distribution of macronutrients in the diet, and not 1 macronutrient in isolation. These criteria allowed the Committee to both consider the relationships with health outcomes of consuming a diet with 1 macronutrient outside of the AMDR, and also how consumption of that macronutrient displaces or replaces intake of other macronutrients within the distribution. The Committee did not label the diets examined as "low" or "high," because no standard definition is currently available for "low-carbohydrate" or "high-fat" diets. Instead, the Committee focused on whether, and the extent to which, the proportions of the macronutrients were below or above the AMDR. Of note, the Committee was not charged with evaluating the evidence for dietary patterns to treat disease and the Committee excluded interventions designed to induce weight loss or treat overweight and obesity through energy-restriction/hypocaloric diets for the purposes of treating additional or other medical conditions. Its review was thus limited to consideration of macronutrient distribution in relation to reducing risk of overweight, obesity, and related health outcomes.

The resulting evaluation of the literature was ultimately unable to address the specific outcomes of type 2 diabetes; growth, size, body composition, and risk of overweight and obesity; sarcopenia; and all-cause mortality as framed by the Committee due to several issues with study designs. For CVD, the evidence was graded only as Limited. The available literature lacked consistency in defining macronutrient distributions such as “low carbohydrate” or “high protein” and most did not examine distributions at extreme ends of the ranges for multiple macronutrients. In many instances, these qualifiers were labelling macronutrient distributions that were within the AMDR. Studies assessed macronutrient distribution using various statistical methods. In several instances, all of the macronutrients of interest were outside of the AMDR, providing an inadequate comparator. Often, the variability in macronutrient proportions within and between distributions was limited and included only small deviations from the AMDR, providing insufficient contrasts of diet comparisons. The major challenge for the Committee was that included studies generally did not maintain the overall dietary pattern as constant, and as a result, the effect of differences in macronutrient distribution on outcomes could not be discerned from effects of diet quality and composition. This made directness difficult to assess across the body of evidence. Ideally, to adequately address the question of how differences in macronutrient distribution affect key health outcomes, studies should be designed to isolate the effects of macronutrients within the context of a constant dietary pattern. For example, it would be possible to compare the effect of a low carbohydrate (e.g., less than 25 percent of energy) to a moderate carbohydrate (i.e., within the AMDR) Mediterranean dietary pattern with specified foods and amounts, in an isocaloric design. Overall, particularly given the level of public interest, future research is essential to further the understanding of the effect of altering macronutrient distribution outside of the current AMDR beyond diets currently used to treat CVD, obesity, or type 2 diabetes.

Limitations and Challenges with Examining Children’s Dietary Patterns

A limited number of manuscripts met the systematic review criteria regarding dietary patterns in children. Validated diet assessment methodology is scarce and remains dependent upon the age and literacy level of the child as well as the need for adaptation of adult assessment methods to children’s food preferences, serving sizes, and variability.[526] Early feeding (birth to age 24 months) represents an important area of consideration.[527-530] The effects of maternal diet on human milk composition is discussed in ***Part D. Chapter 3: Food, Beverage, and Nutrient Consumption During Lactation***. As highlighted in ***Part D. Chapter 5: Foods and Beverages Consumed During Infancy and Toddlerhood***, evidence indicates that introducing peanut and egg in the first year of life (after age 4 months) may reduce the risk of food allergy to peanuts and eggs.[531] For other types of food allergy (to fish, shellfish, cow milk products, tree nuts, seeds, wheat, and soy), the evidence for such protective effects is less clear, but the Committee found no evidence that avoiding such foods in the first year of life is beneficial with regard to preventing food allergies or other atopic or allergic diseases. Recent guidelines from high-income countries are generally consistent in recommending that introduction of potentially allergenic foods should not be delayed beyond the first year of life.[532-534] Exposure to different tastes and textures of foods appears to be crucial in early stages to better develop a child's interest and willingness to consume and enjoy a variety of foods.[535,536] Moving forward, the influence of different dietary patterns on the health of the gut microbiome merits attention.[537-539]

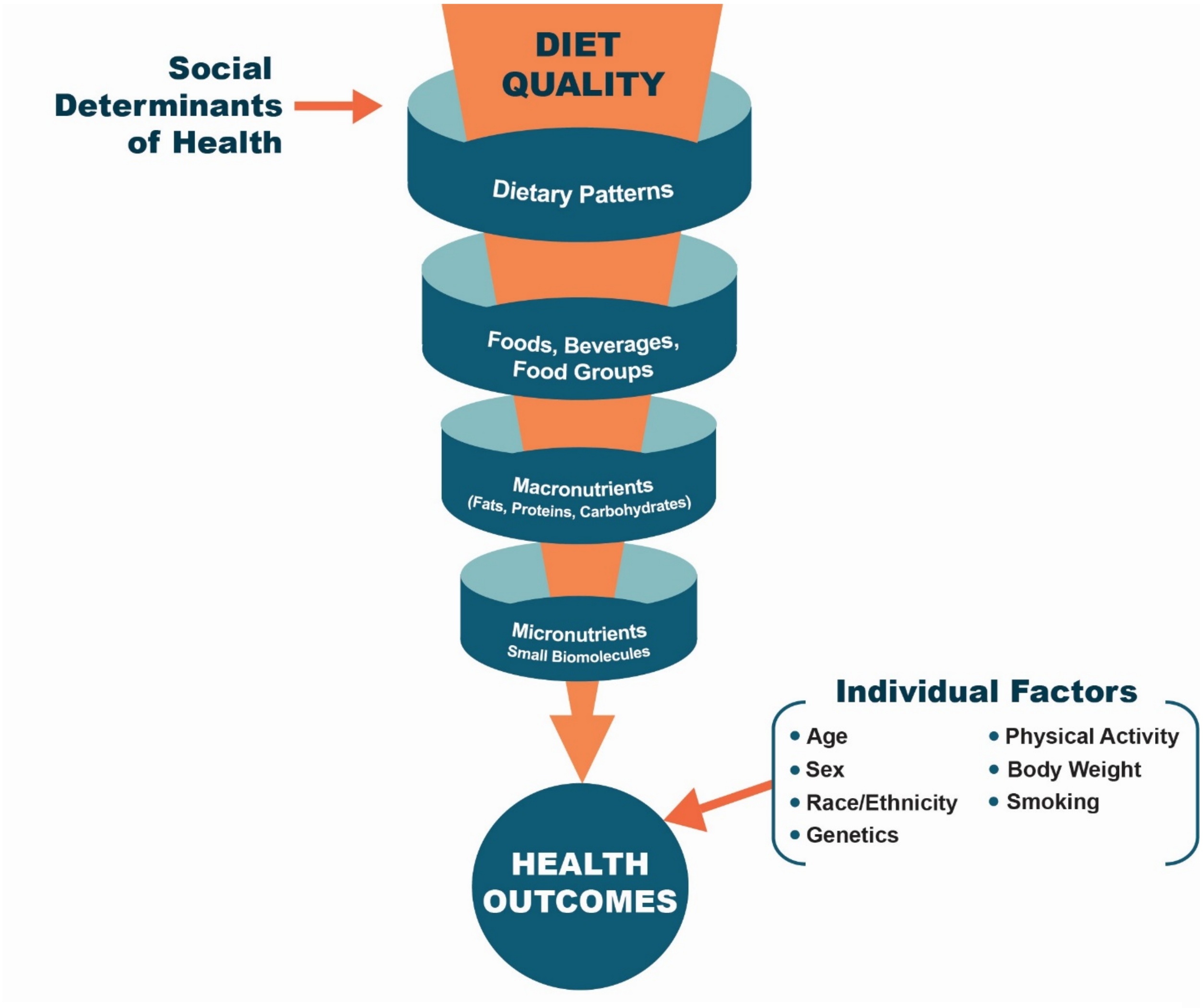
Limitations and Challenges with Assessing Dietary Patterns

Regarding dietary assessment methods (e.g., food frequency questionnaires), concerns have been raised regarding measurement error interfering with fully enumerating the association of dietary patterns with risk of disease. Biomarkers can provide objective information. To address this concern, intake biomarkers based on measures in urine, blood, or other biospecimens, and use of metabolomics to identify dietary patterns have been recommended.[540,541] Indeed, biomarkers of doubly-labeled water are useful for indirectly estimating energy intake.[542] Guillermo et al[543] examined the association of 4 a priori diet quality indexes with blood levels of lipid-soluble micronutrients and biomarkers of inflammation, lipid, and glucose metabolism among 910 men and women representing 5 ethnic groups. Multiple significant relationships confirmed associations between diet quality and nutrition-related biomarkers, supporting the idea of high-quality diets positively influencing biological pathways. Broadly adopting these research ideas may reduce bias and strengthen the important role the high-quality dietary exposures can play to positively influence health and disease. However, cooking methods, the mixture of food eaten together, or the context in which food is consumed are not captured with biomarkers, metabolomics, or doubly-labeled water.[526] Collection of dietary intakes along with biomarkers are needed to provide data on diet quality. For infants and children, age-appropriate and validated diet assessment methods (starting at birth and continuing forward as complementary foods and beverages are introduced) are lacking. Multiple caregivers who may or may not know what others have fed the child further confounds this problem. Potential use of mobile diet monitoring in children has yet to be fully explored. Promoting analytical progress, such as supporting efforts to automate collection of images either using active or passive methods should be encouraged. Using technology-based methods hold promise for more independent capture of foods and beverages among children ages 6 to 12 years[544] and across the lifespan.[545]

SUMMARY

People eat foods and drink beverages for many reasons, including, but certainly not limited to, nourishment. The quantities, proportions, variety or combination of different foods, drinks, and nutrients in diets and the frequency with which they are habitually consumed, constitute dietary patterns. These patterns, which can be characterized by mathematical approaches for research purposes, may vary in their beneficial effects on growth, development, reproduction, and aging. Dietary patterns' nutritional effects exert in vivo actions through each food type's content of macronutrients (e.g., protein, fat, and carbohydrate), micronutrients (e.g., vitamins, minerals), essential trace elements, plant-based phytochemicals and phytonutrients, and bioactive compounds.[8] Figure D8.1 depicts the connections between food patterns, individual food groups, nutrients at the molecular and elemental levels, and health outcomes.

Figure D8.1. Dietary patterns and health outcomes



This figure depicts the connection between dietary patterns and its component parts. It demonstrates how food, beverages, food groups, macronutrient and micronutrients are components of dietary patterns. Diet quality runs throughout each component of the pattern. As an individual adheres to a healthy dietary pattern, the pattern can play a protective role in health, and conversely, less healthy patterns can negatively influence health. The figure also recognizes that social determinants of health, such as food access, food security, settings and environments can play a role in influencing the diet quality of a dietary pattern. Additionally, individual factors also affect health outcomes.

The 2020 Committee examined these food patterns and macronutrient linkages as a means of answering 8 specific questions related to the broad areas of growth, development, and the risk of chronic metabolic, structural, neoplastic, and neurocognitive diseases. The Committee also examined, for the first time, the association between dietary patterns and all-cause mortality. The Committee's extensive review of published literature and the findings therefrom are summarized in Table D8.1 for 7 of the 8 questions; available data were inadequate for an analysis of dietary patterns and the risk of sarcopenia. The question of dietary patterns and the risk of developing cancer is summarized for 3 specific cancer types (breast, lung, and colorectal). A consistent dietary pattern associated with beneficial outcomes was present across all 7 of the reviewed questions for which grades of variable strength were assignable: higher intake of vegetables, fruits, legumes, whole grains, low- or non-fat dairy, lean meat and poultry, seafood, nuts and unsaturated vegetable oils, and low consumption of red and processed meats, sugar-sweetened foods and drinks, and refined grains. Dietary patterns associated with adverse or detrimental outcomes included higher intake of red and processed meats, sugar-sweetened foods and beverages, and refined grains. A notable new observation was an association of the main components of the aforementioned dietary pattern with lower all-cause mortality, a finding the Committee graded as Strong.

Collectively, these observations have major implications for recommending dietary patterns to the U.S. population. Although the patterns identified in Table D8.1 represent different named "diets" (e.g., DASH, Mediterranean), the Committee's review conveys a public health message reflecting key foods across studies that in common comprise a healthy diet that promotes optimum growth and development while minimizing risk factors underlying the onset of chronic diseases.

The Committee's in-depth scientific review identified limitations of the dietary pattern approach to assess the effect of diet on health outcomes and several important gaps in the available published literature. These limitations are advanced by the Committee as recommendations for future research and as suggestions for future Advisory Committees.

Nevertheless, these public health messages are vital, especially in an era undergoing an epidemic of non-communicable diseases, including obesity, type 2 diabetes, CVD, cancer, sarcopenia, and dementias, and that pose potential further immunological risks associated with infectious diseases as well. These chronic diseases often have their origins early in life, highlighting the importance of initiating and maintaining a healthy diet across the life course.

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